The Relationships Among Activity Lifestyle, Self-Reported Health, and Cognition in a Representative Sample of Older Adults

by

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ABSTRACT

The relationships of activity lifestyle and self-reported health to cognitive performance was examined in a representative population of older adults. A total of 943 community-dwelling adults (554 women; 389 men) completed three cognitive tasks (Word Recall, Vocabulary, and Letter Series), and questionnaires regarding leisure activities, and aspects of physical and mental health. Hierarchical regression analysis used to examine the predictive relationships among activity lifestyle, self-reported health and cognition revealed significant but modest effects of physical, social, and intellectual activity participation on the three cognitive tasks. Statistical control of the health and activity variables revealed significant but modest attenuation of age-related variance for Word Recall and Letter Series. Despite the representative nature of the sample, the present study did not provide evidence of a strong link between activity lifestyle, self-reported health, and cognition in later life.

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Dedication

To my daughter, Emma, who gives me such joy.

Chapter I

INTRODUCTION

Many lifespan developmental researchers consider aging a developmental process that reflects not only biological determinants of aging, but also the environmental contexts in which age-related cognitive and biological changes occur. One of the basic propositions of a contextualist perspective is that an individual's developmental trajectory results from interactions among three systems of developmental influences: age-graded, history-graded, and non-normative (Baltes, 1987). Age-graded, or age-normative, influences are those that occur to most individuals at relatively equivalent times in the lifespan, and have a fairly strong relationship to chronological age. They include dimensions such as physical development, (e.g., entering puberty), and social development (e.g., graduating from high school or retirement from a job). History-graded, or history-normative influences, are more cohort-based and include historical events such as the depression of the 1930's or the Gulf war, as well as less specific characteristics of a time period such as educational opportunities or the treatment of the elderly. Theoretically, history-graded influences should affect everyone in the culture or society in some manner. Non-normative influences, on the other hand, involve individual events that are not specifically linked to either age or cohort (e.g., winning the lottery, accidents) and they tend to differentiate one person from another. As a result, their influence on development is neither predictable nor general. In the present study, the relationships between health (an age-graded influence), activity lifestyle (a non-normative influence), and cognitive functioning are of primary interest.

Although researchers have long been aware of differences in cognitive performance across the lifespan the reasons behind these observed variations in performance have not been easy to determine. Chronological age itself has not emerged as a successful explanatory mechanism for age-related cognitive change and the importance of contextual factors to the cognitive performance of older adults has increasingly been acknowledged. Jenkins (1979), for example, has suggested four possible sources of variation within a memory testing situation itself that should be considered: (a) acquisition variables such as attention or levels of encoding; (b) materials, including their organization and structure; (c) test-related variables such as specificity of transfer and quality of retrieval; and (d) characteristics of persons, including both cognitive and non-cognitive factors such as prior knowledge, skills, interests, and motivation. Schaie (1983) further specifies three general categories of subject-related contextual factors which are relevant to changes in cognitive abilities: demographic and health factors, psychological factors (e.g., personality traits), and social factors (e.g., leisure activities). In the present study, two subject-related, contextual sources of variation are examined: activity lifestyle and self-reported health.

Research has shown that predictors associated with age such as self-reported health and activity lifestyle can account for statistically significant amounts of variance in the cognitive performance of older adults (Arbuckle, Gold, & Andres, 1986; Costa & McCrae, 1985; Gribbin, Schaie, & Parham, 1980; Hultsch, Hammer, & Small, 1993). For example, studies investigating the relationship between activity lifestyle and cognitive functioning have indicated that engaging in complex, cognitively demanding activities may be positively associated with cognitive performance (Christensen & Mackinnon, 1993; Hultsch et al., 1993). Likewise, studies that have assessed health by means of self-reports provide evidence that self-rated health may predict cognitive performance in older adults. For example, Perlmutter and Nyquist (1990) found a significant effect of self-reported physical health on memory span and fluid intelligence. However, other studies have indicated a lack of relationship between cognitive functioning and self-reported health (Arbuckle et al., 1986; Salthouse, Kausler, & Saults, 1990). It is important to note that the modest effect sizes associated with activity lifestyle and self-reported health suggest that the relationships of these variables to changes in cognitive performance are not very strong. One plausible explanation for these relatively weak relationships may lie in the demographic composition of the samples used in many of the studies.

The main objective of the present study is to examine the relationships among activity lifestyle, self-reported health, and cognition in a population-representative sample of community-dwelling adults. Research with older adults often relies on samples of convenience, volunteer samples which tend to be highly selective with regard to demographic and health variables (e.g., Christensen, Jorm, Henderson, Mackinnon, Korten, & Scott, 1994; Sliwinski, Lipton, Buschke, & Stewart, 1996). Such samples tend to be comprised of well-educated, active, and healthy individuals, and provide limited variability in measures of these variables. As a result, outcomes of the research may underestimate the role played by contextual variables in late-life cognitive functioning. The present research aims to provide evidence related to these issues from a population-representative sample of older adults. It is expected that the representative nature of the sample will increase the variability in both the activity lifestyle and self-reported health measures. Hypothetically, the resulting evidence should provide a more accurate picture of the relationships between activity lifestyle, self-reported health, and the cognitive performance of older adults.

