Physical activity and cognitive ability in older adults: the role of psychosocial factors

Physical activity and cognitive ability in older adults: the role of psychosocial factors

By

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Abstract

Dementia incidence is rising as our population is ageing. There is growing evidence for the protective effect of physical activity against cognitive decline. However, there are inconsistent results across studies despite the large number of high quality trials. The role of psychosocial factors on cognitive outcomes was investigated in the present thesis due to the evidence of their relationship with physical activity and for their effect on cognitive ability in other contexts. The psychosocial factors investigated were attitudes towards ageing, perceived control, mental health, and self-efficacy using cross-sectional studies and pilot randomised controlled exercise trials to test proof of concept. Study 1a found that more positive attitudes towards ageing were associated with better self-reported subjective and functional health. Perceived control mediated the effect of attitudes related to psychosocial loss with ageing and physical activity level mediated the effect of attitudes related to psychological growth with ageing on subjective health. Attitudes towards ageing mediated the effect of perceived control on functional health. Study 1b and 1c explored attitudes towards ageing in more detail and found that older adults' attitudes towards ageing were similarly negative to those held by young adults in the UK. A substantial proportion of attitudes reported by older adults related to physical functioning and cognitive ability. Attitudes towards ageing in China were more positive than those in the UK which suggested a potential relationship with socio-cultural and environmental factors and possible scope for attitude change from an intervention. A higher proportion of attitudes towards ageing reported in the UK were related to physical functioning and cognitive ability compared to China. These findings highlighted the potential for attitudes towards ageing and perceived control to play a role in the context of physical activity, cognitive ability and subjective health. Study 2a found that physical, social, and mental activities were independently associated with cognitive ability which informed the study design of exercises to include a pseudo control group that controlled for social interaction and mental stimulation. Study 2b found that mental health partially mediated the association between walking and cognitive ability. In older adults with better mental health, walking was not associated with cognitive ability. In older adults with poorer mental health walking was associated with better cognitive ability. Study 3 utilised available data from a pilot resistance training randomised controlled trial with middle-aged adults to test proof of concept for the role of psychosocial factors in this context. Preliminary evidence was provided for a potential association between improvements on some psychosocial factors and cognitive performance improvements. The associations of cognitive gains with psychosocial factors were independent to those of physical fitness improvements, which may indicate a potentially additive effect. Study 4 assessed the feasibility of the pilot randomised controlled trial of resistance training with older adults. Recruitment was successful but high drop-out rates lead to between group differences in age and baseline cognitive ability. Adaption of exercise to suit individual capabilities increased participation and adherence of those who completed the programmes was high. The limited usefulness of analysis by group was highlighted due to the large variation in response to exercise within groups on psychosocial and cognitive measures. Older participants were more likely to report a negative effect of resistance training on psychosocial measures, which indicated a potential confound on outcomes of exercise interventions with older adult populations. Preliminary analysis indicated that improvements on some psychosocial factors were associated with domain specific cognitive gains. This association could be due to a variety of mechanisms, such as meta-cognitive motivational processes, for example sustained effort and attention and the use of memory strategies. However, these findings need to be interpreted with caution due to the parallel change of variables, small sample size and feasibility and pilot nature of the interventions. There is a potential implication for the design of exercise programmes if they facilitate improvements in psychosocial factors as well as physical fitness, then this could enhance the effect of exercise on cognitive outcomes. Future research should replicate these studies with larger sample sizes to further understand the role of psychosocial factors in cognitive gains during exercise interventions in older adults.

Keywords: Physical activity, dementia, cognitive ability, ageing, older adults, exercise, psychosocial, self-efficacy, mental health, attitudes.

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Dedication

I would like to dedicate this work to my grandmothers,

Dorothy de Carteret and Gwen Stock

“We don't stop playing because we grow old; we grow old because we stop playing.”

- George Bernard Shaw

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Publications arising from the thesis

Peer-reviewed journal articles

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Hogervorst, E., Clifford, A., **Stock, J.,** Xin, X., Bandelow, S. (2012) Exercise to Prevent Cognitive Decline and Alzheimer's disease: For Whom, When, What, and (most importantly) How Much? Journal of Alzheimer's Disease and Parkinsonism, 2:e117.

Papers in preparation

Stock, J., Stevinson, C., & Hogervorst, E. (in prep) Attitudes towards ageing in the United Kingdom: a comparison between young and older adults.

Stock, J., Stevinson, C., & Hogervorst, E. (in prep) Attitudes toward ageing and self-reported health in older adults: a cross-sectional study

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Stock, J., Clifford, A., Stevinson, C., Bandelow, S., Ferguson, R., & Hogervorst, E. (in prep) A feasibility study and pilot randomised controlled trail of resistance training on cognitive performance in older adults: the role of psychosocial factors.

Stock, J., Clifford, A., Stevinson, C., Rahardjo, T.B., & Hogervorst, E. (in prep) The relationship between lifestyle activities and cognitive ability of older adults in Indonesia.

Stock, J., Stevinson, C., Rahardjo, T.B., & Hogervorst, E. (in prep) The role of mental health in the relationship between walking and cognitive ability in older adults in Indonesia.

Clifford, A., **Stock, J.,** Ferguson, R., Bandelow, S., Hogervorst, E. (in prep) Randomised controlled trial of home-based resistance and flexibility exercise on cognition in sedentary middle-aged women.

Book Chapters

Stock, J. & Hogervorst, E. (2014) Physical activity and cognitive ability in older adults: a psychosocial approach. In: Tanner, P. ed. *Dementia: Prevalence, Risk Factors and Management Strategies.* New York: Nova Publishers, pp. 59-85

Clifford, A., **Stock, J.,** Bandelow, S., Rahardjo, T.B. & Hogervorst, E. (2013). Alzheimer's Disease and Dementia: A Midlife Approach to Treatment is Needed. In: A.U. Rahman (Ed.). Frontiers in Clinical Drug Research - Alzheimer Disorders. E-book: Bentham Science Publishers. Chapter 6, vol 1.

Conference proceedings

Stock, J. Stevinson, C., Rahardjo, T., Hogervorst, E. Does emotional wellbeing explain the link between physical activity and cognitive decline in older adults? Health and Life Sciences Research School 3rd Research Student Conference, May 2013. Poster presentation

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Stock, J. Stevinson, C., Rahardjo, T., Hogervorst, E. Does improved mental health explain the link between physical activity and memory in older adults. Loughborough University "Research That Matters" Conference, March 2013. Poster presentation

Stock, J., Clifford, A., Bandelow, S., Hogervorst, E. Attitudes towards ageing, perceived control and physical activity to improve cognitive functioning: A pilot study. Scientific Abstracts proceedings of the World Congress of Active Ageing. Journal of Aging and Physical Activity. JAPA Volume 20, Supplement, August 2012, 20, S1 – S369. Poster presentation

Stock, J., Clifford, A., Ferguson, R., Bandelow, S., Hogervorst, E. Attitudes towards ageing, perceived control and physical activity to improve cognitive functioning. Health and Life Sciences Research School Second Annual Research Student Conference, Loughborough University. May 2012. Poster presentation

Stock, J., Clifford, A., Ferguson, R., Bandelow, S., Hogervorst, E. Attitudes towards ageing, perceived control and physical activity to improve cognitive functioning. School of Sport, Exercise and Health Sciences. Postgraduate Research Annual Conference, Loughborough University, March 2012. Poster presentation

Stock, J., Yesufu, A., Rahardjo, T., Hogervorst, E. Social and intellectual activities and cognitive functioning in older adults: An Indonesian cohort. Alzheimer's Research UK, Birmingham, UK, March 2012. Poster presentation

Stock, J., Rahardjo, T., Hogervorst, E. Attitudes to ageing across cultures and generations as mediators of successful ageing, Bali, Indonesia. October 2011. Poster presentation

Hogervorst, E. & **Stock, J.** Attitude Change Intervention to improve well-being in Elderly. API (Indonesian Psychogeriatric Association) April 2011. Makassar, Indonesia. Workshop

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Author's contribution to the thesis

Some of the studies included in the thesis were carried out as part of collaborations. The author's contributions to these studies are detailed below.

For Study 1b and 1c, the author was responsible for study design, participant recruitment, data collection, inputting, coding, sorting, and analysis of the young adult sample in the UK. Recruitment and data collection of the young adults from China were recruited by Professor Tri Budi, one of our collaborators from Universitas Indonesia and Professor Eef Hogervorst, during a visit to China. These data were translated and input by a native speaking research intern and checked by another native speaking Chinese PhD student in our research group. All of the data sorting, coding, and analysis was carried out by the author.

For Study 2, secondary data analysis was carried out by the author on data which was collected in 2006 and 2007 as part of the on-going collaboration between the Centre for Ageing at Universitas in Indonesia and Loughborough University. The author travelled to Indonesia for a one month field visit to continue this collaboration. The main purpose of the visit was to set up a new wave of data collection, this included: visiting new data collection sites; presenting to site managers; organising the translation of measures into Indonesian; training the local researchers; and assisting with pilot data collection. This data collection is ongoing and is therefore not included in the thesis.

For Study 3, the author set up the psychosocial factors arm in the pilot randomised controlled trial carried out by another PhD student (Angela Clifford, 2012). The author put together the psychological factors questionnaire pack, and carried out the data inputting, cleaning, and analysis for this arm. The author also assisted with cognitive data collection in this study.

The remainder of the studies (Study 1a and 4) included in this thesis were carried out by the author including: study design, application for ethical approval, data collection, data inputting and sorting, and data analyses.

Thesis Overview

Part One comprises two reviews of the extant literature. Chapter 1 is a general introduction to dementia and describes its symptoms, definitions and consequences. It explains the importance of investigating modifiable lifestyles interventions, such as physical activity to reduce the risk of dementia with the ageing population as there is currently no cure. The current evidence of the relationship between physical activity on cognitive ability is discussed. Chapter 2 discusses potential psychosocial mediators to explain the mixed findings across exercise intervention studies. A mediating model is suggested in relation to specific features of exercise interventions could impact on psychosocial factors and their subsequently impact on cognitive outcomes. The potential mediating mechanisms of attitudes towards ageing, perceived control, self-efficacy, and mental health in this context are discussed. Chapter 3 presents the overall aims of the present thesis and specific aims of each study in the context of gaps in the current literature.

Attitudes towards ageing were identified as a potential psychosocial mediator in the relationship between physical activity and cognitive ability in older adults in the literature review (Chapter 2). Part Two of the present thesis describes Study 1, which explored attitudes towards ageing in more depth. Study 1 investigated several research questions and is therefore is presented as 1a, 1b, and 1c to distinguish between them.

Study 1a investigated the relationship of attitudes towards ageing in older adults with their self-reported health and level of physical activity in cross-sectional data. The findings suggested that older adults' attitudes towards ageing were related to level of physical activity and self-reported health. Therefore, Study 1b and 1c explored attitudes towards ageing across age groups and cultures to gain insight into how and when they may be formed to indicate whether they may be amendable to change through intervention. Attitudes were captured using a free responses question so that they were not limited to specific domains or categories. Study 1b explored the content of attitudes towards ageing amongst young and older adults in the UK. The findings indicated that a substantial proportion of attitudes captured were related to physical functioning and cognitive ability. Thus, indicating potential scope for the role of attitudes towards ageing in an exercise intervention aiming to improve cognitive ability. Additionally, the findings indicated that the attitudes towards ageing held by young and older adults in the UK were similarly negative. This consistency indicated a lack of “in-group” preference for older adults and could indicate the effect of sociocultural factors on attitudes formation when younger and on maintaining attitudes when growing older. Study 1c explored attitudes towards ageing between cultures to investigate the relationship with the sociocultural environment. The findings indicated that attitudes towards ageing in China compared to the UK were more positive, focused more on internal qualities and reflect older adults as more active. This suggested that the environment may shape attitudes towards ageing. The findings also indicated that a much larger proportion of attitudes towards ageing reported in the UK were related to physical functioning compared to in the China. This suggests potential scope for attitudes towards ageing to play a role in outcome mechanisms exercise interventions in the UK and thus need to be investigated further.

Part Three describes Study 2 which includes two sets of secondary data analysis carried out on an available cross-sectional dataset. Two research questions were investigated which are presented as separate papers and thus named Study 2a and Study 2b. Study 2a investigated the relationship between walking, social, and intellectual activities and cognitive ability in older adults in Indonesia. The findings indicated that social and intellectual activities were independently associated with cognitive ability and therefore highlighted the importance of controlling for the social and mental stimulation of physical activity in interventions which aim to improve cognitive performance. These findings fed into the design of the feasibility and pilot randomised controlled trials included in the present thesis (Study 3 and Study 4) in relation to the pseudo control group who carried out gentle flexibility exercises to control for social interaction and mental stimulation. Study 2b investigated the potential mediating role of mental health in the relationship between walking and cognitive ability in older adults. The findings suggested that mental health partially mediated the effect of walking on cognitive outcomes. In those with better mental health, walking was not associated with cognitive ability. In those with poorer mental health, walking was associated with better cognitive ability. Additionally, mental health was independently associated with global cognitive ability and verbal learning. The results suggested a potential domain specific relationship of mental health with more complex cognitive outcomes. However, causal directions cannot be inferred from this cross-sectional data.

Part Four describes two pilot randomised controlled trials (RCTs) which investigated the role of psychosocial factors experimentally. Study 3 exploited available data (Clifford, 2012) which investigated the effect of resistance training on cognitive performance with middle-aged adults. The purpose of this analysis of secondary data was to test proof of concept to provide preliminary evidence of an association between changes in cognitive and psychosocial variables during the intervention to inform future study design and justify the use of resources for a feasibility study in older adults which would be labour intensive. As a result of the preliminary proof of concept evidence from Study 3, a resistance training intervention was carried out with older adults which is described in Study 4. The primary aim of Study 4 was to assess the feasibility of the exercise programmes utilised in Study 3 with older adults. The secondary aim was to explore whether there was a potential association between change in psychosocial factors and change in cognitive outcome measures in older adults. An additional secondary aim was to give an indication of whether the role of psychosocial factors may be specific to certain domains of cognitive ability. Based on the feasibility nature of Study 4 and thus small sample size, the findings related to the secondary aims need to be interpreted with caution but do indicate the need for further research.

PART ONE

Literature Review

Part One Overview

Part One comprises two reviews of the literature. Chapter 1 is a general introduction to dementia and describes its symptoms, definitions and consequences. It explains the importance of investigating lifestyles interventions, such as physical activity to reduce the risk of dementia with the ageing population as there is currently no cure. The current evidence of the relationship between physical activity on cognitive ability in discussed. Chapter 2 presents potential psychosocial mediators to explain the mixed findings across exercise intervention studies. A mediating model is suggested in terms of how specific features of exercise interventions could impact on psychosocial factors and their subsequently impact on cognitive outcomes. The potential mediating mechanisms of attitudes towards ageing, perceived control, self-efficacy, and mental health in this context are discussed. Chapter 3 presents the overall aims of the present thesis and specific aims of each study in the context of gaps in the current literature.

Chapter 1: General Introduction

A version of this chapter was published in 2014:

Stock, J. & Hogervorst, E. (2014) Physical activity and cognitive ability in older adults: a psychosocial approach. In: Tanner, P. ed. *Dementia: Prevalence, Risk Factors and Management Strategies.* New York: Nova Publishers, pp. 59-85

Ageing population

The world population is ageing. In the United Kingdom, it is estimated that the number of people aged 60 or over will rise by more than 50% in the next 25 years and will exceed 20 million by 2031 (Office for National Statistics, 2009). It is projected that the number of people aged 80 and above will more than double by mid-2037, and that the number of people aged 90 and above will more than triple. This equates to one in 12 of the population being 80 and above by mid-2037 (Office for National Statistics, 2013). Ageing is associated with an increased risk of a range of diseases and conditions, including cognitive impairment and dementia (Launer & Hofman, 1992; Solfrizzi et al., 2004).

Dementia incidence

In the UK in 2010, there were estimated to be over 820,000 older adults afflicted with late onset dementia (Luengo-Fernandez, Leal, & Gray, 2010). This is expected to rise to one million by 2025 and to exceed 1.7 million by 2051 (Alzheimer's Society, 2007). Dementia affects one in six people over 80 years old and one in three over 95 years old. It is estimated that one in three people over 65 years old will die with a form of dementia (Alzheimer's Society, 2007). The economic costs of dementia in the UK are estimated to be £23 billion per year, which is approximately twice as much as cancer (Luengo-Fernandez et al., 2010). This includes the cost of providing health and social care, as well the reduction or loss of income of people with dementia and their caregivers. There are estimated to be 600,000 individuals in the UK acting as the main carers for individuals with dementia (Age UK, 2012). Caring for someone with dementia can have a profound impact on the caregiver's health and wellbeing, as evidence has demonstrated that caregivers suffer from higher rates of depression and anxiety, and show negative immunological changes compared to controls (Kiecolt-Glaser, Dura, Speicher, Trask, & Glaser, 1991; Schulz, O'Brien, Bookwala, & Fleissner, 1995; Richard

Schulz & Martire, 2004). Dementia is also one of the main causes of disability in later life, ahead of some cancers, stroke, and cardiovascular disease (Department of Health, 2009). Older adults are more likely to have multiple health conditions, however, dementia has a disproportionate impact on individuals' capacity for independent living (Alzheimer's Society, 2007).

Cognitive decline and dementia

Three types of cognitive decline associated with ageing have been recognised from a clinical and investigational perspective: age associated memory impairment (AAMI), mild cognitive impairment (MCI) and dementia. Their definitions and the distinctions between them have been discussed (Fillit et al., 2002). AAMI attempts to describe cognitive decline that would be expected to occur with "normal ageing" and has also been called age-related cognitive decline and cognitive impairment-no dementia. Generally, individuals experiencing AAMI have subjective memory complaints but have normal scores on objective cognitive tests for their age group (Crook, Bartus, & Ferris, 1986). Less than 1% go on to develop dementia. Individuals suffering from MCI also experience subjective memory complaints, but score lower than is expected for their age on some objective cognitive tests (1.5 standard deviations below age adjusted mean; Petersen, 1999). MCI can, in some cases, be a prodromal stage of dementia as between six and 31% of individuals with MCI develop dementia each year (Bruscoli & Lovestone, 2004). The reliability of these definitions of cognitive decline and their clinical use have been debated (Petersen, 2004; Petersen et al., 2001; Smith et al., 1991) which has been reflected in recent changes to diagnostic classifications.

The most recent Diagnostic and Statistical Manual (DSM-V) reclassified dementia under 'Neurocognitive Disorders' to distinguish diseases, such as Alzheimer's disease from psychiatric disorders that display cognitive impairment as a symptom rather than a defining feature, such as schizophrenia or depression (American Psychiatric Association, 2013). The terms mild and major neurocognitive disorders have been introduced with a distinction between them. Mild neurocognitive disorder (more widely known as MCI) is indicated by decline in one or more cognitive domains, while the individual can maintain their independence. These cognitive domains include memory loss, attention, executive function, language, and visuospatial, visuoperceptual, or social cognition. Major neurocognitive disorder (more widely known as dementia) is indicated by decline in two or more cognitive domains, which impacts on individuals' capacity for independent living. Evidence of objective decline in memory or learning is required to assign a specific diagnosis of Alzheimer's disease.

There are several types of dementia, which vary in aetiologies, symptoms and progression. Some types of dementia can be halted or potentially reversed by addressing the cause. For example, alcoholism, vitamin deficiencies, endocrine disease, electrolyte imbalance, and lead intoxication (Ghosh, 2010). Other types of dementia cannot be reversed and are progressive, with sufferers showing cognitive decline until death. The most common type of dementia is Alzheimer's disease followed by Vascular dementia which account for approximately 62% and 27% of all cases of dementia, respectively (Alzheimer's Society, 2007). Other less common forms of non-reversible dementia include Lewy Body dementia, Frontotemporal dementia, dementia with Parkinson's disease and Creutzfeldt-Jakob disease (Thies, Bleiler, & Alzheimer's Association, 2013).

By definition, dementia impacts on activities of daily living which can lead to disability and a loss of independence. Cognitive impairment can impact on activities of daily living before dementia is diagnosed (i.e. during a prodromal stage). Functional impairment at baseline was found to be predictive of dementia incidence 3 years later and an increase in level of dependence between baseline and 3-year follow-up was found to predict dementia incidence at 5-year follow-up (Barberger-Gateau, Fabrigoule, Helmer, Rouch, & Dartigues, 1999). Activities which were found to be correlated with cognitive impairment independent of age, sex, and education were: telephone use, use of means of transportation, responsibility for medication intake and handling finances (Pascale Barberger-Gateau et al., 1992). Worldwide projections estimate that if the onset of Alzheimer's disease specifically could be delayed by just one year, by 2050 there would be 9.2 million fewer cases. In the UK, delaying the onset of dementia by five years would reduce deaths directly attributable to dementia by 30,000 a year (Alzheimer's Society, 2007). Therefore, interventions which only modestly delay the onset would have a major impact on public health. For example, reducing the number of individuals needing a high level of care, such as residential placement (Brookmeyer, Johnson, Ziegler-Graham, & Arrighi, 2007).

Clare (2007) discussed different conceptual frameworks for understanding dementia. Traditionally, a medical or disease model (Roth 1994) had been used as the 'standard paradigm' for understanding dementia (Kitwood, 1997). This model focuses on causal mechanisms that lead to neuropathological changes that are associated with dementia. For example, such changes associated with Alzheimer's disease include neuronal atrophy in the medial temporal lobe (an area of the brain thought to be associated with memory) and an increase in amyloid-β plaques and tau tangles (Dubois, Feldman, & Jacova, 2007). Investigating dementia using this model has resulted in important advances in our understanding. However, other findings have indicated that the causal mechanisms are not straightforward. For example, amyloid-β plaques and tau tangles have been found in individuals with no cognitive impairments and conversely, in other individuals displaying the cognitive symptoms of Alzheimer's disease were found to have no observable abnormal neuropathology at post mortem (Snowdon, 2003). There has been controversial debate about whether Amyloid-β plaques are a cause or consequence of Alzheimer's disease, especially as research into pharmacological treatments targeting these plaques have been relatively unsuccessful to date (Johnson & Johnson, 2012; Lilly, 2010). The genetic risk of developing Alzheimer's disease is also not straight forward. The Apolipoprotein E epsilon 4 allele (APOE ε4) has been identified as a major risk factor for Alzheimer's disease (Ahn Jo et al., 2006) and is associated with amyloid-β plaque formation (Carter, 2005). However, not all individuals who have this allele go on to develop Alzheimer's disease and not all individuals who develop Alzheimer's disease have this allele (Henderson et al., 1995).

Possible explanations for the inconsistencies in pathological causal mechanisms and cognitive outcomes have been discussed (Clare, 2007). For example, the "cognitive reserve hypothesis" (Stern, 2002) proposes that a higher level of education, a wider social network and being more physically and mentally active is protective against the effects of Alzheimer's disease pathology (Scarmeas & Stern, 2003). The traditional disease model of dementia also does not explain periods where cognitive ability improves or stabilises after social or environmental changes (Langer & Rodin, 1976; Rodin & Langer, 1977; Sixsmith, Stilwell, & Copeland, 1993; Sixsmith, Stilwell, & Copeland, 1993) or when it rapidly declines following hospitalisation (Kitwood, 1996).

An alternative model was proposed incorporating a biopsychosocial approach (Figure 1.1; Clare, 2007; Kitwood, 1997) in which the emphasis is on the interactions between biological and psychosocial variables. Kitwood (1997) postulated that events or states experienced at the mind or psychological level are also brain events or states.

In addition to brain structure affecting experience, psychological states can also affect the brain structure. The brain develops in reaction to experience and the environment throughout life and there is evidence for the potential for change in the brain (experience-dependent plasticity) of older adults (e.g. Cabeza, Anderson, Locantore, & McIntosh, 2002). This experience-dependent plasticity has been demonstrated in a randomised control trial (RCT) of exercise training in older adults, whereby the aerobic exercise group increased functional connectivity between brain networks central to dysfunction in ageing, compared to the non-aerobic control group (Voss et al., 2010). Thus, Kitwood suggested that the environment and the interactions and behaviours that it facilitates, can have positive or negative effects on cognitive ability and functional health. For example, Kitwood hypothesised that a benign social psychology together with an enriched environment could facilitate some regeneration or at least the maintenance of function. In contrast, a malignant social environment could contribute to excess disability and speed up decline.

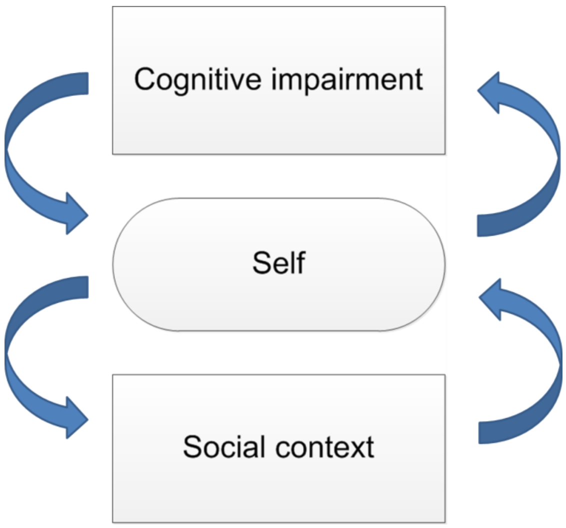

Figure 1.1 A biopsychosocial model of cognitive decline (adapted from Clare, 2007, based on Kitwood, 1997).

Direct physiological mechanisms of improved cognitive ability after physical activity have been investigated. This have included: a reduction in blood lipids and lowering of blood pressure (Leon & Sanchez, 2001), increased cerebral blood flow (Brown et al., 2010), improved vascular output and cerebral perfusion (Bonner & Cousins, 1996) and encouraging neurogenesis through increases in Insulin-Like Growth Factor-1 which induces Brain-Derived Neurotrophic Factor (Bothwell, 1995; Nakajima, Ohsawa, Ohta, Ohno, & Mikami, 2010; Van Praag, Kempermann, & Gage, 1999; Zhao, Deng, & Gage, 2008). However, the evidence of the beneficial effect of cognitive stimulation on cognitive ability and quality of life (Woods, Aguirre, Spector, & Orrell, 2012) demonstrates that these physiological mechanisms may not be necessary to bring about positive effects. In addition, the effect of physical activity on cognitive ability does not appear to follow the same dose-response pattern that it does for physical health benefits which you might expect if the physical exercise itself was driving the effect. This suggests that there are other contributing factors.

The evidence discussed thus far acknowledges that dementia involves changes at the biological, psychological, and social levels and is also experienced within the social context with associated cultural beliefs and practices (Downs, Clare, & Anderson, 2008), therefore a biopsychosocial model for understanding dementia is appropriate (World Health Organization, 2001). The evidence presented here together with the biopsychosocial model highlight the potential scope for the effectiveness of lifestyle interventions targeting modifiable risk factors for dementia.

Modifiable risk factors for cognitive decline: Physical activity

As there is currently no cure for dementia, modifiable lifestyle behaviours, such as physical activity, have been investigated as a preventative strategy for delaying the onset of dementia and thus prolonging independent living (e.g. Angevaren, Aufdemkampe, Verhaar, Aleman, & Vanhees, 2008; Clifford, Bandelow, & Hogervorst, 2009; Colcombe & Kramer, 2003; Lautenschlager, Cox, Cyarto, Gold, & Keller, 2012; Sofi et al., 2010). Physical activity can be defined as any movement of the body by skeletal muscles, which results in energy expenditure and which has a positive correlation with physical fitness (Biddle & Mutrie, 2007; Bouchard & Shephard, 1994; Caspersen, Powell, & Christenson, 1985). Exercise is a subcategory of physical activity which is distinct by its planned and structured nature and involves repetitive bodily movement. It is also highly positively correlated with physical fitness, as the main objective of exercise is to improve or maintain fitness, to improve performance or for health enhancement. Reference to physical activity in the present thesis therefore also includes exercise, and it will only be distinguished between the two where appropriate.

The health benefits of physical activity have been widely demonstrated, including reduced morbidity of numerous health conditions and mortality rates. Moderately vigorous physical activity is associated with increased functional status, measured as the ability to carry out instrumental activities of daily living (Gu et al., 2009). The evidence for exercise and physical activity to improve cardiovascular health is well documented (Warburton, Nicol, & Bredin, 2006). Modifiable risk factors for cardiovascular disease overlap with those of dementia (Kivipelto et al., 2005), thus the scope for physical activity to act on cognitive ability has been the focus of much recent research (e.g. Angevaren, Aufdemkampe, Verhaar, Aleman, & Vanhees, 2008; Clifford, Bandelow, & Hogervorst, 2010; Hogervorst, Clifford, Stock, Xin, & Bandelow, 2012). Physical activity is accessible by almost everyone and is also low-cost and low-tech thus increasing the potential for widespread participation. Effective lifestyle behaviours for reducing dementia risk could be especially important in developing countries where access to healthcare may be limited. Furthermore, physical activity is a targetable risk factor in older adults as they are often inactive and spend much of their time engaging in sedentary behaviours, with the majority of older adults in the UK currently not meeting the minimum level of activity necessary to achieve health benefits (Age UK, 2012).

The physical activity guidelines in the UK recommend that older adults (65+ years old) should aim to be active every day (Bull & the Expert Working Groups, 2010; Nelson et al., 2007). This should add up to at least 150 minutes of moderate-intensity or 75 minutes vigorous-intensity aerobic activity every week. Examples of moderate intensity activities include walking fast, pushing a lawn mower, ballroom dancing, and water aerobics. Examples of vigorous-intensity activities include jogging, swimming fast, playing singles tennis, and playing football. It is recommended that bouts of exercise are at least 10 minutes, for example, 30 minutes on at least five days per week. In addition, older adults should carry out muscle strengthening activities on two or more days a week that work all major muscle groups (hips, legs, back, abdomen, chest, arms and shoulders). Examples of these activities include carrying heavy groceries, heavy gardening like digging, yoga and lifting weights. Older adults are also recommended to minimise being sedentary for extended periods (e.g. sitting). Those at risk of falls should also carry out activities which improve balance and coordination on at least two days per week, for example, T'ai Chi and yoga. It is further recommended that these guidelines should be interpreted within individual physical and mental capabilities. Carrying out some physical activity is better than none, and higher levels of physical activity provide greater health benefits. It is estimated that only 19% of 65-74 year olds and 7% of those 75+ years in the UK say that they meet this level (Age UK, 2012).

The term physical fitness has occasionally been used of instead of physical activity in the context of improving cognitive abilities or delaying the onset of dementia.

Physical fitness refers to a physiological state of wellbeing which represents an individual's capacity to meet the demands of daily living, or which provides the basis for performance in sport, or both. Health-related fitness relates to cardiovascular fitness, musculoskeletal fitness, body composition, and metabolism (Warburton et al., 2006). Physical fitness (assessed using objective measures) has been considered to capture physical activity more accurately than self-reports (Williams, 2001). However, the assessment of physical fitness is not practical in large population based investigations. Nonetheless, self-reports of physical activity are still strong predictors of mortality (Blair & Brodney, 1999) and provide irrefutable evidence for its preventative effect on numerous chronic diseases. These include cardiovascular disease, diabetes, hypertension, cancer, obesity, depression and osteoporosis (Warburton et al., 2006). Interestingly, these physical activity related improvements in health status can occur without improvements in aerobic fitness (Nelson et al., 2007). There has been a shift in research focus to also include the health benefits of improving musculoskeletal fitness, which is associated with an improvement in overall health status and a reduction in chronic disease risk and disability (Warburton, Gledhill, & Quinney, 2001a, 2001b).

Levels of physical fitness (aerobic power, strength, flexibility and functional capacity) and physical activity both decline with age. The extent to which this is a biological process or due to physical inactivity has been discussed in the extant literature. It was found that age related changes in the cardiovascular system can be exacerbated by physical inactivity but can also be reversed by increasing levels of physical activity (Taylor et al., 2004). Age-related muscle weakening was not found to be prevented by aerobic exercise (Harridge, Magnusson, & Saltin, 1997). However, regular resistance exercise is effective in increasing muscle mass and strength, even in very old age (Rogers & Evans, 1993). This evidence demonstrates the positive effects of physical activity for maintaining and improving physical functioning into later life which would also help to prolong independent living. As cognitive decline also contributes substantially to risk of disability and dependence (Warburton et al., 2006), and due to the overlap in risk factors of cardiovascular disease and dementia, the scope for physical activity to reduce dementia risk has been investigated. However, this relationship is less clearly understood.

Evidence for the effect of physical activity on cognitive ability and dementia

Numerous systematic reviews and meta-analyses have been carried out to examine the effect of physical activity on cognitive ability or dementia incidence. It has been highlighted that in spite of the hundreds of studies that have been carried out to further our understanding of this relationship, reviewing the literature is challenging due to the variety of ways it has been investigated (Clifford et al., 2009; Etnier & Labban, 2012; Hogervorst et al., 2012). Variations include the study design, measurements of physical activity (objective and subjective), outcome measures (cognitive tests across domains and dementia risk), specific exercise components (types, intensity, frequency, and duration), and sample populations (different age groups with or without cognitive impairment). There is also evidence to suggest that the effect of physical activity on cognitive ability may not be the same for everyone and that some individuals may benefit more than others. Such moderating factors include age, gender, genetic status, and baseline cognitive status. The present thesis is concerned with the chronic, rather than acute, effects of exercise and physical activity, as this reflects the potential for maintaining cognitive ability over time with increasing age, to delay the onset of dementia, and thus prolong independent living.

Study designs used to examine the evidence for physical activity's effect on cognitive ability vary from cross-sectional observational or prospective cohort data to acute or chronic exercise interventions, and these are discussed below.

Cross-sectional studies

Cross-sectional and observational studies tend to rely on self-report questionnaires of physical activity or exercise and an assessment of cognitive performance on a selection of tests or dementia diagnosis (frequently Alzheimer's disease or vascular dementia). Cross-sectional studies also have tended to examine associations between physical activity and cognitive performance assessed at the same time. A systematic review revealed a variety of results from cross-sectional studies with cognitive performance as an outcome measure: seven studies found a beneficial effect of exercise across all cognitive tests administered, eight found a beneficial effect on some cognitive tests but not others, and one study of very healthy older adults found no beneficial effect (Clifford et al., 2009). No studies found an association between physical activity and lower levels of cognitive abilities.

Prospective Studies

Prospective studies tend to measure baseline self-reported frequency of participation in specific physical activities (e.g. swimming or walking) of healthy middle-age to older adults and level of cognitive decline or dementia status between two to nine years later (Kramer & Erickson, 2007a). Dementia status is usually classified as cognitive impairment, Alzheimer's disease, vascular dementia or dementia as one group.

Overall the prospective evidence is consistent with a small and positive beneficial effect of physical activity on cognitive ability and risk of dementia in older adults. This evidence is based on numerous studies which often included large numbers of participants; for example, the Honolulu-Asia Ageing Study (N > 2000; Abbott, White, Ross, Masaki, & Petrovitch, 2004; Taaffe et al., 2008), the Nurse's Health Study (N > 16,000; Weuve et al., 2004), and the Whitehall II Study (N > 6000; Singh-Manoux, Hillsdon, Brunner, & Marmot, 2005). One review investigating the effect of physical activity on longitudinal cognitive decline found that older adults participating in physical activity showed less cognitive decline over two to ten-year follow up periods (Bherer, Erickson, & Liu-Ambrose, 2013). A review of prospective studies investigating dementia risk found pooled relative risk of 0.72 for dementia and 0.55 for Alzheimer's disease for inactive individuals (Hamer & Chida, 2009). Another review looking at reduction of dementia risk found mixed results, with a reduction of 31% to 88% in dementia risk in those with higher levels of physical activity in five out of the 13 included studies (for Alzheimer's disease and vascular dementia). Four studies found a reduced risk in certain types of dementia only in individuals who exercised, while the remaining four studies found no reduced risk of dementia (Clifford et al., 2009). This may be indicative of a selective effect of physical activity as protective against only some types of dementia. However, it was suggested that the lack of effect in some studies could be attributed to methodological limitations, for example, the small numbers of participants with vascular dementia and other less common types of dementia.

Physical activity measurement in cross-sectional and observational studies

Another methodological limitation of observational studies (both cross-sectional and prospective) is the reliance on self-report questionnaires to capture the level of physical activity that participants engage in. Self-report questionnaires are relatively cheap compared to objective measures of physical activity (e.g. pedometers or accelerometers), which allows data to be collected from a large number of participants. Unfortunately, this is at the expense of accuracy and reliability (Shephard, 2003). Self-report questionnaires rely on participants' ability to accurately estimate and recall levels of physical activity. Self-report in sample populations with cognitive decline is by definition unreliable (Clifford et al., 2009). There is a conceptual discrepancy when discussing the protective effect of physical activity on cognitive decline, as the specific types of physical activities are not standardised across studies. Some studies asked participants to self-report on a few specific physical activities, for example, only walking (e.g. Weuve et al., 2004; Yaffe, Barnes, Nevitt, Lui, & Covinsky, 2001) or only athletic activities (e.g. Lindwall, Rennemark, & Berggren, 2008), which do not represent the overall level of physical activity. Some studies have captured a range of physical activities, however what participants themselves consider "physical activities" may vary. Exercise specifically may be considered a physical activity, but not housework or gardening, despite the prolonged standing periods and lifting heavy loads in the latter, as the bodily movements are incidental from the purpose of the activity. A questionnaire specifically designed to measure participation in exercise and physical training also did not include gardening or household chores (Roth & Goode, 2003). The validity of physical activity measures for accurately capturing levels of physical activity is questionable and different measures used also makes comparisons between studies difficult. The small number of studies that captured a range of physical activities limits the recommendations for which specific physical activities are the most effective for reducing cognitive decline or risk of dementia. Additionally, limited reliability has been seen in the correlations on the same exercise questionnaire administered in the same group of participants on two separate occasions, which varied by 0.47 for light intensity exercise, 0.5 for moderate exercise, and 0.33 for vigorous exercise (Geda et al., 2010). In summary, there is disparity of definitions and variation in ways that frequency and intensity of physical activity has been captured and this makes comparison of findings between studies difficult (Miller, Taler, Davidson, & Messier, 2012).

Some studies assessed physical fitness, e.g. physical function or cardio-fitness in addition to (or instead of) level of physical activity, with the aim of capturing a reflection of physical fitness as a result of overall physical activity carried out by individuals. The Honolulu Asia Aging study longitudinal cohort study (Abbott et al., 2004) demonstrated an association between physical activity and reduced risk of cognitive decline in physically fit elderly Hawaiian men of Japanese descent (between 73 and 91 years old). A much higher correlation was found between walking and lower cognitive decline than with physical function (balance assessment and time taken to walk 10 feet) suggesting that participation itself may be important (Taaffe et al., 2008). This suggests that other components of physical activity, such as mental stimulation or psychosocial factors, may play a part in the protective mechanisms of physical activity on cognitive decline (Miller et al., 2012).

The trajectory of decreases in physical activity rather than just physical activity at baseline can also give more insight into the relationship. In the European FINE study, 295 men gave self-report details of physical activity and were assessed using the Mini Mental State Examination (MMSE) at baseline and at a 10 year follow up. Duration of physical activity at baseline did not predict cognitive decline. However, there was 2.6 times more cognitive decline in those who decreased in physical activity (>60 min/day) over the 10 years compared to those who maintained it. Lowest intensity quartile physical activity at baseline was associated with a 1.8 times cognitive decline compared to other quartiles. However, a decrease in intensity over the 10 years was associated with a 3.6 times larger cognitive decline compared to those that maintained it (Van Gelder, Tijhuis, & Kalmijn, 2004). Although this study appears to suggest a causal direction of this relationship, it is still limited in its explanatory power. For example, lower levels of physical activity may be a consequence rather than a cause of cognitive decline due to the cognitive abilities (and personal confidence) required to participate in physical activity (Bielak, 2010). It may be that these individuals are experiencing prodromal cognitive changes which are affecting their participation in activities prior to detectable cognitive decline.

Limitations of observational studies

Physical activity is often related to other lifestyle choices and medical conditions, such as alcohol consumption, smoking, and obesity. For example, recent evidence suggests that those who are more physically active also tend to have completed a higher level of education and a higher household income (Farrell, Hollingsworth, Propper, & Shields, 2013). Therefore, these factors were often included as covariates in observational studies together with demographic factors, such as socio-economic status, education, and age (Colcombe & Kramer, 2003). It has been suggested that observational studies can be biased through residual confounding as individuals who are physically active are likely to differ from sedentary participants in other unmeasured ways (Barnes et al., 2013). Potential inherent biases can be minimised through conducting intervention studies and allocating participants to groups using blinded randomisation procedures.

Observational studies which focus only on the physical components of physical activity neglect the potential impact of social interaction and mental stimulation. There is evidence for the protective effect of an engaged lifestyle with a larger social network and mentally stimulating leisure activities against cognitive decline (Fratiglioni, Paillard-borg, Winblad, Xu, & Wang, 2004; Fratiglioni, Paillard-borg, & Winblad, 2004; Hui-Xin Wang, Karp, Winblad, & Fratiglioni, 2002). Physical activities themselves can involve a substantial amount of social interaction and mental stimulation. A prospective study which rated the level of mental, physical and social components in leisure activities found that they contributed equally in reducing risk of dementia. Across a broad spectrum of activities, protective effects for risk of dementia were found for leisure activities involving two or more of these components (Karp et al., 2006). It is difficult to isolate the effects of physical activity carried out as part of daily life from social or mental components in observational studies, thus more recent studies have utilised an experimental design.

Randomised controlled trials with healthy older adults

Although observational studies were initially useful in identifying the relationship between physical activity and cognitive ability or risk of dementia, they cannot offer explanations of cause and effect. A smaller but growing number of studies have investigated the relationship between physical activity and cognitive ability using exercise interventions. RCTs have the advantage over observational studies of being able to examine the cause and effect through isolation of physical activity as the variable of interest and by random allocation of participants to exercise and control groups. The majority of trials to date have used aerobic exercise and participants have tended to be aged 60 years and older and relatively sedentary prior to enrolment

(Kramer & Erickson, 2007a). Exercise is usually carried out for between 30 minutes to one hour on several days of the week for several months to a year or more. The evidence from RCTs have generally failed to replicate the same magnitude of effect sizes compared to observational studies (e.g. Etnier et al., 1997a) and have also demonstrated mixed findings (Angevaren, Aufdemkampe, Verhaar, Aleman, & Vanhees, 2008; Clifford et al., 2010; Kramer & Erickson, 2007b). Even meta-analyses with very similar hypothesis have failed to find comparable effects (Angevaren et al., 2008). However, no RCTs have demonstrated a negative effect of exercise interventions on cognitive performance. A meta-analysis examining the dose-response relationship between aerobic fitness and cognitive performance did not find a significant relationship (REF). Thus, a suggested explanation for the mixed findings is that the positive effects of engagement in physical activities is driven by physiological or psychological mechanisms rather than simply aerobic fitness (Etnier, Nowell, Landers, & Sibley, 2006).

There is substantial variability in individual and experimental characteristics across studies. Explanations for the mixed findings in reviews and meta-analyses have included the wide range of cognitive outcome measures, the large variations in specific components of exercise interventions, and also individuals' moderators, such as, age, gender, genetic status, and baseline cognitive ability. The potential moderators identified in the existing exercise intervention literature are discussed in the following sections.

Moderators: Specific components of exercise interventions

Specific components of exercise interventions vary in terms of the type and intensity of exercise, duration and frequency of sessions, and duration of the intervention. The majority of studies have implemented aerobic exercise interventions and found positive effects (Clifford et al., 2009). More recently a growing number of RCTs have investigated the effects of other types of exercise, for example, resistance or strength training and flexibility or toning exercises. For example, there is promising results for the effect of resistance training (e.g. Cassilhas et al., 2007). Additionally, larger effects have been found for interventions which combined aerobic exercise with strength and flexibility training compared to aerobic exercise alone (Colcombe & Kramer, 2003). Many studies have failed to find effects for toning and stretching exercises by themselves.

When studies experimentally isolate physical activity as a variable in RCTs, the most appropriate control group is not entirely known (Miller et al., 2012). Some intervention studies have used a no-intervention or wait-list control group but as exercise does not occur independently of its environment, this does not isolate physical activity from social interaction and mental stimulation. Due to the positive effects of mental stimulation (including social interaction) on cognitive performance in non-exercise related contexts, these are potentially confounding variables (Stock, Clifford, & Hogervorst, 2012). Therefore, due to the lack of effects found for flexibility or stretching exercises on cognitive ability, these have been increasingly used as a pseudo control group (Cassilhas et al., 2007; Colcombe et al., 2004; Kramer et al., 2001; Madden, Blumenthal, Allen, & Emery, 1989; Moul, Goldman, & Warren, 1995; Smiley-Oyen, Lowry, Francois, Kohut, & Ekkekakis, 2008). This can control for the mental stimulation from following instructions of a new type of exercise and the social engagement of interacting with experimenters and potentially exercise instructors and other participants if exercise is done in groups. Other pseudo-control groups have included mental stimulation in the form of group discussions or mental tasks of some kind (e.g. Hassmén, Ceci, & Bäckman, 1992). Cognitive activity control groups have been criticised as it could be priming participants for the cognitive outcome measures (Miller et al., 2012). For example, cognitive training interventions have been effective at producing cognitive improvements (La Rue, 2010), and therefore suggesting that forms of mental stimulation are not an appropriate or true control group.

In a study which looked at the effects of mild aerobic training and cognitive training separately and together, the mild aerobic training group failed to demonstrate cognitive improvements after 4 months compared to mild aerobic training combined with cognitive training and compared to cognitive training alone (Shatil, 2013). It was concluded that the results indicated that the mild aerobic training was not driving the effect. However, there is evidence that the level of intensity could be a moderator of the effect. Reviews have indicated that mild levels of exercise intensity have failed to demonstrate an effect (Denkinger, Nikolaus, Denkinger, & Lukas, 2012) and that moderate levels of intensity are required to demonstrate a beneficial effect on cognitive performance. For resistance exercises, high intensity training does not appear to provide any additional effect over moderate intensity training (Cassilhas et al., 2007). While for aerobic exercise, moderate intensity training appears to provide larger effects compared to both high and low intensity training (Kramer & Erickson, 2007b).

The duration of exercise sessions and whole exercise program have been examined for their moderating effect in improving cognitive performance. It has been suggested that for most elderly it seems safe to recommend as much physical activity that is achievable, while 30 minutes five days per week represents the overall class A recommendation (Denkinger et al., 2012). Short durations of physical activity (<30 minutes) independent of weekly sessions seem to have little impact on cognitive abilities (Denkinger et al., 2012). Sessions which last between 31 and 45 minutes demonstrated the largest effects (Colcombe & Kramer, 2003; Miller et al., 2012). However, the data on the moderating effect of session duration is scarce and more studies utilising objective continuous measures of physical activity are needed (Denkinger et al., 2012). There have been indications that intensity may be more important than duration of physical activities. One study that found significant associations on numerous cognitive outcome measures with intensity of weekly physical activities did not find any associations for weekly duration of physical activities (Angevaren et al., 2007).

Reviews of the literature have indicated that long lasting exercise programs (> 6 months) and shorter programs (1-3 months) have demonstrated larger effect sizes (0.667 and 0.52 respectively) compared to medium length programs (3-6 months) (Clifford et al., 2010; Kramer & Erickson, 2007b). Positive effects have been demonstrated after only four weeks in older adults (Anderson-Hanley, Nimona, & Westena, 2010) and after six weeks in young adults, with little additional gains during the 6-12 weeks periods (Harada, Okagawa, & Kubota, 2004). Therefore, short as well as longer follow-up assessments would be useful to examine the trajectory of cognitive improvements. The rate of change in cognitive performance rather than the absolute gains from pre- to post-assessments has been cited as relevant to assessing the effect of aerobic fitness (Angevaren et al., 2008; Salthouse, 2006). Participants who are less physically fit and healthy may be more likely to drop out of the exercise program (particularly if it is of long duration and high intensity). This would result in a different composition of groups at the end of the study (Miller et al., 2012).

Level of adherence by participants to the exercise programmes has also been suggested as a moderator of the effect on cognitive improvements. Low levels of adherence could contribute to a null effect (Hogervorst et al., 2012) as some individuals who were in exercise groups who had poor adherence could more appropriately fit into the control group (Clifford et al., 2009). For example, in one study attendance of exercise classes ranged from attending just three to 51 out of 52 classes (Brown, Liu-Ambrose, Tate, & Lord, 2009). Additionally, another study reported an adherence rate of 69% for aerobic classes but participants reported completing the home practice on only 54% of all days (Oken et al., 2006). Level of adherence is important to consider and may indicate how feasible a specific exercise is in an older adult population and likelihood of participants continuing with the exercise after the intervention has ended. Psychological factors should be considered when designing an exercise intervention to improve adherence, such as motivation and self-efficacy (Biddle & Mutrie, 2007).

Moderators: Cognitive specificity

Another commonly explored explanation across reviews for the mixed results is the vast range of cognitive measures used (Angevaren et al., 2008; Clifford et al., 2009; Hogervorst et al., 2012; Kramer et al., 2003). A myriad of cognitive tests measuring different domains of cognitive performance have been used as outcome measures across studies. At least one hundred different tests have been used to look at the effect of physical activity on cognitive performance across all age groups and study designs (Etnier et al., 1997). Using a selection of cognitive tests can be useful for exploring the possible associations with physical activity across domains. However, it also increases the risk of finding an effect by chance (Type 1 errors). Cognitive ability is usually assessed either using a measure of global cognition, often the Mini Mental State Examination (MMSE; Folstein, Folstein, & McHugh, 1975) or with specific cognitive tests which assess different domains of cognitive performance. These have been categorised into the domains of i) memory, ii) cognitive speed, iii) executive function, and iv) response inhibition (Angevaren et al., 2008; Clifford et al., 2009). Consistent associations have not been found between physical activity and any of these domains. It has been suggested that the sensitivity of physical activity on cognitive performance is domain specific (Weingarten, 1973). However, the evidence from meta-analyses in terms of which domains are the most sensitive is equivocal (Angevaren et al., 2008; Hogervorst et al., 2012; Miller et al., 2012). The effect of exercise appears to be both broad and specific across cognitive domains (Kramer & Erickson, 2007b), in contrast to cognitive training which is reported to have a task-specific effect on cognitive performance and lacks generalizability to other related tasks (Kramer & Willis, 2002). All domains were found to demonstrate a positive association with physical activity in some studies, but not others. Even the association of specific cognitive tests was not consistent across studies and those showing the most consistent positive associations across studies were from a wide range of domains (Hogervorst et al., 2012).

A meta-analysis which included 18 RCTs which had an aerobic fitness component found robust but selective cognitive benefits with general positive effects on processing speed, controlled processing and visuospatial function. However, the strongest effect was shown on more complex tasks which required executive control processes (Colcombe & Kramer, 2003). A more recent meta-analysis did not replicate these findings (Angevaren et al., 2008). This latter meta-analysis included 11 RCTs, also of aerobic exercise in healthy older adults and concluded that the majority of comparisons yielded no significant results across the 33 cognitive outcome measures. However, they found that the largest positive effects were found for more simple cognitive tasks assessing motor function and auditory attention (with effect sizes of 1.17 and 0.50 respectively) with only moderate positive effects for cognitive speed (0.26) and visual attention (0.26). They also concluded that there was insufficient evidence to attribute the cognitive gains to improvements in cardiovascular fitness, as eight out of the 11 RCTs reported that cardiorespiratory fitness improved in the aerobic fitness group, but only 14% of this improvement coincided with improvements in cognitive performance. Although these two meta-analyses had similar selection criteria, Angevaren et al. (2008) used more strict exclusion criteria (Cochrane) compared to Colcombe and Kramer (2003). For example, they excluded studies which did not have a randomised controlled design. Only four of the same studies were included in both meta-analyses which could explain why that even though both assessed aerobic exercise specifically, they did not find comparable results.

A more recent systematic review corroborated the cognitive domain specific findings of Angevaren et al. (2008) as the strongest effects were also found in simple cognitive tasks, such as concentration and simple reaction time (Clifford et al., 2009). However, the results across the included studies were still mixed, with some cognitive tests showing an effect in some RCTs, but not others. Of the 20 RCTs included, six studies showed a clear positive effect of exercise on cognitive performance across tests, while 13 showed some positive effect on some cognitive tests, and seven studies showed no effect on any cognitive tests. It was suggested that the studies in this review reflected a 50% chance of finding an exercise effect on a simple concentration task, versus only a 32% chance on more complex cognitive tasks (Hogervorst et al., 2012). Thus numerous reviews have concluded that a battery of cognitive tests should be agreed upon in order to be able to compare results between future studies more effectively (Angevaren et al., 2008; Clifford et al., 2009)

The variation across studies and meta-analyses suggests that although the domain specific association between physical activity and cognitive ability cannot be ruled out, it cannot explain the wide variation across studies (Clifford et al., 2009). This could also explain why the positive effects found in cross-sectional and prospective studies are not demonstrated for all cognitive domains in RCTs (Angevaren et al., 2008).

Moderators: participant characteristics

It is likely that there is a complex relationship between physical activity and cognitive ability, with multiple mechanisms that interact and influence each other (Etnier & Labban, 2012). The variation in effect sizes across different samples of populations suggests that individual participant characteristics may also moderate the effect. There is evidence for gender as a moderating variable. Numerous reviews have highlighted that studies which included a higher proportion of females (> 50%) showed the largest effects, and that studies which included only men demonstrated little to no effects (Clifford et al., 2009; Kramer & Erickson, 2007a). This suggests that the potential cognitive gains may be larger for women.

Age has also been suggested as a moderator of the effect (Colcombe & Kramer, 2003; Etnier, 1997). A meta-analysis demonstrated that the effect size of physical activity on cognitive performance varied depending on participants' age, with the largest effect size of 0.69 for those aged 66 to 70 years old, followed by an effect size of 0.55 for those aged 71 to 80 years old, and the smallest effect size of 0.29 for those aged 55 to 65 years old (Colcombe & Kramer, 2003). However, another meta-analysis, which used different age groupings and also included younger participants found contrasting results. The largest effect was found for participants aged 40 to 60 years old and the effect found in participants aged 18 to 30 years old was larger than that for the association for participants aged 60 to 90 years old (Etnier et al., 1997). As this study assigned all older adults aged 60 to 90 years old into one broad group, it is difficult to assess at what age physical activity might be the most effective for improving cognitive ability in older adults. The moderating effect of age on this relationship is yet to be clearly established, and thus further research is needed (Miller et al., 2012).

Genetic status is another potentially moderating variable which has been discussed. The Apolipoprotein E epsilon 4 allele (APOE ε4) has been found to be a major risk factor for Alzheimer's disease. Physical activity has been shown prospectively to be protective against dementia in carriers but did not significantly affect non-carriers (Schuit, Feskens, Launer, & Kromhout, 2001). However, these findings have not since been found consistently (discussed in Clifford, Stock, Bandelow, Rahardjo, & Hogervorst, 2013; Podewils & Guallar, 2005) which further suggests that the relationship is complex with a number of moderating or mediating factors contributing to the effect.

Moderators: Baseline Cognitive Ability

The majority of RCTs have been carried out in cognitively healthy older adults. A smaller number have been carried out with older adults with subjective memory complaints (e.g. Lautenschlager, Cox, & Kurz, 2010), mild cognitive impairment (e.g. Baker et al., 2010), or evident dementia (e.g. Schwenk, Zieschang, Oster, & Hauer, 2010). A meta-analysis with strict inclusion criteria (using Cochrane criteria) - which included only two RCTs in the analysis – concluded there was insufficient evidence of a positive effect of exercise on cognitive performance in those with dementia (Forbes et al., 2008). A systematic review which included only four RCTs concluded that although some studies found positive effects there was insufficient evidence to establish a conclusion (Clifford et al., 2009). A larger meta-analysis was conducted which included a total of 2020 participants with cognitive impairment and dementia in the 30 included trials. They found an effect size of 0.57 for the effect of exercise on global cognition assessed by the MMSE (Heyn, Abreu, & Ottenbacher, 2004). An examination of this meta-analysis and another with cognitively healthy participants (Colcombe & Kramer, 2003) found similar effect sizes of exercise across various analyses (0.57 and 0.60 respectively). This suggests that older adults with or without early dementia may benefit similarly from exercise in this context (Kramer & Erickson, 2007a).

Conclusion

The extant literature is challenging to interpret due to the myriad of ways that the relationship has been investigated. The moderating effect of specific features of exercise interventions has been investigated and lead to recommendations of type, duration and intensity of exercise that are likely to lead to cognitive gains. However, it is not clear which domains of cognitive ability benefit, due to the large variety of cognitive tests used. The effect is inconsistent across studies and appears to be both broad and specific across cognitive domains. Findings vary across reviews and meta-analyses, even between those with similar hypotheses. The effect also appears to be moderated by individual factors, such as gender, age, and genetic status. Despite the existing evidence, the relationship between physical activity and cognitive ability is still not fully understood (Etnier & Labban, 2012).

The inconsistent results across studies lend itself to Kitwood's (1997) alternative model of dementia using a biopsychosocial approach, implicating the social environment as a contributing factor. The consistent positive effects found in observational studies which have not been replicated in RCTs further implicate the contribution of psychosocial factors in the effect. The majority of reviews have not taken into account the psychosocial factors of the relationship or have excluded studies in which participants were suffering from depression. Therefore, although, the impact of psychological factors on cognitive decline has been demonstrated in non-physical activity contexts (Hertzog, Kramer, Wilson, & Lindenberger, 2009), the potential psychological mechanisms on cognitive functioning in a physical activity context have not been widely investigated, and requires further research. The existing literature in this area is discussed in the following chapter.

Chapter 2: Exercise interventions to improve cognitive performance in older adults – Potential psychosocial mediators to explain variation in findings

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Abstract

Evidence suggests that exercise interventions can improve cognitive performance in older adults. However, there are inconsistent results across studies. The exercise environment and specific features of interventions vary greatly. This variation would impact on the psychological experience of the exercise through varying levels of social interaction, mental stimulation and feedback of fitness or skill progression. Potential mediating relationships are discussed in terms of the impact that psychosocial factors related to exercise can have on cognitive performance. The potential psychological mediators discussed here include self-efficacy, attitudes towards ageing, self-perceptions of ageing, perceived control manifesting in a self-fulfilling prophecy, causal attributions of memory problems, and mood. The mechanisms of these mediating relationships are unclear and further research is needed to investigate this. In addition, the magnitude of the effect of psychological mediators and their relative contribution compared to physiological mechanisms in this context should be further investigated.

Introduction

Dementia is characterised by severe cognitive deficiencies that impact on functional activities of daily life (American Psychiatric Association, 1994). With an ageing population, the risk for dementia increases (Launer & Hofman, 1992) which is a major cause of disability in later life, more so than some cancers, stroke and cardiovascular disease in the United Kingdom (Department of Health, 2009). Dementia is a worldwide problem, and yet in the UK in 2010 alone, there were estimated to be over 820,000 elderly afflicted with late onset dementia (Luengo-Fernandez et al., 2010). This is expected to rise to one million by 2025 and to exceed 1.7 by 2051 (Alzheimer's Society, 2007). The economic costs of dementia in the UK are estimated to be £23 million per year (approximately twice as much as cancer; Luengo-Fernandez et al., 2010).

No cure for dementia is currently available; preventative strategies are the key to reducing risk. The nature-nurture debate can be used to illustrate the factors that contribute to individuals' risk for developing cognitive decline and dementia. Dementia risk cannot be entirely explained by genetics: the APOE-4 allele has been recognised as a risk factor for Alzheimer's disease (Ahn Jo et al., 2006); however, not all individuals who have this allele develop dementia and not all individuals who develop dementia have this allele (Henderson et al., 1995). Therefore, environmental factors are implicated for their contribution to risk of dementia. These include demographic factors, such as education, occupation and socioeconomic status (e.g. Fei et al., 2009) as well as lifestyle behaviours including diet (e.g. Solfrizzi, Panza, & Capurso, 2003), smoking (e.g. Peters et al., 2008), social engagement (e.g. Fratiglioni et al., 2004), and physical activity (e.g. Angevaren et al., 2008; Clifford et al., 2010; Colcombe & Kramer, 2003; Etnier et al., 1997).

Modifiable risk factors for dementia overlap with those of cardiovascular disease (Alonso et al., 2009; Howard Fillit, Nash, Rundek, & Zuckerman, 2008; Kerola, Kettunen, & Nieminen, 2011; Kivipelto et al., 2005). The evidence for exercise to improve cardiovascular health is well documented (e.g. Archer & Blair, 2011; Warburton et al., 2006), including in older adults (Bassuk & Manson, 2010). Thus due to the overlap in risk factors, the scope for physical exercise to improve cognitive performance - with the aim of delaying the onset of dementia - has been widely investigated. Many studies demonstrate that physical exercise can help to maintain cognitive abilities into old age, but not all treatment studies have found positive effects (Clifford et al., 2009). It has been suggested that physical activity in midlife could help to reduce the risk of dementia in later life (Clifford et al., 2013). However, once individuals have developed dementia, some cognitive improvement can still be seen through physical exercise.

Direct physiological mechanisms for improving cognitive performance through exercise that have been investigated include: encouraging neurogenesis and neurotrophins (Nakajima et al., 2010; Schaeffer, Novaes, da Silva, Skaf, & Mendes-Neto, 2009; Van Praag et al., 1999) , a reduction in blood lipids and lowering of blood pressure (Leon & Sanchez, 2001) and improved vascular output and cerebral perfusion (Bonner & Cousins, 1996). The effects of these direct mechanisms are unclear; both acute and longer term effects of exercise on cognitive improvement have been reported, but there are wide variations in results across studies, with many not finding any effects (Clifford et al., 2009).

Psychosocial mediators

The inconsistent results across exercise interventions designed to improve cognitive performance despite the large number of high quality trials suggests that they may be explained by differences in specific features of the interventions. Exercise does not occur independently of its environment, thus it is important to consider the interactions between an individual and their environment, as there may be emergent mechanisms that are not captured when this complex relationship is reduced to the internal physiological mechanisms. Specific features of exercise interventions vary greatly (illustrated in Figure 2.1), for example: (1) the exercise environment: whether the exercise was carried out indoors or outdoors, in a lab/institution setting or in the community/at home; (2) social interaction: whether exercise is carried out in a group or alone, supervised, instructor or self-led; (3) mental engagement: was the exercise mentally passive or novel, stimulating and requiring mental effort?; (4) exercise prescription: type of exercise, was there a set intensity and duration?; (5) was the exercise purposeful: were there targets and goals set, was there feedback mechanisms to show progress and improved fitness or strength?; (6) were there opportunities for improving self-efficacy using peer comparison or through mastery experiences and achieving goals? The huge variations of these specific features across exercise interventions would impact differently physiologically and psychologically on participants. Even if the type of exercise was the same, the psychological impact could be markedly different. For example, the experience of an exercise intervention which involved walking on a treadmill in a lab while being observed compared to walking in a group in a local park would involve similar physical movements but the psychological experience would differ greatly.

It has been suggested that the type of exercise is related to the effectiveness of the intervention, where an improvement in VO2max, strength and lung function could be necessary to lead to cognitive improvement (Clifford et al., 2009). Aerobic exercise interventions have more consistently demonstrated cognitive performance improvements compared to other types of exercise. Additionally, interventions which did not aim to improve aerobic fitness, but rather focused on improving strength have also demonstrated cognitive performance gains. However, the evidence is limited due to the fewer number of studies conducted. Additionally, improvements in VO^2 max did not always correlate with cognitive improvements (e.g. Blumenthal et al., 1989), suggesting that improving aerobic fitness alone is not sufficient to bring about such changes and that there are other mechanisms involved.

A mediating relationship may emerge due to the psychological impact of the exercise intervention and the subsequent impact of this on cognitive performance (illustrated in Figure 2.2). In non-exercise related observational and intervention studies, positive attitudes to ageing (Langer & Rodin, 1976), positive self-perceptions (Levy, Slade, Kunkel, & Kasl, 2002; Levy, 2003), better mood (Ganguli, Du, Dodge, Ratcliff, & Chang, 2006), social engagement (Saczynski et al., 2006) and mental stimulation (Salthouse, 2006) have all been associated with improvements in cognitive performance, better health and longevity. It may be that the exercise intervention studies which result in a larger improvement in cognitive performance do so because the exercise acts as a vehicle to improving these psychological factors, resulting in a combined impact. Namely, the participants benefit physiologically (mechanisms mentioned above) from the exercise, as well as psychologically. Figure 2.1 illustrates the potential mechanisms of these variables during an exercise intervention. The specific psychological mechanisms of this potentially mediating relationship are discussed in this chapter.

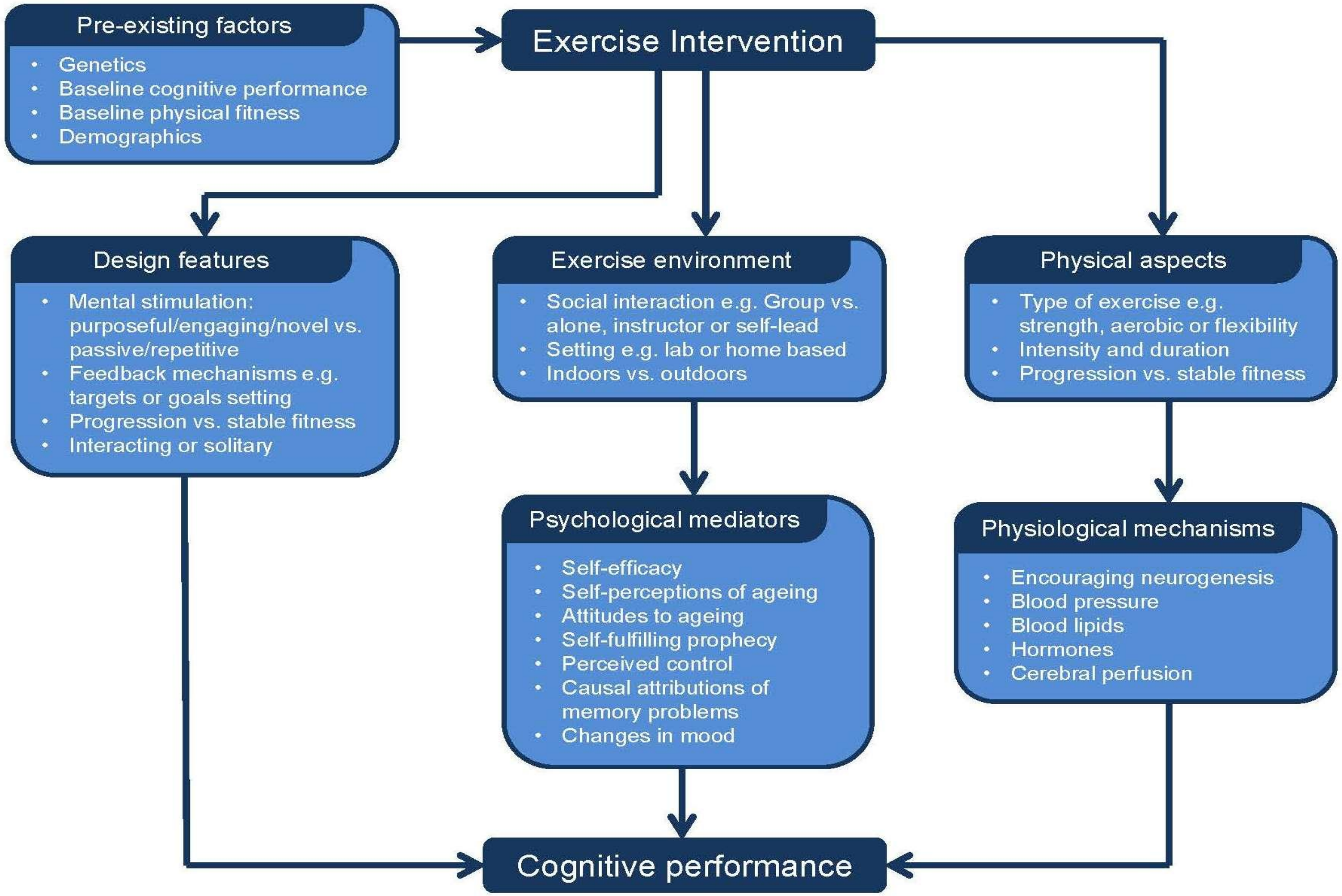


Figure 2.1 Model of the proposed psychosocial interactions brought about by differences in specific features of an exercise intervention

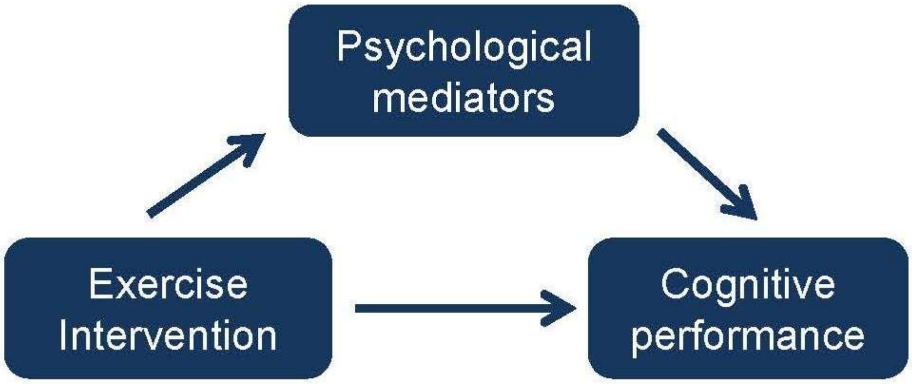


Figure 2.2 Proposed mediating relationship of psychological variables in an exercise intervention designed to improve cognitive performance.

Increases in self-efficacy

Exercise interventions may act as a vehicle to improve self-efficacy through mastery experiences and peer comparisons if the design and features of the exercise environment afford it. Self-efficacy or beliefs can enhance or hinder cognitive performance through a variety of processes, including motivational, affective and meta-cognitive aspects (Bandura, 1989). Bandura coined the term self-efficacy as "the belief in one's capabilities to organize and execute the courses of action required to manage prospective situations" (Bandura, 1995). He implicated self-efficacy as a precursor to other cognitions (Bandura, 1986) and therefore as a determinant of how people think, behave and feel. He also posed that the most effective way to develop a strong sense of self-efficacy is through mastery experiences.

One study in Clifford et al's (2010) review assessed self-efficacy. However, they only investigated this in the domain of physical self-efficacy, rather than self-efficacy for cognitive performance (Tsutsumi, Don, Zaichkowsky, & Delizonna, 1997). Utilising self-report measures they found that, on average, participants in both high and low intensity strength training groups improved their physical self-efficacy similarly, while the control group did not. They used a social cognitive perspective to offer an explanation, whereby the experience of mastery associated with participation in a regular strength training program resulted in enhanced perceptions of physical self-efficacy (Bandura, 1986). Furthermore, they suggested two principle mechanisms by which self-efficacy could be enhanced by exercise (Ewart, 1989): 1) individuals alter their perceptions of their physical competence by comparing their current performance to past performance as well as performance of their peers; 2) internal feedback from exercise induced sensations improved self-efficacy (e.g. "I do not have to put in as much effort in to lift this weight as I used to" or "I do not feel as out of breath after walking that distance"), rather than positive feedback from others.

The scope for individuals to compare their physical performance to past performance depends on the type of exercise undertaken which allows the perception of progression, for example, increases in weights or reps for strength training, or speed or time taken to walk or jog a certain distance. Additionally, whether exercise is undertaken in a class or alone will determine whether participants can compare their performance or progression to that of their peers. Another mechanism through which self-efficacy could be enhanced is through positive feedback from others, which could include peers in an exercise group, exercise instructors or experimenters. These potential mechanisms highlight the importance of a controlled study design and the potential impact that social interaction could have on self-efficacy and consequent cognitive performance.

The majority of the interventions in Clifford et al.'s review did not require participants to explicitly set individual goals. However, most provided some level of feedback which individuals may have utilised to set goals for themselves. Not controlling for potential enhanced self-efficacy gains (either through the study design by giving/restricting feedback or statistically from self-report measures) makes it difficult to infer whether a mediating interaction is present or whether the effects of the exercise on cognitive performance improvements are occurring independently of self-efficacy or other psychological mechanisms. Enhancing self-efficacy may also play a role in improving motivation, effort exerted, adherence and dropout rates for exercise interventions and perhaps for promoting long term effects and behaviour change and should therefore not be neglected in investigations.

The degree to which self-efficacy is transferable across domains has been debated. Evidence suggests that domain specific self-efficacy may not be transferable to a general measure of self-efficacy but may be transferable to another domain (Weitlauf, Smith, & Cervone, 2000). This was demonstrated as a result of a self-defence class for women whereby improvements in physical self-efficacy and beliefs about their ability to protect themselves influenced other domains of self-efficacy that were not targeted during the training and were also unrelated, e.g. to self-efficacy of interpersonal coping skills. Their results also illustrated the lack of sensitivity of a general self-efficacy measure compared to their multi-domain questionnaire to identify changes in beliefs and self-perceptions resulting from a novel and social experience. Their multi-domain questionnaire was contextualised as it assessed self-efficacy in a variety of activity domains including academic achievement, assertiveness, conscientiousness, sports and interpersonal coping skills. This is different to general self-efficacy measures which usually assess general beliefs about oneself, for example to what extent you believe that you are an overall competent person.

In the context of exercise interventions aiming to improve cognitive performance in older adults, a mechanism through which self-efficacy beliefs could transfer from the physical to cognitive performance domain (as a result of improved fitness or strength), could be through challenging individuals' self-perceptions of ageing, thus challenging what they believe they are capable of despite their advancing age. It is these core beliefs and self-perceptions of ageing that could be affected; and therefore potentially also individuals' perceived control over their functional health and whether they believe their decline is inevitable. If individuals believe they have some control over their future health and their ability to maintain it as they age and potentially improve it then this is likely to influence their lifestyle behaviours.

Self-perceptions and attitudes towards ageing

The elderly have been found less likely to engage in preventative health behaviours compared to younger age groups (Burton, Shapiro, & German, 1999; Rosenstock, 1974), despite the continued benefit that these behaviours provide throughout the life span (Gill et al., 2002). Longitudinally, individuals aged 50-80 years with more positive self-perceptions of ageing at baseline were found to be significantly more likely to engage in preventative health behaviours when followed over the next two decades. Age, education, gender and race were not found to be predictive of preventative health behaviours. These behaviours included eating a balanced diet, exercising and following directions for taking medication prescribed (Levy & Myers, 2004). It was hypothesised that this reduction in healthy behaviours (such as disengagement from physical activity) was due to the perception that physical deterioration and illness was inevitable. Negative stereotypes reinforce attitudes that the elderly are too weak to exercise and health improvements are not possible. This would then diminish their major motivation for engaging in health promoting behaviours. Additional evidence of how skewed perceptions can influence preventative health behaviours was found in a study which showed that individuals taking vitamin pills were shown to smoke more, leading to adverse health issues due to an overestimate of perceived health protection afforded by the vitamin supplements (Chiou, Wan, Wu, & Lee, 2011).

There is evidence for the longitudinal effects of negative self-perceptions on longevity, whereby older individuals who had more positive perceptions of ageing (which was measured up to 23 years earlier) lived for an average of 7.5 years longer (Levy, Slade, Kunkel, et al., 2002). This prediction remained even after controlling for age, sex, socioeconomic status, functional health and loneliness. Additionally, investigators found that this relationship was partly mediated by cognitions (e.g. the 'will to live'). There is also evidence for the longitudinal effects of negative self-perceptions of ageing on a faster functional health decline, categorised in that study as: not being able to work a full time job, visit friends/relatives, carry out heavy work around the house, and walking up and down stairs (Levy, Slade, & Kasl, 2002). The mean difference between groups continued to increase significantly over time. It could be argued that this relationship is reciprocal, whereby those with worse health have more reinforcement for negative attitudes that are consequently perpetuated. However, the association remained even when only those with the same baseline functional health were included, indicating the precipitating rather than perpetuating effect of negative self-perceptions on functional health decline.

Attitudes across cultures

A study conducted with young and old Chinese hearing, American Deaf and American hearing individuals found interesting results on memory tasks (Levy & Langer, 1994), whereby there was an interaction effect between age, culture and disability impacting on performance. The three groups of younger participants performed similarly. However, the older Chinese and older American Deaf participants outperformed the older American hearing group. There was also a positive correlation amongst older participants between more positive views toward ageing and memory performance. Supported hypotheses were based on the theory that there is a psychosocial process that contributes to memory loss through negative stereotypes regarding memory in older age. The American Deaf and Chinese would have had less exposure to negative stereotypes of ageing due to their independence from American mainstream culture whilst not sharing other common characteristics to reduce confounding cohort effects. The American Deaf and Chinese cultures both regard elders in high esteem, therefore providing positive stereotypes of ageing (Becker, 1980; Ikels, 1991). This study highlights cultural differences in the psychosocial ageing process suggesting that the findings found in one culture may not be generalisable to others. However, these novel findings further support the extent to which negative stereotypes and attitudes can impact on cognitive performance.

Self-fulfilling prophecy of age-related decline

As previously mentioned, the degree to which an individual perceives their future decline in health is inevitable will affect their present health behaviours, such as levels of physical activity, diet, and other lifestyle choices. Consequently, this reduction in present healthy behaviours would lead to a quicker decline thereby resulting in a self-fulfilling prophecy (Figure 2.3). The self-fulfilling prophecy has been defined as: “in the beginning, a FALSE definition of the situation evoking a new behaviour which makes the originally false conception TRUE” (Merton, 1948). In an exercise intervention context, a participant’s motivation, adherence and effort are likely to be affected by their perception of potential benefits. If a participant believes their cognitive decline is inevitable and exercise cannot alter this, then this may influence how they approach and carry out the exercise, for example, to a lower intensity and lower adherence to session attendance, and may be more likely to drop out. Therefore, it is important to assess attitudes towards ageing as a mediator in an intervention context.

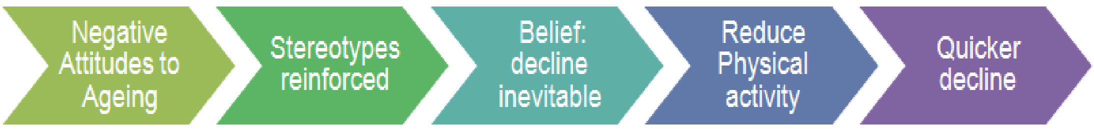


Figure 2.3. Proposed self-fulfilling prophecy of negative attitudes towards ageing and health decline

Perceived control

The self-fulfilling prophecy involves the concept of perceived control. An example of how this is relevant in this context could be, for instance, individuals who do not believe they have control over their future decline are less likely to try and maintain their functional health to delay or slow decline. When Levy et al. (2002) found the association between negative self-perceptions and future functional decline, they also investigated the interaction of perceived control in this relationship. Perceived control was found to act as a partial mediator based on the three criteria described by Kenny, Kashy, & Bolger (1998) whereby: (1) the self-perceptions of ageing predicted functional health over time, (2) self-perceptions of ageing predicted the mediator perceived control, and (3) perceived control remained a significant predictor of functional health over time even when the self-perceptions of ageing was included.

Perceived control is similar to the concept of 'locus of control' which was derived from Rotter's Social Learning Theory (Rotter, Chance, & Phares, 1972). Control beliefs were conceptualised as being either internal or external, where "internal" refers to control residing within oneself and "external" refers to control residing elsewhere (e.g. in other people or being due to chance). The aforementioned studies have demonstrated the positive effects of having stronger perceived control on health outcomes. However, there is evidence to suggest this may not be a simple linear relationship; having stronger perceived control can also be associated with poorer health outcomes, depending on the circumstances (Rodin, 1986; Seeman, 1991). This hypothesis is based on the circumstances where there is a mismatch between perceived control and the environmental affordance, i.e. the actual amount of control an individual objectively has over a situation (Evans, Shapiro, & Lewis, 1993). This incongruence could be detrimental to health in a situation where an individual does not have personal control; strong control beliefs could initiate a physiological stress response. The long term effects of this could have a detrimental impact on health, and stressful events have been implicated in triggering the early symptoms of dementia (Reich, Torres, Arias, Carlino, & Halac, 2012).

A further complication of understanding this relationship is introduced when sense of control is conceptualised as a state rather than trait. Significant associations have been found between higher age and lower sense of control at baseline and also for a gradual decreasing sense of control with age over a period of one year (93% of the sample were aged between 45 and 85) (Wolinsky, Wyrwich, Babu, Kroenke, & Tierney, 2003). Patterned results of decline have also been found whereby participants aged 18 to 50 showed high and stable levels of perceived control compared to older participants who demonstrated successive downward steps of reduced perceived control (Mirowsky, 1995). Physical impairment and low levels of education accounted for a substantive amount of the low sense of control in older participants, the latter accounted for more. However, other socioeconomic factors (race, gender, marital status, occupation, income or earnings) and physical ageing (perceived health, malaise, aches and pains, exercise or body weight) did not contribute to a low sense of control. It may be that physical impairment was closely related to physical ageing which overruled these effects.

Causal attribution of memory problems

Self-perceptions and stereotypes could impact on future decline through the attribution of cognitive problems to particular causes. There was evidence of age differences in attributing causes of memory problems in a study where 39.2% of participants aged 25 to 85 years old considered themselves forgetful (Commissaris, Ponds, & Jolles, 1995). Across groups increasing with age this proportion increased: 29.6% among 25-35 year olds, 34.2% among 40-50 year olds, 41.5% among 55-65 year olds and 52% among 70-85 year olds. Although a slightly higher proportion in the older group experienced hindrance from their forgetfulness compared to the youngest group (22.7% versus 17%), the extent to which participants worried about their forgetfulness did not differ largely from the youngest group (47%) to the older groups (62.2% among 40-50 year olds, 64.4% among 55-65 year olds and 61.5% among 70-85 year olds). When participants were asked to indicate the cause of their forgetfulness, the older participants were more likely to attribute their forgetfulness to their age. On the other hand, younger participants attributed memory problems to tension, emotional problems, poor concentration, lack of exercise and insufficient mental exercise. Already in the 40-50 year old age group there was a relatively high percentage of participants who attributed their forgetfulness to age. It is possible that these attributions are age biased; it is likely that older adults experience memory issues due to emotional problems and other reasons, as the young do, but they attribute ageing as the default cause.

Attributing memory problems to age rather than tension or emotional problems impacts on whether individuals act to overcome the problems. Attributing memory problems to age establishes the perceived locus of control as external because chronological ageing is inevitable, individuals may therefore surrender to memory problems as inevitable, thus not making the effort to overcome them in terms of employing memory strategies. Furthermore, attributing memory problems to age establishes them as chronic, as opposed to acute in the case of emotional causes. This expectation of chronic reoccurring memory problems rather than an isolated episode would further reinforce the attitude of inevitable decline with increasing age. In a research context this could be problematic when participants are recruited based on self-reported memory problems, and also may lead those succumbing to memory problems to employ less effort or concentration in testing conditions.