Chapter II

LITERATURE REVIEW

In this chapter, the theoretical background to the present study will be introduced and recent empirical research will be reviewed. First, the two main influences guiding the exploration of the relationship between activity lifestyle and cognition in older adults will be discussed. Next, cross-sectional and longitudinal research into this relationship will be presented. In the final section, research investigating the influence of self-reported health on the cognitive performance of older adults will be reviewed.

Theoretical Perspective

Activity lifestyle research has been guided, in part, by Schooler's (1984) environmental complexity theory. There are often contextual influences affecting cognitive functioning that may lie beyond an individual's immediate control, such as the cognitive environment in which a person functions; for example, is that environment cognitively demanding and complex, or undemanding and simple? According to the environmental complexity theory, an individual's environment is defined as substantively complex by the stimulus and demand characteristics of that environment. A substantively complex environment likely contains the following characteristics: diverse stimuli, a large number of decisions to be made plus a large number of considerations involved in those decisions, and ill-defined and apparently contradictory contingencies. Complex environments reward initiative and independent judgement, whereas simple environments may provide insufficient rewards to ensure development or a continuance of relatively high levels of cognitive functioning and self-directedness. Hypothetically, complex environments result in an increase in, or maintenance of, a high level of cognitive functioning; simple environments may lead to a decrement in intellectual functioning.

Research has revealed that substantive complexity in certain situations, such as an individual's occupation or leisure time pursuits, is highly correlated with a self-directed orientation (Schooler, 1984). Self-direction is purported to increase the effectiveness of cognitive functioning in adulthood in several different ways. First, it increases an individual's intellectual flexibility, or the ability to cope with the demands of a complex situation (Kohn & Schooler, 1983). Second, it affects motivation through self-efficacy: those with a belief in their own self-efficacy may respond with increased motivation and effort, decreased anxiety and, ultimately, better performance. Concurrently, there is a strong positive effect of substantive complexity of work on the intellectuality of both men's and women's leisure-time activity. Research in this area has generally concentrated on male-oriented occupations because men have traditionally been those employed outside the home. However, research that has looked at the substantive complexity of housework, defined as work done almost exclusively by women, has shown that the effects of the complexity of the work are very similar to those effects seen when work is done for pay (Miller, Schooler, Kohn, & Miller, 1979). There is also strong evidence that individuals generalize from job experiences to the activities undertaken in leisure time (Miller & Kohn, 1983), suggesting that adults who have cognitively demanding jobs are more likely to pursue leisure activities that are also cognitively demanding. The environmental complexity theory, then, provides an hypothesis for research into activity lifestyles: if environmental complexity in one's work environment increases the effectiveness of cognitive functioning in adulthood, then environmental complexity in one's leisure activities may provide the same benefits. This is of particular importance in the study of older adults who have retired from paid employment.

Strongly related to the environmental complexity theory is the 'disuse' perspective (Salthouse, 1991). The environmental complexity theory proposes that differences in the complexity of environments can affect cognitive functioning, whereas the disuse perspective attempts to explain the mechanisms through which these environments act. In essence, this perspective suggests that variations in daily experiences, and the frequencies of those experiences, may account for many of the observed age differences in cognitive functioning among older adults. The main idea behind this perspective is that, as individuals age, certain skills and knowledge once familiar to them atrophy through 'disuse' when the patterns and frequencies of the individual's experiences are altered. Thus, some of the age-related cognitive declines observed in research studies occur because aging individuals no longer have any, or extensive, experience with the types of abilities and skills needed to successfully complete the tasks typically used in cognitive testing situations. The changes in daily experiences that result in the atrophy of skills and knowledge can lead to what in the environmental complexity theory would be labelled simple environments. Such environments may no longer provide opportunities for individuals to exercise and maintain their intellectual capacities.

If cognitive performance appears to decline through 'disuse', it follows that deliberate or continued 'use' may ameliorate such declines. Support for the disuse perspective comes from research investigating the influence of deliberate intervention, in the form of specific training or practice, on cognitive performance, and the influence of expertise on cognitive performance (e.g., Salthouse & Mitchell, 1990). Cognitive training studies focus on areas such as spatial and reasoning abilities (e.g., Schaie &

Willis, 1986), where intensive practice with specific tasks produce improvements in the related cognitive domains, but tend not to display generalization to other areas of cognition. Physical training research compares cognitive task performances between participants who report high levels of physical activity and participants reporting more sedentary lifestyles (e.g., Clarkson-Smith & Hartley, 1989). Research investigating the relationship between expertise and cognitive functioning is based on the idea that cognitively demanding occupations may provide experience with complex cognitive tasks that is analogous to cognitive training. In the following section, studies pertaining to the influences of deliberate intervention and expertise on the cognitive performance of older adults will be presented.

Researchers speculate that, because many experiences are under an individual's control, it may be possible to prevent or remediate age differences on cognitive tests through practice and training. For example, Schaie and Willis (1986) provided training on spatial ability and reasoning ability to participants who had evidenced longitudinal decline in these areas. Participants completed a battery of psychometric tests both before and after five 1-hour training sessions. The researchers found that participants showed improvements in the areas they had received training in, thus indicating that remediation in the loss of cognitive functioning may occur. Although results such as these are encouraging, Baltes and Baltes (1990) point out that there are age-related limits to cognitive plasticity: research indicates that older adults are unable to match the memory task performances of younger adults with comparable IQ levels and that such age differences exist even when younger and older adults are similar in terms of occupational expertise.