Changes in mood

The environment of exercise can affect mood, for example, outdoor exercise was found to bring about more positive changes in mood (greater pleasant affective states) compared to indoor exercise (Focht, 2009). Moreover, depression has been associated with poorer cognitive performance longitudinally, whereby there is an acceleration in age related decline compared to age matched controls (Gualtieri & Johnson, 2008). Depression is an overall risk factor for dementia (Lyketsos et al., 2010), heart disease and stroke in women (Whang et al., 2009). There is a high prevalence of depressive symptoms in individuals over 65 years old (approximately 15% with depressive symptoms, and approximately 4% with major depression; Lyketsos et al., 2010) and there is observational evidence for the protective effect of physical activity on depression in middle aged and older adults, which included disabled participants (Strawbridge, Deleger, Roberts, & Kaplan, 2002). Other associations found include depression with no regular physical exercise and higher well-being with regular exercise (Ruuskanen & Ruoppila, 1995). The presence of these associations necessitates a closer look at improvements in mood in interventions to indicate whether it could act as a mediator for cognitive performance improvements after exercise in older adults.

The association between depression and poorer cognitive performance is a controversial one due to the lack of understanding of the causal pathways and mechanisms involved. One review reported that subjective memory complaints were inconsistently related to current cognitive impairment, but more strongly related to risk of decline in the future (MacLullicha & Reid, 2006). It was suggested that the inability to sustain effort on memory tasks due to poor motivation resulted in poorer performance on cognitive tasks, thus masking actual cognitive capabilities. However, patients with a major depressive episode demonstrated similar impairment across cognitive tasks of varying difficulties (auditory verbal learning test, recall and recognition) that correlated with depression severity (Austin et al., 1992; MacLullicha & Reid, 2006). This suggested that effort is not the main determinant of cognitive performance amongst those with depression because impairment would have been worse in more difficult tasks compared to easier tasks if this was the case. This suggests that more complex mechanisms are involved in the association between depressive symptoms and lower cognitive performance.

The majority of studies in the Clifford et al review did not include measures of mood. However, those studies that did, found improvements in mood (e.g. anxiety and vigour) in exercise groups, but not in control groups (Cassilhas et al., 2007; Tsutsumi et al., 1997). Amongst these studies, cognitive improvements for the exercise groups were not universal for all participants, suggesting that mood improvements may not be the only mediator. Furthermore, several studies showed that physiological improvements do not necessarily correlate with improvements on psychological measures (Blumenthal & Madden, 1988; Tsutsumi et al., 1997). The latter study failed to find an association of strength training intensity levels (high or low) with improvements in psychological outcomes. They implied that cognitive behavioural mechanisms (e.g. enhanced self-efficacy) might be more important to consider than physiological mechanisms.

Conclusion

Exercise does not occur independently of its environment. Indeed, interventions vary greatly in terms of their environment and specific features, and consequently the different types of social interaction, mental engagement, goal setting and feedback will alter the psychological impact of the exercise. As psychological factors impact on cognitive performance, this suggests a mediating relationship. The probable psychological mediators discussed here include self-efficacy, self-perceptions and attitudes to ageing, perceived control manifesting in a self-fulfilling prophecy and causal attributions of memory problems and mood. It is apparent that exercise can improve the cognitive performance of older adults in many interventions; however, inconsistent results across studies may indicate that specific features of the effective interventions are having a psychological effect that consequently impacts on cognitive performance Therefore, future research utilising exercise interventions to improve cognitive functioning should include measures of psychological variables to further our understanding of the interaction effect. Potentially, the effectiveness of interventions could improve if they facilitate a positive psychological impact, for example improving self-efficacy through goal setting and feedback thus challenging negative attitudes to ageing. Further research is needed to investigate the magnitude of the effect of psychological mediators and their relative contribution compared to physiological mechanisms in an exercise intervention aiming to improve cognitive performance in older adults.

Chapter 3: Overall aims of thesis

Chapters 1 and 2 discussed the substantial extant literature on the beneficial effect of physical activity on cognitive ability. Figure 3.1 illustrates McAuley, Kramer, and Colcombe's (2004) descriptive model summary of the empirical literature. Despite the large number of good quality studies, there remain many equivocal findings in the physical activity and cognitive ability literature, and thus suggesting that other factors need to be considered. Kitwood (1997) and Clare (2007) have indicated the importance of using a broader biopsychosocial model of disease to understand cognitive decline and dementia. This is partly accounted for by McAuley and colleagues (2004) who highlighted the influence of personal (including psychological) factors in predicting physical activity. However, the role of psychosocial factors in delaying decline has been neglected in the context of physical activity as a preventative strategy for cognitive decline. Thus, the present thesis aimed to understand the role of psychosocial factors in the relationship between physical activity and cognitive ability in older adults. In addition, given the universal issue of cognitive decline, it is important to draw upon cultural differences in any identified factors. Therefore, the present thesis aimed to build upon McAuley and colleagues' descriptive model, by incorporating an appreciation of sociocultural factors (such as attitudes to ageing) in the physical activity, health and cognitive ability framework.

McAuley and colleagues' (2004) model summarised the relationship between physical activity and cognitive ability, which they suggested occurred principally through improved physical fitness. However, studies also have consistently shown the improved psychological benefits of physical activity (Arent, Landers, & Etnier, 2000; Fox, 1999; Sjösten & Kivelä, 2006) and psychological factors have been demonstrated to have an effect on cognitive ability (Halvorsen et al., 2012; Levy, 2012). Therefore, although a very useful summary of the literature at the time, it could be argued that McAuley and colleagues' model needs to be expanded to include the possibility that personal or psychological factors not only predict physical activity behaviour, but also that they may improve as a result of physical activity and this may have a mediating effect on cognitive ability.

In addition, the understanding of cognitive decline and dementia requires an appreciation of the role of biopsychosocial factors (Clare, 2007; Kitwood, 1997b), which incorporates sociocultural factors. The McAuley et al. model illustrates that physical activity leads to improved fitness, but this ignores wider improvements in biopsychosocial functioning from physical activity, e.g. healthy ageing. Consequently, the current thesis aimed to explore the potential role of sociocultural values such as attitudes to ageing and biopsychosocial values of general subjective health in the current field of investigation.

To address these aims, the following questions were proposed:

Primary question:

- Do psychosocial factors play a role in the relationship between physical activity and cognitive ability?

Secondary questions:

- Which psychosocial factors are important in this relationship?
- What are the potential mechanisms of psychosocial factors on cognitive outcomes?
- Are socio-cultural factors important in the physical activity and health relationship?
- Is the role of psychosocial factors in the relationship between physical activity and cognitive ability domain specific?

Specific aims of each study presented in the present thesis are:

- To investigate the relationship between attitudes towards ageing, perceived control, and self-reported health (Study 1a)
- To explore inter-generational differences in attitudes towards ageing in the UK between young and older adults (Study 1b)
- To explore cross-cultural differences in attitudes towards ageing in the UK in young adults compared to young adults in China (Study 1c)
- To investigate the associations between physical, social and mental activities on cognitive ability (Study 2a)
- To investigate the mediating effect of mental health in the relationship between physical activity and cognitive ability (Study 2b)

- To test proof of concept of the potential role of psychosocial factors (attitudes towards ageing, perceived control, and mental health) in an exercise intervention to improve cognitive ability in middle-aged adults (Study 3)
- The primary aim was to assess the feasibility of a home-based resistance training intervention with older adults. The secondary aim was to provide preliminary data on the role of psychosocial factors (attitudes towards ageing, perceived control, mental health, and self-efficacy) on cognitive outcomes (Study 4)

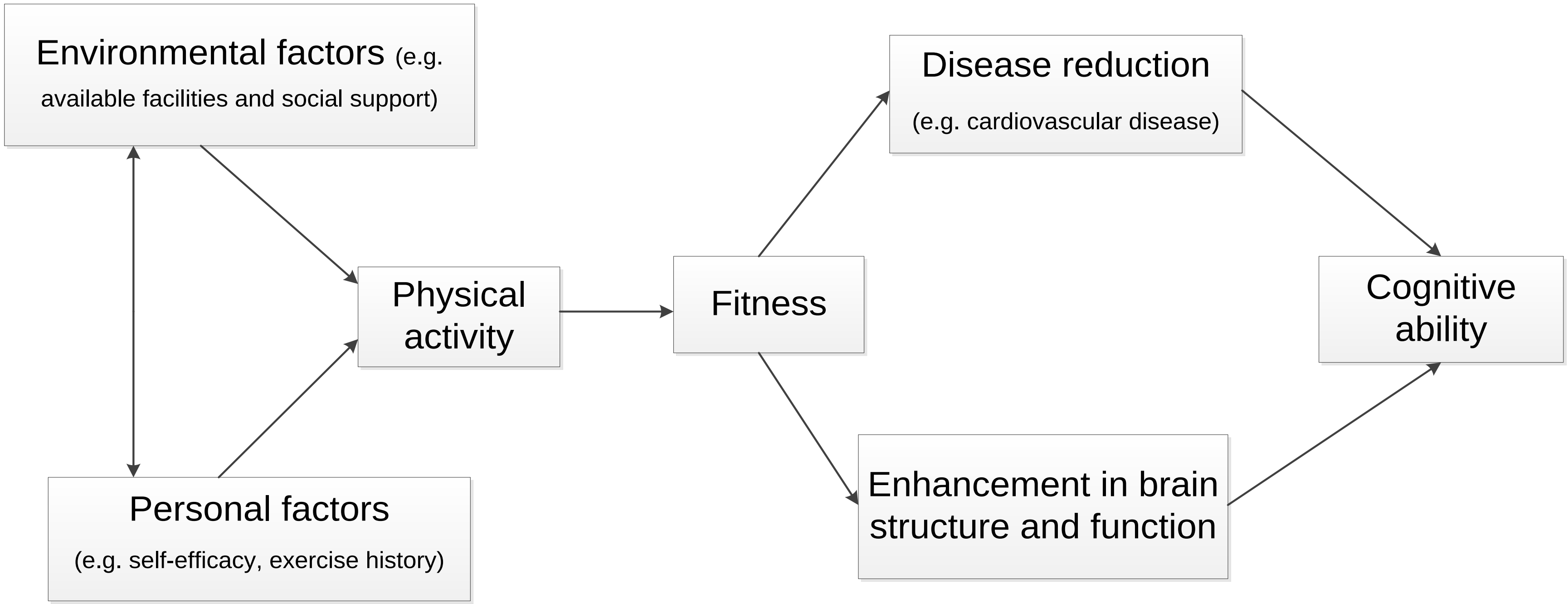


Figure 3.1 Schematic illustration adapted from McAuley, Kramer and Colcombe (2004) to show a speculative summary of the current state of knowledge of some of the factors identified as important for participation in physical activity and potential mechanisms and influence on cognitive ability.

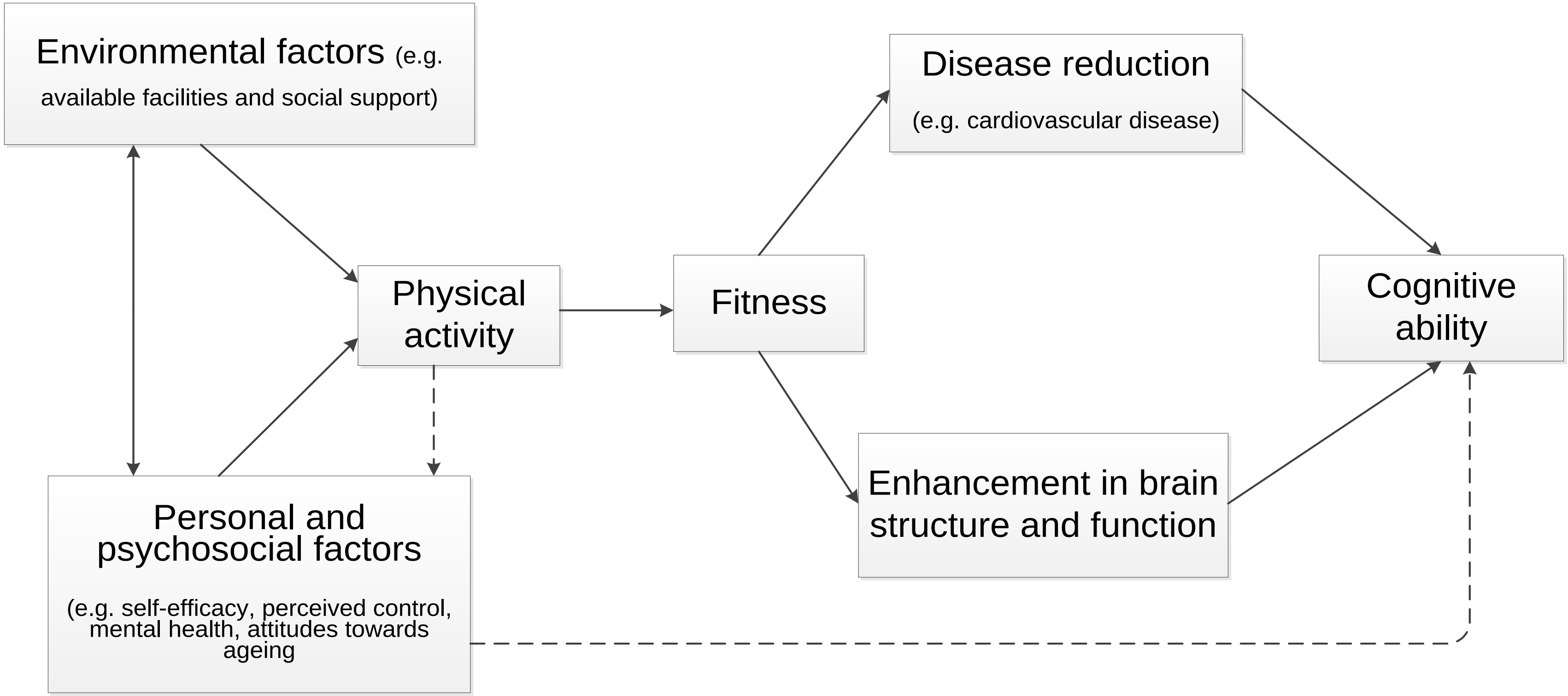


Figure 3.2 Schematic illustration of the adapted from McAuley, Kramer and Colcombe (2004) to show a speculative summary of the current state of knowledge of some of the factors identified as important for participation in physical activity and potential mechanisms and influence on cognitive ability. Dashed arrows indicate the pathway investigated in the present thesis

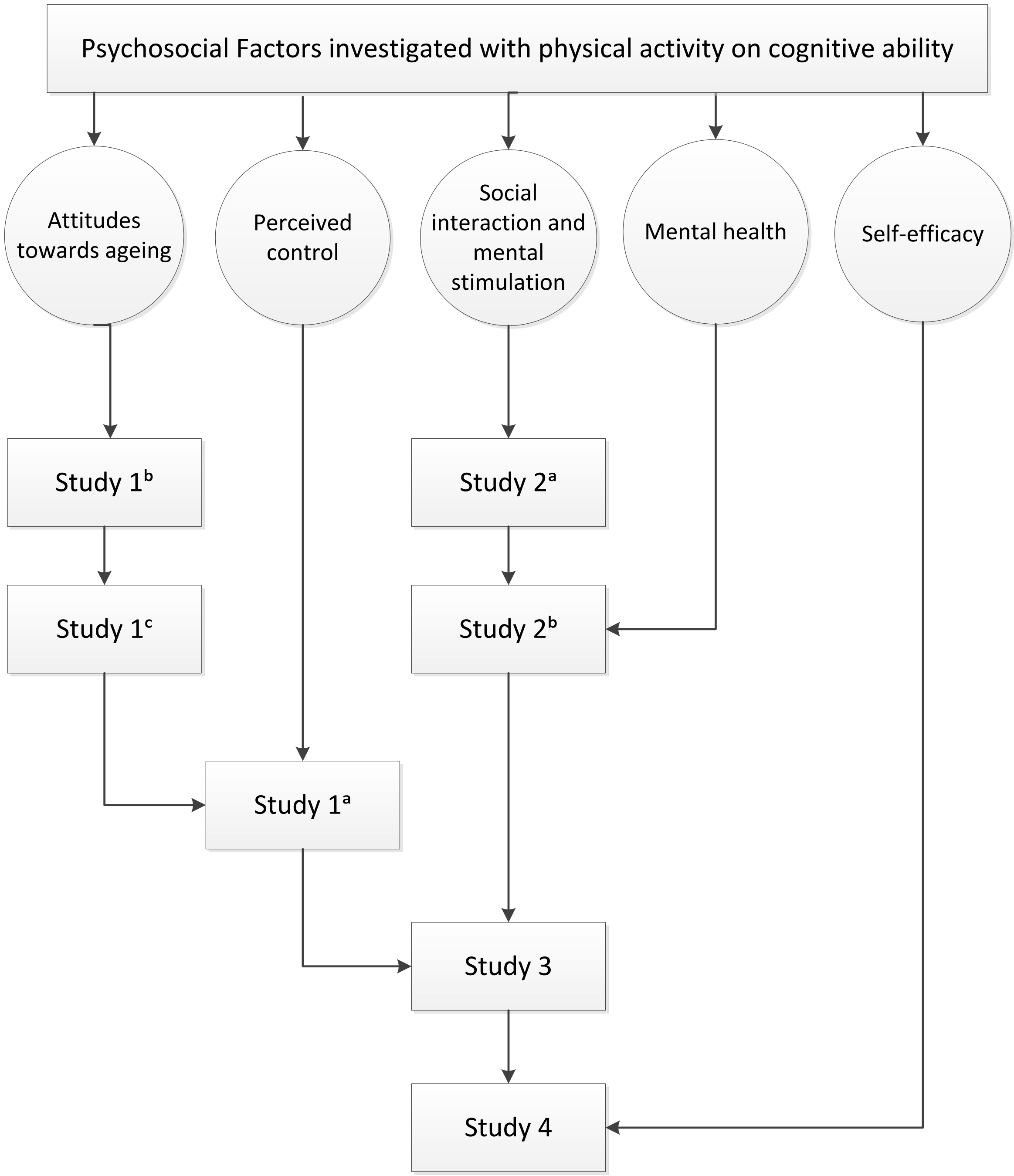


Figure 3.3 Studies in the present thesis and the psychosocial factors investigated.

PART TWO

Attitudes towards ageing

Overview of Part Two

Attitudes towards ageing were identified as a potential psychosocial mediator in the relationship between physical activity and cognitive ability in older adults in the literature review (Chapter 2). Part Two of the present thesis describes Study 1, which explored attitudes towards ageing in more depth. Study 1 investigated several research questions and is therefore is presented as 1a, 1b, and 1c to distinguish between each research question.

Study 1a investigated the relationship of attitudes towards ageing in older adults with their self-reported health and level of physical activity in cross-sectional data. The findings suggested that older adults' attitudes towards ageing were related to level of physical activity and self-reported health. Therefore, Study 1b and 1c explored attitudes towards ageing in more detail across age groups and cultures to gain insight into how and when they may be formed to indicate whether they may be amendable to change through intervention. Study 1b explored the content of attitudes towards ageing amongst young and older adults in the UK. Attitudes were captured using a free responses question so that they were not limited to specific domains or categories. The findings indicated that a substantial proportion of attitudes captured were related to physical functioning and cognitive ability. Thus, indicating potential scope for the role of attitudes towards ageing in exercise intervention aiming to improve cognitive ability. Additionally, the findings indicated that the attitudes towards ageing held by young and older adults in the UK were similarly negative. This consistency indicated a lack of "in-group" preference for older adults and could indicate the effect of sociocultural factors on attitudes formation when younger and on maintaining attitudes when growing older. Study 1c explored attitudes towards ageing between cultures to investigate the relationship with the sociocultural and environmental possible scope for attitude change in an intervention. The findings indicated that attitudes towards ageing in China were more positive, focused more on internal qualities and reflect older adults as more active compared to the UK. This suggested that environment is related to attitudes towards ageing. The findings also indicated that a much larger proportion of attitudes towards ageing reported in the UK were related to physical functioning and cognitive ability compared to in the China. These findings highlighted the potential for attitudes towards ageing and perceived control to play a role in the context of physical activity, cognitive ability and subjective health and thus the need for them to be investigated further.

Chapter 4: Study 1a - Attitudes to ageing, physical activity, and health of older adults in the UK

Introduction

There are negative connotations to growing old. There is substantial evidence that attitudes towards older adults are more negative compared to those towards young adults and tend to depict a picture of frailty, depression, decline, and dependence rather than optimism, resilience, and happiness (Kite, Stockdale, Whitley, & Johnson, 2005). However, there is some evidence that demonstrates this is not necessarily true, for example, happiness has been found to increase with age (Yang, 2008). Additionally, although ageing is associated with cognitive and health decline, increased heterogeneity in cognitive and physical abilities has been found amongst older age groups and also an overlap in abilities between age groups (Christensen & Mackinnon, 1994; Christensen, 2001; Steel, Huppert, McWilliams, & Melzer, 2003). Attitudes towards ageing can influence societal behaviours including how older adults are valued and treated in the community. There is also evidence for the damaging effect of negative attitudes towards ageing and stereotypes on an individual's personal health outcomes. This indicates that ageing is not solely a biological process, but also a psychosocial process whereby attitudes, self-perceptions, and stereotypes of ageing can affect cognitive and physical health outcomes (Levy, 2003). This evidence comes from cross-cultural, longitudinal, and experimental studies. A variety of terms have been used to describe attitudes towards ageing. Attitudes towards and stereotypes of ageing encompass views of ageing which can refer either to other older adults or themselves. Self-stereotypes or self-perceptions refer specifically to internalised attitudes towards oneself.

Longitudinal evidence has demonstrated that older adults (aged 50-80 years) with more positive self-perceptions of ageing tended to participate in more preventative health behaviours over the next two decades, after controlling for age, education, functional health, gender, race and self-rated health. These preventative health behaviours included eating a balanced diet, exercising, alcohol consumption, medication compliance, seatbelt use, tobacco use, and regular doctor visits (Levy & Myers, 2004). Perhaps unsurprisingly, positive self-perceptions of ageing have also been found to be associated with slower functional health decline compared to negative self-perceptions. Further analyses were carried out on this data to assess whether this association was due to negative self-perceptions as a result of lower functional health. However, the effect remained even when only those with the same baseline functional health were included in analysis indicating the causal direction of the effect of negative self-perceptions on health overtime (Levy, Slade, & Kasl, 2002).

Older adults with positive self-perceptions of ageing were also found to live on average 7.5 years longer compared to those with negative self-perceptions of ageing, measured up to 23 years earlier. This effect was still found after controlling for age, gender, socioeconomic status, loneliness, and functional health, however it was partially mediated by 'will to live' (Levy, Slade, Kunkel, & Kasl, 2002). Another study by a different research group found that poor self-perceptions of ageing at baseline and also decline in self-perceptions of ageing over time were related to an increased risk of mortality at 16-year follow-up, independent of demographics, physical health, cognitive functioning and wellbeing (Sargent-Cox, Anstey, & Luszcz, 2013).

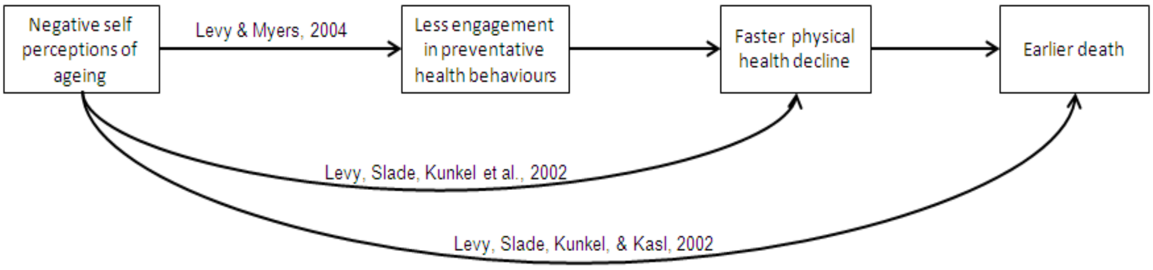


Figure 4.1. Potential knock-on-effects of engagement in preventative health behaviours, functional health decline, and longevity related to negative self-perceptions

The potential knock-on-effects of engagement in preventative health behaviours, functional health decline, and longevity related to negative self-perceptions in these studies are illustrated in Figure 4.1. It may be that the mechanisms through which longevity and functional health decline are affected by self-perceptions of ageing is through the level of engagement in preventative health behaviours, including physical activity. The studies described thus far which have investigated the effect on negative stereotypes or attitudes towards ageing on health outcomes have controlled for a number of demographic, psychosocial and health factors. However, they did not control for level of physical activity despite its well documented health benefits (Gu et al., 2009; Warburton, Nicol, & Bredin, 2006).

There is further longitudinal evidence for the effect of negative attitudes or stereotypes of ageing on other specific health outcomes. Participants aged 49 years and younger who were healthy at baseline with negative age stereotypes were significantly more likely to experience a cardiovascular event (i.e. strokes, myocardial infarctions, congestive heart failures, transient ischemic attacks, and angina attacks) during the 38-year follow-up compared to those with positive age stereotypes. A similar effect was found in a subsample of young participants at baseline (<40 years old) who had their first cardiovascular event after they were aged 60 years, despite the 20-year interval. Both of these effects were found after controlling for age, body mass index, depression, education, elevated blood pressure, family history of cardiovascular death, gender, marital status, number of chronic health-related conditions, race, self-rated health, cholesterol level, and smoking history (Levy, Zonderman, Slade, & Ferrucci, 2009). Another study investigated whether attitudes towards ageing contributed to hearing loss, in contrast to previous research which focused on whether hearing loss in older adults leads to psychosocial outcomes. Their findings indicated that their two age-stereotype variables (negativity and externality) had a stronger impact on hearing at 3-year follow-up compared to other established predictors of hearing loss, such as depressive symptoms, gender, race, and smoking history (Levy, Slade, & Gill, 2006).

In addition to the effect of age stereotypes on physical health, there is also evidence for their effect on cognitive performance. A longitudinal study was the first to demonstrate the influence of age stereotypes on memory performance over time (Levy et al., 2011). Those with more negative age stereotypes at 60 years old demonstrated significantly worse memory performance over the following 38 years compared to those with less negative stereotypes with increasingly greater disparities as they aged. At 70 years old, the memory performance of those with more negative age stereotypes was equivalent to the 73.14 year old participants with fewer negative age stereotypes. This age interval increased to 6.16 years at the ages of 80 and to 9.18 years at the age of 90. Overall, there was a greater memory decline of 30.2% after 60 years of age in those with more negative age stereotypes compared to those with fewer negative age stereotypes while controlling for objective and subjective health. Negative age stereotypes remained a significant predictor in a subsample of participants with excellent self-reported health who had a maximum of one health-related chronic condition at baseline. Additionally, perceived self-relevance moderated the effect of negative age stereotypes on memory performance which did not appear to be due to health differences. It may be that the self-relevance of attitudes and stereotypes of ageing could also moderate the effect on other health outcomes.

The moderating effect of self-relevance has been demonstrated between age groups, whereby cultural differences between attitudes towards ageing had an impact on the memory performance on older adults between cultures, but no differences were found between younger adults (Levy & Langer, 1994). This cross-sectional evidence demonstrated that groups of older adults (51-91 years old) with less cultural exposure to negative age stereotypes (Chinese and American Deaf cultural groups) performed better on memory tasks compared to those with more exposure to negative age stereotypes (United States cultural group). A positive correlation was also found between views toward ageing and memory performance.

There is experimental evidence that short-term exposure to positive or negative ageing stereotypes can affect physical health measures and cognitive ability. A meta-analysis of seven studies found that negative age priming elicited a three times greater detrimental effect on health outcomes compared to the beneficial effect of positive age priming in older adults (>60 years old). This effect was not influenced by whether priming was implicit or explicit (Meisner, 2012). For example, a 30 minute subconscious reinforcement of a positive ageing stereotype was shown to bring about improvements in walking speed and gait, compared to exposure to negative stereotypes (Hausdorff, Levy, & Wei, 1999). These improvements were reported to be related to the positive intervention, but not to age, gender, health status or psychosocial status. Further experimental evidence demonstrated that an intervention which managed to implicitly activate positive stereotypes of ageing tended to lead to an improvement in memory performance. Additionally, an intervention which managed to activate negative stereotypes of ageing tended to lead to worse memory performance (Levy, 1996).

Older adults who were subliminally exposed to negative ageing stereotypes demonstrated heightened cardiovascular responses (i.e. blood pressure and heart rate) when they faced mathematical and verbal challenges and at follow-up measurement (average of 26 minutes afterwards) compared to those who subliminally exposed to positive ageing stereotypes. It was hypothesised that self-efficacy may mediate this relationship as those in the negative prime group reported lower self-efficacy for mathematical performance which was associated with mathematical performance. In contrast, the positive prime condition reported higher levels of self-efficacy which were related to higher levels of performance (Levy, Hausdorff, Hencke, & Wei, 2000). Although, participants were randomly assigned to groups and did not vary on cardiovascular risk factors, baseline cognitive performance was not measured and therefore differences between groups not assessed. However, these studies demonstrate that even short interventions which expose older adults to negative attitudes and stereotypes of ageing can bring about significant physiological responses and negative changes in various cognitive and physical health outcomes. This evidence, together with the findings from longitudinal studies, indicate the importance of investigating attitudes towards ageing in relation to health outcomes.

The effects found in longitudinal studies may be a result of chronic exposure to negative attitudes and stereotypes of ageing via environmental cues. The effects of environmental age-related cues on health and longevity have been investigated across different domains. Those who wore uniforms to work were found to have lower morbidity compared to those who did not wear uniforms but who earned the same amount of money. Individual with younger spouses lived longer than those with older spouses, as did women who had children later in life compared to those who had children earlier in life. Both of the former groups would have been surrounded by younger age-related cues (Hsu, Chung, & Langer, 2010). Environmental cues are also likely to differ between cultures, which is likely to play a role in the development of attitudes towards ageing throughout life.

Aims and Hypotheses

This study investigated the relationship between attitudes towards ageing and self-reported health in older adults in the UK. The majority of the extant literature investigating the relationship between attitudes towards ageing and health is based on studies carried out in the United States and China. It was hypothesised that more negative attitudes towards ageing would be associated with poorer health based on the findings from other cultures. Perceived control was included in this study to explore whether it was a mechanism through attitudes towards ageing could impact on health outcomes. It was further hypothesised that perceived control would not mediate this relationship based on previous findings in Germany (Wurm, Tesch-Romer, & Tomasik, 2007). The present study also investigated whether level of physical activity mediated the effect of attitudes towards ageing on self-reported health as mechanism through which attitudes towards ageing could impact on health could be through higher participation in preventative health behaviours (Levy & Myers, 2004), such as physical activity.

Method

Participants

Participants aged 60 years and older resident in the UK (n = 123) were recruited using opportunity sampling through various methods to increase the diversity of the sample. Community dwelling older adults were recruited using volunteer sampling via email adverts which were distributed on the University of 3rd Age email lists in the Charnwood and Leicestershire divisions and were also passed on through social contacts. Participants were also recruited in sheltered housing communities and care homes using opportunistic sampling during coffee mornings. The mean age of the older adults who remained in the sample for analyses was 72.43 (SD = 8.53) with a range of 60 to 94 years (apart from age missing data, n = 5).

Measures

Attitudes towards ageing

Attitudes towards ageing were also captured using a validated questionnaire. The Attitudes to Ageing Questionnaire (AAQ; Laidlaw, Power, Schmidt, & Group, 2007) was used to capture internalised attitudes which related to the individual and their own experience of ageing as opposed to the open-response question aimed to capture participants' general view of older adults as a group. The AAQ also provides better resolution of responses that is also more standardised across participants compared to the open-response question. The AAQ has been validated cross-culturally and has been shown to have good internal consistency (0.74 to 0.81). It is made up of three subscales: psychological growth (e.g. "As people get older they are better able to cope with life"), physical change (e.g. "Problems with my physical health do not hold me back from doing what I want to"), and psychosocial loss (e.g. "Old age is a time of loneliness"). The subscales allowed domains of attitudes towards ageing to be analyses individually, rather than as a whole. The psychosocial loss subscale was reverse scored so that a higher score on each subscale indicated a more positive attitude towards ageing in each domain.

Perceived control

Perceived control was included due to its potentially mediating effect on health. It was captured using the dispositional trait hope scale (Snyder et al., 1991), which has previously been used to assess control beliefs as a mediator of the effect of age-related cognitions on health in later life (Wurm et al., 2007). The scale consists of 12 items and is made up of two subscales (agency and pathway with four items each) and four distracter items. Responses are coded on an 8-point continuum (1 = “definitely false”, to 8 = “definitely true”). The agency subscale consists of efficacy expectancies reflecting the belief in one's capacity to initiate and sustain actions to achieve goals e.g. “I energetically pursue my goals”. The pathway subscale consists of outcome expectancies reflecting belief in one's capacity to generate routes and strategies to reach goals, e.g. “There are lots of ways around any problem”. The agency and pathways subscales were previously found to be related but separate consistently (correlations of .40 to .50) with an overarching hope factor (Babyak, Snyder, & Yoshinobu, 1993). The scale was shown to be internally reliable (alphas of .74 to .88) and temporally stable (test retests over several weeks of .85).

Self-reported health

The EuroQol’s EQ-5D-5L health-related quality of life measure was used to capture health (Herdman, et al., 2011). It has been validated in a diverse patient population across 6 countries, including 8 patient groups with chronic conditions (cardiovascular disease, respiratory disease, depression, diabetes, liver disease, personality disorders, arthritis, stroke) and a student sample. Redistribution of responses to the EQ-5D-5L from a previous version (EQ-5D-3L) with fewer response levels was validated for all dimensions and all levels. The measurement properties of EQ-5D-5L were superior to the EQ-5D-3L in terms of feasibility, ceiling effects, discriminatory power and convergent validity. The scale is made up of two parts. The first part indicates participants’ functional health across five domains: mobility, self-care, usual activities, pain/discomfort, anxiety/depression. Each domain consisted of one question that was scored on five dimensions which indicate level of functioning or distress. The five levels included: no problems, slight problems, moderate problems, severe problems, and extreme problems. This 5-level version had significantly increased reliability and sensitivity while maintaining feasibility and reducing ceiling effects compared to a previous version with only three response dimensions. The second part of the EQ-5D-5L captures subjective health using a 0 - 100 visual analogue scale which is used alongside the EQ-5D-5L. Participants were asked how good their health was ‘today’, with 0 indicating the worst possible health and 100 indicating the best possible health. There is evidence for its independent predictive value of age of death (Idler & Benyamini, 1997).

Level of physical activity

To capture a quick estimate of participants’ level of physical activity, they were asked a single question which considered their physical activity level relative to others their own age: “compared to others your own age, do you think you are…” with the options: “much more physically active”, “more physically active”, “about the same” or “less physically active”. This question is similar to two used in the National Health Interview Survey in the United States (*National Health Interview Survey*, 1985).

Although recall questionnaires may provide a more detailed picture of an individual’s level of physical activity, this single-item question provided a quick alternative. This single question was found to have better convergent validity compared to an absolute physical activity question in older adults (What best describes your activity level?" with three response options: vigorously active for at least 30 min, 3 times per week; moderately active at least 3 times per week; or seldom active, preferring sedentary activities). It indicated evidence for discriminant validity and moderate agreement when re-administered seven days later. It also had fair / moderate to good associations when compared with indicators of physical function and little to no associations when compared with measured which were hypothesised to be theoretically not related to physical activity (Gill, Jones, Zou, & Speechley, 2012). Lower levels of physical activity on this single item question have been found to be inversely related to excellent/very good health and higher quality of life in older adults (Sternfeld, Cauley, & Harlow, 2000).

Data Analyses

Spearman's rho correlations were carried out to identify associations between age, attitudes towards ageing and perceived control subscales, and subjective and functional health. Two sets of hierarchical regressions were performance with self-reported functional health and subjective health as dependent variables to examine the relationship with attitudes towards ageing. In Step 1, age and gender were entered to assess their effect on functional and subjective health. Age and gender remained in all other steps as covariates. In Step 2, the three attitudes to ageing subscales (psychological growth, physical change, and psychosocial loss) were added. In Step 3, the perceived control subscales (agency and pathway) were added to see whether they mediated the effect of attitudes towards ageing. In Step 4, level of physical activity was added to investigate whether this mediated the effect of any of the psychosocial variables. Step 2b was an additional post-hoc step in which the perceived control subscales were entered with the covariates only. This was to assess their predictive value separate from attitudes to ageing subscales.

Interrater reliability

Interrater reliability was assessed by a second rater who rated 20% of the words (the first word given by each participant) from both groups across the three dimensions and who was blinded to group membership. Landis & Koch (1977) proposed this scale to describe the degree of concordance: 0.21-0.40, "Fair"; 0.41-0.60, "Moderate"; 0.61-0.80, "Substantial"; 0.81-1.00, "Almost perfect". As the categories were ordered, the weighted Kappa was calculated (using linear weighting) to adjust for close matches (for example positive and neutral is closer to a match compared to positive and negative).

The number of observed agreements of words on the positivity dimension between the two raters was 108 out of a total of 123 (compared to the number expected by chance of 51, Kappa = .792, SE = .049 95% CI from 0.697-0.888), this strength of agreement was considered to be 'substantial'. After adjustment for weighted agreement, it was still considered to be 'substantial' (Kappa = 0.854). Between the two raters on the internality dimension the number of observed agreements of words was 103 out of a total of 123 (compared to the number expected by chance of 41) this strength of agreement was considered to be 'substantial' (Kappa

= 0.756, SE = .049 95% CI from 0.659-0.853); after adjustment for weighted agreement, it was still considered to be ‘substantial’ (Kappa = 0.786). Between the two raters on the activity dimension the number of observed agreements of words was 104 out of a total of 123 (compared to the number expected by chance of 56, Kappa = .715, SE = .060 95% CI from 0.598-0.832), this strength of agreement was considered to be ‘substantial’, after adjustment for weighted agreement, it was still considered to be ‘substantial’ (Kappa = 0.744).

Results

The average age of participants was 72.5 years with a range from 60 to 94 and 81% of the sample was female. Descriptive information of attitudes to ageing, perceived control and health measures are shown in Table 4.1 split by those who are less or more physically active compared to others their own age. Due to the small numbers of some responses for level of physical activity, the two higher and two lower responses were combined to form two new variables. Older adults who considered themselves as less physically active compared to others the same age or about the same were combined into a ‘less active’ group. Older adults who considered themselves to be more or much more physically active compared to others the same age were combined into a ‘more active’ group. This also created a dichotomous variable which was suitable for use in the regression models.

No significant differences were found between more or less active groups on the open-response positivity, internality and activity dimensions (data not shown). The only significant correlations between the open-response attitudes towards ageing dimensions and other measures included: the positivity dimension with psychological growth and psychosocial loss subscales from the AAQ and with the perceived control pathway subscale (Table 4.3). However, the Spearman’s rho reflected small effect sizes using Cohen’s (1992) criteria for correlations (.1 = small effect; .3 = medium effect; .5 = large effect). There were no significant correlations between positivity, internality and activity dimensions and either health outcome measure (Table 4.3). These non-significant results may indicate that the positivity, internality, and activity dimensions captured external rather than internalised attitudes towards ageing (see discussion) and therefore they were not included in the regression analyses.

Participants in the more physically active peer comparison group were on average older than those in the less physically active group (Table 4.1). Significant differences were found between groups on some attitudes to ageing questionnaire and perceived control subscales. On average, participants who were more physically active were also more positive about physical change with ageing and had a higher perceived control on the agency subscale compared to those who were less physically active. Additionally, on average participants who were more physically active had higher levels of subjective and functional health compared to those who were less physical active. There were no significant differences between men and women in age, subjective or functional health, or attitudes to ageing or perceived control subscales (data not shown).

Table 4.1. Descriptives and tests of differences between participants who were more or less physical active across all demographic, psychosocial and health variables (n = 102)

Peer comparison of physical activity	Mean (SD)		Test of difference
	More	Less	
Physically active; n	58	44	
Female; n	42	41	0.12
Male; n	**20**	**8**	**5.14***
Age	**74.6 (9.1)**	**69.6 (7.4)**	**858.5****
Psychological growth	26.3 (3.9)	24.8 (5.5)	1054.5
Physical Change	**28.9 (5.1)**	**23.6 (5.1)**	**579.5*****
Psychosocial loss	31.3 (5.3)	29.5 (6.1)	1051.0
Agency	**26.2 (4.0)**	**23.9 (4.8)**	**937.0***
Pathway	25.6 (4.3)	24.7 (4.8)	1128.5
Subjective health	**87.4 (10.3)**	**71.5 (24.1)**	**726.0*****
Functional health	**.84 (.13)**	**.71 (.24)**	**935.0***

Note: Significance levels *p < .05, ** p < .01 ***p < .001. SD = Standard deviation, Mann-Whitney U Test of difference was carried out were for all continuous variables and χ^2 tests were carried out for gender. Significant correlations highlighted in bold.

Table 4.2 Spearman correlations between age, attitudes to ageing questionnaires and perceived control subscales, subjective health, and functional health (n=102)

		1	2	3	4	5	6	7
1	Age							
2	Psychological growth	**-.15**						
3	Physical change	**-.16**	.55**					
4	Psychosocial loss	**-.18**	.26*	.27**				
5	Agency	**-.06**	.51**	.46**	.44**			
6	Pathway	**-.16**	.36**	.36**	.43**	.72**		
7	Subjective health	-.26**	.26**	.60**	.33**	.38**	.37**	
	Functional health	-.30**	.26**	.52**	.31**	.32**	.28**	.71**

Note: Significance levels *p < .05, ** p < .01 ***p < .001. Non-significant correlations highlighted in bold.

There were significant correlations between all attitudes to ageing questionnaire and perceived control subscales with both functional health (EQ5D) and subjective health ratings (Table 6.2). On average, participants who were more positive about psychological growth, physical change and psychosocial loss with ageing also had higher perceived control (agency and pathways subscales). Older age was significantly correlated with poorer functional and subjective health, but was not significantly correlated with any attitudes to ageing questionnaire or perceived control subscales.

Table 4.4 shows the hierarchical regression models for subjective health ratings. In Step 1, age was a significant predictor of subjective health but not gender. These variables explained 3% of adjusted subjective health variance. However, in Step 2 when attitude to ageing subscales were included, physical change and psychosocial loss were significant and they attenuated the effect of age. The attitude to ageing subscales explained an additional 40% of the variance. In Step 2b, when perceived control subscales were included with age and gender only, the pathway subscale was significant. The perceived control subscales explained an additional 19% of subjective health variance. In Step 3, when both attitudes to ageing and perceived control subscales were included, psychological growth and physical change were significant as well as the pathway perceived control subscale. Thus the addition of perceived control subscales attenuated the effect of psychosocial loss. In this step, a total of 44% adjusted variance of subjective health. In Step 4, when physical activity level was included, level of physical activity was significant and attenuated the effect of psychological growth. Physical change and pathway also remained independent contributors in explaining the variance of subjective health in the final model and age became significant again. The addition of level of physical activity reduced the independent contribution (standardised beta) of physical change. The total adjusted variance explained in Step 4 was 48%. The R^2 change at each step was significant indicating a significantly additional amount of variance explained.

Table 4.5 shows the hierarchical regression models for functional health. In Step 1, age was a significant predictor of subjective health but not gender. These variables explained 3% of adjusted functional health variance. However, in Step 2 when attitude to ageing subscales were included, physical change and psychosocial loss were significant and they attenuated the effect of age. The attitude to ageing subscales explained an additional 37% of the variance. In Step 2b, when perceived control subscales were included with age and gender only, the pathway subscale was significant. The perceived control subscales explained an additional 15% of functional health variance. In Step 3, when both attitudes to ageing and perceived control subscales were included, psychosocial loss and physical change remained significant but they attenuated the effect of the pathway perceived control subscale. Thus, the addition of perceived control subscales explained only a further non-significant 1% of the functional health variance. In Step 4, when physical activity level was included, this was not a significant predictor (adding an additional non-significant 1%) while physical change and psychosocial loss remained significant predictors of functional health in the final model. The total adjusted variance of functional health explained in Step 4 was 40%.

Table 4.4 Regression model of attitudes to ageing and perceived control subscales to predict subjective health rating (n = 102)

Step		β	Adjusted R^2	Cum R^2	R^2 change	F
1	**Age**	**-.22***	.03	.05	.05*	2.55
	Gender	-.28				
2	Age	-.09	.41	.45	.40***	15.44***
	Gender	.05				
	Psychological growth	-.15				
	Physical change	**.62*****				
	Psychosocial loss	**.24****				
2b	Age	-.17	.21	.24	.19***	7.54***
	Gender	-.09				
	Agency	.15				
	Pathway	**.34****				
3	Age	-.09	.44	.48	.04*	12.44***
	Gender	.01				
	Psychological growth	**-.21***				
	Physical change	**.60*****				
	Psychosocial loss	.16				
	Agency	-.05				
	Pathway	**.25***				
4	**Age**	**-.17***	.48	.52	.04*	12.59***
	Gender	.04				
	Psychological growth	-.17				
	Physical change	**.46*****				
	Psychosocial loss	.13				
	Agency	-.09				
	Pathway	**.28****				
	Physically active	**-.25****				

Significance levels *p < .05, ** p < .01 ***p < .001. Cum R^2=cumulative R^2, β = standardised beta values

Table 4.5 Regression model of attitudes to ageing and perceived control to predict functional health (n = 103).

Step		β	Adjusted R^2	Cum R^2	R^2 change	F
1	**Age**	**-.23***	.03	.05	.05*	2.71*
	Gender	-.04				
2	Age	-.11	.39	.42	.37***	14.00***
	Gender	.03				
	Psychological growth	-.14				
	Physical change	**.54*****				
	Psychosocial loss	**.30*****				
2b	Age	-.19	.17	.21	.15***	6.33***
	Gender	-.10				
	Agency	.17				
	Pathway	**.27***				
3	Age	-.11	.39	.43	.01	10.30***
	Gender	.00				
	Psychological growth	-.18				
	Physical change	**.53*****				
	Psychosocial loss	**.24****				
	Agency	-.02				
	Pathway	.15				
4	Age	-.15	.40	.44	.01	9.37***
	Gender	.02				
	Psychological growth	-.16				
	Physical change	**.45*****				
	Psychosocial loss	**.23***				
	Agency	-.04				
	Pathway	.16				
	Physically active	-.14				

Significance levels *p < .05, ** p < .01 ***p < .001. Cum R^2=cumulative R^2, β = standardised beta values

Discussion

Attitudes towards ageing, perceived control, and self-reported health differed between those who considered themselves to be less or more physically active compared to others their own age. Participants who considered themselves to be more or much more physically active compared to others their own age reported significantly higher levels of subjective and functional health, more positive attitudes towards ageing in relation to physical change, and higher perceived control in relation to efficacy expectancies reflecting the belief in one's capacity to initiate and sustain actions to achieve goals (agency subscale). Participants who considered themselves to be more or much more physically active compared to others their own age were also older compared to those who considered themselves to be about the same or less physically than others their own age. More positive attitudes towards ageing and higher levels of perceived control were significantly correlated to each other on all subscales. They were also positively correlated with better self-reported functional and subjective health. Age was significantly correlated with self-reported functional and subjective health but not with any attitudes towards ageing and perceived control subscales. Older age was associated with poorer subjective and functional health.

The final model in the hierarchical regression for subjective health indicated that more negative attitudes related to physical change with ageing, lower perceived control (pathway subscale), and lower levels of peer comparison level of physical activity were independently associated with worse subjective health. Earlier models indicated that the perceived control pathway subscale attenuated the effect of psychosocial loss and that level of physical activity attenuated the effect of psychological growth. The final model in the hierarchical regression for functional health indicated that more negative attitudes related to physical change with ageing and psychosocial loss were independently associated with worse functional health. The association between pathway and functional health in an earlier model was attenuated by the addition of the attitudes towards ageing subscales. Peer comparison level of physical activity did not significantly explain additional variance of functional health. Although age was a significant predictor of functional and subjective health when entered with gender only, when either the attitudes to ageing or perceived control subscales were added, age was no longer significant. With the exception of the final subjective health regression model when it became significant again.

The results from the present study supported the hypothesis that more negative attitudes towards ageing would be associated with poorer health. This was true of self-reported subjective as well as functional health. These findings from the UK are consistent with the associations found between attitudes towards ageing and various health outcomes in other cultures (Levy, Slade, & Kasl, 2002). However, not all attitude towards ageing subscales remained independently significant, thus suggesting a potentially domain specific effect of certain attitudes towards ageing on health outcomes. More negative attitudes relating to physical change with ageing remained a significant predictor of both subjective and functional health after controlling for perceived control and level of physical activity. More negative attitudes towards ageing relating to psychosocial loss remained a significant predictor of self-reported functional health after controlling for perceived control and level of physical activity. More negative attitudes related to psychosocial loss with ageing remained a significant independent predictor of poorer functional health after perceived control and level of physical activity were controlled for.

Psychological growth was not a significant predictor of function health and did not remain a significant predictor of subjective health after controlling for level of physical activity. It has been suggested that attitudes towards ageing are domain specific control beliefs themselves, as they refer solely to ageing which is associated with a decline in health and a loss of control over the body and mind (Wurm et al., 2007). Thus, the belief that ageing brings functional health losses reflects low perceived control as they relate to beliefs about inevitable functional decline with ageing. This is in contrast to the belief that ageing brings ongoing development (for example, wisdom) which would reflect higher perceived control. The findings of the present study suggest that only attitudes relating to domains of ageing which are associated with loss are predictive of health. This could explain why psychological growth was not a significant predictor of functional health or subjective health. These findings corroborate the findings from other studies which found that the deleterious effect of negative attitudes on various health outcomes is larger than the benefits of positive attitudes towards ageing. It also suggests that perceived control may play a role in how attitudes towards ageing affect health outcomes.

The hypothesis that perceived control would not mediate the relationship between attitudes towards ageing and health was supported for functional health but not for subjective health. The hierarchical regression models for subjective health indicated that the pathway aspect of perceived control mediated the effect of psychosocial loss to the extent that psychosocial loss no longer independently explained variance of subjective health. However, it did not mediate the effect of attitudes related to physical change with ageing. The pathway subscale consists of outcome expectancies reflecting belief in one's capacity to generate routes and strategies to reach goals. Having higher belief in one's capacity in this context could be protective against negative attitudes towards ageing relating to psychosocial loss. The common pathway could reflect coping strategies and psychological resilience. Another study found that resilience, attitude and lack of depression appear to play a more important role than physical health and cognitive acuity in self-reported successful ageing (Jeste et al., 2013). This suggests that perceptions of successful ageing are distinct from simply the maintenance of physical health. Subjective health ratings may reflect perceptions of health and may be more closely related to perceptions of successful ageing compared to self-reported functional health, which captures more tangible functional limitations. This distinction may explain the different pattern of results between these health measures. Perceptions of good health despite functional limitations may reflect an individual's coping and adaptive strategies. It also indicates a potential scope for interventions to improve older adults' coping and adaptive strategies to promote successful ageing.

It has previously been suggested that a mechanism through which attitudes towards ageing can affect health is through influencing participation in behaviours associated with healthy ageing, for example physical and social activities. Psychosocial loss could be associated with fewer social interactions as a result of functional health decline, as individuals who are less functionally independent may be less able to leave the house to engage in social activities. Alternatively, individuals with more negative attitudes related to psychosocial loss with ageing may not strive to maintain social connections. This may lead to faster functional health decline through fewer social activities and related incidental physical activity. Additionally, physical activities often involve a social component, thus cessation of physical activities may increase social isolation.

Level of physical activity mediated the effect of attitudes towards ageing for subjective health but not for functional health. The hierarchical regression models for subjective health indicated that peer comparison level of physical activity mediated the effect of attitudes relating to psychological growth with ageing to the extent that psychological growth no longer independently explained variance of subjective health. Attitudes related to psychological growth with ageing may be related to motivation to exercise, which could explain why their effects on subjective health were not independent of each other. Another potential mechanism is through mental health as attitudes towards ageing have also been found to impact on mental health. Whereby their effect was stronger than the other measured predictive factors including socio-demographic variables and health variables (Lai, 2009).

The between group test of difference indicated that lower levels of physical activity were related to poorer functional health. Therefore, it was surprising that level of physical activity did not independently explain additional variance of functional health, particularly as the physical change subscale was the strongest predictor for both subjective and functional health. Lower levels of physical activity were also related to attitudes towards ageing related to physical change. The presence of a relationship between physical activity and attitudes about physical change with ageing could result in covariance and thus limit the independent contribution of physical activity to the model. However, as physical activity remained a significant predictor of subjective health, it is unlikely that this is the case.

The non-significant contribution of level of physical activity may indicate that there are other mechanisms through which attitudes towards ageing impact on health other than through the participation in preventative health behaviours as previously found in other studies (Levy & Myers, 2004). Alternatively, the simple self-report measure may not have accurately captured levels of physical activity as it relies on individuals making a judgement based on their perceptions of the levels of physical of other older adults. It is also limited in its resolution.

Another potential mechanism of the effect of attitudes towards ageing on health that has been suggested is through physiological mechanisms (Wurm et al., 2007). The belief that ageing in associated with physical decline may cause anxiety and stress due to the perception that decline is inevitable and therefore individuals have a lower level of control over this. Psychological stress and depression has been related to immune down-regulation in older adults which can lead to declines in health (Kiecolt-Glaser & Glaser, 2002; Kiecolt-Glaser & McGuire, 2002). In contrast, there is evidence for the protective effect of attitudes towards ageing against physiological stress responses (Levy et al., 2000).

The finding that age was not significantly correlated with any of the attitudes towards ageing or perceived control subscales indicated inter-individual variation in levels of positivity of attitudes toward ageing and in levels of perceived control. Thus, older age is not necessarily associated with more negative attitudes towards ageing and lower levels of perceived control.

It was surprising that those who reported that they were more active than others their own age could were significantly older compared to those who reported they were either about the same or less physically active. This could reflect a sampling or survivor bias. Potentially those who were more likely to volunteer to participate in the study were also more likely to be more physically active. An alternative explanation could be that the peer comparison of ‘others their own age’ may reflect their stereotypes of other older adults. Those who held more negative stereotypes of other older adults may perceive them to not physically active and thus their relative comparison would be based on this stereotype. However, participants who reported that they were more physically active also reported more positive attitudes towards ageing in relation to physical change so this is unlikely to have been the case. This may reflect the distinction between self-concept and externalised attitudes towards others which has been found in older adults in Japan (Levy, 1999). This was indicated by the lack of correlation between any dimensions of the open-response attitudes towards ageing question and attitudes towards ageing in relation to physical change (AAQ subscale). The AAQ asks more about personal experiences of ageing and attitudes relating to the participant themselves, compared to the open-response question which refers to older adults as a group. Thus the AAQ, is more likely to capture attitudes towards ageing that are self-stereotypes or self-perceptions are therefore would also be more likely to reflect their own behaviours. This may explain why there was no significant difference in open-response dimensions between those who considered themselves to be more or less physically active compared to others their own age.

These results add to the growing body of that evidence that ageing is not solely a biological process, but also a social and psychological process. These findings support the current literature on the importance of attitudes towards ageing on health.

The findings further indicate that perceived control may be important to consider in this context. However, the mediating effect of perceived control on subjective but not functional health suggests that further research is needed to investigate the mechanisms of this relationship. The cross-sectional and self-report nature of the data limits the conclusions that can be drawn from this finding. Further research should be carried out to see whether participating in physical activity can improve attitudes towards ageing. The implications of this research could indicate whether physical activity could have a protective effect on health outcomes which have previously declined with negative attitudes towards ageing.

Chapter 5: Study 1b - Attitudes towards ageing in young and older adults in the UK

Introduction

There is substantial evidence that attitudes towards older adults are more negative compared to those towards young adults and tend to depict a picture of frailty, depression, decline, and dependence rather than optimism, resilience, and happiness (Kite, Stockdale, Whitley, & Johnson, 2005). However, there is evidence that demonstrates this is not necessarily true, for example, happiness has been found to increase with age (Yang, 2008) as well as increased heterogeneity in cognitive and physical abilities has been found and also an overlap in abilities between age groups (Christensen & Mackinnon, 1994; Christensen, 2001; Steel, Huppert, McWilliams, & Melzer, 2003). There is also evidence for the damaging effect of negative attitudes towards ageing and stereotypes on an individual's personal health outcomes. This indicates that ageing is not solely a biological process, but also a psychosocial process whereby attitudes, self-perceptions, and stereotypes of ageing can affect cognitive and physical health outcomes (Levy, 2003). A variety of terms have been used to describe attitudes towards ageing. Attitudes towards and stereotypes of ageing encompass views of ageing which can refer either to other older adults or themselves. Self-stereotypes or self-perceptions refer specifically to internalised attitudes towards oneself.

Development and internalisation of ageing stereotypes

The internalisation of ageing stereotypes into self-stereotypes when individuals become older has been discussed and termed ‘stereotype embodiment’ (Levy, 2009). When individuals consider themselves to be ‘old’, they move from the out-group to the in-group, and it has been suggested that ageing attitudes and stereotypes are the only domain for which the social psychological theory of in-group preference does not apply (Levy, 2003). The development and operation of ageing stereotypes in terms of how culturally held attitudes towards ageing internalise to become self-stereotypes and thus impact on personal health outcomes has also been discussed (Levy, 2003). Self-stereotypes originate as ageing stereotypes which are formed during childhood, they are internalized as children adopt the attitudes and stereotypes from their family and cultural environments (Allport, 1954). There is evidence that children in America as young as three can identify a drawing of the oldest man (compared to three others at earlier stages of life), and that 67% of children ranging from preschool to sixth grade considered the oldest man as 'helpless' and 'incapable of caring for himself'. These negative attitudes are also projected onto the children's' own expectations for ageing, whereby 60% of them responded negatively when asked how they would feel about becoming an 'elderly person' e.g. 'I would feel awful' (Seefeldt, Jantz, Galper, & Serock, 1977). Stereotypes can be reinforced by the repeated exposure to cultural ageing stereotypes.

While individuals are young, ageing stereotypes do not yet apply to themselves, thus there is no psychological need to defend against them while they are being acquired. This could, in part, explain why children seem to be more susceptible to adopting these stereotypes (Levy & Banaji, 2002). Additionally, Levy (2003) proposed that stereotypes could be reinforced through cognitive processes. For example, individuals are likely to continue to draw on stereotypes which facilitate fast and efficient processing of the vast amount of the information encountered as part of daily life (Bodenhausen, Kramer, & Susser, 1994; Macrae, Milne, & Bodenhausen, 1994); they can be considered 'shortcuts' for perceptual processing regarding categories of individuals (Braithwaite, 2002). Furthermore, individuals may selectively recall information about older adults which is congruent with their stereotypes (Levy, 1996).

The potential for young adults' attitudes towards ageing to be influenced by their experiences and frequency of interactions with older adults has been investigated. One study suggested that negative age stereotypes had primacy over experience with older adults. Their results demonstrated that nursing home caregivers with negative attitudes towards ageing communicated with older adults using 'elderspeak', regardless of the physical or cognitive abilities of the older adults they were addressing (Kemper, 1994). They spoke more slowly, paused for longer, used fewer long words, and reduced the length and complexity of what they were saying, However, another study found that having frequent or occasional contact with unrelated older adults accounted for some of the variance in attitudes towards older adults (Funderburk, Damron-Rodriguez, Storms, & Solomon, 2006). These inconsistencies may reflect differences in how attitudes towards ageing were captured.

Young adults' attitudes towards ageing

The stereotypes that young adults hold have been found to affect how they engage with older adults. For example, in the United States young adults holding negative stereotypes of older adults were found to make fewer demands on an older adults, due to judgements of diminished competence (Rodin & Langer, 1980). Also, nursing home caregivers with negative attitudes towards ageing spoke to all older adults using 'elderspeak' despite the varied cognitive abilities or physical health of the older adults they were addressing (Kemper, 1994). These interactions between young adults or caregivers and older adults provide social reinforcement for negative self-stereotypes those older adults may already hold and may also have a priming effect on physical and cognitive health, similar to those in the aforementioned experimental studies. This may have a profound long-term effect if these interactions occur on a daily basis.

Young adults' stereotypes of older adults also affect how they feel about ageing and how they perceive their own future (Lowin, Knapp, & Mccrone, 2001; Seefeldt et al., 1977). This could influence their perceived control of future health and the degree to which they believe age-related decline is inevitable, and would thus dissuade them from carrying out preventative health behaviours (Levy & Myers, 2004). A reduction in preventative health behaviours due to a belief in inevitable age-related decline could lead to a self-fulfilling prophecy of health decline.

A final point of note is that young adults' ageing stereotypes become self-stereotypes when they reach older adulthood (Levy, 2003). There is evidence for a consistency between attitudes towards ageing across age groups within the same culture (Luborsky & McMullen, 1999; Sokolovsky, 1993). Therefore, it may be that the attitudes towards ageing and age stereotypes formed when younger, impact on physical and cognitive health later in life, for example, up to 38 years later for cardiovascular events (Levy et al., 2009).

Aim and hypotheses

This study aimed to identify and compare attitudes to ageing in younger versus older adults in the UK. Previous studies carried out in the UK have explored young adults' attitudes towards ageing using qualitative methods (Phoenix & Grant, 2009; Phoenix & Sparkes, 2006, 2007) or compared specific domains of attitudes towards ageing (filial piety) across older adults in different cultures (Laidlaw et al., 2010). However, no studies to the author's knowledge have investigated differences between attitudes towards ageing across generations within the UK. It was hypothesised that there would not be significant differences between attitudes towards ageing between age groups based on previous findings in other cultures of consistencies between generations (e.g. Levy & Langer, 1994). This study also aimed to investigate whether attitudes towards ageing vary between young adults who have different levels of contact with older adults

Method

Participants

The older adults group in the UK (n = 123) were recruited using opportunity sampling through various methods to increase the diversity of the sample. Community dwelling older adults were recruited using volunteer sampling via email adverts which were distributed on the University of 3rd Age email lists in the Charnwood and Leicestershire divisions and were also passed on through social contacts. Older adults were also recruited in sheltered housing communities and care homes using opportunistic sampling during coffee mornings. The mean age of the older adults who remained in the sample for analyses was 72.43 (SD = 8.53) with a range of 60 to 94 years (apart from age missing data, n = 5). Precise age data were not available for the young adults in the UK; however, a common age for attending university for undergraduate degrees in the UK is 18 to 21 years old.

Attitudes towards ageing

Attitudes towards ageing were captured using an open-response question. Participants were asked to "Write down five words or short phrases that you associate with the elderly". This was used to capture attitudes that were culturally relevant to participants in each country without limiting responses to predefined domains which may be culturally biased. This method of capturing attitudes towards ageing has previously been used in older and younger populations across cultures (Levy et al., 2006; Levy & Langer, 1994). The Chinese responses were translated and back translated to ensure the meanings were accurate. The present studies used the same method of coding as previous studies to code each response on three dimensions. Each response was coded in terms of whether it was a positive, negative or neutral attribute (positivity dimension) and also by the type of adjective it was (internality and activity dimensions):

Positivity dimension: descriptions were scored based on whether the rater thought they described the elderly in a positive (score = 1), neutral or not applicable (score = 0.5) or negative light (score = 0).

Internality dimension: descriptions were scored based on whether the rater thought they described an internal quality/trait/characteristic of the elderly (score = 1), neutral quality or not applicable (score = 0.5) or external quality (score = 0).

Activity dimension: descriptions were scored based on whether the rater thought they described the elderly as being active (not only physically active, but could mean active within the community/society) (score = 1) or inactive (score = 0) or not applicable to that word (score = 0.5).

The dimensions were not mutually exclusive e.g. "often teaches children" would be positive on positivity dimension (score=1), neutral on internality dimension (score=0.5) and active on activity dimension (score=1). It was assumed, as in Levy and Langer (1994), that those individuals with more positive attitudes towards ageing would report more positive (e.g., “friendly” or “wise” as opposed to “stubborn” or “boring”) and active descriptions (e.g., “walks a lot” as opposed to “sleeps a lot”). They also thought that those with more positive attitudes towards ageing would report more internal qualities of an older person, such as their disposition (e.g., “kind” or “funny”) rather than more external characteristics (e.g., “wrinkled” or “grey hair”).

Interrater reliability

Interrater reliability was assessed by a second rater who rated 20% of the words (the first word given by each participant) from both groups across the three dimensions and who was blinded to group membership. Landis & Koch (1977) proposed this scale to describe the degree of concordance: 0.21-0.40, "Fair"; 0.41-0.60, "Moderate"; 0.61-0.80, "Substantial"; 0.81-1.00, "Almost perfect". As the categories were ordered, the weighted Kappa was calculated (using linear weighting) to adjust for close matches (for example positive and neutral is closer to a match compared to positive and negative).

The number of observed agreements of words on the positivity dimension between the two raters was 181 out of a total of 215 (compared to the number expected by chance of 90, Kappa = .728, SE = .040 95% CI from 0.649-0.807), this strength of agreement was considered to be ‘substantial’. After adjustment for weighted agreement, this improved the interrater reliability to ‘almost perfect’ (Kappa = 0.820). Between the two raters on the internality dimension the number of observed agreements of words was 185 out of a total of 225 (compared to the number expected by chance of 78) with a this strength of agreement was considered to be ‘substantial’ (Kappa = 0.726, SE = 0.038 95% CI from 0.652-0.801); after adjustment for weighted agreement, it was still considered to be ‘substantial’ (Kappa = 0.777). Between the two raters on the activity dimension the number of observed agreements of words was 187 out of a total of 215 (compared to the number expected by chance of 100) (SE = 0.050 95% CI from 0.700-0.897), this strength of agreement was considered to be ‘substantial’ (Kappa = 0.757 after adjustment for weighted agreement, it was still considered to be ‘substantial’ (Kappa = 0.779).

Frequency of contact with older adults

Frequency of contact with older adults was captured in young adults in the UK. The amount of contact that young adults had with older adults was self-reported on three levels: “no contact” = 0, “a little contact” (infrequently) = 1, and “a lot of contact” (e.g. regularly or once a week) = 2.

Data analysis

Participants with missing data on the open-response attitudes towards ageing question were excluded from all analysis. Interrater reliability for coding of the open-response question was calculated using cross tabs in SPSS 21.0 and then an online calculator calculated the weighted kappa scores (GraphPad Software, 2014). Descriptions were sorted into clusters which formed semantic categories and subcategories to identify patterns in frequencies of responses from the UK and China. The categories and subcategories identified were: (1) Functional health, consisting of physical functioning, cognitive functioning, health, and independent living; (2) Activities, consisting of physical activities and sedentary behaviours, and leisure activities; (3) Social, consisting of social support, social interaction, social status, and identity; (4) Personal attributes, consisting of mental attitudes, personal disposition, personal affect, and wisdom; (5) External attributes, consisting of appearance, objects, and wealth. The clusters of words and short phrases into semantic categories were discussed with a number of other researchers to ensure that the descriptions were reliability sorted and the categories were appropriately named. Descriptions that fitted into more than one category were counted in all relevant categories, for example, “slow” could be referring to cognitive or physical functioning, “grandparents” could be interpreted as social support as well as identity, and “hearing aids” are objects which also relate to health.

Tests of difference were carried out using Chi-square and independent t-tests for categorical and continuous variables, respectively. Adjustments were used when necessary by Levene’s test for equality of variance. Mann-Whitney U tests where used when histograms indicated non-normal distributions. An independent t-test was also carried out to test for mean differences on positivity, internality and activity dimensions between groups of young adults who responded with “no contact” and “a lot of contact” with older adults. Participants with missing data were excluded listwise for analyses. The Kruskal Wallis test was used to assess mean differences on the positivity, internality and activity dimensions between three groups based on level of contact that young adults had with older adults.

Results

Positivity, internality and activity dimensions

On average, there were no significant differences between attitudes towards ageing reported by young and older adults on all three dimensions (Table 5.1). The difference between groups on the activity dimension approached significance; older adults responded with more descriptions related to being active compared to young adults. On average, responses from both groups were predominantly negative and related more to internal qualities, rather than external attributes and inactivity than being active. Within groups, there was a larger variation in responses on the positivity dimension for older adults, with a skew towards negative responses. The young adults’ responses on this dimension were normally distributed. A mean score of 0 indicated that, for example, on the positivity dimension, all of the participant’s five descriptions of older adults were negative, and conversely a mean score of 1 would indicate that all five of their descriptions were positive. It can be seen in Figure 5.1 and table 5.2 that the distribution of frequency percentages of attitudes to ageing across each dimension was similar in young and older adults. However, nearly three times as many older adults responded with entirely negative descriptions compared to young adults. Additionally, over twice as many older adults responded with only positive descriptions compared to young adults. No significant differences were found between men and women within age groups across positivity, internality or activity dimensions (Table 5.3).

No significant association was found between young adults' frequency of contact with older adults and their levels of positivity χ^2 (2) = 0.56, *p* = .76), internality χ^2 (2) = 2.31, *p* = .32 or activity χ^2 (2) = 0.14, *p* = .93 in their responses. No significant association was found on any dimension even when the group who had no contact with older adults was compared to those who had frequent contact (positivity: *t* = -0.49, *p* = .63; internality: *t* = -1.21, *p* = .23; activity: *t* = -0.02, *p* = .99).

Table 5.1. Means of attitudes to ageing responses across dimensions and cultures.

Attitudes dimension	Mean (Standard deviation)		Test of difference	
	Older adults	Young adults	*t*	*p*
Positivity	0.41 (0.30)	0.45 (0.25)	-1.12	.26
Internality	0.58 (0.25)	0.57 (0.24)	0.37	.71
Activity	0.44 (0.20)	0.40 (0.16)	1.81	.07

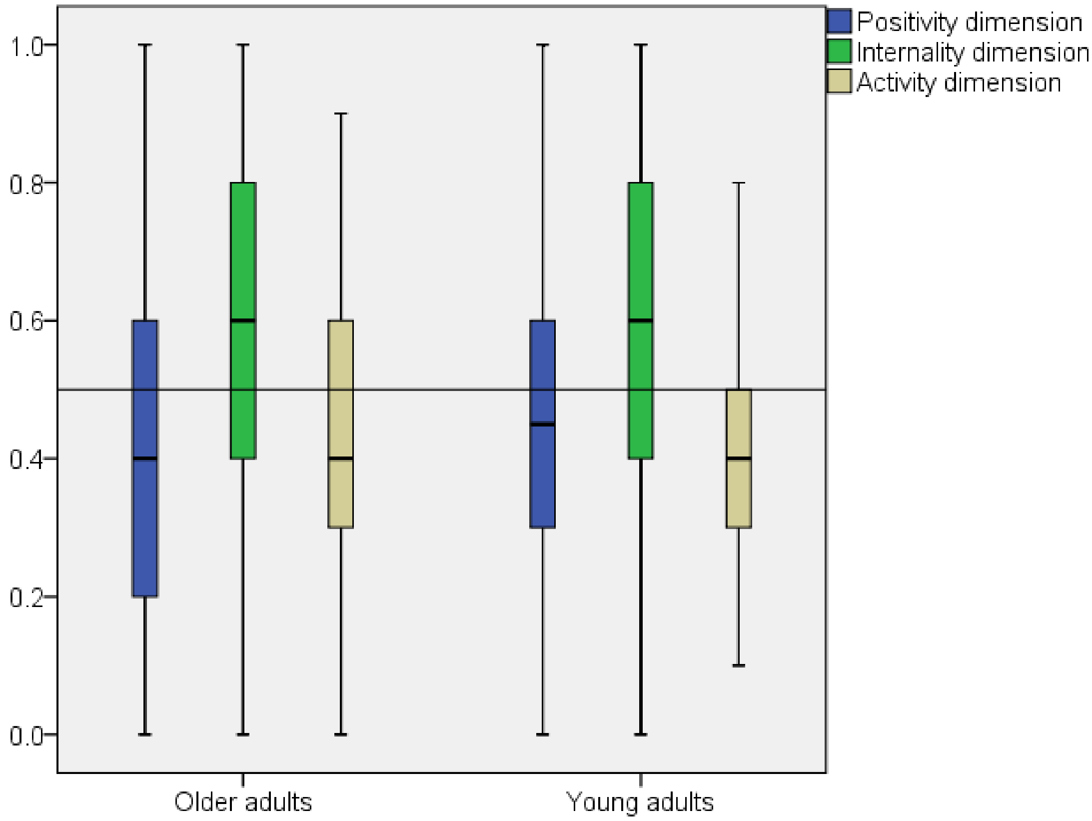


Figure 5.1. Box plots of attitudes towards ageing of young and older adults across positivity, internality and activity dimensions.

Table 5.2 Mean scores of participant responses across cultures and dimensions

		Mean scores of five words/phrases										
		0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1
Positivity dimension												
Young	frequency	5.0	8.0	8.0	12.0	13.0	10.0	16.0	7.0	11.0	0.0	2.0
	%	5.4	8.7	8.7	13.0	14.1	10.9	17.4	7.6	12.0	0.0	2.2
Older	frequency	19	9	18	8	19	10	10	9	11	4	6
	%	15.4	7.3	14.6	6.5	15.4	8.1	8.1	7.3	8.9	3.3	4.9
Internality dimension												
Young	frequency	3.0	3.0	5.0	4.0	12.0	12.0	18.0	8.0	19.0	3.0	5.0
	%	3.3	3.3	5.4	4.3	13.0	13.0	19.6	8.7	20.7	3.3	5.4
Older	frequency	4	2	7	7	15	19	24	9	15	10	11
	%	3.3	1.6	5.7	5.7	12.2	15.4	19.5	7.3	12.2	8.1	8.9
Activity dimension												
Young	frequency	0.0	3.0	14.0	21.0	21.0	17.0	9.0	4.0	3.0	0.0	0.0
	%	0.0	3.3	15.2	22.8	22.8	18.5	9.8	4.3	3.3	0.0	0.0
Older	frequency	3	6	12	20	22	18	24	10	5	3	0
	%	2.4	4.9	9.8	16.3	17.9	14.6	19.5	8.1	4.1	2.4	0.0

Table 5.3 Gender comparisons within age groups across attitudes towards ageing dimensions

Attitudes dimension	Mean (Standard deviation)						Test of difference	
	Young		Mann-Whitney U	*p*	Older		Mann-Whitney U	*P*
	Men	Women			Men	Women		
Positivity	0.49 (0.26)	0.43 (0.25)	458.5	.32	0.42 (0.27)	0.40 (0.31)	1587.8	.78
Internality	0.57 (0.25)	0.56 (0.22)	507.0	.68	0.64 (0.22)	0.56 (0.26)	1401.5	.20
Activity	0.40 (0.15)	0.39 (0.16)	521.0	.80	0.44 (0.19)	0.45 (0.21)	1586.0	.78

Domains of attitudes towards ageing

When responses were clustered into semantic categories, differences in the distributions of responses between age groups emerged (Figure 5.3). However, the words and phrases used were similar in the majority of categories (Table 5.4). In terms of functional health, young adults responded with considerably more descriptions of physical functioning (20.5%) and cognitive functioning (10.6%) compared to older adults (12.0% and 7.1% respectively). All of the physical functioning descriptions were negative for young adults and the majority were also negative for older adults, such as, 'slow', 'frail', 'weak', 'aching', and 'less agile'. For cognitive functioning, the majority of descriptions were negative for both, for example, 'forgetful', and 'slow'. Older adults responded with nearly double the number of descriptions relating to health and independent living (7.7% and 5.9% respectively) compared to young adults (4.4% and 3.3% respectively). The majority of responses related to health were negative for both groups, for example, 'illness', 'disease', and 'dementia'. Approximately two thirds of responses were negative in both groups, for example 'dependent', 'helpful', and 'vulnerable' and the most common positive response from older adults was 'striving/wanting to be independent'.

In the activities category, young adults responded with less than half (2.1%) the number of descriptions related to physical activity and sedentary behaviour compared to older adults (4.5%). The majority of these were negative for young adults (for example, 'inactive' and 'less mobile'). However, there were approximately equal proportions for negative and positive responses from older adults (for example, 'less active', 'sleeping' and 'active/activities'). Young adults responded with no descriptions relating to leisure activities compared to 4% of responses from older adults, which were all positive, for example, 'holidays', 'travelling', and 'more time for hobbies'.

In the social category, the distribution of responses was considerably different for each group. Older adults responded with over four times (7.0%) the number of descriptions relating to social support compared to young adults (1.7%). These responses were a mixture of negative, positive and neutral responses and the most common were 'lonely', 'isolated', and 'grandparents'. The number of responses relating to social status was also considerably more for older adults (4.0%) with only one positive response ('heroes') from the young adults (0.2%). The majority of responses from older adults were negative, for example, 'invisible', 'nuisance', 'nothing to offer'.

However, a smaller number of positive responses from older adults included ‘valued member of family/community’. Young adults responded with nearly twice as many (7.4%) descriptions related to identity compare to older adults (3.9%). The majority of these responses were coded as neutral, for example, ‘old’, ‘grandparents’, and ‘retired’. Young and older adults responded with a similar number of descriptions of relating to social engagement (1.9 and 2.2 % respectively). None of these were negative and there was a high proportion of positive descriptions from older adults, for example, ‘sociable’, ‘talkative’, and ‘good company’.

Personal disposition, in the personal attributes category was the most the commonly described subcategory across all categories in both groups, making up 15.6% of descriptions from older adults and 24.6% from young adults. The most common descriptions varied between groups with responses from young adults included ‘kind’, ‘generous’, ‘friendly’, ‘funny’, ‘grumpy’, and ‘caring’. Responses from older adults included ‘interesting/interested’, ‘mature’, ‘friendly’, ‘less tolerant’, and ‘cautious’. Older adults responded with considerably more descriptions of mental attitudes and personal affect (11.7% and 5.8% respectively), compared to young adults (0.4% and 1.4% respectively). There was an even distribution of positive, negative, and neutral across mental attitude responses from older adults, of which the most common included ‘more freedom’, ‘wide variation/varied in outlook/health’, and ‘lucky’. The only two responses relating to mental attitude from young adults were ‘change’ and ‘lots of time’. The majority of responses for personal affect were coded as negative and the most common descriptions varied between groups; those from young adults included ‘miserable’, ‘happy’, and ‘angry’; and for older adults included ‘concerned about future/life’, ‘enjoying freedom/retirement’, ‘anxious’, and ‘sad’. Young adults responded with more than triple the number of descriptions of wisdom compared to older adults (12.8 versus 3.6% respectively), which were all positive, for example, ‘wise’, ‘experienced’, and ‘knowledgeable’.

In the external attributes category, young adults responded with more than double (8.1%) the number of descriptions relating to appearance compared to older adults (3.4%), and the majority of descriptions were ‘wrinkles/wrinkly’ and ‘grey hair’. Both groups responded with few objects and wealth descriptions (<4% and no descriptions relating to wealth from young adults). The responses from older adults relating to wealth (1.9%) were a mixture of negative and positive and included ‘financially challenged/struggling’, ‘some with better wealth’, ‘mostly financially independent/comfortable'. Responses relating to objects included 'walking stick/aids', 'bus pass', 'false teeth'.

Overall, the responses from older adults were more varied and the proportions were spread more widely across categories compared to those from young adults, from whom the majority of responses were spread over fewer categories. The largest proportion of responses from both young and older adults were related to personal disposition followed by physical functioning. Each of these subcategories equated to 20-25% and 12-16% for responses from younger and older adults, respectively. For older adults, this was closely followed by mental attitudes (>11%), then lower but still substantial proportions (5-10%) for health, cognitive functioning, social support, independent living, and personal affect. This was followed by smaller proportions (4-5%) for physical activities and sedentary behaviours, leisure activities, and social status. For the young adults, after personal disposition and physical functioning, the majority of the remaining responses were spread over fewer subcategory proportions. There substantial proportions of responses related to wisdom and cognitive functioning (11-13%), followed by smaller proportions for appearance and identity (7-8%) and then health and independent living (3-4%).