The disuse perspective raises the possibility that, if skills and experiences did not decline or change with age, an individual might be able to perform certain tasks at an optimal level throughout the lifespan, at least on those abilities continually exercised. However, a number of studies on the effects of aging and experience on spatial abilities suggest that experience does not necessarily alter the pattern of age-related declines in some tests of those abilities. In a study on age-related declines in spatial ability (Salthouse, Babcock, Mitchell, Skovronek & Palmon, 1990), the researchers measured the spatial visualization performances of practicing architects and an age-matched sample of unselected participants. They found the older architects were superior on several measures. Two possible interpretations of age-related decline emerged from the results. The first was that the architects evidenced preserved spatial abilities because of continual use in their work, whereas the unselected participants evidenced a decline in these abilities because of disuse. The second interpretation involved the idea that the two groups may always have differed in spatial visualization ability, and the initial differences were preserved as they aged. In an attempt to differentiate between the two interpretations, a follow-up study was conducted using only architects in different age groups. The researchers found significant age declines nearly identical to those in the initial study, thus offering support for the second interpretation that extensive experience in a particular domain does not alter patterns of age-related declines in those domains.

In another study involving mechanical engineers, Salthouse and Mitchell (1990) asked participants to rate the amount of experience they had with specific activities requiring spatial visualization abilities and to perform several spatial ability tests. One major finding was that although performance levels did vary with amounts of experience, the relationships between age and performance on the spatial tests were similar for each of the different experiential levels. In similar studies of pilots and air traffic controllers (Cobb, Lay & Bourdet, 1971; Trites & Cobb, 1964; cited in Salthouse, 1991), researchers found that the patterns of performance on spatial tests, something that both groups should have continuous and related experience with, showed similar age-related declines for both experienced and inexperienced participants. These contradict the expectations put forth by the disuse hypothesis that continuous experience may preserve selected abilities, suggesting instead that expertise may be domain specific.

Additional support for the disuse perspective comes from studies on deliberate physical training. Clarkson- Smith and Hartley (1989) examined the relationship between vigorous physical exercise and performance on measures of reasoning, reaction time, and working memory. They compared a group of self-reported physically active participants with a self-reported sedentary group of participants. An initial examination of the physiological fitness levels of the two groups revealed that the high-exercise group was superior in measures of heart rate and vital capacity, but not in blood pressure. The results of the cognitive task performances indicated a positive correlation between high levels of physical exertion and cognitive performance. These findings suggest that older adults who continue to physically 'use' their bodies may inhibit some of the changes that often occur with 'disuse', both physiologically and cognitively.

In sum, it appears from the literature reviewed above that an individual's cognitive performance can be positively influenced by both deliberate training and expertise, and physical training. This suggests that a cognitively complex and demanding environment, whether in a training session or one's occupation, can mediate some, but not all, of the cognitive declines often associated with aging. In the next section, studies that have investigated the relationship between environmental complexity and leisure activity participation will be reviewed and discussed within the framework of the disuse perspective.

Activity Lifestyle Research

If, as indicated previously, cognition shows evidence of plasticity when specific task training or practice is involved, it is possible that everyday and leisure activities provide an analogous form of cognitive training and practice. For example, engaging in leisure activities that emphasize memory and concentration, such as reading books or taking a university course, may activate the kinds of cognitive skills necessary to maintain an optimal level of cognitive performance. Because leisure activities are under the control of most adults, it is possible for individuals to consciously make choices that will encourage or maintain the 'use' of their cognitive abilities, and prevent them from falling into 'disuse'

Investigation into the relationship between activity lifestyle and cognitive performance has revealed that there is a relationship between maintaining an intellectually demanding lifestyle and better cognitive functioning throughout the lifespan (Schaie, 1983). Both cross-sectional (e.g., Hultsch et al., 1993) and longitudinal (e.g., Schaie, 1983) research have shown evidence supporting the idea that engaging in a cognitively stimulating activity lifestyle can facilitate higher levels of cognitive functioning in later life. However, the results from both types of studies also suggest that the relationship between activity lifestyle and cognitive performance is not robust. Moreover, there are methodological issues that make interpretations and conclusions difficult. The following literature review is organized into three sections. First, cross-sectional research pertaining to the relationship between activity lifestyle and cognition will be presented, followed by a review of longitudinal studies. Finally, several methodological issues that arise in the study of activity lifestyle and cognition will be addressed.

Cross-sectional Research

In general, cross-sectional research has shown that a lifestyle characterized by intellectual and social stimulation is correlated with better performance on memory tasks, even after confounds such as health and education have been statistically controlled (Arbuckle et al., 1986; Christensen & Mackinnon, 1993; Crabtree, Antrim, & Klenke, 1990; Craik, Byrd, & Swanson, 1987). In all of the studies reviewed below, however, it must be noted that the magnitude of the relationship between activity lifestyle and cognitive performance is modest, and does not provide overwhelming evidence that this relationship is robust.