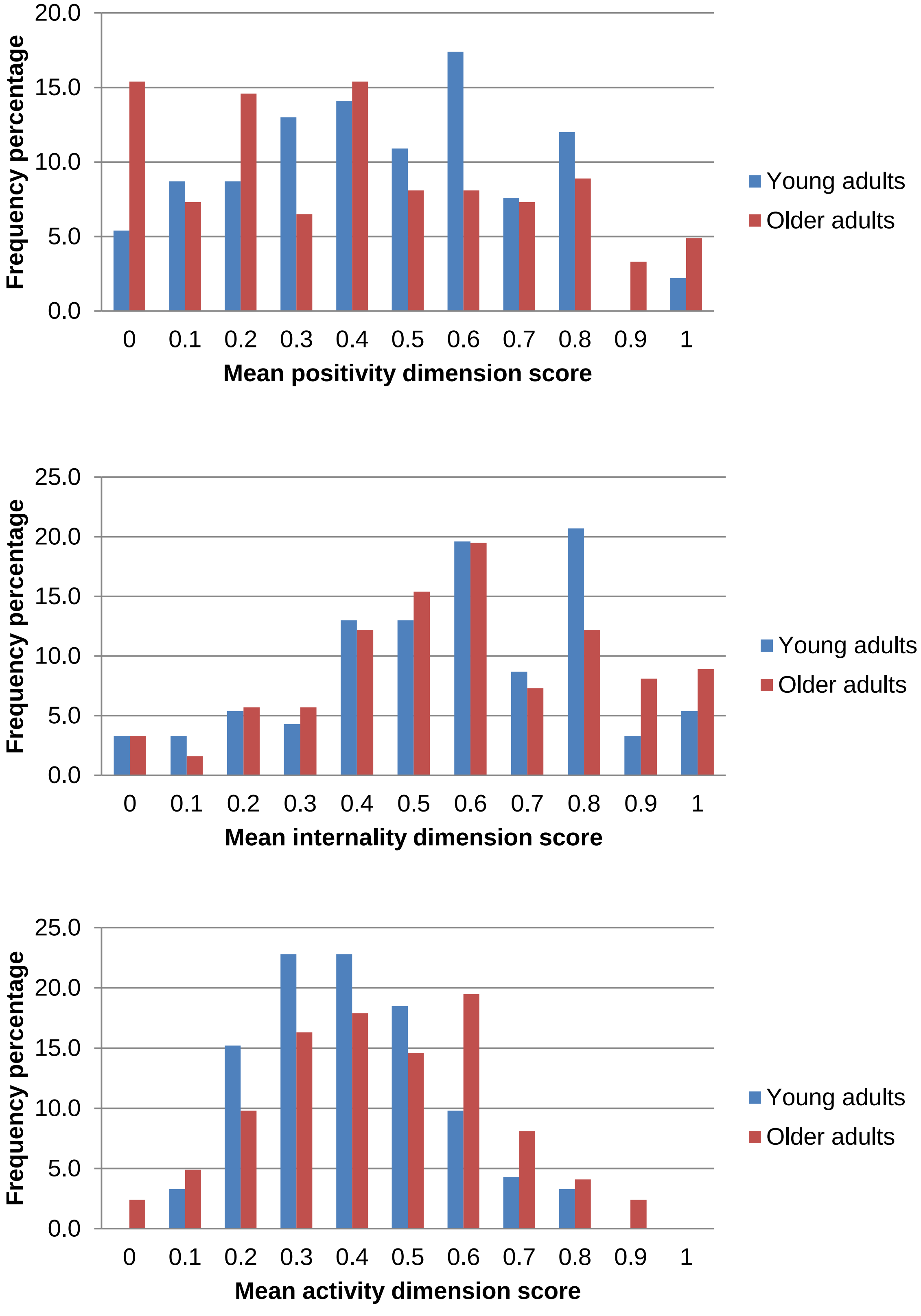


Figure 5.2 Histograms showing percentage frequencies across positivity, internality and activity dimensions

Table 5.4 Semantic categories of responses from young and older adults in the UK

Categories	Young Adults		Older adults	
	%	Most common descriptions	%	Most common descriptions
Functional health				
Physical functioning	20.5	Slow, frail, fragile, weak	12.0	Slow(er), aching/aches and pains, walking stick/aids, less agile/fit/mobile
Cognitive functioning	10.6	Slow, forgetful	7.1	Forgetful(ness), slow/slower
Health	4.4	Illness, ill, poor health, health problems, disease, dying, deaf	7.7	Failing/poor/ill health, dementia, infirm, Alzheimer's
Independent living	3.3	Dependence/dependent, helpful, vulnerable	5.9	Dependent, vulnerable, striving/wanting to be independent
Activities				
Physical activities & sedentary behaviours	2.1	Inactive, less active/mobile,	4.5	Less/not active, sleep(ing), active/activities,
Leisure activities	0.0	-	4.0	Holidays, travel/travelling, more time for hobbies/activities
Social				
Social support	1.7	Lonely, grandparents	7.0	Lonely/loneliness, isolated, grandparents/grandchildren,
Social engagement	1.9	Sociable, chatty, talkative	2.2	Sociable, good company, visiting one another, talking
Social status	0.2	Heroes	4.0	Invisible, others find not worth bothering/nuisance/nothing to offer, undervalued, valued member of family/community
Identity	7.4	Old, grandparents, retired, aged	3.9	Old, grandparents, senior (citizen), retired
Personal attributes				
Mental attitudes	0.4	Change, lots of time	11.7	More freedom, wide variation/varied in e.g. outlook/health, lucky
Personal disposition	24.6	Kind, generous, friendly, funny, grumpy, caring	15.6	Interesting/interested, mature, friendly, less tolerant, cautious
Personal affect	1.4	Miserable, happy, angry	5.8	Concerned about future/life, enjoying freedom/retirement etc., anxious, sad, depressed
Wisdom	12.8	Wise/wisdom, experienced , knowledgeable	3.6	Wise/wisdom, experienced, knowledgeable
External attributes				
Appearance	8.1	Wrinkles/wrinkly, grey (hair), smelly	3.4	Grey/white (hair), stooped, wrinkles/wrinkly
Objects	0.6	Walking stick	3.6	Walking stick/aids, bus pass, false teeth
Wealth	0.0	-	1.9	Financially challenged/struggling, some with better wealth, mostly financially independent/comfortable

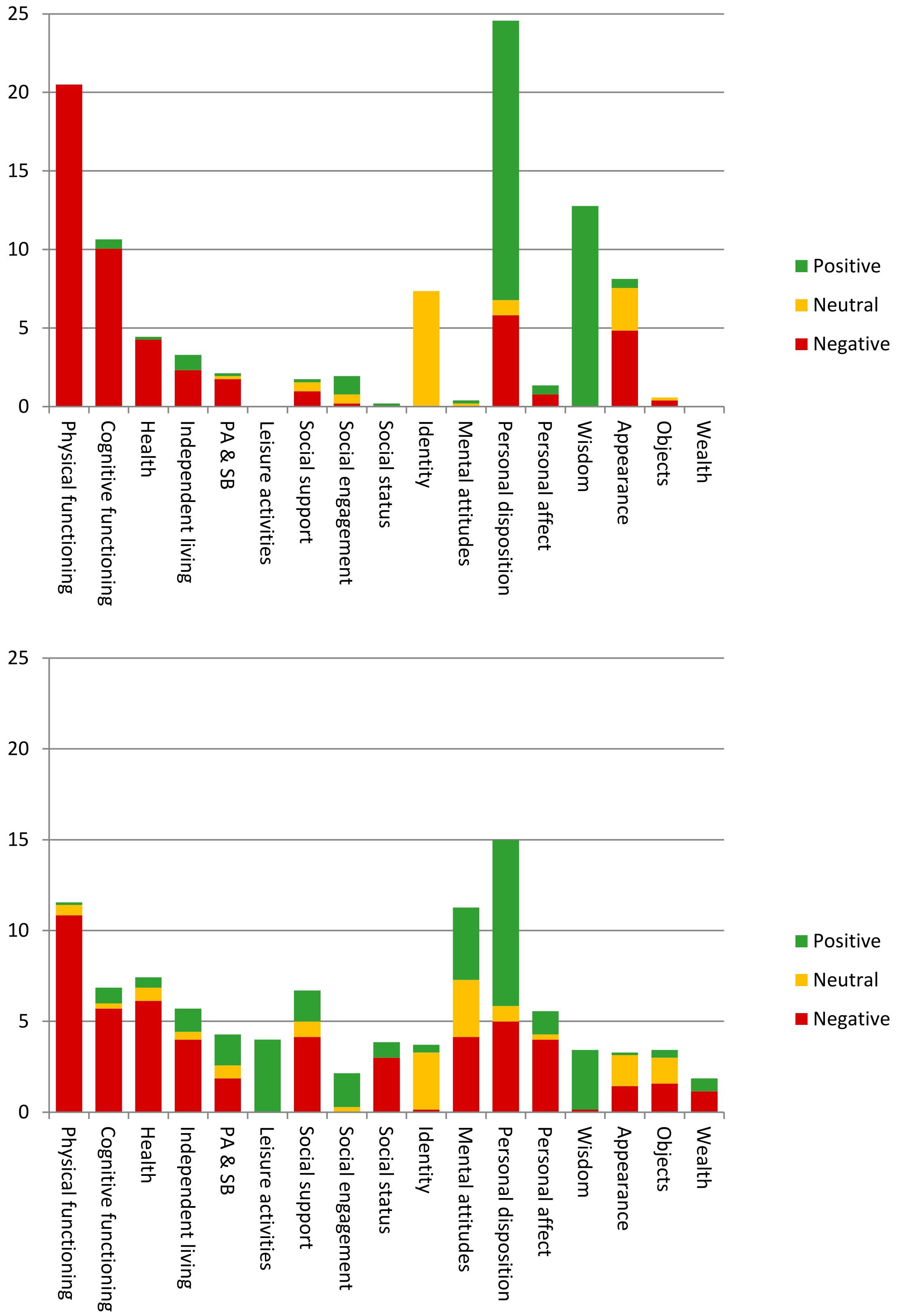


Figure 5.3 Distribution of responses across semantic categories from young adults (top) Older adults (lower). Note: PA & SB = Physical activity and sedentary behaviour

Discussion

Overall, there were no significant differences between young and older adults on all three (positivity, internality and activity) dimensions. On average, responses from both groups were predominantly negative and related more to internal qualities rather than external attributes and described older adults as inactive rather than active. No significant differences were found between young adults grouped by level of contact on any positivity, activity or internality dimensions, not even when those with no contact were compared with those with a lot of contact. Therefore, the frequency of contact with young adults have with older adults does not appear to be associated with attitudes towards ageing. In relation to domains of attitudes towards ageing, responses from older adults were distributed more evenly across categories of descriptions compared to responses from young adults which were predominantly distributed over only a few categories. These results suggest that the level of overall positivity, internality or activity of attitudes towards ageing does not differ between young and older adults. However, there are differences across domains of attitudes towards ageing.

The similar levels of positivity of attitudes towards ageing for young and older adults in the UK are consistent with findings of other cultures (Levy, 2003; Levy & Langer, 1994). These findings appear to support the theory that ‘favouring the in-group’ does not apply for ageing attitudes and stereotypes (Levy, 2003). This suggests that the attitudes towards ageing formed when younger may be similar to attitudes towards ageing that are held when older. However, this was a cross-sectional design so it cannot be inferred whether individuals’ attitudes towards ageing are stable over time and that ageing stereotypes become self-stereotypes when individual consider themselves to be ‘old’. Follow-up studies are thus required.

There was a wide age range in the older adults group, with some participants being only 60 years old. Some of the ‘older’ adults may therefore not have considered themselves to be ‘old’. Therefore, the open-response question is likely to have captured general attitudes towards ageing for young adults and those in the older adults group who did not consider themselves to be ‘elderly’. However, the open-response question is likely to have captured self-perceptions and self-stereotypes for those in the older adults group who did consider themselves to be ‘old’. It would have been useful to distinguish between those who identified themselves as being in the group that they were being asked to describe to see whether in-group preference moderated the attitudes towards ageing that were reported. Furthermore, it should be investigated whether the level of negativity affected the age at which individuals consider themselves to be ‘old’ (Levy, 2003).

Levy (1999) attempted to further understand the mechanisms between attitudes towards ageing and the self-perceptions of older adults. She investigated how Japanese older adults managed to maintain a positive self-image despite negative ageist attitudes, which have been argued to be stronger than in the United States. Results indicated that they maintained a distinction between their inner self and societal views of ageing by differentiating what applies to themselves and what applies to ‘other older adults’. Results also indicated that the Japanese older adults held more negative view of older adults in general, compared to Chinese or American participants. More studies like these are required to more fully understand how older adults react or are resilient against negative stereotypes and where interventions may be possible to reduce the deleterious effect of them on health outcomes.

The finding that attitudes towards ageing were not associated with the level of contact that young adults had with older adults was consistent with findings of another study which found that age stereotypes had primacy over experience (Kemper, 1994). However, the present study did not investigate how negative attitudes towards ageing affected how young adults communicated with older adults. The results of the present study are not consistent with those of another study which found that having frequent or occasional contact with unrelated older adults accounted for some of the variance in attitudes towards older adults (Funderburk et al., 2006). However, the resolution of the variable capturing contact with older adults in the present study was limited to only three levels of a categorical variable, rather than a continuous variable with more resolution. As there was no significant difference even when only the group with no contact was compared with the group with frequent contact, it is unlikely that level of contact alone explains variance in attitudes towards ageing. Future research could assess whether the type or quality of interactions moderate the effect of attitudes towards ageing and whether this varies cross-culturally. The personal attributes and level of physical or cognitive functioning of the older adults that they interact with may also moderate the relationship as these domains made up the majority of the responses.

The differences in domains of attitudes towards ageing may reflect which domains of behaviours young adults have observed or experienced through their interactions with older adults. There was a much larger proportion of responses relating to mental attitudes in the older adults group compared to none in the young adults group. This may reflect older adults' own attitudes towards ageing. For young adults, the domains which made up the largest proportions of responses were physical functioning and personal disposition. This may reflect what behaviours and interactions they might have had with older adults. It may be that the amount of contact that young adults have with older adults does not affect the level of positivity in their attitudes towards ageing, but that it affects the domains of attitudes towards ageing and older adults.

The large number of domains of attitudes to ageing that were reported highlight the many facets of ageing and thus care needs to be taken not to oversimplify the relationship between attitudes towards ageing and other factors. The effect of attitudes towards ageing on health could be domain specific, whereby negative attitudes in some domains have more of an impact on behaviours and health outcomes than others. For example, attitudes or stereotypes which are associated with functional health, e.g. physical or cognitive attributes may have more of an impact on memory and independent living. Individuals holding attitudes or stereotypes relating to older adults being inactive may be more likely themselves to be less active when they are older and this may impact on their health.

Future research should investigate the impact of domains of attitudes towards ageing on health in the UK to see whether the deleterious relationship of negative attitudes towards ageing on health found in other cultures are also present in the UK.

Chapter 6: Study 1c - Young adults' attitudes towards ageing in the UK and China

Introduction

There is substantial evidence that attitudes towards older adults are more negative compared to those towards young adults and tend to depict a picture of frailty, depression, decline, and dependence rather than optimism, resilience, and happiness (Kite, Stockdale, Whitley, & Johnson, 2005). However, there is evidence that demonstrates this is not necessarily true, for example, happiness has been found to increase with age (Yang, 2008) as well as increased heterogeneity in cognitive and physical abilities has been found and also an overlap in abilities between age groups (Christensen & Mackinnon, 1994; Christensen, 2001; Steel, Huppert, McWilliams, & Melzer, 2003). There is also evidence for the damaging effect of negative attitudes towards ageing and stereotypes on an individual's personal health outcomes. This indicates that ageing is not solely a biological process, but also a psychosocial process whereby attitudes, self-perceptions, and stereotypes of ageing can affect cognitive and physical health outcomes (Levy, 2003).

Attitudes towards ageing in different cultures

Stereotypes of ageing stem from cultural attitudes and beliefs, and are related to the evidence of cross-cultural differences in attitudes towards ageing (Luborsky & McMullen, 1999; Sokolovsky, 1993). Thus, it is important to study UK as well as other cultures to further understand their effect on the ageing process and health outcomes (Kite & Wagner, 2004). Cross-cultural studies also allow theoretical propositions to be tested that would not be possible within one culture. For example, it could be investigated whether a culture's attitudes towards ageing impacts on the health of older adults living there by comparing cultures that differ in their attitudes towards ageing. Langer & Levy (1994) recruited young (15-30 years old) and older adults (51-91 years old) from three cultures: (i) Americans with normal hearing, (ii) the American Deaf community, and (iii) China. They proposed that the latter two cultures would not have been exposed to mainstream American negative beliefs and attitudes towards ageing compared to the American hearing participants (while not sharing other common characteristics to reduce confounding cohort effects). They found cultural differences in memory performance across older participants but no differences between younger participants. Amongst the older participants, those from cultures with more positive attitudes towards ageing (the American Deaf and Chinese) had better memory performance across all tests. There was also a positive correlation amongst older participants between more positive views toward ageing and memory performance regardless of culture. These results supported their hypotheses which were based on the theory that there is a psychosocial process that contributes to memory loss through negative stereotypes regarding memory in older age.

A replication of Levy and Langer's (1994) study failed to find the same cultural group effects across all memory tests in Chinese Canadians (recently relocated from Hong Kong) and Anglophone Canadians, but did however find the same correlation between more positive attitudes towards ageing and better memory performance (Yoon, Hasher, Feinberg, Rahhal, & Winocur, 2000). This study may have had a less distinct divide in cultural groups as the Chinese participants were living in Canada at the time of testing and therefore may have been exposed to some of the mainstream Canadian attitudes to ageing, which may explain the difference in group results.

Evidence from American and Chinese cultures suggests that attitudes and stereotypes of ageing tend to differ between cultures but are consistent between younger and older individuals within the same culture (Levy, 2003). For example, comparisons between attitudes towards ageing in young and older adults within the same cultures (China, American Deaf, and American hearing) did not yield significant effects of age on positivity, internality or activity dimensions of attitudes towards ageing (Levy & Langer, 1994). This is consistent with 'stereotype embodiment' through the internalisation of age stereotypes with as individuals become older (Levy, 2009).

It is commonly assumed that attitudes towards ageing are more positive in East Asian cultures compared to Western cultures. The majority of cross-cultural studies have compared the United States with other countries. There is evidence that individuals from China hold their elders in higher esteem compared to the United States (Becker, 1980; Ikels, 1991). Both young and older adults in China were found to hold more positive attitudes towards ageing compared to those in the United States (Levy & Langer, 1994). Older adults in Japan reported more negative attitudes towards older adults in general, but also more positive self-concepts compared to older adults in China and the United States (Levy, 1999). This study highlights the distinction between general attitudes towards ageing and self-concepts of ageing, such as self-perceptions or self-stereotypes. These findings also demonstrate differences within Eastern cultures. There is further evidence for variation within Western cultures. For example, young adults from Germany tended to view ageing much more negatively, compared to those from the United States. This was assessed in terms of fear of old people, psychological concerns associated with ageing, concern over changes in physical appearance as a result of ageing and fear of losses associated with ageing (McConatha, Schnell, & Volkwein, 2003). Another study compared attitudes and anxieties towards ageing in young, middle-aged, and older adults in Turkey compared to the United States. Turkish participants reported fewer concerns over the ageing process, but appeared to be more psychologically concerned over ageing compared to participants from the United States (McConatha, Hayta, Rieser-Danner, McConatha, & Polat, 2004). Another cultural comparison found that all three groups of older adults had positive self-perceptions of ageing, with resident Americans being the most positive, followed by Chinese Americans, and then Chinese in Taiwan (Tien-Hyatt, 1986). It is difficult to compare results between studies which have used different measures to capture attitudes towards ageing or ageing stereotypes. Measures may also be limited in their ability to capture cultural differences in attitudes if they have been developed within one culture.

Domains of attitudes towards ageing

Cultural differences in positive attitudes towards ageing may reflect which specific domains of attitudes have been measured and the relative importance of these in different cultures. For example, filial piety has been described as central in Asian culture and refers to care for one's parents as part of a traditional concept of Confucianism and preserves the family as a fundamental unit of society (Park & Chesla, 2007). It is dualistic in nature: it is both reciprocal and authoritarian. The reciprocal nature of filial piety is seen as the more traditional meaning. It is positive as it facilitates respect, care, and love and also a wish to repay parents for their sacrifices (Yeh, 2003). This is different to the authoritarian nature which encourages obedience and compliance. Western cultures do not have an equivalent philosophy that is as prevalent in society. Although there is research into attitudes towards ageing within the UK (e.g. Phoenix & Sparkes, 2006), there is only limited research comparing attitudes towards ageing in the UK to other cultures. One study which compared two groups of Chinese older adults (immigrants residing in Scotland or residing in Beijing) and one group of British older adults (residing in Scotland) found that the two Chinese groups held similar and higher expectations for filial piety compared to the British group (Laidlaw, Wang, Coelho, & Power, 2010). However, the Chinese-immigrant and UK groups reported similar and more positive attitudes towards ageing compared to the Beijing-Chinese group. The authors suggested these results could be explained through the distinction between general stereotypes of ageing and self-stereotypes. There were age differences between groups in this study, therefore the attitudes towards questionnaire may be capturing different constructs with different items which ask about personal experience (self-stereotypes) or general attitudes of all older adults. General stereotypes of ageing may be captured for the younger group and personal experiences of ageing in the older group, which are thus more self-relevant. A study investigating the specific ways older adults are respected by Korean and American young adults found that they differed by degree rather than categorically (Sung, 2004). Both groups cited similar types of respect of older adults, however the young adults from Korea cited them with a higher frequency compared to the American young adults.

Contradictory findings between Eastern and Western cultures have prompted further cross-cultural investigations into domains of attitudes towards ageing. One study demonstrated that overall there is little difference between Chinese and American cultures and reported that age-related stereotypes are multidimensional and that the level of negativity is context specific (Boduroglu, Yoon, Luo, & Park, 2006). Regardless, these studies add to the evidence of the profound impact of attitudes towards ageing on cognitive abilities. This is particularly important with the ageing population worldwide and increasing dementia incidence. The evidence discussed thus far also highlights the potential for positive attitudes to help delay cognitive decline and improve health, and thus the need for further research.

Aim and hypotheses

This study aimed to explore the cultural differences in positivity and domains of attitudes towards ageing amongst young adults in the UK and China. It was hypothesised that young adults in China would have more positive attitudes to ageing compared to young adults in the UK. It was also hypothesised that attitudes of young adults in China would focus more on internal qualities of older adults (e.g. personal disposition, such as 'kind') and focus less on external attributes, (e.g. appearance) compared to those in the UK. These hypotheses are based on previous research that has demonstrated cultural differences in attitudes to ageing in these directions (Levy & Langer, 1994). It was further hypothesised that the young adults in China would report more descriptions related to filial piety, such as 'respect' compared to young adults in the UK due to the reported Asian and Western cultural differences in these traditional expectations described above (Laidlaw et al., 2010; Sung, 2004).

Method

Participants

Participants were recruited using opportunistic sampling. The young adults group from the UK (n = 113) were students recruited at the end of a lecture at Loughborough University. The young adults group from China (n = 73) were students who were recruited at the end of a lecture at Shaanxi Normal University in Xi'An. Precise age data were not available for the young adults in the UK; however, a common age for attending university for undergraduate degrees in the UK is 18 to 21 years old. The mean age of the young adults from China was 23.94 (SD = 2.00) with a range of 20 to 28 years, after mature students above the age of 30 years were excluded (n = 2).

Attitudes towards ageing

Attitudes towards ageing were captured using an open-response question. Participants were asked to "Write down five words or short phrases that you associate with the elderly". This was used to capture attitudes that were culturally relevant to participants in each country without limiting responses to predefined domains which may be culturally biased. This method of capturing attitudes towards ageing has previously been used in older and younger populations across cultures (Levy et al., 2006; Levy & Langer, 1994). The Chinese responses were translated and back translated to ensure the meanings were accurate. The present studies used the same method of coding as previous studies to code each response on three dimensions. Each response was coded in terms of whether it was a positive, negative or neutral attribute (positivity dimension) and also by the type of adjective it was (internality and activity dimensions):

Positivity dimension: descriptions were scored based on whether the rater thought they described the elderly in a positive (score = 1), neutral or not applicable (score = 0.5) or negative light (score = 0).

Internality dimension: descriptions were scored based on whether the rater thought they described an internal quality/trait/characteristic of the elderly (score = 1), neutral quality or not applicable (score = 0.5) or external quality (score = 0).

Activity dimension: descriptions were scored based on whether the rater thought they described the elderly as being active (not only physically active, but could mean active within the community/society) (score = 1) or inactive (score = 0) or not applicable to that word (score = 0.5).

The dimensions were not mutually exclusive e.g. "often teaches children" would be positive on positivity dimension (score=1), neutral on internality dimension (score=0.5) and active on activity dimension (score=1). It was assumed, as in Levy and Langer (1994), that those individuals with more positive attitudes towards ageing would report more positive (e.g., "friendly" or "wise" as opposed to "stubborn" or "boring") and active descriptions (e.g., "walks a lot" as opposed to "sleeps a lot"). They also thought that those with more positive attitudes towards ageing would report more internal qualities of an older person, such as their disposition (e.g., "kind" or "funny") rather than more external characteristics (e.g., "wrinkled" or "grey hair").

Interrater reliability

Interrater reliability was assessed by a second rater who rated 20% of the words (the first word given by each participant) from both groups across the three dimensions and who was blinded to group membership. Landis & Koch (1977) proposed this scale to describe the degree of concordance: 0.21-0.40, "Fair"; 0.41-0.60, "Moderate"; 0.61-0.80, "Substantial"; 0.81-1.00, "Almost perfect". As the categories were ordered, the weighted Kappa was calculated (using linear weighting) to adjust for close matches (for example positive and neutral is closer to a match compared to positive and negative).

The number of observed agreements of words on the positivity dimension between the two raters was 117 out of a total of 144 (compared to the number expected by chance of 57, Kappa = .689, SE = .047 95% CI from 0.597-0.781), this strength of agreement was considered to be 'substantial'. After adjustment for weighted agreement, this improved the interrater reliability to 'almost perfect' (Kappa = 0.810). Between the two raters on the internality dimension the number of observed agreements of words was 111 out of a total of 144 (compared to the number expected by chance of 52) with a Kappa = 0.643 (SE = 0.050 95% CI from 0.545-0.742). This strength of agreement was considered to be 'substantial'; after adjustment for weighted agreement, it was still considered to be 'substantial' (Kappa = 0.736). Between the two raters on the activity dimension the number of observed agreements of words was 130 out of a total of 144 (compared to the number expected by chance of 75) (SE = 0.050 95% CI from 0.700-0.897). This strength of agreement was considered to be 'substantial' (Kappa = 0.799); and after adjustment for weighted agreement, it was improved to 'almost perfect' Kappa = (0.813).

Data analysis

Participants with missing data on the open-response attitudes towards ageing question were excluded from all analysis. Interrater reliability for coding of the open-response question was calculated using cross tabs in SPSS 21.0 and then an online calculator calculated the weighted kappa scores (GraphPad Software, 2014). Descriptions were sorted into clusters which formed semantic categories and subcategories to identify patterns in frequencies of responses from the UK and China. The categories and subcategories identified were: (1) Functional health, consisting of physical functioning, cognitive functioning, health, and independent living; (2) Activities, consisting of physical activities and sedentary behaviours, and leisure activities; (3) Social, consisting of social support, social interaction, social status, and identity; (4) Personal attributes, consisting of mental attitudes, personal disposition, personal affect, and wisdom; (5) External attributes, consisting of appearance, objects, and wealth. The clusters of words and short phrases into semantic categories were discussed with a number of other researchers to ensure that the descriptions were reliability sorted and the categories were appropriately named. Descriptions that fitted into more than one category were counted in all relevant categories, for example, "slow" could be referring to cognitive or physical functioning, "grandparents" could be interpreted as social support as well as identity, and "hearing aids" are objects which also relate to health.

Tests of difference were carried out using Chi-square and independent t-tests for categorical and continuous variables, respectively. Adjustments were used when necessary by Levene's test for equality of variance. Mann-Whitney U tests where used when histograms indicated non-normal distributions. An independent t-test was also carried out to test for mean differences on positivity, internality and activity dimensions between groups of young adults who responded with "no contact" and "a lot of contact" with older adults. Participants with missing data were excluded listwise for analyses.

Results

Positivity, internality and activity dimensions

On average, there were significant differences between attitudes to ageing reported by young adults from China and the UK across all three dimensions. Attitudes towards ageing of young adults in China were overall more positive, described more internal qualities of older adults, and also described older adults as having higher levels of activity compared to those of young adults in the UK (Table 6.1 and Figure 6.1). On average, attitudes towards ageing reported by young adults in the UK were more negative than positive, as demonstrated by the mean of 0.45 being less than 0.5. On average, attitudes towards ageing reported by young adults in China were more positive than negative demonstrated by the mean of 0.6 being higher than 0.5. On average, responses from both groups predominantly related more to internal qualities and inactivity. No significant differences were found between men and women within cultures across positivity, internality or activity dimensions (Table 6.3).

Figure 6.2 and Table 6.2 show the spread of frequencies across each dimension. A mean score of 0 indicates that, for example, on the positivity dimension, all of the participant's five descriptions of older adults were negative and conversely, a mean score of 1 would indicate that all five of their descriptions were positive. Only 2.2% of participants in the UK responded with only positive descriptions, compared to 13.5% in China. Additionally, zero participants in China responded with only negative descriptions compared to 5.5% in UK. This data also indicated that majority of responses were mixed, reflecting both positive and negative attitudes.

To further explore the data, the three lowest (0, 0.1, and 0.2) and highest (0.8, 0.9 and 1) mean percentages were combined to capture responses which were almost all considered positive or negative, described almost all internal or external qualities, and those that described almost all active or inactive behaviours (highlighted in bold in in Table 6.2). Only 14.2% of young adults in the UK were almost all positive about ageing compared to 38.5% of those in China. In keeping with this, only 11.6% of participants in China responded with almost all negative descriptions of older adults, compared to 22.8% in the UK. Nearly half (48.1%) of participants in China focused on almost all internal qualities in their descriptions, compared to under a third in the UK (29.4%). Only 3.8% of participants in China focused on almost all external descriptions compared to 12.0% of participants in the UK. A much larger proportion of participants in the UK (18.5%) descriptions were almost all associated with inactive behaviour compared to those in China (5.7%). Neither participants in the UK or China descriptions were responded with almost all descriptions of active behaviours (3.3% and 1.9% respectively).

Table 6.1. Descriptive statistics and tests of difference for attitudes to ageing responses across dimensions and cultures.

Attitudes dimension	Mean (Standard deviation)		Test of difference	
	UK	China	*t*	*p*
Positivity	0.45 (0.25)	0.62 (0.27)	-4.04	<.001
Internality	0.57 (0.24)	0.69 (0.22)	-3.17	<.001
Activity	0.40 (0.16)	0.46 (0.14)	-2.08	.040

Table 6.2 Mean scores of participant responses across cultures and dimensions.

		Mean scores of five descriptions										
		0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1
Positivity dimension												
UK	frequency	5.0	8.0	8.0	12.0	13.0	10.0	16.0	7.0	11.0	0.0	2.0
	%	**5.4**	**8.7**	**8.7**	13.0	14.1	10.9	17.4	7.6	**12.0**	**0.0**	**2.2**
China	frequency	0.0	3.0	3.0	5.0	1.0	5.0	8.0	7.0	10.0	3.0	7.0
	%	0.0	5.8	5.8	9.6	1.9	9.6	15.4	13.5	**19.2**	**5.8**	**13.5**
Internality dimension												
UK	frequency	3.0	3.0	5.0	4.0	12.0	12.0	18.0	8.0	19.0	3.0	5.0
	%	**3.3**	**3.3**	**5.4**	4.3	13.0	13.0	19.6	8.7	**20.7**	**3.3**	**5.4**
China	frequency	1.0	0.0	1.0	0.0	1.0	10.0	10.0	4.0	11.0	8.0	6.0
	%	**1.9**	**0.0**	**1.9**	0.0	1.9	19.2	19.2	7.7	**21.2**	**15.4**	**11.5**
Activity dimension												
UK	frequency	0.0	3.0	14.0	21.0	21.0	17.0	9.0	4.0	3.0	0.0	0.0
	%	**0.0**	**3.3**	**15.2**	22.8	22.8	18.5	9.8	4.3	**3.3**	**0.0**	**0.0**
China	frequency	0.0	1.0	2.0	8.0	17.0	9.0	10.0	4.0	1.0	0.0	0.0
	%	**0.0**	**1.9**	**3.8**	15.4	32.7	17.3	19.2	7.7	**1.9**	**0.0**	**0.0**

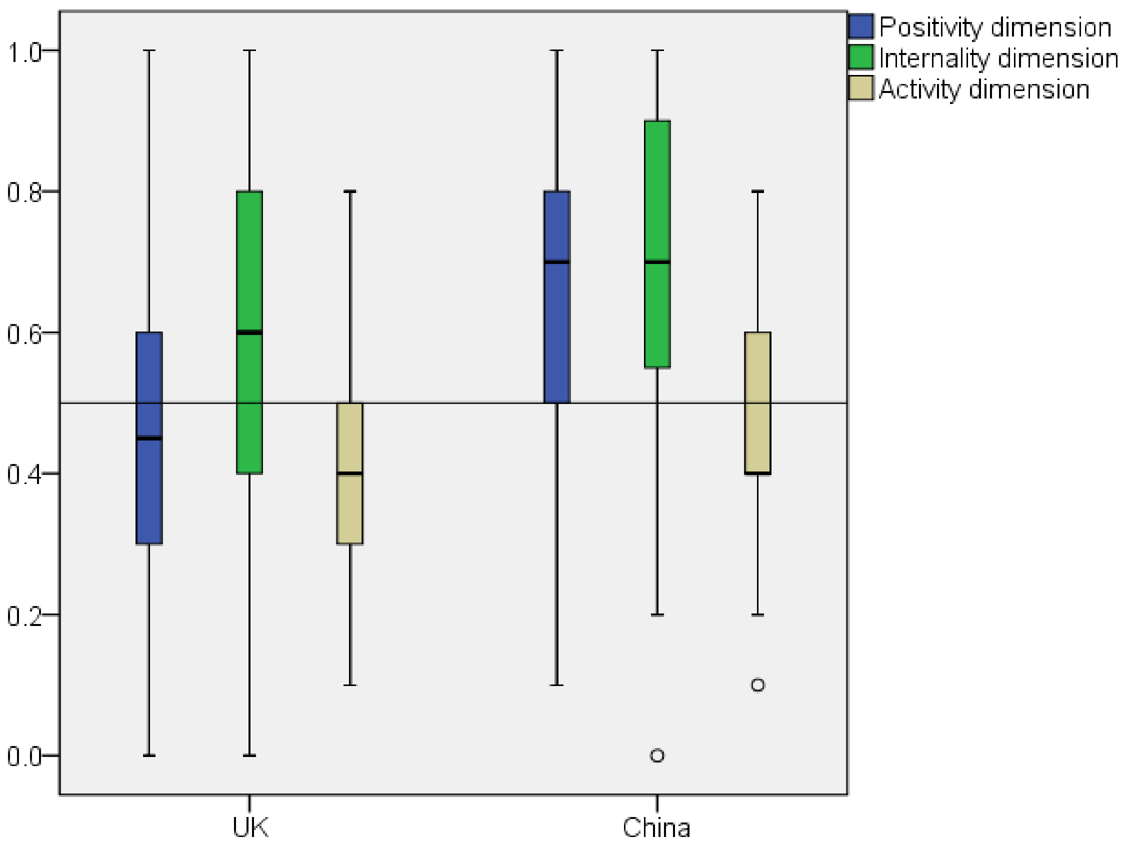
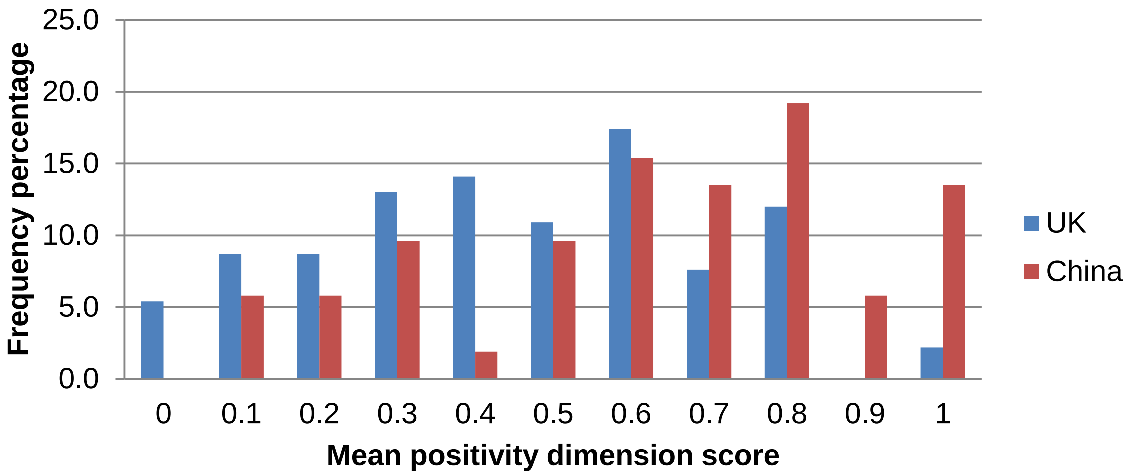
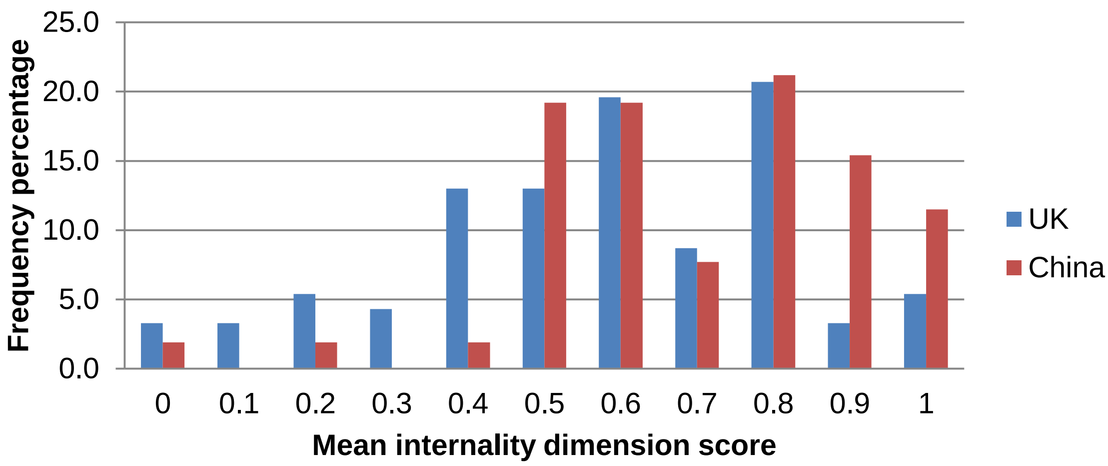


Figure 6.1 Box plots of attitudes towards ageing in the UK and China across the positivity, internality and activity dimensions.

Table 6.3 Gender comparisons within cultures across attitudes towards ageing dimensions

Attitudes dimension	Mean (Standard deviation)						Test of difference	
	UK		Mann-Whitney U	*p*	China		Mann-Whitney U	*P*
	Men	Women			Men	Women		
Positivity	0.49 (0.26)	0.43 (0.25)	458.5	.32	0.68 (0.28)	0.62 (0.24)	211.0	.33
Internality	0.57 (0.25)	0.56 (0.22)	507.0	.68	0.75 (0.23)	0.66 (0.21)	185.5	.12
Activity	0.40 (0.15)	0.39 (0.16)	521.0	.80	0.43 (0.17)	0.48 (0.48)	202.0	.23





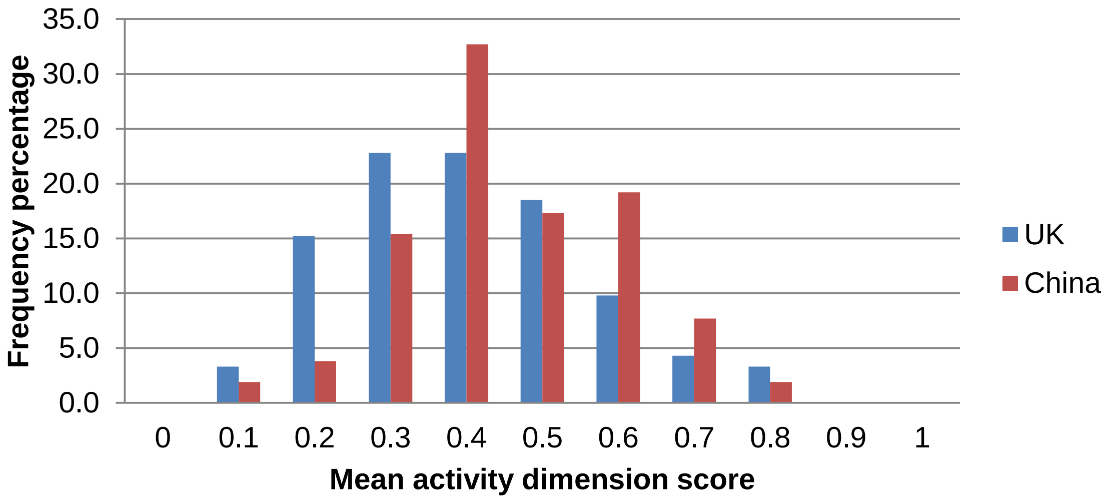


Figure 6.2. Histograms showing percentage frequencies across positivity, internality and activity dimensions

Table 6.4 Semantic categories of responses from young adults in China and the UK.

Categories	UK		China	
	%	Most common words/phrases	%	Most common words/phrases
Functional health				
Physical functioning	20.5	Slow, frail, fragile, weak	5.4	Slow, weak
Cognitive functioning	10.6	Slow, forgetful	6.8	Slow, misunderstanding
Health	4.4	Illness, ill, poor health, health problems, disease, dying, deaf	6.8	Unhealthy, healthy, poor health, sick (ness)
Independent living	3.3	Dependence/dependent, helpful, vulnerable	6.4	Dependence/dependent, helpful, need care
Activities				
Physical activities and sedentary behaviours	2.1	Inactive, less active/mobile,	1.4	Active, inactive, should do more exercise
Leisure activities	0.0	-	0.7	Hobby, learn
Social				
Social support	1.7	Lonely, grandparents	6.1	Lonely, family, relationships
Social engagement	1.9	Sociable, chatty, talkative	3.7	Talkative, (good) communication, chatty
Social status	0.2	Heroes	6.4	Respected/respect
Identity	7.4	Old, grandparents, retired, aged	3.4	Old
Personal attributes				
Mental attitudes	0.4	Change, lots of time	2.7	Life is short, fortunate
Personal disposition	24.6	Kind, generous, friendly, funny, grumpy, caring	34.8	Kind (hearted), nosey, childish, helpful, caring
Personal affect	1.4	Miserable, happy, angry	7.1	Lonely, happy, satisfied, afraid
Wisdom	12.8	Wise/wisdom, experienced , knowledgeable	4.4	Experienced, wise/wisdom
External attributes				
Appearance	8.1	Wrinkles/wrinkly, grey (hair), smelly	3.4	Wrinkly, grey/white hair, complexion
Objects	0.6	Walking stick	0.0	-
Wealth	0.0	-	0.3	Poor

Domains of attitudes towards ageing

When responses were clustered into semantic categories representing domains of attitudes towards ageing, differences in the distributions of responses between countries emerged (Figure 6.3). However, the words and phrases used were similar in the majority of categories (Table 6.4). In terms of functional health, young adults from the UK responded with approximately four times more descriptions of physical functioning (20.5%) and nearly double for cognitive functioning (10.6%) compared to young adults in China (5.4% and 6.8% respectively). The majority of these descriptions were negative from both groups, such as 'slow', 'frail', 'weak', 'forgetful', and 'misunderstanding'. Young adults from China responded with a slightly higher proportion of descriptions of health and independent living (6.8% and 6.4%) compared to the UK (4.4% and 3.3%). The percentage of negative descriptions from both countries was similar, with the higher proportion of total responses in these categories being made up by the small additional amount of positive responses in China. Both countries responded with similar words in the negative categories, for example, 'poor health', 'disease', 'dependence', and 'helpful'.

In the activities category, young adults from both countries responded with few (<3%) descriptions, with those from the UK reporting no leisure activities and those from China reporting <1%, which were all positive (e.g. 'hobby' and 'learn'). Young adults from the UK responded with mostly negative descriptions in the physical activity and sedentary behaviour category (with words such as 'inactive') compared to those from China who had an approximately even amount of negative and positive words. Both countries responded with similar words, such as, 'inactive', 'less mobile, and 'should do more exercise'.

In the social category, those from China responded with a much higher proportion (6.4%) of descriptions relating to social status compared to those from the UK (0.2% - only one word 'heroes'), of which the majority were related to 'respect'. Young adults from China also responded with more descriptions relating to social engagement (3.7%) and social support (6.1%) compared to the UK (1.9% and 1.7% respectively). Descriptions of social support from China were considerably more positive, including 'close relationships', 'family', and loved'. Young adults from China responded with fewer descriptions of identity compared to the UK, which from both countries were neutral and were most commonly 'old' or 'grandparents'.

Personal disposition was the most the commonly described subcategory across all categories, making up 35% of descriptions from China and 25% from the UK. In terms of other personal attributes categories, young adults from China also responded with more descriptions of mental attitudes and personal affect (2.7% and 7.2% respectively, compared to those from the UK (0.4% and 1.4% respectively). However, those from the UK responded with approximately triple the number of descriptions of wisdom compared to those from China (12.8 versus 4.4% respectively). These descriptions were all positive, for example, 'wise', 'experienced', and 'knowledgeable'. The majority of personal disposition descriptions were positive for both countries (e.g. 'kind', 'generous', and 'caring'), and for personal affect there was an even distribution of negative and positive descriptions (e.g. 'miserable' and 'happy').

In the external attributes category, young adults from the UK responded with more than double (8.1%) the descriptions of appearance compared to those from China (3.4%), with the majority of words describing 'wrinkles' and 'grey hair'. Both groups responded with few descriptions related to objects and wealth (<1%, with no descriptions related to objects from China and no descriptions related to wealth from the UK).

Overall, the category proportions of responses for the young adults from China were largest by a great deal for personal disposition, followed by similar proportions for physical functioning, cognitive functioning, health, independent living, social support, social status and personal affect. The category proportions for the young adults from the UK were the largest for personal disposition, closely followed by physical functioning, then lower but still substantial proportions for wisdom, cognitive, functioning, appearance, and identity (in decreasing order).

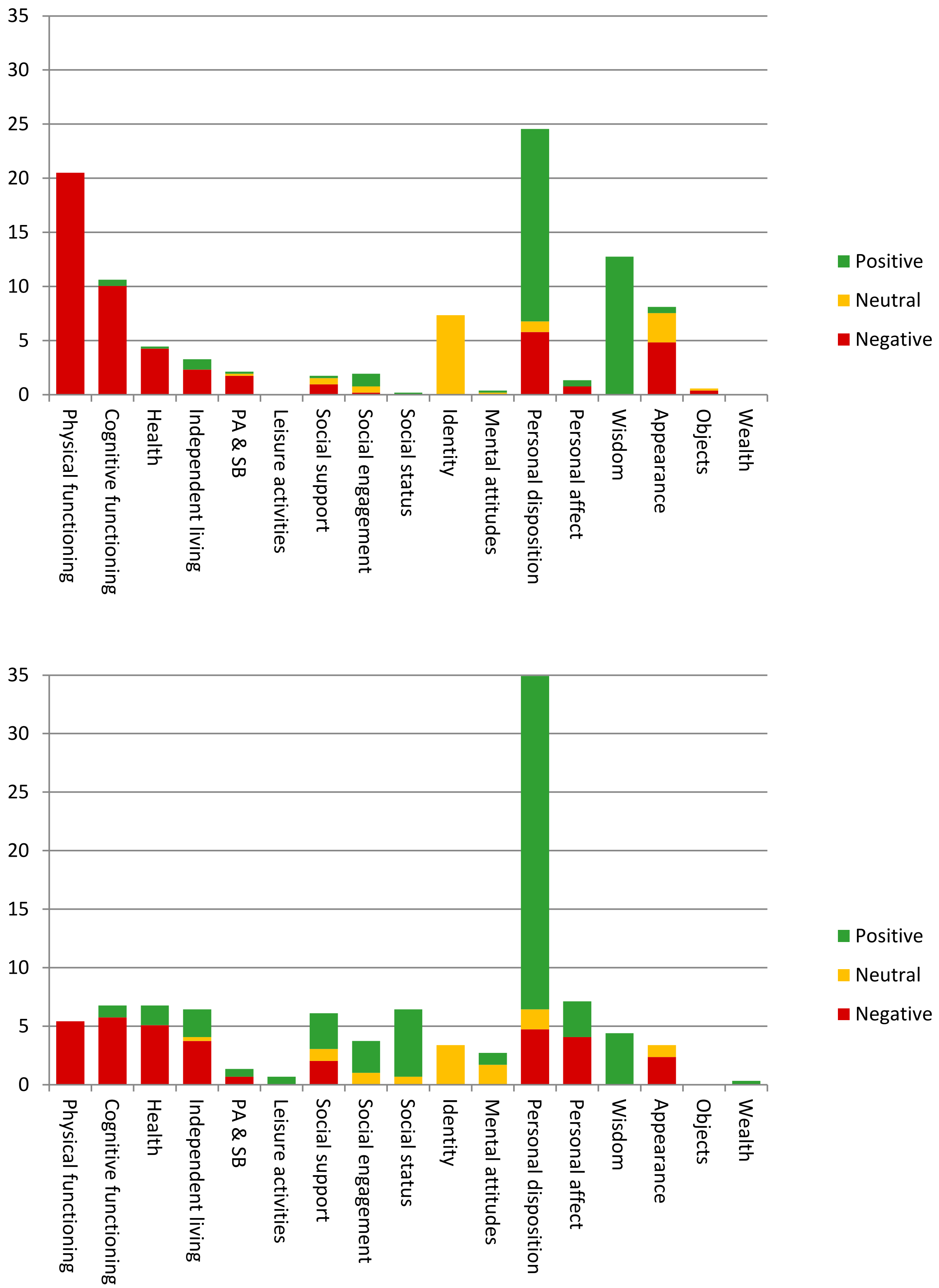


Figure 6.3 Distribution of responses across semantic categories from the UK (top) and China (lower). Note: PA & SB = Physical activity and sedentary behaviour

Discussion

Similarities and differences were found in the young adults' attitudes towards ageing in China and the UK. Attitudes towards ageing were captured by asking the young adults an open-response question to name five words or short phrases they would use to describe the elderly. On average, mean responses calculated for each participant from China were significantly higher on the positivity, internality and activity dimensions compared to the UK. This indicated that young adults in China described older adults more positively, more in terms of internal qualities or traits, and as having a higher level of activity. The analysis of the responses sorted into semantic categories revealed responses from both groups largely covered the same categories of descriptions. Additionally, the words and phrases used by both groups were similar in the majority of the categories. However, the frequency distributions across the categories varied between groups. The category with the largest percentage of responses for both groups was personal disposition. For the young adults from the UK this was closely followed by descriptions of physical functioning and with smaller but substantial frequencies in the wisdom, cognitive function, appearance, and identity categories. For the young adults from China, after personal disposition, the distribution of responses was relatively even across a number of categories, in descending order from personal affect, cognitive functioning, health, social status, social support, and then physical functioning.

The results on the positivity and internality dimensions supported the hypotheses that young adults in China would hold more positive attitudes to ageing, would reflect more internal qualities of older adults, and focus less on external attributes compared to young adults in the UK. This pattern of results is similar to a cross-cultural finding between young adults in the United States and China (Levy & Langer, 1994). The hypothesis that young adults in China would report more descriptions related to filial piety, such as 'respect' compared to young adults in the UK was also supported. Approximately six percent of descriptions from the young adults in China were either 'respect' or 'respected' compared to zero from young adults in the UK. This finding reflects the results from another UK and China comparison in young adults which found higher expectations of filial piety in China based, and Chinese-immigrants older adults compared to the UK (Laidlaw et al., 2010). The pattern of results across semantic categories of the present study is similar to the findings of Sung (2004) in which the cultural differences in young adults seemed to reflect the degrees of attitudes rather than categories. For instance, in the present study the responses from both groups included the same categories, but the proportions of responses across the categories differed. It is important to note the distinction that needs to be made between these studies, as Sung (2004) specifically investigated domains of respect (and the level of importance of these to the participant), whereas the present study investigated attitudes towards ageing more broadly, including all the categories that were formed as a result of the open-response question format. Although the young adults from the UK did not respond with any descriptions that explicitly mentioned 'respect', one of the categories with a substantial proportion of the responses was "wisdom", which included descriptions, such as 'experienced', 'wise' and 'knowledgeable'. These responses do not describe respect in relation to filial piety, but they give an indication that the young adults who used these words consider older adults to have value within the community in terms of what individuals can learn from their knowledge and wisdom. This may be an alternative form of respect for older adults in UK culture.

The present study may be limited in the degree to which these results can be generalised to other parts of each country. China is a vast nation with diverse communities. Attitudes towards ageing in Xi'An may not generalise to other parts of the country, for example, areas which are more remote or less developed. It should also be noted that all of the participants recruited were educated to the same level (University students). Although this helped to minimise potential confounding factors between groups, they may be an unrepresentative sample of young adults in these countries if the attitudes towards ageing of young adults with lower levels of education differ. The group of young adults from China were slightly older than the UK group, however as evidence suggests that attitudes towards ageing remain relatively constant throughout lifetimes (Levy, 2003), this is unlikely to have been a confounding factor between groups. This study did not find any gender differences within groups. However, gender differences have been found between American and German young adults and found that women held more positive attitudes towards older adults (Slevin, 1991) compared to men and women were also more concerned with age-related changes in their physical appearance (McConatha et al., 2003). Gender differences may be more prominent in individuals' expectations for their own ageing, as opposed to attitudes towards older adults, which the present study investigated.

There is the danger of the over-simplification of cultures' attitudes towards ageing, which has been discussed (Tobin, 1987). It has been suggested that the United States tend to idealise the devotion and respect towards older adults in Japan without a full understanding (Levy, 1999). Therefore, culturally appropriate research is required to understand the complexity of attitudes towards ageing. Using the same measures and questionnaires or even research questions across different cultures may not be appropriate. A strength of the present study was the use of an open-response question to capture attitudes towards ageing. Thus the present study was not limited by a potentially culturally-biased questionnaire or by pre-defined domains of attitudes. However, a potential limitation of the present study is the use of the term 'elderly' in the open-response question to capture attitudes towards ageing. It is important to note that this term has been considered to have negative connotations (International Council on Active Aging, 2011). This may have provoked more negative responses than a term considered more neutral in Western and British culture, for example 'older adults'.

This study gives insight into the frequencies and domains of attitudes towards ageing in young adults in the UK and China. However, it did not explore how these attitudes are formed and how they may manifest in behaviours and interactions with older adults or how these interactions may different between cultures. The findings of the present study indicate that attitudes towards ageing held by young adults in the UK are more negative than positive. These findings are important because these attitudes have been found to affect how young adults interact with older adults (Kemper, 1994; Rodin & Langer, 1980). Interactions which provide social reinforcement for negative stereotypes could have a priming effect which has a three times greater deleterious effect of negative stereotypes, compared to the beneficial effects of positive age stereotypes on cognitive and physical health outcomes (Meisner, 2012). Additionally, it is important as young adults' ageing stereotypes become self-stereotypes when they reach older adulthood. Longitudinal evidence suggests this may result in a self-fulfilling prophecy of negative stereotypes (Levy, 2003). For example, lower participation in preventative health behaviours, such as physical activity can affect various cognitive and physical health outcomes. Future research should investigate how the attitudes towards ageing which young adults in the UK hold affect how they interact with older adults and whether this is moderated by the amount of experience or interactions they have with older adults in everyday life. This could inform intervention design of potential strategies to improve attitudes towards ageing.

Potentially, cultures which hold more positive attitudes towards ageing and stereotypes about older adults could facilitate a more healthy ageing society. This is of particular importance with the growing ageing population around the world. Currently with an ageing population, the levels of dependence and care costs are also increasing. The variation in levels of positivity between young adults within both countries reflect the individual differences within cultures and influence of other factors besides culture. This highlights the potential for an intervention aiming to improve attitudes towards ageing to prevent the deleterious effects of negative attitudes on various health outcomes and also their behavioural manifestations in interactions with older adults.

The 'impressionable years' hypothesis proposes that individuals are highly susceptible to attitude change during late adolescence and early adulthood and that this susceptibility drops after this and remains low (Krosnick & Alwin, 1989). The 'increasing persistence' hypothesis proses that individuals become increasingly resistant to change as they age. Evidence of the stability of political attitudes supports the impressionable years hypothesis but not the increasing persistence hypothesis. If these findings can be applied to attitudes towards ageing then perhaps the young adults would be the most appropriate target for attitude change interventions. Additionally, the lack of support for the 'increasing persistence' hypothesis highlights the potential for attitude change interventions in older adults. There is evidence of successful interventions with young adults in Australia, involving a fact sheet and inducing cognitive dissonance for improving attitudes towards older workers in a study aiming to reduce age-related employment discrimination (Gringart, Helmes, & Speelman, 2008). Additionally, a creative-bonding intervention with Taiwanese nursing students was successful, and resulted in significantly more positive attitudes towards older adults after the intervention compared to a 'friendly visit' control group (Chen & Walsh, 2009). However, an education intervention programme in secondary schools in Australia brought about little change in attitudes towards older people (Scott, Minichiello, & Browning, 1998). This education intervention was designed to increase the knowledge of students about the ageing process, in terms of biological and psychological changes associated with growing older and the social determinants of ageing. Future research needs to assess which interventions can lead to long-term meaningful changes in attitudes towards ageing. For example, through improving interactions with older adults so as to not provide social reinforcement for negative stereotypes by using 'elderspeak' or by placing less demands on them and being cruel by being too kind. Longitudinal or experimental studies also need to be done to see whether improvements in attitudes remain long-term and whether they negate deleterious effects on physical and cognitive health outcomes.

In conclusion, young adults in China held more positive attitudes towards ageing, focused on more internal qualities, and described older adults are more active compared to young adults in the UK. Due to the well documented detrimental effects of negative effects, interventions which could improve attitudes towards ageing in young and older adults should be investigated.

PART THREE

Physical activity and cognitive ability

Overview of Part Three

Part Three describes Study 2 which includes two sets of secondary data analysis carried out an available cross-sectional dataset. Two research questions were investigated which are presented as separate papers and thus named Study 2a and Study 2b.

Study 2a investigated the relationship between walking, social, and intellectual activities and cognitive ability. The findings indicated that social and intellectual activities had independent associations with cognitive ability and therefore highlights the importance of controlling for the social and mental stimulation of physical activity in interventions aiming to improve cognitive performance. These findings fed into the design of the feasibility and pilot randomised controlled trials included in the present thesis (Study 3 and Study 4) in relation to the pseudo control group who carried out gentle flexibility exercises to control for social interaction and mental stimulation.

Study 2b investigated the potential mediating role of mental health in the relationship between walking and cognitive ability in older adults. The findings suggested that mental health appeared to partially mediate the effect of walking on cognitive outcomes. In those with better mental health, walking was not associated with cognitive ability. In those with poorer mental health walking was associated with better cognitive ability. Additionally, mental health was independently associated with global cognitive ability and verbal learning. The results suggested a domain specific relationship of mental health with more complex cognitive outcomes. However, causal directions cannot be inferred from this cross-sectional data.

Chapter 7: Study 2a - The relationship between walking, social and intellectual activities and cognitive ability of older adults living in Indonesia

Introduction

Nearly 35.6 million people currently live with dementia worldwide. This is an estimated two to eight per 100 people in the general population aged 60 and over. This number is expected to double by 2030 (65.7 million) and more than triple by 2050 (115.4 million). Much of this increase is due to the rising number of people with dementia living in low- and middle-income countries where currently more than half (58%) are currently living and by 2050, this is likely to rise to more than 70%. By 2025 approximately 70% of dementia cases worldwide will live in developing countries, making this a global issue (Prince, 1997). Approximately 8% of the current population in Indonesia is 60 years or older (equivalent to 17 million), this is expected to rise to 13.5% (equivalent to 37 million) by 2025 (Wibowo, 1999). With a 5% prevalence of dementia, this would equate to 1.8 million cases aged over 60 years in 2025 (Hogervorst, 2011).

The global costs for treating and caring for people with dementia currently costs more than US$ 604 billion per year. This includes the cost of providing health and social care as well the reduction or loss of income of people with dementia and their caregivers. Social and economic changes that are happening in low- to middle-income countries will mean that family carers are less available due to an increase in migration between countries and from rural to urban areas (World Health Organization, 2012). Additionally, research in different cultures with different levels of economic and industrial development will also increase the variance of environmental exposure. This facilitates the investigation and identification of environmental and lifestyle risk factors and gene-environment interactions for dementia (Prince, 1997).

Lifestyle activities

The value of protective lifestyle factors against dementia is especially important in lower-income countries where access to medical care can be limited. Slowing cognitive decline in older adults can improve quality of life and prolong independent living whilst also reducing care needs. Lifestyle activities that have been identified longitudinally as protective against cognitive decline include: physical activity, cognitive leisure activity, and social activities (Fratiglioni et al., 2004; Hertzog, Kramer, Wilson, & Lindenberger, 2009; Kramer, Bherer, & Colcombe, 2004). One review assessed the proportion of studies that found an association (versus those that did not) between each of these types of activities and better cognitive performance, lower levels of dementia and Alzheimer's disease (AD). The majority of studies found a protective effect across outcomes measures with the exception of social network for dementia and AD risk which had an equal number of studies finding no effect. Physical activity had the highest proportion of studies that found a protective effect (the evidence is discussed in more detail in Chapter 1). Thus, it has been argued that out of the lifestyle factors investigated, physical activity has the most support against the deleterious effects of ageing on health and cognitive ability (Bherer et al., 2013; Fratiglioni, Paillard-borg, & Winblad, 2004). However, observational studies which focus only on the physical components of physical activity neglect the potential impact of social interaction and mental stimulation on cognitive ability. Physical activities themselves can involve a substantial amount of social interaction and mental stimulation. A prospective study which rated the level of mental, physical and social components in leisure activities found that they contributed equally in reducing risk of dementia. Across a broad spectrum of activities, protective effects for risk of dementia were found for leisure activities involving two or more of these components (Karp et al., 2006). This evidence highlights the need for multimodal studies to identify the protective aspects of activities, for instance cognitive and social aspects.

Cognitive activities

The 'use it or lose it' hypothesis suggests that keeping the mind active will maintain its performance, therefore preventing age related cognitive decline. Reviews have reported positive associations between individuals in certain occupations, experts, or mental activity levels by self-reports and level of cognitive performance (Salthouse, 2006). Additionally, empirical evidence involving cognitive training interventions have demonstrated immediate beneficial effects on the tasks that participants were trained in (Owen et al., 2010). However, there is a lack of evidence for the transfer effects to untrained tasks. Cognitive stimulation training has also been effective in improving cognitive abilities in older adults with dementia (Woods et al., 2012). Salthouse's (2006) review evaluated the validity of the 'use it or lose it' hypothesis; but it was concluded that there is little scientific evidence that demonstrates that differential engagement in mental activities can alter the rate of mental ageing due to the numerous limitations of the research conducted. The limitations discussed included: (1) the hypothesis may be primarily applicable amongst individuals whose cognitive ability is below a certain level at baseline e.g. those with low levels of education; (2) a paradoxical issue whereby mental activities become more challenging as decline progresses, therefore according to the hypothesis might be expected never to decline as the challenge for carrying out the same activities increases; (3) differences in the impact of mentally challenging exercises may change over different periods of adulthood. The limited statistical power prevents the identification of these interactions; and (4) it is apparent that the mechanisms relevant to the 'use it or lose it' hypothesis are complex and not fully understood. For example, variety of cognitive activities may be more important than the degree of mental challenge. A study found that participation in a variety of cognitive activities, regardless of cognitive challenge, was associated with a 8 to 11% reduction in risk of impairment in verbal memory or global cognitive outcomes over 9.5 year follow-up (Carlson et al., 2012).

Social Network

There is a wealth of observational research showing an association between better cognitive functioning and various measures of social engagement (e.g. Seeman, Lusignolo, Albert, & Berkman, 2001; Zunzunegui, Alvarado, Del Ser, & Otero, 2003). Social network or engagement has been categorised in a variety of ways in observational research; for example, number or frequency of participation in social activities, being married, number of children, and amount of contact with family and friends. The numerous ways that social network has been investigated makes it difficult to draw conclusions about what aspects of social interactions are protective against dementia. The number of social activities that individuals participate in has been inversely related to decline in Mental Status Questionnaire scores in a larger cohort (n = 2387) of elderly Taiwanese over 11-year follow-up (Glei et al., 2005). However, A study which tested the association between several social network variables found that quality and not the quantity of social interactions was protective against dementia and Alzheimer's disease. The delay between social network assessment and dementia diagnosis was five to 15 years, so the issue of reverse causality was minimised (Amieva et al., 2010).

There is also evidence from prospective cohort studies for the independent aetiological and prognosis role of social network on cardiovascular disease, particularly coronary heart disease and associated mortality (Eng & Rimm, 2002). One animal study investigated the relationship of social engagement and exercise in rats and found some interesting results (Stranahan, Khalil, & Gould, 2006). The findings demonstrated that the social isolation of rats delays the positive effects of short term running on neurogenesis in the hippocampus. Additionally, in the presence of stress, social isolation suppressed the generation of new neurons. This study indicates an interactional relationship between social interaction and exercise, therefore suggesting that these factors should be investigated together so that the relationship of the emergent interactions and outcome measures can be further understood.

Interactional relationships

Despite the evidence of interactional relationships between cognitive, social and physical activities, the number of multimodal studies investigating these activities together is limited. It has been suggested they have common pathways rather than specific mechanisms (Fratiglioni et al., 2004). This seems plausible due to the common overlap in components of activities. For example, going to a social gathering may involve incidental physical activity through active transport (e.g. walking) to get there and participating in conversation would provide cognitive stimulation. Another example includes, participating in a ballroom dancing class. This would involve physical movements, social interaction with a dance partner and mental stimulation from remembering steps and routines.

In conclusion, there is evidence for the protective effect of physical, social and mental activities against cognitive decline and dementia. The overlap in activity components suggests there may be common pathways for their protective effect. However, there are a limited number of multimodal studies investigating these activities together. Thus, our understanding of potential interactional relationships is also limited.

Aims and hypotheses

The present study aimed to assess the cross-sectional associations between physical, social, and intellectual activities and cognitive ability within a sample of middle-aged to older adults in Indonesia. It was hypothesised that physical and social activities would be stronger predictors of cognitive ability compared to intellectual activities. This was based on the previous research which found that activities which involved two or more activity components demonstrated the strongest protective effect against cognitive decline (Karp et al., 2006). The intellectual activities included in this study (reading and writing) are unlikely to have involved more than one activity component, whereas the physical and social activities are likely to have involved multiple components.

Method

The data were collected by collaborators as part of the Study of Elderly's Memory Impairment and Associated Risk Factors (SEMAR), which was a collaboration between Loughborough University and the Centre for Ageing Studies at University of Indonesia (described in detail in Yesufu, 2009). Ethical approval from Loughborough University (UK) and Universitas Indonesia (Jakarta) as well as governmental and local permits were obtained prior to onset of the study.

Participants

Data were collected from 719 participants (mean age 69.4, range 52-98, 65% female) living in three areas in Indonesia: Borobudor, near Yogyakarta (n=214; 100% Javanese ethnicity) and Sumedang, near Bandung (n=207; 100% Sudanese ethnicity) in December 2006 to February 2007, and Jakarta (n=298; 47% Javanese, 17% Sudanese and 36% other ethnicities) in April-June 2006. Borobudor and Sumedang are rural areas while Jakarta is urban. Participants residing in rural areas were recruited using opportunity sampling through information forwarded through village elders and staff at local community health centres. Interested participants were invited to attend the local community health centre for data collection. None of those who attended declined to participate. A convenience sample was recruited in Jakarta of those attending local community health centres or at the institute in which they were living. Arrangements were made with participants with limited mobility to be tested at home (n=3).

Cognitive outcome measures

Validated and culturally adapted versions of The Mini Mental Status Examination (MMSE; Folstein, Folstein, & McHugh, 1975) and Hopkins Verbal Learning Test (HVLT, Brandt, 1991) were completed by participants. The MMSE assesses global cognition and can be used to indicate cognitive impairment. It utilises a question-answer format and measures orientation, registration (immediate memory), short– term memory, attention, calculation and language functioning. A score of 17 or less is considered to indicate severe cognitive impairment, 18-25 indicates mild to moderate impairment and 26-30 indicates normal or borderline impairment (NICE, 2011). The HVLT assesses verbal short-term memory and involves a list of 12 words being read out aloud to the participant which they are asked to recall. This is done three times consecutively using the same list of words. There are standardised instructions for this test and words are read out loud at a speed of approximately one word per second. Participants were then asked to recall as many words from the list as they could. Scoring high on this test requires the recruitment of memory strategies, such as chunking the words into categories. This provides the advantage of no ceiling effects as healthy controls do not scores full marks (Hogervorst et al., 2002). It also has acceptable test-retest reliability estimates (0.75) in healthy older adults (Wesnes, 2012). The HVLT Trial 1 score was included in addition to the total score as an outcome measure in these studies as it has been found to measure memory abilities affected by Alzheimer’s disease (Clifford, 2012). Both of these cognitive tests have been validated for dementia screening in Indonesia (Hogervorst et al., 2011). Adaptations for local knowledge and illiterate participants were made, including the season question (changed to dry/rainy), remembering three objects that would be familiar (house, rice, child) and backwards spelling task (changed to days of the week backwards) in the MMSE and the precious stones category in the HVLT were changed to more familiar words.

Other measures

Participants completed an extensive questionnaire pack verbally with native speaking researchers which included demographic characteristics (such as age, sex, education), functional abilities and lifestyle behaviour information regarding types and frequencies of specific activities. Responses to participants' self-reported frequency of one physical activity, two intellectual and six social activities were captured on a 5-point Likert scale (Never = 0, Seldom = 1, Sometimes = 2, Often = 3, Very Often = 4). The specific physical activity captured was walking, and the intellectual activities included reading and writing. Social activities included talking to friends, neighbours or family, going to social gatherings, having dinners with friends/family, going to the theatre/film, going to musical gatherings, and being involved in community social activities. Although some of the social activities may have involved an intellectual component they were categorised as social as they were considered to be primarily a social activity. Composite intellectual and social activity scores were calculated using the sum of frequency activity Likert-scale scores. The possible ranges for the intellectual and social composite scores were 0-8 and 0-24 respectively. Although other physical activities were assessed on the extensive questionnaire, they were either not captured as a frequency or captured in a different way to walking and the social and intellectual activities. Thus, creating a suitable composite score of physical activities comparable to social and intellectual activities was not possible, therefore only walking was included. The Instrumental Activities of Daily Living Scale (IADL; Lawton & Brody, 1969) was used to assess the functional abilities of participants. The scale captures participants' self-reported ability to perform basic tasks independently, such as preparing meals, shopping, housekeeping, managing finances and taking medication. Higher scores indicate better functional ability. It has been shown to have good inter-rater reliability (.85) and good concurrent validity with four other scales measuring domains of functional status (Graf, 2008).

Design

This observational study was cross-sectional. Although Indonesia is a culturally diverse country in relation to demographics and socio-economic status, there is less variation in terms of diet, alcohol consumption, employment and education. As these lifestyle factors are associated with an increased risk of cognitive decline, this cohort allows an investigation into variables of interest on their own with a lower risk of interactions with other factors. Age in years, sex, level of education completed and smoking status (self-reported as having ever smoked) were included in the analysis as covariates. Increased age, female gender, smoking, and lower levels of education are known risk factors for Alzheimer's disease (Launer, Andersen, Dewey, & Letenneur, 1999). Functional health was also included in analyses as a potential moderator because it could be a limiting factor on participants' ability to carry out certain activities. Therefore, this allowed the independent relationship between the lifestyle activities and cognitive ability to be assessed.

Procedure

Prior to study onset, forwards and backwards translations (English and Indonesian) of the questionnaire pack and cognitive tests were carried out several times to ensure that they maintained their intended meaning. Participants were invited to community health centres for assessment between 8am and 11am to avoid circadian interference or the effect of heat. The procedure was standardised for all participants. Informed consent was given by participants (if a caregiver was present, they also gave informed consent) prior to starting the demographic and lifestyle behaviour questionnaires. If a participant's level of cognitive ability was sufficiently impaired that they were unable to give informed consent, a caregiver provided consent by proxy and remained present for the duration of the assessments. Consent procedures were followed by cognitive assessments and then the functional health questionnaire.

Data analysis

The data were analysed using SPSS version 21.0 with a required significance level of $p < 0.05$. Demographic characteristics, functional health and cognitive test mean scores were calculated using descriptives for means and cross-tabs for percentages. T-tests and chi-square tests were used to assess differences between men and women and also between participants 65 years and younger compared to older than 65 years old. The majority of variables consisted of either ordinal data (walking and education) or inspection of the histograms indicated non-normal distributions (IADL, MMSE, intellectual composite scores). Therefore, Mann-Whitney U tests of difference and Spearman's correlations were used.

The walking variable was captured on only a 5-point Likert scale, thus it was converted into dummy variables using backwards difference contrast coding so that it was appropriate for using in regression analysis (Chen, Ender, Mitchell, & Wells, 2003). Hierarchical regression analysis was carried out using the 'Enter' method to assess whether walking and social and intellectual activities independently predicted cognitive ability. Separate regressions were run for each of the three cognitive outcome measures. In Step 1, the covariates age, gender, education, and smoking status were entered into the model on their own. In Step 2, the four dummy walking variables were added. In Step 3, social and intellectual activity composite scores were added. In Step 4, functional health was added to see if it had a moderating effect on the activity variables.

Results

Mean scores and percentages of demographic characteristics, functional health, and cognitive tests scores can be seen in Table 11.1 for the whole sample and stratified by sex and age group. On average, women were significantly younger (Median = 67 years) compared to men (Median = 70 years; z = -2.41, p = .016). On average, men were educated to a higher level (Median = 3, completed elementary/primary school) compared to women (Median = 2, did not finish elementary/primary school; z = -2.07, p = .038). However, using Cohen's (1992) criteria (.2 = small effect; .5 = medium effect) these differences only represented very small effect sizes for age (*r* = .09) and education (*r* = .08). Women were less likely to have smoked χ^2 (1) = 315.88, p < .001. Men and women did not significantly differ on any of the cognitive ability or activity variables.

On average, participants aged 65 years or younger were more likely to have been educated to a higher level (z = 20.95, *p* < .001, *r* = .84), have better functional health (z = -6.55, *p* < .001, *r* = .26) and better cognitive abilities indicated by higher MMSE scores (z = -4.47, *p* < .001, *r* = .18), higher HVLT trial 1 scores (z = -4.85, *p* < .001, *r* = .19), and higher HVLT total scores (z = -5.10, *p* < .001, *r* = .21), compared to those older than 65 years. These differences represented small effect sizes for functional health and cognitive ability but a large effect size for education. There was no significant difference between age groups on whether they had ever smoked.

Table 7.1 also shows frequency of participation in walking, social and intellectual activities for the whole sample and stratified by sex and age group. There were no differences between men and women for frequency of walking, intellectual or social activities. However, on average participants aged 65 years or younger reported walking more frequently (z = -4.63, *p* < .001, *r* = .19), and participating more often in intellectual (z = -3.34, *p* = .001, *r* = .13) and social activities (z = -3.37, *p* = .001, *r* = .14); compared to those older than 65 years old. However, these differences represented small effect sizes.

Table 7.2 shows the Spearman correlations coefficients between variables. Large effect sizes for correlations (≥.5) are highlighted in bold, using Cohen's (1992) criteria for correlations (.1 = small effect; .3 = medium effect; .5 = large effect). As would be expected from the significant differences between age groups, age is moderately and negatively correlated with all variables (small to medium effect sizes), showing that increasing age was associated with lower levels of education completed (*rho* = -.20), lower scores across all cognitive outcome measures (*rho*: MMSE = -.29; HVLT 1 = -.29; HVLT total = -.30), lower functional health (*rho* = -.37), walking less frequently (*rho* = -.23) and lower levels of participation in social (*rho* = -.17) and intellectual (*rho* = -.19) activities. Higher levels of education were positively associated with better scores on all cognitive measures (rho: MMSE = .61; HVLT 1 = .48; HVLT total = .56) and with frequency of participation in intellectual activities (*rho* = .62), which had large effect sizes. Higher frequency of walking was positively associated with higher levels of social (*rho* = .19) and intellectual (*rho* = .26) activity participation and participation in social and intellectual activities were also positively associated with each other (rho = .36), with small to medium effect sizes. Higher levels of participation in any of the types of activities was positively associated with better scores on all cognitive outcome measures: Walking showed small to medium effect sizes (*rho*: MMSE = .25; HVLT trial 1 = .20; HVLT total = .23); social activities showed medium effect sizes (*rho*: MMSE = .38; HVLT trial 1 = .41; HVLT total = .41) and intellectual activities showed medium to large effect sizes (*rho*: MMSE = .54; HVLT trial 1 = .34; HVLT total = .50).

Hierarchical regression models are shown in Table 7.3 Step 2 showed that walking was positively associated with all cognitive outcomes when controlling for age, education, sex and smoking status, and explained an additional 1.8 - 5.5% of the variance of cognitive outcome measures. In Step 3, social and intellectual activities were added to the model, walking remained a significantly independent contributor across all cognitive outcomes (Step 3). Social and intellectual activities together explained an additional 2.8 - 5% of the variance of cognitive outcome measures. Social and intellectual activities were significant predictors for all cognitive outcome measures with the exception of intellectual activities, which were not a significant predictor for HVLT trial 1 scores. In Step 4, when functional health was included, it which explained a further 1.3-9.4% of variance. Social and intellectual activities were significant predictors for all cognitive outcome measures with the exception of intellectual activities, which were still not a significant predictor for HVLT trial 1 scores.

Table 7.1. Descriptive statistics for demographic characteristics, functional health, cognitive test scores, and activities.

Variable	Whole sample	Men	Women	≤65 years	>65 years
N	719	255	464	285	434
Age	69.38 (7.85) *52-98*	**70.14** **(7.68)** ***56-98***	**68.96*** **(7.93)** ***52-90***	**61.98** **(2.27)** ***52-65***	**74.24***** **(6.26)** ***66-98***
Education completed; % total					
≤Primary/Elementary	80.2	**28.9**	**51.3***	**30.6**	**49.6****
≥Secondary/High	19.8	**6.0**	**13.8***	**9.1**	**10.7****
Ever smoked; %	25.2	**64.2**	**3.9*****	21.4	27.8
IADL	13.31 (3.86) *0-16*	**12.92** **(4.00)** ***0-16***	**13.53*** **(3.77)** ***0-16***	**14.67** **(2.22)** ***3-16***	**12.39**** **(4.42)** ***0-16***
MMSE	24.18 (5.59) *0-30*	24.27 (5.33) *0-30*	24.13 (5.73) *0-30*	**25.60** **(4.29)** ***6-30***	**23.25**** **(6.12)** ***0-30***
HVLT total score	14.74 (7.73) *0-34*	13.81 (6.68) *0-31*	15.24 (8.22) *0-34*	***16.92*** **(7.55)** ***0-34***	***13.26****** **(7.51)** ***0-33***
HVLT trial 1	3.96 (2.47) *0-12*	3.72 (2.18) *0-11*	4.08 (2.61) *0-12*	**4.59** **(2.52)** ***0-12***	**3.53***** **(2.35)** ***0-11***
Walking; %					
Never v seldom	1.4	1.2	1.5	**0.4**	**2.1****
Seldom v sometimes	13.3	15.0	12.3	**8.4**	**16.5****
Sometimes v often	22.8	22.5	22.9	**17.2**	**26.5****
Often v very often	54.4	55.3	53.9	**64.6**	**47.7****
Very Often	8.1	5.9	9.3	**9.5**	**7.2****
Intellectual	2.13 (2.09) *0-8*	2.11 (2.00) *0-8*	2.15 (2.14) *0-8*	**2.49** **(2.13)** ***0-8***	**1.89** **(2.03)**** ***0-7***
Social	6.96 (3.37) *0-22*	6.96 (3.06) *0-15*	6.96 (3.54) *0-22*	**7.48** **(3.13)** ***1-20***	**6.63** **(3.48)**** ***0-22***

Note: Mean (SD) *range* displayed; unless otherwise stated (%). Test of difference (men v women; ≤65 years v >65 years) significantly different at *p < .05, ** p < .01 ***p < .001; highlighted in bold. SD = Standard Deviation; IADL = Instrumental Activities of Daily Living; MMSE = Mini Mental Status Examination; HVLT = Hopkins Verbal Learning Test.

Table 7.2. Spearman's correlation matrices for the whole sample

		1	2	3	4	5	6	7	8
1	Age								
2	Education	-.20***							
3	IADL	-.37***	.24***						
4	MMSE	-.29***	**.61*** **	.44***					
5	HVLT trial1	-.29***	**.48*** **	.33***	**.61*** **				
6	HVLT total	-.30***	**.56*** **	.37***	**.70*** **	**.88*** **			
7	Walking	-.23***	.19***	.31***	.25***	.20***	.23***		
8	Social	-.17***	.29***	.28***	.38***	.41***	.41***	.19***	
	Intellectual	-.19***	**.62*** **	.31***	**.54** **	.34***	**.50*** **	.26***	.36***

Note: Significance levels *p < .05, ** p < .01 ***p < .001; large effect sizes highlighted in bold (≥.45 as this would be rounded up to .5). SD = Standard Deviation; IADL = Instrumental Activities of Daily Living; MMSE = Mini Mental Status Examination; HVLT = Hopkins Verbal Learning Test.

Table 7.3. Regression models demonstrating the effect of activity predictors on cognitive ability

Step	Independent variables	β	MMSE	β	HVLT trial 1	β	HVLT total
1	Age	-.26***	Adj R^2 = .291	-.21***	Adj R^2 = .301	-.21***	Adj R^2 = .378
	Gender	.02	R^2 change = .296***	.08	R^2 change = .305***	.14**	R^2 change = .382***
	Smoking	.04	F(4,646) = 67.75***	.02	F(4,617) = 67.85***	.07	F(4,616) = 95.37***
	Education	.44***		.48***		.54***	
2	Age	-.22***		-.19***		-.19***	
	Gender	.03		.08		.14***	
	Smoking	.04	Adj R^2 = .342	.02	Adj R^2 = .315	.07	Adj R^2 = .397
	Education	.42***	Cum R^2 = .350	.46***	Cum R^2 = .324	.53***	Cum R^2 = .405
	Walk never v seldom	.54***	R^2 change = .055***	.31***	R^2 change = .018**	.32***	R^2 change = .022***
	Walk seldom v sometimes	.74***	F(8,642) = 43.23***	.44***	F(8,613) =36.72***	.44***	F(8,612) = 51.99***
	Walk sometimes v often	.77***		.50***		.52***	
	Walk often v very often	.31***		.24**		.22**	
3	Age	-.20***		-.17***		-.17***	
	Gender	.02		.07		.13**	
	Smoking	.04		.02		.07	
	Education	.28***	Adj R^2 = .390	.38***	Adj R^2 = .341	.41***	Adj R^2 = .439
	Walk never v seldom	.51***	Cum R^2 = .400	.28**	Cum R^2 = .352	.29***	Cum R^2 = .448
	Walk seldom v sometimes	.67***	R^2 change = .050***	.41***	R^2 change = .028***	.40***	R^2 change = .044***
	Walk sometimes v often	.67***	F(10,640) = 42.61***	.45***	F(10,611) = 33.12***	.45***	F(10,610) = 49.55***
	Walk often v very often	.28***		.24**		.22**	
	Intellectual activities	.16***		.05		.10*	
	Social Activities	.18***		.17***		.19***	
4	Age	-.08*		-.13***		-.11**	
	Gender	-.002		.06		.12**	
	Smoking	.04		.02		.07	
	Education	.28***		.38***		.41***	
	Walk never v seldom	.31***	Adj R^2 = .485	.21*	Adj R^2 = .353	.19*	Adj R^2 = .462
	Walk seldom v sometimes	.36***	Cum R^2 = .494	.30**	Cum R^2 = .365	.25*	Cum R^2 = .471
	Walk sometimes v often	.32**	R^2 change = .094***	.32*	R^2 change = .013***	.28*	R^2 change = .023***
	Walk often v very often	.15*	F(11,639) = 56.74***	.19*	F(11,610) = 31.81***	.15*	F(11,609) = 49.34***
	Intellectual activities	.11**		.03		.08*	
	Social Activities	.12***		.15***		.17***	
	Functional health	.38***		.14***		.18***	

Note: Significance levels *p < .05, ** p < .01 ***p < .001. MMSE = Mini Mental Status Examination; HVLT = Hopkins Verbal Learning Test; β = standardised beta, Adj = adjusted.

Discussion

Frequency of walking and participation in social activities were positively and independently associated with cognitive performance across all three cognitive outcome measures, while controlling for age, education, sex, smoking status, and the other types of activities. Participation in intellectual activities was significantly associated with cognitive performance as measured by MMSE and HVLT total, but not when measured by HVLT trial 1. The significant associations also remained after controlling for functional health status, which was assessed in relation to activities of daily living.