Hultsch et al. (1993) explored the predictive relationships among individual differences in self-reported activity lifestyle and performance on a battery of cognitive tasks. Activity life style was separated into two distinct factors: (1) Active Life Style, consisting of physical activities (e.g., bicycling), integrative information processing (e.g., drive a car), and novel information processing (e.g., crossword puzzles); and (2) Passive Life Style, consisting of social activities (e.g., preparing dinner), self-maintenance tasks (e.g., take a bus), and passive information processing (e.g., eat out). Significant correlations were found between these two factors and virtually all of the cognitive variables, suggesting that individuals who participated in more activities performed better. In addition, statistically significant amounts of variance, ranging from 1% to 3%, were accounted for by Active Life Style variables on measures of semantic processing time, comprehension time, verbal fluency, word recall, and text recall. Passive Life Style variables accounted for significant amounts of variance (1% to 1.3%) in vocabulary, verbal fluency, word recall, text recall, and world knowledge. Overall, the researchers found that cognitive performance was related to participation in cognitively demanding activities, and that this relationship grew stronger with age. The researchers note that, while statistically significant, the reported effect sizes were modest, and did not account for all of the observed age-related decrements. In addition, the researchers noted the highly select and homogenous nature of their sample, and suggest that this may have had an impact on the findings.

In a study using a large sample of adults aged 65 to 93 years, Arbuckle et al. (1986) examined the relationship between memory performance and several contextual variables, including level of participation in intellectual and social activities, education, and aspects of personality. Among other things, their results indicated that higher memory scores were associated with participation in more intellectual activities, which accounted for approximately 3% of the variance. Similarly, when investigating the relationship between mental and physical activity and cognitive test performance, researchers found a modest, positive relationship between higher activity level and improved cognitive performance, where activity accounted for approximately 1% to 2% of the variance in the measures (Christensen, Korten, Jorm, Henderson, Scott, & Mackinnon, 1996). However, these researchers also found that education levels accounted for more variance on measures of crystallised intelligence than did activity level, and that age accounted for substantial amounts of variance in the cognitive measures even after controlling for contextual variables such as activity level, education, disability, and self-reported health. The researchers suggest that this finding contradicts the hypothesis that activity levels, and other contextual variables, are responsible for the majority of age-related changes in cognition.

Longitudinal Research

One of the questions in activity lifestyle research that is not addressed by cross-sectional studies concerns the function of activity across the lifespan. For example, does an intellectually demanding activity lifestyle serve to maintain higher cognitive functioning in older adults or is it the case that higher functioning individuals are more likely to pursue intellectually demanding leisure activities? One advantage to using longitudinal designs in research is that questions regarding the direction or nature of such relationships can be addressed.

Information from the Seattle Longitudinal Study (SLS) provides additional supportive evidence for the positive relationship between activity lifestyle and cognitive functioning across the lifespan. Schaie (1983) suggests that involvement in complex and stimulating activities such as travel, continuing education, attending cultural events, and joining clubs and professional associations, is one source of reducing the risk of decline in cognitive abilities. In a study examining intellectual change over the course of 14 years and the contribution of activity patterns to that change, Schaie (1984) noted that the least amount of decline was evidenced by those participants who maintained an activity pattern characterised by high levels of cognitively demanding activities and who were of high socioeconomic status. The greatest amount of decline was seen in women who were widows, who had never worked outside of the home, and whose activity patterns did not contain any of the aforementioned complex and stimulating activities. Moderate decline was noted in those individuals who were somewhat engaged in cognitively demanding activities, and those who were highly active but of average socioeconomic status.

In another longitudinal study, Schwartzman, Gold, Andres, Arbuckle, and Chaikelson (1987) investigated intellectual change in a sample of 260 Canadian World War II army veterans by re-administering the Revised Examination "M" test approximately 40 years after the initial testing. As expected, early intellectual functioning was the strongest predictor of current intellectual performance. In addition, a positive relationship was found between high current intellectual functioning and a high current level of activity, as measured by a 24-item activity checklist encompassing social, recreational, physical, family, intellectual, occupational, and community activities. In a similar study of 326 army veterans, researchers also found a positive, significant relationship between intellectual activity and cognitive performance, as measured by the Canadian Army M Test (Arbuckle, Gold, Andres, Schwartzman, & Chaikelson, 1992) . Again, participants who maintained an intellectually active lifestyle, and who were healthier and more educated, showed less decline and thus performed at a higher level than did participants who were less intellectually active, less healthy and less educated.

The results noted above are not limited to community dwelling adults, but are also seen in institutionalized adults. In a short-term longitudinal study spanning 10 months, researchers again found a positive relationship between activity level and cognitive performance on a battery of tests (Winocur, Moscovitch, & Freedman, 1987). Activity level was strongly correlated with the cognitive measures at the first time of testing, and was very close to significance at the second time of measurement. However, the most important finding was that change in activity level was a strong predictor of change in cognitive performance. More specifically, when activity levels increased, performance on the cognitive test battery also increased. It should be noted that the same results were found with a measure of locus of control, suggesting not only that an increase in personal control also contributes to an improvement in cognitive performance, but that these two contextual variables may be strongly related.

Methodological Issues

One of the problems encountered in researching the relationship between activity lifestyle and cognitive performance is accounting for, and controlling, potentially confounding variables. For example, leisure participation can be affected by social economic status (SES), education, occupation, health, social support, and gender. Research has shown that greater involvement with intellectually demanding activities is correlated with higher SES (Lawton,1985) and education (Christensen & Mackinnon, 1993). In terms of occupation, it has been shown that those individuals involved in manual labour tend to choose different activities than those who were involved in 'intellectual' labour (Miller & Kohn, 1983). Health affects activity level itself and preferences for involvement in that the lower the health rating the more passive the choice of activity (Lawton, Moss, & Fulcomer, 1986-1987). Social support can impact activity interests and levels such that older adults who are socially isolated often tend toward passive activities. Individuals with companions, whether spouses or friends, tend to gravitate towards more communal activities compared to those individuals without companions (Kelly, 1987). Gender may also affect activity lifestyles. In general, women are often less involved in team sports and more involved in passive forms of activity, as well as in social, expressive and artistic activities. In contrast, men tend to be more involved with more physically demanding activities and less with expressive and artistic activities (Kelly, 1987). It appears, then, that it is important for researchers to recognise and account for these potential confounds to activity lifestyle research, if meaningful interpretation and generalization of the results are to be made.

The relationship between activity lifestyle and cognition has also been difficult to assess because of problems in establishing accurate estimates of activity types and frequency of those activities. One potentially useful method of measuring activity lifestyle involves the on-line collection of data on various activities over a specified period of time. However, time and budgetary constraints render this method impractical for most researchers. The majority of studies investigating this area use some form of activity checklist (Arbuckle et al., 1986; Hultsch et al., 1993), detailed interviews (Gribbin, et al., 1980), or an inventory of routine and special activities (Stones & Kozma, 1986), all of which are practical and economical, but rely heavily on participants' subjective responses and memories. One implication of this methodological problem is the difficulty in making valid comparisons among results from studies using these various forms of checklists. A related complication is that the operational definitions of particular components of activity lifestyle, which may be defined as intellectual, social, passive or active, are not standardized across studies, again making comparisons and conclusions problematic. As well, there are few complete or even partial activity inventories that are representative of adults of different ages, and few activity measures have been assessed for validity and reliability (Arbuckle, Gold, Chaikelson, & Lapidus,

1994) making generalizations to the other populations of seniors difficult.

Finally, there is often a selection bias in the samples employed in studies investigating activity lifestyle and cognition. As was mentioned in a previous chapter, volunteer samples of older adults tend to be comprised of healthy, well-educated, and active individuals. As such, these samples may not present the entire range of responses to activity checklists or cognitive tasks (and other measures), with the result that generalizations to more representative populations of older adults may not be valid. Thus, most results from these studies must be interpreted with some degree of caution.

Summary

In sum, there is evidence from both cross-sectional and longitudinal studies to suggest a positive relationship between activity lifestyle and cognitive performance. However, in all studies reviewed, the amounts of variance in the cognitive measures accounted for by the activity lifestyle indices were only modest, at best. This apparently weak link may be the result of methodological issues such as those addressed above, or it may be that activity lifestyle is not a key factor in age-related cognitive decline.

In the present study, the relationship between activity lifestyle and cognitive performance is examined in a large, population-representative sample of older adults. Activity lifestyle is indexed by self-reports of activity type and frequency. The relationship is assessed independently of potentially confounding variables such as age, gender, and income.

Self-Reported Health

A second factor intuitively related to cognitive performance is health. It is known that significant declines in cognitive performance occur in later life when substantial levels of chronic disease, such as those related to cardiovascular functioning, are present (see Elias, Elias, & Elias, 1990, for review). What is not as clear, however, is what effect less serious illnesses or diseases have on individual age differences in cognitive performance.

The health levels of participants have generally been assessed using subjective self-report methods rather than objective physician ratings. This is due, in part, to certain benefits associated with self-report techniques. Compared to obtaining physician ratings, self-report questionnaires have a lower cost and are more convenient for researchers to administer and for participants to complete. There are also ethical considerations involved in health data collection related to issues of privacy, the maintainance of anonymity, and the intrusiveness of some physiological measurement techniques. In addition, there is supportive evidence indicating that self-reports of physical health are moderately but significantly correlated with reported medical problems (Liang, 1986), examination-based physician evaluations of overall health (LaRue, Bank, Jarvik, & Hetland, 1979), and with future survival (Botwinick, West, & Storandt, 1978; LaRue et al., 1979). Other researchers, however, have noted a relationship between poor self-reports of health and neuroticism (Costa & McCrae, 1985). In addition, there can be misleading categorization of participants into 'healthy' and 'unhealthy' based on such self-reports (Elias et al., 1990). For example, a participant may report suffering from 10 chronic conditions while a second participant reports having only one chronic condition. If researchers consider only the number of chronic conditions to be indicative of health status, then the first participant would appear to be less healthy than the second. However, the severity and incapacitating effects of the conditions are not known. It is possible that the first participant suffers from such symptoms as mild diabetes and hearing problems, while the second participant is recovering from a serious heart attack. Therefore, it is important that a variety of self-report health measures be utilised and the results interpreted with caution.