The results of the present study support the hypothesis that physical and social activities would be stronger predictors of cognitive ability compared to intellectual activities. This is demonstrated by larger standardised beta values and also by the lack of a significant independent effect of intellectual activities on HVLT trial 1 scores. This hypothesis was based on previous research which found that activities which involved two or more activity components demonstrated the strongest protective effect against cognitive decline (Karp et al., 2006). It is difficult to assess the relative importance of different types of activities as often an activity can involve a combination of physical activity, social interaction and mental stimulation. The intellectual activities included in this study are unlikely to have involved more than one activity component as reading and writing would usually be carried out alone and is sedentary. There is more likely to have been an overlap between activity components of physical and social activities. For example, walking may involve social interaction, either through walking with other individuals or if walking is incidental as active transport to go shopping or to attend a social gathering. The social activities included were also likely to have included a mental component. For example, talking to friends, neighbours or family is mentally stimulating in terms of following and contributing to conversation; having dinners with friends/family may involve preparing and cooking food; going to the theatre/film would provide mental stimulation through following storylines; and musical gatherings may involve social interaction and playing some instruments or singing, which would require reading lyrics and following a tune. Perhaps the intellectual activities assessed in this study demonstrated a smaller contribution to enhanced cognitive ability because reading and writing are unlikely to have involved a social or physical component. It may be that activities which involved a combination of activity components may demonstrate the most beneficial effect.

Another potential explanation for intellectual activities not being a significant predictor for the specific domain of cognitive functioning measured by HVLT trial 1 scores could be the limited variance on both of these variables, and thus limiting the scope for explaining variance. The HVLT trial has a possible range of scores from 0 to 12. However, it is very unusual for even healthy participants to score the maximum (Hogervorst et al., 2002). The intellectual composite score was only made up of two activities compared to six for the social composite score. Therefore the range of scores for intellectual activities was from 0 to 8 compared to 0 to 24 for social activities. Additionally, there was a large proportion of participants which scored zero on intellectual activities (36%) by responding with “never” to both reading and writing. Furthermore, the intellectual activities composite score may not accurately represent all intellectual activities carried out by participants. There may have been other intellectual activities which participants took part in but were not captured (those other than reading and writing). This is a limitation of using a questionnaire with ‘closed’ responses to predefined activities. This limitation also applied to the walking variable. Although other physical activities were assessed on the extensive questionnaire, they were either not captured as a frequency, or frequency was assessed in a different way to walking and social and intellectual activities. Thus creating a suitable composite score of physical activities comparable to social and intellectual activities was not possible. A further limitation of the activity measures was that they relied on self-reported frequency. What one participant considers to be ‘often’ may vary from another participant. Furthermore, self-report for those with cognitive decline is possibly unreliable. However, a strength of the present study was that caregivers, where possible, corroborated the responses of participants. Another limitation is that there was no information captured regarding the intensity of walking as a physical activity, which has been previously found to moderate the effect of the physical activity on cognitive outcomes (Denkinger et al., 2012).

Regardless of the limitations of the intellectual composite score, intellectual activities were still independently and positively associated with MMSE and HVLT total scores. Therefore, although the effect of intellectual activities captured in this study demonstrated a weaker positive association with cognitive outcome measures, it still demonstrated an independent positive association with MMSE and HVLT total scores. Thus the findings of the present study demonstrate that walking, and social and intellectual activities are all independently and positively associated with better cognitive performance. This agrees with a previous study which found that mental, physical and social components in leisure activities equally contribute to dementia risk (Karp et al., 2006). Furthermore, this positive association appears to be a dose-response relationship as each activity was captured as a frequency, suggesting that the more often participants engaged in any of these activities, the better their cognitive performance was. Social and intellectual composite scores also captured number of activities, thus suggesting that participating in a high number of these activities is associated with better cognitive performance. A previous study found that participation in a variety of lifestyle activities was more predictive than frequency or level of cognitive challenge for significant reductions in risk of incident impairment on measures sensitive to cognitive aging and risk for dementia (Carlson et al., 2012).

The results of the present study highlight the importance of controlling for social interaction and mental stimulation in exercise interventions aiming to improve cognitive performance. However, social interaction is not always controlled for in exercise interventions despite the wealth of observational research implicating social engagement as protective against cognitive decline and dementia. Some of the control groups in the Clifford et al (2009) review did not receive the same level of engagement as exercise groups, in terms of frequency of sessions or level of interest and attention (e.g. Fabre et al., 1999; Molloy, McLaughlin, Richardson, & Crilly, 1988). This may explain some of the between group differences found in cognitive performance change post intervention. The results of the present study, together with the increasing evidence from other longitudinal studies support the biopsychosocial model of dementia.

Although no studies have demonstrated a detrimental effect of engaging in physical, mental and social activities on cognitive performance, there is much about these relationships which are still not understood. This includes the mechanisms through which these activities are protective against cognitive decline. Evidence for the protective effect of the quality (and not quantity) of social relationships against dementia (Amieva et al., 2010) suggests that psychosocial mechanisms play an important role. Furthermore, the evidence that the social isolation of rats delays the positive effects of short term running on neurogenesis in the hippocampus and in the presence of stress, social isolation suppressed the generation of new neurons (Stranahan et al., 2006) also demonstrates the potential for psychosocial effects on physiological mechanisms. Emotional support afforded through a social network may also contribute to the effect as it has been found to play a role in determining a favourable prognosis on physical health conditions (Berkman et al., 1992). It has been suggested that in addition to the mental requirements of social engagement, maintaining social connections are associated with a commitment to family and the community which would be likely to be associated with a health-promoting sense of purpose and fulfilment and thus could be protective against cognitive decline (Bassuk, Glass, & Berkman, 1999). The mechanisms through which religious attendance increases survival are reported to be through improving and maintaining good health behaviours, mental health, and social relationships (Strawbridge, Shema, Cohen, & Kaplan, 2001). Additionally, it may be that individuals who have better cognitive abilities and/or mood have a tendency to participate in more social activities throughout their lives. The range of factors used to capture social engagement across studies also clouds our understanding as to which aspects of engagement are important for maintaining cognitive functioning into old age. It has been suggested that future studies should aim to unpack the social engagement 'black box' because generic measures of exposure are insufficient to further our understanding of the mechanisms underlying this association (Gallacher, Bayer, & Ben-Shlomo, 2005).

The main limitation of this study is the cross-sectional design. Thus causal mechanisms and trajectories of activity participation and cognitive decline cannot be inferred. It could be suggested that participation in fewer activities in those with worse cognitive abilities may simply reflect what they are able to do. However, the associations between activities and cognitive abilities remained significant after controlling for functional health; therefore it is less likely that participation in activities reflected only what participants were able to do. Additionally, the associations found agree with findings from longitudinal studies which suggest a causal effect of activities at baseline of cognitively healthy participants on cognitive abilities at follow-up (Fratiglioni, Paillard-borg, & Winblad, 2004).

Despite the limitations of the cross-sectional design, there are important implications from the current study's findings. The findings suggest that walking and participation in social and mental activities may be beneficial for maintaining cognitive abilities in older adults in Indonesia. It is difficult to isolate the effects of physical activity carried out as part of daily life from social or mental components in observational studies, thus more recent studies have utilised an experimental design. The majority of studies into the potential mechanisms of the protective effect of these activities have predominantly focused on physiological mechanisms. The smaller number of studies which have investigated the psychosocial factors of various activities cognitive decline have indicated that they do play a role. However, future research is needed to further understand these psychological mechanisms.

Chapter 8: Study 2b - The role of mental health in the relationship between physical activity and cognitive ability in Indonesia

Introduction

Dementia is a global issue with nearly 35.6 million people currently live with dementia worldwide which equates to approximately two to eight per 100 people in the general population aged 60 and over. This number is expected to double by 2030 (65.7 million) and more than triple by 2050 (115.4 million). Much of this increase is due to the rising number of people with dementia living in low- and middle-income countries. It is predicted that by 2025 approximately 70% of dementia cases worldwide will live in developing countries (Prince, 1997). Treating and caring for people with dementia currently globally costs more than US$ 604 billion per year in terms of providing health and social care as well the reduction or loss of income of people with dementia and their caregivers. Additionally, social and economic changes occurring in low- to middle-income countries will mean that family carers are less available due to an increase in migration between countries and from rural to urban areas (World Health Organization, 2012).

As there is currently no cure for dementia, modifiable lifestyle behaviours, such as physical activity, have been investigated as a preventative strategy for delaying the onset of dementia and thus prolong independent living (e.g. Angevaren, Aufdemkampe, Verhaar, Aleman, & Vanhees, 2008; Clifford, Bandelow, & Hogervorst, 2009; Colcombe & Kramer, 2003; Lautenschlager, Cox, Cyarto, Gold, & Keller, 2012; Sofi et al., 2010). The value of identifying protective lifestyle factors, such as, physical activity, against dementia is especially important in lower-income countries where access to medical care may be limited. Physical activity is accessible by almost everyone and is also low-cost and low-tech thus increasing the potential for widespread participation. However, reviewing the literature investigating the relationship between physical activity and cognitive ability is challenging due to the wide variety of ways that this relationship has been investigated. There are inconsistent results across exercise interventions designed to improve cognitive performance despite the large number of high quality trials. This suggests that they may be explained by differences in specific features of the interventions. Previous reviews and meta-analyses have identified moderators of the relationship including the type, duration and intensity of physical activity. However, the moderating effect of the environment has not been investigated.

The biopsychosocial model of dementia (Clare, 2007; Kitwood, 1997) implicates the importance of considering the impact of the social context and environment for their role on cognitive outcomes. When investigating physical activity as a protective lifestyle behaviour against cognitive decline it is important to remember that it does not occur independently of the environment. The physical activity environment varies widely, which could influence the psychological impact of the activity. For example, if it was carried out alone or in a group, whether it was self-directed or with an instructor, whether participants received feedback in terms of skill or fitness improvements versus no feedback etc. However, the majority of reviews of exercise intervention studies have not taken into account the psychosocial factors of the relationship or have excluded studies in which participants were suffering from depression (Hertzog, Kramer, Wilson, & Lindenberger, 2009). Psychosocial factors have occasionally been considered but usually only in terms of their influence on participation of physical activity (McAuley, Kramer, & Colcombe, 2004) and not as a mechanism through which physical activity could impact on cognitive outcomes.

The consistent positive effects found in observational studies which have not been replicated from physical activity interventions suggest potential scope for the contribution of psychosocial factors in the effect. Potential psychosocial mechanisms are neglected when this complex relationship is reduced to internal physiological mechanisms alone. More recent reviews have considered the role of psychosocial factors in this relationship (Miller et al., 2012; Stock et al., 2012). A potential mediating relationship was been suggested due to the evidence for the psychological impact of the exercise intervention and the subsequent impact of this on cognitive performance (Stock et al., 2012). For example, exercise interventions have demonstrated positive effects on psychological outcomes including depression and self-efficacy (Callaghan, 2004; Callaghan, Khalil, Morres, & Carter, 2011; Katula, Sipe, Rejeski, & Focht, 2006; Stanton & Reaburn, 2013). Additionally, in non-exercise related observation and intervention studies, psychosocial factors have been associated with improvements in cognitive performance, including improved mental health (e.g. Ganguli, Du, Dodge, Ratcliff, & Chang, 2006) The potential mechanisms through which improved mental health could mediate the positive effect of physical activity on cognitive outcomes has been discussed in Chapter 2 (Stock et al., 2012). For example, improved self-efficacy may occur as a result of mastery experiences of physical exercises (Bandura, 1986; McAuley, Blissmer, Katula, Duncan, & Mihalko, 2000). Self-efficacy or beliefs can enhance or hinder cognitive performance through a variety of processes, including motivational, affective and meta-cognitive aspects (Bandura, 1989). Therefore, it may be that the exercise intervention studies which facilitate psychosocial improvements results in larger cognitive gains through psychosocial mechanisms (Stock et al., 2012).

Mental health is important to consider as a potential mediator in this relationship because there is a high prevalence (approximately 15%) of depressive symptoms in individuals over 65 years old (Lyketsos et al., 2010). Individuals with late onset depression are more likely to have cognitive impairment but late onset depression is not considered a prodrome to dementia (Schweitzer, Tuckwell, Brien, & Ames, 2002). Lower levels of social and productive activities were found to be associated with higher cross-sectional levels of depression (Glass, De Leon, Bassuk, & Berkman, 2006). Participation in physical activities is also associated with improved mood in older adults (Arent et al., 2000). Increasing participation in activities have been used is a therapeutic context (behavioural activation) for depression (Dimidjian, Barrera, Martell, Muñoz, & Lewinsohn, 2011). However, there is sufficient evidence to recommend exercise specifically as treatment in mild anxiety and depression (Fox, 1999). It was found to improve wellbeing and to be protective against depression (Peluso & Andrade, 2005). Evidence from RCTs demonstrated that exercise was effective in treating depression in older adults suffering from minor or major depression and also in reducing depressive symptoms amongst those who had high levels at baseline (Sjösten & Kivelä, 2006). Another study found age differences, whereby in older adults (65 – 79 years old) in China who walked more on a daily basis predicted fewer depressive symptoms at follow up, even after adjusting for confounders. Interestingly, this association was not found in middle-aged adults (40 - 64 years old) (Fukukawa et al., 2004). A meta-analysis looking at older adults without clinical disorders found that wellbeing in exercise groups improved three times as much compared to control groups. They also found that aerobic training was the most beneficial, as was moderate intensity activity. Longer exercise duration was less beneficial for several types of wellbeing. Physical activity had the strongest effect on self-efficacy compared to other psychosocial measures and physical improvements (cardiovascular status, strength and functional capacity) were linked to overall improvement in wellbeing (Netz, Wu, Becker, & Tenenbaum, 2005).

Mood or wellbeing has rarely been measured in exercise interventions which assessed cognitive performance improvements, despite the high incidence of depression in older adults (Lyketsos et al., 2010), the evidence for its detrimental effect on cognitive performance (Ganguli et al., 2006; Yaffe et al., 1999) and the beneficial effect of exercise for depressive symptoms (e.g. Sjösten & Kivelä, 2006) and wellbeing (Netz et al., 2005). One cross-sectional study found that the effect of physical activity on cognitive performance remained significant on some cognitive measures independent of depression (Trail Making Task B, Stoop, Digit Symbol Test) but not Verbal Fluency (Swardfinger et al., 2010). Although, depression has been suggested as a potential mediator of the relationship between physical activity and cognitive performance, the number of clinically depressed patients in studies is usually low. This could be due to they exclude themselves by not choosing to participate or by dropping out of the exercise intervention; consequently the variation in scores on a depression measures would be limited (Miller et al., 2012). Therefore, although, the impact of psychological factors on cognitive decline has been demonstrated in non-physical activity contexts (Hertzog et al., 2009), Thus, our understanding of the role of mental health in the relationship between physical activity and cognitive ability is limited and requires further research.

Aim and hypothesis

The present study aimed to investigate the role of mental health in the relationship between physical activity and cognitive performance. It was hypothesised that mental health would have a partially mediating effect. This is based on the evidence that suggests positive effects of physical activity on mental health and the association between mental health and cognitive performance (Stock et al., 2012 – Chapter 2).

Method

The data were collected by collaborators as part of the Study of Elderly's Memory Impairment and Associated Risk Factors (SEMAR), which was a collaboration between Loughborough University and the Centre for Ageing Studies at University of Indonesia (described in detail in Yesufu, 2009). Ethical approval from Loughborough University (UK) and Universitas Indonesia (Jakarta) as well as governmental and local permits were obtained prior to onset of the study.

Participants

Data were collected from 719 participants (mean age 69.4, range 52-98, 65% female) living in three areas in Indonesia: Borobudor, near Yogyakarta (n=214; 100% Javanese ethnicity) and Sumedang, near Bandung (n=207; 100% Sudanese ethnicity) in December 2006 to February 2007, and Jakarta (n=298; 47% Javanese, 17% Sudanese and 36% other ethnicities) in April-June 2006. Borobudor and Sumedang are rural areas while Jakarta is urban. Participants residing in rural areas were recruited using opportunity sampling through information forwarded through village elders and staff at local community health centres. Interested participants were invited to attend the local community health centre for data collection. None of those who attended declined to participate. A convenience sample was recruited in Jakarta of those attending local community health centres or at the institute in which they were living. Arrangements were made with participants with limited mobility to be tested at home (n=3).

Measures

Cognitive outcome measures

Validated and culturally adapted versions of The Mini Mental Status Examination (MMSE; Folstein, Folstein, & McHugh, 1975) and Hopkins Verbal Learning Test (HVLT, Brandt, 1991) were completed by participants. The MMSE assesses global cognition and can be used to indicate cognitive impairment. It utilises a question-answer format and measures orientation, registration (immediate memory), short– term memory, attention, calculation and language functioning. A score of 17 or less is considered to indicate severe cognitive impairment, 18-25 indicates mild to moderate impairment and 26-30 indicates normal or borderline impairment (NICE, 2011). The HVLT assesses verbal short-term memory and involves a list of 12 words being read out aloud to the participant which they are asked to recall. This is done three times consecutively using the same list of words. There are standardised instructions for this test and words are read out loud at a speed of approximately one word per second. Participants were then asked to recall as many words from the list as they could. Scoring high on this test requires the recruitment of memory strategies, such as chunking the words into categories. This provides the advantage of no ceiling effects as healthy controls do not scores full marks (Hogervorst et al., 2002). It also has acceptable test-retest reliability estimates (0.75) in healthy older adults (Wesnes, 2012). The HVLT Trial 1 score was included in addition to the total score as an outcome measure in these studies as it has been found to measure memory abilities affected by Alzheimer's disease (Clifford, 2012). Both of these cognitive tests have been validated for dementia screening in Indonesia (Hogervorst et al., 2011). Adaptations for local knowledge and illiterate participants were made, including the season question (changed to dry/rainy), remembering three objects that would be familiar (house, rice, child) and backwards spelling task (changed to days of the week backwards) in the MMSE and the precious stones category in the HVLT were changed to more familiar words.

Other measures

Participants completed an extensive questionnaire pack verbally with native speaking researchers which included demographic characteristics (such as age, sex, education), functional abilities and lifestyle behaviour information regarding types and frequencies of specific activities. These are described in more detail elsewhere (Yesufu, 2009). The present study utilised participant responses regarding frequency of walking which was captured on a 5-point Likert scale (Never = 0, Seldom = 1, Sometimes = 2, Often = 3, Very Often = 4). Mental health was captured using part of the Medical Outcome Survey Short-Form-36 questionnaire (SF-36v2; Ware & Sherbourne, 1992). This questionnaire has undergone extensive psychometric testing internationally and across diverse patient populations (Ware & Gandek, 1998). Internal consistency and discriminant validity are high and reliability coefficients range from .65 to .94 (McHorney, Ware, Lu, & Sherbourne, 1994), and in the majority of studies they exceed .80 (Ware & Gandek, 1998).The mean score on three of the four subscales that make up the mental health summary measure was used. The three subscales used were emotional wellbeing, social functioning and energy/fatigue. The 'limitations due to emotional problems subscale' was not included as information about limitations in daily life was already captured by the IADL questionnaire. The Instrumental Activities of Daily Living Scale (IADL; Lawton & Brody, 1969) was used to assess the functional abilities of participants. The scale captures participants' self-reported ability to perform basic tasks independently, such as preparing meals, shopping, housekeeping, managing finances and taking medication. Higher scores indicate better functional ability. It has been shown to have good inter-rater reliability (.85) and good concurrent validity with four other scales measuring domains of functional status (Graf, 2008).

Design

This observational study was cross-sectional. Although Indonesia is a culturally diverse country in relation to demographics and socio-economic status, there is less variation in terms of diet, alcohol consumption, employment and education. As these lifestyle factors are associated with an increased risk of cognitive decline, this cohort allows an investigation into variables of interest on their own with a lower risk of interactions with other factors. Age in years, sex, level of education completed and smoking status (self-reported ever smoked) were included in the analysis as covariates. Increased age, female gender, smoking, and lower levels of education are known risk factors for Alzheimer's disease (Launer, Andersen, Dewey, & Letenneur, 1999). Functional health was also included in analyses as a potential moderator because it could be a limiting factor on participants' ability to carry out certain activities. Therefore, this allowed the independent relationship between walking, mental health, and cognitive ability to be assessed.

Procedure

Prior to study onset, forwards and backwards translations (English and Indonesian) of the questionnaire pack and cognitive tests were carried out several times to ensure that they maintained their intended meaning. Participants were invited to community health centres for assessment between 8am and 11am to avoid circadian interference or the effect of heat. The procedure was standardised for all participants. Informed consent was given by participants (if a caregiver was present, they also gave informed consent) prior to starting the demographic and lifestyle behaviour questionnaires. If a participant's level of cognitive ability was sufficiently impaired that they were unable to give informed consent, a caregiver provided consent by proxy. Consent procedures were followed by cognitive assessments and then the functional health questionnaire.

Data analysis

The data were analysed using SPSS version 21.0 with a required significance level of $p < 0.05$. Demographic characteristics, functional health and cognitive test mean scores were calculated using descriptives for means and cross-tabs for percentages. T-tests and chi-square tests were used to assess differences between men and women and also between participants 65 years and younger compared to older than 65 years old. The majority of variables consisted of either ordinal data (walking and education) or inspection of the histograms indicated non-normal distributions (IADL, MMSE, intellectual composite scores). Therefore, Mann-Whitney U tests of difference and Spearman's correlations were used.

The walking variable was captured on only a 5-point Likert scale, thus it was converted into dummy variables using backwards difference contrast coding so that it was appropriate for using in regression analysis (Chen, Ender, Mitchell, & Wells, 2003). Hierarchical regression analysis was carried out using the 'Enter' method to assess whether mental health mediated the effect of walking on cognitive ability. Separate regressions were run for each of the three cognitive outcome measures. In Step 1, the covariates age, gender, education, and smoking status were entered into the model on their own. In Step 2, the four dummy walking variables were added. In Step 3, mental health was added. In Step 4, functional health was added to see if it had a moderating effect on walking. Residuals statistics and plots for all regression analyses indicated normal distributions and absence of outliers. Participants with missing data were excluded listwise for regression analyses. Post-hoc analyses were carried out to see whether walking and functional health independently predicted mental health, while controlling for each other and the covariates.

Results

Table 8.1 shows the descriptive statistics for participants' demographic characteristics, mental health, walking, functional health, and cognitive outcome measures for the whole sample and stratified by a median split for poorer and better mental health. On average, participants with poorer mental health had significantly poorer functional health (z = -7.15, p <.001, r = .3), lower levels of education (z = -6.34, p <.001, r = .2), and lower cognitive ability on all three outcome measures (MMSE: z = -7.41, p <.001, r = 3; HVLT total: z = -6.23, p <.001, r = .2; HVLT trial 1: z = -4.51, p <.001, r = .2). They were also significantly older (z = -2.50, p = .012, r = .1) and reported walking less frequently (z = -6.27, p <.001, r = .2). However, these significant differences represent only small effect sizes using Cohen's (1992) criteria (.2 = small effect; .5 = medium effect). There was no significant difference in gender χ^2 (1) = 2.84, p = .09 or smoking status χ^2 (1) = 1.25, p = .26 between those with better or poorer mental health.

Table 8.2 shows that Spearman correlations were significant between all variables. Walking more frequently was associated with better cognitive abilities and also better mental and functional health, with medium correlation effect sizes (.1 = small effect; .3 = medium effect; .5 = large effect; Cohen, 1992). An older age was associated with poorer cognitive abilities, poorer functional health, and walking less frequently, with medium effect sizes. Older age was associated with poorer mental health with only a small effect size. Better mental health was associated with better cognitive abilities with medium effect sizes.

Tables 8.3 shows hierarchical regression analyses for MMSE, HVLT trial 1 and HVLT total scores for the whole group. In Step 1, age and education were significant predictors of all cognitive outcome measures. They remained significant throughout all further steps. In Step 2, walking was a significant independent predictor of all cognitive outcome measures while controlling for covariates and gender became a significant predictor for HVLT total scores. In Step 3, mental health was added and was a significant independent predictor on all three cognitive outcome measures and walking also remained a significant independent predictor. In Step 4, functional health was added and was a significant predictor of all three cognitive outcome measures. However, it did attenuate the effect of walking, particularly for HVLT trial 1 and total scores. For MMSE scores, functional health only attenuated the effect of the walking “often” versus “very often” contrast. This may be due to a small number of participants in the groups walking ”very often”. Mental health remained a significant independent predictor of all three cognitive outcome measures.

Table 8.4 shows the hierarchical regression models for MMSE, HVLT trial 1 and HVLT total scores for participants who had poorer mental health based on a median split. In Step 1, the covariates age and education were significant predictors of all three cognitive outcome measures and they remained significant in all other steps. In Step 2, walking was a significant predictor of all three cognitive outcome measures with the exception of HVLT trial 1 scores where only the walking “often” versus “very often” contrast was not significant. In Step 3, mental health was a significant independent predictor of all three cognitive outcome measures and the addition of mental health to the model did not alter the independent effect of walking. In Step 4, the addition of functional health to the model attenuated the effect of mental health on MMSE scores. It also attenuated the effect of the walking “often” versus “very often” contrast for MMSE scores.

Functional health attenuated the effect of mental health and all walking contrasts on HVLT trial 1 scores. Functional health did not attenuate the effect of mental health on HVLT total scores but the three more frequent walking contrasts were attenuated. Gender also became a significant predictor of HVLT total scores in this final model.

Table 8.5 shows the hierarchical regression models for MMSE, HVLT trial 1 and HVLT total scores for participants who had better mental health based on a median split. In Step 1, age and education were significant predictors of all three cognitive outcome measures. Additionally, gender was a significant predictor of HVLT total scores and remained a significant predictor in all further steps. No walking contrasts were significant predictors of any cognitive outcome measures in any steps. In Step 3, mental health was a significant predictor of HVLT trial 1 and total scores, but not of MMSE scores. In Step 4, functional health was a significant predictor of all MMSE and HVLT total scores, but not of HVLT trial 1 scores. Mental health remained an independent significant predictor for HVLT trial 1 and total scores. Functional health attenuated the effect of age on MMSE scores.

Table 8.4 shows the post-hoc regression analysis indicated that walking frequency predicts mental health independently of functional health, and also whilst controlling for age, gender, education and smoking status. Functional health also independently predicts mental health. Out of covariates, education was the only significant independent predictor.

Table 8.1 Descriptive statistics for demographic characteristics, functional and mental health and cognitive test scores

Variable	Mean	Mental health: Poorer	Mental health: Better
n	719	287	308
Female; %	64.8	33.7	31.1
Age	69.38 (7.85) *52-98*	**70.18 (8.0)** ***54-90***	**68.05 (6.77)*** ***52-90***
Education completed; %			
≤Primary/Elementary	80.2	**44.2**	**35.4*** **
≥Secondary/High	19.8	**5.8**	**14.6*** **
Ever smoked; %	25.2	11.5	13.5
Walking	3.55 (0.87) *1-5*	**3.33 (0.94)** ***1-5***	**3.76 (0.73)*** ** ***1-5***
Mental health	79.47 (14.34) *0-100*	**68.50 (12.06)** ***0-81***	**90.56 (5.76)*** ** ***82-100***
Functional health	13.31 (3.86) *0-16*	**12.30 (4.52)** ***0-16***	**14.50 (2.49)*** ** ***1-16***
MMSE	24.18 (5.59) *0-30*	**22.59 (5.97)** ***0-30***	**25.77 (4.42)*** ** ***0-30***
HVLT total score	14.74 (7.73) *0-34*	**12.31 (7.20)** ***0-32***	**16.61 (7.34)*** ** ***0-34***
HVLT trial 1	3.96 (2.47) *0-12*	**3.32 (2.25)** ***0-11***	**4.36 (2.41)*** ** ***0-11***

Note: Mean (SD) *range* displayed; unless otherwise stated (%). Test of difference (poorer v better mental health) significantly different at *p < .05, ** p < .01 ***p < .001. SD = Standard Deviation; IADL = Instrumental Activities of Daily Living; MMSE = Mini Mental Status Examination; HVLT = Hopkins Verbal Learning Test.

Table 8.2 Spearman correlations between demographic characteristics, functional and mental health and cognitive test scores

		1	2	3	4	5	6	7
1	Age							
2	Education	-.20**						
3	Functional health	-.37***	.24***					
4	MMSE	-.29***	**.61*** **	.44***				
5	HVLT trial1	-.29***	**.48*** **	.33***	**.61*** **			
6	HVLT total	-.30***	**.56*** **	.37***	**.70*** **	**.88*** **		
7	Walking	-.23***	.19***	.31***	.25***	.20***	.23***	
	Mental Health	-.14***	.30***	.36***	.35***	.28***	.34***	.29***

Note: Significance levels *p < .05, ** p < .01 ***p < .001; large effect sizes highlighted in bold (≥.45 as this would be rounded up to .5). IADL = Instrumental Activities of Daily Living; MMSE = Mini Mental State Examination; HVLT = Hopkins Verbal Learning Test.

Table 8.3. Regression models demonstrating the effect of walking, mental health and functional health on cognitive ability

Step	Independent variables	β	MMSE	β	HVLT trial 1	β	HVLT total
1	Age	-.25***	Adj R^2 = .298	-.20***	Adj R^2 = .308	-.20***	Adj $R^{2 =}$ .385
	Gender	.02	R^2 change = .302***	.09	R^2 change = .312***	.14**	R^2 change = .389***
	Smoking	.04	F(4,680) = 73.68***	.03	F(4,655) = 73.81***	.07	F(4,650) = 103.54***
	Education	.45***		.48***		.55***	
2	Age	-.21***		-.18***		-.18***	
	Gender	.03		.09		.15**	
	Smoking	.04	Adj R^2 = .347	.03	Adj R^2 = .320	.07	Adj R^2 = .403
	Education	.43***	Cum R^2 = .355	.47***	Cum R^2 = .328	.54***	Cum R^2 = .410
	Walk never v seldom	.54***	R^2 change = .052***	.30***	R^2 change = .016**	.31***	R^2 change = .021***
	Walk seldom v sometimes	.73***	F(8,676) = 46.33***	.43***	F(8,647) = 39.53***	.44***	F(8,646) = 56.20***
	Walk sometimes v often	.77***		.47***		.51***	
	Walk often v very often	.30***		.21**		.21**	
3	Age	-.20***		-.17***		-.17***	
	Gender	.03		.09*		.15***	
	Smoking	.03	Adj R^2 = .377	.03	Adj R^2 = .332	.07	Adj R^2 = .438
	Education	.39***	Cum R^2 = .385	.44***	Cum R^2 = .341	.50***	Cum R^2 = .435
	Walk never v seldom	.44***	R^2 change = .030***	.24**	R^2 change = .013***	.23**	R^2 change = .025***
	Walk seldom v sometimes	.56***	F(9,675) = 46.93***	.33**	F(9,646) = 37.20***	.29**	F(9,645) = 55.17***
	Walk sometimes v often	.58***		.35**		.35**	
	Walk often v very often	.23**		.17*		.15*	
	Mental health	.20***		.13***		.17***	
4	Age	-.08*		-.13***		-.11**	
	Gender	-.00		.08		.13**	
	Smoking	.03		.03		.07	
	Education	.37***	Adj R^2 = .465	.44**	Adj R^2 = .344	.49***	Adj R^2 = .448
	Walk never v seldom	.28***	Cum R^2 = .473	.18*	Cum R^2 = .354	.15*	Cum R^2 = .457
	Walk seldom v sometimes	.31**	R^2 change = .088***	.24*	R^2 change = .013***	.17	R^2 change = .022***
	Walk sometimes v often	.30**	F(10,674) = 60.53***	.25	F(10,645) = 35.32***	.21	F(10,644) = 54.16***
	Walk often v very often	.12		.13		.09	
	Mental health	.09**		.09*		.12***	
	Functional health	.38***		.14***		.18***	

Note: Significance levels *p < .05, ** p < .01 ***p < .001. IADL = Instrumental Activities of Daily Living; MMSE = Mini Mental State Examination; HVLT = Hopkins Verbal Learning Test; β = standardised beta, Adj = adjusted.

Table 8.4 Regression models demonstrating the effect of walking, mental health and functional health on cognitive ability in participants with poorer mental health (n = 330)

Step	Independent variables	β	MMSE	β	HVLT trial 1	β	HVLT total
1	Age	-.33***	Adj R^2 = .229	-.25***	Adj R^2 = .221	-.25***	Adj R^2 = .241
	Gender	-.01	R^2 change = .239***	.06	R^2 change = .230***	.12	R^2 change = .251***
	Smoking	.03	F(4,325) = 25.47***	.01	F(4,310) = 23.21***	.09	F(4,309) = 25.84***
	Education	.33***		.39***		.40***	
2	Age	-.28***		-.21***		-.21***	
	Gender	-.01		.05		.12	
	Smoking	.02	Adj R^2 = .302	.01	Adj R^2 = .245	.09	Adj R^2 = .273
	Education	.33***	Cum R^2 = .319	.38***	Cum R^2 = .264	.40***	Cum R^2 = .291
	Walk never v seldom	.63***	R^2 change = .081***	.38**	R^2 change = .034**	.43***	R^2 change = .041**
	Walk seldom v sometimes	.83***	F(8,321) = 18.81***	.55***	F(8,306) = 13.74***	.59***	F(8,305) = 15.68***
	Walk sometimes v often	.74***		.51**		.62***	
	Walk often v very often	.28**		.19		.26*	
3	Age	-.27***		-.20***		-.20***	
	Gender	-.01		.06		.13	
	Smoking	.03		.02		.10	
	Education	.33***	Adj R^2 = .319	.39***	Adj R^2 = .260	.40***	Adj R^2 = .298
	Walk never v seldom	.56***	Cum R^2 = .337	.31**	Cum R^2 = .281	.34**	Cum R^2 = .318
	Walk seldom v sometimes	.71***	R^2 change = .018**	.44**	R^2 change = .017**	.45**	R^2 change = .027**
	Walk sometimes v often	.66***	F(9,320) = 18.09***	.43*	F(9,305) = 13.25***	.52**	F(9,304) = 15.75***
	Walk often v very often	.27**		.18		.25*	
	Mental health	.15**		.14**		.18**	
4	Age	-.11*		-.14*		-.12*	
	Gender	.01		.06		.13*	
	Smoking	.05		.03		.11	
	Education	.30***	Adj R^2 = .433	.37***	Adj R^2 = .278	.39***	Adj R^2 = .326
	Walk never v seldom	.34**	Cum R^2 = .450	.22	Cum R^2 = .301	.23*	Cum R^2 = .348
	Walk seldom v sometimes	.37*	R^2 change = .113***	.30	R^2 change = .020**	.28	R^2 change = .030***
	Walk sometimes v often	.29*	F(10,319) = 26.14***	.28	F(10,304) = 13.12***	.33	F(10,303) = 16.15***
	Walk often v very often	.13		.12		.17	
	Mental health	.05		.09		.12*	
	Functional health	.43***		.18**		.22***	

Note: Significance levels *p < .05, ** p < .01 ***p < .001. IADL = Instrumental Activities of Daily Living; MMSE = Mini Mental Status Examination; HVLT = Hopkins Verbal Learning Test; β = standardised beta, Adj = adjusted, Cum = cumulative.

Table 8.5 Regression models demonstrating the effect of walking, mental health and functional health on cognitive ability in participants with better mental health (n = 340)

Step	Independent variables	β	MMSE	β	HVLT trial 1	β	HVLT total
1	Age	-.10*	Adj R^2 = .326	-.13**	Adj R^2 = .342	-.12**	Adj R^2 = .462
	Gender	.08	R^2 change = .334***	.12	R^2 change = .350***	.18**	R^2 change = .469***
	Smoking	.06	F(4,335) = 42.08***	.04	F(4,322) = 43.30***	.05	F(4,322) = 70.98***
	Education	.56***		.55***		.63***	
2	Age	-.09*		-.13**		-.12**	
	Gender	.09		.12		.18**	
	Smoking	.07	Adj R^2 = .323	.04	Adj R^2 = .336	.06	Adj R^2 = .457
	Education	.55***	Cum R^2 = .339	.54***	Cum R^2 = .352	.64***	Cum R^2 = .471
	Walk never v seldom	-.06	R^2 change = .005	.13	R^2 change = .002	.01	R^2 change = .002
	Walk seldom v sometimes	-.08	F(8,331) = 21.25***	.16	F(8,318) = 21.61***	-.00	F(8,318) = 35.36***
	Walk sometimes v often	-.01		.20		.02	
	Walk often v very often	-.03		.11		-.03	
3	Age	-.10*		-.12*		-.11**	
	Gender	.09		.09		.17**	
	Smoking	.07		.04		.05	
	Education	.55***	Adj R^2 = .321	.52***	Adj R^2 = .352	.62***	Adj R^2 = .465
	Walk never v seldom	-.06	Cum R^2 = .339	.13	Cum R^2 = .370	.01	Cum R^2 = .480
	Walk seldom v sometimes	-.08	R^2 change = .000	.14	R^2 change = .018**	-.02	R^2 change = .009*
	Walk sometimes v often	-.01	F(9,330) = 18.84***	.16	F(9,317) = 20.66***	-.00	F(9,317) = 32.45***
	Walk often v very often	-.03		.08		-.05	
	Mental health	-.01		.14**		.10*	
4	Age	-.04		-.10*		-.09*	
	Gender	.03		.07		.13*	
	Smoking	.04		.03		.04	
	Education	.51***	Adj R^2 = .376	.50***	Adj R^2 = .356	.60***	Adj R^2 = .479
	Walk never v seldom	-.02	Cum R^2 = .394	.14	Cum R^2 = .375	.03	Cum R^2 = .495
	Walk seldom v sometimes	-.03	R^2 change = .055***	.16	R^2 change = .006	.02	R^2 change = .016**
	Walk sometimes v often	.02	F(10,329) = 21.41***	.17	F(10,316) = 18.99***	.01	F(10,316) = 30.99***
	Walk often v very often	-.00		.09		-.04	
	Mental health	-.04		.13**		.09*	
	Functional health	.26***		.08		.14**	

Note: Significance levels *p < .05, ** p < .01 ***p < .001. IADL = Instrumental Activities of Daily Living; MMSE = Mini Mental Status Examination; HVLT = Hopkins Verbal Learning Test; β = standardised beta, Adj = adjusted, Cum = cumulative.

Table 8.6. Post-hoc regression analysis for predictors of mental health

Independent variables	β	
Age	.04	
Gender	-.03	
Smoking	-.001	
Education	.18***	
Walk never v seldom	.32***	Adjusted R^2 = .261 F(9,687) = 23.38***
Walk seldom v sometimes	.61***	
Walk sometimes v often	.62***	
Walk often v very often	.23**	
Functional health	.33***	

Significance levels *p < .05, ** p < .01 ***p < .001, β = standardised beta values

Discussion

Regression models for the whole group indicated that mental health and functional health were significant independent predictors of all three cognitive outcome measures. Walking remained a significant independent predictor of all cognitive outcome measures when controlling for mental health and covariates. However, functional health attenuated the effect of walking frequency (but not mental health) for all cognitive outcome measures. Functional health only attenuated one walking frequency contrast (“often” versus “very often”) for MMSE scores, which assesses global cognitive ability.

Regression models for participants with poorer mental health (median split) indicated that walking was a significant independent predictor of global cognitive ability and verbal learning (HVLT total and MMSE scores) while controlling for covariates. Mental health was a significant independent predictor of all cognitive outcome measures and did not attenuate the effect of walking. However, functional health attenuated the effect of mental health on global cognitive ability and verbal learning (MMSE and HVLT trial 1). Functional health was a significant independent predictor of all measures of cognitive ability and it also attenuated the effect of walking on all cognitive outcome measures. However, functional health only attenuated one walking frequency contrast (“often” versus “very often”) for MMSE scores.

Regression models for participants with better mental health (median split) indicated that walking was not a significant independent predictor of any cognitive outcome measures, even before controlling for mental and functional health. Mental health was a significant independent predictor of verbal learning (HVLT) but not global cognitive ability (MMSE). Functional health did not attenuate the independent effects of mental health on cognitive ability. Functional health was a significant independent predictor of only MMSE and HVLT total scores while controlling for all other variables.

The effect of walking on cognitive outcome measures appears to be moderated by functional health as demonstrated in the whole group analysis and in median split analysis of only those with poorer mental health. This may have indicated that participants who reported walking less frequently, did so because they were unable to. Interestingly, walking did not predict any cognitive outcome measures in participants with better mental health, even before controlling for mental or functional health. It could be that those with better mental health reported walking more frequently as a group and thus reduced the variance and predictive value of walking. However, the test of difference indicated only a small effect size of those with better mental health walking more frequently. Additionally, participants in both the poorer and better mental health median split groups reported the full range of walking frequency responses (from “never” to “very often”). It may be that walking is more strongly associated with cognitive outcome measures in those with poorer mental health because walking acts on improving mental health which provides additional positive effects of cognitive outcomes.

Post-hoc analysis indicated that walking frequency predicted mental health independently of functional health and also whilst controlling for age, gender, education and smoking status. This finding is consistent with other studies which have found an independent effect of physical activity on depression even after adjustments for age, gender, smoking, social relations, chronic conditions, and disability (Strawbridge et al., 2002). As the effect of walking on cognitive outcomes was not independently significant, but the effect of walking on mental health did remain independently significant, this suggests there may be a mediating relationship.

Increased cerebral blood flow has also been investigated as a mechanism of improved cognitive abilities from physical activity (Brown et al., 2010). It has also been investigated in the context of mental health. Recovery from depression has been associated with a significant increase in regional cerebral blood flow in specific regions of the brain. These are the same areas in which decreases of cerebral blood flow are associated with in those with depression compared to controls (Bench, Frackowiak, & Dolan, 1995). The relationship between regional cerebral blood flow and cognitive performance in individuals with depression has been investigated. Findings have indicated that cognitive deficits in depression are associated with lowered regional cerebral blood flow, particularly the medial prefrontal cortex (Bench et al., 1992; Dolan et al., 1992; Dolan, Bench, Brown, Scott, & Frackowiak, 1994). Thus, if participating in physical activity can improve mental health, then this could have a subsequent positive effect on cognitive abilities. In addition to increased cerebral blood flow, potential mediating mechanisms could also include psychosocial mechanisms.

The association found between mental health and cognitive ability in the current study is in line with the existing literature which has demonstrated a close association between depression and cognitive performance. For example, depression has been associated with slower processing speed and poorer working memory (Halvorsen et al., 2012). Problems with encoding could be due to slower processing speed or rumination, which may mean that information is missed. In older adults with mild cognitive impairment, depression impacted on general life functioning, and this was partially mediated by slower processing speed (Brown et al., 2013). In working-age outpatients with major depressive disorder, reduced memory ability was observed compared to healthy controls (Lyche, Jonassen, Stiles, Ulleberg, & Landrø, 2011). Cognitive impairment in individuals with depression have been found in language function, memory (both recall and recognition), attention and behavioural regulation (Brown, Scott, Bench, & Dolan, 1994). Additionally, the greatest depression-related impairment was found on cognitive and motor tasks that required sustained effort (Cohen, Weingartner, Smallberg, Pickar, & Murphy, 1982). Affective symptoms in those with depression predicted subjective cognitive ability (Miskowiak, Vinberg, Christensen, & Kessing, 2012). Subjective cognitive ability can also been referred to as memory self-efficacy, which is suggested to impact on cognitive performance through motivational or meta-cognitive mechanisms (Bandura, 1989). This could partly explain the findings of the current study as motivational mechanisms could impact on how motivated participants are to perform well on the cognitive tasks, and therefore how much effort they elicit to sustain attention or whether they employ memory strategies, such as chunking words into categories during the HVLT.

In participants with poorer mental health, mental health remained a significant predictor of only HVLT total scores after controlling for functional health, whilst in participants with better mental health, mental health remained a significant predictor of HVLT total and trial 1 scores after controlling for functional health. There appear to be an interactional effect of mental health on the HVLT but not the MMSE. As MMSE scores capture global cognition, it could be that MMSE more closely reflects functional abilities. HVLT scores reflect participants' ability to employ memory, such as chunking the words into categories. There may be a domain specific effect of poorer mental health on cognitive ability. Certain types of cognitive tasks, such as the HVLT may be more likely to be affected by psychosocial factors due to the more complex cognitive processes required to perform well on the test, such as sustained attention (Cohen, Weingartner, Smallberg, Pickar, & Murphy, 1982) or motivation to employ memory strategies (Bandura, 1989).

The pattern of results in those with better mental health is different to that of participants with poorer mental health and for the whole sample. Walking was not associated with better cognitive ability on any of the outcome measures in those who have better mental health, even before controlling for mental and functional health. This could indicate that better mental health is protective of cognitive decline and it may be through common pathways or mechanisms with walking. This could have implications for the effectiveness of physical activity interventions. Baseline or change in mental health measures could moderate the effect on cognitive outcomes. Another difference in the pattern of results in participants with better mental health was the lack of effect with MMSE, even before controlling for functional health. This may reflect the ceiling effect of this measure, particularly as MMSE scores were significantly higher in those with better mental health, with a small-medium effect size. Additionally, it could reflect a domain specific effect of mental health, whereby global cognition is less sensitive to mental health compared to the processing speed, sustained attention, language, verbal learning and recruitment of strategies for the HVLT (Brown et al., 1994; Cohen, 1982).

The pattern of attenuation of walking contrast dummy variables was that higher frequencies of walking were the first to become non-significant as model steps progressed, and lower frequencies of walking ("never" versus "seldom" contrast) nearly always remained significant. This may indicate that walking "very often" compared to "often" does not provide an additional protective effect on cognitive ability. However, the lower frequencies which remained significant may indicate the importance of doing some physical activity and the strong detrimental effects of being sedentary on cognitive ability and protective effects of even small amounts of physical activity compared to none, for instance walking "seldom" compared to "never".

The post-hoc analysis indicated that functional health independently predicted mental health. This is consistent with findings from another study which found that depression was associated with lower quality of life and lower functional abilities in activities of daily living in Indonesia, Vietnam and Japan (Wada et al., 2005). However, a change in functional capacity or dependency in activities of daily living was not associated with a change in mental health among older people living in residential care facilities (Conradsson et al., 2013). This could indicate that improvements in mental health from physical activity are not due to increases in functional capacity. However, it could be that the *perception* of physical fitness benefits may lead to improvements in mental health, regardless of objective physical gains. The main limitation of the present study was the cross-sectional nature of the data and thus causal relationships cannot be inferred. Additionally, the measures used were self-reported and therefore relied upon accurate recall information (e.g. frequency of walking). The reliability of these measures in those with cognitive decline may have been limited. Despite these limitations, the present study did find an important association between physical activity, mental health and cognitive ability. Future research should investigate the mechanisms of improved mental health from physical activity and associated cognitive gains.

In conclusion, there appears to be a potentially interactional relationship between physical activity, mental health, and cognitive ability. The domain specific effect of mental health on cognitive outcomes could explain some of the domain discrepancies between exercise interventions discussed in Chapter 1. However, the main limitation of this observational study is its cross-sectional nature. Causal pathways cannot be inferred from these findings. The common mechanisms of effects of physical activity and mental health on cognitive outcomes could indicate that physical activity which leads to improvements in physical fitness as well as improved mental health may bring about the largest beneficial effect on cognitive outcomes. Activity interventions can address these limitations by isolating components of activities to identify the relative protective effects against cognitive decline and also investigate causal pathways. Experimental studies are required to investigate these relationships further.

PART FOUR

The role of psychosocial factors in randomised controlled trials of resistance training on cognitive ability

Part Four Overview

A potentially mediating model of psychosocial factors in the relationship between exercise and cognitive improvements was presented in Chapter 2. The findings of Study 2b indicated the independent associations of mental health with cognitive ability in cross sectional data from Indonesia. Additionally, Study 1a identified a relationship between attitudes towards ageing and perceived control on self-reported health independent of level of physical activity. As the cross-sectional data presented in Study 2a and Study 2b are limited in terms of the causal inferences that can be made, Part Four investigated the role of psychosocial factors experimentally.

Study 3 exploited available data from a pilot randomised controlled trial (Clifford, 2012) investigating the effect of resistance training on cognitive performance with middle-aged adults. The purpose of this analysis of secondary data was to test proof of concept to provide preliminary evidence of a potential association between changes in cognitive and psychosocial variables during the intervention to inform future study design and justify the use of resources for a feasibility study in older adults which would be labour intensive.

As a result of the preliminary proof of concept evidence from Study 3, a resistance training intervention was carried out with older adults (Study 4). The primary aim of Study 4 was to assess the feasibility of the exercise programmes utilised in Study 3 with older adults. The secondary aim was to explore whether there was a potential association between change in psychosocial factors and change in cognitive outcome measures in older adults. An additional secondary aim was to give an indication of whether the role of psychosocial factors may be specific to certain domains of cognitive ability. Based on the feasibility nature of Study 4 and thus small sample size, the findings related to the secondary aims need to be interpreted with caution but do indicate the need for further research.

Chapter 9: Study 3 - The role of psychosocial factors in a randomised controlled trial of resistance training on cognitive ability: a proof of concept study

Introduction

Our population is ageing. In the United Kingdom, it is estimated that the number of people aged 60 or over will rise by more than 50% in the next 25 years and will exceed 20 million by 2031 (Office for National Statistics, 2009). Ageing is associated with an increased risk of a range of diseases and conditions, including cognitive impairment and dementia (Launer & Hofman, 1992; Solfrizzi et al., 2004). In the UK in 2010, there were estimated to be over 820,000 older adults afflicted with late onset dementia (Luengo-Fernandez, Leal, & Gray, 2010). This is expected to rise to one million by 2025 and to exceed 1.7 million by 2051 (Alzheimer's Society, 2007). As there is currently no cure for dementia, modifiable lifestyle behaviours, such as physical activity, have been investigated as a preventative strategy for delaying the onset of dementia (e.g. Angevaren et al., 2008; Clifford et al., 2009; Colcombe & Kramer, 2003; Lautenschlager, et al., 2012; Sofi et al., 2010).

Numerous systematic reviews and meta-analyses have been carried out to examine the effect of physical activity on cognitive ability or dementia incidence. It has been highlighted that in spite of the hundreds of studies that have been carried out (including high quality trials) to further our understanding of this relationship, reviewing the literature is challenging due to the variety of ways it has been investigated (Clifford et al., 2009; Etnier & Labban, 2012; Hogervorst et al., 2012). Variations include the study design, measurements of physical activity (objective and subjective), outcome measures (cognitive tests across domains and dementia risk), specific exercise components (types, intensity, frequency, and duration), and sample populations (different age groups with or without cognitive impairment). There is also evidence to suggest that the effect of physical activity on cognitive ability may not be the same for everyone and that some individuals may benefit more than others. Such moderators include age, gender, genetic status, and baseline cognitive status. Psychosocial factors have been suggested as possible meditators to explain some of the variation of the effect of exercise interventions on cognitive outcomes (Stock et al., 2012). This suggestion was based on the potential psychological impact of the exercise intervention and the subsequent impact of this on cognitive performance. There is evidence from non-exercise related observational and intervention studies that psychosocial factors, such as positive attitudes to ageing (Langer & Rodin, 1976), positive self-perceptions (Levy, Slade, Kunkel, & Kasl, 2002; Levy, 2003), better mood (Ganguli, Du, Dodge, Ratcliff, & Chang, 2006) are associated with improvements in cognitive performance. Thus, it may be that the exercise intervention studies which result in a larger improvement in cognitive performance do so because the exercise acts as a vehicle to improving these psychological factors, potentially in addition to direct physiological mechanisms.

Kitwood (1997) and Clare (2007) have indicated the importance of using a broader biopsychosocial model of disease to understand cognitive decline and dementia. However, previous research has largely investigated the role of psychosocial factors primarily in the context of predicting physical activity (McAuley et al., 2004). The role of psychosocial factors in delaying decline has been neglected in the context of physical activity as a preventative strategy for cognitive decline.

The findings from Study 1a identified a relationship between attitudes towards ageing and perceived control on self-reported health independent of level of physical activity. Additionally, the findings of Study 2b indicated the independent association of mental health with cognitive ability in cross sectional data from Indonesia. These findings are limited in the explanation of mechanisms due to the cross-sectional nature of the data. Thus, the present study investigated the relationship between changes in psychosocial factors and cognitive performance during an exercise intervention.

Aims

The primary aim of Study 3 was to explore the potential relationship between change in cognitive performance and change in psychosocial factors during an exercise intervention. The present study exploited available data from a pilot randomised controlled trial (Clifford, 2012) investigating the effect of resistance training on cognitive performance with middle-aged adults. The purpose of this analysis of secondary data was to test proof of concept to provide preliminary evidence of a potential association between changes in cognitive and psychosocial variables during the intervention to inform future study design and justify the use of resources for a feasibility study in older adults which would be labour intensive. The specific psychosocial factors investigated were: attitudes towards ageing, perceived control, and mental health. It was hypothesised that improvements on psychosocial measures would be associated with improvements in cognitive ability due to the evidence from Study 2c that mental health appeared to partially mediate the effect of walking on cognitive outcomes.

Method

The present study has been described according to the CONSORT guidelines for the presentation of clinical trials where possible (Moher et al., 2010).

Participants

The participants (n = 13; female = 11, males = 2) are a subsample from a pilot RCT (n = 20; females = 16, males = 4) which utilised a cross-over design (Clifford, 2012). Participants completed the resistance programme and also one of the control programmes. There were two control programmes: (1) a sedentary control for which participants were asked to maintain their normal lifestyle behaviour before they enrolled onto the study; and (2) a flexibility exercise programme which acted as an active control group. The order in which participants carried out their programmes were counterbalanced with a 4 week washout period between them. The subsample only included participants from their second exercise programme. It did not include those from the sedentary group. Participants were recruited using opportunity sampling and were community-dwelling, healthy, middle-aged (between 40-65 years at study onset), and sedentary prior to starting the intervention (< 2 hours physical activity per week). The sample size for this secondary analysis was determined by the number of participants for which there was data available on the psychosocial variables of interest.

All participants completed a health screening questionnaire prior to recruitment to ensure that they would be able to carry out the exercises and were not at high risk of contraindications. Participants were asked to consult their GP before starting if this questionnaire raised any concerns. If participants were coincidentally embarking on new diets or exercise regimes of their own initiative at time of recruitment, they were asked to stabilise their new routine for a minimum of two months beforehand (n = 2) so as not to interfere with the study. Those suffering from a physical disability or illness which would prevent them from carrying out or being exacerbated by the training programme were excluded (n = 1). Further exclusion criteria included presence of a co-morbid psychiatric disorder, other neurological disease, substance abuse and previous use of medication that would affect cognition. Participants were recruited through contacting local community groups, word of mouth, and advertisements on the Loughborough University website, in newspapers (Loughborough Echo and Leicester Mercury) and on posters in GP surgeries, libraries and shops around the local area. To further spread awareness of the study an interview was conducted on local radio.

Ethical considerations for this study included potential risk to participants of carrying out the exercise programmes. Efforts were made to minimise risk to participants by emphasising the importance of starting gently, prioritising of warm-up and cool down exercises (see ‘safety considerations’ for more details). Another ethical consideration was potential pressure to continue with participation in relation to demand characteristics during interactions with the researcher. The voluntary nature of participation was emphasised from the start and repeated at future sessions. It was also emphasised that starting the intervention did not mean that participants had to complete it and that they could stop at any point if they wished and were not obliged to give a reason.

Training programmes

All exercise programmes lasted 12 weeks and were home based and self-directed. Permission to use photographs for exercise programme instruction booklets was obtained.

Resistance programme

The resistance training programme utilised latex free resistance bands to carry out six specified exercises designed to increase muscle strength from baseline to post-intervention assessments. There were five bands of increasing levels of resistance that could be progressed through over the course of the programme as participants strength increased. Participants were asked to carry out the resistance training sessions three times per week throughout the twelve weeks to see an expected strength increase. The six specified exercises included arm extension, upper body rotation, arm raise, arm curl, knee extension and lunge which targeted several muscles groups across the body namely the pectorals, obliques, deltoids, biceps, quadriceps and gastrocnemius respectively. Participants were given a booklet to take home with written and illustrated instructions which were talked through at the baseline session. Each exercise was explained by the investigator and demonstrated where necessary.

Each session lasted approximately 30 minutes with a 5 minute warm-up beforehand and 5 minute cool-down afterwards. Participants were asked to gradually build up to performing three sets of 12 to 15 repetitions (reps) of each exercise with one minute rest in between. All participants in Study 3 began for the programme for at least 2 weeks using the lightest resistance band for all exercises. Once participants could performance 3 sets of 15 reps comfortably without strain for two sessions in a row, they could move onto the next band in the next session. Therefore, they could progress onto the next band for different muscles groups at different stages to optimise training. If they struggled with the next band (e.g. could perform less than 8 reps), then they could return to using the previous band. It was also explained to them that they could use a different band for different exercises if they progressed at different rates to optimise training. Participants were given an exercise diary in which to record the level of resistance band used in each session and the number of repetitions so that they could keep track of their progress.

All bands were standardised to arm length to ensure that the extension of each band was the equivalent for each participant. The bands were measured and cut so that when held out straight but not stretched, they reached from the participants outstretched arm to the centre of their chest with extra length for wrapping around their hands (similar to the procedure that was used in (Lachman, Neupert, Bertrand, & Jette, 2006). Resistance bands were chosen for this study for two reasons. First, they are considered to be provide similar weight standards to free weights in the early stages of training (Colado & Triplett, 2008). Second, they are safer and more compact for participants to store in their homes compared to free weights. Additionally, they are easily transportable so that location would not prevent participants from carrying out the exercises (for example, if on holiday) which encourages adherence.

Flexibility programme

The flexibility programme acted as an active control. This was to control for the level of mental stimulation that following instructions and learning how to carrying out new exercises involved. Study 2a indicated the independent association of mental activities with cognitive ability, which other studies have also found (Karp et al., 2006), therefore it was important to control for this. The flexibility programme involved yoga-type stretching exercises (Currie, 2002). These included: the energising breath (gently stretching neck by raising chin), sideways stretch, the mountain pose (clasping hands together and lifting them above head), pose of a cow (one hand above shoulder reaching down back and the other behind back reaching up aiming to join hands), thigh stretch, simple twist, back stretch, pose of a cat (hunching and straightening of back), and single knee hug. As with the resistance training programme, exercises were also carried out three times per week for 12 weeks. Each session also lasted approximately 30 minutes with a 5 minute warm-up beforehand and 5 minute cool-down afterwards. This programme also targeted several muscle groups but did not aim to increase strength. Participants were given a booklet to take home with written and illustrated instructions which were talked through at the baseline session.

The flexibility programme was designed to act as an active control group to account for the effects of mental stimulation from taking up a new activity whilst not targeting cognition (flexibility and stretching programmes have been used as control groups in other intervention studies and showed no effect on cognitive performance, (Cassilhas et al., 2007; Colcombe et al., 2004; Kramer et al., 2001; Madden, Blumenthal, Allen, & Emery, 1989; Moul, Goldman, & Warren, 1995; Smiley-Oyen, Lowry, Francois, Kohut, & Ekkekakis, 2008). Participants were given an exercise diary in which to record how long they each stretch and how many times so that they could keep track of their progress.

Maximising adherence to the programmes

The issue of adherence in exercise programmes was discussed in Chapter 1. The level of attrition has been suggested to often exceed 50% in exercise studies (Dishman & Buckworth, 1997). Additionally, the number of completed sessions for those who do finish the programme can also be low (Brown, Liu-Ambrose, Tate, & Lord, 2009). Therefore, a number of strategies were used that have been previously effective in increasing adherence to exercise programmes. These included: education about the benefits of the exercise programme, support to overcome perceived barriers, goal setting, and self-monitoring (Jones & Rose, 2005).

Education about the benefits of exercise, anticipatory guidance of potential barriers to exercising, and strategies to overcome barriers was found to improve adherence (Keele-Smith & Leon, 2003). Prior to starting the intervention, the investigator explained to each participant about the benefits of the exercise programme. The benefits included personal fitness as well as their participation in terms of the whole research project. They were also promised a letter explaining the results of the study.

Support to overcome perceived barriers was provided through regular contact between the investigator and participants. For example, for resuming the exercise after illness participants were told to start gently by doing fewer reps or using a lighter resistance band. The investigator phoned the participant approximately once a month and the participant was also encouraged to phone the investigator if they had any issues with the exercise program.

Goal setting and self-monitoring have been found to increase adherence (Chao, Foy, & Farmer, 2000; Duncan & Pozehl, 2002; Pinto, Rabin, & Dunsiger, 2009). These strategies can increase self-efficacy (e.g. Pinto et al., 2009) which predicts time, effort, and persistence of behaviours (Bandura, 1978). Barring health factors, self-efficacy has been found to exert a powerful influence on exercise behaviour of older adults, (Brassington, Atienza, Perczek, DiLorenzo, & King, 2002; McAuley, Lox, & Duncan, 1993; Resnick, 2001). Participants were asked to keep a record of their exercise sessions in the diary provided. This included details about how many reps of resistance exercises were performed or how long they held flexibility stretches. They were also asked to rate how difficult they found each exercise. This allowed participants to monitor their progress. Participants were not asked to write down their goals, however, their individual targets were discussed with the investigator over the phone and during the 6-week session (e.g. when they would move onto the next level of resistance band).

Exercise diaries

Participants were asked to carry out the exercises three times per week. However, if they were unable to carry out the exercises for some reasons then they were asked to note this in the diary. They were asked to fill out the diary honestly and accurately. This allowed adherence to be assessed so that it could be controlled for in analysis if necessary.

Safety considerations

The training programmes were designed to be suitable for sedentary middle- to older-aged adults with adherence to the guidelines on prescribing exercise programmes from the American College of Sports Medicine (Brubaker, Otto, & Whaley, 2006) and also with the guidance of a trained geriatric exercise physiologist (Dr R Ferguson). In addition to the instruction booklet with photos and written instructions, all participants underwent a training session with the investigator at the end of the baseline session. All exercises were talked through and demonstrated where necessary to ensure that participants understood how to carry out them out safely at home. Participants were encouraged to phone the investigator if they had any further questions regarding how to carry out the exercises at home. The importance of carrying out the warm-up and cool-down was emphasised and participants were instructed to prioritise these over the resistance/flexibility exercises when they were short on time. Participants were advised to start the exercises very gently and gradually build up to carrying out more repetitions or stretching further. They were reassured that performing a small number of repetitions to start with was fine to ensure that they did not overdo it to begin with. Participants were instructed to stop carrying out the exercises if initial muscle ache persisted or they became ill or injured at any point. No direct adverse effects were reported for participants.

Randomisation

Participants were randomly assigned to exercise groups. This was done using a coin that was flipped twice. First to decide whether the participant would carry out the resistance or control programme first and second, to decide which control programme (sedentary or flexibility) they would carry out.

Cognitive outcome measures

A range of cognitive outcome measures were included which assessed different domains of cognitive ability. This is because it is not clear which domains of cognitive ability are affected by exercise interventions are domain specific results are not consistent across studies or even between meta-analyses (discussed in Chapter 1). Cognitive test selection was based on: previous effects demonstrated in exercise intervention or physical activity longitudinal studies, accessibility of measure; and ease of administration i.e. suitable for use in older adult populations and short in duration.

Global cognitive ability

The MMSE (Folstein, Folstein, & McHugh, 1975) was used to screen for dementia. It assesses global cognitive ability and can be used to indicate cognitive impairment. It utilises a question-answer format and measures orientation, registration (immediate memory), short–term memory, attention, calculation and language functioning. Scores of less than 27 generally considered to indicated cognitive impairment with a sensitivity and specificity of 0.89 and 0.91 respectively (O'Bryant et al., 2008).

Memory

The Hopkins Verbal Learning Test (HVLT; Brandt, 1991) assesses short-term verbal memory. The HVLT assesses verbal short-term memory and involves a list of 12 words being read out aloud to the participant which they are asked to recall. This is done three times consecutively using the same list of words. There are standardised instructions for this test and words are read out loud at a speed of approximately one word per second. Participants were then asked to recall as many words from the list as they could. Scoring high on this test requires the recruitment of memory strategies, such as chunking the words into categories. This provides the advantage of no ceiling effects as healthy controls do not scores full marks (Hogervorst et al., 2002). The HVLT Trial 1 score was included in addition to the total immediate recall score as an outcome measure in these studies as it has been found to measure memory abilities affected by Alzheimer's disease (Clifford, 2012). It also has acceptable test-retest reliability estimates (0.75) in healthy older adults (Wesnes, 2012).

The Verbal Fluency task involves word generation and recruits neural network particularly implicated in semantic memory (Kitabayashi et al., 2001). Deficits in word generation have been demonstrated in those with dementia (e.g. Taler & Phillips, 2008). The Verbal Fluency task involves participants naming as many words as they can that belong to a specified category in on minute. Category (semantic) fluency was used as it shows higher sensitivity and specificity to dementia compared to letter (phonemic) fluency which involves words that begin with a certain letter of the alphabet (100% [specificity 92.5%] v 89% [specificity 85%], respectively; (Cerhan et al., 2002; Monsch et al., 1992). The commonly used category of “animals” was used for baseline, mid- and post-intervention assessment. An alternative validated category of clothes was used for the familiarisation session (Cunje, Molloy, Standish, & Lewis, 2007). Good test-retest reliability (0.83) has been reported in older adults with and without Alzheimer’s disease for category fluency (Solomon et al., 1998).

Executive function

The Trail Making Test (TMT; Reitan, 1955) was used to assess executive functioning. It consists of two parts (A and B) and involves concept shifting. In TMT Part A, participants are given a series of randomly positioned circled numbers (1-25) that they are asked to connect in ascending order (1-2-3-4 and so on) by drawing between them as quickly as they can without taking the pencil off the paper. This serves as a baseline measure of psychomotor speed and visual scanning. In TMT Part B, participants are circled numbers (1-13) and letters (A-L) and asked to connect them by alternating between ascending numbers and letters (1-A-2-B-3-C-4 and so on). The time taken to complete each part is recorded. Part B has the added cognitive component of task switching which results in slower times to complete and more mistakes. The extra time taken to complete Part B is the interference effect which is calculated by subtracting the time taken to complete Part A away from the time taken to complete Part B. Individuals with cognitive impairment and dementia have difficulty with Part B with longer time taken to complete and more errors with dementia severity (Ashendorf et al., 2008). The TMT appear to have moderate test-retest reliability coefficients. For example, a TMT reliability coefficient of <0.65 was found in older adults (Wesnes, 2012). However, these assessments were carried out over the course of 1 year which could have allowed some cognitive decline as a confound.

Working memory

Working memory was tested using forwards and backwards components of the digit span as used in the Wechsler Adult Intelligence Scale-III (The Psychological Corporation, 1997). Each component is made up of six pairs of number sequences which are read aloud by the researcher. For the digit span forwards, participants are asked to repeat the sequence of numbers in the same order. For the digit span backwards, participants are asked to repeat the sequence of numbers in the reverse order. Digit span forwards targets the phonological loop and participants may use strategies such as chunking, which involves grouping pairs or small groups of numbers together. The digit span backwards targets the visual spatial sketchpad and central executive processes of working memory and is more challenging. When participants correctly repeat a sentence, the research reads out a sequence which is longer by one more digit. If the participant fails to repeat a sequence correctly, a second sequence of the same length is read out. If the participant fails to repeat the sequence correctly again, then the test is stopped. If the participant repeats it correctly, the researcher moves onto the next length of sequence. The digit span is useful in intervention contexts as it is not affected by ceiling effects. It also has good test-retest reliability with coefficients ranging from 0.66 to 0.89 (Matarazzo & Herman, 1984; Snow, Tierney, Zorzitto, Fisher, & Reid, 1989).

Physical measures

Physical measures were assessed at baseline and post-intervention. Increase in level of resistance in strength training over the course of an intervention was found to predict memory improvement, after controlling for age, education, gender, and disability level (Lachman et al., 2006). Therefore, strength was included to see whether it was associated with cognitive outcomes. It was also included to see whether it was associated with increases in self-efficacy.

Grip strength was measured using a handheld dynamometer as increases have previously been found to be related to better cognitive ability and lower risk of MCI and Alzheimer’s disease (Atkinson et al., 2010; Boyle, Buchman, Wilson, Leurgans, & Bennett, 2009; Buchman, Wilson, Boyle, Bienias, & Bennett, 2007). This was measured in the right hand. Leg muscle strength was assessed in a seated position and captured both isokinetic and isometric strength. Isokinetic strength involved kicks which pushed a bar at shin level at varying resistance levels. Isometric strength involved pushing against a bar which did not move to maintain a constant force for three seconds. This was done on both legs and took approximately 20 minutes.

Other physical measures included: blood pressure and heart rate, height and weight to calculate Body Mass Index (BMI), and Waist and hip circumference. Additionally, participants were asked to wear a pedometer for one week (when logistically possible) to give an indication of physical activity levels prior to starting the intervention. This was repeated at the end of the intervention to assess knock-on effects of the intervention for increasing overall physical activity which could confound results. Pedometers were sealed so that participants could not see how many steps they had done, as this has been shown to increase the number of steps per day (Rooney, Smalley, Larson, & Havens, 2003). Saliva samples were collected from participants pre and post intervention, first thing in the morning before they had anything to eat or drink to test for cortisol and free testosterone (not analysed in the present thesis).

Self-reported health

The EuroQol's EQ-5D-5L health-related quality of life measure was used to capture health (Herdman, et al., 2011). It has been validated in a diverse patient population across 6 countries, including 8 patient groups with chronic conditions (cardiovascular disease, respiratory disease, depression, diabetes, liver disease, personality disorders, arthritis, stroke) and a student sample. Redistribution of responses to the EQ-5D-5L from a previous version (EQ-5D-3L) with fewer response levels was validated for all dimensions and all levels. The measurement properties of EQ-5D-5L were superior to the EQ-5D-3L in terms of feasibility, ceiling effects, discriminatory power and convergent validity. The scale is made up of two parts. The first part indicates participants' functional health across five domains: mobility, self-care, usual activities, pain/discomfort, anxiety/depression. Each domain consisted of one question that was scored on five dimensions which indicate level of functioning or distress. The five levels included: no problems, slight problems, moderate problems, severe problems, and extreme problems. This 5-level version had significantly increased reliability and sensitivity while maintaining feasibility and reducing ceiling effects compared to a previous version with only three response dimensions. The second part of the EQ-5D-5L captures subjective health using a 0 - 100 visual analogue scale which is used alongside the EQ-5D-5L. Participants were asked how good their health was ‘today’, with 0 indicating the worst possible health and 100 indicating the best possible health. There is evidence for its independent predictive value of age of death (Idler & Benyamini, 1997).

Psychosocial questionnaires

Psychosocial questionnaires were selected based on their previous use in health and ageing contexts and also their suitability for use in older adult populations. Short versions of questionnaires were included where available to minimise fatigue and maximise completion.

Attitudes towards ageing

The Attitudes to Ageing Questionnaire (AAQ; Laidlaw, Power, Schmidt, & Group, 2007) was used to capture participants attitudes towards ageing at baseline and post-intervention. It was used in Study 3 and demonstrated independent effects on self-reported health. The AAQ has been validated cross-culturally has good internal consistency (0.74 to 0.81). It is made up of three subscales: psychological growth (e.g. “As people get older they are better able to cope with life”), physical change (e.g. “Problems with my physical health do not hold me back from doing what I want to”), and psychosocial loss (e.g. “Old age is a time of loneliness”). The subscales allowed domains of attitudes towards ageing to be analyses individually, rather than as a whole. The psychosocial loss subscale was reverse scored so that a higher score on each subscale indicated a more positive attitude towards ageing in each domain.

Perceived control

Perceived control was captured using the dispositional trait hope scale (Snyder et al., 1991), which has previously been used to assess control beliefs as a mediator of the effect of age-related cognitions on health in later life (Wurm et al., 2007). It was also used in Study 1a to assess the effect of perceived control with attitudes towards ageing on self-reported health. The scale consists of 12 items and is made up of two subscales (agency and pathway with four items each) and four distracter items. Responses are coded on an 8-point continuum (1 = “definitely false”, to 8 = “definitely true”). The agency subscale consists of efficacy expectancies reflecting the belief in one's capacity to initiate and sustain actions to achieve goals e.g. “I energetically pursue my goals”. The pathway subscale consists of outcome expectancies reflecting belief in one's capacity to generate routes and strategies to reach goals, e.g. “There are lots of ways around any problem”. The agency and pathways subscales were previously found to be related but separate consistently (correlations of .40 to .50) with an overarching hope factor (Babyak, Snyder, & Yoshinobu, 1993). The scale was shown to be internally reliable (alphas of .74 to .88) and temporally stable (test retests over several weeks of .85).

Mental health

The Hospital Anxiety and Depression Scale (HADS; Zigmond & Snaith, 1983) was used to assess mood. It consists of anxiety and depression subscales and has been found to perform well in assessing symptom severity and detecting cases of anxiety disorders and depression in a range of populations including primary care patients and the general population (Bjelland, Dahl, Haug, & Neckelmann, 2002). Cronbach's alpha for the anxiety subscale varied from .68 to .93 (mean .83) and for the depression subscale from .67 to .90 (mean .82). Correlations between the HADS and other commonly used questionnaires were in the range .49 to .83.

Procedure

Enrolment

Details of the intervention procedure are illustrated in Figure 9.1. As part of recruitment, individuals who showed an interest in taking part were given an information sheet about the study which included details about what taking part would involve and contact details of the investigator. Their contact details were also taken and they were phoned a few days later to see if they had any questions. If they wanted to volunteer to participate, a familiarisation session was booked.

Familiarisation session

The familiarisation session was arranged for approximately one week before baseline and lasted between 30 to 60 minutes. The cognitive tests were carried out so that the participants could familiarise themselves with them to reduce anxiety and learning effects. Significant learning effects were found on these tests between the first and second time they were carried out, but not between the second and third time (Clifford, 2012). Thus, the familiarisation session minimised confounding learning effects during the exercise intervention. The word 'test' was not used to refer to the cognitive tests and participants were reassured that they should not worry and to just try their best. During the familiarisation session the demographic and health questionnaire was completed by participants. Participants were also given a salivette to provide a saliva sample on the morning of the baseline session.

Baseline session

During the baseline session, participants completed the cognitive tests followed by the psychosocial and lifestyle questionnaires. When they had been sitting quietly for 10-15 minutes their blood pressure was taken, followed by the other physical measures. Finally, participants were assigned to their exercise group and given their instruction booklet and diary. The exercise instructions were talked through and demonstrated where necessary. An example entry for the diary was also talked through to ensure they understood how to fill it in at home. The participants were asked if they had any questions and were encouraged to phone the investigator if they thought of any while at home. Participants were not informed that they were in a control group for the flexibility programme. Instead, all participants were informed that the study was investigating the benefits of different types of exercise to keep expectations for outcomes consistent between groups. This session lasted between 90 to 120 minutes.

Continuation of the programme at home and mid-intervention session

Participants began the exercise programme at home immediately after the baseline session. Participants were phoned after a few weeks to see how they were getting on and to arrange the mid-intervention session after 6 weeks of the exercise programme. At the mid-intervention session only the cognitive tests were carried out with the session lasting approximately 30 minutes. Participants were asked how they were getting on with the exercise programme and asked if they had any issues. Participants were also asked to bring their exercise diaries and progress was discussed.

Post-intervention session

After 12 weeks, participants had completed the exercise programme and met with the investigator for their last session. Participants brought with them their saliva sample taken that morning and completed the cognitive tests, questionnaires and physical measures. This session lasted approximately 60 – 90 minutes.

All sessions were carried out at the University where possible, sessions were booked for the same time of day for each participant to control for circadian effect on outcome measures.

Week Session	-3 (approx.) Recruitment	-2 (approx.) Familiarisation 1	-1 (approx.) Familiarisation 2	0 Baseline	6 Mid-intervention	12 Post-intervention
Details of session	Information sheet	Informed consent Cognitive tests Health and demographic questionnaire	Cognitive tests	Cognitive tests Physical measures Psychosocial and lifestyle questionnaires	Cognitive tests	Cognitive tests Physical measures Psychosocial and lifestyle questionnaires

Figure 9.1 Details of intervention session procedure including order that cognitive tests were carried out.

Statistical analysis

Mann-Whitney U and Chi-square tests were used to assess differences between groups at baseline. Initially, repeated measures ANCOVAs were used to assess the effect of resistance training on each cognitive outcome, with age and education as covariates. Further repeated measures ANCOVAS were run with residualised change scores of psychosocial factors as covariates, in addition to age and education. Exercise group was the between subjects measures and cognitive outcomes were the dependent variables. Subscales or measures for each psychosocial factor were entered simultaneously as covariates in the ANCOVA. For instance, the attitudes towards ageing subscales (psychosocial loss, physical change, and psychological growth) were entered simultaneously. This was also the case for the perceived control subscales (agency and pathway), and separately for the mental health subscales (anxiety and depression). A custom model of interactions was used with each psychosocial measure entered by time only and also by time and exercise group. Mauchly's test of sphercity was applied to all ANCOVAS and a correction was applied where necessary.

Correlations were carried out between all variables at baseline. Non parametric correlations (Spearman's rho) were utilised due to the small sample size and non-normally distributed data indicated by histograms. Residualised baseline cognitive scores were used to control for age differences. Spearman correlations were also carried out between residualised change scores of all variables, controlling for baseline.

Residualized change scores were used for analysis as they adjust for baseline variance by using residuals from linear regressions of post-intervention scores on pre-intervention scores. They are viewed as superior to simple pre-test – post-test difference scores (Veldman and Brophy, 1974) and are referred to as "base-free" measures of change (Tucker et al., 1966) that are independent of the pre-score. They were also appropriate to use due to the ceiling effects in some cognitive tests and floor effects in some questionnaires. For example, participant who scored highly on a measure at baseline would have less scope to improve on this compared to a participant who scored low at baseline.

Correlation analyses involved a large number of tests, which would have increased the chance of Type I error (false positive results) if p = .05. Therefore, for correlation analysis with a larger number of statistical tests, a p value of .01 was utilised. More conservative methods were considered, such as Bonferroni correction or Holmes sequential. However, these corrections are considered to increase the probability of Type II errors (false negative results) (Perneger, 1998). This is particularly the case when the multiple tests being carried out are related to each other and thus not independent tests which require full correction.

Winsorizing was carried out on TMT interference scores (for one participant) when inspection of the TMT interference z scores indicated that one participant was considerably slower than other participants (>2 standard deviations). The TMT is a timed test and therefore participants who make mistakes can often take a much longer time to complete the test. Participants who took a much longer time to complete Part B scores compared to Part A had a much larger TMT interference scores. Interference scores were winsorized to reduce their weight and leverage. This was done by replacing the observed score with the next highest score from another participant.

Multiple linear regression analysis was carried out to assess the potential mediation model of psychosocial changes on the effect of physical changes on cognitive outcomes during the exercise intervention. This was carried out only on HVLT total recall scores as this was the only cognitive outcome to demonstrated significant associations of changes on both psychosocial and physical measures. Exercise group, residualised change scores (controlling for baseline) of leg strength, and levels of anxiety and depression were included as independent variables and HVLT total recall scores was the dependent variable. Age and education were also included as covariates.

Results

Descriptive statistics

Participant characteristics and baseline psychosocial, self-reported health, cognitive and physical measures are shown in table 9.1. There were no significant differences between demographic or baseline variables between exercise groups.

Table 9.1 Baseline participant characteristics

Variable	Resistance	Flexibility
N	8	5
Age	62.3 (2.1) *59-65*	56.2 (8.8) *44-63*
Female, *n*	7	4
Smoke, n	0	0
Education completed; % total		
≤Secondary	15.4	15.4
≥College/University	46.2	23.1
Psychosocial measures		
Attitudes towards ageing total	89.9 (8.3) *79-103*	94.9 (8.1) *88-108*
Psychosocial loss subscale	34.1 (3.4) *29-38*	36.4 (3.0) *32-39*
Physical change subscale	26.1 (3.8) *21-31*	29.0 (4.4) *25-36*
Psychological growth subscale	29.6 (6.0) *21-40*	29.5 (3.5) *27-35*
Perceived control total	54.4 (6.5) *42-61*	52.2 (6.7) *44-60*
Agency subscale	26.8 (3.2) *22-30*	26.0 (3.5) *22-30*
Pathway subscale	27.6 (3.9) *19-31*	26.2 (3.2) *22-30*
Mental health total	6.9 (3.6) *3-12*	11.8 (6.9) *3-19*
Anxiety subscale	4.8 (2.3) *2-7*	6.4 (3.9) *1-10*
Depression subscale	2.13 (1.9) *0-5*	5.4 (3.0) *2-9*
Self-reported health		
Subjective health	89.4 (5.6) *80-100*	82.0 (5.7) *75-90*
Functional health	0.73 (0.1) *0.6-1.0*	0.81 (0.32) *0.3-1.0*
Cognitive ability measures		
MMSE	29.5 (1.1) *27-30*	28.6 (1.5) *27-30*
HVLT trial 1	8.4 (0.7) *8-10*	10.0 (2.3) *7-12*
HVLT total	31.3 (2.2) *28-34*	32.4 (3.4) *28-36*
Verbal Fluency	31.3 (9.0) *17-41*	29.8 (6.1) *25-40*
TMT interference	19.8 (16.9) *8-59*	13.6 (10.5) *6-32*
Physical measures		
Grip strength	29.3 (5.1) *24-41*	30.2 (10.0) *17-40*
Isometric strength (90°), kg	119.7 (18.3) 92-139	145.4 (26.9) 121-191
Isokinetic strength (180°), kg	67.8 (14.5) 45-87	70.8 (14.3) 56-89

Note: Mean (standard deviation) *range* displayed; unless otherwise stated (e.g. %). Test of difference (Resistance v Flexibility group) indicated no significant differences at baseline between these variables. MMSE = Mini Mental State Examination; HVLT = Hopkins Verbal Learning Test; TMT = Trail Making Task

Baseline associations between cognitive ability, psychosocial factors and physical measures

Semi-partial Spearman correlations were calculated between residualised cognitive scores (controlling for age), all psychosocial subscales (attitudes towards ageing, perceived control, and mental health), physical measures and self-reported health at baseline. Baseline grip strength was significantly correlated with baseline TMT interference scores (r = .70, p = .007). No other correlations between cognitive ability, psychosocial factors and physical measures were significant.

Overall effect of resistance training and cognitive ability

The overall RCT (n = 20) from which the subsample in the present study was taken from did not find a significant effect of the resistance training on any cognitive task performance when analysed as a whole sample (Clifford, 2013). However, when the data was stratified by gender, several significant effects of resistance training on memory tasks (but not on executive function) were found in women. Analysis was not possible in men as there were only four in the sample. In women only (n = 16), there was a significant interaction effect of exercise group by time and an effect of education on verbal fluency. On average, there was a larger increase in verbal fluency scores after 12 weeks of the resistance intervention compared to the control intervention while controlling for age. Those who had completed a higher level of education also showed larger improvements in Verbal Fluency compared to those who had completed a lower level of education. Additionally in women, a significant group by time interaction was found for the HVLT trial 1 and HVLT total scores. On average, there was an improvement in recall scores for the resistance training group, but not for the control intervention. There was no significant effect of resistance training on TMT interference scores. However, the power estimate for this analysis was low (<.3) compared to estimates on the other cognitive tests (>.45). Therefore, it was concluded that a larger sample would be needed to rule out an effect of this resistance training programme on this measure of executive functioning in middle-aged adults.