Cross-sectional research examining the relationship between self-reported health and cognitive performance have noted mixed results. In a study using the Wechsler Adult Intelligence Scale and an extensive self-reported health measure, Perlmutter and Nyquist (1990) found a significant amount of variance in memory span and fluid intelligence was accounted for by self-reported health, independent of the effects of gender and education. Self-reported health was not predictive of significant amounts of variance for crystallized intelligence. Similar results are reported by Hultsch et al. (1993). In their study, various aspects of physical health were measured, including chronic illness, number of illness episodes, number of prescription medications, whether health interfered with daily activities, and overall health ratings. Controlling for the effects of age, education, gender, and neuroticism, the results indicated that health status predicted significant amounts of variance (1% to 3%) in text recall, working memory, and processing speed. Health status did not predict performance on tests of vocabulary, verbal fluency, fact recall, or word recall. In contrast, Salthouse et al. (1990), in their analyses of health-adjusted data with unadjusted data, found nearly identical age trends in cognitive performance and no significant age by health interactions. Similarly, Arbuckle et al. (1986) found no effect of self-rated health on measures of memory, including digit span, free recall, and fact recall.

Longitudinal research has indicated a relationship between health status and changes in cognitive performance. In a fourteen-year longitudinal study, Field, Schaie, & Leino (1988) examined the relationship between health and performance and verbal IQ scores, as measured by the WAIS, in a sample of older adults. Health status was measured by summing four variables: health rating, the effect of health on daily activities, present heath rating compared to age 40, and an objective rating of energy level. Results indicated that health status did not predict declines in performance or verbal IQ, nor did it predict verbal IQ in cross-sectional analyses. It did, however, predict performance IQ, but at the latter time of measurement only. An interesting finding was that, although the relation between health and cognition was weak for the sample as a whole, health status was strongly implicated in the cognitive performance of outliers, those whose change in cognitive functioning was extreme.

Two interpretations can be suggested by the conflicting results noted in the literature. One interpretation is that the volunteer samples of participants tend to be healthier than their age cohorts in the general population, and thus represent a very restricted range of health status. A second interpretation is that the health measures may be insensitive to health factors that could influence cognitive functioning. For example, many studies use only a single measure of health, such as rating current health status on a Likert-type scale, or listing the number of illnesses experienced in the past year. When studies use only a single measure of health, only single dimensions of health are assessed, with the result that valuable information on both past and current health status is lost. Liang (1986) proposes a multi-dimensional model for self-reported health that integrates physical or medical, social, and psychological aspects of health. These three definitions encompass five dimensions of health. The medical aspect includes chronic illnesses and number of sick days in a specified period of time. The social aspect is reflected by self-maintenance and instrumental activities of daily living. Finally, the psychological aspect is indexed by the subjective ratings of health. According to this model, self-reported health must be measured along these multiple dimensions in order to adequately assess an individual's perceptions of his or her health, and to accurately interpret the relationship of health and cognitive performance. By using measures that encompass a wide range of health problems, the separate and unique contributions of an individual's physical, social and psychological health to cognitive performance can be measured and compared.

Summary

In sum, there is some supportive evidence of a modest relationship between self-reported health and cognitive functioning in older adults. This relationship is particularly apparent when measures of fluid intelligence are used, but not when the measures reflect crystallized abilities. Inconsistent results may reflect some of the same methodological issues encountered in activity lifestyle research, in particular, the operational definition of health and the sample composition. In the present study, the relationship between self-reported health and cognitive performance is assessed in a large, population-representative sample of older adults. Further, the relationship is assessed independently of potentially confounding variables such as age, gender, and income. Self-reported health indices are obtained through the medical, social, and psychological dimensions defined by Liang (1986).

Chapter III

OBJECTIVES AND HYPOTHESES

Objectives of the Study

This study was undertaken as part of the analyses from the Baseline Study, a comprehensive investigation of a large, representative sample of seniors residing in the Capital Regional District of British Columbia. The purpose of this survey was threefold: (1) to establish characteristics of seniors in the area and to provide indications of the distinctiveness or similarities of the population to other comparable populations in Canada; (2) to provide a resource for researchers who require or could benefit from a large sample population; and (3) to provide information that would benefit the local community.

The purpose of the present investigation is to examine the relationships of activity levels and self-reported health to performance on a series of cognitive tasks, independent of potentially confounding variables. Importantly, this study investigates the relationship of activity level, health and cognition in a sample that is more population-representative than most samples of convenience. One of the difficulties encountered in studying cognition in older adults is the tendency to recruit volunteers who are healthier, more active, and better educated than their cohorts in the general population. The expectation of using a more representative sample is that the diversity within the sample will increase the variability in the activity lifestyle and health measures, and will also allow more valid generalizations to be drawn from the results.

Hypotheses

A number of questions are addressed in this study of the relationships between activity lifestyle, self-reported health, and cognitive performance.

1. To what extent do activity lifestyle and self-reported health predict performance on cognitive tasks independent of potentially confounding variables such as age, gender, and education? It is hypothesized that components of both activity lifestyle and self-reported health will account for modest amounts of variance in the cognitive measures once the effects of age, gender, and education have been statistically controlled. Previous research has indicated, for example, that activity lifestyle is modestly predictive of performance on word recall (e.g., Hultsch et al., 1993) and vocabulary tasks (e.g., Christensen et al., 1994). Self-reported health has evidenced a predictive relationship with cognitive functioning (e.g., Perlmutter & Nyquist, 1990), but there is also research contradicting such findings (e.g., Salthouse et al., 1990). In the present study, it is further hypothesized that the less select nature of the sample will serve to increase the magnitude of the effect sizes observed.

2. Will intellectually demanding activities predict performance on cognitive tasks more strongly than will physical or social activities, independent of the previously mentioned confounding variables? According to Schooler's (1984) environmental complexity theory, environments defined as cognitively complex will serve to maintain a higher level of cognitive functioning than environments defined as simple. It is hypothesized that those activities which require an individual to exercise his or her cognitive abilities will account for more of the variance in the cognitive measures than will less intellectually stimulating activities. There is previous research which suggests that this is true (e.g., Arbuckle et al., 1986; Hultsch et al, 1993). In the present study, an activity lifestyle characterised by frequent participation in intellectual activities is

considered to represent a complex environment.

3. To what extent might age differences in cognitive performance be attenuated after accounting for individual differences in activity lifestyle and self-reported health? It is hypothesized that modest attenuation in age-related variance will be observed in the memory and inductive reasoning tasks, but not in the vocabulary task when activity lifestyle has been controlled. Previous research has indicated that partialling individual differences in activity lifestyle results in modest attenuation (e.g., Hultsch et al., 1993). Due to the more representative nature of this sample, it is suggested that the effects sizes will be of a larger magnitude than those observed in more select samples. It is hypothesized that accounting for individual differences in self-reported health will not result in significant attenuation in age-related variance.

Chapter IV

METHOD

Participants

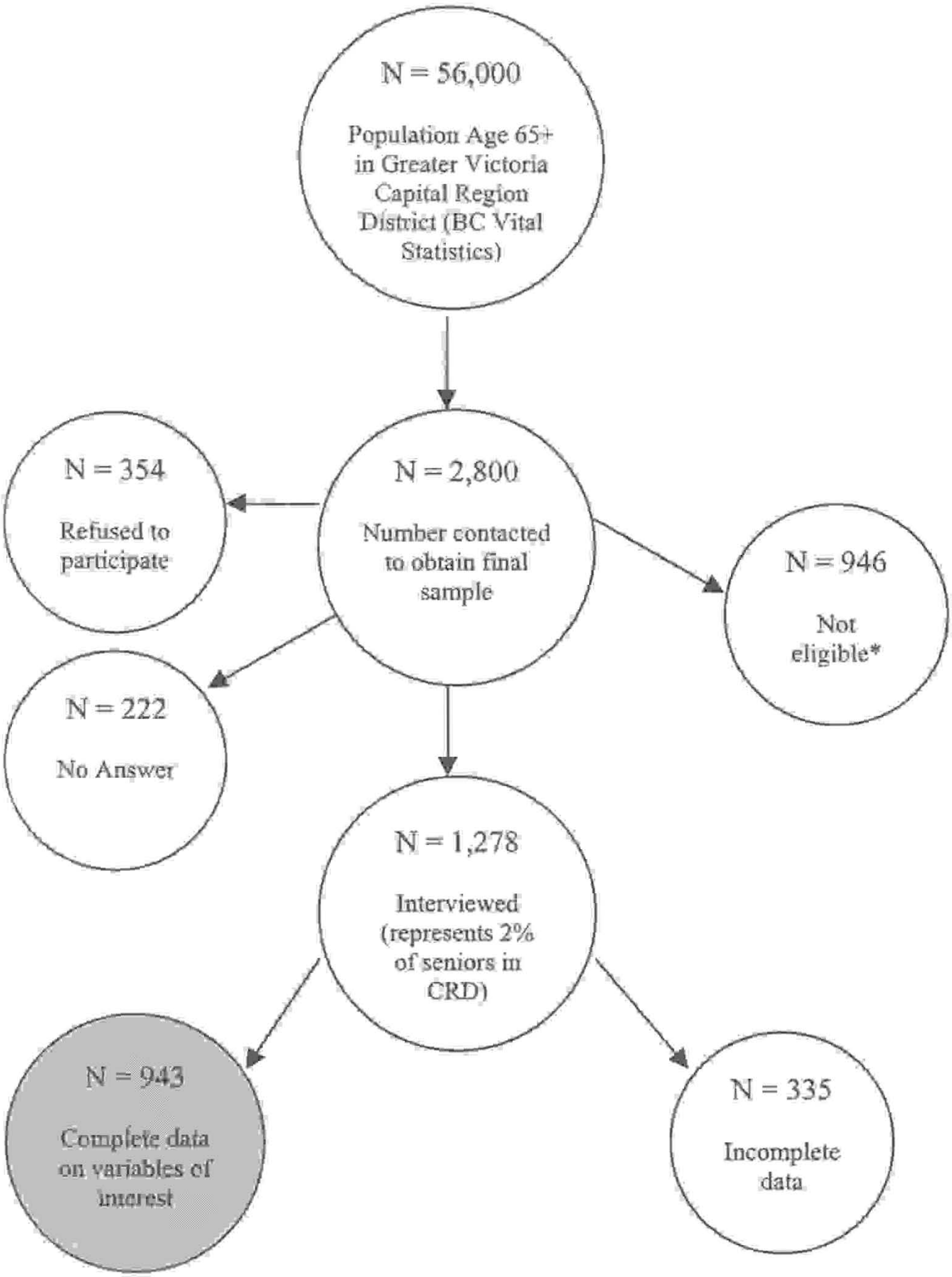
Participants were part of the Baseline Study, a survey designed to provide representative data on seniors in the Capital Regional District (CRD) of British Columbia. The goal of the researchers was to sample approximately 2 % of seniors from this area. To achieve this goal, over 56,000 names were obtained from the British Columbia Department of Vital Statistics, from which researchers then drew an initial random sample of 3,600 individuals. From this sample, a total of 2,800 seniors had to be contacted in order to obtain the target sample of 2 % (1,200) of seniors in the region.