When the analyses were repeated in the subsample (on which psychosocial measures data had been collected), no significant effects were found in the whole sample (n = 13). However, in women (n = 11) after 12 weeks a significant group by time interaction was found for HVLT total $F(1,8) = 9.12$, $p = .017$), and HVLT trial 1 $F(1,8) = 10.39$, $p = .01$), but not for verbal fluency $F(1,8) = 0.06$, $p = .82$) or TMT interference scores $F(1,8) = 0.20$, $p = .67$). On average, women in the resistance training group improved compared to women in the flexibility group for HVLT total and trial 1 scores. Both the verbal fluency and TMT interference group by time effects had very low power (<.1).

The role of psychosocial factors on cognitive outcomes

ANCOVAs were carried out with change scores (residualised to control for baseline) of psychosocial factors as covariates (as well as age and education) in the whole subsample to see whether they had a significant association with cognitive outcomes during the intervention. The significant effects are illustrated as a model in Figure 9.7, together with changes associations between health, physical and psychosocial variables.

Attitudes towards ageing

Attitudes to Ageing Questionnaire subscales (psychosocial loss, physical change, and psychological growth) demonstrated significant or trend significant effects on Verbal Fluency (Table 9.2). Changes in attitudes related to psychological growth with ageing demonstrated a significant effect by time on change in Verbal Fluency scores. Changes in attitudes related to physical change with ageing and attitudes related to psychosocial loss with ageing demonstrated a borderline significant effect by group and time on Verbal Fluency scores. When the attitudes towards ageing subscales were added to the model, the - previously non-significant – exercise time by group effect on Verbal Fluency approached significance. No significant effects of changes in attitudes towards ageing were found with changes on other cognitive outcomes (HVLT and TMT).

The significant (and borderline significant) effects of psychosocial variables on cognitive outcomes were plotted on graphs to check for the direction of the effects with a median split for change on each psychosocial variable (residualised change scores controlling for baseline). Figure 9.2 illustrates that participants who reported increased positivity of attitudes related to psychological growth with ageing demonstrated improvements on Verbal Fluency compared to those who reported decreased positivity of attitudes related to psychological growth with ageing who remained stable over the 12 week intervention. Figure 9.3 illustrates the borderline significant interaction between increased positivity in attitudes towards in psychosocial loss with ageing and Verbal Fluency. Participants who reported increased positivity in attitudes related to psychosocial loss with ageing improved on Verbal Fluency and those who reported decreased positivity in these attitudes showed a decline during the intervention.

There were no significant differences in baseline attitudes towards ageing between those who reported increased positivity compared to those who reported a decrease in positivity in attitudes ($p > .05$). There were also no baseline differences in Verbal Fluency performance between these groups ($p > .05$). Independent tests of difference indicated no significant differences between exercise groups in terms of change in level of positivity on any of the attitudes towards ageing subscales ($p > .05$). Paired test of difference indicated no significant differences between participants' pre- and post-intervention attitudes towards ageing scores on subscales ($p > .05$).

Table 9.2 Significant effects of attitudes towards ageing in the whole subsample

Perceived control interaction	Cognitive outcome	*F*	*P*
psychosocial loss*group*time	Verbal Fluency	9.17	.056
physical change*group*time		6.51	.084
psychological growth*time		12.50	.038
time*group		7.23	.074

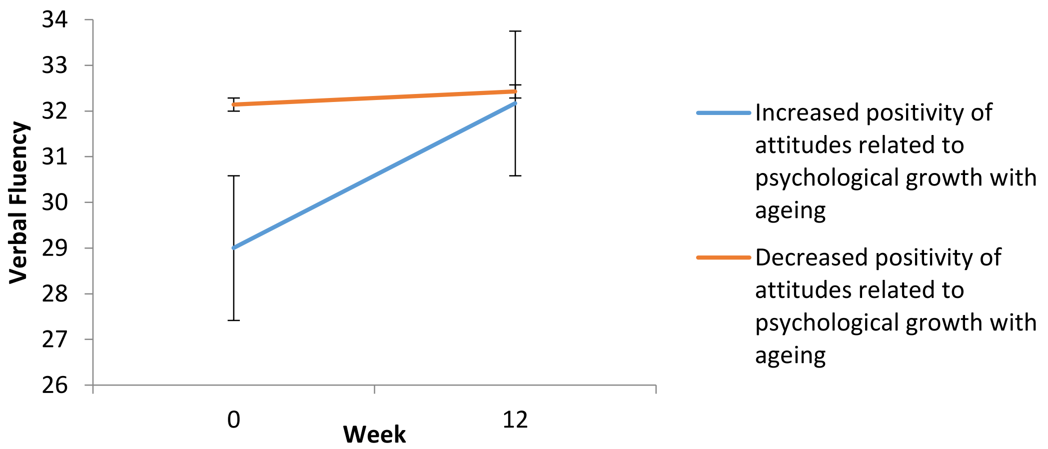


Figure 9.2. Change in Verbal Fluency performance during the 12-week exercise programmes for participants who reported an increase or decrease in positivity of attitudes related to psychological growth with ageing.

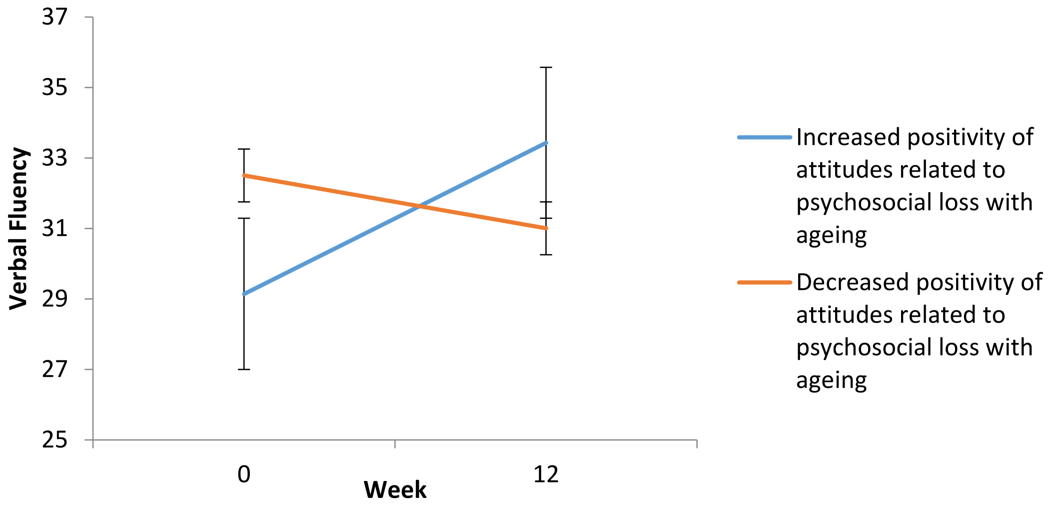


Figure 9.3. Change in Verbal Fluency performance during the 12-week exercise programmes for participants who reported an increase or decrease in positivity of attitudes related to psychosocial loss with ageing.

Perceived control

There were no significant interactions between changes in perceived control (agency or pathway subscales) and cognitive outcomes. However, when the perceived control subscales were added to the model in the whole subsample, the - previously non-significant - exercise group by time effect on HVLT total recall scores became significant, with the resistance group demonstrating larger improvements on HVLT total scores compared to the flexibility group, $F(1,5) = 9.74$, $p = .0.26$. This was also the case for HVLT trial 1 scores, $F(1,5) = 13.79$, $p = .0.14$.

Paired tests of difference indicated no significant differences between participants' pre- and post-intervention scores on perceived control subscales. However, there was a borderline significant improvement as a result of the intervention (exercise groups combined) on the agency subscale ($z = -1.91$, $p = .056$). Participants who reported an increase in perceived control on the agency subscale during the intervention had a significantly higher level of perceived control at baseline compared to those who reported a decrease ($z = -2.93$, $p = .003$). This was also the case on the pathway subscale of perceived control ($z = -3.00$, $p = .003$). There were no baseline differences in HVLT trial 1 or total recall performance between these groups ($p > .05$). Independent tests of difference indicated no significant differences between exercise groups in terms of change in level of perceived control on either subscale ($p > .05$).

Independent tests of difference indicated no significant differences between exercise groups in terms of change in level of perceived control ($p > .05$).

Mental health

Mental health subscales demonstrated significant effects on short-term verbal memory (Table 9.3). Changes in level of anxiety demonstrated a significant interaction effect by group by time effect on HVLT total scores. Changes in level of depression demonstrated a significant effect by time on HVLT total scores. When the mental health subscales were added, the - previously non-significant - exercise group by time effect on HVLT total scores in the subsample became significant. Although changes in anxiety or depression were not associated with HVLT trial 1 changes, when these subscales were added, the - previously non-significant - exercise group by time effect on HVLT trial 1 scores approached significance. Changes in level of depression demonstrated a borderline significant group by time effect on TMT interference scores. With the addition of the mental health subscales, the exercise group by time effect on TMT interference scores was still non-significant.

Figure 9.4 indicates that a reduction in anxiety was associated with improvements on HVLT total scores compared to increased anxiety which was associated with a slight decrease in HVLT total scores. Figure 9.5 indicates that those who reported a reduction in depression demonstrated an improvement on HVLT total scores, while those who reported increased levels of depression demonstrated a decline on HVLT total scores at 12-week follow-up. Figure 9.6 indicates that participants who reported an increase in levels of depression demonstrated slower TMT interference at 12-week follow-up compared to participants who reported a reduction in depression and demonstrated stable TMT performance between baseline and 12-week follow-up. There was no significant difference between baseline levels of anxiety in those who reported a reduction compared to an increase in anxiety during the intervention ($p > .05$). There was also no significant difference between baseline levels of depression in those who reported a reduction compared to an increase in depression during the intervention ($p > .05$). Those who either reported an increase or a reduction in depression or anxiety did not have significantly different HVLT total scores at baseline ($p > .05$). Independent tests of difference indicated no significant differences between exercise groups in terms of change in level of perceived control (*p*

> .05). Paired test of difference indicated no significant differences between participants' pre- and post-intervention perceived control scores on subscales ($p > .05$).

Table 9.3 Significant effects of mental health in the whole subsample

Mental health interaction	Cognitive outcome	*F*	*P*
anxiety*group*time	HVLT total	10.88	.021
depression*time		8.97	.030
time*group		7.49	.041
time*group	HVLT trial 1	5.48	.066
depression*time	TMT interference	6.55	.051
time*group		0.62	.467

Note: HVLT = Hopkins Verbal Learning Test, Trail Making Task.

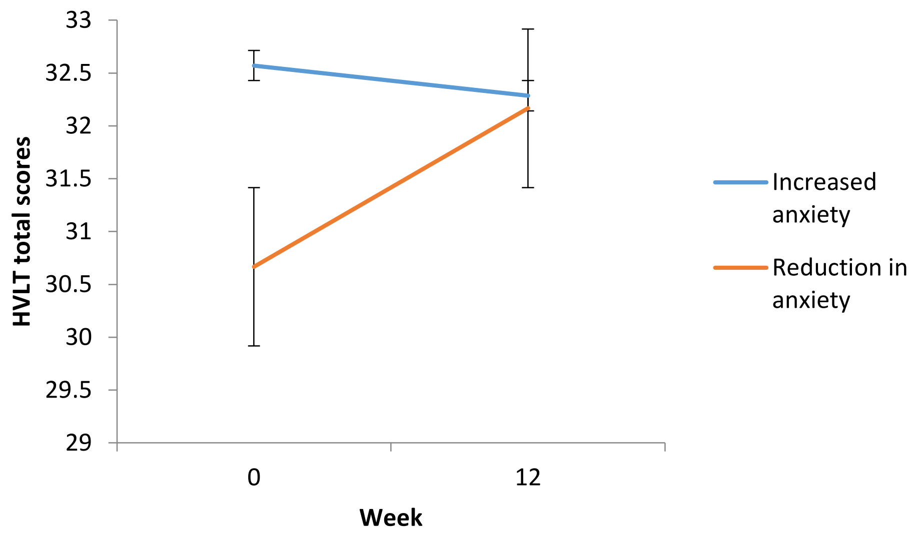


Figure 9.4 Change in HVLT total score performance during the 12-week exercise programmes for participants who reported an increase or reduction in levels of anxiety.

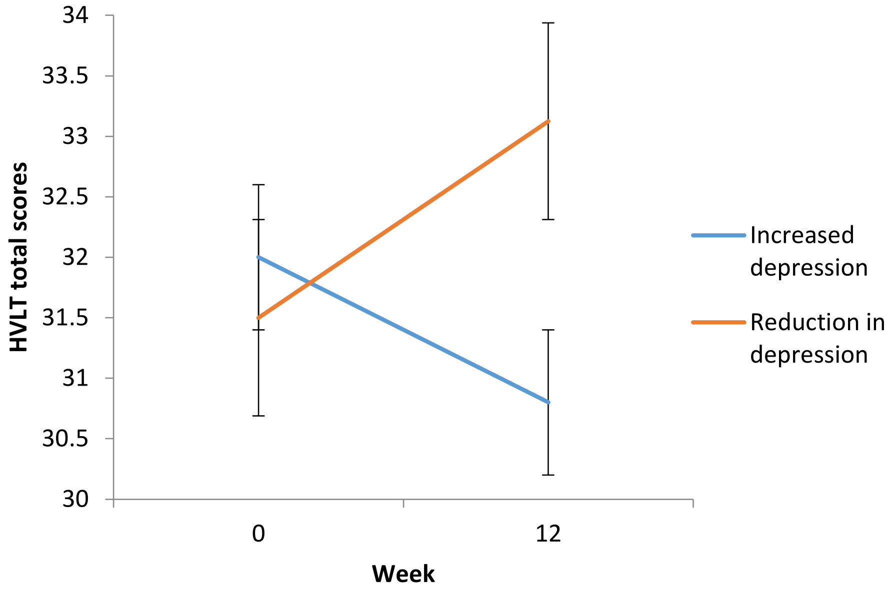


Figure 9.5 Change in HVLT total score performance during the 12-week exercise programmes for participants who reported an increase or reduction in levels of depression .

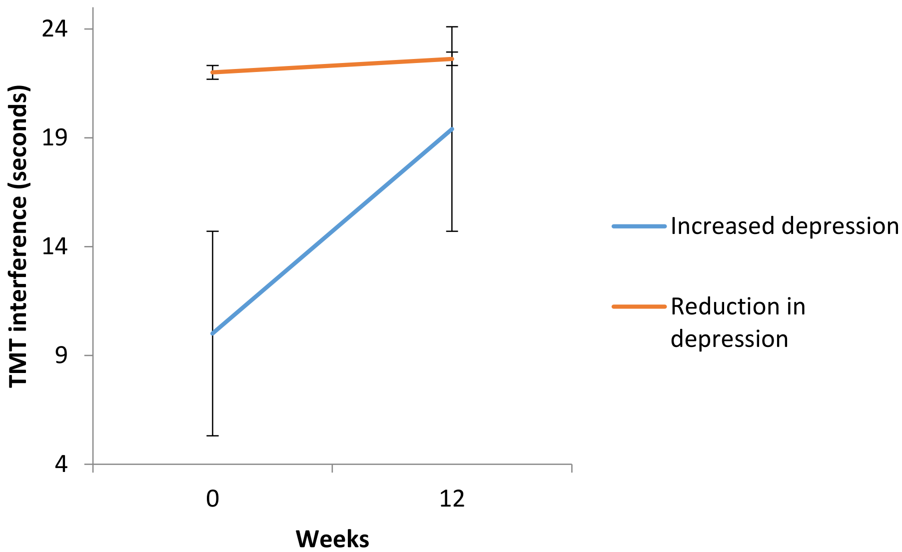


Figure 9.6. Change in TMT interference performance during the 12-week exercise programmes for participants who reported an increase or reduction in levels of anxiety.

Group differences in improvements in physical measures and self-reported health

Mann-Whitney U tests of difference indicated no significant differences in change scores between the resistance and flexibility programmes for changes in subjective health, self-reported functional health, grip strength, or leg muscle strength ($p > .05$).

Association between improvements in physical and self-reported health measures and cognitive ability

Spearman correlations between improvements in physical measures and self-reported health, and cognitive ability were calculated using residualised change scores (controlling for baseline). There was a correlation between improvements in isokinetic leg strength and HVLT total scores, which approached significance ($r = .724$, $p = .020$). There were no other significant correlations between changes in self-reported health measures and cognitive ability.

Association between improvements in physical and self-reported health measures and psychosocial variables

Spearman correlations between improvements in physical measures and self-reported health, and psychosocial measures (attitudes toward ageing, perceived control, and mental health subscales) were calculated using residualised change scores (controlling for baseline). There was a significant correlation between a reduction in levels of depression and improved subjective health ($r = -.80$, $p = .001$). There was a borderline significant correlation between increased perceived control on the pathway subscale and improved subjective health ($r = -.68$, $p = .011$).

Association between improvements in psychosocial factors

Spearman correlations between improvements psychosocial measures (attitudes toward ageing, perceived control, and mental health subscales) were calculated using residualised change scores (controlling for baseline). There were correlations between increased positivity of attitudes related to physical change with ageing and a reduction in anxiety ($r = -.62$, $p = .024$), increased level of perceived control on both the agency (*r* = .66, *p* = .020) and pathway (*r* = .66, *p* = .014) subscales, which approached significance.

Adherence

There were no significant Spearman correlations between number of sessions attempted or completed and baseline psychosocial or self-reported health measures (*p* > .01).

Independent effects of exercise and psychosocial factors on cognitive ability

Regression analysis was carried out to investigate whether psychosocial factors mediated the effects of physical factors on cognitive outcomes (Table 9.4). This was carried out only with HVLT total recall scores as both psychosocial and physical measures demonstrated significant changes associations with this cognitive outcome (Verbal Fluency and TMT interference only demonstrated change associations with psychosocial factors). Improvements in mental health, increases in leg strength, and exercise group were independent predictors of short-term verbal memory gains during the exercise intervention. Age and education did not significantly predict improvements in short-term verbal memory.

Table 9.4. Regression analysis of improvements on HVLT total recall with improvements in mental health and leg strength

Independent variables	Standardised β	*p*	Adjusted R^2	F	*p*
Depression	-.74	.003			
Anxiety	.46	.019			
Leg strength	.96	.002	.96	39.55	.006
Exercise group	-.85	.002			
Age	-.16	.173			
Education	.06	.472			

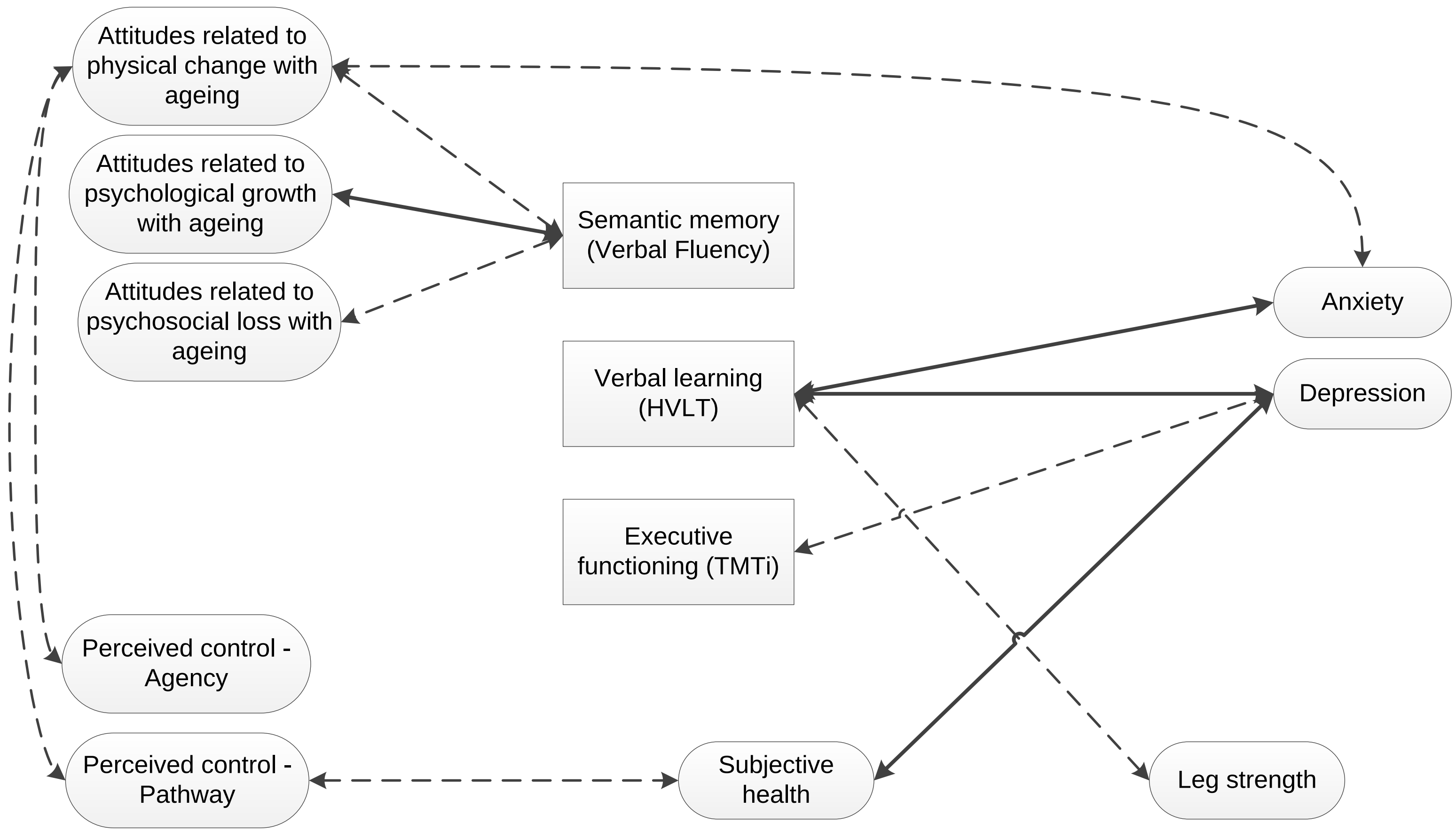


Figure 9.7 associations of change between psychosocial factors, cognitive outcomes, self-reported health, and physical measures (trend significant effects illustrated by dashed arrows).

Discussion

The aim of the present study was to investigate the potential role of psychosocial factors on cognitive outcomes in available data of a pilot RCT of resistance training exercise intervention with middle-aged adults (Clifford, 2012). The purpose of this analysis of secondary data was to test proof of concept of an association between cognitive and psychosocial variables to inform future study design and justify the use of resources for a feasibility study in older adults which would be labour intensive. The specific psychosocial factors investigated were: attitudes towards ageing, perceived control, and mental health. It was hypothesised that improvements on psychosocial measures would be associated with improvements in cognitive ability due to the evidence from Study 2c that mental health appeared to partially mediate the effect of walking on cognitive outcomes.

Neither the larger trial nor the subsample in this study found an effect of resistance training on cognitive outcomes when analysis was conducted on the whole group (men and women), while controlling for age and education only. However, positive effects of resistance training were found on some cognitive outcomes when improvements in psychosocial factors were controlled for. When increased perceived control or improved mental health were controlled for, the effect of resistance training became significant for verbal learning (HVLT). Also, the effect of resistance training on semantic memory (Verbal Fluency) became trend significant when changes in attitudes towards ageing were controlled for. No effect of resistance training was found on executive function (TMT interference), even after controlling for improvements in psychosocial factors.

The present study found associations between improvements in some psychosocial factors and improvements of some cognitive outcomes. Attitudes towards ageing were associated with improvements in semantic memory (Verbal Fluency) over the 12-week intervention. Participants who reported increased positivity of attitudes related to psychological growth with ageing demonstrated larger improvements on semantic memory (Verbal Fluency) compared to those who reported a decrease in positivity in these attitudes. Additionally, the results suggested that increased positivity in attitudes related to psychosocial loss and physical changes with ageing may also associated with improvements in semantic memory (borderline or trend significant effects). These findings were interactions by group as well as over time, suggesting that exercise group may affect the degree to which attitudes increased in positivity. However, no significant differences between exercise groups were found on improvements in attitudes towards ageing. Improvements in mental health were associated with improvements in verbal learning (HVLT total recall) over the 12-week intervention. A reduction in anxiety and depression were associated with improvements in verbal learning. These findings were interactions by group as well as time, however no differences between exercise groups were found on improvements in mental health. Additionally, the results suggested that a reduction in depression was associated with improvements in executive functioning (borderline significant). There were no significant associations between increased perceived control and changes in cognitive outcomes during the 12-week exercise intervention in this sample of middle-aged adults. However, as the effect of resistance training became significant when these subscales were added, this suggests that they could play a role but perhaps the sample was too small to detect a significant effect due to low power. These findings need to be interpreted with caution due to the small sample size.

Correlation analyses indicated relationships between changes in other variables during the exercise intervention, while controlling for baseline. A correlation between improvements in isokinetic leg strength and HVLT total recall scores approached significance. Improvements in subjective health were significantly correlated with a reduction in levels of depression and were borderline significant correlated with increased perceived control.

The findings of the present study suggest there could be a link between psychosocial and cognitive improvements during an exercise intervention. In relation to the potential mediating model discussed in Chapter 2, improvements on mental health did not show full mediation of the effect of leg strength improvements on short-term verbal memory. However, the relationship between mental health and cognitive gains was independent to that of increased leg strength and cognitive gains. This suggests that improvements in psychosocial factors during an exercise intervention could have an additive positive effect on cognitive outcomes on top of the effect from increases in physical fitness and therefore warrants further research.

Increased positivity of attitude towards ageing were associated with semantic memory (assessed using the Verbal Fluency task), whereas mental health (levels of anxiety and depression) were associated with verbal learning and executive functioning (assessed using the HVLT and TMT interference, respectively). These associations suggest that the relationships between psychosocial factors and cognitive improvements could be domain specific. This could be due to the different skills required to carry out different cognitive tasks successfully. For example, the Verbal Fluency task requires the retrieval of information from semantic categories whereas the HVLT and TMT requires dual tasking. The HVLT requires paying careful attention to the list of words that is being read aloud and allocating the words into categories for easier retrieval. The TMT requires holding lists of numbers and letters in your head simultaneously and switching between them while scanning the page for the next number or letter. These results suggest that cognitive tests which require complex dual tasking are affected by levels of depression and anxiety and semantic retrieval of information is affected by attitudes towards ageing. All of the cognitive tasks included in the present study required high order functioning, thus it is not clear whether psychosocial factors are related to more simple cognitive tasks. Previous research has found that higher levels of depression are associated with slower processing speed (Halvorsen et al., 2012). Slower processing speed could be a mechanism through which higher order functions are affected by psychosocial factors. Slower processing speed may be a limiting factor, for example on how quickly information can be sorted into categories as the list of words is being read aloud during the HVLT. Thus, future research should include a measure of processing speed to investigate the effect of psychosocial factors on processing speed in this context. It could be that different psychosocial factors act upon different mechanisms that manifest in cognitive performance, e.g. behaviours including motivation to perform well, effort to sustain attention, and use of strategies.

The results of the present study suggest there could be a two-way pathway between psychosocial factors and participation in physical activity. Previous longitudinal evidence found that attitudes towards ageing predicted participation in preventative health behaviours later in life (Levy & Myers, 2004). However, the present study demonstrated that participation in healthy behaviours, such as this exercise intervention, can lead to increased levels of perceived control and more positive attitudes towards ageing in some individuals. Furthermore, these improvements were associated with cognitive outcomes. As psychosocial factors did not predict adherence in the present study, it could be suggested that there are other mechanisms through which they impact on cognitive outcomes. However, it should be noted that there was a very high level of adherence in the present study and there may have not been enough variance to detect effects. Another potential mechanism discussed in Chapter 2 was increased self-efficacy. Self-efficacy has been suggested to enhance or hinder cognitive performance through a variety of processes, including motivational, affective and meta-cognitive aspects (Bandura, 1989). It could be that the attitudes towards ageing subscales actually captured self-efficacy by proxy, thus self-efficacy measures were included in Study 4.

It has been suggested that the benefits of physical activity on cognitive outcomes is moderated by age and may have the largest protective effect in middle-age (Clifford et al., 2013), However, there is prospective evidence which suggests that physical activity still demonstrates a protective effect against dementia in the oldest old (≥ 85 years), particularly in women (Sumic, Michael, Carlson, Howieson, & Kaye, 2007). It could be that the role of psychosocial factors in this context is also moderated by age, particularly as there is evidence for the moderating role of self-relevance of attitudes towards ageing on memory performance over time (Levy et al., 2011). The present study with middle-aged adults only found a relationship between attitudes towards ageing and semantic memory and not on other cognitive domains. Perhaps, as this sample of participants were middle-aged, the attitudes towards ageing captured in those subscales are not self-relevant and therefore do not have as broad an impact on cognitive outcomes during middle-age. It may be that the impact of attitudes towards ageing on cognitive performance is more pertinent in older adults and therefore their impact on cognitive outcomes would be broader across domains.

A limitation of the present study was that the subsample of participants in the present study was captured on their second exercise programme in the cross over design of the larger randomised controlled trial. The change in psychosocial factors during their first exercise programme may have differed from their second exercise programme. Carrying out the second exercise programme would have been a less novel experience. The psychosocial experience of participants who were all sedentary and begun to exercise may have resulted in larger positive psychosocial benefits compared to the psychosocial benefits of carrying out a different exercise programme. Although there was a four week wash out period, there may have been carry-over effects on psychosocial factors. This is a limitation of the use of a crossover design in this context of psychosocial mediators, thus Study 4 utilised parallel groups with no crossover to capture initial psychosocial benefits of the exercise programme and also psychosocial measures at 6-week follow-up to assess shorter term changes.

Another potential confounding influence on the findings was that participants in the present study pro-actively volunteered themselves and therefore may have already had higher perceived control and positive attitudes prior to starting the intervention, particularly as the intervention required a high level of participant commitment. This would have limited the scope for psychosocial improvements. Thus, in order to recruit a more diverse sample Study 4 utlised different strategies to recruitment participants who may not have otherwise been exposed to the type of advertisements used in the present study or may not have pro-actively responded to the adverts themselves.

In conclusion, the findings of the present study suggest that psychosocial factors could play a role in cognitive outcomes in an exercise intervention. The findings suggest that the relationship between improvements on psychosocial factors and cognitive gains could be independent to those from increases in physical fitness. Thus psychosocial improvements could have an additive effect and are therefore important to assess and control for in exercise interventions in this context. Specifically, increased positivity in attitudes towards ageing was associated with improvements in semantic memory and improvements in mental health were associated with improvements in verbal learning and potentially executive function. This suggests that the effect could be domain specific whereby different psychosocial factors are associated with different cognitive domains. These findings need to be interpreted with caution due to the small sample size. However, they provide preliminary proof of concept evidence that suggests that psychosocial factors could be associated with cognitive outcomes in a resistance training intervention. Further research with larger sample sizes is warranted to further investigate this relationship.

Chapter 10: Study 4 – A feasibility study and pilot randomised controlled trial of resistance training on cognitive ability with older adults: the role of psychosocial factors

Introduction

Increasing age is associated with an increased risk of a range of diseases and conditions, including cognitive impairment and dementia (Launer & Hofman, 1992; Solfrizzi et al., 2004). The incidence of dementia is expected to increase as our population ages. In the UK in 2010, there were estimated to be over 820,000 older adults afflicted with late onset dementia (Luengo-Fernandez, Leal, & Gray, 2010). This is expected to rise to one million by 2025 and to exceed 1.7 million by 2051 (Alzheimer's Society, 2007). As there is currently no cure for dementia, modifiable lifestyle behaviours, including physical activity, have been investigated as a preventative strategy to delay the onset of dementia (e.g. Angevaren et al., 2008; Clifford et al., 2009; Colcombe & Kramer, 2003; Lautenschlager, et al., 2012; Sofi et al., 2010).

Despite numerous systematic reviews and meta-analyses have been carried out to examine the effect of physical activity on cognitive ability or dementia incidence, the relationship is not clearly understood. Some moderators of this effect have been identified including specific exercise components, such as, types, intensity, frequency, and duration, and sample populations, such as, different age groups with or without cognitive impairment (Angevaren et al., 2008). Psychosocial factors have been suggested as possible meditators to further explain some of the variation of the effect of exercise interventions on cognitive outcomes (Stock et al., 2012). This suggestion was based on the potential psychological impact of the exercise intervention and the subsequent impact of this on cognitive performance. There is evidence from non-exercise related observational and intervention studies that psychosocial factors, such as positive attitudes to ageing (Langer & Rodin, 1976), positive self-perceptions (Levy, Slade, Kunkel, & Kasl, 2002; Levy, 2003), better mood (Ganguli, Du, Dodge, Ratcliff, & Chang, 2006) are associated with improvements in cognitive performance. Thus, it may be that the exercise intervention studies which result in a larger improvement in cognitive performance do so because the exercise acts as a vehicle to improving these psychological factors, potentially in addition to direct physiological mechanisms.

Kitwood (1997) and Clare (2007) have indicated the importance of using a broader biopsychosocial model of disease to understand cognitive decline and dementia. However, previous research has largely investigated the role of psychosocial factors primarily in the context of predicting physical activity (McAuley et al., 2004). The role of psychosocial factors in delaying decline has been neglected in the context of physical activity as a preventative strategy for cognitive decline. The findings from Study 1a identified a relationship between attitudes towards ageing and perceived control on self-reported health independent of level of physical activity. Additionally, the findings of Study 2b indicated the independent association of mental health with cognitive ability in cross sectional data from Indonesia. These findings are limited in the explanation of mechanisms due to the cross-sectional nature of the data. Thus, the present study investigated the relationship between changes in psychosocial factors and cognitive performance during an exercise intervention.

The findings of the Study 3 provided preliminary proof of concept evidence to suggest that psychosocial factors could play a role in cognitive outcomes in an exercise intervention with middle-aged adults. The findings suggest that the relationship between improvements on psychosocial factors and cognitive gains could be independent to those from increases in physical fitness. Thus psychosocial improvements could have an additive effect and are therefore important to assess and control for in exercise interventions in this context. Specifically, increased positivity in attitudes towards ageing was associated with improvements in semantic memory and improvements in mental health were associated with improvements in verbal learning and potentially executive function. This suggests that the effect could be domain specific whereby different psychosocial factors are associated with different cognitive domains. These findings need to be interpreted with caution due to the small sample size but justified the use of time and resources to further investigate this relationship with older adults. The resistance and flexibility programmes utilised in Study 3 with middle-aged adults was well tolerated with high rates of adherence and no concerns regarding feasibility. The resistance training programme utilised in Study 3 was considered appropriate for this feasibility study with older adults as exercises can be adapted for those who are frailer and are not confident or are unable to carry out exercises while standing. Additionally, the effectiveness of resistance training for improving cognitive abilities is less clear as the majority of RCTs carried out in this context have utilised aerobic exercise programmes (discussed in Chapter 1). Resistance training can also be carried out at home which, compared to exercise programmes in a group setting, controls for the effect of social interaction, which was found to be positively associated with better cognitive ability in Study 2a.

Aims

The primary aim of the present study was to assess the feasibility of the exercise programmes utilised in Study 3 with older adults. The secondary aim was to explore whether there was a potential association between change in psychosocial factors and change in cognitive outcome measures in older adults. The psychosocial factors included were attitudes towards ageing, perceived control, mental health, and self-efficacy. An additional secondary aim was to give an indication of whether the role of psychosocial factors may be specific to certain domains of cognitive ability.

Method

Data collection for this study was ongoing at the time of the present thesis submission and the data collected in the analysis presented here will contribute to the final analysis. Thus the present study was considered an internal pilot. The CONSORT group are currently developing guidelines for reporting feasibility trials and pilot studies (Eldridge et al., 2013) so this study has been described according to the CONSORT guidelines for the presentation of clinical trials where appropriate (Moher et al., 2010).

Participants

Participants were recruited using opportunity sampling and using the inclusion criteria of aged 60 years and older and who were sedentary prior to starting the intervention (< 2 hours physical activity per week). The recruitment strategies used in Study 3 may have led to an unrepresentative sample as participants were required to be proactive and contact the investigator to volunteer after seeing the advertisements. The sample was also highly educated with the majority of participants having completed college or university. Study 4 aimed to recruit participants in different ways so that the sample was not limited to those who were very proactive in volunteering and also those who were not part of community groups, or did not buy newspapers or visit libraries or shops. Thus, participants were recruited from care homes and sheltered housing communities. The investigator liaised with the manager, warden, or activity coordinator of each residence and attended a coffee morning to explain the research project, what participation would involve, and ask for volunteers. Non-residents who attended these coffee mornings and volunteered to participate were also recruited. Recruitment posters were also distributed to sheltered housing communities which were displayed on noticeboards. Managers/wardens or activity coordinators also spoke with residents who did not attend coffee mornings to see whether they would like to take part.

Sheltered housing is different from homes for the elderly or care homes in that care staff are not on site all the time, so residents care needs are generally lower. Sheltered housing offers independent living with support. Usually residents have their own room or flat, some sheltered housing offers one or two meals a day while others have facilities within the flat for residents to prepare their own food. Some residents have carers who visit if needed, for example to prepare meals for them. Residents in sheltered housing communities were suitable for the self-directed exercise programmes used in Study 4 as they have a sufficient level of independence to carry out the programmes. The participants who were recruited from care homes (n = 3) were initially approached by the activity coordinator as they were capable of independently carry out the self-directed exercise programmes.

The participants for Study 4 were older than in Study 3. Study 4 aimed to recruit older adults for which attitudes towards ageing are more likely to be self-relevant. This is because the perceived self-relevance of attitudes towards ageing have been found to moderate the long-term effect of negative age stereotypes on memory performance, which did not appear to be due to health differences (Levy et al., 2011). Initially, the inclusion criteria for age was 65 years and older. However, this was extended to 60 years and older to maximise recruitment as some volunteers were aged between 60 and 65 years. The participants in Study 4 were also frailer compared to those in Study 3. Study 3 recruited healthy middle-aged participants who were able to carry out the exercises fully from the beginning. However, the number of healthy individuals in the older adult population is limited and very few of the volunteers did not have any physical problems. Therefore, to increase the representational value of the sample of the older adult population and avoid excluding the majority of volunteers, participants for Study 4 were not excluded on the basis of not being able to carry out the exercises fully due to physical problems. It could be that a sedentary lifestyle exasperates physical functioning problems and these individuals may stand to benefit the most of exercise programmes. The benefits of increasing physical activity outweigh the risks of doing so and also the risks of staying sedentary (Melzer, Kayser, & Pichard, 2004). Additionally, it is individuals who are less physically active that are at higher risk of cognitive decline (discussed in Chapter 1 and Study 2). Although individuals with physical problems may be limited in their ability to carry out the exercises fully at the start of the intervention, their ability may improve during the intervention.

All participants completed a health screening questionnaire prior to recruitment to ensure that they would be able to carry out the exercises and were not at high risk of contraindications. Participants were asked to consult their GP before starting if this questionnaire raised any concerns. If participants were coincidentally embarking on new diets or exercise regimes of their own initiative at time of recruitment, they were asked to stabilise their new routine for a minimum of two months beforehand (n = 2) so as not to interfere with the study. Exclusion criteria included presence of a co-morbid psychiatric disorder, other neurological disease, substance abuse and previous use of medication that would affect cognition.

After data collection pedometer data collected indicated that one participant walked >10,000 steps per day on average which was considerably more than the rest of the participants. Previous research has proposed that <5000 steps per day reflects a sedentary lifestyle and <10,000 steps per day can be considered “low-active” in healthy adults (Tudor-Locke & Bassett, 2004). This participant was in the flexibility group. Thus, on average this group walked significantly more per day ($z = -2.2$, $p = .03$) and this difference represented a medium effect size (r = .58). Therefore, this participant was excluded from group analyses as they did not meet the inclusion criteria. The remaining participants were all considered either sedentary or “low-active”.

Figure 10.1 illustrates in a flow diagram the number of participants who showed interest and were given information, were recruited, dropped out or completed the exercise programmes. Before the onset of both studies, approval was granted by the Loughborough University Ethical Advisory Committee and all participants gave written informed consent. Ethical considerations for this study included potential risk to participants of carrying out the exercise programmes. Efforts were made to minimise risk to participants by emphasising the importance of starting gently, prioritising of warm-up and cool down exercises, and possible adaptations of exercises to suit individual capabilities (see ‘safety considerations’ for more details). Another ethical consideration was potential pressure to participate as the researcher recruitment within place of residence for participants. The voluntary nature of participation was emphasised from the start and repeated at future sessions. It was also emphasised that starting the intervention did not mean that participants had to complete it and that they could stop at any point if they wished and were not obliged to give a reason.

A recruitment target of n = 30 participants (n = 15 per exercise group) was considered a sufficient sample size to estimate the parameters of interest without exposing too many participants to the potential risks associated with the exercise interventions at this stage of development.

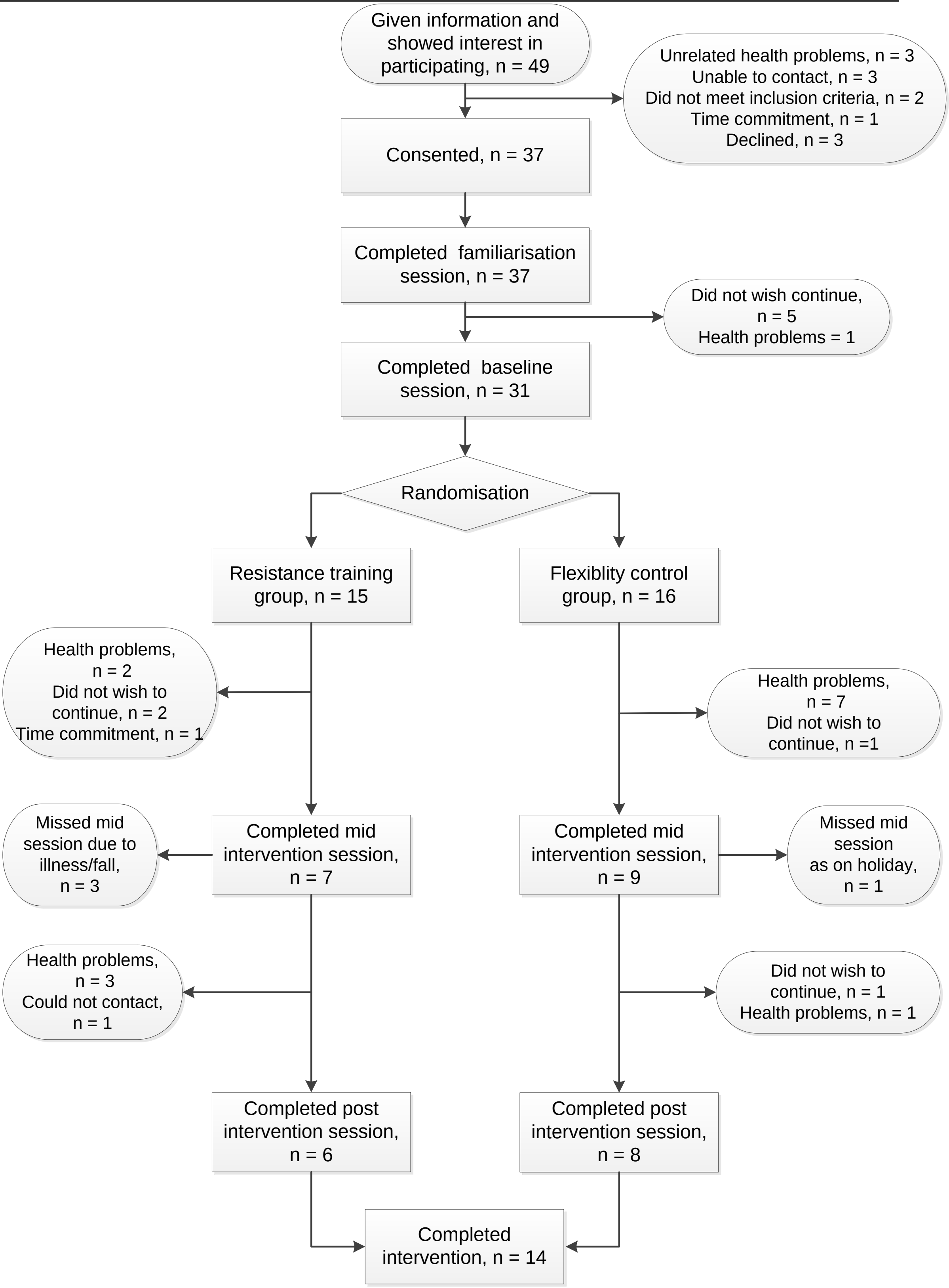


Figure 10.1 Flow diagram of Study 4 participant recruitment, drop-out and completion.

Exercise programmes

All exercise programmes lasted 12 weeks and were home based and self-directed. Permission to use photographs for exercise programme instruction booklets was obtained.

Resistance programme

The resistance training programme utilised latex free resistance bands to carry out six specified exercises designed to increase muscle strength from baseline to post-intervention assessments. There were five bands of increasing levels of resistance that could be progressed through over the course of the programme as participants strength increased. However, participants only reached band 2. Participants were asked to carry out the resistance training sessions three times per week throughout the twelve weeks to see an expected strength increase. The six specified exercises included arm extension, upper body rotation, arm raise, arm curl, knee extension and lunge which targeted several muscles groups across the body namely the pectorals, obliques, deltoids, biceps, quadriceps and gastrocnemius respectively. Participants were given a booklet to take home with written and illustrated instructions which were talked through at the baseline session. Each exercise was explained by the investigator and demonstrated where necessary.

Each session lasted approximately 30 minutes with a 5 minute warm-up beforehand and 5 minute cool-down afterwards. Participants were asked to gradually build up to performing three sets of 12 to 15 repetitions (reps) of each exercise with one minute rest in between. All participants began for the programme for at least 4 weeks using the lightest resistance band for all exercises. Once participants could performance 3 sets of 15 reps comfortably without strain for two sessions in a row, they could move onto the next band in the next session. Therefore, they could progress onto the next band for different muscles groups at different stages to optimise training. If they struggled with the next band (e.g. could perform less than 8 reps), then they could return to using the previous band. It was also explained to them that they could use a different band for different exercises if they progressed at different rates to optimise training. Participants were given an exercise diary in which to record the level of resistance band used in each session and the number of repetitions so that they could keep track of their progress. Participants were also asked for rate how difficult they found each exercise on the 10-point Borg Scale which captures rate of perceived exertion (Borg, 1982). Participants were also asked to indicate on a visual analogue scale how much they enjoyed the exercise each week.

All bands were standardised to arm length to ensure that the extension of each band was the equivalent for each participant. The bands were measured and cut so that when held out straight but not stretched, they reached from the participants outstretched arm to the centre of their chest with extra length for wrapping around their hands (similar to the procedure that was used in (Lachman, Neupert, Bertrand, & Jette, 2006). Resistance bands were chosen for this study for two reasons. First, they are considered to be provide similar weight standards to free weights in the early stages of training (Colado & Triplett, 2008). Second, they are safer and more compact for participants to store in their homes compared to free weights. Additionally, they are easily transportable so that location would not prevent participants from carrying out the exercises (for example, if on holiday) which encourages adherence.

Study 4 included participants who were frailer compared to those in Study 3. Therefore, adaptations were included for each exercise (e.g. a seated version) to suit the individual abilities of participants. This allowed participants to start gently and build up their strength gradually and safely. It was suggested to participants that they could progress from the exercises adaptations when their strength has increased and they felt comfortable doing so. The exercise adaptations included: (1) seated versions for the arm extension, upper body rotation, arm raise, arm curl exercises; (2) sitting in a chair as opposed to on the floor for the knee extension exercises; and (3) holding onto a chair instead of using the band for the lunge exercise.

Flexibility programme

The flexibility programme acted as an active control. This was to control for the level of mental stimulation that following instructions and learning how to carrying out new exercises involved. Study 2a indicated the independent association of mental activities with cognitive ability, which other studies have also found (Karp et al., 2006), therefore it was important to control for this. The flexibility programme involved yoga-type stretching exercises (Currie, 2002). These included: the energising breath (gently stretching neck by raising chin), sideways stretch, the mountain pose (clasping hands together and lifting them above head), pose of a cow (one hand above shoulder reaching down back and the other behind back reaching up aiming to join hands), thigh stretch, simple twist, back stretch, pose of a cat (hunching and straightening of back), and single knee hug. As with the resistance training programme, exercises were also carried out three times per week for 12 weeks. Each session also lasted approximately 30 minutes with a 5 minute warm-up beforehand and 5 minute cool-down afterwards. This programme also targeted several muscle groups but did not aim to increase strength. Participants were given a booklet to take home with written and illustrated instructions which were talked through at the baseline session.

The flexibility programme was designed to act as an active control group to account for the effects of mental stimulation from taking up a new activity whilst not targeting cognition (flexibility and stretching programmes have been used as control groups in other intervention studies and showed no effect on cognitive performance, (Cassilhas et al., 2007; Colcombe et al., 2004; Kramer et al., 2001; Madden, Blumenthal, Allen, & Emery, 1989; Moul, Goldman, & Warren, 1995; Smiley-Oyen, Lowry, Francois, Kohut, & Ekkekakis, 2008). Participants were given an exercise diary in which to record how long they each stretch and how many times so that they could keep track of their progress. Participants were also asked to rate how difficult they found each exercise on the 10-point Borg Scale which captures rate of perceived exertion (Borg, 1982). Participants were also asked to indicate on a visual analogue scale how much they enjoyed the exercise each week.

As with the resistance training, the flexibility programme also included adaptations for frailer participants in Study 4 who were unable to carry out the versions of the exercise used in Study 3. These included: (1) holding onto something steady or sitting down for the energising breath (gently stretching neck by raising chin), sideways stretch, the mountain pose (clasping hands together and lifting them above head), pose of a cow (one hand above shoulder reaching down back and the other behind back reaching up aiming to join hands); (2) sitting in a chair rather than on the floor for thigh stretch, simple twist, back stretch, (3) carrying out thigh stretch one leg at a time; (4) pose of a cat carried out standing resting hands on a chair rather than on knees on the floor; and (5) single knee hug could be carried out lying on a bed rather than on the floor.

Maximising adherence to the programmes

The issue of adherence in exercise programmes was discussed in Chapter 1. The level of attrition has been suggested to often exceed 50% in exercise studies (Dishman & Buckworth, 1997). Additionally, the number of completed sessions for those who do finish the programme can also be low (Brown, Liu-Ambrose, Tate, & Lord, 2009). Therefore, a number of strategies were used that have been previously effective in increasing adherence to exercise programmes. These included: education about the benefits of the exercise programme, support to overcome perceived barriers, goal setting, and self-monitoring (Jones & Rose, 2005).

Education about the benefits of exercise, anticipatory guidance of potential barriers to exercising, and strategies to overcome barriers was found to improve adherence (Keele-Smith & Leon, 2003). Prior to starting the intervention, the investigator explained to each participant about the benefits of the exercise programme. The benefits included personal fitness as well as their participation in terms of the whole research project. They were also promised a letter explaining the results of the study.

Support to overcome perceived barriers was provided through regular contact between the investigator and participants. For example, for resuming the exercise after illness participants were told to start gently by doing fewer reps or using a lighter resistance band. The investigator phoned the participant approximately once a month and the participant was also encouraged to phone the investigator if they had any issues with the exercise program.

Goal setting and self-monitoring have been found to increase adherence (Chao et al., 2000; Duncan & Pozehl, 2002; Pinto et al., 2009). These strategies can increase self-efficacy (e.g. Pinto et al., 2009) which predicts time, effort, and persistence of behaviours (Bandura, 1978). Barring health factors, self-efficacy has been found to exert a powerful influence on exercise behaviour of older adults, (Brassington et al., 2002; McAuley et al., 1993; Resnick, 2001). Participants were asked to keep a record of their exercise sessions in the diary provided. This included details about how many reps of resistance exercises were performed or how long they held flexibility stretches. They were also asked to rate how difficult they found each exercise. This allowed participants to monitor their progress. Participants were not asked to write down their goals, however, their individual targets were discussed with the investigator over the phone and during the 6-week session (e.g. when they would move onto the next level of resistance band). Initially it was planned that participants would be asked to set goals with a view to providing tangible feedback for progress. They would be asked to write down specific goals with time frame for completion. They would also be asked on a visual analogue scale to what extent they though it will be possible to achieve the goal (given any practical or physical limitations) and how much they wanted to achieve the goal. Subsequently, they would be asked to indicate on another visual analogue scale to what extent they achieved this goal. However, this was not feasible due to the large amount of information that needed to be given to participant during the baseline session, regarding how to perform the exercises, in addition to carrying out the cognitive and physical assessments.

Exercise diaries

Participants were asked to carry out the exercises three times per week. However, if they were unable to carry out the exercises for some reasons then they were asked to note this in the diary. They were asked to fill out the diary honestly and accurately. This allowed adherence to be assessed so that it could be controlled for in analysis if necessary. Participants were also asked to make a note of any other physical activities they carried out besides those in the programmes, including the type and intensity based on the Borg Scale. Participants were also asked weekly at the bottom of the page for each week to indicate on a visual analogue scale (10 centimetres), how much they enjoyed the exercises during that week.

Safety considerations

The training programmes were designed to be suitable for sedentary middle- to older-aged adults with adherence to the guidelines on prescribing exercise programmes from the American College of Sports Medicine (Brubaker et al., 2006) and also with the guidance of a trained geriatric exercise physiologist (Dr R Ferguson). In addition to the instruction booklet with photos and written instructions, all participants underwent a training session with the investigator at the end of the baseline session. All exercises were talked through and demonstrated where necessary to ensure that participants understood how to carry out them out safely at home. Participants were encouraged to phone the investigator if they had any further questions regarding how to carry out the exercises at home. The importance of carrying out the warm-up and cool-down was emphasised and participants were instructed to prioritise these over the resistance/flexibility exercises when they were short on time. Participants were advised to start the exercises very gently and gradually build up to carrying out more repetitions or stretching further. They were reassured that performing a small number of repetitions to start with was fine to ensure that they did not overdo it to begin with. Participants were instructed to stop carrying out the exercises if initial muscle ache persisted or they became ill or injured at any point.

Randomisation

Randomisation procedures were included in this feasibility study to assess participant willingness to be randomised into exercise groups. Stratified randomisation was used for gender and age groups to minimise group differences. Block randomisation was used to ensure similar number of participants in each group (Altman & Bland, 1999). Blocks of two were computed using an online random number generator. Exercise group allocation was concealed from the investigator during the participant recruitment process by another researcher not involved in the study who enclosed the numbers in opaque envelopes (Altman & Schulz, 2001).

Feasibility assessments

A range of measures and participant feedback were used to assess feasibility. These included participant recruitment and randomisation, drop-out rates, level of adherence to exercise programmes, tolerance and enjoyment of exercise programmes, tolerance of assessment sessions, and variance of cognitive outcome measures. Participant feedback including verbal comments during assessment sessions and phone contact were also included.

Cognitive outcome measures

A range of cognitive outcome measures were included which assessed different domains of cognitive ability. This is because it is not clear which domains of cognitive ability are affected by exercise interventions are domain specific results are not consistent across studies or even between meta-analyses (discussed in Chapter 1). Cognitive test selection was based on: previous effects demonstrated in exercise intervention or physical activity longitudinal studies, accessibility of measure; and ease of administration i.e. suitable for use in older adult populations and short in duration.

Global cognitive ability

The MMSE (Folstein, Folstein, & McHugh, 1975) was used to screen for dementia. It assesses global cognitive ability and can be used to indicate cognitive impairment. It utilises a question-answer format and measures orientation, registration (immediate memory), short–term memory, attention, calculation and language functioning. Scores of less than 27 generally considered to indicated cognitive impairment with a sensitivity and specificity of 0.89 and 0.91 respectively (O'Bryant et al., 2008).

Memory

The Hopkins Verbal Learning Test (HVLT; Brandt, 1991) assesses short-term verbal memory. The HVLT assesses verbal short-term memory and involves a list of 12 words being read out aloud to the participant which they are asked to recall. This is done three times consecutively using the same list of words. There are standardised instructions for this test and words are read out loud at a speed of approximately one word per second. Participants were then asked to recall as many words from the list as they could. Scoring high on this test requires the recruitment of memory strategies, such as chunking the words into categories. This provides the advantage of no ceiling effects as healthy controls do not scores full marks (Hogervorst et al., 2002). The HVLT Trial 1 score was included in addition to the total immediate recall score as an outcome measure in these studies as it has been found to measure memory abilities affected by Alzheimer's disease (Clifford, 2012). It also has acceptable test-retest reliability estimates (0.75) in healthy older adults (Wesnes, 2012).

The Verbal Fluency task involves word generation and recruits neural network particularly implicated in semantic memory (Kitabayashi et al., 2001). Deficits in word generation have been demonstrated in those with dementia (e.g. Taler & Phillips, 2008). The Verbal Fluency task involves participants naming as many words as they can that belong to a specified category in on minute. Category (semantic) fluency was used as it shows higher sensitivity and specificity to dementia compared to letter (phonemic) fluency which involves words that begin with a certain letter of the alphabet (100% [specificity 92.5%] v 89% [specificity 85%], respectively; (Cerhan et al., 2002;

Monsch et al., 1992). The commonly used category of “animals” was used for baseline, mid- and post-intervention assessment. An alternative validated category of clothes was used for the familiarisation session (Cunje et al., 2007). Good test-retest reliability (0.83) has been reported in older adults with and without Alzheimer’s disease for category fluency (Solomon et al., 1998).

Executive function

The Trail Making Test (TMT; Reitan, 1955) was used to assess executive functioning. It consists of two parts (A and B) and involves concept shifting. In TMT Part A, participants are given a series of randomly positioned circled numbers (1-25) that they are asked to connect in ascending order (1-2-3-4 and so on) by drawing between them as quickly as they can without taking the pencil off the paper. This serves as a baseline measure of psychomotor speed and visual scanning. In TMT Part B, participants are circled numbers (1-13) and letters (A-L) and asked to connect them by alternating between ascending numbers and letters (1-A-2-B-3-C-4 and so on). The time taken to complete each part is recorded. Part B has the added cognitive component of task switching which results in slower times to complete and more mistakes. The extra time taken to complete Part B is the interference effect which is calculated by subtracting the time taken to complete Part A away from the time taken to complete Part B. Individuals with cognitive impairment and dementia have difficulty with Part B with longer time taken to complete and more errors with dementia severity (Ashendorf et al., 2008). The TMT appear to have moderate test-retest reliability coefficients. For example, a TMT reliability coefficient of <0.65 was found in older adults (Wesnes, 2012). However, these assessments were carried out over the course of 1 year which could have allowed some cognitive decline as a confound.

Processing speed

Tests that assess processing speed and working memory due to the evidence of depressive symptoms on performance (Brown et al., 2013; Halvorsen et al., 2012). The Digit Symbol Modalities Test (DSMT; Smith, 1982) is a practical measure of processing speed presented in the visual modality. It is a pen and paper task in which participants are presented with nine numbers which are paired with unique symbols in a key. Below the key are numbers with empty space below each one. Participants are asked to draw the corresponding symbol for each number in the box below it.

Participants are first given non-timed practice of 10 numbers. Then they are asked to complete as many as they can in 90 seconds. It is scores by counting the number completed correctly.

Working memory

Working memory was tested using forwards and backwards components of the digit span as used in the Wechsler Adult Intelligence Scale-III (The Psychological Corporation, 1997). Each component is made up of six pairs of number sequences which are read aloud by the researcher. For the digit span forwards, participants are asked to repeat the sequence of numbers in the same order. For the digit span backwards, participants are asked to repeat the sequence of numbers in the reverse order. Digit span forwards targets the phonological loop and participants may use strategies such as chunking, which involves grouping pairs or small groups of numbers together. The digit span backwards targets the visual spatial sketchpad and central executive processes of working memory and is more challenging. When participants correctly repeat a sentence, the research reads out a sequence which is longer by one more digit. If the participant fails to repeat a sequence correctly, a second sequence of the same length is read out. If the participant fails to repeat the sequence correctly again, then the test is stopped. If the participant repeats it correctly, the researcher moves onto the next length of sequence. The digit span is useful in intervention contexts as it is not affected by ceiling effects. It also has good test-retest reliability with coefficients ranging from 0.66 to 0.89 (Matarazzo & Herman, 1984; Snow et al., 1989).

Physical measures

Physical measures were assessed at baseline, mid-intervention, and post-intervention. Increase in level of resistance in strength training over the course of an intervention was found to predict memory improvement, after controlling for age, education, gender, and disability level (Lachman et al., 2006). Therefore, strength was included to see whether it was associated with cognitive outcomes. It was also included to see whether it was associated with increases in self-efficacy.

Grip strength was measured using a handheld dynamometer as increases have previously been found to be related to better cognitive ability and lower risk of MCI and

Alzheimer's disease (Atkinson et al., 2010; Boyle et al., 2009; Buchman et al., 2007). This was measured in both hands twice and the mean was taken from the highest score from each hand. Leg muscle strength was assessed using the get up and go test measures the time taken to rise from a chair, walk three metres, turn 180 degrees, walk another 3 metres and sit down in the same chair and was used as a proxy for lower body strength.

Other physical measures included: blood pressure and heart rate, height and weight to calculate Body Mass Index (BMI), and Waist and hip circumference. Additionally, participants were asked to wear a pedometer for one week (when logistically possible) to give an indication of physical activity levels prior to starting the intervention. This was repeated at the end of the intervention to assess knock-on effects of the intervention for increasing overall physical activity which could confound results. Pedometers were sealed so that participants could not see how many steps they had done, as this has been shown to increase the number of steps per day (Rooney et al., 2003). Saliva samples were collected from participants pre and post intervention, first thing in the morning before they had anything to eat or drink to test for cortisol and free testosterone (not analysed in the present thesis).

Self-reported health

The EuroQol's EQ-5D-5L health-related quality of life measure was used to capture health (Herdman, et al., 2011). It has been validated in a diverse patient population across 6 countries, including 8 patient groups with chronic conditions (cardiovascular disease, respiratory disease, depression, diabetes, liver disease, personality disorders, arthritis, stroke) and a student sample. Redistribution of responses to the EQ-5D-5L from a previous version (EQ-5D-3L) with fewer response levels was validated for all dimensions and all levels. The measurement properties of EQ-5D-5L were superior to the EQ-5D-3L in terms of feasibility, ceiling effects, discriminatory power and convergent validity. The scale is made up of two parts. The first part indicates participants' functional health across five domains: mobility, self-care, usual activities, pain/discomfort, anxiety/depression. Each domain consisted of one question that was scored on five dimensions which indicate level of functioning or distress. The five levels included: no problems, slight problems, moderate problems, severe problems, and extreme problems. This 5-level version had significantly increased reliability and sensitivity while maintaining feasibility and reducing ceiling effects compared to a previous version with only three response dimensions. The second part of the EQ-5D-5L captures subjective health using a 0 - 100 visual analogue scale which is used alongside the EQ-5D-5L. Participants were asked how good their health was ‘today’, with 0 indicating the worst possible health and 100 indicating the best possible health. There is evidence for its independent predictive value of age of death (Idler & Benyamini, 1997).

Psychosocial measures

Psychosocial questionnaires were selected based on their previous use in health and ageing contexts and also their suitability for use in older adult populations. Short versions of questionnaires were included where available to minimise fatigue and maximise completion.

Attitudes towards ageing

The Attitudes to Ageing Questionnaire (AAQ; Laidlaw, Power, Schmidt, & Group, 2007) was used to capture participants attitudes towards ageing at baseline and post-intervention. It was used in Study 3 and demonstrated independent effects on self-reported health. The AAQ has been validated cross-culturally has good internal consistency (0.74 to 0.81). It is made up of three subscales: psychological growth (e.g. “As people get older they are better able to cope with life”), physical change (e.g. “Problems with my physical health do not hold me back from doing what I want to”), and psychosocial loss (e.g. “Old age is a time of loneliness”). The subscales allowed domains of attitudes towards ageing to be analyses individually, rather than as a whole. The psychosocial loss subscale was reverse scored so that a higher score on each subscale indicated a more positive attitude towards ageing in each domain.

Perceived control

Perceived control was captured using the dispositional trait hope scale (Snyder et al., 1991), which has previously been used to assess control beliefs as a mediator of the effect of age-related cognitions on health in later life (Wurm et al., 2007). It was also used in Study 3 to assess the effect of perceived control with attitudes towards ageing on self-reported health. The scale consists of 12 items and is made up of two subscales (agency and pathway with four items each) and four distracter items.

Responses are coded on an 8-point continuum (1 = “definitely false”, to 8 = “definitely true”). The agency subscale consists of efficacy expectancies reflecting the belief in one's capacity to initiate and sustain actions to achieve goals e.g. “I energetically pursue my goals”. The pathway subscale consists of outcome expectancies reflecting belief in one's capacity to generate routes and strategies to reach goals, e.g. “There are lots of ways around any problem”. The agency and pathways subscales were previously found to be related but separate consistently (correlations of .40 to .50) with an overarching hope factor (Babyak, Snyder, & Yoshinobu, 1993). The scale was shown to be internally reliable (alphas of .74 to .88) and temporally stable (test retests over several weeks of .85).

Mental health

The short-form Geriatric Depression scale (GDS; Yesavage et al., 1983) and Geriatric Anxiety Inventory (GAI; Pachana et al., 2007) were used to assess mental health. Scores on the GDS above 5 are considered to indicate depression. The GDS 15 has previously shown a high level of internal consistency (Cronbach's alpha = 0.80; D'Ath, Katona, Mullan, Evans, and Katona, 1994). Scores above 10 or 11 on the GAI have been found to indicate generalised anxiety disorder. Higher scores indicate higher levels of anxiety. Cronbach’s alpha for internal consistency on the GAI was good (.91) among healthy community-dwelling older adults (Pachana & Byrne, 2012). The WHO well-being index (WHO-5) was also included to capture a positive dimension to mental health (Heun, Bonsignore, Barkow, & Jessen, 2001). This scale is made up of five items which are scored on a four point Likert scale and higher scores on this scale indicate better well-being. This scale and has been validated for use with older adults and showed good external and internal validity (Mokken coefficients >.4)

Self-efficacy

A number of questionnaires were used to assess different types of self-efficacy. Perceived physical ability was assessed using the 10-item Perceived physical ability (PPA) subscale of the Physical Self-Efficacy scale (PSES; Ryckman, Robbins, Thornton, & Cantrell, 1982). The 10 items reflect strength, agility, reflexes, and physical condition and participants indicate the extent to which they believe each item reflects their own capabilities. Each item is scored on a 6 point scale from strongly disagree to strongly agree. This measure was appropriate as it had been used in an older adult population before (McAuley et al., 2000) and certain items had been modified to ensure the questions were appropriate. The item "I can run fast" was altered to "Walking up and down the stairs is easy for me" to reflect the physical activity abilities. Higher values indicate a better perceived physical ability. The internal consistencies have been found to be acceptable in older adults (>.80; McAuley et al., 2000).

Memory Self-efficacy was assessed with the General Memory Efficacy scale (GME; West, Dark-Freudeman, & Bagwell, 2009) and the Frequency Of Forgetting Scale (FOF-10; Zelinski & Gilewski, 2004). The GME is a simple questionnaire and quick to complete. It consists of four items, the first item on the GME is just a "setup" item ("How important has it been to you to perform well on memory activities in your everyday life?") to get people thinking about the importance of memory, before answering the other three. The total scale score is the sum of the last three items (e.g. "How do you think your memory compares with most other people your age?"). The 10-item FOF-10 scale assesses memory self-efficacy. It was developed from responses to the 33-item FOF subscale from the Memory Functioning Questionnaire (MFQ). The 10-item version takes less time to complete but is highly correlated with the original 33-item version and is also associated with the same predictors and has similar construct validity. A higher score on both measures indicates better perceived memory.

The General Self-Efficacy scale (GSE; Schwarzer & Jerusalem, 1995), The scale assesses a general sense of perceived self-efficacy and aims to predict coping with daily hassles as well as adaptation after experiencing all kinds of stressful life events. Responses are made on a 4-point scale from "not true at all" to "exactly true" and higher total scores indicated higher general self-efficacy. Items refer to successful coping and imply an internal and stable attribution of success in terms of goal-setting, effort investment, persistence in face of barriers and recovery from setbacks. It has been described as a positive resistance resource factor. Example items include "I am confident that I could deal efficiently with unexpected events" and "I can always manage to solve difficult problems if I try hard enough". It has been shown to have good internal consistency (0.76-.90).

Procedure

Enrolment

Details of the intervention procedure are illustrated in Figure 10.2. As part of recruitment, individuals who showed an interest in taking part were given an information sheet about the study which included details about what taking part would involve and contact details of the investigator. Their contact details were also taken and they were phoned a few days later to see if they had any questions. If they wanted to volunteer to participate, a familiarisation session was booked.

Familiarisation session

The familiarisation session was arranged for approximately one week before baseline and was expected to last between 30 to 60 minutes. The cognitive tests were carried out so that the participants could familiarise themselves with them to reduce anxiety and learning effects. Significant learning effects were found on these tests between the first and second time they were carried out, but not between the second and third time (Clifford, 2012). Thus, the familiarisation session minimised confounding learning effects during the exercise intervention. The word ‘test’ was not used to refer to the cognitive tests and participants were reassured that they should not worry and to just try their best. During the familiarisation session the demographic and health questionnaire was completed by participants. Participants were also given a salivette to provide a saliva sample on the morning of the baseline session.

Baseline session

During the baseline session, participants completed the cognitive tests followed by the psychosocial and lifestyle questionnaires. When they had been sitting quietly for 10-15 minutes their blood pressure was taken, followed by the other physical measures. Finally, participants were assigned to their exercise group and given their instruction booklet and diary. The exercise instructions were talked through and demonstrated where necessary. An example entry for the diary was also talked through to ensure they understood how to fill it in at home. The participants were asked if they had any questions and were encouraged to phone the investigator if they thought of any while at home. Participants were not informed that they were in a control group for the flexibility programme. Instead, all participants were informed that the study was investigating the benefits of different types of exercise to keep expectations for outcomes consistent between groups. This session was expected to last between 90 to 120 minutes.

Continuation of the programme at home and mid-intervention session

Participants began the exercise programme at home immediately after the baseline session. Participants were phoned after a few weeks to see how they were getting on and to arrange the mid-intervention session after 6 weeks of the exercise programme. The cognitive test, questionnaires and physical measures were carried out and the session was expected to last approximately 60 to 90 minutes. Participants were asked how they were getting on with the exercise programme and asked if they had any issues. Participants were also asked to bring their exercise diaries and progress was discussed.

Post-intervention session

After 12 weeks, participants had completed the exercise programme and met with the investigator for their last session. Participants brought with them their saliva sample taken that morning and completed the cognitive tests, questionnaires and physical measures. This session was expected to last approximately 60 – 90 minutes. Participants were invited to be interviewed about their experience of the exercise programme (Study 8).

All sessions were carried out at either the participants' residence or the University. Where possible, sessions were booked for the same time of day for each participant to control for circadian effect on outcome measures.

Week Session	-2 (approx.) Recruitment	-1 (approx.) Familiarisation	0 Baseline	6 Mid-intervention	12 Post-intervention
Details of session	Information sheet	Informed consent Cognitive tests Health and demographic questionnaire	Cognitive tests Physical measures Psychosocial and lifestyle questionnaires	Cognitive tests Physical measures Psychosocial and lifestyle questionnaires	Cognitive tests Physical measures Psychosocial and lifestyle questionnaires

Figure 10.2 Details of intervention session procedure including order that cognitive tests were carried out.

Statistical analysis

Mann-Whitney U and Chi-square tests were used to assess differences between groups at baseline. Correlations were carried out between all variables at baseline. Non parametric correlations (Spearman's rho) were utilised due to the small sample size and non-normally distributed data indicated by histograms. Residualised baseline cognitive scores were used to control for age differences. Spearman correlations were also carried out between residualised change scores of all variables, controlling for baseline. Residualized change scores were used for analysis as they adjust for baseline variance by using residuals from linear regressions of post-intervention scores on pre-intervention scores. They are viewed as superior to simple pre-test – post-test difference scores (Veldman and Brophy, 1974) and are referred to as "base-free" measures of change (Tucker et al., 1966) that are independent of the pre-score. They were also appropriate to use due to the ceiling effects in some cognitive tests and floor effects in some questionnaires. For example, participant who scored highly on a measure at baseline would have less scope to improve on this compared to a participant who scored low at baseline.

Correlation analyses involved a large number of tests, which would have increased the chance of Type I error (false positive results) if $p = .05$. Therefore, for correlation analysis with a larger number of statistical tests, a p value of .01 was utilised. More conservative methods were considered, such as Bonferroni correction or Holmes sequential. However, these corrections are considered to increase the probability of Type II errors (false negative results) (Perneger, 1998). This is particularly the case when the multiple tests being carried out are related to each other and thus not independent tests which require full correction.

Winsorizing was carried out on TMT interference scores (for one participant) when inspection of the TMT interference z scores indicated that one participant was considerably slower than other participants (>2 standard deviations). The TMT is a timed test and therefore participants who make mistakes can often take a much longer time to complete the test. Participants who took a much longer time to complete Part B scores compared to Part A had a much larger TMT interference scores. Interference scores were winsorized to reduce their weight and leverage. This was done by replacing the observed score with the next highest score from another participant.

Independent Mann-Whitney U tests of difference were used to assess whether one exercise group improved significantly more on psychosocial measures. Paired Wilcoxon tests of difference were used to assess differences between pre- and post-intervention changes on psychosocial measures. Mann-Whitney U tests of difference were used in post-hoc analysis between exercise groups to assess differences on psychosocial measures to compare participants who improved on cognitive outcome measures compared to those who did not. Due to the non-linear effect indicated by plot, these analyses were separated for baseline to 6-week follow-up and 6-week to 12-week follow-up. Further Mann-Whitney U tests of difference were used to assess baseline differences on cognitive, psychosocial and physical measures between participants who dropped out compared to those who completed their exercise programme. Spearman correlations were used to assess the association between number of exercise sessions completed or attempted and baseline cognitive, psychosocial and physical measures. Spearman correlations were also used to assess the association between mean level of weekly enjoyment and number of exercise sessions completed or attempted. Paired Wilcoxon tests of difference were also used to assess knock-on effects of the exercise interventions on differences between pre- and post-intervention changes on physical measures, self-reported health and mean number of steps measures by a pedometer. These analyses were carried out as a whole group initially then stratified by exercise group.

Results

Descriptive statistics

Participant characteristics and baseline cognitive test scores are shown in Table 10.1 for the whole sample that started the exercise interventions, and separated by exercise group for those who completed the programmes. Table 16.1 shows baseline psychosocial measures, self-reported health, physical measures and mean number of steps per day for the whole sample that started the exercise interventions, and separated by exercise group for those who completed the programmes. There were no significant differences between exercise groups for age, education or smoking status. However, participants in the flexibility group scored significantly higher at baseline on verbal fluency compared to those in the resistance group (z = -2.2, p = .02). This difference represented a medium effect size (r = .6), using Cohen’s (1992) criteria (.2 = small effect; .5 = medium effect). There were no other significant differences between exercise groups on other cognitive tests. There were also no significant differences between exercise groups on any psychosocial, self-reported health or physical measures.

Table 10.1 Baseline demographic information, cognitive ability, psychosocial, and physical measures and self-reported health at baseline.

Variable	Whole sample (starters)	Exercise Group (completers) Resistance	Exercise Group (completers) Flexibility
n	31	6	7
Age	80.3 (9.8) 60-94	82.8 (7.7) 70-90	76.7 (9.4) 62-88
Female, *n*	26	5	6
Regular smoker, n	1	1	0
Education completed; n			
≤Secondary	19	5	1
≥College/University	11	1	6
Cognitive ability			
MMSE	28.3 (1.1) *25-30*	28.3 (0.8) *27-29*	29.1 (0.7) *28-30*
HVLT trial 1	5.5 (1.1) *0-9*	5.2 (2.6) *0-7*	6.4 (1.8) *4-9*
HVLT total	22.0 (5.5) *7-31*	18.7 (7.4) *7-27*	23.0 (5.8) *16-30*
Verbal Fluency	19.1 (6.3) *6-30*	17.2 (5.2) *12-25**	23.9 (4.0) *18-28**
TMT interference	45.0 (36.8) *7-173*	40.8 (17.8) *15-60*	30.5 (27.6) *7-90*
DSMT	43.6 (11.4) *25-69*	40.4 (11.8) *25-58*	50.4 (11.0) *27-62*
Digit Span Forwards	7.2 (1.1) *5-9*	7.2 (1.2) *6-9*	7.6 (1.0) *6-9*
Digit Span Backwards	4.8 (1.2) *3-8*	4.8 (1.6) *4-8*	5.4 (1.0) *4-7*
Attitudes towards ageing			
AAQ total	81.9 (11.4) *62-102*	83.9 (5.5) *78-91*	80.3 (6.5) *70-88*
Psychosocial loss	29.7 (5.1) *20-37*	30.0 (4.3) *23-35*	28.6 (5.6) *21-34*
Physical change	26.0 (6.5) *15-40*	27.7 (3.7) *25-34*	26.6 (4.9) *21-34*
Psychological growth	26.1 (3.9) *17-33*	26.2 (2.9) *21-29*	25.1 (3.9) *20-32*
Perceived control			
Perceived control total	47.7 (5.9) *36-57*	47.0 (3.0) *43-51*	48.2 (7.3) *39-57*
Agency	23.9 (3.7) *15-31*	23.3 (3.1) *20-27*	24.4 (3.6) *20-28*
Pathway	23.8 (3.4) *16-29*	23.7 (1.4) *22-26*	23.7 (4.1) *17-29*
Mental health			
Geriatric Depression Scale	3.2 (3.1) *0-11*	2.7 (1.5) *1-5*	2.6 (2.4) *0-6*
Geriatric Anxiety Inventory	4.2 (5.1) *0-18*	1.4 (1.5) *0-4*	6.2 (7.1) *0-18*
WHO-5 well-being	14.8 (4.8) *3-22*	14.2 (5.3) *7-20*	14.9 (4.0) *9-21*
Self-efficacy			
General Self-Efficacy	29.6 (5.4) *10-38*	28.4 (1.8) *26-31*	31.0 (3.7) *27-36*
Physical Self-Efficacy	30.0 (7.5) *12-44*	33.3 (3.1) *29-36*	30.8 (5.8) *23-37*
General Memory Efficacy	14.3 (2.7) *10-19*	13.8 (2.6) *12-19*	13.3 (3.1) *10-17*
Frequency Of Forgetting	47.7 (6.9) *36-63*	43.6 (6.4) *36-51*	48.0 (6.4) *39-58*
Physical measures			
Grip strength	18.8 (6.7) *6-33*	17.8 (5.6) *12-26*	20.5 (6.7) *13-33*
Get up and go test (seconds)	19.0 (29.1) *6-159*	18.9 (15.0) *6-42*	8.4 (3.2) *6-15*
Self-reported health			
Subjective health	74.1 (20.0) *20-100*	77.5 (8.2) *70-90*	80.4 (8.3) *68-90*
Functional health	.72 (.15) *.37-1.00*	.77 (.71) *.71-.88*	.80 (.12) *.65-1.00*
Physical activity			
Steps/day (pedometer)	3497 (3189) *520-13344*	1785 (1634) *520-4074*	5075 (2484) *889-8148*

Note: Mean (standard deviation) *range* displayed. Tests of difference (Resistance v Flexibility group) significant *p < .05.

Feasibility

A range of measures and participant feedback were used to assess feasibility. This included participant recruitment and randomisation, drop-out rates, level of adherence to exercise programmes, tolerance and enjoyment of exercise programmes, tolerance of assessment sessions.

Recruitment and randomisation

The recruitment of sheltered housing communities to participate in the study depended on permission by the appropriate warden or manager. There was a poor initial response from the letters that were sent out to them. When the researcher contacted wardens and managers by phone, the majority were happy for the researcher to attend a coffee morning or equivalent to give residents information about the study and what participation would involve. One reason given by wardens or managers for declining was that they already found it challenging to encourage residents to get involved in other ways and therefore this may hinder that further. Warden and managers were also happy for posters advertising the study to be put up on notice boards; however a very limited number of participants were recruited through this method and the majority of participants were recruited through face to face contact. The majority of older adults who volunteered to participate were female (83.8%).

Reasons given for not wishing to take part in the study included: time constraints related to carrying out the exercises, not wanting to fill out the questionnaires and a number of participants reported wanting to have an instructor present during the exercises as they were anxious that they would not be carrying out the exercise correctly and may cause injury.

Prior to enrolment, a number of participants expressed an interest in participating in a specific exercise group. However, once the reasons for randomisation were explained and they were told that after the 12 week programme was finished they could do the alternative exercise programme in their own time and would be provided with the necessary materials (e.g. exercise booklet, resistance bands), they were happy to be allocated into either exercise group.

Participant drop-out

A number of reasons were reported for participant drop-out. These included unrelated health problems or falls (n = 11), previous injury or conditions exasperated by carrying out the exercises (n = 2), and not wishing to continue (n = 1), for instance because of time constraints (n = 2) or were not contactable (n = 1).

The drop-out rate of participants was high with 54.8% of those who started the intervention not completing it. Independent tests of difference between those who dropped out of the intervention (n = 17) compared to those who completed the intervention (n = 14) were carried out. Those who completed the intervention had significantly higher self-reported functional health at baseline compared to those who dropped out (z = -2.02, p = .043). There were no significant differences in subjective health rating, grip strength, mean number of steps per day, or on the Get up and Go test at baseline. There were no significant differences between those who dropped-out or completed the intervention on attitudes towards ageing, perceived control, self-efficacy measures, or mental health at baseline. Participants who dropped-out scored significantly lower on the DSMT (z = -2.15, p = .032), MMSE (z = -2.336, p = .026), HVLT trial 1 (z = -2.08, p = .042) cognitive tests, and were also significantly slower on the TMT Part A (z = -2.76, p = .005) at baseline.

Adherence

The overall mean percentage of sessions attempted and completed for those who completed the intervention were 89.9% (range of 75 to 100%) and 85.1% (range of 67 to 100%), respectively. For the resistance group the mean percentage of sessions attempted and completed for those who completed the intervention were 88.9% (range of 78 to 100%) and 79.4% (range of 72 to 97%), respectively. For the flexibility group the mean percentage of sessions attempted and completed for those who completed the intervention were 90.2% (range of 75 to 100%) and 87.8% (range of 67 to 100%), respectively.

Spearman correlations were carried out between adherence to the exercise programmes (number of sessions completed and attempted) and psychosocial, cognitive, physical and self-reported health measures at baseline. There were no significant correlations between baseline cognitive test scores and number of sessions completed or attempted. Stronger grip strength at baseline was significantly correlated with a higher number of sessions completed (*rho* = .77, *p* = .007) and attempted (*rho* = .57, *p* = .035). Baseline self-reported health was not significantly correlated with adherence. Higher level of anxiety was significantly and positively correlated with number of sessions completed (*rho* = .73, *p* = .003) and attempted (*rho* = .74, *p* = .002). Mean level of weekly enjoyment was not significantly correlated with number of sessions completed and attempted.

Tolerance and enjoyment of exercise programmes

The majority of participants from both groups reported enjoying the exercises programmes. However, after 12 weeks some participants reported boredom due to the repetitive nature of the programme and lack of variation in exercises. This was more frequently reported in the flexibility group than the resistance group. Two participants reported that the arm raise resistance exercise caused them pain due to a previous injury. One of these participants dropped out due to this on the advice of their doctor and the other carried out an adapted version of the exercises which did not cause any pain.

On average, participants mean level of weekly enjoyment of the exercise programme was significantly correlated with baseline attitudes towards physical change with ageing (*rho* = .66, *p* = .011) but not change in attitudes. Mean level of enjoyment was not related to baseline or change scores on other psychosocial measures. Enjoyment was not significantly correlated with improvements in cognitive ability, self-reported health or physical ability.

None of the participants in the resistance training group proceeded beyond band level 2 out of 5 possible levels. This is in contrast to Study 3 with middle-aged participants, in which the majority progressed past level 2 and some up to level 5. Thus, age was further investigated as there was a wide age range in this sample. It was found that older participants reported different changes on psychosocial measures compared to younger participants. A trend significant correlation was found between age and residualised change (controlling for baseline) on the psychosocial loss subscale (*rho* = .55, *p* = .052), whereby, older participants were more likely to report an increase in positivity in attitudes related to psychosocial loss. A significant correlation was found between age and residualised change (controlling for baseline) on both the agency (rho = -.58, p = .037) and pathway (rho = -.68, p = .011) subscales, whereby, older participants were more likely to report a reduction in perceived control. Although there was no significant difference in age between exercise groups, the average age of participants in the resistance group (mean = 82.8, range = 70-90 years) was higher than participants in the flexibility group (mean = 76.7, range = 62-88 years).

Tolerance of assessment sessions

The majority of participants either reported feeling anxious or appeared anxious at some point during the cognitive assessment sessions. Therefore, familiarisation session was useful for reducing participants' anxiety regarding the tests as they knew what to expect and were more familiar with the researchers and the environment (if testing took place at the university). Participants frequently enquired during the testing sessions about feedback of their cognitive performance, however to ensure standardisation between participants specific feedback was not given. Participants were reassured not to worry and encouraged just to try their best. The duration of the assessment session varied widely and for some participants took an unexpectedly long time (between 30 minutes and up to 2 hours). Participants for which the session lasted longer may have experienced more fatigue.

Some of the participants reported dislike for filling out the questionnaires as they found it took a long time. Although the questionnaires were printed in large font with shaded alternating rows for tick boxes, participants with eyesight problems reported (n = 2) reported difficulty filling them out.

Physical health and activity outcomes of the exercise interventions

Participants were asked at the end of the final assessment session whether they had noticed any fitness improvements and the majority of participants from both exercise programmes reported noticing some improvement. This was described in relation to finding the exercises easier and also in relation to carrying out activities as part of everyday life.

A paired Wilcoxon test between the mean number of steps that participants did per day pre- and post-intervention indicated no significant difference (z = -.06, p = .953). A paired Wilcoxon test between participants pre- and post-intervention scores (whole sample of completers) indicated significant improvements on self-reported functional health as a result of the intervention (z = -2.26, p = .024) but not on other measured physical measures (grip strength and Get Up and Go test). When these analyses were repeated with participants in the resistance group only, there were still no significant improvements on these physical measures or self-reported health ($p >$ .05).

Baseline associations

Correlations were carried out between cognitive, psychosocial, physical, and health measures at baseline to assess associations prior to starting the exercise programmes.

Cognitive ability and psychosocial variables

Spearman correlations were carried out between residualised cognitive ability scores (controlling for age) and other variables at baseline. In the whole sample of starters, more positive attitudes related to psychosocial loss with ageing were correlated with better TMT interference scores (*rho* = -.54, *p* = .006) and better verbal fluency (*rho* = .51, *p* = .006). Higher perceived control on the agency subscale was also related to better verbal fluency (*rho* = .62, *p* = .001).

Psychosocial variables and physical and self-reported health measures

Spearman correlations were carried out between baseline physical measures and psychosocial variables. In the whole sample of starters, stronger grip strength was significantly correlated with more positive attitudes related to psychological growth with ageing (*rho* = .49, *p* = .007) and higher physical self-efficacy (*rho* = .48, *p* = .008). Faster performance on the Get Up and Go test was significantly correlated with higher physical self-efficacy (*rho* = .49, *p* = .009) and borderline significant with more positive attitudes related to psychological growth with ageing (*rho* = .49, *p* = .010). Spearman correlations were also carried out between self-report health measures and psychosocial variables. Better subjective health was significantly correlated with more positive attitudes towards physical change with ageing (*rho* = .63, *p* < .001), higher general self-efficacy (*rho* = .53, *p* = .003), higher physical self-efficacy (*rho* = .54, *p* = .005), lower levels of depression (*rho* = -.49, *p* = .007), and higher well-being (*rho* = .52, *p* = .003). Better self-reported functional health was significantly correlated with higher physical self-efficacy (*rho* = .69, *p* < .001).

Physical and self-reported health measures and cognitive ability

Spearman correlations were carried out between physical and self-reported health measures and residualised cognitive ability scores (controlling for age) baseline, however no correlations were significant.

Psychosocial measures

Spearman correlations were calculated between psychosocial variables. More positive attitudes towards ageing were significantly correlated with higher perceived control (total questionnaires scores: *rho* = .58, *p* = .001). More positive attitudes related to physical change were significantly correlated with higher physical self-efficacy (*rho* = .59, *p* < .001), lower levels of depression (*rho* = .58, *p* = .001), better well-being (*rho* = .70, *p* < .001) and was borderline significant with higher general self-efficacy (*rho* = .45, *p* = .010). More positive attitudes related to psychological growth with ageing were significantly correlated with higher well-being (*rho* = .50, *p* = .005). Higher perceived control on the agency subscale was significantly correlated with a lower perceived frequency of forgetting (*rho* = .58, *p* = .001) and higher well-being scores (*rho* = .53, *p* = .003). Higher perceived control on the pathway subscale was also significantly correlated with lower perceived frequency of forgetting (*rho* = .48, *p* = .009) and higher well-being (*rho* = .54, *p* = .002). Higher general self-efficacy was significantly correlated with higher well-being (*rho* = .60, *p* = .001). Higher general memory efficacy was significantly correlated with lower perceived frequency of forgetting (*rho* = .59, *p* = .001) and lower levels of depression (*rho* = .56, *p* = .001). Lower perceived frequency of forgetting was also significantly correlated with lower levels of depression (*rho* = .54, *p* = .009) and higher levels of well-being (*rho* = .60, *p* = .001). Lower levels of depression were significantly correlated with lower levels of anxiety (*rho* = .47, *p* = .009) and higher levels of well-being (*rho* = .73, *p* < .001).

Variance in cognitive outcomes measures

Figures 1.03 and 10.4 illustrate cognitive performance for each exercise group at baseline, mid-intervention, and post-intervention. These plots indicate large baseline differences between groups and large variance within groups at each time point, and some non-linear relationships over time.

There was a large variation of change scores across cognitive outcome measures within both exercise groups. Due to this and the small sample, the usefulness of analysing the data split by exercise groups was limited. Thus, the data was further investigated in terms of individual differences in change scores of cognitive outcome measures. Figures 10.5 and 10.6 illustrate the range of change scores on cognitive outcome measures. There appears to be a range of improvers and decliners regardless of groups. To illustrate the spread of change scores within each group more clearly, scatterplots were created (Figures 10.5 and 10.6). A limitation to be noted of these scatterplots is that multiple data points with the same values cannot be seen as they plotted in the same place, however the bar charts indicate when this is the case. HVLT Trial 1 change scores (Figure 10.5) demonstrated a bi-modal spread of change scores in the resistance training group with some participants showing larger improvements and others showing larger declines compared to the flexibility group, which demonstrates a narrower uni-modal spread of data. The change scores on HVLT total recall indicate a similar pattern of change scores.

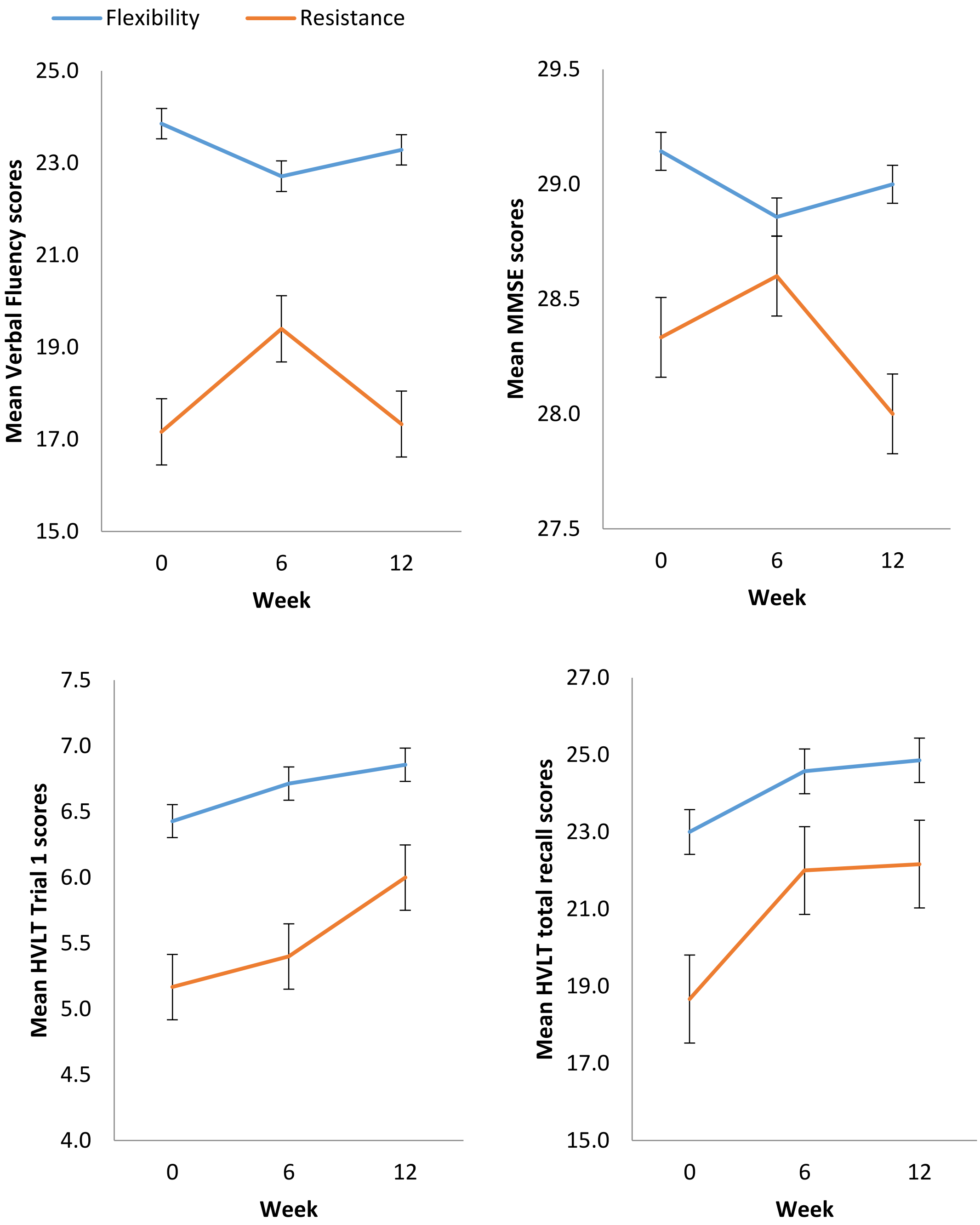


Figure 10.3 Cogntive outcome scores over 12 weeks of resistance and flexibility interventions

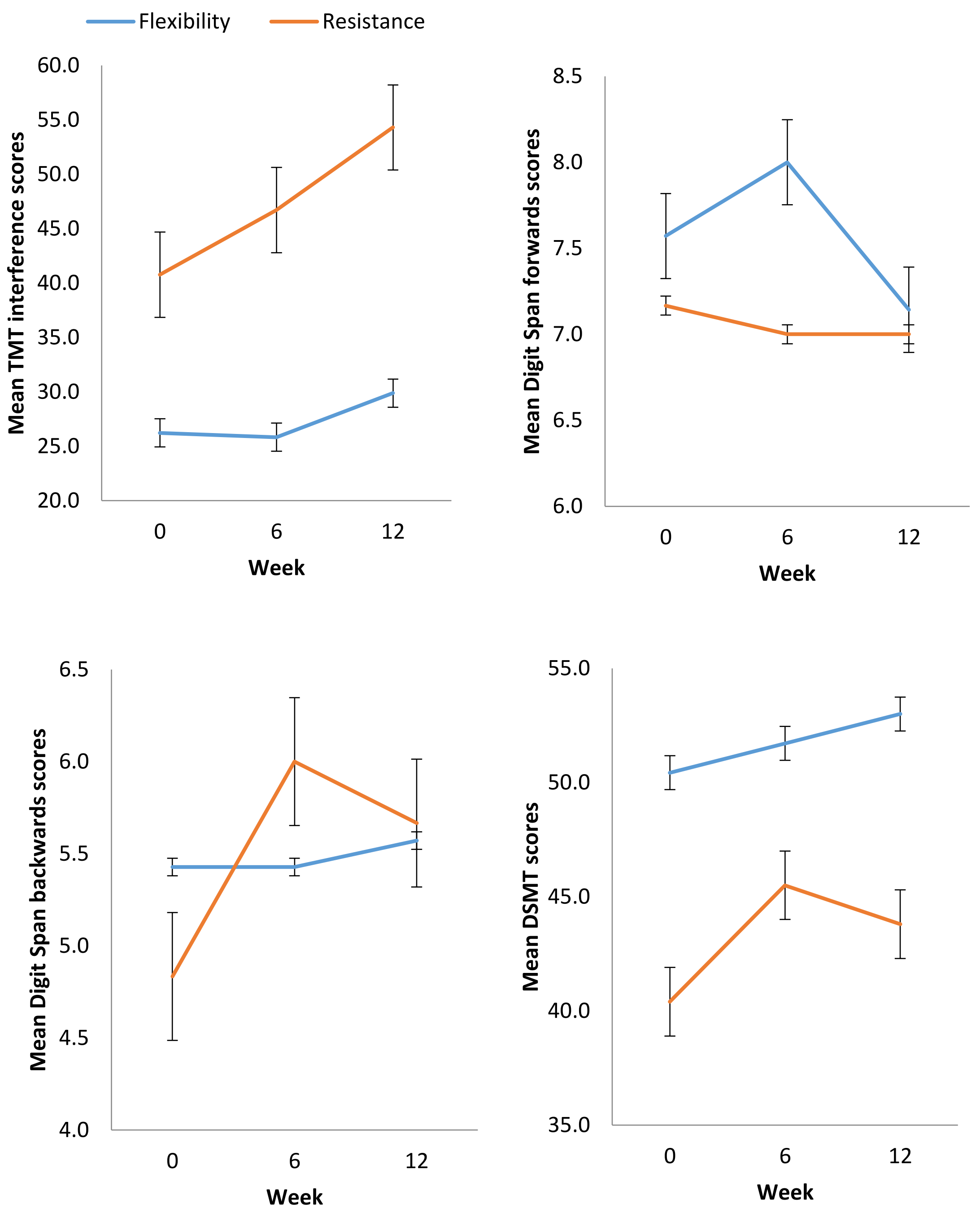


Figure 10.4 Cognitive effects over 12 weeks of resistance and flexibility interventions

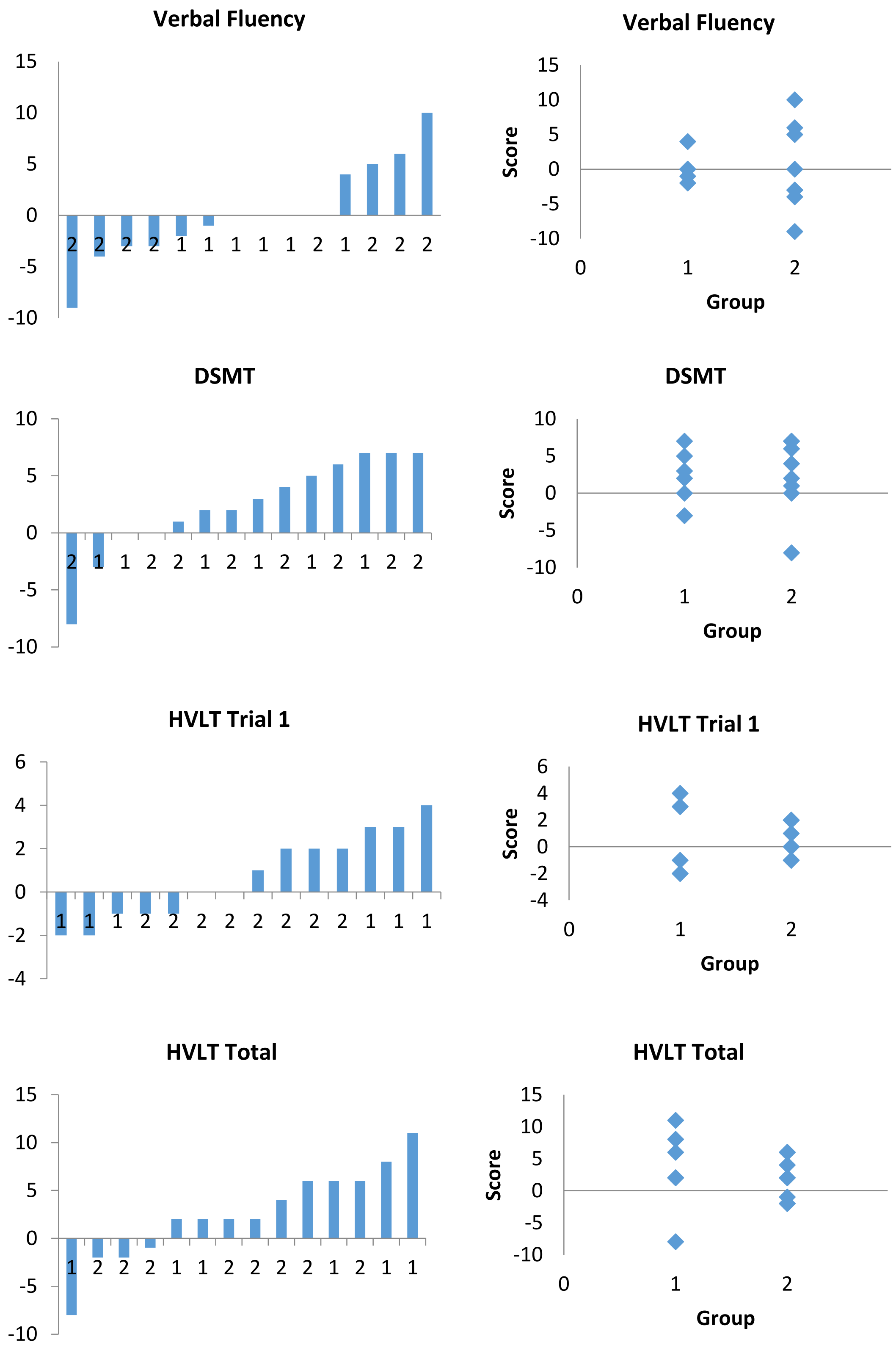


Figure 10.5 Bar chart and scatter plots of delta change scores on cognitive outcome measures from baseline to 12-week follow-up. Indicated on the x-axis, 1 = resistance group; 2 = flexibility group.

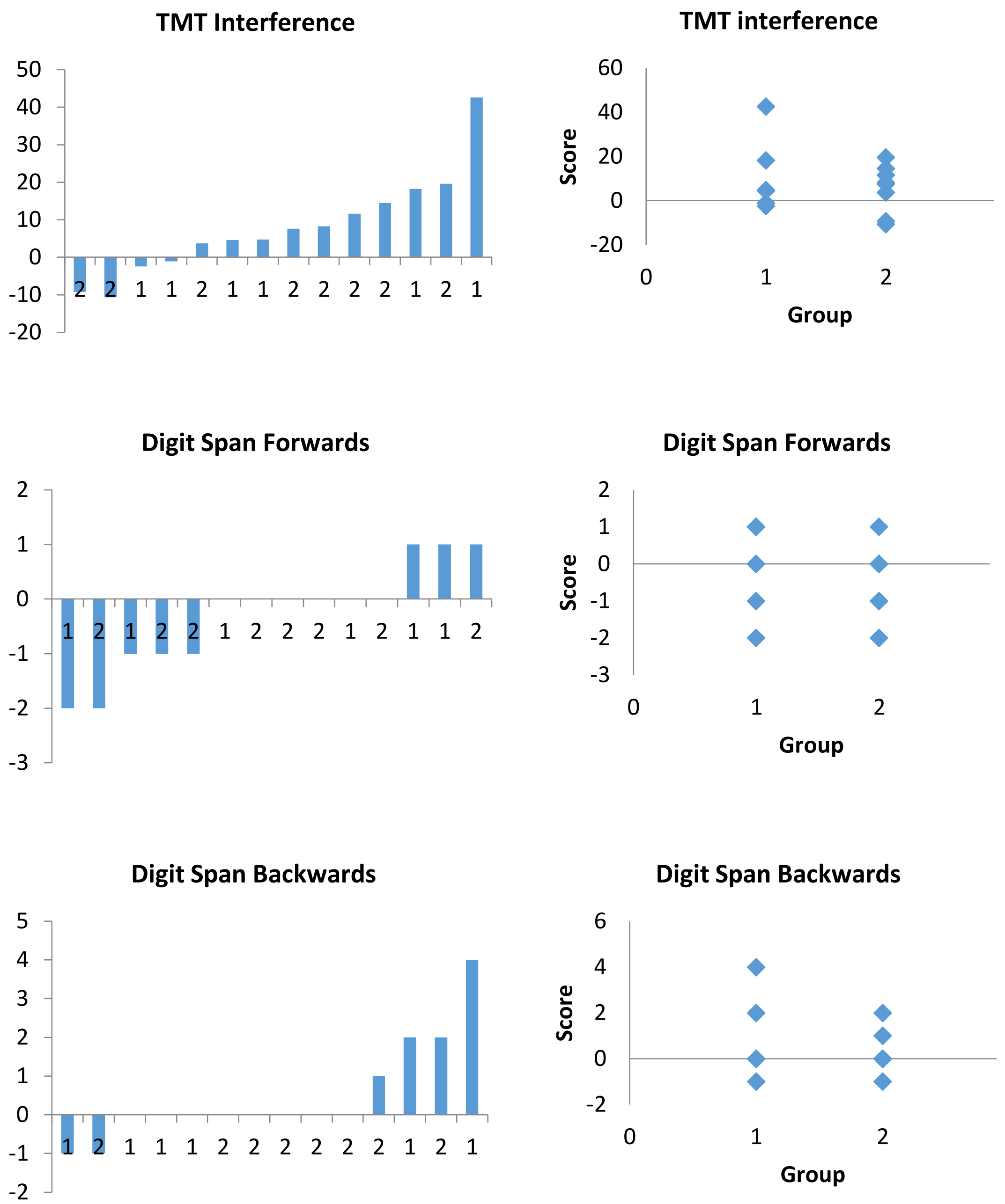


Figure 10.6 Bar chart and scatter plots of delta change scores on cognitive outcome measures from baseline to 12-week follow-up. Indicated on the x-axis, 1 = resistance group; 2 = flexibility group.

The role of psychosocial factors

Change on each psychosocial factor between exercise groups and from baseline to post-intervention was assessed.

Attitudes towards ageing

There were no significant differences between exercise groups on residualised change scores (controlling for baseline) of any attitudes towards ageing subscales ($p > .05$). However, participants reported significantly more positive attitudes related to psychosocial loss at post-intervention compared to pre-intervention ($z = -2.60$ $p = .009$). There was no significant difference between pre- and post-intervention reported level of positivity on attitudes related to physical change or psychological growth with ageing ($p > .05$).

Perceived control

Independent tests of difference on residualised change scores (between baseline and 12 weeks) controlling for baseline, indicated that participants in the flexibility group on average reported increased levels of perceived control on both the agency (mean = 2.05, $z = -2.14$, $p = .032$) and pathway subscales (mean = 1.95, $z = -2.71$, $p = .007$) compared to the resistance group who reported a decrease (mean: agency = -2.05, pathway = -2.76) and while controlling for baseline scores. Paired tests of difference indicated there was no significant difference between pre- and post-intervention reported level of positivity on either perceived control subscale when analyses as a whole group ($p > .05$).

Mental health

There were no significant differences between exercise groups on any mental health measures ($p < .05$). Participants reported significantly lower levels of anxiety at post-intervention compared to pre-intervention ($z = -2.11$ $p = .035$). However, it should be noted that at baseline the majority of participants reported low levels of anxiety except one participant who reported high levels at baseline (score of 18) and subsequently lower levels of anxiety at post-intervention. Thus, this one participant may be driving the significant effect of the exercise interventions on a reduction in anxiety. There was no significant difference between pre- and post-intervention scores on other mental health measures (p > .05). There were no significant correlations between age and residualised change (controlling for baseline) on mental health measures (p > .05).

Self-efficacy

The flexibility group reported increased in general self-efficacy (mean = 0.92) compared to the resistance group who reported decreases in general self-efficacy (mean = -1.15, z = -2.00, p = .046). There were no other significant differences between exercise groups on any other self-efficacy measures (p > .05). Paired tests of difference also indicated that overall there were also no significant difference between pre- and post-intervention scores on self-efficacy measures (p > .05). There were no significant correlations between age and residualised change (controlling for baseline) on self-efficacy measures (p > .05).

Interactions between exercise group and psychosocial improvements

When cognitive scores were split by improvement or decline on psychosocial measures, these separate groups followed a similar pattern to those split by exercise group. In these cases, the majority of one exercise group improves on the psychosocial measure and the majority of the other exercise group declines on the psychosocial measures. Thus, the pattern of cognitive outcomes for participants split by psychosocial changes is similar to when split by exercise group.

For instance, HVLT trial 1 scores for those who reported an increase in perceived control (agency subscale; Figure 10.7) followed a similar pattern to the flexibility group (Figure 10.3) and those who reported a decrease in perceived control followed a similar pattern the resistance group. Additionally for HVLT trial 1 scores, those who reported an increase in general self-efficacy (Figure 10.7) followed a similar pattern to the flexibility group and those who reported a decrease in general self-efficacy followed a similar pattern to the resistance group (Figure 10.3).

For DSMT scores, participants who reported an increase in perceived control (pathway subscale; Figure 10.8) followed similar pattern to those in the flexibility group (Figure 10.4) and those who reported a decrease in perceived control followed a similar pattern to the resistance group. Additionally for DSMT scores, participants who reported an increase in depression (Figure 10.8) followed similar pattern to those in the resistance group (Figure 10.4) and those who reported a reduction in depression followed a similar pattern to the flexibility group.

For MMSE scores, the group of participants who reported a decrease in memory efficacy (Figure 10.9) appear to follow a similar pattern to the flexibility group (Figures 10.3) and those who reported an increase in memory efficacy (Figure 10.9) appear to follow a similar pattern to the resistance group (Figure 10.3).

For TMT interference scores, those who reported a decline in frequency of forgetting (Figure 10.10) followed a similar pattern to the resistance group (Figure 10.4) and those who reported an improvement in frequency of forgetting (Figure 10.10) followed a similar pattern to those in the flexibility group (Figure 10.4).

In summary, improvements on psychosocial measures appeared to follow a similar pattern to the flexibility groups on some cognitive outcomes and declines on psychosocial measures appeared to follow a similar pattern to the resistance group on some cognitive outcomes.

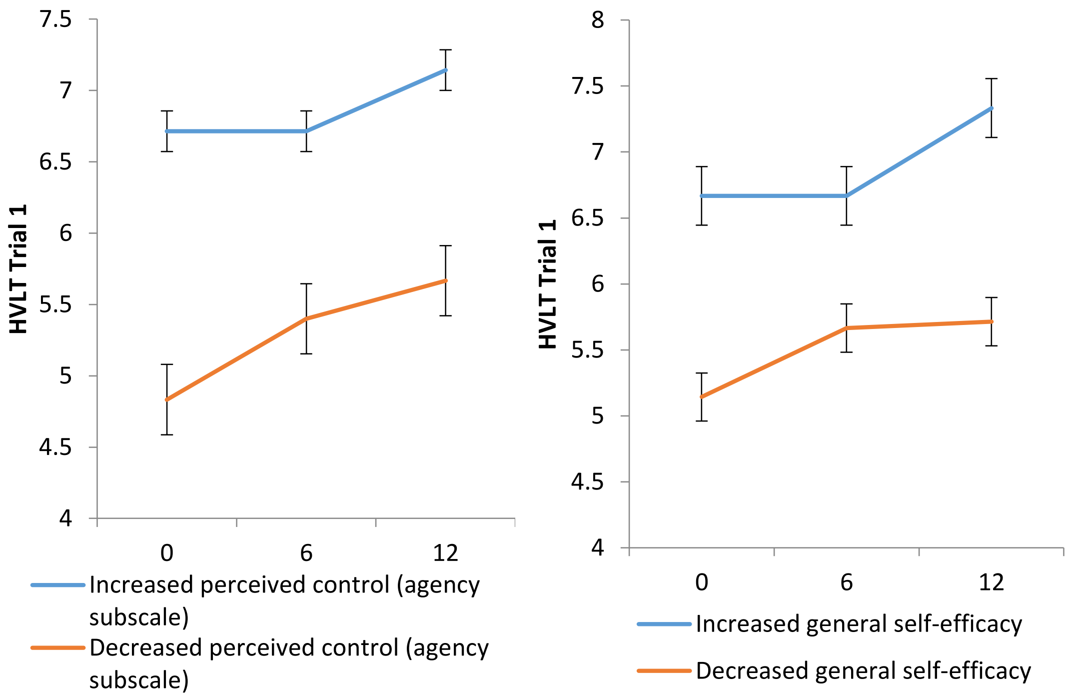


Figure 10.7 Change in HVLT trial 1 scores during the 12-week exercise programmes for participants who reported an increase or decrease in perceived control and General Self-efficacy.

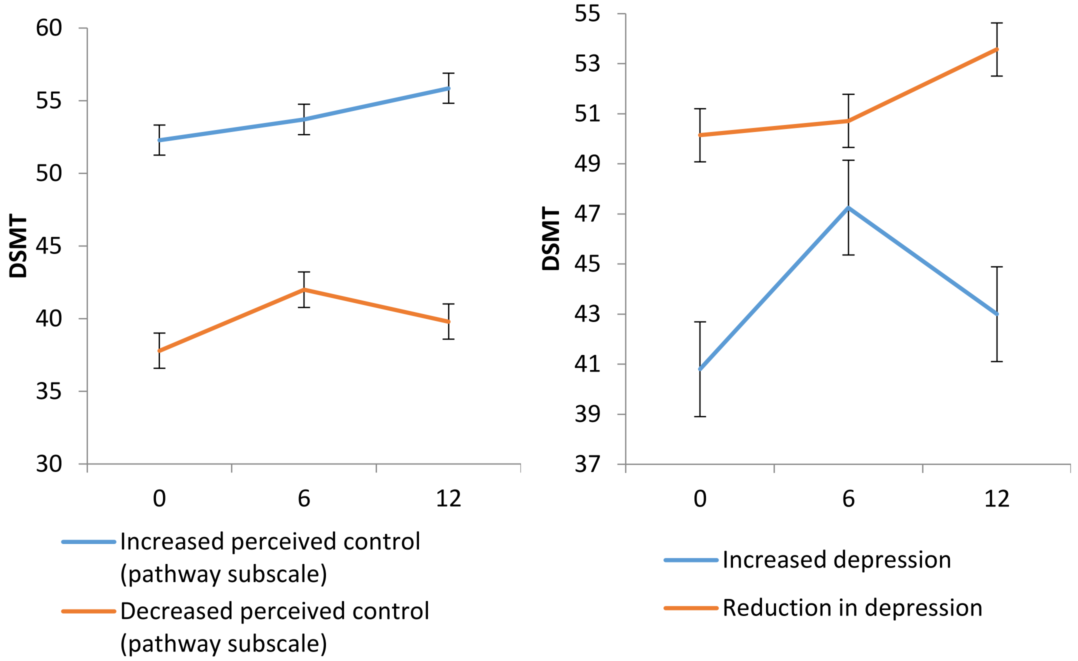


Figure 10.8 Change in DSMT scores during the 12-week exercise programmes for participants who reported an increase or decrease in perceived control and depression.

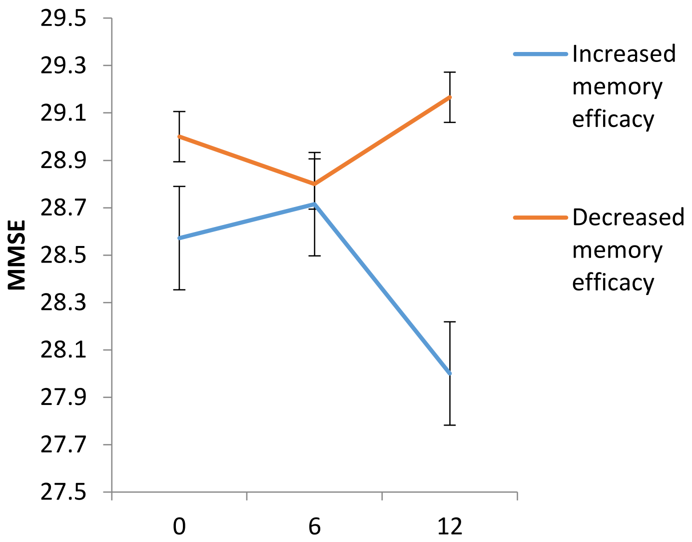


Figure 10.9 Change in MMSE scores during the 12-week exercise programmes for participants who reported an increase or decrease in memory efficacy.

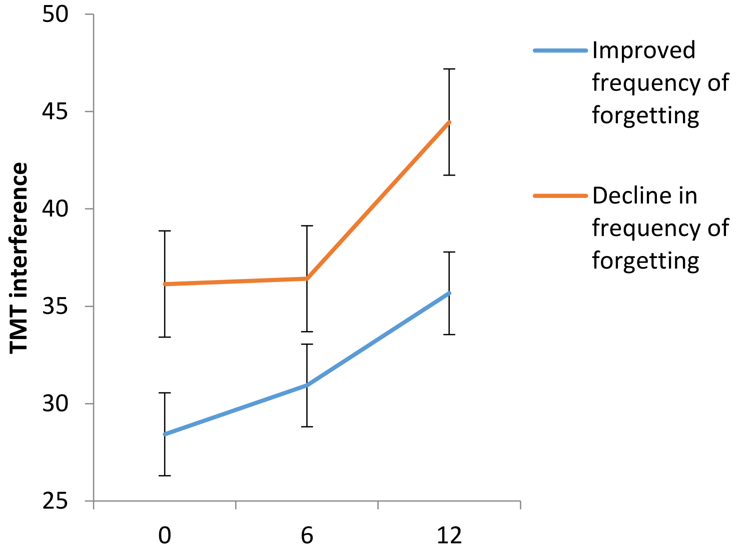


Figure 10.10 Change in cognitive outcomes during the 12-week exercise programmes for participants who reported an increase or decrease in perceived frequency of forgetting.

Differences in improvers versus non-improvers

The findings presented so far indicated non-linear exercise group effects on cognitive outcomes between baseline and 6 weeks compared to 6 and 12 weeks. They also indicated large baseline differences between participants who demonstrated an improvement or decline on psychosocial measures. Therefore, tests of difference were carried out on psychosocial and self-reported health measures between participants who demonstrated an improvement or decline on cognitive outcomes measures (regardless of exercise group) to give an indication of potential relationship between these variables. This was carried out at baseline to 6 weeks and also between 6 to 12 weeks due to the non-linear relationships. These significant differences are illustrated as a model in Figure 10.11.

Between baseline and 6 weeks, participants who improved on the MMSE reported a significant reduction in levels of depression (z = -2.70, p = .004) compared to those who declined on the MMSE. Participants who improved on the HVLT trial 1 reported a significant reduction in levels of anxiety (z = -2.12, p = .038) compared to those who declined on the HVLT trial 1. Participants who improved on the DSMT demonstrated significantly improved (faster) performance on the Get Up and Go test (z = -2.47, p = .011) compared to those who declined on the DSMT. Participants who improved on the Digit Span forwards reported significantly improved self-reported functional health (z = -2.20, p = .029) compared to those who declined on the Digit Span forwards.

Between 6 and 12 weeks, participants who improved on the MMSE reported a significant increase in general self-efficacy (z = -2.85, p = .003) compared to those who declined on the MMSE. Participants who improved on the TMT interference reported a significant increase in general memory efficacy (z = -2.01, p = .043) compared to those who declined on the TMT interference. And surprisingly participants who improved on the HVLT total recall reported a significant increase in depression (z = -2.25, p = .026) compared to those who declined on the HVLT total recall. Participants who improved on the Digit Span forwards demonstrated a significant increase in grip strength (z = -2.13, p = .038) compared to those who declined on the Digit Span forwards.

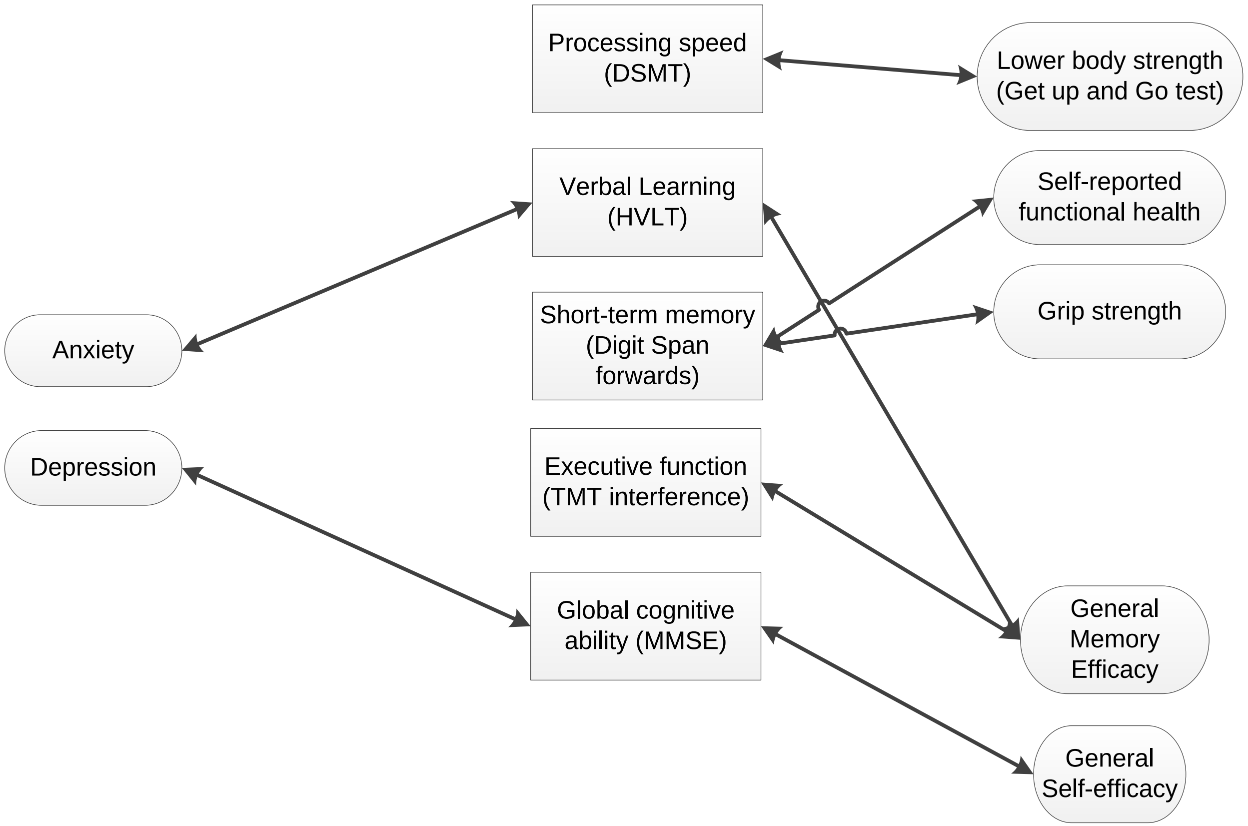


Figure 10.11 Model of significant differences of change in psychosocial variables between participants who improved or decline in cognitive ability during the exercise intervention

The relationship between change scores

There were no significant differences between exercise groups for changes in grip strength, Get Up and Go test, subjective health, or self-reported functional health ($p > .05$).

Spearman correlations were carried out between residualised (controlling for baseline) change scores of psychosocial variable and self-reported health and physical measures. There were no significant correlations between these change variables when analysed as a whole sample. However, in the resistance training group faster Get Up and Go scores were correlated with increased physical self-efficacy (*rho* = -.89, $p = .019$), improved frequency of forgetting (*rho* = -.90, $p = .037$). Improved subjective health was also correlated with improved frequency of forgetting (*rho* = .90, $p = .037$). In the flexibility group, improved self-reported functional health was correlated with increased general self-efficacy (*rho* = .86, $p = .014$).

Spearman correlations were carried out between residualised change scores of cognitive outcome measures and self-reported health and physical measures to see whether this may have mediated cognitive improvements. When analysed as a whole group, there were no significant correlations. No significant correlations were found when analysis was repeated stratified by exercise group.

Spearman correlations were carried out between psychosocial measures. Increases in physical self-efficacy were correlated with increase in general self-efficacy with borderline significance (*rho* = .69, $p = .010$). Increases in physical self-efficacy were very strongly positively correlated with improvements in frequency of forgetting when participants in the resistance group only were included. As Spearman's ranking method was used in this small sample (n = 6 in resistance group) and this very strong correlation, the coefficient was *rho* = 1.0 ($p < .001$). When this correlation was repeated using Pearson's method a strong correlation was also found ($r = .93$, $p = .022$).

Discussion

The primary aim of the present study was to assess the feasibility of this home-based resistance training exercise programmes with older adults. The secondary aim was to give an indication of the association between change in psychosocial factors and change in cognitive outcome measures in older adults. An additional secondary aim was to give an indication of whether the role of psychosocial factors was specific to specific domains of cognitive ability.

Feasibility

The various feasibility measures included in the present study indicated some challenges with carrying out this exercise intervention with older adults that were not previously encountered with a sample of middle-aged adults (Study 3). Sheltered housing site recruitment required pro-active phone calls after no response to letters. Participant recruitment using a pro-active approach with face-face contact was successful and resulted in a more varied sample compared to Study 3 in terms of demographic characteristics, including level of education. This highlights the importance of considering the most appropriate recruitment strategies for the target sample population. The majority of participants who volunteered did have some previous injury or health condition, thus it may be unrealistic and even unrepresentative of the wider population to recruit sedentary but "healthy" older adults.

The drop-out rate was high and participants who dropped out scored significantly lower on four cognitive tests at baseline which assessed different domains of cognitive ability compared to those who completed the intervention. The high drop-out rate also led to systematic differences between the groups which could indicate issues with tolerance of the exercises amongst older adults if only certain participants complete the programme. Despite attempts to control for age between groups by using randomisation procedures which stratified for age, participants who completed programme in the control group were younger than the resistance training group. The direction of exercise effects in favour of the flexibility group between HVLT trial 1 and total recall scores after controlling for changes in perceived control may be explained by the age differences between groups. This age difference was not statistically significant; however this may be due to the small sample size. However, the younger control group had better mean baseline scores across all cognitive tests (this difference was significant for Verbal Fluency). These baseline differences make it difficult to assess the effect of exercise and the potential role of psychosocial factors on cognitive outcomes.

Interestingly, there appeared to be a potentially moderating effect of age of psychosocial improvements during the resistance exercise programme. Participants who were older were more likely to report a decrease in perceived control during the intervention and participants in the resistance group were also generally older. Additionally, older participants were more likely to report an increase in positivity in attitudes related to psychosocial loss compared to younger participants. This could be related to the social interaction afforded by participation in the intervention but baseline social interactions were not included in analysis. These findings suggest that the impact of exercise on psychosocial factors may not be universal and age could moderate this effect. This is important to consider for the design of future exercise interventions as this potentially moderating effect of age on psychosocial factors could interact with cognitive outcomes. Additionally, this highlights an issue with categorising older adults into one group (for example, 65 years and older) when there is scope for large variations across these ages. This could also suggest that the moderating effect of age on cognitive outcomes could potentially be through psychosocial mechanisms.

It is important to mention that six out the 14 participants who completed the exercise programmes suffered from an illness at least once during the intervention. This may have impacted on the effects in a number of ways. For example, performance on cognitive tasks if not fully recovered for assessment sessions, lower levels of adherence as they stopped carrying out the exercises while they were ill, and participants may have found the exercises exhaustive if they resumed the programme before fully recovered. This may explain some of the non-linear effects found on cognitive outcomes.

Adherence to both of the exercise programmes for those who completed was high and it was slightly higher for the flexibility programme. One of the resistance exercises caused pain in two participants due to previous injuries. An adaptation of this exercise allowed them to continue with the programme which highlights the potentially more inclusive scope of individualised or tailored programmes. Self-reported functional health improved on average for the whole sample of participants who completed the programme. The majority of participants reported that they enjoyed the exercise sessions although some felt bored with the flexibility programme towards the end due to the lack of variation in exercises. None of the participants progressed past the second level of the resistance band which could indicate they were carrying out the exercises at a lower intensity and highlights the challenge of monitoring during home-based exercise programmes.

The majority of participants reported feeling or appeared anxious during the cognitive assessment sessions. The familiarisation session appeared to alleviate some of the anxiety as it allowed participants to know what to expect and should therefore be considered for inclusion in future trials for this reason as well as to reduce learning effects between pre- and post-intervention not due to the exercise programme. Some participants expressed dislike for filling in questionnaires and two participants did not want to take part for this reason. The wide variation in time taken to complete assessment sessions could confound results due to the effect of fatigue on performance. These issues emphasise the importance of careful selection of outcome measures so as to not overload participants with assessments.

Variance in cognitive outcomes

In addition to large baseline differences between exercise groups, there was also large variance in change on cognitive outcome measures, even within groups. This suggests that the usefulness of group only analysis may be limited and that investigating individuals differences and associations of those who did improve on cognitive outcomes compared to those who did not may give more insight into potential mechanisms. Thus, further analyses were carried out comparing the psychosocial, physical and self-reported health changes of participants who either improved or declined on cognitive outcomes. These findings revealed a consistent positive association between improvement in psychosocial factors and cognitive outcomes. Improvements in global cognitive ability were associated with a reduction in depression and an increase in general self-efficacy. Increases in general memory efficacy were associated with improvements in verbal learning and executive function. This suggests that improvements on psychosocial factors could be associated with cognitive improvements in an exercise intervention.

Domain specific effects

When participants were split by those who improved or declined on cognitive outcomes, it appears that increases in strength and improvements in functional health were associated with improvements on more simple cognitive outcomes, while improvements on psychosocial factors were associated with improvements on global and more complex cognitive tasks. There was no overlap between cognitive domains which were associated with psychosocial or physical improvements. This suggests there may be a domain specific effect of change in psychosocial factors on cognitive outcomes which is distinct from the positive effects from improvements in physical fitness and health. As discussed in previous chapters, more complex cognitive tasks (e.g. HVLT and TMT) may be more likely to be related to changes in psychosocial factors due to the more complex cognitive processes required to perform well on these tests, such as sustained attention (Cohen, Weingartner, Smallberg, Pickar, & Murphy, 1982) or motivation to employ memory strategies (Bandura, 1989). Self-efficacy has been suggested to enhance or hinder cognitive performance through a variety of processes, including motivational, affective and meta-cognitive aspects (Bandura, 1989). Additionally, the greatest depression-related impairment was found on cognitive and motor tasks that required sustained effort (Cohen, Weingartner, Smallberg, Pickar, & Murphy, 1982). The psychosocial improvements (in depression and general self-efficacy) associated with improvements in global cognitive ability suggests they have broad effects across cognitive domains. This is consistent with evidence from non-exercise contexts for the effect of depression across numerous cognitive tasks, including language function, memory (both recall and recognition), attention, behavioural regulation, slower processing speed, and poorer working memory (Brown et al., 1994; Halvorsen et al., 2012).

Increases in lower body strength were associated with increases in physical self-efficacy. However, there is no indication of the mechanisms through which other psychosocial improvements occurred in this small feasibility study. One potential mechanism could be through increased blood flow which has previously been found to be associated with a reduction in depression (Bench, Frackowiak, & Dolan, 1995). Additionally, cognitive deficits in depression were associated with lowered regional cerebral blood flow, particularly the medial prefrontal cortex (Bench et al., 1992; Dolan et al., 1992; Dolan, Bench, Brown, Scott, & Frackowiak, 1994) and so increased blood flow from the increased exercise participation could have had both an indirect as well as direct effect on cognitive performance.

Change in psychosocial factors may explain the different conclusions in terms of cognitive outcomes between reviews and meta-analyses of previous exercises interventions. Some have suggested that more simple cognitive domains benefit the most from exercise interventions (Angevaren et al., 2008; Clifford et al., 2009), whilst others suggest that more complex domains are affected (Colcombe & Kramer, 2003). The preliminary findings from this feasibility could suggest that exercise interventions which facilitate psychosocial improvements are more likely to bring about cognitive gains on complex tasks and that cognitive gains on simple tasks are more dependent on increases in physical fitness. This could be because of the different cognitive skills used to carry out different tasks. However, a larger sample would be required to investigate this relationship further.

The role of psychosocial factors

Attitudes towards ageing

There were no significant associations between changes in attitudes towards ageing and cognitive outcomes. However, the intervention (exercise groups combined) resulted in more positive attitudes related to psychosocial loss at post-intervention compared to pre-intervention. The lack of associations could suggest that attitudes towards ageing are unlikely to be a mechanism through which psychosocial factors impact on cognitive ability in an exercise intervention context with older adults. However, it may be that these exercise interventions did not sufficiently alter attitudes towards ageing for them to have an impact on cognitive outcomes. No differences were found between exercise groups for change in attitudes towards ageing and only a change in attitudes related to psychosocial loss with ageing improved overall (exercise groups combined) from pre- to post-intervention. This could provide support for the ‘increasing persistence’ hypothesis (Krosnick & Alwin, 1989). This hypothesis proposed that individuals become increasingly resistant to change in attitudes as they age. It could be that in older adults’ attitudes towards ageing are more fixed and less amenable to change as a result of experiences, such as taking up a healthy behaviour like physical activity. It could have been expected that carrying out the exercises may have challenged participants’ attitudes towards ageing related to physical changes due to observed increases in fitness. However, it could be that the exercise programmes did not challenge the participants’ attitudes towards ageing and instead provided confirmatory evidence for their negative self-stereotypes. The exercise programmes may have made participants more aware of their physical limitations and difficulties, particularly if they found the exercises difficult. This may have been the case in the resistance training programme in particular which lead to a decrease in perceived control and general self-efficacy. Although the increased positivity in attitudes related to psychosocial loss with ageing during the 12 weeks was not related to cognitive outcomes, it may have reflected a positive effect of taking part in the intervention which included social interaction with the researcher.

Perceived control

Exercise group appears to moderate change in perceived control as participants in the flexibility group were more likely to report an increase in perceived control and those in the resistance group were more likely to report a decrease. Also, those who reported either an increase or decrease in perceived control demonstrated a similar pattern of results as the exercise groups. The group of participants who reported a decrease in perceived control followed a similar pattern to the resistance group for performance in processing speed and verbal learning compared to group of participants who reported an increase in perceived control who followed a similar pattern to the flexibility group on these cognitive outcome measures.

These systematic differences between groups due to the different effects of flexibility and resistance training on perceived control make it difficult to determine the role of perceived control in the relationship between physical activity and cognitive ability. However, previous research has suggested that the role of perceived control on cognitive ability is related to spontaneous use of mnemonic strategies that aid memory performance self-regulation during cognitive tests (Lachman & Andreoletti, 2006; Riggs, Lachman, & Wingfield, 1997) This suggests that level of perceived control may effect more complex cognitive tasks because complex tasks (such as the HVLT to assess verbal learning) would benefit from using strategies (e.g. categorising words). Therefore, the role of changes in perceived control should therefore be investigated in future studies.

Mental health

These preliminary finding suggest that level of anxiety could be associated with verbal fluency. The mechanisms through which anxiety impacts of cognitive ability have been investigated. Previous research found that anxiety was related to poorer performance in working memory, and executive function in older adult longitudinally (Wetherell, Reynolds, Gatz, & Pedersen, 2002). Cognitive tasks which rely on long-term retrieval of knowledge and perceptual speed were not found to be affected by anxiety. It has been suggested that anxiety impairs processing efficacy through mechanisms, such as attentional control e.g. inhibiting attention to task-irrelevant stimuli and flexibly switching attention between and within tasks to maximise performance (Derakshan & Eysenck, 2009). These preliminary findings also suggest that level of depression could potentially be associated with global cognitive performance. This would be in agreement with previous research which has indicated a negative association between depressive symptoms on a range of cognitive outcomes including memory recall, language, function, working memory, and cognitive tasks which required sustained effort (Brown, Scott, Bench, & Dolan, 1994; Halvorsen et al., 2012; Weingartner & Cohen, 1981). This suggests that there may be domain specific interactions of psychosocial factors for global and complex cognitive tasks, however further research with larger samples is needed to investigate this further.

There were no significant differences between exercise groups on any mental health measures. However, there were similar pattern of results for processing speed and verbal learning when split by exercise group to when split by change in level of depression. The cognitive outcomes for the flexibility group were similar to participants who reported a reduction in depression and the cognitive outcomes of the resistance group were similar to participants who reported an increase in depression. The systematic differences between exercise groups make it is difficult to determine the role of depression in the present study because the flexibility exercises lead to a reduction in depression while the resistance training had a positive effect on cognitive outcomes for which there is evidence from previous studies (e.g. Cassilhas et al., 2007; Clifford, 2012; Nagamatsu, Handy, Hsu, Voss, & Liu-Ambrose, 2012). It is also important to note that the level of depression amongst participants in the present study was low (mean = 3.2, highest score at baseline of 6, with the cut-off for depression >5). Thus, there would have been limited resolution in scores and scope for improvement. Levels of anxiety were also low at baseline (mean = 4.2) with the exception of one participant (score of 18) who reported a reduction in anxiety at 12-week follow-up. Thus this participant may have been driving the effects found for a reduction in anxiety.

Self-efficacy

The flexibility group reported significant increases in general self-efficacy compared to the resistance group. This suggests that different exercise interventions can lead to different effects on general self-efficacy. Previous research has found that physical self-efficacy increased in both low and high intensity strength training programmes but not in the control group (Ewart, 1989). However, this was not in a specifically older adult population. In a study with older adults only, strength training resulted in increases in self-efficacy for physical strength when accompanied with an empowerment intervention compared to traditional strength training alone (Katula, Sipe, Rejeski, & Focht, 2006). The empowerment intervention involved supervised group-mediated counselling component which included the topics: disability and sarcopenia, self-awareness and monitoring, progress and feedback, focusing on accomplishment, the proactive process of motivation and examining changes in everyday life. The authors suggested that and empowerment-based exercise programs may be particularly motivating for older adults by creating a more meaningful physical activity experience for them. Perhaps the present study did not find increases in self-efficacy in the resistance training group because it did not facilitate empowering feelings amongst participants. Instead, it led to a decrease in self-efficacy which may have confounded cognitive outcomes. Additionally, an intervention study with older adults found that those who participated in T’ai Chi reported increases in self-efficacy for physical capabilities compared to a wait-list control (Li et al., 2001). This indicates that low intensity exercises in older adults can lead to increases in self-efficacy and suggests that focusing on increasing strength is not the only way to do this and that the psychosocial meaning may also be important.

The correlations between increases in physical self-efficacy and increases in general self-efficacy suggest there could be a transfer between self-efficacy domains. Additionally, there was strong correlation between increases in physical self-efficacy and improvements in frequency of forgetting for those in the resistance group. Evidence from a previous study suggested that domain specific self-efficacy may not be transferable to a general measure of self-efficacy, but may be transferable to another domain (Weitlauf et al., 2000). The results of the present study did not agree with this as they suggest a transfer from a specific self-efficacy domain to general self-efficacy. The previous study was carried out in working age adults. Perhaps the results of the present study indicate that physical self-efficacy is more closely related to general self-efficacy in older adults. This could be because physical ability may be more likely to be related to ability to carry out activities of daily living among older adults. The transfer of increased self-efficacy from the physical domain to the memory domain in the resistance training group suggests that self-efficacy could be a mechanism through resistance training improves cognitive ability. This transfer was not found in the flexibility group which suggests that noticeable increases in strength from the resistance training may have been necessary for this potentially mediating relationship. There is evidence for the relationship between memory self-efficacy and objective memory performance (e.g. Desrichard & Köpetz, 2005), although this was not apparent in the present study. Due to the sample group size it was not appropriate to carry out mediation analysis but these preliminary findings give an indication that self-efficacy could play a role in the relationship between exercise and cognitive outcomes and should therefore be investigated with larger samples.

Strengths and limitations of the present study

The use of a pseudo-control group which carried out flexibility exercises was a strength of the present study because this controlled for the mental stimulation of following exercise instructions, filling in an exercise diary and planning when to carry out the exercise to fit into daily routines etc. Additionally, the exercise programmes were home-based and therefore controlled for the effect of social interaction on cognitive ability. However, there appeared to be similar patterns of cognitive improvements when the participants were split by exercise group (resistance versus flexibility) as when split by psychosocial improvements versus declines. This could indicate that type of exercise influences the effect on psychosocial factors and therefore this should be taken into account when considering appropriate control groups. For instance, in the present study the progressive nature of the resistance training compared to the consistent intensity of the flexibility exercise may have influenced psychosocial factors. Thus potential psychosocial mechanisms would not be controlled for.

The present study did not investigate the effect of gender in the association between psychosocial and cognitive outcomes as there were only two men in the sample who completed then interventions. A previous study found that gender was a significant predictor of physical self-efficacy on most physical performance tests (Bosscher, Van Der Aa, Van Dasler, Deeg, & Smit, 1995). Men showed lowered levels of performance on most tests which was associated with more negative beliefs of self-efficacy. This was moderated by age, as older men had more negative beliefs of physical self-efficacy than women. Additionally, gender is suggested to moderate the effect of exercise on cognitive outcomes, with women showing more cognitive improvements after exercise (Clifford et al., 2009; Denkinger et al., 2012; Hogervorst et al., 2012). Potentially, the moderating role of gender in this relationship could be due to psychosocial factors and should therefore be investigated further in future studies with larger numbers of men.

An additional limitation to consider when interpreting the role of psychosocial factors in this design of study is the parallel nature of change between variables. Thus it is difficult to establish cause and effect because the associations between improved psychosocial factors and cognitive outcomes occurred in parallel. In a study with a larger sample it could be possible to investigate change in these variables at the mid-point and subsequent assessment post-intervention to further investigate causal mechanisms. This is something to consider when designing such interventions.

Conclusion

The findings of the present study suggest that the exercise programmes were feasible in this sample of older adults, however they indicate some challenges and limitations. Recruitment was successful using a pro-active face-to-face approach; however drop-out rates could lead to systematic bias and an unrepresentative sample. Capacity to adapt exercises for individual may increase inclusivity and reduce drop-out rates. Adherence rates of those who completed the programmes were good, however as participants in the resistance programme did not progress past the second level of band it is difficult to know to what intensity the exercises were carried out. This could be a limitation of home-base exercise programmes. The findings highlight the importance of careful selection of outcome measures so as to not overload participants with assessments. Additionally, the large variation in cognitive outcomes within both groups may indicate the limited usefulness of grouping participants together for analysis. Analysing individual differences may give more insight into these relationships.

The results of the present study indicated that psychosocial factors may be associated with some cognitive outcomes after the exercise training intervention. However, these findings need to be interpreted with caution for a number of reasons. These include the small sample size, high drop-out rate, non-linear relationships and large variance in outcome measures. Additionally, resistance training was associated with decreased perceived control and general self-efficacy which may confound exercise effects. Analysis of the data split by participants who improved or declined on each cognitive outcome measures suggested that improvements in psychosocial factors were associated with improvements on cognitive outcomes. Furthermore, this association applied to global and complex cognitive tasks compared to increases in strength and self-reported health which were associated with simple cognitive tasks. However, these findings need to be interpreted with caution due to the small sample size. Future research should utilise larger samples and a process evaluation to further understand the role of psychosocial factors in the relationship between exercise interventions and cognitive outcomes.

PART FIVE

General Discussion

Chapter 11: General Discussion

Introduction

This chapter presents the findings of the present thesis. First, the aims are presented, followed by a summary of the results for each study. Second, the findings are discussed in relation to each psychosocial factor. Finally, the limitations and implications of the findings are discussed, followed by final conclusions.

Aims of the thesis

The present thesis aimed to investigate the role of psychosocial factors in the relationship between physical activity and cognitive ability in older adults. Despite the large number of good quality studies, there remains many equivocal findings in the physical activity and cognitive ability literature, and thus suggested that other factors needed to be considered. The importance of using a biopsychosocial model of disease to understand cognitive decline and dementia has been proposed (Kitwood, 1997; Clare, 2007). Psychosocial factors in non-exercise contexts have demonstrated effects on cognitive ability, and there is evidence for the beneficial effect of physical activity on psychosocial factors. Thus a potentially mediating relationship was plausible. Previous literature has investigated the effect of psychosocial factors on participation in physical activity in this context, for example in McAuley and colleagues' (2004) descriptive model. However, the role of psychosocial factors in the relationship of physical activity on cognitive ability has been neglected and thus the primary aim of the present thesis was to investigate them. The present thesis employed both cross-sectional observational studies and randomised controlled trials of exercise to explore the research questions and aims. The research questions and specific aims for each study are presented below:

Primary question:

- Do psychosocial factors play a role in the relationship between physical activity and cognitive ability?

Secondary questions:

- Which psychosocial factors are important in this relationship?
- What are the potential mechanisms of psychosocial factors on cognitive outcomes?
- Are socio-cultural factors important in the physical activity and health relationship?
- Is the role of psychosocial factors in the relationship between physical activity and cognitive ability domain specific?

Specific aims of each study in the present thesis were:

- To investigate the relationship between attitudes towards ageing, perceived control, and self-reported health (Study 1a)
- To explore inter-generational differences in attitudes towards ageing in the UK between young and older adults (Study 1b)
- To explore cross-cultural differences in attitudes towards ageing in the UK in young adults compared to young adults in China (Study 1c)
- To investigate the associations between physical, social and mental activities on cognitive ability (Study 2a)
- To investigate the mediating effect of mental health in the relationship between physical activity and cognitive ability (Study 2b)
- To test proof of concept of the potential role of psychosocial factors (attitudes towards ageing, perceived control, and mental health) in an exercise intervention to improve cognitive ability in middle-aged adults (Study 3)
- The primary aim was to assess the feasibility of a home-based resistance training intervention with older adults. The secondary aim was to provide preliminary data on the role of psychosocial factors (attitudes towards ageing, perceived control, mental health, and self-efficacy) on cognitive outcomes (Study 4)

Summary of findings

Study 1a: Attitudes to ageing, physical activity, and health of older adults in the UK

Study 1a investigated the relationship between attitudes towards ageing and self-reported health in older adults in the UK. The majority of the extant literature investigating the relationship between attitudes towards ageing and health is based on studies carried out in the United States and China. It was hypothesised that more negative attitudes towards ageing would be associated with poorer health, based on the findings from other cultures. Perceived control was included in this study to explore whether it was a mechanism through which attitudes towards ageing could impact on health outcomes. It was further hypothesised that perceived control would not mediate this relationship based on previous findings in Germany (Wurm et al., 2007). Study 3 also investigated whether level of physical activity mediated the effect of attitudes towards ageing on self-reported health as a mechanism through which attitudes towards ageing could impact on health could be through higher participation in preventative health behaviours (Levy & Myers, 2004), such as physical activity.

More negative attitudes related to physical change with ageing, lower perceived control, and lower levels of peer comparison level of physical activity were also independently associated with worse subjective health. Perceived control mediated the effect of attitudes related to psychosocial loss with ageing and physical activity mediated the effect of attitudes related to psychological growth with ageing. More negative attitudes related to physical change with ageing and psychosocial loss were independently associated with worse functional health. Attitudes towards ageing mediated the effect of perceived control on functional health. Peer comparison level of physical activity did not significantly explain additional variance of functional health which suggested the potential importance of attitudes towards ageing in relation to health outcomes. Attitudes to ageing or perceived control mediated the effect of age on functional and subjective health even though age was not significantly correlated with either of those psychosocial factors.

Study 1b: Attitudes towards ageing in young and older adults in the UK

Study 1b study aimed to identify and compare attitudes to ageing in younger versus older adults in the UK. Previous studies carried out in the UK have explored young adults' attitudes towards ageing using qualitative methods (Phoenix & Grant, 2009; Phoenix & Sparkes, 2006, 2007) or compared specific domains of attitudes towards ageing (filial piety) across older adults in different cultures (Laidlaw et al., 2010). However, no studies to the author's knowledge have investigated differences between attitudes towards ageing across generations within the UK. It was hypothesised that there would not be significant differences between attitudes towards ageing between age groups based on previous findings in other cultures of consistencies between generations. This study also aimed to investigate whether attitudes towards ageing vary between young adults who have different levels of contact with older adults

Overall, there were no significant differences between young and older adults on all three (positivity, internality and activity) dimensions. On average, responses from both groups were predominantly negative and related more to internal qualities rather than external attributes and described older adults as inactive rather than active. No significant differences were found between young adults grouped by level of contact with older adults on any positivity, activity or internality dimensions, not even when those with no contact were compared with those with a lot of contact. Therefore, the frequency of contact that young adults have with older adults does not appear to be associated with their attitudes towards ageing. In relation to domains of attitudes towards ageing, responses from older adults were distributed more evenly across a large number of categories of descriptions compared to responses from young adults which were predominantly distributed over only a few categories i.e. personal disposition, physical functioning, cognitive functioning, and wisdom. These results suggest that the level of overall positivity, internality or activity of attitudes towards ageing does not differ between young and older adults. However, there are differences across domains of attitudes towards ageing.

Study 1c: Young adults' attitudes towards ageing in the UK and China

Study 1c aimed to explore the cultural differences in positivity and domains of attitudes towards ageing amongst young adults in the UK and China. It was hypothesised that young adults in China would have more positive attitudes to ageing compared to young adults in the UK. It was also hypothesised that attitudes of young adults in China would focus more on internal qualities of older adults (e.g. personal disposition, such as ‘kind’) and focus less on external attributes, (e.g. appearance) compared to those in the UK. These hypotheses were based on previous research that has demonstrated cultural differences in attitudes to ageing in these directions (Levy & Langer, 1994). It was further hypothesised that the young adults in China would report more descriptions related to filial piety, such as ‘respect’ compared to young adults in the UK due to the reported Asian and Western cultural differences in these traditional expectations described above (Laidlaw et al., 2010; Sung, 2004). Attitudes towards ageing were captured by asking the young adults an open-response question to name five words or short phrases they would use to describe the elderly.

On average, mean responses from China were significantly higher on the positivity, internality and activity dimensions compared to the UK. This indicated that young adults in China described older adults more positively, more in terms of internal qualities or traits, and as having a higher level of activity. On the other hand, the analysis of the responses sorted into semantic categories revealed responses from both groups largely covered the same categories of descriptions. Additionally, the words and phrases used by both groups were similar in the majority of the categories. However, the frequency distributions across the categories varied between groups. The category with the largest percentage of responses for both groups was personal disposition. For the young adults from the UK this was closely followed by descriptions of physical functioning and with smaller but substantial frequencies in the wisdom, cognitive function, appearance, and identity categories. For the young adults from China, after personal disposition, the distribution of responses was relatively even across a number of categories, in descending order from personal affect, cognitive functioning, health, social status, social support, and then physical functioning.

Study 2a: The relationship between walking, social and intellectual activities and cognitive ability of older adults living in Indonesia

Study 2a aimed to assess the cross-sectional associations between physical, social, and intellectual activities and cognitive ability within a sample of middle-aged to older adults in Indonesia. It was hypothesised that walking and social activities would be stronger predictors of cognitive ability compared to intellectual activities. This was based on the previous research which found that activities which involved two or more activity components demonstrated the strongest protective effect against cognitive decline (Karp et al., 2006). The intellectual activities included in this study (reading and writing) are unlikely to have involved more than one activity component, whereas walking and social activities are likely to have involved multiple components.

Frequency of walking and participation in social activities were positively and independently associated with cognitive performance for global cognitive ability and verbal learning while controlling for age, education, sex, smoking status, and the other types of activities. Participation in intellectual activities was significantly associated with cognitive performance on global cognitive ability and one but not the other verbal learning outcomes. The significant associations also remained after controlling for functional health status, which was assessed in relation to activities of daily living. These findings demonstrate the importance of controlling for mental stimulation and social interaction in exercise interventions investigating the effect on cognitive ability as they demonstrate independent effects.

Study 2b: The role of mental health in the relationship between physical activity and cognitive ability in Indonesia

Study 2b aimed to investigate the role of mental health in the relationship between physical activity and cognitive performance. It was hypothesised that mental health would have a partially mediating effect in this association. This was based on the evidence that suggests positive effects of physical activity on mental health and the association between mental health and cognitive ability. The moderating role of functional health was also investigated.

Mental health appeared to partially mediate the effect of walking on cognitive outcomes. In those with better mental health, walking was not associated with cognitive ability. In those with poorer mental health walking was associated with better cognitive ability. However, functional health was found to moderate the effect of walking on cognitive ability, perhaps because functional health facilitates ability to walk. Additionally, mental health was independently associated with global cognitive ability and verbal learning. The results further suggested a domain specific relationship of mental health with more complex cognitive outcomes. However, causal directions cannot be inferred from this cross-sectional data.

Study 3: The role of psychosocial factors in a randomised controlled trial of resistance training on cognitive ability: a proof of concept study

The aim of Study 3 was to test proof of concept of a potential role of psychosocial factors on cognitive outcomes in an exercise intervention in middle-aged adults. It was hypothesised that improvements in psychosocial factors would be associated with improvements in cognitive ability.

Increased positivity in attitudes towards ageing was associated with improvements in semantic memory and improvements in mental health were associated with improvements in verbal learning and potentially executive function. This suggested that the effect could be domain specific as different psychosocial factors were associated with different cognitive domains. The findings further suggested that the relationship between improvements in mental health and cognitive gains could be independent to those from increases in physical fitness. Thus psychosocial improvements could have an additive effect and are therefore important to assess and control for in exercise interventions in this context. These findings need to be interpreted with caution due to the small sample size but justified the use of time and resources to further investigate this relationship with older adults.

Study 4: A feasibility study and pilot randomised controlled trial of resistance training on cognitive ability with older adults: the role of psychosocial factors

The aim of Study 4 was to assess the feasibility of the exercise programmes utilised in Study 3 with older adults. The secondary aim was to explore whether there was a potential association between change in psychosocial factors and change in cognitive outcome measures in older adults. The psychosocial factors included were attitudes towards ageing, perceived control, mental health, and self-efficacy. An additional secondary aim was to give an indication of whether the role of psychosocial factors may be specific to certain domains of cognitive ability.

The findings of Study 4 suggest that the exercise programmes utilised in Study 3 were feasible in a sample of older adults, however they indicate some challenges and limitations. Recruitment was successful using a pro-active face-to-face approach; however drop-out rates could lead to systematic bias and an unrepresentative sample. Capacity to adapt exercises for individual may increase inclusivity and reduce drop-out rates. Adherence rates of those who completed the programmes were good, however as participants in the resistance programme did not progress past the second level of band it is difficult to know to what intensity the exercises were carried out. This could be a limitation of home-base exercise programmes. The findings highlight the importance of careful selection of outcome measures so as to not overload participants with assessments. Additionally, the large variation in cognitive outcomes within both groups may indicate the limited usefulness of grouping participants together for analysis. Analysing individual differences may give more insight into these relationships.

The results of the present study indicated that psychosocial factors may be associated with some cognitive outcomes after the exercise training intervention. However, these findings need to be interpreted with caution for a number of reasons. These include the small sample size, high drop-out rate, non-linear relationships and large variance in outcome measures. Additionally, resistance training was associated with decreased perceived control and general self-efficacy which may confound exercise effects. Analysis of the data split by participants who improved or declined on each cognitive outcome measures suggested that improvements in psychosocial factors were associated with improvements on cognitive outcomes. Furthermore, this association applied to global and complex cognitive tasks compared to increases in strength and self-reported health which were associated with simple cognitive tasks. However, these findings need to be interpreted with caution due to the small sample size. Future research should utilise larger samples and a process evaluation to further understand the role of psychosocial factors in the relationship between exercise interventions and cognitive outcomes.

The role of psychosocial factors in the relationship between physical activity and cognitive ability

The primary aim of the present thesis was to investigate whether psychosocial factors play a role in the relationship between physical activity and cognitive ability. Four potential psychosocial factors that could play a role were identified in the non-physical activity literature (discussed in Chapter 2) and these were investigated in the present thesis. The findings for each psychosocial factor across the studies will now be discussed. Secondary research questions are addressed in relation to each psychosocial factor.

Attitudes towards ageing

Attitudes towards ageing in the present thesis were initially explored cross-culturally in young adults and between generations in the United Kingdom. This was to expand knowledge and understanding of attitudes towards ageing in the United Kingdom which was limited as the majority of studies on this topic to date have been carried out in other countries. In order to understand attitudes towards ageing and their relationship to engagement in healthy behaviours and with cognitive and health outcomes, they needed to be explored in their socio-cultural context. Study 1c found that attitudes towards ageing amongst young adults were more negative, focused on more external traits and described older adults as less active in the UK compared to China. Study 1b indicated consistency of this negativity in attitudes towards ageing amongst older adults. Although this was not a longitudinal study, this may reflect a consistency of attitudes towards ageing over time as previous research has suggested that stereotypes of older adults are formed when younger are internalised to become self-stereotypes as individuals age (Levy, 2009). This could be a concern due to the evidence for attitudes towards ageing that are formed when younger, gaining salience and negatively impacting on future cognitive and health outcomes when they become self-relevant (Levy et al., 2011; discussed in more detail in Study 1). However, there is limited but important research being carried out which has found a beneficial effect of a positive outlook on ageing in the face of difficult circumstances or powerful socio-cultural pressures and attitudes (Levy, 1999; Zimmermann & Grebe, 2014). Experimental evidence has shown that inducing mild positive feelings demonstrated positive effects on working memory and complex decision making (Carpenter, Peters, Västfjäll, & Isen, 2013). These studies indicate that succumbing to socio-cultural negative age stereotypes is not inevitable and that there is scope for intervention.

The results of Study 1a indicated that more positive attitudes towards ageing were related to better subjective and self-reported health in older adults in the UK. This is in line with evidence from other countries (Levy et al., 2011; Levy, Slade, & Kasl, 2002; Levy et al., 2009; Yoon et al., 2000). The findings from Study 1a are cross-sectional, however the evidence from other countries include longitudinal and experimental studies (discussed in more detail in Chapter 4) which suggest the causal role of attitudes towards ageing on future health and cognitive outcomes. It has been suggested that the mechanisms through which attitudes towards ageing affect health and cognitive outcomes is through indirect effects on lifestyle choices and participation in healthy behaviours (Hertzog et al., 2009; Levy & Myers, 2004). Study 1a found that higher levels of peer comparison physical activity were independently associated with better subjective health but not with functional health. This suggests that there may be psychological mechanisms through which participation in physical activity impacts on subjective perceptions of health, in addition to physical benefits and the impact on functional abilities.

It is important to note that in Study 1a, attitudes towards ageing attenuated the independent association between age and subjective and functional health. Previous evidence has indicated the association between increased age and poorer functional health (e.g. Wensing, Vingerhoets, & Grol, 2001). This indicated the powerful independent associations between attitudes and health, particularly as age was not correlated with attitudes towards ageing. These results support the biopsychosocial approach that ageing is not solely a biological process, but also a social and psychological process which impacts on health outcomes. It also suggests that because negative attitudes towards ageing are not associated with older chronological age and thus could be targetable through intervention.

Positive attitudes and beliefs have been discussed in terms of their importance of whether individuals strive to maintain a high quality of life in the face of age- and disease-related challenges (Hertzog et al., 2009). It was argued that active life-management requires processes such as selection, optimisation, and compensation to enable older adults to maximise quality of life with losses of physical and cognitive functioning that accompany the ageing process (Freund & Baltes, 2002). There is evidence that compensatory behaviours in older age are positively associated with successful adaptations to ageing and also with positive psychological functioning, such as well-being (Riediger, Li, & Lindenberger, 2006). The construct of resilience has been discussed in terms of enabling adjustment to challenges and loss in order to optimise functioning or compensate for loss (Greve & Staudinger, 2006). There is evidence to suggest that maintaining positive affect and attitudes in the face of adversity is beneficial for adaptation to negative life events (Zautra, 2005). For example, adaptation to widowhood is assisted by experiencing feelings of hope for the future and positive affect (Ong, Bergeman, Bisconti, & Wallace, 2006; Ong, Edwards, & Bergeman, 2006). This evidence from the current literature, together with the findings from Study 3, suggest that individuals with more positive attitudes towards ageing may be more likely to make more healthy choices in relation to behaviours, such as participation in physical activity. This indirect effect subsequently impacts on future health and cognitive outcomes as a result of participation in healthy behaviours. The literature also suggests that maintaining a positive attitude with increasing age may be related to resilience with ageing and affect choice of behaviours in reaction to age- and disease-related challenges. Rather than simply having positive attitudes towards ageing, it may be that the ability to maintain this positivity in the face of difficulties is more predictive of future health and cognitive outcomes. Future research should investigate which factors predict psychological resilience with ageing.

The exercise interventions included in the present thesis (Study 3 and Study 4) assessed whether attitudes towards ageing were susceptible to change from pre- to post-intervention and how this was related to cognitive gains. The findings from the exercise intervention studies suggested that there may be a two-way pathway between attitudes towards ageing and participation in physical activity. In addition to evidence discussed so far that attitudes towards ageing predict future participation in physical activity and other health behaviours (e.g. Levy & Myers, 2004), the findings from Study 3 suggest that attitudes towards ageing became more positive through participation in an exercise intervention with middle-aged adults. Furthermore, increased positivity in attitudes towards ageing was associated with cognitive gains with middle-aged adults. This suggests that increased positivity of attitudes towards ageing could be one of the mechanisms through which the exercise intervention improved cognitive ability. Previous studies have provided evidence for the priming effects of attitudes and stereotypes of ageing on cognitive performance (Levy, 1996; Stein, Blanchard-Fields, & Hertzog, 2010). Study 1a found that more positive attitudes towards ageing were associated with higher levels of perceived control. This could be a mechanism through which attitudes towards ageing impact on cognitive ability in a self-fulfilling prophecy. If attitudes towards ageing reflect beliefs of personal control over cognitive ability and that decline is not inevitable with ageing then this may affect behaviours which impact on cognitive performance. These behaviours could include the employment of memory strategies and sustained effort and attention. This is discussed in more detail in the next section related to perceived control.

In previous literature, the impact of attitudes towards ageing on health and cognitive outcomes was found to be moderated by self-relevance (Levy et al., 2011). Self-relevance was not measured in the present thesis, however it could be assumed that attitudes towards ageing are more likely to have been self-relevant in the older adult sample (Study 4) compared to the middle-aged sample (Study 3). Therefore, it was hypothesised that attitudes towards ageing would be more strongly associated with cognitive outcomes in older adults. However, in Study 3 increased positivity in attitudes related to psychological growth with ageing were related to semantic memory improvements. In contrast, changes in positivity of attitudes towards ageing in the exercise intervention with older adults were not related to any cognitive improvements in Study 4. This could reflect that attitudes towards ageing are less amenable to change in older adults compared to middle-aged adults which would support the “increasing persistence” hypothesis (Krosnick & Alwin, 1989). This hypothesis suggests that individuals become increasingly resistant to change as they age. However, it could be that the exercise intervention itself did not facilitate attitude change in older adults. Attitudes towards ageing were not an explicitly targeted component of the intervention. Change in attitudes towards ageing in the intervention would have been an implicit side-effect of participation. There was no overall change in attitudes towards ageing in Study 3 and there was only increased positivity for attitudes related to psychosocial loss with ageing but not physical change or psychological growth in Study 4. Perhaps carrying out the exercises did not challenge participants’ attitudes towards ageing but rather provided support for negative self-stereotypes in relation to physical ability. This may have occurred when participants found the exercises physically challenging during the intervention. This theory is based on the findings in Study 4 that the resistance training programme led to decreases in general self-efficacy and perceived control. This is discussed in more detail in later sections. The increased positivity of attitudes related to psychosocial loss with ageing could has been a result of participation in the study and the social contact with the investigator and sense of accomplishment from completing the exercise programme. Additionally, it is important to acknowledge individual differences between self-relevance. Some older adults of a certain age may consider themselves to be old while other older adults of the same age may not. It is a subjective judgement which has been found to moderate the effect of attitudes towards ageing on cognitive outcomes (Levy et al., 2011). Therefore, the usefulness of grouping older adults together on the basis of chronological age when investigating attitudes towards ageing and cognitive outcomes and behaviour may be limited for understanding this relationship.

It is possible that participants’ prior attitudes towards ageing affect their experience of exercise. In Study 4, more positive baseline attitudes related to physical change with ageing were related to a higher average level of enjoyment of the exercise sessions. However, attitudes towards ageing at baseline were not related to likelihood of dropping out of the intervention or adherence to the sessions in Study 4. Instead, higher likelihood of dropping out of the exercise intervention in was related to poorer physical and cognitive ability at baseline. It may be that older adults who agreed to take part in the study and completed the programme had more positive attitudes towards ageing compared to those who did not volunteer. This theory would agree with previous evidence of attitudes towards ageing impacting on participation in future health behaviours, such as physical activity (e.g. Levy & Myers, 2004) and also the findings of Study 1a which found that older who were more physically active compared to other their own age had more positive attitudes towards ageing.

In conclusion, attitudes towards ageing in the UK were more negative amongst young adults than in China and these negative attitudes were also found amongst older adults in the UK. This could be a cause for concern due to evidence from other studies demonstrating the negative effect on cognitive and health outcomes in later life. The present thesis also found a cross-sectional association between more negative attitudes towards ageing and poorer subjective and functional health. The strength of this association was demonstrated as it attenuated the association between age and health. The exercise interventions in the present thesis demonstrated limited scope for improving attitudes towards ageing and did not change attitudes related specifically to physical change with ageing. However, increased positivity in attitudes related to psychological growth with ageing was related to improvements in semantic memory in middle-aged adults. No associations were found between change in attitudes towards ageing and cognitive improvements in older adults. This could reflect the physically challenging nature of the exercise programme which provides support for negative ageing stereotypes rather than a lack of relationship. Future research should take into account the self-relevance of attitudes towards ageing to further understand the relationship with cognitive outcomes in a physical activity context.

Perceived control

The construct of perceived control was investigated in the present thesis to see whether it could be a mechanism through which attitudes towards ageing impacted on health in Study 1a and on cognitive outcomes in Study 3 and Study 4. For instance, individuals who do not believe they have control over their future decline are less likely to try and maintain their functional health to delay or slow decline. Perceived control has been defined as the belief that a desired outcome is contingent on one’s actions (Skinner, 1996) and the belief that one has the means to achieve desired ends. Therefore, individuals with high perceived control would be more likely to engage in behaviours that they believe will lead to desired outcomes, for example there is evidence to suggest they are more likely to be active in everyday life, maintain exercise programmes and adhere to physician regimens (Marcus, Eaton, Rossi, & Harlow, 1994; Schwarzer, 2008). The mechanism through which perceived control impacts on future health has been described as a self-fulfilling prophecy, which has been defined as “in the beginning, a FALSE definition of the situation evoking a new behaviour which makes the originally false conception TRUE” (Merton, 1948).

Control beliefs have previously been assessed as a mediator of the effect of age-related cognitions on health in later life (e.g. Wurm et al., 2007). Wurm et al. used the same measure of perceived control as in the present thesis and they found that it did not mediate this effect. However, in Study 1a perceived control was independently associated with subjective health but not functional health. Attitudes towards ageing attenuated the association between perceived control and functional health. Another study which used a different measure of perceived control found that it partially mediated the effect of self-perceptions of ageing on future functional health (Levy & Myers, 2004). The different measures of attitudes towards ageing and perceived control used may explain these different results. The present study used the two perceived control subscales of the dispositional trait hope scale (Snyder et al., 1991) as separate variables in analyses. Only the pathway subscale was associated with health, whilst the agency subscale was not. The agency subscale consists of efficacy expectancies reflecting the belief in one's capacity to initiate and sustain actions to achieve goals e.g. “I energetically pursue my goals”. The pathway subscale consists of outcome expectancies reflecting belief in one's capacity to generate routes and strategies to reach goals, e.g. “There are lots of ways around any problem” (Snyder et al., 1991). The distinction between these subscales could be important. The findings from Study 1a suggest that the belief that one has the capacity to generate routes and strategies to reach goals is related to health rather than the belief in one’s capacity to initiate and sustain actions. This suggests that the relationship with health is based on more than just motivation for behaviour and instead reflect beliefs related to self-efficacy. The role of self-efficacy is discussed further in the next section.

It is important to recognise that the relationship between perceived control and health outcomes in unlikely to be linear whereby higher perceived control is linearly related to better health outcomes. There is evidence from previous studies which suggests that having stronger perceived control can also be associated with poorer health outcomes, depending on the circumstances (Rodin, 1986; Seeman, 1991). This hypothesis is based on the circumstances where there is a mismatch between perceived control and the environmental affordance, i.e. the actual amount of control an individual objectively has over a situation (Evans et al., 1993). This incongruence could be detrimental to health in a situation where an individual does not have personal control; strong control beliefs could initiate a physiological stress response. The long term effects of this could have a detrimental impact on health, and stressful events have been implicated in triggering the early symptoms of dementia (Reich et al., 2012). Thus, an optimistic but realistic perception of perceived control may have the most protective effect. Caution needs to be taken when using analyses which assume a linear relationship.

It was discussed in Chapter 2 that perceived control can be conceptualised as a state which can change over time rather than a trait. Significant associations have been found between older age and lower sense of control at baseline and also for a gradual decreasing sense of control with age over a period of one year (93% of the sample were aged between 45 and 85) (Wolinsky et al., 2003). Study 3 and Study 4 investigated whether perceived control could be increased through participation in an exercise intervention and whether this change was related to improvements in cognitive ability. In Study 3 with middle-aged adults, there was no association between change in perceived control and cognitive improvements. However, after controlling for changes in perceived control the previously non-significant effect of resistance training on cognitive outcomes became significant. This suggested that change in perceived control explained some of the variance in cognitive improvements and that controlling for this allowed the effect of resistance training on cognitive outcomes to be detected. The lack of association between changes in perceived control and cognitive improvements could be due to the lack of change in perceived control overall in the sample during the intervention. The middle-aged sample (40-65 years) may have not yet experienced a significant decline in perceived control and therefore have less scope for this to increase. However, the sample for Study 4 was older adults which could have been expected to have a lower sense of control at baseline (Wolinsky et al., 2003). In Study 4, the large baseline differences between groups made the interpretation of the direction of the effect challenging. Interestingly, the resistance group on average reported decreased perceived control compared to the flexibility who reported increased perceived control. It was suggested that different types of exercise may have had different psychosocial effects on participants due to the differences in the design of the exercise programmes. The resistance training was designed to be progressive and was therefore continually challenging compared to the flexibility programme which was not progressive. Carrying out exercises which are continually challenging does not afford feelings of performing exercises more easily due to increased fitness. This could have resulted in decreased perceived control as participants in this group would not have bodily feedback of improved fitness despite their efforts with the exercises. The level of decrease in perceived control was moderated by age whereby participants who were older were more likely to report a reduction in perceived control in terms of both agency and pathway. This could reflect that older adults' perceived control is less resilient and more susceptible to decrease as a result of challenging physical exercise.

In the context of cognitive ability, individuals who do not believe they have more control over their future decline may be less likely to try and maintain their cognitive ability to delay or slow decline. For example, individuals with higher perceived control over cognitive decline may use more memory strategies, and be more motivated to concentrate and sustain effort and attention during the cognitive task. Previous research found that older adults were more likely to attribute memory problems to age compared to younger participants who attributed them to tension, emotions problems, poor concentration and insufficient mental exercise (Commissaris et al., 1995). Attributing memory problems to age reflects lower levels of perceived control compared to the other reasons that younger adults cited which individual have more control over. There is additional evidence that a high sense of agency and personal control has direct effects on cognitive performance (Berry, 1999; Hertzog et al., 2009; Hess, 2005) and everyday problem solving (Artistico, Cervone, & Pezzuti, 2003). Hertzog and colleagues (2009) discussed this evidence and suggested that the role of perceived control on cognitive ability is related to spontaneous use of mnemonic strategies that aid memory performance (e.g. Lachman & Andreoletti, 2006). It was further suggested that control beliefs may be related to self-regulation during cognitive tests (Riggs et al., 1997). The findings from Study 3 found that change in perceived control was associated with verbal fluency. A potential mechanism though which perceived control may act upon verbal could be through the use of recall strategies (e.g. categorising words).

Another mechanism through which perceived control could affect cognitive outcomes could be through an indirect effect on how the exercises are carried out which would impact on subsequent physiological mechanisms. As previously mentioned, perceived control has been defined as the belief that a desired outcome is contingent on one's actions (Skinner, 1996). Therefore, if participants believed that participating in the exercise intervention would have a positive effect on their health and cognitive ability, then this may have affected how they carried out the exercises. Adherence (number of sessions completed or attempted) was not related to baseline level of perceived control, however it may have affected how participants carried out the exercises. For example, participants with higher perceived control may have carried out the exercises with more intensity or a higher number of repetitions. This was not analysed in the present thesis.

The findings of Study 3 suggest that the mechanism through which change in attitudes towards ageing impact on cognitive outcomes could potentially be through increased perceived control. This is suggested because the increases in attitudes related to psychological growth with ageing were associated with increases in both agency and pathway aspects of perceived control. Attitudes towards ageing were each associated with cognitive improvements but Agency and pathway beliefs were not on any task. This suggests that the role of perceived control on cognitive outcomes in an exercise intervention context could be the driving mechanism of attitudes towards ageing effects with older adults. However, as perceived control decreased in the resistance group in Study 4 which did show some cognitive improvements, these findings need to be interpreted with caution and further research is needed. The measure of perceived control used in the present thesis captured beliefs related to non-specific goals and problems. Using a measure of perceived control which captures beliefs specific to ageing, cognitive and health decline, and physical activity may provide a clearer picture of the mechanisms through which changes in perceived control affect cognitive outcomes in an exercise intervention.

In conclusion, the present thesis found that higher perceived control related to pathway beliefs was independently associated with better subjective health but this association was attenuated by attitudes towards ageing for functional health. This association with pathway but not agency beliefs suggests that the relationship with health is based on more than just motivation for behaviour and instead reflect beliefs related to self-efficacy. The findings of the exercise intervention with older adults suggested that increases in perceived control did explain some of the variance in processing speed and verbal learning as the effect of resistance training on these cognitive outcomes only became significant when this was controlled for. In middle-aged adults the exercises programmes did not significantly change perceived control. However, in older adults the resistance programme lead to decreased perceived control on average compared to the flexibility programme which lead to an increase. Age may be a moderator of the role of perceived control in this context. In relation to the effect of the exercise programme on perceived control, an older age was more likely to be associated with a decrease perceived control during the exercise intervention. The findings from Study 3 suggest that the association between increased perceived control and improvements in verbal learning may be as a result of increased effort and attention and use of memory strategies. However, due to the small sample sizes these findings need to be interpreted with caution and more research is needed to further investigate these potential mechanisms.

Self-efficacy

Self-efficacy was only investigated in Study 4 of the present thesis which was primarily assessing the feasibility of the exercise programmes in older adults. Memory, physical, and general self-efficacy measures were included to investigate whether they were a mechanism through which other psychosocial factors impacted on cognitive outcomes during the exercise intervention. Bandura coined the term self-efficacy as “the belief in one’s capabilities to organize and execute the courses of action required to manage prospective situations” (Bandura, 1995). Self-efficacy was investigated as a possible mechanism due to the evidence from non-exercise contexts: self-efficacy beliefs are suggested to enhance or hinder cognitive performance through a variety of processes, including motivational, affective and meta-cognitive aspects (Bandura, 1989). Self-efficacy is implicated as a precursor to other cognitions and therefore as a determinant of how people think, behave and feel (Bandura, 1986). Self-efficacy is also related to perceived control, in particular the pathway beliefs investigated in the present thesis appear to reflect general self-efficacy beliefs related to everyday problem solving and achieving goals.

The overall decrease in general self-efficacy of participants in the resistance training group was a surprising finding. However, a recent meta-analysis assessed which behaviour change techniques were most effective at increasing self-efficacy and physical activity in older adults (French, Olander, Chisholm, & Mc Sharry, 2014). They concluded that commonly used self-regulatory techniques that are effective for younger adults may not be effective for increasing self-efficacy in older adults. The techniques which were associated overall with lower levels of self-efficacy (and physical activity) were goal setting, self-monitoring, planning for relapses, providing normative information, and providing feedback on performance. Study 4 used a number of self-regulatory techniques during the intervention as the exercise programme was self-led and carried out in participants' place of residence. Exercise diaries were used for self-monitoring so that participants could keep track of how many set and repetitions (in the resistance group) they did or for how long they held each stretch (in the flexibility group). This also acted as a method of feedback as they would have been able to notice progression, e.g. whether the number of sets or repetitions increased. Another method of feedback for the resistance group was the colour of the resistance bands which represented different levels of strength which the participants could progress through. However, no participants progressed past the second level. Participants in both groups were also asked to rate how difficult they found each exercise in each session. The resistance programme was designed to be progressive and thus would have continued to be challenging through the 12 weeks. These self-regulatory techniques may have caused the older adults to become more aware of physical limitations or challenges. In contrast, the flexibility programme was designed to be low intensity and not progressive and thus participants would have been more likely to notice the exercise becoming easier during the 12 weeks. Internal feedback from exercise induced sensations has been suggested to impact on self-efficacy (Ewart, 1989). Perhaps participants in the resistance group did not experience positive bodily feedback from exercises feeling easier and may have instead experienced negative bodily feedback e.g. aches and pains. These differences in the programmes may explain the decreased self-efficacy in the resistance programme compared to the increased self-efficacy in the flexibility programme.

There could have been other components of the intervention design which hindered increases in self-efficacy. It has been suggested that self-efficacy can be enhanced through exercise through individuals comparing their performance to their past performance as well as performance of their peers (Ewart, 1989). Therefore, as exercise programmes in the present study were home-based and carried out alone there was no opportunity for peer comparison or social benefits. Bandura (1986) cited mastery experiences and peer comparison as important methods for improving self-efficacy. The lack of social interaction involved in the exercise intervention and the lack of mastery experiences in the progressive resistance training programme due to it being continually challenging may further explain the decreased self-efficacy in the resistance programme.

Previous research in a memory context, found that goal setting in older adults did not led to an increase in self-efficacy but it did in younger adults (West & Thorn, 2001). This evidence together with the findings from the recent meta-analysis (French et al., 2014) suggest that exercise interventions for older adults should be designed with this specific population in mind and should not be based on assumptions that what is effective for younger adults will also be for older adults. The increases in general self-efficacy in the control group who carried out the flexibility programme suggests that lower intensity exercise may be more effective for increasing self-efficacy in older adults. An intervention study with older adults found that those who participated in T'ai Chi reported increases in self-efficacy for physical capabilities compared to a wait-list control (Li et al., 2001). However, the literature of exercise interventions assessing cognitive outcomes suggest that moderate intensity exercise is required to bring about cognitive improvements (e.g. Cassilhas et al., 2007; Kramer & Erickson, 2007b). Perhaps a personalised exercise plan is required to balance a suitable level of intensity to bring about cognitive benefits but not too challenging that it would decrease self-efficacy and adherence. It is important to maintain or increase self-efficacy as it has been identified as one of the most intensively studied and consistent predictors of initiation and maintenance of physical activity in those 50 years and older (van Stralen, De Vries, Mudde, Bolman, & Lechner, 2009). Additionally, a stronger longitudinal association has been found between self-efficacy and physical activity in older adults compared to younger adults (Schwarzer & Renner, 2000). A treadmill based exercise intervention of preferred intensity with women suffering from depression resulted in more positive outcomes compared to an exercise intervention of prescribed intensity (Callaghan, Khalil, Morres, & Carter, 2011). These positive outcomes included a reduction in levels of depression, better self-esteem, better general mental health, better quality of life, and higher levels of exercise adherence. It is important to note that the preferred level of intensity was lower than the prescribed level of intensity but still brought about these positive effects. Future exercise interventions with older adults should investigate the effectiveness of preferred rather than prescribed programmes. Utilising a preferred exercise programme design could facilitate psychological improvements and higher levels of adherence which could enhance potentially the cognitive gains in relation to long-term maintenance and future cognitive decline.

The results of Study 4 suggested that self-efficacy may be associated with cognitive improvements. Specifically, increases in memory self-efficacy were associated with improvements in verbal learning and executive function. Interestingly, improvements in global cognitive ability were associated with increases in general self-efficacy which is a non-memory specific domains of self-efficacy and improvements in cognitive ability were also found. However, the large baseline differences on cognitive tasks between groups (split by increase or decrease on self-efficacy measures) make it difficult to interpret the direction of associations. Additionally, participants in the resistance group reported a decrease in general self-efficacy compared to those in the flexibility group who reported an increase (as was the case with perceived control). This created a further challenge for interpreting the results. In relation to the association between increases in memory self-efficacy and improvements in cognitive ability, it is difficult to assess the causal direction. The reciprocal nature of this relationship has been acknowledged (e.g. Bandura, 1989) and discussed (Hertzog at al., 2009). It has been argued that longitudinal changes in self-efficacy beliefs could be a result of monitoring cognitive changes and are a consequence rather than a cause of cognitive change. It has been further suggested that monitoring cognitive changes could be a major influence on perceived disability and general self-efficacy due to central importance given to effective cognitive ability for well-being in older adults (Hertzog et al., 2009). The potentially reciprocal nature of the relationship between self-efficacy beliefs and cognitive changes makes the interpretation of associations challenging. However, Study 4 also investigated the effect of the exercise intervention on physical and general self-efficacy and the transfer between domains. This transfer between domains could indicate some possible casual pathways.

The findings of Study 4 suggest a potential transfer from increased physical self-efficacy to increased general self-efficacy during the intervention for the sample as a whole. This does not agree with a previous study which suggested that domain specific self-efficacy may not be transferable to a general measure of self-efficacy, but may be transferable to another domain (Weitlauf et al., 2000). These findings could indicate that physical self-efficacy is closely related to general self-efficacy in older adults. This could be because physical ability may be more likely to be related to ability to carry out activities of daily living among older adults compared to younger adults. In the resistance group only, there was strong correlation between increases in physical self-efficacy and improvements in frequency of forgetting which does agree with the findings of Weitlauf et al., (2000). Bandura argued that self-efficacy is domain specific, however he also recognised that there is some inter-domain relation in perceived efficacy when performance in different activities is guided by similar self-regulatory skills (Bandura, 1997). For example, in this context: self-efficacy in domains that are associated with decline in ageing including physical and cognitive ability (findings from Study 1b). It may be that by improving self-efficacy in one domain (e.g. physical which was associated with increases in lower body strength) this challenges core beliefs of what older adults believe they are capable of and the degree to which their decline is inevitable and out of their control (Stock et al., 2012). This then transfers to another domain of self-efficacy which is associated with decline in ageing e.g. cognitive ability. This could be a mechanism through which exercise improves cognitive ability, due to motivational, affective and meta-cognitive aspects (Bandura, 1989), such as use of memory strategies.

Overall, increases in self-efficacy were associated with improvements on more complex and global cognitive tasks. In contrast, increases in lower body strength, grip strength, and better self-reported functional health were associated with improvements on more simple cognitive outcomes. There was no overlap between cognitive domains which were associated with these self-efficacy or physical improvements. This suggests there may be a domain specific effect of change in these psychosocial factors on cognitive outcomes which is distinct from the positive effects from improvements in physical fitness and health. As previously suggested, more complex cognitive tasks may be more likely to be related to changes in psychosocial factors due to the more complex cognitive processes required to perform well on these tests, such as sustained attention (Cohen, Weingartner, Smallberg, Pickar, & Murphy, 1982) or motivation to employ memory strategies (Bandura, 1989). These findings agree with the work of Bandura who argued that those who are high in self-efficacy are low in performance anxiety and more strategic in their efforts to achieve their goals. He also argued that they are more persistent in their pursuit when faced with adversity or complicating circumstances (Bandura, 1986), which could be particularly important for resilience with ageing. This finding could potentially explain the differences in conclusions between reviews and meta-analyses of whether cognitive gains from exercise interventions are on complex or simple domains (Angevaren et al., 2008; Clifford et al., 2009; Colcombe & Kramer, 2003; Hogervorst et al., 2012).

In conclusion, the findings of the exercise intervention with older adults suggested that change in memory self-efficacy could potentially play a role in cognitive gains. Increases in self-efficacy were associated with improvements on complex and global cognitive tasks compared to increases in grip and lower body strength and better self-reported functional health were associated with improvements on more simple cognitive outcomes. Surprisingly, the resistance group reported an overall decline in general self-efficacy compared to the flexibility group which reported an overall increase in general self-efficacy. It was suggested that this may be due to the self-regulatory components and the continually challenging nature of the progressive resistance training programme may have contributed to this. Commonly used self-regulatory techniques (e.g. goal setting, self-monitoring, and feedback) that are effective for younger adults may not be effective for increasing self-efficacy in older adults. The findings indicate that a transfer of increases in physical self-efficacy to memory self-efficacy may have occurred during this exercise intervention with older adults. This may have occurred due to the commonalities involved as they are both domains which were reported to be associated with decline with increasing age in Study 1b. The findings of the present thesis suggest that numerous domains of self-efficacy could play a role in exercise interventions aiming to improve cognitive ability. However, future research with larger samples is required investigate the mechanisms of how different domains of self-efficacy interact with each other and impact on physical, cognitive and psychological outcomes.

Mental health

Depression is an overall risk factor for dementia (Lyketsos et al., 2010) and is associated with poorer cognitive performance longitudinally, whereby there is an acceleration in age related decline compared to age matched controls (Gualtieri & Johnson, 2008). Previous research has demonstrated the positive benefits of exercise on mental health (Callaghan et al., 2011; Martinsen, 2008; Stanton & Reaburn, 2014). There is a high prevalence of depressive symptoms in individuals over 65 years old (approximately 15% with depressive symptoms, and approximately 4% with major depression; Lyketsos et al., 2010) which indicates the potential scope for intervention.

In the present thesis mental health was captured and investigated in a number of different ways. In Study 2b, overall mental health was captured as part of a quality of life measure in a cross-sectional study with middle and older-aged adults in Indonesia. In Study 3, levels of depression and anxiety were captured before, at mid-intervention, and after the exercise intervention with middle-aged adults. In Study 4, levels of depression, anxiety and also well-being were captured before, at mid-intervention, and after the exercise intervention with older-aged adults.

The findings of Study 2b indicated that mental health was associated with global cognitive ability and a complex cognitive task i.e. verbal learning, independently of the association between frequency of walking and these cognitive outcomes. However, functional health moderated the association of walking but not mental health with cognitive ability. Furthermore, in participants with better mental health, walking was not associated with cognitive ability. However, in those with worse mental health, walking was still associated with better cognitive ability. Additionally, functional health and frequency of walking were both independently associated with mental health. Causal directions could not be inferred from this cross-sectional data. This study demonstrated that the independent association between mental health and cognitive ability in the context of walking appears to have a broad effect across domains, including global cognitive ability.

Mental health is the only psychosocial factor in the present thesis that has been considered in the previous literature as a potential mediator in this context of exercise interventions to the author’s knowledge to date (discussed in Miller, et al., 2012; Hertzog et al., 2009). However, few intervention studies have included a measure of mental health. In the studies that have, usually a measure of depression was included to screen and exclude those with levels of depression above cut-off scores or as a covariate (e.g. Dustman et al., 1984). Dustman et al., found an improvement in cognitive ability but not depression. The interventions included in the present thesis investigated the relationship further by assessing whether an improvement in mental health was associated with cognitive improvements.

The findings from Study 3 indicated that a reduction in depression was associated with an improvement in cognitive outcomes from complex cognitive domains including semantic memory and potentially executive functioning in middle-aged adults. In Study 4, depression was also associated with performance on a global cognitive test which includes a range of cognitive outcomes which included both simple (e.g. processing speed) and complex (e.g. verbal learning) domains with older adults. Simple cognitive tasks were not included in Study 3, however the results of Study 4 indicate that a reduction in depressive symptoms appeared to have a broad effect on cognitive ability across multiple domains. In a non-exercise context, depression has been associated with slower processing speed and poorer working memory (Halvorsen et al., 2012). Problems with encoding could be due to slower processing speed or rumination, which may mean that information is missed. In older adults with mild cognitive impairment, depression impacted on general life functioning, and this was partially mediated by slower processing speed (Brown et al., 2013). Therefore, a reduction in depressive symptoms during the intervention could result in faster processing speed which could positively impact on other cognitive domains. Other research has also indicated a negative effect of depressive symptoms on a range of cognitive outcomes including memory recall, language, function, working memory, and cognitive tasks which required sustained effort (Brown, Scott, Bench, & Dolan, 1994; Halvorsen et al., 2012; Weingartner & Cohen, 1981).

There are a number of potential mechanisms through which alleviation of depressive symptoms could improve cognitive ability. One potential mechanism that a reduction in depression could impact on improved cognitive ability is through increased blood flow in certain brain regions which has previously been found to be associated with a reduction in depression (Bench, Frackowiak, & Dolan, 1995). Additionally, cognitive deficits in depression were associated with lowered regional cerebral blood flow, particularly the medial prefrontal cortex (Bench et al., 1992; Dolan et al., 1992; Dolan, Bench, Brown, Scott, & Frackowiak, 1994) and so exercise participation could cause increased blood flow which could impact on cognitive performance. Another potential mechanism that a reduction in depression could impact on improved cognitive ability could be through motivational processes. This is suggested as the greatest depression-related impairment has been found on cognitive and motor tasks that required sustained effort (Cohen, Weingartner, Smallberg, Pickar, & Murphy, 1982). Motivational mechanisms could impact on how motivated participants are to perform well on the cognitive tasks, and therefore how much effort they elicit to sustain attention or whether they employ memory strategies, such as chunking words into categories during the HVLT. Therefore, exercise participation and an associated reduction in depression could have had both an indirect as well as direct effects on cognitive performance.

Despite depression having been suggested as a potential mediator of the relationship between physical activity and cognitive performance previously (e.g. Miller et al., 2012), the understanding of this interaction is limited due to the low numbers of clinically depressed patients in intervention studies. Previous exercise intervention studies have often either excluded patients who scored above cut-offs for depression or those who did not exclude on this basis had low levels or few participants who reported higher levels of depressive symptoms (Hertzog et al., 2009; Miller et al., 2012). Individuals with higher levels of depression may exclude themselves by not choosing to participate or by dropping out of the exercise intervention; consequently the variation in scores on a depression measures has usually been limited (Miller et al., 2012). This was true of Study 3 and Study 4, few participants reported high levels of depression or anxiety at baseline, thus there would have been limited scope for improvement. Future studies with more participants with higher levels of depression are needed to understand the mechanisms of this interaction.

A reduction in anxiety appeared to play a similar role to depression in Study 3 and Study 4. In Study 3, a reduction in anxiety was associated with an improvement in verbal learning. There was also a possible link with increased positivity with attitudes related to physical change with ageing during the intervention. In Study 4, anxiety appeared to have a somewhat broad association with global and complex domains (i.e. verbal learning) but not on simple cognitive tasks. The mechanisms through which anxiety impacts of cognitive ability have been investigated. Previous research found that anxiety was related to poorer performance in working memory, and executive function in older adult longitudinally (Wetherell, Reynolds, Gatz, & Pedersen, 2002). Cognitive tasks which rely on long-term retrieval of knowledge and perceptual speed were not found to be affected by anxiety. It has been suggested that anxiety impairs processing efficacy through mechanisms, such as attentional control e.g. inhibiting attention to task-irrelevant stimuli and flexibly switching attention between and within tasks to maximise performance (Derakshan & Eysenck, 2009). The findings of the exercise interventions in the present thesis agree somewhat with the previous literature. Processing efficacy and attentional control are likely to have played a role in the complex tasks that associations were found with e.g. verbal fluency and verbal learning. However, a number of complex tasks were not associated with a reduction in anxiety e.g. the digit span backwards assessing working memory. Additionally, a reduction in levels of anxiety could be related to increased self-efficacy as Bandura argued that those who are high in self-efficacy are low in performance anxiety and more strategic in their efforts to achieve their goals. He also argued that they are more persistent in their pursuit when faced with adversity or complicating circumstances (Bandura, 1986). It is important to note that, a large proportion of participants reported feeling anxious during the cognitive testing session. This state anxiety is likely to have affected performance.

The association between anxiety and depression with verbal learning in Study 3 was independent from that of increased leg strength and exercise group. This could indicate a possible additive effect of psychosocial factors to physical fitness mechanisms on cognitive outcomes. This suggests that exercise interventions which facilitate improvements in mental health as well as physical fitness could enhance the effect on cognitive gains.

Well-being was captured in Study 4 to assess positive feelings as opposed to a reduction in depressed or anxious feelings as a result of the intervention. Amongst these older adults, no association was found between change in self-reported well-being and change in cognitive outcomes. This may suggest that increases in feelings of well-being plays less of a role in cognitive outcome in an exercise intervention compared to a reduction in depressive and anxiety symptoms which appeared to have a potentially broader effect across cognitive domains in this context. However, these findings are based on very small sample sizes and the measure of well-being used may not have been sensitive enough to pick up effects. Thus, further research should consider the role of improved well-being as a potential mediator of cognitive outcomes.

In conclusion, improvements in mental health were found to be associated with cognitive improvements in the exercise interventions with both middle-aged and older adults. Depression appeared to have a potentially broad effect, with a reduction in depression being associated with an improvement across a number of complex and global cognitive tasks. A reduction in anxiety had less broad associations across cognitive domains with verbal learning. Improvements in anxiety and depression were associated with improvements in verbal learning independent of the effects of an increase in physical fitness. This suggests that improvements in mental health could have a potentially additive effective to physical effects in an exercise intervention context. Despite the high prevalence of depressive symptoms in individuals over 65 years old (Lyketsos et al., 2010) and potential scope for exercise to improve mental health and subsequently improve cognitive ability there is a limited number of intervention studies which have investigated this. Future work could investigate the interactions between different psychosocial factors in this context. They are likely to be interrelated, for example physical self-efficacy has been found to be the strongest predictor of depressive symptoms compared to objective physical measures (Davis-Berman, 1990). However, due to the small sample sizes these findings need to be interpreted with caution and more research is needed to further investigate these potential mechanisms.

Strengths and limitations of the present thesis including future directions

The present thesis investigated the role of four psychosocial factors in the relationship between physical activity and cognitive ability in older adults. A strength of the present thesis is that it adds to current knowledge as three out of four of these psychosocial factors had not been investigated experimentally in this context. However, it is likely that there are other psychosocial factors not included in the present thesis that may also play a role in this relationship, such as personality. Personality has been investigated in relation to ageing and some evidence suggests that higher levels of openness to experience were longitudinally associated with more successful ageing (Gregory, Nettelbeck, & Wilson, 2010) and that neuroticism was associated with a higher risk of dementia (Wang et al., 2009). Another psychosocial factor that should be investigated in future work is resilience with ageing, in relation to the ability to overcome adversity (Kessel, 2013). This is relevant in this context for the maintenance of physical activity despite physical limitations. Furthermore, in relation to attitudes towards ageing, it may be that resilience against socio-cultural negative stereotypes of ageing is also important for maintaining positivity. This could potentially moderate the effect of attitudes towards ageing on health and cognitive outcomes and thus is worthy of further investigation.

A further limitation of the present thesis is there are factors that could impact on cognitive ability in an exercise intervention that were not assessed but may have mediated or moderated the effects on cognitive outcomes. Such factors include diet (e.g. Francesco Sofi, Abbate, Gensini, & Casini, 2010), hormone levels (e.g. Hogervorst, Bandelow, Combrinck, & Smith, 2004), and genetic risk (e.g. Podewils & Guallar, 2005). Hormone data including cortisol and testosterone was collected in Study 3 and Study 4 and further work related to this is ongoing.

There are many methodological challenges in physical activity research with older adults (Chase, 2013). The variation in physical health, fitness, cognitive performance, level of independence etc. between individuals increases with age. As many of these factors could influence the relationship between physical activity and cognitive outcomes, it becomes challenging to isolate variables of interest when this can result in strict exclusion criteria, for example no comorbidities. This can limit the generalisability of the findings as so many older adults do have chronic health conditions. A limitation of the exercise interventions is that the participants who volunteered are likely to have been those who were more positive and socially and physically active beforehand already as part of their daily life. An issue with this sampling bias is that the older adults who may stand to benefit the most from such interventions are not captured. However, a strength of the exercise intervention with older adults was the recruitment strategy used which targeted older adults living in sheltered housing communities with higher levels of dependence and mobility problems, with the aim of capturing a more diverse sample.

One main limitation of the pilot exercise interventions was the small sample size and large number of drop-outs in the older adult sample (Study 4) which led to systematic differences between the groups as well as large baseline cognitive differences. Additionally, there appeared to be a potentially moderating effect of age of psychosocial improvements during the resistance exercise programme. Participants who were older were more likely to report a decrease in perceived control during the intervention and participants in the resistance group were also generally older. Additionally, older participants were more likely to report an increase in positivity in attitudes related to psychosocial loss compared to younger participants. This could be related to the social interaction afforded by participation in the intervention but baseline social interactions were not included in analysis. These findings suggest that the impact of exercise on psychosocial factors may not be universal and age could moderate this effect. This is important to consider for the design of future exercise interventions as this potentially moderating effect of age on psychosocial factors could interact with cognitive outcomes. Additionally, this highlights an issue with categorising older adults into one group (for example, 65 years and older) when there is scope for large variations across these ages. This could also suggest that the moderating effect of age on cognitive outcomes could potentially be through psychosocial mechanisms. In addition to large baseline differences between exercise groups in Study 4, there was also large variance in change on cognitive outcome measures, even within groups.

This suggests that the usefulness of group only analysis may be limited and that investigating individuals differences and associations of those who did improve on cognitive outcomes compared to those who did not may give more insight into potential mechanisms.

The primary aim of Study 4 was to assess the feasibility of the exercise programmes with older adults and therefore the findings need to be interpreted with caution and the generalizability is limited. Thus, these interventions need to be replicated with larger sample sizes. A further limitation of the exercise interventions in particular was they small number of male participants. It was not possible to investigate gender differences in the role of psychosocial factors on cognitive outcomes. Future work should investigate whether gender plays a moderating role in this context.

The mechanisms of the associations between changes in psychosocial factors and cognitive outcomes should be investigated further. The associations of change between these variables do not indicate the casual pathways and therefore it is difficult to determine whether psychosocial factors are a cause or consequence of changes in cognitive ability. The present thesis did not investigate is the relationship between psychosocial factors and maintenance of exercise after cessation of programme. Improvements in psychosocial factors could be of further importance in an exercise intervention context if they increase the likelihood of maintenance of physical activity. The present thesis also did not investigate the role of psychosocial factors in relation to long-term effects on cognitive ability. Future work should investigate this as it is of central relevance to the preventative strategy to delay cognitive decline and dementia beyond the relatively short-term effects assessed in the present thesis.

Implications

The findings of the present thesis could have implications in terms of study design for exercise interventions that aim to improve cognitive ability in older adults. The findings suggest that the design of the exercise programme could impact on psychosocial factors which are also associated with cognitive outcomes. Careful thought is required when designing exercise interventions for older adults because self-regulatory strategies that are effective in younger adults may not be effective for older adults and were shown in the intervention to have a detrimental effect on psychosocial outcomes, in this instance on self-efficacy. This is important to note due to the preliminary evidence of negative associations of decreased self-efficacy with cognitive outcomes found in the present thesis and evidence for its predictive power of maintenance of physical activity behaviour (van Stralen et al., 2009). The findings of the present thesis have further implications for the design of exercise interventions which aim to isolate the effects of the exercise itself. Components of the exercise programme and environment need to be considered, particularly when deciding on an appropriate control programme that controls for psychosocial components. Both exercise interventions in the present thesis were self-led and carried out alone to control for the effect of social interactions on psychosocial factors and for logistical reasons. However, the findings of Study 2b suggest that social interaction has independent effects on cognitive ability. Thus, to maximise the cognitive gains from an exercise intervention, these findings together with evidence from other literature (Karp et al., 2006) suggest that including a social component could enhance the cognitive gains. The role of psychosocial factors on cognitive ability in this context may also increase if a social component was included, for example this would afford the opportunity for change in self-efficacy through peer comparison. An additional advantage of group based exercise programmes would be that instructors can monitor participants' progress and techniques and give advice and positive feedback at the time.

The proof of concept preliminary evidence that the association of psychosocial factors with cognitive outcomes was independent to that of physical fitness gains, suggests that there could be a potentially additive effect. Therefore, designing an exercise intervention which facilitates psychosocial improvements may further enhance cognitive gains. There are exercise interventions which have been effective at improving psychosocial outcomes (e.g. Callaghan et al., 2011) and psychosocial interventions which have been effective at improving cognitive outcomes (e.g. Stein et al., 2010). Future randomised controlled trials should combine components of effective interventions to investigate potential additive effects.

The findings of the present thesis could have implications in relation to the debate regarding different conclusions between reviews and meta-analyses of whether cognitive gains from exercise interventions are on complex or simple domains (Angevaren et al., 2008; Clifford et al., 2009; Colcombe & Kramer, 2003; Hogervorst et al., 2012). The findings from the present thesis suggested that physical fitness improvements in the exercise intervention with older adults were related to improvements on simple cognitive tasks whilst improvements in psychosocial factors were generally related to improvements on complex and global cognitive tasks. Depression was also related to improvement on simple tasks. This is likely to be due to the different mechanisms involved.

Another implication from the present thesis is that the usefulness of research that groups older adults of all ages together should be questioned, particularly as variation in cognitive and physical abilities increases with age. In the exercise intervention with older adults, there was large variation at baseline for cognitive and physical abilities and also in terms of cognitive outcomes within the same exercise groups. Additionally, age was also found to moderate the effect of exercise on psychosocial outcomes. This suggests the usefulness of grouping older adults together into groups for analyses is limited. There is a tendency to categorise everyone older than 65 years of age into one group. However, someone 20 years of age would be unlikely to be put in the same category as someone 50 years of age, so why should an individual that is 65 years of age be put in the same category as someone 95 years of age? There is a trend starting to group older adults into smaller age categories (e.g. young old to oldest old) which is likely to be a more useful way of understanding of ageing. Regardless, there is still likely to be large variation between individuals in these smaller age categories. Thus, an exercise intervention that can be adapted to suit different abilities would be the ideal option. For example, all exercises in the programmes used in the present thesis could be adapted to be carried out sitting down or with support.

A future implication could be the identification of effective interventions which maximise cognitive gains in older adults potentially those which facilitate psychosocial improvements as well as physical fitness gains. This could provide evidence to support government-funded exercise programmes that could be part of the preventative strategy against dementia to promote well-being and prolong independent living.

Conclusion

The findings from the present thesis provide support for the psychosocial approach to cognitive decline and dementia. The cross-sectional studies in the present thesis indicated relationships between psychosocial factors, physical health and cognitive ability. McAuley and colleague's (2004) model summarised the literature of the relationship between physical activity and cognitive ability (discussed in Chapter 3). The exercise intervention studies thesis provided proof of concept preliminary evidence for the hypothesised expansion of this model. This expansion suggests the role of psychosocial factors, in an exercise context for their potential impact on cognitive outcomes and not only as predictive of physical activity behaviour. The preliminary evidence suggested that improvements in psychosocial factors were associated with improvements in cognitive outcomes. Additionally, the preliminary findings with older adults suggested that this relationship could be domain specific on cognitive outcomes for different psychosocial factors. The potential mechanisms through which psychosocial factors impact on cognitive performance may explain the domain specific effects which could may explain some of the variation in findings in the literature. The association between mental health and cognitive outcomes appeared to be independent to physical fitness improvements, which suggested a potential additive effect on cognitive outcomes. However, these findings need to be interpreted with caution due to the parallel change of variables, small sample size and feasibility and pilot nature of the interventions. There could be a potential implication for the design of exercise programmes if they facilitate improvements in psychosocial factors as well as physical fitness, then this could enhance the effect of exercise on cognitive outcomes. Future research should replicate these studies with larger sample sizes to further understand the role of psychosocial factors in cognitive gains during exercise interventions in older adults.

References

Abbott, R. D. R., White, L. L. R., Ross, G. W., Masaki, K. H., & Petrovitch, H. (2004). Walking and dementia in physically capable elderly men. *JAMA: The Journal of the American Medical Association*, *292*(12), 1447–1453.

Age UK. (2012). *Later Life in the United Kingdom*. Retrieved from http://www.ageuk.org.uk/Documents/EN-GB/Factsheets/Later_Life_UK_factsheet.pdf?dtrk=true

Ahn Jo, S., Ahn, K., Kim, J.-H., Kang, B.-H., Kim, E., Jo, I., & Kim, D. K. (2006). ApoE-epsilon 4-dependent association of the choline acetyltransferase gene polymorphisms (2384G>A and 1882G>A) with Alzheimer's disease. *Clinica Chimica Acta; International Journal of Clinical Chemistry*, *368*(1-2), 179–182.

Allport, G. W. (1954). *The nature of prejudice*. Cambridge, UK: Addison-Wesley.

Alonso, A., Jacobs, D. R., Menotti, A., Nissinen, A., Dontas, A., Kafatos, A., & Kromhout, D. (2009). Cardiovascular risk factors and dementia mortality: 40 years of follow-up in the Seven Countries Study. *Journal of the Neurological Sciences*, *280*, 79–83.

Altman, D. G., & Bland, J. M. (1999). How to randomise. *The BMJ (Clinical Research Ed.)*, *319*(7211), 703–704.

Altman, D. G., & Schulz, K. F. (2001). Concealing treatment allocation in randomised trials. *BMJ: British Medical Journal*, *323*, 446–447.

Alzheimer's Society. (2007). Dementia UK: The full report. Retrieved October 03, 2013, from http://medcontent.metapress.com/index/A65RM03P4874243N.pdf

American Psychiatric Association. (1994). *Task Force on DSM-IV, Diagnostic and statistical manual of mental disorders: DSM-IV-TR.* Arlington, VA: American Psychiatric Publishing.

American Psychiatric Association. (2013). *Highlights of Changes from DSM-IV-TR to DSM-5, Neurodevelopmental Disorders*. Retrieved from http://www.dsm5.org/Documents

Amieva, H., Stoykova, R., Matharan, F., Helmer, C., Antonucci, T. C., & Dartigues, J.-F. (2010). What aspects of social network are protective for dementia? Not the quantity but the quality of social interactions is protective up to 15 years later. *Psychosomatic Medicine*, *72*(9), 905–911.

Anderson-Hanley, C., Nimona, J. P., & Westena, S. C. (2010). Cognitive health benefits of strengthening exercise for community-dwelling older adults. *Journal of Clinical and Experimental Neuropsychology*, *32*(9), 996–1001.

Angevaren, M., Aufdemkampe, G., Verhaar, H., Aleman, A., & Vanhees, L. (2008). Physical activity and enhanced fitness to improve cognitive function in older people without known cognitive impairment. *Cochrane Database of Systematic Reviews*, (3).

Angevaren, M., Vanhees, L., Wendel-Vos, W., Verhaar, H. J. J., Aufdemkampe, G., Aleman, A., & Verschuren, W. M. (2007). Intensity, but not duration, of physical activities is related to cognitive function. *European Journal of Cardiovascular Prevention & Rehabilitation*, *14*(6), 825–830.

Archer, E., & Blair, S. N. (2011). Physical activity and the prevention of cardiovascular disease: from evolution to epidemiology. *Progress in Cardiovascular Diseases*, *53*(6), 387–396.

Arent, S. M., Landers, D. M., & Etnier, J. L. (2000). The effects of exercise on mood in older adults : A meta-analytic review. *The Journal of Aging and Physical Activity*, *8*, 407–430.

Artistico, D., Cervone, D., & Pezzuti, L. (2003). Perceived self-efficacy and everyday problem solving among young and older adults. *Psychology and Aging*, *18*(1), 68–79.

Ashendorf, L., Jefferson, A. L., O'Connor, M. K., Chaisson, C., Green, R. C., & Stern, R. A. (2008). Trail Making Test errors in normal aging, mild cognitive impairment, and dementia. *Archives of Clinical Neuropsychology : The Official Journal of the National Academy of Neuropsychologists*, *23*(2), 129–137.

Atkinson, H. H., Rapp, S. R., Williamson, J. D., Lovato, J., Absher, J. R., Gass, M., … Espeland, M. A. (2010). The relationship between cognitive function and physical performance in older women: results from the women's health initiative memory study. *The Journals of Gerontology. Series A, Biological Sciences and Medical Sciences*, *65*(3), 300–306.

Austin, M. P., Ross, M., Murray, C., O'Carroll, R. E., Ebmeier, K. P., & Goodwin, G. M. (1992). Cognitive function in major depression. *Journal of Affective Disorders*, *25*(1), 21–29.

Babyak, M. A., Snyder, C. R., & Yoshinobu, L. (1993). Psychometric properties of the Hope Scale: A confirmatory factor analysis. *Journal of Research in Personality,* 27, 154–169.

Baker, L. D., Frank, L. L., Foster-Schubert, K., Green, P. S., Wilkinson, C. W., McTiernan, A., … Craft, S. (2010). Effects of aerobic exercise on mild cognitive impairment: a controlled trial. *Archives of Neurology*, *67*(1), 71–79.

Bandura, A. (1978). Self-efficacy: Toward a unifying theory of behavioral change. *Advances in Behaviour Research and Therapy*, *1*(4), 139–161.

Bandura, A. (1986). The explanatory and predictive scope of self-efficacy theory. *Journal of Social and Clinical Psychology*, *4*(3), 359–373.

Bandura, A. (1989). Regulation of cognitive processes through perceived self-efficacy. *Developmental Psychology*, *25*(5), 729–735.

Bandura, A. (1995). Exercise of personal and collective efficacy in changing societies. In A. Bandura (Ed.) *Self-Efficacy in Changing Societi*es (pp. 1–45). Cambridge University Press, New York.

Barberger-Gateau, P., Commenges, D., Gagnon, M., Letenneur, L., Sauvel, C., & Dartigues, J. F. (1992). Instrumental Activities of Daily Living as a screening tool for cognitive impairment and dementia in elderly community dwellers. *Journal of the American Geriatrics Society*, *40*(11), 1129–1134.

Barberger-Gateau, P., Fabrigoule, C., Helmer, C., Rouch, I., & Dartigues, J. F. (1999). Functional impairment in instrumental activities of daily living: an early clinical sign of dementia? *Journal of the American Geriatrics Society*, *47*(4), 456–462.

Barnes, D. E., Santos-Modesitt, W., Poelke, G., Kramer, A. F., Castro, C., Middleton, L. E., & Yaffe, K. (2013). The Mental Activity and eXercise (MAX) trial: a randomized controlled trial to enhance cognitive function in older adults. *JAMA Internal Medicine*, *173*(9), 797–804.

Bassuk, S. S., Glass, T. A., & Berkman, L. F. (1999). Social disengagement and incident cognitive decline in community-dwelling elderly persons. *Annals of Internal Medicine*, *131*(3), 165–173.

Bassuk, S. S., & Manson, J. E. (2010). Physical activity and cardiovascular disease prevention in women: a review of the epidemiologic evidence. *Nutrition, Metabolism, and Cardiovascular Diseases : NMCD*, *20*(6), 467–473.

Becker, G. (1980). *Growing old in silence*. University of California Press.

Bench, C. (1995). Changes in regional cerebral blood flow on recovery from depression. *Psychological Medicine*, *25*, 247–251.

Bench, C. J., Friston, K. J., Brown, R. G., Scott, L. C., Frackowiak, R. S. J., & Dolan, R. J. (1992). The anatomy of melancholia: Focal abnormalities of cerebral blood flow in major depression. *Psychological Medicine*, *22*, 607–615.

Berkman, L. F., Leo-Summers, L., & Horwitz, R. I. (1992). Emotional support and survival after myocardial infarction. A prospective, population-based study of the elderly. *Annals of Internal Medicine*, *117*(12), 1003–1009.

Berry, J. (1999). Memory self-efficacy in its social cognitive context. In T. M. Hess & F. Blanchard-Fields (Eds.), *Social Cognition and Aging* (pp. 69–96). San Diego, CA, US: Academic Press.

Bherer, L., Erickson, K. I., & Liu-Ambrose, T. (2013). A Review of the Effects of Physical Activity and Exercise on Cognitive and Brain Functions in Older Adults. *Journal of Aging Research*, *2013*, 657508.

Biddle, S., & Mutrie, N. (2007). *Psychology of physical activity: Determinants, well-being and interventions*. London: Routledge.

Bielak, A. (2010). How can we not "lose it"if we still don't understand how to "use it"? Unanswered questions about the influence of activity participation on cognitive performance in older. *Gerontology*, *56*, 507–519.

Bjelland, I., Dahl, A. A., Haug, T. T., & Neckelmann, D. (2002). The validity of the Hospital Anxiety and Depression Scale. *Journal of Psychosomatic Research*, *52*(2), 69–77.

Blair, S., & Brodney, S. (1999). Effects of physical inactivity and obesity on morbidity and mortality: current evidence and research issues. *Medicine and Science in Sports and Exercise*, *31*, S646–S662.

Blumenthal, J. A., Emery, C. F., Madden, D. J., George, L. K., Coleman, R. E., Riddle, M. W., … Williams, R. S. (1989). Cardiovascular and behavioral effects of aerobic exercise training in healthy older men and women. *Journal of Gerontology*, *44*(5), M147–M157.

Blumenthal, J. A., & Madden, D. J. (1988). Effects of aerobic exercise training, age, and physical fitness on memory-search performance. *Psychology and Aging*, *3*(3), 280–285.

Bodenhausen, G., Kramer, G., & Susser, K. (1994). Happiness and stereotypic thinking in social judgment. *Journal of Personality and Social Psychology*, *66*, 621–632.

Boduroglu, A., Yoon, C., Luo, T., & Park, D. C. (2006). Age-related stereotypes: a comparison of American and Chinese cultures. *Gerontology*, *52*(5), 324–333.

Bonner, A., & Cousins, S. (1996). Exercise and Alzheimer's disease: benefits and barriers. *Activities, Adaptation & Aging*, *20*(4), 21–34.

Borg, G. (1982). Psychophysical bases of perceived exertion. *Medicine & Science in Sports & Exercise*, *14*(5), 377–381.

Bosscher, R. J., Van Der Aa, H., Van Dasler, M., Deeg, D. J. H., & Smit, J. H. (1995). Physical Performance and Physical Self-Efficacy in the Elderly: A Pilot Study. *Journal of Aging and Health*, *7*(4), 459–475.

Bothwell, M. (1995). Functional interactions of neurotrophins and neurotrophin receptors. *Annual Review of Neuroscience*, *132*(18), 223–253.

Bouchard, C., & Shephard, R. (1994). Physical activity fitness and health: the model and key concepts. In S. T. Bouchard C, Shephard RJ (Ed.), *Physical activity, fitness, and health: International proceedings and consensus statement.* (pp. 77–88). IL: Champaign: Human Kinetics.

Boyle, P. A., Buchman, A. S., Wilson, R. S., Leurgans, S. E., & Bennett, D. A. (2009). Association of muscle strength with the risk of Alzheimer disease and the rate of cognitive decline in community-dwelling older persons. *Archives of Neurology*, *66*(11), 1339–1344.

Braithwaite, V. (2002). Reducing ageism. In T. Nelson (Ed.), *Ageism: Stereotyping and Prejudice Against Older Persons* (pp. 311–337). Cambridge, MA: MIT Press.

Brandt, J. (1991). The hopkins verbal learning test: Development of a new memory test with six equivalent forms. *Clinical Neuropsychologist*, *5*(2), 125–142.

Brassington, G. S., Atienza, A. A., Perczek, R. E., DiLorenzo, T. M., & King, A. C. (2002). Intervention-related cognitive versus social mediators of exercise adherence in the elderly. *American Journal of Preventive Medicine*, *23*(2), 80–86.

Brookmeyer, R., Johnson, E., Ziegler-Graham, K., & Arrighi, H. M. (2007). Forecasting the global burden of Alzheimer's disease. *Alzheimer's & Dementia*, *3*(3), 186–191.

Brown, A. D., McMorris, C. A., Longman, R. S., Leigh, R., Hill, M. D., Friedenreich, C. M., & Poulin, M. J. (2010). Effects of cardiorespiratory fitness and cerebral blood flow on cognitive outcomes in older women. *Neurobiology of Aging*, *31*(12), 2047–2057.

Brown, A. K., Liu-Ambrose, T., Tate, R., & Lord, S. R. (2009). The effect of group-based exercise on cognitive performance and mood in seniors residing in intermediate care and self-care retirement facilities: a randomised controlled trial. *British Journal of Sports Medicine*, *43*(8), 608–614.

Brown, P. J., Liu, X., Sneed, J. R., Pimontel, M. A., Devanand, D. P., & Roose, S. P. (2013). Speed of processing and depression affect function in older adults with mild cognitive impairment. *The American Journal of Geriatric Psychiatry*, *21*(7), 675–684.

Brown, R. G., Scott, L. C., Bench, C. J., & Dolan, R. J. (1994). Cognitive function in depression: its relationship to the presence and severity of intellectual decline. *Psychological Medicine*, *24*(4), 829–847.

Brubaker, P., Otto, R., & Whaley, M. (2006). *American College of Sports Medicine: ACSM's guidelines for exercise testing and prescription*. *American College of Sports Medicine* (7th ed.). Philadelphia, US: Lippincott Williams & Wilkins.

Bruscoli, M., & Lovestone, S. (2004). Is MCI really just early dementia? A systematic review of conversion studies. *International Psychogeriatrics*, *16*(2), 129–140.

Buchman, A. S., Wilson, R. S., Boyle, P. A., Bienias, J. L., & Bennett, D. A. (2007). Grip strength and the risk of incident Alzheimer's disease. *Neuroepidemiology*, *29*(1-2), 66–73.

Bull, F., & the Expert Working Groups. (2010). *Physical Activity Guidelines in the UK: Review and Recommendations. School of Sport, Exercise and Health Sciences, Loughborough University*.

Burton, L. C., Shapiro, S., & German, P. S. (1999). Determinants of Physical Activity Initiation and Maintenance among Community-Dwelling Older Persons. *Preventive Medicine*, *29*(5), 422–430.

Cabeza, R., Anderson, N. D., Locantore, J. K., & McIntosh, A. R. (2002). Aging Gracefully: Compensatory Brain Activity in High-Performing Older Adults. *NeuroImage*, *17*(3), 1394–1402.

Callaghan, P., Khalil, E., Morres, I., & Carter, T. (2011). Pragmatic randomised controlled trial of preferred intensity exercise in women living with depression. *BMC Public Health*, *11*(1), 465.

Carlson, M. C., Parisi, J. M., Xia, J., Xue, Q.-L., Rebok, G. W., Bandeen-Roche, K., & Fried, L. P. (2012). Lifestyle activities and memory: variety may be the spice of life. The women's health and aging study II. *Journal of the International Neuropsychological Society*, *18*(2), 286–294.

Carpenter, S. M., Peters, E., Västfjäll, D., & Isen, A. M. (2013). Positive feelings facilitate working memory and complex decision making among older adults. *Cognition & Emotion*, *27*(1), 184–192.

Carter, D. B. (2005). The interaction of amyloid-beta with ApoE. *Sub-Cellular Biochemistry*, *38*, 255–272.

Caspersen, C. J., Powell, K. E., & Christenson, G. M. (1985). Physical activity, exercise, and physical fitness: definitions and distinctions for health-related research. *Public Health Reports*, *100*(2), 126–131.

Cassilhas, R. C., Viana, V. A. R., Grassmann, V., Santos, R. T., Santos, R. F., Tufik, S., & Mello, M. T. (2007). The impact of resistance exercise on the cognitive function of the elderly. *Medicine & Science in Sports & Exercise*, *39*(8), 1401–1407.

Cerhan, J. H., Ivnik, R. J., Smith, G. E., Tangalos, E. C., Petersen, R. C., & Boeve, B. F. (2002). Diagnostic utility of letter fluency, category fluency, and fluency difference scores in Alzheimer's disease. *The Clinical Neuropsychologist*, *16*(1), 35–42.

Chao, D., Foy, C. G., & Farmer, D. (2000). Exercise adherence among older adults. *Controlled Clinical Trials*, *21*(5), S212–S217.

Chase, J.-A. D. (2013). Methodological challenges in physical activity research with older adults. *Western Journal of Nursing Research*, *35*(1), 76–97.

Chen, S., & Walsh, S. (2009). Effect of a creative-bonding intervention on Taiwanese nursing students' self-transcendence and attitudes toward elders. *Research in Nursing & Health*, *32*(2), 204–216.

Chen, X., Ender, P., Mitchell, M. and Wells, C. (2003). Regression with SAS. Retrieved March 07, 2014, from http://www.ats.ucla.edu/stat/sas/webbooks/reg/default.htm.

Cheng, S.-J., Yu, H.-K., Chen, Y.-C., Chen, C.-Y., Lien, W.-C., Yang, P.-Y., & Hu, G.-C. (2013). Physical activity and risk of cardiovascular disease among older adults. *International Journal of Gerontology*, *7*(3), 133–136.

Chiou, W. B., Wan, C. S., Wu, W. H., & Lee, K. T. (2011). A randomized experiment to examine unintended consequences of dietary supplement use among daily smokers: taking supplements reduces self-regulation of smoking. *Addiction*, *106*(12), 2221–2228.

Christensen, H. (2001). What cognitive changes can be expected with normal ageing? *Australian and New Zealand Journal of Psychiatry*, *35*(6), 768–775.

Christensen, H., & Mackinnon, A. (1994). Age differences and interindividual variation in cognition in community-dwelling elderly. *Psychology and Aging*, *9*(3), 381–390.

Clare, L. (2007). *Neuropsychological rehabilitation and people with dementia* (p. 192). East Sussex: Psychology Press.

Clifford, A. (2012). *Physical activity and cognition in the elderly. A Doctoral Thesis*. Loughborough University.

Clifford, A., Bandelow, S., & Hogervorst, E. (2009). The Effects of Physical Exercise on Cognitive Function in the Elderly : A Review. In Q. Gariépy & R. Ménard (Eds.), *Handbook of Cognitive Aging: Causes, Processes and Effects* (pp. 109–150). New York: Nova Science Publishers, Inc.

Clifford, A., Stock, J., Bandelow, S., Rahardjo, T. B., & Hogervorst, E. (2013). Alzheimer's Disease and Dementia: A Midlife Approach to Treatment is Needed. In Atta-ur-Rahman (Ed.), *Frontiers in Clinical Drug Research – Alzheimer Disorders* (1st ed., Vol. 1, pp. 217–242). Bentham Science Publishers.

Cohen, J. (1992). A power primer. *Psychological Bulletin*, *112*(1), 155–159.

Cohen, R. (1982). Effort and cognition in depression. *Archives of General Psychiatry*, *39*(5), 239–252.

Colado, J., & Triplett, N. (2008). Effects of a short-term resistance program using elastic bands versus weight machines for sedentary middle-aged women. *The Journal of Strength & Conditioning Research*, *22*(5), 1441–1448.

Colcombe, S. J., Kramer, A. F., Erickson, K. I., Scalf, P., McAuley, E., Cohen, N. J., … Elavsky, S. (2004). Cardiovascular fitness, cortical plasticity, and aging. *Proceedings of the National Academy of Sciences of the United States of America*, *101*(9), 3316–3321.

Colcombe, S., & Kramer, A. F. (2003). Fitness effects on the cognitive function of older adults: A Meta-Analytic study. *Psychological Science*, *14*(2), 125–130.

Commissaris, C. J. A. M., Ponds, R. W. H. M., & Jolles, J. (1995). Chapter 6. Subjective memory problems and people's need for education and intervention. In J. Jolles, P. J. Houx, M. P. J. van Boxtel, & R. W. H. M. Ponds (Eds.), *The*

Maastricht Aging Study. Determinants of cognitive aging. Maastricht: Datawyse/University Press Maastricht.

Conradsson, M., Littbrand, H., Boström, G., Lindelöf, N., Gustafson, Y., & Rosendahl, E. (2013). Is a change in functional capacity or dependency in activities of daily living associated with a change in mental health among older people living in residential care facilities? *Clinical Interventions in Aging*, *8*, 1561–1568.

Crook, T., Bartus, R., & Ferris, S. (1986). Age associated memory impairment: Proposed diagnostic criteria and measures of clinical change—report of a national institute of mental health work group. *Developmental Neuropsychology*, *2*(4), 261–276.

Cunje, A., Molloy, D. W., Standish, T. I., & Lewis, D. L. (2007). Alternate forms of logical memory and verbal fluency tasks for repeated testing in early cognitive changes. *International Psychogeriatrics*, *19*(1), 65–75.

Currie, B. (2002). *10-Minute Yoga Workouts*. London: Thorsons, HarperCollins Publishers.

D'Ath, P., Katona, P., Mullan, E., Evans, S. and Katona, C. (1994). Screening, detection and management of depression in elderly primary care attenders. I: The acceptability and performance of the 15 item Geriatric Depression Scale (GDS15) and the development of short versions. *Family Practice, 11,* 260–266.

Davis-Berman, J. (1990). Physical self-efficacy, perceived physical status, and depressive symptomatology in older adults. *The Journal of Psychology*, *124*(2), 207–215.

Denkinger, M. D., Nikolaus, T., Denkinger, C., & Lukas, A. (2012). Physical activity for the prevention of cognitive decline: current evidence from observational and controlled studies. *Zeitschrift Für Gerontologie Und Geriatrie*, *45*(1), 11–16.

Department of Health. (2009). More help for dementia research. Retrieved October 03, 2013, from http://www.wired-gov.net/wg/wg-news-1.nsf/lfi/408275

Derakshan, N., & Eysenck, M. W. (2009). Anxiety, processing efficiency, and cognitive performance : new developments from attentional control theory. *European Psychologist*, *14*(2), 168–176.

Desrichard, O., & Köpetz, C. (2005). A threat in the elder: the impact of task-instructions, self-efficacy and performance expectations on memory performance in the elderly. *European Journal of Social Psychology*, *35*(4), 537–552.

Dimidjian, S., Barrera, M. J., Martell, C., Muñoz, R. F., & Lewinsohn, P. M. (2011). The origins and current status of behavioral activation treatments for depression. *Annual Review of Clinical Psychology*, *7*, 1–38.

Dishman, R., & Buckworth, J. (1997). Adherence to physical activity. In W. P. Morgan (Ed.), *Physical activity and mental health* (pp. 63–80). Philadelphia, PA, US: Taylor & Francis.

Dolan, R., & Bench, C. (1994). Neuropsychological dysfunction in depression: the relationship to regional cerebral blood flow. *Psychological Medicine*, *24*, 849–857.

Dolan, R., Bench, C., & Brown, R. (1992). Regional cerebral blood flow abnormalities in depressed patients with cognitive impairment. *Journal of Neurology, Neurosurgery & Psychiatry*, *55*, 768–773.

Downs, M., Clare, L., & Anderson, E. (2008). Dementia as a Biopsychosocial Condition: Implications for Practice and Research. In B. Woods & L. Clare (Eds.), *Handbook of the Clinical Psychology of Ageing*. Chichester, UK: John Wiley & Sons, Ltd.

Dubois, B., Feldman, H., & Jacova, C. (2007). Research criteria for the diagnosis of Alzheimer's disease: revising the NINCDS–ADRDA criteria. *The Lancet Neurology*, *6*, 734–746.

Duncan, K. A., & Pozehl, B. (2002). Staying on Course: The Effects of an Adherence Facilitation Intervention on Home Exercise Participation. *Progress in Cardiovascular Nursing*, *17*(2), 59–71.

Dustman, R. E., Ruhling, R. O., Russell, E. M., Shearer, D. E., Bonekat, H. W., Shigeoka, J. W., … Bradford, D. C. (1984). Aerobic exercise training and improved neuropsychological function of older individuals. *Neurobiology of Aging*, *5*(1), 35–42.

Eldridge, S., Bond, C., Campbell, M., Lancaster, G., Thabane, L., & Hopwell, S. (2013). Definition and reporting of pilot and feasibility studies. *Trials*, *14*(Suppl 1), O18.

Eng, P., & Rimm, E. (2002). Social ties and change in social ties in relation to subsequent total and cause-specific mortality and coronary heart disease incidence in men. *American Journal of Epidemiology*, *155*(8), 700–709.

Etnier, J. L., Nowell, P. M., Landers, D. M., & Sibley, B. a. (2006). A meta-regression to examine the relationship between aerobic fitness and cognitive performance. *Brain Research Reviews*, *52*(1), 119–130.

Etnier, J. L., Salazar, W., Landers, D. M., Petruzzello, S. J., Han, M., & Nowell, P. (1997). The influence of physical fitness and exercise upon cognitive functioning: a meta-analysis. *Journal of Sport & Exercise Psychology*, *19*, 249–277.

Etnier, J., & Labban, J. (2012). Physical Activity and Cognitive Function: Theoretical Bases, Mechanisms, and Moderators. In E. O. Acevedo (Ed.), *The Oxford Handbook of Exercise Psychology*. New York: Oxford University Press.

Evans, G. W., Shapiro, D. H., & Lewis, M. A. (1993). Specifying dysfunctional mismatches between different control dimensions. *British Journal of Psychology*, *84*(2), 255–273.

Ewart, C. K. (1989). Psychological effects of resistive weight training: Implications for cardiac patients. *Medicine & Science in Sports & Exercise*, *21*(6), 683–688.

Fabre, C., Masse-Biron, J., Chamari, K., Varray, A., Mucci, P., Préfaut, C., & Masse, J. (1999). Evaluation of quality of life in elderly healthy subjects after aerobic and/or mental training. *Archives of Gerontology and Geriatrics*, *28*(1), 9–22.

Farrell, L., Hollingsworth, B., Propper, C., & Shields, M. A. (2013). *The Socioeconomic Gradient in Physical Inactivity in England*. *CMPO Working Paper Series* (Vol. 13/311). Retrieved from http://www.bristol.ac.uk/media-library/sites/cmpo/migrated/documents/wp311.pdf

Fei, M., Qu, Y. C., Wang, T., Yin, J., Bai, J. X., & Ding, Q. H. (2009). Prevalence and distribution of cognitive impairment no dementia (CIND) among the aged population and the analysis of socio-demographic characteristics: the community-based cross-sectional study. *Alzheimer Disease & Associated Disorders*, *23*(2), 130–138.

Fillit, H., Butler, R., O'Connell, A., Albert, M., Birren, J., Cotman, C., … Tully, T. (2002). Achieving and maintaining cognitive vitality with aging. *Mayo Clinic Proceedings*, *77*(July), 681–696.

Fillit, H., Nash, D. T., Rundek, T., & Zuckerman, A. (2008). Cardiovascular risk factors and dementia. *The American Journal of Geriatric Pharmacotherapy*, *6*(2), 100–118.

Focht, B. C. (2009). Brief walks in outdoor and laboratory environments: effects on affective responses, enjoyment, and intentions to walk for exercise. *Research Quarterly for Exercise and Sport*, *80*(3), 611–620.

Folstein, M., Folstein, S., & McHugh, P. (1975). "Mini-mental state": a practical method for grading the cognitive state of patients for the clinician. *Journal of Psychiatric Research*, *23*(3), 189–198.

Forbes, D., Forbes, S., Dg, M., Wood, J., Culum, I., Morgan, D., & Markle-Reid, M. (2008). Physical activity programs for persons with dementia. *Cochrane Database of Systematic Reviews*, (3).

Fox, K. R. (1999). The influence of physical activity on mental well-being. *Public Health Nutrition*, *2*(3A), 411–418.

Fratiglioni, L., Paillard-borg, S. S., Winblad, B., Xu, W., & Wang, H.-X. (2004). An active lifestyle postpones dementia onset by more than one year in very old adults. *Journal of Alzheimer's Disease*, *3*(4), 343–353.

Fratiglioni, L., Paillard-borg, S., & Winblad, B. (2004). An active and socially integrated lifestyle in late life might protect against dementia. *The Lancet Neurology*, *3*(6), 343–353.

French, D. P., Olander, E. K., Chisholm, A., & Mc Sharry, J. (2014). Which behaviour change Techniques are most effective at increasing older adults' self-efficacy and physical activity behaviour? A systematic review. *Annals of Behavioral Medicine*, *48*(2), 225–234.

Freund, A. M., & Baltes, P. B. (2002). The adaptiveness of selection, optimization, and compensation as strategies of life management: evidence from a preference study on proverbs. *The Journals of Gerontology Series B: Psychological Sciences and Social Sciences*, *57*(5), P426–P434.

Fukukawa, Y., Nakashima, C., Tsuboi, S., Kozakai, R., Doyo, W., Niino, N., … Shimokata, H. (2004). Age differences in the effect of physical activity on depressive symptoms. *Psychology and Aging*, *19*(2), 346–351.

Funderburk, B., Damron-Rodriguez, J., Storms, L. L., & Solomon, D. H. (2006). Endurance of undergraduate attitudes toward older adults. *Educational Gerontology*, *32*(6), 447–462.

Gallacher, J., Bayer, A., & Ben-Shlomo, Y. (2005). Commentary: Activity each day keeps dementia away - does social interaction really preserve cognitive function? *International Journal of Epidemiology*, *34*(4), 872–873.

Ganguli, M., Du, Y., Dodge, H. H., Ratcliff, G. G., & Chang, C.-C. H. (2006). Depressive symptoms and cognitive decline in late life: a prospective epidemiological study. *Archives of General Psychiatry*, *63*(2), 153–160.

Geda, Y. E., Roberts, R. O., Knopman, D. S., Christianson, T. J. H., Pankratz, V. S., Ivnik, R. J., … Rocca, W. A. (2010). Physical exercise, aging, and mild cognitive impairment: a population-based study. *Archives of Neurology*, *67*(1), 80–86.

Ghosh, A. (2010). Endocrine, metabolic, nutritional, and toxic disorders leading to dementia. *Annals of Indian Academy of Neurology*, *13*(Suppl 2), S63–S68.

Gill, D. P., Jones, G. R., Zou, G., & Speechley, M. (2012). Using a single question to assess physical activity in older adults: a reliability and validity study. *BMC Medical Research Methodology*, *12*, 20.

Gill, T. M., Baker, D. I., Gottschalk, M., Peduzzi, P. N., Allore, H., & Byers, A. (2002). A program to prevent functional decline in physically frail, elderly persons who live at home. *New England Journal of Medicine*, *347*(14), 1068–1074.

Glass, T. a, De Leon, C. F. M., Bassuk, S. S., & Berkman, L. F. (2006). Social engagement and depressive symptoms in late life: longitudinal findings. *Journal of Aging and Health*, *18*(4), 604–628.

Glei, D. A., Landau, D. A., Goldman, N., Chuang, Y.-L. L., Rodríguez, G., & Weinstein, M. (2005). Participating in social activities helps preserve cognitive function: an analysis of a longitudinal, population-based study of the elderly. *International Journal of Epidemiology*, *34*(4), 864–871.

Graf C (2008) How to try this: the Lawton instrumental activities of daily living (IADL) scale. *American Journal of Nursing 108,* 52–6.

GraphPad Software. (2014). GraphPad QuickCalcs: Quantify interrater agreement with kappa. Retrieved March 07, 2014, from http://graphpad.com/quickcalcs/kappa1/

Gregory, T., Nettelbeck, T., & Wilson, C. (2010). Openness to experience, intelligence, and successful ageing. *Personality and Individual Differences*, *48*(8), 895–899.

Greve, W., & Staudinger, U. (2006). Resilience in later adulthood and old age: Resources and potentials for successful aging. In D. Cicchetti & D. J. Cohen (Eds.), *Developmental psychopathology* (pp. 796–840). Hoboken, NJ, US: John Wiley & Sons Inc.

Gringart, E., Helmes, E., & Speelman, C. (2008). Harnessing cognitive dissonance to promote positive attitudes toward older workers in Australia. *Journal of Applied Social Psychology*, *38*(3), 751–778.

Gu, D., Dupre, M. E., Sautter, J., Zhu, H., Liu, Y., & Yi, Z. (2009). Frailty and mortality among Chinese at advanced ages. *The Journals of Gerontology. Series B, Psychological Sciences and Social Sciences*, *64*(2), 279–289.

Gualtieri, C. T., & Johnson, L. G. (2008). Age-related cognitive decline in patients with mood disorders. *Progress in Neuro-Psychopharmacology and Biological Psychiatry*, *32*(4), 962–967.

Halvorsen, M., Høifødt, R. S., Myrbakk, I. N., Wang, C. E. A., Sundet, K., Eisemann, M., & Waterloo, K. (2012). Cognitive function in unipolar major depression: a comparison of currently depressed, previously depressed, and never depressed individuals. *Journal of Clinical and Experimental Neuropsychology*, *34*(7), 782–790.

Hamer, M., & Chida, Y. (2009). Physical activity and risk of neurodegenerative disease: a systematic review of prospective evidence. *Psychological Medicine*, *39*(1), 3–11.

Harada, T., Okagawa, S., & Kubota, K. (2004). Jogging improved performance of a behavioral branching task: implications for prefrontal activation. *Neuroscience Research*, *49*(3), 325–337.

Harridge, S., Magnusson, G., & Saltin, B. (1997). Life-long endurance-trained elderly men have high aerobic power, but have similar muscle strength to non-active elderly men. *Aging (Milan, Italy)*, *9*(1-2), 80–87.

Hassmén, P., Ceci, R., & Bäckman, L. (1992). Exercise for older women: a training method and its influences on physical and cognitive performance. *European Journal of Applied Physiology and Occupational Physiology*, *64*(5), 460–466.

Hausdorff, J., Levy, B., & Wei, J. (1999). The power of ageism on physical function of older persons: reversibility of age-related gait changes. *Journal of the American Geriatrics Society*, *47*(11), 1346–1349.

Henderson, A. S., Jorm, A. F., Korten, A. E., Christensen, H., Jacomb, P. A., Easteal, S., … Mackinnon, A. J. (1995). Apolipoprotein E allele∈ 4, dementia, and cognitive decline in a population sample. *The Lancet*, *346*(8987), 1387–1390.

Herdman, M., Gudex, C., Lloyd, A., Janssen, M., Kind, P., Parkin, D., … Badia, X. (2011). Development and preliminary testing of the new five-level version of EQ-5D (EQ-5D-5L). *Quality of Life Research*, *20*(10), 1727–1736.

Hertzog, C., Kramer, A. F., Wilson, R. S., & Lindenberger, U. (2009). Enrichment Effects on Adult Cognitive Development. *Journal of the Association for Psychological Science*, *9*(1), 1–65.

Hess, T. M. (2005). Memory and aging in context. *Psychological Bulletin*, *131*(3), 383–406.

Heun, R., Bonsignore, M., Barkow, K., & Jessen, F. (2001). Validity of the five-item WHO Well-Being Index (WHO-5) in an elderly population. *European Archives of Psychiatry and Clinical Neuroscience*, *251*(S2), 27–31.

Heyn, P., Abreu, B. C., & Ottenbacher, K. J. (2004). The effects of exercise training on elderly persons with cognitive impairment and dementia: A meta-analysis. *Archives of Physical Medicine and Rehabilitation*, *85*(10), 1694–1704.

Hogervorst, E., Bandelow, S., Combrinck, M., & Smith, A. D. (2004). Low free testosterone is an independent risk factor for Alzheimer's disease. *Experimental Gerontology*, *39*(11-12), 1633–9.

Hogervorst, E., Clifford, A., Stock, J., Xin, X., & Bandelow, S. (2012). Exercise to prevent cognitive decline and Alzheimer's disease: for whom, when, what, and (most importantly) how much? *Journal of Alzheimer's Disease & Parkinsonism*, *02*, e117.

Hogervorst, E., Combrinck, M., Lapuerta, P., Rue, J., Swales, K., & Budge, M. (2002). The Hopkins Verbal Learning Test and screening for dementia. *Dementia and Geriatric Cognitive Disorders*, *13*(1), 13–20.

Hogervorst, E., Mursjid, F., Ismail, R., Prasetyo, S., Nasrun, M., & Rahardjo, T. B. (2011). Validation of two short dementia screening tests in Indonesia. In S. Jacobsen (Ed.), *Vascular Dementia: Risk factors, Diagnosis and Treatment*. NY: Nova Science Publishers, Inc.

Hsu, L. M., Chung, J., & Langer, E. J. (2010). The influence of age-related cues on health and longevity. *Perspectives on Psychological Science*, *5*(6), 632–648.

Idler, E., & Benyamini, Y. (1997). Self-rated health and mortality: a review of twenty-seven community studies. *Journal of Health and Social Behavior*, *38*(1), 21–37.

Ikels, C. (1991). Aging and disability in China: Cultural issues in measurement and interpretation. *Social Science & Medicine*, *32*(6), 649–665.

International Council on Active Aging. (2011). *ICAA' s Guidelines for effective communication with older adults*. Vancouver, Canada.

Jeste, D. V, Savla, G. N., Thompson, W. K., Vahia, I. V, Glorioso, D. K., Martin, A. S., … Depp, C. A. (2013). Association between older age and more successful aging: critical role of resilience and depression. *The American Journal of Psychiatry*, *170*(2), 188–96.

Johnson & Johnson. (2012). Johnson & Johnson announces discontinuation of Phase 3 development of Bapineuzumab Intravenous (IV) in mild-to-moderate Alzheimer's Disease. Retrieved February 05, 2014, from http://www.jnj.com/news/product/johnson-and-johnson-announces-discontinuation-of-phase-3-development-of-bapineuzumab-intravenous-iv-in-mild-to-moderate-alzheimers-disease

Jones, C. J., & Rose, D. (2005). Strategies to increase exercise adherence in older adults. In *Physical Activity Instruction of Older Adults*. Champaign, IL: Human Kinetics Publishers.

Karp, A., Paillard-Borg, S., Wang, H.-X., Silverstein, M., Winblad, B., & Fratiglioni, L. (2006). Mental, physical and social components in leisure activities equally contribute to decrease dementia risk. *Dementia and Geriatric and Cognitive Disorders*, *21*, 65–73.

Katula, J. a., Sipe, M., Rejeski, W. J., & Focht, B. C. (2006). Strength training in older adults: an empowering intervention. *Medicine & Science in Sports & Exercise*, *38*(1), 106–111.

Keele-Smith, R., & Leon, T. (2003). Evaluation of individually tailored interventions on exercise adherence. *Western Journal of Nursing Research*, *25*(6), 623–640.

Kemper, S. (1994). Elderspeak: Speech accommodations to older adults. *Aging, Neuropsychology, and Cognition*, *1*(1), 17–28.

Kenny, D., Kashy, D., & Bolger, N. (1998). Data analysis in social psychology. In D. Gilbert, S. Fiske, & G. Lindzey (Eds.), *Handbook of social psychology* (4th ed., pp. 233–265). New York: McGraw-Hill.

Kerola, T., Kettunen, R., & Nieminen, T. (2011). The complex interplay of cardiovascular system and cognition: how to predict dementia in the elderly? *International Journal of Cardiology*, *150*(2), 123–9.

Kessel, G. Van. (2013). The ability of older people to overcome adversity: a review of the resilience concept. *Geriatric Nursing*, *34*(2), 122–127.

Kiecolt-Glaser, J., & Glaser, R. (2002). Depression and immune function: central pathways to morbidity and mortality. *Journal of Psychosomatic Research*, *53*(4), 873–876.

Kiecolt-Glaser, J. K., Dura, J. R., Speicher, C. E., Trask, O. J., & Glaser, R. (1991). Spousal caregivers of dementia victims: longitudinal changes in immunity and health. *Psychosomatic Medicine*, *53*(4), 345–362.

Kiecolt-Glaser, J., & McGuire, L. (2002). Psychoneuroimmunology: psychological influences on immune function and health. *Journal of Consulting and Clinical Psychology*, *70*(3), 537–547.

Kitabayashi, Y., Ueda, H., Tsuchida, H., Iizumi, H., Narumoto, J., Nakamura, K., … Fukui, K. (2001). Relationship between regional cerebral blood flow and verbal fluency in Alzheimer's disease. *Psychiatry and Clinical Neurosciences*, *55*(5), 459–463.

Kite, M. M. E., Stockdale, G. G. D., Whitley, B. E., & Johnson, B. T. (2005). Attitudes Toward Younger and Older Adults: An Updated Meta-Analytic Review. *Journal of Social Issues*, *61*(2), 241–266.

Kite, M., & Wagner, L. (2004). Attitudes toward older adults. In T. Nelson (Ed.), *Ageism: Stereotyping and Prejudice Against Older Persons*. Cambridge, MA: MIT Press.

Kitwood, T. (1996). A dialectical framework for dementia. In *Handbook of clinical psychology of ageing*. Chichester: John Wiley & Sons Ltd.

Kitwood, T. (1997a). *Dementia Reconsidered: The Person Comes First*. Buckingham: Open University Press.

Kitwood, T. (1997b). The experience of dementia. *Aging & Mental Health*, *1*, 13–22.

Kivipelto, M., Ngandu, T., Fratiglioni, L., Viitanen, M., Kareholt, I., Winblad, B., … Nissinen, A. (2005). Obesity and vascular risk factors at midlife and the risk of dementia and Alzheimer disease. *Archives of Neurology*, *62*(10), 1556–1560.

Kramer, A., Bherer, L., & Colcombe, S. (2004). Environmental influences on cognitive and brain plasticity during aging. *The Journals of Gerontology: Series A: Biological Sciences and Medical Sciences*, *59A*(9), 940–957.

Kramer, A. F., Colcombe, S. J., Mcauley, E., Eriksen, K. I., Scalf, P., Jerome, G. J., … Webb, A. G. (2003). Enhancing brain and cognitive function of older adults through fitness training. *Journal of Molecular Neuroscience*, *20*(3), 213–221.

Kramer, A. F., & Erickson, K. I. (2007a). Capitalizing on cortical plasticity: influence of physical activity on cognition and brain function. *Trends in Cognitive Sciences*, *11*(8), 342–348.

Kramer, A. F., & Erickson, K. I. (2007b). Effects of physical activity on cognition, well-being, and brain: human interventions. *Alzheimer's & Dementia*, *3*, S45–S51.

Kramer, A. F., Hahn, S., McAuley, E., Cohen, N. J., Banich, M. T., Harrison, C., … Colcombe, A. (2001). Exercise, aging, and cognition: Healthy body, healthy mind. *Human Factors Interventions for the Health Care of Older Adults*, 91–120.

Kramer, A. F., & Willis, S. L. (2002). Enhancing the cognitive vitality of older adults. *Current Directions in Psychological Science*, *11*(5), 173–177.

Krosnick, J., & Alwin, D. (1989). Aging and susceptibility to attitude change. *Journal of Personality and Social Psychology*, *57*(3), 416–425.

La Rue, A. (2010). Healthy brain aging: Role of cognitive Reserve, cognitive stimulation, and cognitive exercises. *Clinics in Geriatric Medicine*, *26*(1), 99–111.

Lachman, M. E., & Andreoletti, C. (2006). Strategy use mediates the relationship between control beliefs and memory performance for middle-aged and older adults. *The Journals of Gerontology Series B: Psychological Sciences and Social Sciences*, *61*(2), 88–94.

Lachman, M. E., Neupert, S. D., Bertrand, R., & Jette, A. M. (2006). The effects of strength training on memory in older adults. *Journal of Aging and Physical Activity*, *14*(1), 59–73.

Lai, D. W. L. (2009). Older chinese' attitudes toward aging and the relationship to mental health: an international comparison. *Social Work in Health Care*, *48*(3), 243–259.

Laidlaw, K., Power, M. J., Schmidt, S., & Group, W. (2007). The attitudes to ageing questionnaire (AAQ): development and psychometric properties. *International Journal of Geriatric Psychiatry*, *22*, 367–379.

Laidlaw, K., Wang, D., Coelho, C., & Power, M. (2010). Attitudes to ageing and expectations for filial piety across Chinese and British cultures: a pilot exploratory evaluation. *Aging & Mental Health*, *14*(3), 283–292.

Landis, J., & Koch, G. (1977). The measurement of observer agreement for categorical data. *Biometrics*, *33*(1), 159–174.

Langer, E. J., & Rodin, J. (1976). The effect of choice and enhanced personal responsibility for the aged: a field experiment in an institutional setting. *Journal of Personality and Social Psychology*, *34*(2), 191–198.

Launer, L., Andersen, K., Dewey, M., & Letenneur, L. (1999). Rates and risk factors for dementia and Alzheimer's disease: results from EURODEM pooled analyses. *Neurology*, *52*(1), 78–84.

Launer, L. J., & Hofman, A. (1992). Studies on the incidence of dementia: the European perspective. *Neuroepidemiology*, *11*(3), 127–134.

Lautenschlager, N. T., Cox, K., Cyarto, E. V., Gold, B. T., & Keller, J. N. (2012). The influence of exercise on brain aging and dementia. *Biochimica et Biophysica Acta*, *1822*(3), 474–481.

Lautenschlager, N. T., Cox, K., & Kurz, A. F. (2010). Physical activity and mild cognitive impairment and Alzheimer's disease. *Current Neurology and Neuroscience Reports*, *10*(5), 352–358.

Leon, A. S., & Sanchez, O. A. (2001). Response of blood lipids to exercise training alone or combined with dietary intervention. *Medicine & Science in Sports & Exercise*, *33*(6), S502–S515.

Levy, B. (1996). Improving memory in old age through implicit self-stereotyping. *Journal of Personality and Social Psychology*, *71*(6), 1092–1107.

Levy, B. (1999). The inner self of the Japanese elderly: A defense against negative stereotypes of aging. *The International Journal of Aging and Human Development*, *48*(2), 131–144.

Levy, B. (2003). Mind matters: cognitive and physical effects of aging self-stereotypes. *The Journals of Gerontology. Series B, Psychological Sciences and Social Sciences*, *58*(4), 203–211.

Levy, B. (2009). Stereotype Embodiment: A Psychosocial Approach to Aging. *Current Directions in Psychological Science*, *18*(6), 332–336.

Levy, B., & Banaji, M. (2002). Implicit ageism. In T. D. Nelson (Ed.), *Ageism: Stereotyping and Prejudice Against Older Persons* (pp. 49–75). Cambridge, MA: MIT Press.

Levy, B., Hausdorff, J. M., Hencke, R., & Wei, J. Y. (2000). Reducing cardiovascular stress with positive self-stereotypes of aging. *The Journals Gerontology: Psychological Sciences*, *55B*(4), 205–213.

Levy, B., & Langer, E. (1994). Aging free from negative stereotypes: Successful memory in China among the American deaf. *Journal of Personality and Social Psychology*, *66*(6), 989–997.

Levy, B., & Myers, L. (2004). Preventive health behaviors influenced by self-perceptions of aging. *Preventive Medicine*, *39*(3), 625–629.

Levy, B. R., Zonderman, A. B., Slade, M. D., & Ferrucci, L. (2011). Memory Shaped by Age Stereotypes over Time. *The Journals of Gerontology: Series B*, *67*(4), 432–436.

Levy, B. R., Slade, M. D., & Gill, T. M. (2006). Hearing Decline Predicted by Elders ' Stereotypes, *61*(2), 82–87.

Levy, B. R., Slade, M. D., & Kasl, S. V. (2002). Longitudinal benefit of positive self-perceptions of aging on functional health. *The Journals of Gerontology Series B: Psychological Sciences and Social Sciences*, *57*(5), P409–P417.

Levy, B. R., Slade, M. D., Kunkel, S. R., & Kasl, S. V. (2002). Longevity increased by positive self-perceptions of aging. *Journal of Personality and Social Psychology*, *83*(2), 261–270.

Levy, B. R., Zonderman, A. B., Slade, M. D., & Ferrucci, L. (2009). Age stereotypes held earlier in life predict cardiovascular events in later life. *Psychological Science*, *20*(3), 296–298.

Li, F., Harmer, P., McAuley, E., Fisher, K. J., Duncan, T. E., & Duncan, S. C. (2001). Tai Chi, self-efficacy, and physical function in the elderly. *Prevention Science : The Official Journal of the Society for Prevention Research*, *2*(4), 229–239.

Lilly. (2010). Lilly Halts Development of Semagacestat for Alzheimer's Disease Based on Preliminary Results of Phase III Clinical Trials - Aug 17, 2010. Retrieved February 05, 2014, from http://lilly.mediaroom.com/index.php?s=9042&item=12812

Lindwall, M., Rennemark, M., & Berggren, T. (2008). Movement in mind: the relationship of exercise with cognitive status for older adults in the Swedish National Study on Aging and Care (SNAC). *Aging & Mental Health*, *12*(2), 212–220.

Lowin, A., Knapp, M., & Mccrone, P. (2001). Alzheimer's disease in the UK: comparative evidence on cost of illness and volume of health services research funding. *International Journal of Geriatric Psychiatry*, *16*(12), 1143–1148.

Luborsky, M., & McMullen, C. (1999). Culture and aging. In *Gerontology: an interdisciplinary perspective* (pp. 65–90). New York: Oxford University Press.

Luengo-Fernandez, R., Leal, J., & Gray, A. (2010). Dementia 2010 – The economic burden of dementia and associated research funding in the United Kingdom. Retrieved October 13, 1BC, from www.dementia2010.org/reports/Dementia2010Full.pdf

Lyche, P., Jonassen, R., Stiles, T. C., Ulleberg, P., & Landrø, N. I. (2011). Verbal memory functions in unipolar major depression with and without co-morbid anxiety. *The Clinical Neuropsychologist*, *25*(3), 359–375.

Lyketsos, C. G., Marano, C., Norton, M., Tschanz, J. A., Smith, G., Rosenberg, P., … Steffens, D. B. (2010). Risk reduction factors for Alzheimer's Disease and cognitive decline in older adults: depression and related neuropsychiatric disturbances. In *Preventing Alzheimer's Disease and Cognitive Decline Program and Abstracts* (p. 85). Bethesda, MD.

Macrae, C., Milne, A., & Bodenhausen, G. (1994). Stereotypes as energy-saving devices: a peek inside the cognitive toolbox. *Journal of Personality and Social Psychology*, *66*, 37–47.

Madden, D. J., Blumenthal, J. A., Allen, P. A., & Emery, C. F. (1989). Improving aerobic capacity in healthy older adults does not necessarily lead to improved cognitive performance. *Psychology and Aging*, *4*(3), 307–320.

Marcus, B. H., Eaton, C. A., Rossi, J. S., & Harlow, L. L. (1994). Self-efficacy, decision-making, and stages of change: an integrative model of physical exercise. *Journal of Applied Social Psychology*, *24*(6), 489–508.

Martinsen, E. W. (2008). Physical activity in the prevention and treatment of anxiety and depression. *Nordic Journal of Psychiatry*, *62 Suppl 4*(10), 25–29.

Matarazzo, J. D., & Herman, D. O. (1984). Base rate data for the WAIS-R: Test-Retest stability and VIQ-PIQ differences. *Journal of Clinical Neuropsychology*, *6*(4), 351–366.

McAuley, E., Blissmer, B., Katula, J., Duncan, T. E., & Mihalko, S. L. (2000). Physical activity, self-esteem, and self-efficacy relationships in older adults: a randomized controlled trial. *Annals of Behavioral Medicine*, *22*(2), 131–139.

McAuley, E., Kramer, A. F., & Colcombe, S. J. (2004). Cardiovascular fitness and neurocognitive function in older adults: a brief review. *Brain, Behavior, and Immunity*, *18*(3), 214–220.

McAuley, E., Lox, C., & Duncan, T. (1993). Long-term maintenance of exercise, self-efficacy, and physiological change in older adults. *Journal of Gerontology*, *48*(4), 218–224.

McConatha, J., Schnell, F., & Volkwein, K. (2003). Attitudes toward aging: a comparative analysis of young adults from the United States and Germany. *The International Journal of Aging and Human Development*, *57*(3), 203–215.

McConatha, J. T., Hayta, V., Rieser-Danner, L., McConatha, D., & Polat, T. S. (2004). Turkish and U.S. Attitudes Toward Aging. *Educational Gerontology*, *30*(3), 169–183.

McHorney, C.A., Ware, J.E., Lu, J.F.R., & Sherbourne, C.D. (1994). The MOS 36-Item Short-Form Health Survey (SF-36®): III. Tests of data quality, scaling assumptions and reliability across diverse patient groups. *Medical Care,* 32(4), 40-66.

Meisner, B. A. (2012). A meta-analysis of positive and negative age stereotype priming effects on behavior among older adults. *The Journals of Gerontology: Series B*, *67*(1), 13–17.

Melzer, K., Kayser, B., & Pichard, C. (2004). Physical activity: the health benefits outweigh the risks. *Current Opinion in Clinical Nutrition and Metabolic Care*, *7*(6), 641–617.

Merton, R. K. (1948). The self-fulfilling prophecy. *The Antioch Review*, *8*(2), 193–210.

Miller, D. I., Taler, V., Davidson, P. S. R. R., & Messier, C. (2012). Measuring the impact of exercise on cognitive aging: methodological issues. *Neurobiology of Aging*, *33*(3), 622.e29–43.

Mirowsky, J. (1995). Age and the sense of control. *Social Psychology Quarterly*, *58*(1), 31–43.

Miskowiak, K., Vinberg, M., Christensen, E. M., & Kessing, L. V. (2012). Is there a difference in subjective experience of cognitive function in patients with unipolar disorder versus bipolar disorder? *Nordic Journal of Psychiatry*, *66*(6), 389–395.

Moher, D., Hopewell, S., Schulz, K. F., Montori, V., Gøtzsche, P. C., Devereaux, P. J., … Altman, D. G. (2010). CONSORT 2010 explanation and elaboration: updated guidelines for reporting parallel group randomised trials. *Journal of Clinical Epidemiology*, *63*(8), e1–37.

Molloy, D. W., McLaughlin, J. S., Richardson, L. D., & Crilly, R. G. (1988). The effects of a three-month exercise programme on neuropsychological function in elderly institutionalized women: a randomized controlled trial. *Age and Ageing*, *17*(5), 303.

Monsch, A. U., Bondi, M. W., Butters, N., Salmon, D. P., Katzman, R., & Thal, L. J. (1992). Comparisons of verbal fluency tasks in the detection of dementia of the Alzheimer type. *Archives of Neurology*, *49*(12), 1253–1258.

Moul, J., Goldman, B., & Warren, B. (1995). Physical activity and cognitive performance in the older population. *Journal of Aging and Physical Activity*, *3*, 135–145.

Nagamatsu, L. S., Handy, T. C., Hsu, C. L., Voss, M., & Liu-Ambrose, T. (2012). Resistance training promotes cognitive and functional brain plasticity in seniors with probable mild cognitive impairment. *Archives of Internal Medicine*, *172*(8), 666–668.

Nakajima, S., Ohsawa, I., Ohta, S., Ohno, M., & Mikami, T. (2010). Regular voluntary exercise cures stress-induced impairment of cognitive function and cell proliferation accompanied by increases in cerebral IGF-1 and GST activity in mice. *Behavioural Brain Research*, *211*(2), 178–184.

National Health Interview Survey. (1985). Retrieved from http://www.cdc.gov/nchs/data/nhis/physicalactivity/pa_questions.pdf

Nelson, M. M. E., Rejeski, W. J., Blair, S. N., Duncan, P. W., Judge, J. O., King, A. C., … Castaneda-Sceppa, C. (2007). Physical activity and public health in older adults: recommendation from the American College of Sports Medicine and the American Heart Association. *Medicine and Science in Sports and Exercise*, *39*(8), 1435–1445.

Netz, Y., Wu, M.-J., Becker, B. J., & Tenenbaum, G. (2005). Physical activity and psychological well-being in advanced age: a meta-analysis of intervention studies. *Psychology and Aging*, *20*(2), 272–284.

O'Bryant, S. E., Humphreys, J. D., Smith, G. E., Ivnik, R. J., Graff-Radford, N. R., Petersen, R. C., & Lucas, J. A. (2008). Detecting dementia with the mini-mental state examination in highly educated individuals. *Archives of Neurology*, *65*(7), 963–967.

Office for National Statistics. (2009). *National population projections, 2008-based Statistical Bulletin*.

Office for National Statistics. (2013). National Population Projections , 2012-based Statistical Bulletin. Retrieved November 06, 2013, from http://www.ons.gov.uk/ons/dcp171778_334975.pdf

Oken, B. S., Zajdel, D., Kishiyama, S., Flegal, K., Dehen, C., Haas, M., … Leyva, J. (2006). Randomized, controlled, six-month trial of yoga in healthy seniors: effects on cognition and quality of life. *Alternative Therapies in Health and Medicine*, *12*(1), 40–47.

Ong, A. D., Bergeman, C. S., Bisconti, T. L., & Wallace, K. A. (2006). Psychological resilience, positive emotions, and successful adaptation to stress in later life. *Journal of Personality and Social Psychology*, *91*(4), 730–749.

Ong, A. D., Edwards, L. M., & Bergeman, C. S. (2006). Hope as a source of resilience in later adulthood. *Personality and Individual Differences*, *41*(7), 1263–1273.

Owen, A. M., Hampshire, A., Grahn, J. A., Stenton, R., Dajani, S., Burns, A. S., … Ballard, C. G. (2010). Putting brain training to the test. *Nature*, *465*(7299), 775–778.

Pachana, N. A., & Byrne, G. J. (2012). The Geriatric Anxiety Inventory: international use and future directions. *Australian Psychologist*, *47*(1), 33–38.

Pachana, N. A., Byrne, G. J. G., Siddle, H., Koloski, N., Harley, E., & Arnold, E. (2007). Development and validation of the Geriatric Anxiety Inventory. *International Psychogeriatrics*, *19*(1), 103–114.

Park, M., & Chesla, C. (2007). Revisiting Confucianism as a conceptual framework for Asian family study. *Journal of Family Nursing*, *13*(3), 293–311.

Peluso, M., & Andrade, L. (2005). Physical activity and mental health: the association between exercise and mood. *Clinics*, *60*(1), 61–70.

Perneger, T. V. (1998). What's wrong with Bonferroni adjustments. *BMJ*, *316*(7139), 1236–1238.

Peters, R., Poulter, R., Warner, J., Beckett, N., Burch, L., & Bulpitt, C. (2008). Smoking, dementia and cognitive decline in the elderly, a systematic review. *BMC Geriatrics*, *8*(1), 36.

Petersen, R. C. (1999). Mild Cognitive Impairment: Clinical Characterization and Outcome. *Archives of Neurology*, *56*(3), 303–308.

Petersen, R. C. (2004). Mild cognitive impairment as a diagnostic entity. *Journal of Internal Medicine*, *256*(3), 183–194.

Petersen, R. C., Doody, R., Kurz, A., Mohs, R. C., Morris, J. C., Rabins, P. V., … Winblad, B. (2001). Current concepts in mild cognitive impairment. *Archives of Neurology*, *58*(12), 1985–1992.

Phoenix, C., & Grant, B. (2009). Expanding the agenda for research on the physically active aging body. *Journal of Aging and Physical Activity*, *17*(3), 362–379.

Phoenix, C., & Sparkes, A. C. (2006). Keeping it in the family: narrative maps of ageing and young athletes' perceptions of their futures. *Ageing and Society*, *26*(4), 631.

Phoenix, C., & Sparkes, A. C. (2007). The narrative construction of self in an ageing, athletic body. In *Narrative and Memory* (pp. 73–80). University of Huddersfield, Huddersfield.

Pinto, B. M., Rabin, C., & Dunsiger, S. (2009). Home-based exercise among cancer survivors: adherence and its predictors. *Psycho-Oncology*, *18*(4), 369–376.

Podewils, L., & Guallar, E. (2005). Physical activity, APOE genotype, and dementia risk: findings from the Cardiovascular Health Cognition Study. *American Journal of Epidemiology*, *161*(7), 639–651.

Prince, M. (1997). The need for research on dementia in developing countries. *Tropical Medicine & International Health*, *2*(10), 993–1000.

Reich, E., Torres, C., Arias, E., Carlino, M., & Halac, E. (2012). Development of Alzheimer's disease and recent stress events. In *22nd Meeting of the European Neurological Society*. Prague, Czech Republic.

Reid, L., & MacLullicha, A. (2006). Subjective memory complaints and cognitive impairment in older people. *Dementia and Geriatric Cognitive Disorders*, *22*, 471–485.

Reitan, R. M. (1955). The relation of the Trail Making Test to organic brain damage. *Journal of Consulting Psychology*, *19*(5), 393–394.

Resnick, B. (2001). Testing a model of exercise behavior in older adults. *Research in Nursing & Health*, *24*(2), 83–92.

Riediger, M., Li, S.-C., & Lindenberger, U. (2006). Selection, Optimization, and Compensation as Developmental Mechanisms of Adaptive Resource Allocation: Review and Preview. In J. E. Birren & K. W. Schaire (Eds.), *Handbook of the psychology of aging* (6th ed., pp. 289–313). Amsterdam, Netherlands: Elsevier.

Riggs, K. M., Lachman, M. E., & Wingfield, A. (1997). Taking charge of remembering: locus of control and older adults' memory for speech. *Experimental Aging Research*, *23*(3), 237–256.

Rodin, J. (1986). Aging and health: effects of the sense of control. *Science*, *233*(4770), 1271–1276.

Rodin, J., & Langer, E. (1977). Long-term effects of a control-relevant intervention with the institutionalized aged. *Journal of Personality and Social Psychology*, *35*(12), 897–902.

Rodin, J., & Langer, E. (1980). Aging labels: The decline of control and the fall of self-esteem. *Journal of Social Issues*, *36*(2), 12–29.

Rogers, M., & Evans, W. (1993). Changes in skeletal muscle with aging: effects of exercise training. *Exercise & Sport Sciences Reviews*, *21*(1), 65–102.

Rooney, B., Smalley, K., Larson, J., & Havens, S. (2003). Is knowing enough? Increasing physical activity by wearing a pedometer. *WMJ*, *102*(4), 31–36.

Rosenstock, I. M. (1974). Historical origins of the health belief model. *Health Education Behavior*, *15*(2), 175–183.

Roth, D., & Goode, K. (2003). Association of physical activity and visual attention in older adults. *Journal of Aging and Health*, *15*(3), 534–547.

Rotter, J. B., Chance, J. E., & Phares, E. J. (1972). An introduction to social learning theory. In J. B. Rotter, J. E. Chance, & E. J. Phares (Eds.), *Applications of a social learning theory of personality* (pp. 1–44). New York: Holt.

Ruuskanen, J. M., & Ruoppila, I. (1995). Physical activity and psychological well-being among people aged 65 to 84 years. *Age and Ageing*, *24*(4), 292–296.

Ryckman, R. M., Robbins, M. A., Thornton, B., & Cantrell, P. (1982). Development and validation of a physical self-efficacy scale. *Journal of Personality and Social Psychology*, *42*(5), 891–900.

Saczynski, J. S., Pfeifer, L. A., Masaki, K., Korf, E. S. C., Laurin, D., White, L., & Launer, L. J. (2006). The effect of social engagement on incident dementia: the Honolulu-Asia Aging Study. *American Journal of Epidemiology*, *163*(5), 433–440.

Salthouse, T. a. (2006). Mental exercise and mental aging: evaluating the validity of the “Use It or Lose It” hypothesis. *Perspectives on Psychological Science*, *1*(1), 68–87.

Sargent-Cox, K. A., Anstey, K. J., & Luszcz, M. A. (2013). Longitudinal change of self-perceptions of aging and mortality. *The Journals of Gerontology. Series B, Psychological Sciences and Social Sciences*, *69*(2), 168–173.

Scarmeas, N., & Stern, Y. (2003). Cognitive reserve and lifestyle. *Journal of Clinical and Experimental Neuropsychology*, *25*(5), 625–633.

Schaeffer, E. L., Novaes, B. A., da Silva, E. R., Skaf, H. D., & Mendes-Neto, Á. G. (2009). Strategies to promote differentiation of newborn neurons into mature functional cells in Alzheimer brain. *Progress in Neuro-Psychopharmacology and Biological Psychiatry*, *33*(7), 1087–1102.

Schuit, A. J., Feskens, E. J., Launer, L. J., & Kromhout, D. (2001). Physical activity and cognitive decline, the role of the apolipoprotein e4 allele. *Medicine and Science in Sports and Exercise*, *33*(5), 772–777.

Schulz, R., & Martire, L. M. (2004). Family caregiving of persons with dementia: prevalence, health effects, and support strategies. *The American Journal of Geriatric Psychiatry*, *12*(3), 240–249.

Schulz, R., O’Brien, a T., Bookwala, J., & Fleissner, K. (1995). Psychiatric and physical morbidity effects of dementia caregiving: prevalence, correlates, and causes. *The Gerontologist*, *35*(6), 771–91.

Schwarzer, R. (2008). Modeling Health Behavior Change: How to Predict and Modify the Adoption and Maintenance of Health Behaviors. *Applied Psychology*, *57*(1), 1–29.

Schwarzer, R., & Jerusalem, M. (1995). Generalized self-efficacy scale. In J. Weinman, S. Wright, & M. Johnston (Eds.), *Measures in health psychology: A user's portfolio. Causal and control beliefs* (pp. 35–37). Windsor, UK: NFER-NELSON.

Schwarzer, R., & Renner, B. (2000). Social-cognitive predictors of health behavior: action self-efficacy and coping self-efficacy. *Health Psychology*, *19*(5), 487–495.

Schweitzer, I., Tuckwell, V., Brien, J. O., & Ames, D. (2002). Is late onset depression a prodrome to dementia? *International Journal of Geriatric Psychiatry*, *17*(11), 997–1005.

Schwenk, M., Zieschang, T., Oster, P., & Hauer, K. (2010). Dual-task performances can be improved in patients with dementia: a randomized controlled trial. *Neurology*, *74*(24), 1961–1968.

Scott, T., Minichiello, V., & Browning, C. (1998). Secondary school students' knowledge of and attitudes towards older people: does an education intervention programme make a difference? *Ageing and Society*, *18*(2), 167–183.

Seefeldt, C., Jantz, R., Galper, A., & Serock, K. (1977). Using pictures to explore children's attitudes toward the elderly. *The Gerontologist*, *17*(6), 506–512.

Seeman, T. E. (1991). Personal control and coronary artery disease: How generalized expectancies about control may influence disease risk. *Journal of Psychosomatic Research*, *35*(6), 661–669.

Seeman, T. E., Lusignolo, T. M., Albert, M., & Berkman, L. (2001). Social relationships, social support, and patterns of cognitive aging in healthy, high-functioning older adults: MacArthur studies of successful aging. *Health Psychology*, *20*(4), 243–255.

Shatil, E. (2013). Does combined cognitive training and physical activity training enhance cognitive abilities more than either alone? A four-condition randomized controlled trial among healthy older adults. *Frontiers in Aging Neuroscience*, *5*, 8.

Shephard, R. J. (2003). Limits to the measurement of habitual physical activity by questionnaires. *British Journal of Sports Medicine*, *37*(3), 197–206.

Singh-Manoux, A., Hillsdon, M., Brunner, E., & Marmot, M. (2005). Effects of physical activity on cognitive functioning in middle age: evidence from the Whitehall II prospective cohort study. *American Journal of Public Health*, *95*(12), 2252–2258.

Sixsmith, A., Stilwell, J., & Copeland, J. (1993). "Rementia": Challenging the limits of dementia care. *International Journal of Geriatric Psychiatry*, *8*(12), 993–1000.

Sjösten, N., & Kivelä, S.-L. (2006). The effects of physical exercise on depressive symptoms among the aged: a systematic review. *International Journal of Geriatric Psychiatry*, *21*(5), 410–418.

Skinner, E. (1996). A guide to constructs of control. *Journal of Personality and Social Psychology*, *71*(3), 549–570.

Slevin, O. Ď. (1991). Ageist attitudes among young adults: implications for a caring profession. *Journal of Advanced Nursing*, *16*(10), 1197–1205.

Smiley-Oyen, A. L., Lowry, K. A., Francois, S. J., Kohut, M. L., & Ekkekakis, P. (2008). Exercise, fitness, and neurocognitive function in older adults: the “selective improvement” and “cardiovascular fitness” hypotheses. *Annals of Behavioral Medicine*, *36*(3), 280–291.

Smith, A. (1982). *Symbol Digit Modalities Test Manual–Revised*. Los Angeles, California: Western Psychological Services.

Smith, G., Ivnik, R. J., Petersen, R. C., Malec, J. F., Kokmen, E., & Tangalos, E. (1991). Age-associated memory impairment diagnoses: Problems of reliability and concerns for terminology. *Psychology and Aging*, *6*(4), 551–558.

Snow, W. G., Tierney, M. C., Zorzitto, M. L., Fisher, R. H., & Reid, D. W. (1989). WAIS-R test-retest reliability in a normal elderly sample. *Journal of Clinical and Experimental Neuropsychology*, *11*(4), 423–428.

Snowdon, D. A. (2003). Healthy aging and dementia: findings from the Nun Study. *Annals of Internal Medicine*, *139*(5), 450–454.

Snyder, C., Harris, C., Anderson, J. R., Holleran, S. A., Irving, L. M., Sigmon, S. T., … Harney, P. (1991). The will and the ways: development and validation of an individual-differences measure of hope. *Journal of Personality and Social Psychology*, *60*(4), 570–585.

Sofi, F., Abbate, R., Gensini, G. F., & Casini, A. (2010). Accruing evidence on benefits of adherence to the Mediterranean diet on health: an updated systematic review and meta-analysis. *The American Journal of Clinical Nutrition*, *92*(5), 1189–96.

Sofi, F., Valecchi, D., Bacci, D., Abbate, R., Gensini, G. F., Casini, A., & Macchi, C. (2010). Physical activity and risk of cognitive decline: a meta-analysis of prospective studies. *Journal of Internal Medicine*, *269*(1), 107–17.

Sokolovsky, J. (1993). Images of aging: A cross-cultural perspective. In D. Shenk & W. A. Achenbaum (Eds.), *Changing perceptions of aging and the aged* (pp. 85–94). New York: Springer.

Solfrizzi, V., Panza, F., & Capurso, A. (2003). The role of diet in cognitive decline. *Journal of Neural Transmission*, *110*(1), 95–110.

Solfrizzi, V., Panza, F., Colacicco, A. M., D'Introno, A., Capurso, C., Torres, F., … Capurso, A. (2004). Vascular risk factors, incidence of MCI, and rates of progression to dementia. *Neurology*, *63*(10), 1882–1891.

Solomon, P. R., Hirschoff, A., Kelly, B., Relin, M., Brush, M., DeVeaux, R. D., & Pendlebury, W. W. (1998). A 7 Minute Neurocognitive Screening Battery Highly Sensitive to Alzheimer's Disease. *Archives of Neurology*, *55*(3), 349–355.

Stanton, R., & Reaburn, P. (2014). Exercise and the treatment of depression: A review of the exercise program variables. *Journal of Science and Medicine in Sport*, *17*(2), 177–182.

Steel, N., Huppert, F., McWilliams, B., & Melzer, D. (2003). Physical and cognitive function. In M. Michael, J. Banks, R. Blundell, C. Lessof, & J. Nazroo (Eds.), *Health, wealth and lifestyles of the older population in England: The 2002 English Longitudinal Study of Ageing*. London: Institute for Fiscal Studies.

Stein, R., Blanchard-Fields, F., & Hertzog, C. (2010). The effects of age-stereotype priming on the memory performance of older adults. *Experimental Aging Research*, *28*(2), 169–181.

Stern, Y. (2002). What is cognitive reserve? Theory and research application of the reserve concept. *Journal of the International Neuropsychological Society*, *8*(03), 448–460.

Sternfeld, B., Cauley, J., & Harlow, S. (2000). Assessment of physical activity with a single global question in a large, multiethnic sample of midlife women. *American Journal of Epidemiology*, *152*(7), 678–687.

Stock, J., Clifford, A., & Hogervorst, E. (2012). Exercise interventions to improve cognitive performance in older adults – potential psychological mediators to explain variation in findings. *European Neurological Review*, *7*(2), 107–112.

Stranahan, A. M., Khalil, D., & Gould, E. (2006). Social isolation delays the positive effects of running on adult neurogenesis. *Nature Neuroscience*, *9*(4), 526–533.

Strawbridge, W. J., Deleger, S., Roberts, R. E., & Kaplan, G. A. (2002). Physical activity reduces the risk of subsequent depression for older adults. *American Journal of Epidemiology*, *156*(4), 328–334.

Strawbridge, W. J., Shema, S. J., Cohen, R. D., & Kaplan, G. A. (2001). Religious attendance increases survival by improving and maintaining good health behaviors, mental health, and social relationships. *Annals of Behavioral Medicine*, *23*(1), 68–74.

Sumic, A., Michael, Y. L., Carlson, N. E., Howieson, D. B., & Kaye, J. A. (2007). Physical activity and the risk of dementia in oldest old. *Journal of Aging and Health*, *19*(2), 242–259.

Sung, K. (2004). Elder respect among young adults: A cross-cultural study of Americans and Koreans. *Journal of Aging Studies*, *18*(2), 215–230.

Taaffe, D. R., Irie, F., Masaki, K. H., Abbott, R. D., Petrovitch, H., Ross, G. W., & White, L. R. (2008). Physical activity, physical function, and incident dementia in elderly men: the Honolulu-Asia Aging Study. *The Journals of Gerontology. Series A, Biological Sciences and Medical Sciences*, *63*(5), 529–535.

Taler, V., & Phillips, N. A. (2008). Language performance in Alzheimer's disease and mild cognitive impairment: a comparative review. *Journal of Clinical and Experimental Neuropsychology*, *30*(5), 501–556.

Taylor, A. H., Cable, N. T., Faulkner, G., Hillsdon, M., Narici, M., & Van Der Bij, A. K. (2004). Physical activity and older adults: a review of health benefits and the effectiveness of interventions. *Journal of Sports Sciences*, *22*(8), 703–725.

The Psychological Corporation. (1997). *The Psychological Corporation WAIS-III–WMS-III technical manual*. San Antonio, TX: The Psychological Corporation.

Thies, W., Bleiler, L., & Alzheimer's Association. (2013). Alzheimer's disease facts and figures. *Alzheimer's & Dementia: The Journal of the Alzheimer's Association*, *9*(2), 208–245.

Tien-Hyatt, J. (1986). Self-perceptions of aging across cultures: myth or reality? *The International Journal of Aging and Human Development*, *24*(2), 129–148.

Tsutsumi, T., Don, B. M., Zaichkowsky, L. D., & Delizonna, L. L. (1997). Physical fitness and psychological benefits of strength training in community dwelling older adults. *Applied Human Science*, *16*(6), 257–266.

Tudor-Locke, C., & Bassett, D. R. (2004). How many steps/day are enough? Preliminary pedometer indices for public health. *Sports Medicine*, *34*(1), 1–8.

Van Gelder, B., Tijhuis, M., & Kalmijn, S. (2004). Physical activity in relation to cognitive decline in elderly men The FINE Study. *Neurology*, *63*(12), 2316–2321.

Van Praag, H., Kempermann, G., & Gage, F. H. (1999). Running increases cell proliferation and neurogenesis in the adult mouse dentate gyrus. *Nature Neuroscience*, *2*(3), 266–270.

Van Stralen, M. M., De Vries, H., Mudde, A. N., Bolman, C., & Lechner, L. (2009). Determinants of initiation and maintenance of physical activity among older adults: a literature review. *Health Psychology Review*, *3*(2), 147–207.

Voss, M. W., Prakash, R. S., Erickson, K. I., Basak, C., Chaddock, L., Kim, J. S., … Kramer, A. F. (2010). Plasticity of brain networks in a randomized intervention trial of exercise training in older adults. *Frontiers in Aging Neuroscience*, *2*, 1–17.

Wada, T., Ishine, M., Sakagami, T., Kita, T., Okumiya, K., Mizuno, K., … Matsubayashi, K. (2005). Depression, activities of daily living, and quality of life of community-dwelling elderly in three Asian countries: Indonesia, Vietnam, and Japan. *Archives of Gerontology and Geriatrics*, *41*(3), 271–80.

Wang, H.-X., Karp, A., Herlitz, A., Crowe, M., Kåreholt, I., Winblad, B., & Fratiglioni, L. (2009). Personality and lifestyle in relation to dementia incidence. *Neurology*, *72*(3), 253–9.

Wang, H.-X., Karp, A., Winblad, B., & Fratiglioni, L. (2002). Late-life engagement in social and leisure activities is associated with a decreased risk of dementia: a longitudinal study from the Kungsholmen project. *American Journal of Epidemiology*, *155*(12), 1081–7.

Warburton, D. E. R., Gledhill, N., & Quinney, A. (2001a). Musculoskeletal fitness and health. *Canadian Journal of Applied Physiology*, *26*(2), 217–237.

Warburton, D. E. R., Gledhill, N., & Quinney, A. (2001b). The effects of changes in musculoskeletal fitness on health. *Canadian Journal of Applied Physiology*, *26*(2), 161–216.

Warburton, D. E. R., Nicol, C. W., & Bredin, S. S. D. (2006). Health benefits of physical activity: the evidence. *Canadian Medical Association Journal*, *174*(6), 801–809.

Ware, J. E., Jr., & Gandek, B. (1998). Overview of the SF-36 health survey and the international quality of life assessment (IQOLA) project. *Journal of Clinical Epidemiology, 51*, 903–912.

Weingartner, H., & Cohen, R. (1981). Cognitive processes in depression. *Archives of General Psychiatry*, *38*(1), 42–47.

Weitlauf, J. C., Smith, R. E., & Cervone, D. (2000). Generalization effects of coping-skills training: Influence of self-defense training on women's efficacy beliefs, assertiveness, and aggression. *Journal of Applied Psychology*, *85*(4), 625–633.

Wensing, M., Vingerhoets, E., & Grol, R. (2001). Functional status, health problems, age and comorbidity in primary care patients. *Quality of Life Research*, *10*(2), 141–148.

Wesnes, K. (2012). A comparison of traditional neuropsychological tests and automated cognitive tests in assessing cognitive decline in the elderly. Vienna, Austria: Poster session presented at the meeting of the 25th European College of Neuropsychopharmacology (ECNP).

West, R. L., Dark-Freudeman, A., & Bagwell, D. K. (2009). Goals-feedback conditions and episodic memory: Mechanisms for memory gains in older and younger adults. *Memory*, *17*(2), 233–44.

West, R. L., & Thorn, R. M. (2001). Goal-setting, self-efficacy, and memory performance in older and younger adults. *Experimental Aging Research*, *27*, 41–65.

Wetherell, J. L., Reynolds, C. A., Gatz, M., & Pedersen, N. L. (2002). Anxiety, cognitive performance, and cognitive decline in normal aging. *The Journals of Gerontology Series B: Psychological Sciences and Social Sciences*, *57*(3), P246–P255.

Weuve, J., Kang, J. H., Manson, J. E., Breteler, M. M. B., Ware, J. H., & Grodstein, F. (2004). Physical activity, including walking, and cognitive function in older women. *JAMA : The Journal of the American Medical Association*, *292*(12), 1454–1461.

Whang, W., Kubzansky, L. D., Kawachi, I., Rexrode, K. M., Kroenke, C. H., Glynn, R. J., … Albert, C. M. (2009). Depression and risk of sudden cardiac death and coronary heart disease in women: results from the Nurses' Health Study. *Journal of the American College of Cardiology*, *53*(11), 950–958.

Wibowo, A. (1999). Ageing in the South-East Asian region. *Health for the Millions*, *25*(5), 8–9.

Williams, P. T. (2001). Physical fitness and activity as separate heart disease risk factors: a meta-analysis. *Medicine and Science in Sports and Exercise*, *33*(5), 754–61.

Wolinsky, F. D., Wyrwich, K. W., Babu, A. N., Kroenke, K., & Tierney, W. M. (2003). Age, aging, and the sense of control among older adults: A longitudinal reconsideration. *The Journals of Gerontology Series B: Psychological Sciences and Social Sciences*, *58*(4), S212–S220.

Woods, B., Aguirre, E., Spector, A. E., & Orrell, M. (2012). Cognitive stimulation to improve cognitive functioning in people with dementia. *The Cochrane Database of Systematic Reviews*, *2*, CD005562.

World Health Organization. (2001). International Classification of Functioning , Disability and Health. Retrieved from http://www.sustainable-design.ie/arch/ICIDH-2Final.pdf

World Health Organization. (2012). Dementia: a public health priority. Retrieved November 06, 2013, from http://apps.who.int/iris/bitstream/10665/75263/1/9789241564458_eng.pdf

Wurm, S., Tesch-Romer, C., & Tomasik, M. J. (2007). Longitudinal findings on aging-related cognitions, control beliefs, and health in later life. *Journal of Gerontology*, *62*(3), 156–164.

Yaffe, K., Barnes, D., Nevitt, M., Lui, L. Y., & Covinsky, K. (2001). A prospective study of physical activity and cognitive decline in elderly women: women who walk. *Archives of Internal Medicine*, *161*(14), 1703–1708.

Yaffe, K., Blackwell, T., Gore, R., Sands, L., Reus, V., & Browner, W. S. (1999). Depressive Symptoms and Cognitive Decline in Nondemented Elderly Women. *Archives of General Psychiatry*, *56*(5), 425.

Yang, Y. (2008). Social inequalities in happiness in the United States, 1972 to 2004: an age-period-cohort analysis. *American Sociological Review*, *73*(2), 204–226.

Yeh, K. (2003). The Beneficial and Harmful Effects of Filial Piety: An Integrative Analysis. In K. S. Yang, K. K. Hwang, P. B. Pedersen, & D. Ikuo (Eds.), *Progress* *in Asian social psychology: Conceptual and Empirical Contributions*. Santa Barbara, USA: Greenwood Press.

Yesavage, J. A., Brink, T. L., Rose, T. L., Lum, O., Huang, V., Adey, M., & Leirer, V. O. (1983). Development and validation of a geriatric depression screening scale: a preliminary report. *Journal of Psychiatric Research*, *17*(1), 37–49.

Yoon, C., Hasher, L., Feinberg, F., Rahhal, T. a, & Winocur, G. (2000). Cross-cultural differences in memory: the role of culture-based stereotypes about aging. *Psychology and Aging*, *15*(4), 694–704.

Zautra, A. J. (2005). *Emotions, Stress, and Health* (p. 310). London: Oxford University Press.

Zelinski, E. M., & Gilewski, M. J. (2004). A 10-item Rasch modeled memory self-efficacy scale. *Aging & Mental Health*, *8*(4), 293–306.

Zhao, C., Deng, W., & Gage, F. (2008). Mechanisms and functional implications of adult neurogenesis. *Cell*, *132*(4), 645–660.

Zigmond, A. S., & Snaith, R. P. (1983). The Hospital Anxiety and Depression Scale. *Acta Psychiatrica Scandinavica*, *67*(6), 361–370.

Zimmermann, H., & Grebe, H. (2014). “Senior coolness”: living well as an attitude in later life. *Journal of Aging Studies*, *28*, 22–34.

Zunzunegui, M.-V. V, Alvarado, B. E., Del Ser, T., & Otero, A. (2003). Social networks, social integration, and social engagement determine cognitive decline in community-dwelling Spanish older adults. *The Journals of Gerontology Series B: Psychological Sciences and Social Sciences*, *58*(2), S93–S100.

Appendices

Appendix A: Study 1 Consent form

Participant Informed consent Form

The purpose and details of this study have been explained to me. I understand that this study is designed to further scientific knowledge and that all procedures have been approved by Loughborough University Ethical Advisory Committee.

I have read and understood the information sheet and this consent form.

I have had an opportunity to ask questions about my participation.

I understand that I am under no obligation to take part in the study.

I understand that I have the right to withdraw from this study at any stage for any reason, and that I will not be required to explain my reasons for withdrawing.

I understand that all the information I provide will be treated in strict confidence.

I agree to participate in this study.

Your Name : …………………………………………………

Your Signature : …………………………………………………

Name of Investigator : …………………………………………………

Signature of Investigator : …………………………………………………

Date : ____ / _____________ / 2011

Appendix B: Study 1 Questionnaire

Young people's attitudes to ageing

1. Write down 5 words (adjectives) that you associate with the elderly:

1.
2.
3.
4.
5.

2. What do ***you*** do for the elderly?

3. What do ***the elderly*** do for you?

4. What expectations do you have for yourself when you are an elderly person?

5. How much contact do you have with elderly people? How do you know them?

6. Do the elderly you engage with... (please circle):

   a. Keep physically active? Yes No
   If yes, what kind of activities? ____________________________

   b. Socialise? Yes No
   If yes, how?____

   c. Depend on others to do things for them? Yes No
   If yes, what things? __________________________________

Appendix C: Participant Questionnaire for Study 2

Questionnaire

SEMAR
2006

I. Local Orientation

1. District / City :

Jakarta	1
Sumedang	2
Yogyakarta	3
How long have you lived here…yrs Where did you live before rural/urban	

2. Subdistrict :

3. Village

RT : _______ RW : _______

How long have you lived here………………… Where did you live before……….

4. Location

Institution	1
Community	2
Other place, please specify ……………………….	3

5. Interviewer

6. Interviewer No.:

7. Respondent Name

8. Respondent No. :

II. Interviewer Visit and Recapitulation

9. Interview date : date _ _ / month _ _ / 2006

10. Interview time:

Start	hour _____ minute ____
Finish	hour _____ minute____

11. Carer present:

Spouse	1
Child	2
Relative	3
Caregiver	4
Other, please specify ……………………….	5

12. Visit result ***:***

Rejection	1 →		Reason for ***rejection***:	
Completion	2		No reason	1

Incomplete	3
Delayed	4
Respondent not present	5
Other, please specify	6
………………………………	

Weak condition	2
Serious illness	3
Other	4
Please specify…………….	5
…………………………..	

13. Completion and consistency of answers to this questionnaire is inspected by:

Name	Status	Examination Date	Signature
	Interviewer I		
	Interviewer II		
	Supervisor		

F1

Informed Consent

Consent from Study Respondent of the influence of phytoestrogen levels on memory in men and women in Indonesia

The purpose and details of this study have been explained to me. I understand that this study is designed to further scientific knowledge and that all procedures have been approved by the Faculty of Medicine University of Indonesia Ethical Advisory Committee.

I have read and understood the information sheet and this consent form.

I have had an opportunity to ask questions about my participation.

I understand that I am under no obligation to take part in the study.

I understand that I have the right to withdraw from this study at any stage for any reason, and that I will not be required to explain my reasons for withdrawing.

I agree that a saliva sample will be taken and used to assess the level of plant hormones in my body.

I understand that all the information I provide will be treated in strict confidence.

I am happy to provide a saliva sample for testing of plant hormones.

I agree to participate in this study.

Your Name : ………………………………………………….

Your Signature : ………………………………………………….

Caregiver Name : ………………………………………………….

Caregiver Signature : ……………………………………………...........

Name of Investigator : ………………………………………………….

Signature of Investigator : ………………………………………………….

Date : ____/ ______________/ 2006

F2

F2.1 Respondent Characteristics

F2.1a How old are you (**age from your last birthday**) ?

Age *(if any doubt about the answer/doesn't remember/doestn't know, check respondent's ID card)*	…. Yrs old
Doesn't know/ doesn't remember	98
No answer	99

F2.1b Sex:

Male	1
Female	2

F2.1c What was the highest education level you graduated from?

No formal education	1
Elementary school (unfinished)	2
Elementary school/Hollands Inlandische School/equivalent	3
Primary school/ Middelbaar Uitgebreid Lagere Onderwijs/domestic girls school/equivalent	4
High school/ Hoge Burgerlijke School/equivalent	5
Academy/ University	6
Other, please specify………..	97
No answer	99

F2.1d What's your **profession** before retire?

Not working	1
Civil servant (teacher/lecturer/government employee)	2
Entrepreneur (businessman/trader)	3
Employee in private company	4
Army/police	5
Doctor/Lawyer	6
Farmer	7
Fisherman	8
Labour/ no permanent job	9
Other, please specify	97

F2.1e What is your parents race?

	F2.1e1 Father	F2.1e2 Mother
Javanese	1	1
Sundanese	2	2
Malayan	3	3
Batak	4	4
Minang	5	5
Other, please specify	97 ………………………	97 ………………………

F2.1f Your religion/faith:

Islam	1
Protestant	2
Catholic	3
Hinduism	4
Buddha	5
Confucianism	6
Other, …………..……..	97
No answer	99

F2.1g Living area:

Urban	1
Rural	2

F2.1h With whom do you live at this moment?

Alone	1
Wife/husband	2
Wife/husband and child	3
Child (without wife/husband)	4
Relatives	5
Institution	6
Others............................	9

F2.1l House ownership

Own house	1
Renting	2
Live in other's house	3
Social institution	4
Others.................................	97

F2.1j Children :

How many children do you have (including the one(s) who passed away)	.... persons
How many children are still alive	.... persons
How many children live nearby (easy to visit)	.... persons

F2

HEALTH STATUS

Important for respondent is they are healthy and never experienced serious illness in the past. This is to confirm (i) their own health, and (ii) to avoid possibility of health problems as confounding factor in study result. Complete this questionnaire fully and clearly to assert the ability to become a participant. Explain clearly and comprehensively whether you have health problems, no serious problems, or in good maintenance (controlled).

F2.2 Health Complaint

		Participant		Caregiver	
At present, do you have any health problem for which you are:		Yes **(1)**	No **(2)**	Yes **(1)**	No **(2)**
a	On medication, prescribed or otherwise (traditional medicine: ask to see boxes etc., write down names of drugs and number)	1	2	1	2
b	Attending your doctor, health provider or traditional healer (and for what)	1	2	1	2
In the past two years, have you had any illness which require you to:					
c	Consult your doctor health provider or traditional healer	1	2	1	2
d	Attend a hospital outpatient department or health centre	1	2	1	2
E	Be admitted to hospital	1	2	1	2

F2.3 Tobacco, Alcohol Consumption and Other Risk Factor for Dementia

F2.3a Have you EVER smoke?

Yes	1
No (**continue to F2.3e**)	2

F2.3b Are you a REGULAR smoker ?

Yes	1
No (**continue to F2.3e**)	2

F2.3c How much do you smoke? (*choose amount of cigarettes and one time frame which respondent remember easily*)

	Yes	Amount
Amount per day	1	...... cigarettes
Amount per week	1	...... cigarettes
Amount per month	1	...... cigarettes

F2.3d Cigarettes type:

Kretek	1
White	2

F2.3e Have you EVER drink alcoholic beverages?

Yes	1
No (**continue to F2.3h**)	2

F2.3f Do you ROUTINELY/ALL THE TIME/OFTEN drink alcoholic beverages?

Yes	1
No (**continue to F2.3h**)	2

F2.3g How much alcohol consumptions you have each week?

1 glass of beer	1
1 glass of wine	2
1 unit of spirits	3
Other, please specify	97

F2.3h Do you drink tea?

GREEN TEA	
Yes	1
No (**continue to F2.3j**)	2
BLACK TEA	
Yes	
No (**continue to F2.3j**)	

F2.3i How much tea you drink? (*conform the answer to glass amount/time frame which respondent remember easily*)

	Yes	Amount
Amount per day	1	...... glass
Amount per week	1	...... glass
Amount per month	1	...... glass

F2.3j Do you drink coffee?

Yes	1
No (**continue to F2.4**)	2

F2.3k How much coffee you drink? (*conform respondent's answer to glass amount/time frame which respondent remember easily*)

	Yes	Amount
Amount per day	1	...... glass
Amount per week	1	...... glass
Amount per month	1	...... glass

F2.4 Are you on hormone therapy in the past 6 months? (e.g. use of hormone (for men), viagra, plants) **circle**

Yes	1
No	2

F2.5 Compare to others:

	More	The same	Less
a. Do you feel happy?	1	2	3
b. Do you feel secure?	1	2	3
c. Do you in stress or anxious?	1	2	3

F2.6 Food Consumption

How much do you consume the following food item		Do you eat it daily? *If yes, ask how many times a day and continue to the next food item*			Days in a week	Days in a month
		Yes, how many times a day		No		
a	Rice	1	....	2		
b	Fruit/juice	1	....	2		
c	Orange/red colored vegetables	1	....	2		
d	Green vegetables	1	....	2		
e	Fish	1	....	2		
f	Tempe	1	....	2		
g	Tahu/Tofu	1	....	2		
h	Soy milk, other soy product	1	....	2		
i	Tumeric as jamu (herbal medicine)	1	....	2		
j	Tumeric as spices	1	....	2		
k	Tumeric as raw vegetables	1	....	2		
l	White meat (chicken)	1		2		
m	Red meat (beef/lamb/veal)	1		2		

F2.7 Physical, Mental and Social Activities

F2.7a Your position during activities

Position		Never (1)	Seldom (2)	Sometimes (3)	Often (4)	Very often (5)
	Sit	1	2	3	4	5
	Stand	1	2	3	4	5
	Walk	1	2	3	4	5
	Lift heavy things	1	2	3	4	5
	Feel tired afterwards	1	2	3	4	5
	Sweat afterwards	1	2	3	4	5

F2

F2.7b Compared to people of you own age, how do you rate your physical activity:

Lighter	1
As heavy	2
Heavier	3

F2.7c Do you play sport regularly:

Yes	1
No **continue to F2.8**	2

F2.7d What kind of sport:

Kind of sport played	Frequency (how often)	Time frame		
		Day	Week	Month
1.	...... times	1	2	3
2.	...... times	1	2	3
3.	...... times	1	2	3
4.	...... times	1	2	3
5.	...... times	1	2	3

F2.8 Mental/Social Activities

F2.8a Do you engaged in the following activities :

Activities:		Never (1)	Seldom (2)	Sometimes (3)	Often (4)	Very often (5)
a	Read	1	2	3	4	5
b	Write letters	1	2	3	4	5
c	Watch TV	1	2	3	4	5
d	Talk to friends, neighbours or family	1	2	3	4	5
e	Go to gatherings (social)	1	2	3	4	5
f	Pray together	1	2	3	4	5
g	Have dinners with friends/family	1	2	3	4	5
h	Go to theatre /film (ketoprak, ludruk, reog, topeng, lenong)	1	2	3	4	5
i	Go to musical gathering (jaipongan,gending)	1	2	3	4	5
j	Involved in community social activities	1	2	3	4	5

F2.13 INFORMATION FROM CAREGIVER

THE FOLLOWING QUESTIONS ABOUT THE ELDERLY IN LAST COUPLE OF YEARS IS DIRECTED ONLY TO CAREGIVER

F2.13a Does the elderly you care for (the one concerned with this questionnaire) have memory problems :

Yes	1
If yes which? explain	
No, **please continue to F2.13**	2

F2.13b If yes, does it happen consistently

Yes	1
No	2

Appendix D - Instrumental Activities of Daily Living Questionnaire

Activities			Criteria	
F6.1	Extending message/using the telephone	0	I am unable to use the phone	
		1	I am capable of answering phone but unable to operate it	
		2	I am able to operate the phone	
F6.2	Shopping	0	I am unable to do any shopping	
		1	I am capable of purchasing up to 3 items, otherwise I need help	
		2	I do my shopping independently	
F6.3	Preparing meal	0	I am unable to cook	
		1	I am able to cook if the ingredients are ready or to warm cooked food	
		2	I cook independently	
F6.4	Housekeeping	0	I am unable to do the housekeeping	
		1	I am able to do light tasks (sweeping, make the bed) only, but otherwise I need help	
		2	I do the housekeeping independently (capable to do all household tasks including mopping and washing clothes)	
F6.5	Washing clothes	0	I am unable to wash my clothes	
		1	I am able to wash light clothes or ironing, but otherwise need help	
		2	I do my washing independently (using washing machine included)	
F6.6	Utilisation of transportation means	0	I am unable to travel with any transportation means	
		1	I travel on public transport/taxi or private car if I am helped/accompanied by another	
		2	I travel independently	
F6.7	Responsibility of own medication/ preparing own medication	0	I need help from others to prepare and consume my medication	
		1	I am able to take it if medication is previously prepared	
		2	I take my medication independently (I am able to prepared my own medication according to prescribed dose and time)	
F6.8	Ability to handle finances	0	I am incapable at handling my own finances	
		1	I am able to arrange my daily purchases but need help with banking/major purchasing	
		2	I am able to manage financial problems (household budget, pay the rent, receipts, bank matters) or to monitor my income	

Appendix E: SF-36 Questionnaire (Health-related Quality of Life)

1. In general, would you say your health is:	
Excellent	1
Very Good	2
Good	3
Fair	4
Poor	5
2. Compared to one year ago, how would your rate your health in general now?	
Much better now than one year ago	1
Somewhat better now than one year ago	2
About the same	3
Somewhat worse now than one year ago	4
Much worse now than one year ago	5

The following items are about activities you might do during a typical day. Does **your health now limit you** in these activities? If so, how much?
(Circle One Number on Each Line)

	Yes, Limited a Lot	Yes, Limited a Little	No, Not limited at All
3. **Vigorous activities**, such as running, lifting heavy objects, participating in strenuous sports	[1]	[2]	[3]
4. **Moderate activities**, such as moving a table, pushing a vacuum cleaner, bowling, or playing golf	[1]	[2]	[3]
5. Lifting or carrying groceries	[1]	[2]	[3]
6. Climbing **several** flights of stairs	[1]	[2]	[3]
7. Climbing **one** flight of stairs	[1]	[2]	[3]
8. Bending, kneeling, or stooping	[1]	[2]	[3]
9. Walking **more than a mile**	[1]	[2]	[3]
10. Walking **several blocks**	[1]	[2]	[3]
11. Walking **one block**	[1]	[2]	[3]
12. Bathing or dressing yourself	[1]	[2]	[3]

During the **past 4 weeks**, have you had any of the following problems with your work or other regular daily activities **as a result of your physical health**?

(Circle One Number on Each Line)

	Yes	No
13. Cut down the amount of time you spent on work or other activities	1	2
14. **Accomplished less** than you would like	1	2
15. Were limited in the **kind** of work or other activities	1	2
16. Had **difficulty** performing the work or other activities (for example, it took extra effort)	1	2

During the **past 4 weeks,** have you had any of the following problems with your work or other regular daily activities **as a result of any emotional problems** (such as feeling depressed or anxious)?

(Circle One Number on Each Line)

	Yes	No
17. Cut down the **amount of time** you spent on work or other activities	1	2
18. **Accomplished less** than you would like	1	2
19. Didn't do work or other activities as **carefully** as usual	1	2

20. During the **past 4 weeks,** to what extent has your physical health or emotional problems interfered with your normal social activities with family, friends, neighbors, or groups?

(Circle One Number)

Not at all 1

Slightly 2

Moderately 3

Quite a bit 4

Extremely 5

21. How much **bodily** pain have you had during the **past 4 weeks**?

(Circle One Number)

None 1

Very mild 2

Mild 3

Moderate 4

Severe 5

Very severe 6

22. During the **past 4 weeks,** how much did **pain** interfere with your normal work (including both work outside the home and housework)?
(Circle One Number)

Not at all 1

A little bit 2

Moderately 3

Quite a bit 4

Extremely 5

These questions are about how you feel and how things have been with you **during the past 4 weeks**. For each question, please give the one answer that comes closest to the way you have been feeling.

How much of the time during the **past 4 weeks** . . .

(Circle One Number on Each Line)

	All of the Time	Most of the Time	A Good Bit of the Time	Some of the Time	A Little of the Time	None of the Time
23. Did you feel full of pep?	1	2	3	4	5	6
24. Have you been a very nervous person?	1	2	3	4	5	6
25. Have you felt so down in the dumps that nothing could cheer you up?	1	2	3	4	5	6
26. Have you felt calm and peaceful?	1	2	3	4	5	6
27. Did you have a lot of energy?	1	2	3	4	5	6
28. Have you felt downhearted and blue?	1	2	3	4	5	6
29. Did you feel worn out?	1	2	3	4	5	6
30. Have you been a happy person?	1	2	3	4	5	6
31. Did you feel tired?	1	2	3	4	5	6

32. During the **past 4 weeks,** how much of the time has your **physical health or emotional problems** interfered with your social activities (like visiting with friends, relatives, etc.)?
(Circle One Number)

All of the time 1

Most of the time 2

Some of the time 3

A little of the time 4

None of the time 5

How TRUE or FALSE is each of the following statements for you.

(Circle One Number on Each Line)

	Definitely True	Mostly True	Don't Know	Mostly False	Definitely False
33. I seem to get sick a little easier than other people	1	2	3	4	5
34. I am as healthy as anybody I know	1	2	3	4	5
35. I expect my health to get worse	1	2	3	4	5
36. My health is excellent	1	2	3	4	5

Appendix F: Backwards difference contrast coding for walking variable used in Study 2

	Coded walking variables			
Self-report level of walking	Never-Seldom	Seldom-sometimes	Sometimes-often	Often-very often
Never	-1	0	0	0
Seldom	1	-1	0	0
Sometimes	0	1	-1	0
Often	0	0	1	-1
Very often	0	0	0	1

Reference: http://www.asasts.ucla.edu/stat/sas/webbooks/reg/chapter5/sasreg5.htm#backward

Appendix G: Study 3 and Study 4 Enrolment Questionnaire

Participant ID: ……………

1. Date of Birth: ……./……./19……

2. Gender (please circle): male / female

3. What is your occupation? (please tick): Higher
manager, admin or professional … Intermediate
manager, admin or professional …
Supervisory or clerical, junior manager, admin or professional …
Skilled manual …

Semi or unskilled manual …
Retired …

4. What is the highest level of education you have completed? (please tick):
Primary …
Secondary …

College, diploma or equivalent …
University Degree (undergraduate) …
University Degree (postgraduate) …

5. What is your marital status? (please tick):

Single…
Married…
Separated…
Widowed…

6. Do you have children? (please circle): yes / no

If yes, how many? ……..

7. Do you or have you in the past suffered from any of the listed medical conditions? (please tick)

- Diabetes mellitus …
- Endocrine problems (prostate/testicular) or hypofunction of the thyroid …
- Coronary heart disease/arrhythmia/ myocardial infarct/stroke …
- Asthma or other lung disease …
- Thrombosis or other blood (clotting) disorder …

- Digestive, gastrointestinal problems …

- Dementia (e.g. Alzheimer's disease) …

- Cancer or benign growths (polyps etc.) …

- Vision / ear / hearing problems …

- Kidney or liver problems …

- Allergies (please state) ……………………………………………………………………….
- Other (please circle): lung or kidney disease, neurological (e.g. epilepsy, or mental health disorders e.g. depression for which you are receiving medical treatment) or (please state)

……………………………………………………………………………………………………

……………………………………………………………………………………………………

Are you still receiving medical treatment for these conditions now? (please circle) yes / no

8. Do you have any memory complaints? (please circle): yes / no

9. Has anyone in your direct family (e.g. parent, sibling) suffered from dementia or memory problems? (please circle): yes / no

10. Do you have a physically demanding job? (please circle): yes / no

Appendix H: Resistance training exercises

Sit on the floor or mat with your back straight. Wrap your band across the ends of your feet and pull the band towards you. Rotate the top half of your body pulling the band keeping your abdominals pulled in tight. Repeat to the opposite side.

Stand with your feet shoulder width apart and your back almost straight. Wrap your band round the top of your back with either end in your hands. Start with your elbows slightly bent and push your hands out in front of you until your elbows are almost straight.

Stand with a split stance with your front foot over the middle of your band holding either end in your hands by your side. Raise both your arms up to shoulder height and slightly tilt them forwards then slowly back down. Repeat with the other side.

Stand with a split stance with your front foot supporting the middle of your band holding both ends by your side. Curl your arms up to the point of tension bending at the elbows and slowly back down again.

Sit with your knees bent and your back tilted slightly back, wrap your band round one foot holding each end at your knees. Push your leg out straight keeping your grip at your knees and bring back in slowly. Repeat on the other leg.

Stand with a split stance and place your band under your front foot holding either end at the side of your body and bend your legs down into a lunge position. Pull your band tight and push up through your feet to a standing position and slowly back down.

Appendix I: Study 3 Exercise diary

Participant ID…………..

Week	Date	Time (AM/PM)	Completed?
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			

Appendix K: Social Support Questionnaire

Please rate on a scale of 1-7 how well your social networks provide the type of support or help that is listed in the left hand column as follows.

1	2	3	4	5	6	7
Never			Sometimes			Always

To what extent can you:	Friends /	Family/	Colleagues
Trust, talk frankly and share feelings with?	…..	…..	…..
Lean on and turn to in times of difficulty?	…..	…..	…..
Get interest, reassurance and a good feeling about you?	…..	…..	…..
Get physical comfort?	…..	…..	…..
Resolve unpleasant disagreements if they occurred?	…..	…..	…..
Get financial and practical help?	…..	…..	…..
Get suggestions, advice and feedback?	…..	…..	…..
Visit them or spend time with them socially?	…..	…..	…..
Get help in an emergency?	…..	…..	…..
Share interests and hobbies and have fun with?	…..	…..	…..

Appendix L: Study 4 - Participant Information Sheet

Title: Exercise to improve memory and wellbeing.

Researcher: Jennifer Stock
Email: J.Stock@lboro.ac.uk, Tel: ***** *****
Supervisor: Professor Eef Hogervorst
Email: E.Hogervorst@lboro.ac.uk, Tel: ***** ******
School of Sport, Exercise and Health Sciences,
Loughborough University

You are invited to participate in a research project. Before you decide whether or not you wish to participate, it is important that you understand what it will involve if you agree to take part. Please read the following information carefully and be sure to ask any questions that you may have.

What will the study entail?

Previous research has shown that exercise can have positive effects on memory and wellbeing, the purpose of this research is to investigate the benefits of different types of exercise. To answer this question we will ask half of those who volunteer to carry out specific exercises designed to build up strength and other half to carry out exercise designed to improve flexibility. This will allow us to compare between the two types of exercise. The strength exercises will start very gently and use large resistance bands made of elastic giving you control over how much effort is required. The flexibility exercises also go at your own pace. We will provide you with instruction booklets and exercises diaries to help you keep track of your progress. The exercises programmes last for 12 weeks and would take approximately 30-40 minutes, three times per week. We will need to randomly assign you to a type of exercise, however if after the 12 weeks you would like to try the other exercise then we will provide the materials.

In order to see whether the exercises lead to measureable improvements we would ask you to complete some questionnaires, physical measurements and memory tasks before starting the programme. These would be repeated half way through after 6 weeks and also at the end after 12 weeks. These will be all explained and demonstrated where appropriate and you will be able to take breaks whenever you like.

1. Questionnaires about general health, mood, age, previous job, sleep, attitudes towards ageing, what activities and hobbies they do already and their perception of their physical abilities and memory.
2. Physical measurements which will include height, weight, blood pressure, grip strength, get up and go (rising from chair, walking 6 metres and sitting back down), wearing a pedometer to measure the number of steps in a day before starting the exercise programme and at the end and a small saliva sample.
3. Memory and concentration tasks looking at different types of memory which you will be able to practice beforehand. Some of these are carried out on a computer, some using pen and paper and some just through talking.

Are there any risks or side effects?
There is a risk of temporary muscle strain from the exercises, however carrying out the warming up and cooling down exercises will reduce this risk. Also the elastic bands allow you to be in control of how much strain you put yourself under. Before you start we will explain how to complete the exercises safely. If you no longer wish to take part and wish to stop either the exercise then you can easily stop without giving a reason (See below – Your rights as a research participant). Also if you feel tired during any of the memory tasks, physical assessments or while filling out questionnaires then you can have as many breaks as you wish for as long as you need.

Who is doing this research and why?
Jennifer Stock, a postgraduate research student, is carrying out this research as part of her PhD under the supervision of Professor Eef Hogervorst.

Will my taking part in this study be kept confidential?
Yes. Data will be kept securely and destroyed after 10 years. Anonymity will also be ensured by issuing participants with a unique code and hence, your name will not appear on any materials. Details of your code will be kept securely in case you wish to withdraw your data at any time.

What will happen to the results of the study?
The results of the study will be written up as part of a PhD, and may be written up as a scientific paper with the aim of publication.

Your rights as a research participant

You should feel free to ask any questions regarding the study and your participation in it. Participation is entirely voluntary and you are free to refuse to take part or to withdraw from the study at any time. Your participation in this research is confidential. Only the researcher will have access to your identity and to information that can be associated with your identity. Information will be stored securely on computer and no identifying information will be attached to any of the questionnaires or test data. A code will be used instead of a name on all questionnaires and research materials.

What if I am not happy with how the research was conducted?

The University has a policy relating to Research Misconduct and Whistle Blowing which is available online at:
http://www.lboro.ac.uk/admin/committees/ethical/Whistleblowing(2).htm.

Appendix N: Study 4 – Informed consent form

Loughborough University

Informed Consent: to be completed after reading the information sheet

This section indicates that you are giving informed consent to participate in the research. Please read it carefully and sign below.

The purpose and details of this study have been explained to me. I understand that this study is designed to further scientific knowledge and that all procedures have been approved by Loughborough University Ethical Advisory Committee.

I have read and understood the information sheet and this consent form.

I have had an opportunity to ask questions about my participation.

I understand that I am under no obligation to take part in the study.

I understand that I have the right to withdraw from this study at any stage for any reason, and that I will not be required to explain my reasons for withdrawing.

I understand that all the information I provide will be treated in strict confidence and will be kept anonymous and confidential to the researchers unless it is judged that confidentiality will have to be breached for the safety of the participant or others.

I agree to participate in this study.

Your Name : ………………………………………………………

Your Signature : ………………………………………………….

Your phone number : ………………………………………………….

Researcher

I certify that the informed consent procedure has been followed and that I have answered any questions from the participant above as fully as possible.

Name of Investigator : ………………………………………………….

Signature of Investigator : ………………………………………………….

Date : ____ / _____________ / ______

Appendix O: Permission from Manager/Warden

Research study: ***Exercise to improve memory and wellbeing***

Previous research has shown that exercise can have positive effects on memory and wellbeing, the purpose of this research is to investigate the benefits of different types of exercise. To answer this question we will ask half of those who volunteer to carry out specific exercises designed to build up strength and other half to carry out exercise designed to improve flexibility. This will allow us to compare between the two types of exercise. The strength exercises will start very gently and use large resistance bands made of elastic giving control over how much effort is required. The flexibility exercises also go at volunteer's own pace. We will provide instruction booklets and exercises diaries to help volunteers keep track of their progress. The exercises programmes last for 12 weeks and would take approximately 30-40 minutes, three times per week in their own time. We will need to randomly assign volunteers to a type of exercise, however if after the 12 weeks they would like to try the other exercise then we will provide the materials.

In order to see whether the exercises lead to measureable improvements we would ask them to complete some questionnaires, physical measurements and memory tasks before starting the programme. These would be repeated half way through after 6 weeks and also at the end after 12 weeks. These will be all explained and demonstrated where appropriate and they will be able to take breaks whenever they like.

1. Questionnaires about general health, mood, age, previous job, sleep, attitudes towards ageing, what activities and hobbies they do already and their perception of their physical abilities and memory.
2. Physical measurements which will include height, weight, blood pressure, grip strength, get up and go (rising from chair, walking 6 metres and sitting back down), wearing a pedometer to measure the number of steps in a day before starting the exercise programme and at the end and a small saliva sample.
3. Memory and concentration tasks looking at different types of memory which they will be able to practice beforehand. Some of these are carried out on a computer, some using pen and paper and some just through talking.

Resident's participation is always voluntary so if they change their mind at any point during the study then they can easily stop without needing to give a reason. We are always happy for you or them to contact us at any point to answer and any questions you and/or the residents may have. You can contact us either by telephone or email:

Jennifer Stock tel: *********** email: J.Stock@lboro.ac.uk
Prof Hogervorst tel: *********** email: E.Hogervorst@lboro.ac.uk

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I confirm that I am happy for this research to be undertaken.
Name: ______________________ Date: _________________________

Signed: ____________________ Name of residence: ________________________

Appendix P: Resistance training diary

Example Week - Week beginning: Monday ***10/11//2012***

		Session 1	Session 2	Session 3
Day		*Monday*	*Wednesday*	*Friday*
Start and finish time		*10.30 – 11am*	*2 – 2.30pm*	*11 – 11.35am*
Resistance exercises:				
Exercise 1	**Reps/sets:**	*9 repetitions x 3 sets*	*10 x 3*	*11 x 3*
	Band colour:	*Yellow*	*Yellow*	*Red (moved up to band 2!)*
	Difficulty:	*4*	*4*	*5*
Exercise 5	**Reps/sets:**	*8 x 3*	*9 x 3*	*10 x 3*
	Band colour:	*Yellow*	*Yellow*	*Yellow*
	Difficulty:	*4*	*3*	*3*
Exercise 9	**Reps/sets:**	*11 x 3*	*11 x 3*	*13 x 3*
	Band colour:	*Yellow*	*Yellow*	*Yellow*
	Difficulty:	*2*	*2*	*2*
Exercise 13	**Reps/sets:**	*7 x 3*	*8 x 3*	*10 x 3*
	Band colour:	*Yellow*	*Yellow*	*Yellow*
	Difficulty:	*4*	*4*	*4*
Exercise 19	**Reps/sets:**	*10 x 3*	*10 x 3*	*11 x 3*
	Band colour:	*Yellow*	*Yellow*	*Yellow*
	Difficulty:	*4*	*3*	*3*
Exercise 24	**Reps/sets:**	*5 x 2*	*6 x 2*	*7 x 3*
	Band colour:	*Yellow*	*Yellow*	*Yellow*
	Difficulty:	5	5	5
Other comments:		*1, 5 and 19 were carried out sitting on a chair*		

How much did you **enjoy** doing the resistance training this week?

Not at all |——————————|—————| Extremely enjoyed it

Appendix Q: Flexibility exercises diary

Example Week - Week beginning: Monday ***10/11//2012***

		Session 1	Session 2	Session 3
Day		*Monday*	*Wednesday*	*Friday*
Start and finish time		*10.30 – 11am*	*2 – 2.30pm*	*11 – 11.35am*
Exercises:				
Energizing breath	**No./Seconds:**	*Held for 10 seconds x times*		
	Difficulty:	*2*		
Sideways stretch	**No./Seconds:**	*5 seconds twice on each side*		
	Difficulty:	*6*		
Mountain pose	**No./Seconds:**	*7 seconds, twice*		
	Difficulty:	*4*		
Pose of a cow	**No./Seconds:**	*5 seconds, once on each side*		
	Difficulty:	*6*		
Thigh stretch	**No./Seconds:**	*Held 5 seconds, 5 x each leg*		
	Difficulty:	*6*		
Simple twist	**No./Seconds:**	*4 seconds 2 x each side*		
	Difficulty:	*4*		
Back stretch	**No./Seconds:**	*2 x 5 seconds held*		
	Difficulty:	*3*		
Pose of a cat	**No./Seconds:**	*5 times*		
	Difficulty:	4		
Knee hug	**No./Seconds:**	Twice each leg, 5 seconds		
	Difficulty:	6		
Other comments:		*Used tea towel for pose of a cow*		

How much did you **enjoy** doing the flexibility exercises this week?

Not at all |——————————|—————| Extremely enjoyed it

Appendix R: Flexibility exercises diary Borg Scale

This scale is for rating how difficult you find each exercise:

0	**Rest, nothing at all**
1	**Really easy**
2	**Easy**
3	**Moderate**
4	**Sort of difficult**
5	**Difficult**
6	
7	**Really difficult**
8	
9	**Really, really difficult**
10	**Maximum difficulty**

Note: Ratings of 6 indicate a level of difficulty between ”Difficult” and ”Really difficult”

And ratings of 8 indicate a level of difficulty between ”Really difficult” and ”Really, really difficult”

Appendix S: Attitudes towards ageing – free response question

Study 4 Questionnaire Pack

Please fill out the following questions and take breaks whenever you like. P No:_____

Please write down **5 words, adjectives or short phrases** you would use to describe elderly people?

1.
2.
3.
4.
5.

Appendix T: Attitudes towards Ageing Questionnaire

These questions ask you how you feel about growing older. **Please answer all questions**. If you are unsure which response to give, please choose the one that appears the most appropriate. This can often be your first response. Please keep in mind your standards, hopes, pleasures and concerns. We ask that you think about your life in **general**. The following questions ask **how much you <u>agree</u>** with the following statements are for you. Please tick the appropriate boxes.

AAQ

		Strongly Disagree	Disagree	Uncertain	Agree	Strongly Agree
1	As people get older they are better able to cope with life					
2	It is a privilege to grow old					
3	Old age is a time of loneliness					
4	Wisdom comes with age					
5	There are many pleasant things about growing older					
6	Old age is a depressing time of life					
7	It is important to take exercise at any age					

Appendix T: Attitudes towards Ageing Questionnaire

The following questions ask **how <u>true</u>** the following statements are for you. Please tick the appropriate boxes.

		Not true at all	**Slightly true**	**Moderately true**	**Very true**	**Extremely true**
8	Growing older has been easier than I thought.					
9	I find it more difficult to talk about my feelings as I get older					
10	I am more accepting of myself as I have grown older					
11	I don't feel old					
12	I see old age mainly as a time of loss					
13	My identity is not defined by my age					
14	I have more energy now than I expected for my age					
15	I am losing my physical independence as I get older					
16	Problems with my physical health do not hold me back from doing what I want					
17	As I get older I find it more difficult to make new friends					
18	It is very important to pass on the benefits of my experiences to younger people					
19	I believe my life has made a difference					
20	I don't feel involved in society now that I am older					
21	I want to give a good example to younger people					
22	I feel excluded from things because of my age					
23	My health is better than I expected for my age					
24	I keep as fit and active as possible by exercising					

Appendix U: Dispositional Trait Hope Scale (Perceived control)

The Goals Scale - Please read each statement carefully and tick the box which **best describes YOU**. PC

		Definitely True	Mostly True	Somewhat True	Slightly True	Slightly False	Somewhat False	Mostly False	Definitely False
1	I can think of many ways to get out of a jam.								
2	I energetically pursue my goals.								
3	I feel tired most of the time.								
4	There are lots of ways around any problem.								
5	I am easily downed in an argument.								
6	I can think of many ways to get the things in life that are most important to me.								
7	I worry about my health.								
8	Even when others get discouraged, I know I can find a way to solve the problem.								
9	My past experiences have prepared me well for the future.								
10	I've been pretty successful in life.								
11	I usually find myself worrying about something.								
12	I meet the goals that I set for myself.								

Appendix V: General Self-Efficacy scale

For each of the following statements, please **tick** the choice that is **closest** to how true you think it is for you. The questions ask about your opinion. **<u>There are no right or wrong answers</u>**

GSE

		Not at all true	Hardly true	Moderately true	Exactly true
1	I can always manage to solve difficult problems if I try hard enough				
2	If someone opposes me, I can find the means and ways to get what I want				
3	It is easy for me to stick to my aims and accomplish my goals				
4	I am confident that I could deal efficiently with unexpected events				
5	Thanks to my resourcefulness, I know how to handle unforeseen situations				
6	I can solve most problems if I invest the necessary effort				
7	I can remain calm when facing difficulties because I can rely on my coping abilities				
8	When I am confronted with a problem, I can usually find several solutions				
9	If I am in trouble, I can usually think of a solution				
10	I can usually handle whatever comes my way				

Appendix W: Physical Self-Efficacy scale

These questions ask about what you think of yourself **physically compared to other people the same age**. For each statement **please tick how much you agree.** PSE

	Compared to other people my age….	**Strongly Disagree**	**Disagree**	**Uncertain**	**Agree**	**Strongly Agree**
1	I have excellent reflexes					
2	I am not agile and graceful					
3	My physique is rather strong					
4	Walking up and down the stairs is easy for me					
5	I don't feel in control when I take tests involving physical dexterity					
6	I have poor muscle tone					
7	I take little pride in my ability in sports					
8	My speed has helped me out of some tight spots					
9	I have a strong grip					
10	Because of my agility, I have been able to do things which many others could not do					

Appendix X: General Memory Efficacy scale

On this page, there are some questions asking for your opinions about your recent memory. To answer each question, you should circle the number that best indicates your opinion. Please read each question carefully before you decide how to answer. There are no right or wrong answers on these questions. GME

First, do the EXAMPLE:

Please give us your opinion about the weather.

What do you think about the weather outside today?

Wonderful						**Horrible**
1	2	3	4	5	6	7

QUESTIONS ABOUT RECENT MEMORY PERFORMANCE

1. How important has it been to you to perform well on memory activities in your everyday life?

Not at all important						**Very important**
1	2	3	4	5	6	7

2. How have you performed on most memory tasks you have done recently?

Very poor						**Very good**
1	2	3	4	5	6	7

3. How do you think your memory compares with most other people your age?

Much worse						**Much better**
1	2	3	4	5	6	7

4. How satisfied are you with your recent memory performance?

Very unsatisfied						**Very satisfied**
1	2	3	4	5	6	7

Appendix Y: Frequency of forgetting scale

These questions ask about how you remember information. There are no right or wrong answers. Circle a number between 1 and 7 that best reflects your judgment about your memory. Think carefully about your responses, and try to be as realistic as possible when you make them. Please answer all questions. FOF-10

General frequency of forgetting problems

How would you rate your memory in terms of the kind of problems that you have?

Major problems		**Some minor problems**			**No problems**	
1	2	3	4	5	6	7

How often do these present a problem for you?

		Always			**Sometimes**			**Never**
2	Names	1	2	3	4	5	6	7
3	Faces	1	2	3	4	5	6	7
4	Where you put something	1	2	3	4	5	6	7
5	Directions to places	1	2	3	4	5	6	7
6	Beginning to do something and forgetting what you were doing	1	2	3	4	5	6	7

As you are reading a novel/book/newspaper/magazine, how often do you have trouble remembering what you have read…

		Always			**Sometimes**			**Never**
7	The paragraph just before the one you are currently reading	1	2	3	4	5	6	7
8	The sentence before the one you are currently reading	1	2	3	4	5	6	7

How well you remember things which occurred. . .

		Very bad			**Fair**			**Very good**
9	Between one and five years ago is	1	2	3	4	5	6	7
10	The sentence before the one you are currently reading	1	2	3	4	5	6	7

Appendix Z: Geriatric Depression Scale

Please circle the answer (yes or no) most relevant to you. GDS

1	Are you basically satisfied with your life?	Yes	No
2	Have you dropped many of your activities and interests?	Yes	No
3	Do you feel that your life is empty?	Yes	No
4	Do you often get bored?	Yes	No
5	Are you in good spirits most of the time?	Yes	No
6	Are you afraid that something bad is going to happen to you?	Yes	No
7	Do you feel happy most of the time?	Yes	No
8	Do you often feel helpless?	Yes	No
9	Do you prefer to stay at home, rather than going out and doing new things?	Yes	No
10	Do you feel you have more problems with memory than most?	Yes	No
11	Do you think it is wonderful to be alive now?	Yes	No
12	Do you feel pretty worthless the way you are now?	Yes	No
13	Do you feel full of energy?	Yes	No
14	Do you feel that your situation is hopeless?	Yes	No
15	Do you think that most people are better off than you are?	Yes	No

Appendix ZA: Geriatric Anxiety Index

These statements also relate to how you feel, for each statement please tick to say whether you agree or disagree GAI

		Disagree	Agree
1	I worry a lot of the time.		
2	I find it difficult to make a decision.		
3	I often feel jumpy.		
4	I find it hard to relax.		
5	I often cannot enjoy things because of my worries.		
6	Little things bother me a lot.		
7	I often feel like I have butterflies in my stomach.		
8	I think of myself as a worrier.		
9	I can't help worrying about even trivial things.		
10	I often feel nervous.		
11	My own thoughts often make me anxious.		
12	I get an upset stomach due to my worrying.		
13	I think of myself as a nervous person.		
14	I always anticipate the worst will happen.		
15	I often feel shaky inside.		
16	I think that my worries interfere with my life.		
17	My worries often overwhelm me.		
18	I sometimes feel a great knot in my stomach.		
19	I miss out on things because I worry too much.		
20	I often feel upset.		

Appendix ZB: WHO-5 Well-being

Please tick for each of the five statements which is closest to how you have been feeling over the **last two weeks.**

WHO-5

	OVER THE LAST TWO WEEKS…	All of the time	Most of the time	More than half of the time	Less than half of the time	Some of the time	At no time
1	I have felt cheerful and in good spirits						
2	I have felt calm and relaxed						
3	I have felt active and vigorous						
4	I woke up feeling fresh and rested						
5	My daily life has been filled with things that interest me						

Appendix ZC: Functional Health EQ5D

Under each heading, please tick the ONE box that best describes your health **TODAY**

EQ5D

MOBILITY

- I have no problems in walking about ❑
- I have slight problems in walking about ❑
- I have moderate problems in walking about ❑
- I have severe problems in walking about ❑
- I am unable to walk about ❑

SELF-CARE

- I have no problems washing or dressing myself ❑
- I have slight problems washing or dressing myself ❑
- I have moderate problems washing or dressing myself ❑
- I have severe problems washing or dressing myself ❑
- I am unable to wash or dress myself ❑

USUAL ACTIVITIES *(e.g. work, study, housework, family or leisure activities)*

- I have no problems doing my usual activities ❑
- I have slight problems doing my usual activities ❑
- I have moderate problems doing my usual activities ❑
- I have severe problems doing my usual activities ❑
- I am unable to do my usual activities ❑

PAIN / DISCOMFORT

- I have no pain or discomfort ❑
- I have slight pain or discomfort ❑
- I have moderate pain or discomfort ❑
- I have severe pain or discomfort ❑
- I have extreme pain or discomfort ❑

ANXIETY / DEPRESSION

- I am not anxious or depressed ❑
- I am slightly anxious or depressed ❑
- I am moderately anxious or depressed ❑
- I am severely anxious or depressed ❑
- I am extremely anxious or depressed ❑

Appendix ZC: Subjective Health EQ5D

The BEST HEALTH
you can imagine

We would like to know how good or bad your health is **<u>TODAY</u>.**

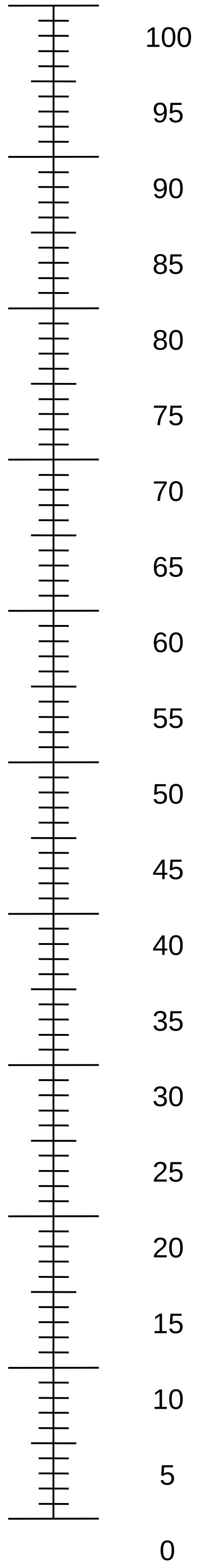
This scale is numbered from 0 to 100.

100 means the <u>best</u> health you can imagine.
0 means the <u>worst</u> health you can imagine.

Mark an X on the scale to indicate how your health is TODAY.

Now, please write the number you marked on the scale in the box below.

YOUR HEALTH TODAY = ☐



The WORST HEALTH
you can imagine