The final Baseline Study sample consisted of 1,278 community-dwelling seniors (768 females and 510 males) aged 65 to 100 years with an average age of 75.13 years. They were first contacted by letter explaining the purpose of the study and a follow-up phone call determined agreement to participate in the study. Because the goal was to obtain a less select, more population-representative nature of the study, participants were not screened for serious physical health problems, nor were they screened for dementia. Complete data on the measures of relevance to the analyses in the present study were available for 943 participants. Figure 1 provides an illustration of the sampling procedure used to obtain the sample for this study.

Demographics: The Victoria area is a relatively affluent community and significant numbers of older adults migrate to the region from other parts of the country at retirement. An area of consideration when studying activity patterns and frequencies within such a population is the tendency for individuals who move to so-called retirement

Figure 1

Sampling Procedure



* E.g., nursing home resident, language barrier, unable to contact

communities to be younger, healthier, and economically more secure than comparable populations in other geographical locations. Thus, it was important to examine the demographic profile of the individuals who were included in the present study and to compare it with the appropriate census data.

The following demographic variables were examined, and the means and standard deviations were calculated to construct a profile of the sample: age, gender, education, income and aspects of self-reported health (see Table 1). Within the present sample, there were significant age differences in income, F (2,856) = 11.70, $p < .001$, $\eta^2 = .027$. Post hoc tests using the Scheffé procedure indicated that the older age group reported a lower mean income than both the younger and middle age groups. There were significant gender differences in education, F (1, 941) = 16.94, $p < .001$, $\eta^2 = .018$, and income, F (1,857) = 57.85, $p < .001$, $\eta^2 = .063$. Men in the sample had higher levels of education and income than the women. The significant age and gender differences for self-reported health are reported later in this paper.

An examination of the demographic and health variables for the 943 participants revealed that, compared to other seniors in Canada, participants were above the national average on many of the variables (Statistics Canada, 1994). In general, the sample was well educated: only 5.4% of the present sample had less than 8 years of education compared to 36.9% of the Canadian seniors population. Over 40% of the participants had 9 to 13 years of education compared to approximately 35% in the population of Canadian seniors. Almost 20% of the participants had a bachelors degree or more, compared to the national figure of only 5.1% (Statistics Canada, 1994). The participants also reported themselves to be above average in terms of income, health and life satisfaction compared

Table 1
Demographic and Health Characteristics of Sample

	Age 65-72 years		Age 73-80 years		Age 81-100 years	
	Women	Men	Women	Men	Women	Men
n	248	164	209	146	97	79
Age						
M	68.96	68.96	76.52	75.73	85.20	84.78
SD	2.06	2.10	2.49	2.27	3.90	3.17
Education level[a]						
M	3.74	4.30	3.69	4.15	3.54	3.77
SD	1.55	1.80	1.50	1.79	1.56	1.87
Income level[b]						
M	4.59	5.11	4.33	5.06	3.78	4.72
SD	1.31	1.10	1.39	1.17	1.26	1.20
Chronic[c]						
M	2.75	2.56	3.80	3.02	4.44	3.63
SD	1.88	1.93	2.23	2.11	2.02	2.24

Table 1 continued on next page.

Table 1 (cont'd).

Self-rated health[d]						
M	3.11	3.02	2.97	3.10	3.01	3.04
SD	.69	.68	.67	.73	.71	.71
CES-D[e]						
M	9.23	8.76	9.78	8.73	9.82	9.15
SD	3.35	3.07	3.33	3.41	3.96	3.57

[a] Highest level of school completed on an 7-point scale: 01 = *some elementary school*, through 03 = *completed high school*, to 07 = *a graduate*. [b] Calculated as household or individual income, whichever was greater; rated on a 6-point scale (from 1 = *less than $5,000* to 6 = *$40,000 and above)*. [c] Incidence of 20 chronic conditions (higher score = more conditions). [d] Average of current health plus health compared to others of same age, rated on a 4-point scale (from 1 = *poor* to 4 = *excellent*). [e] Rating of depressive affect on a 5-point scale: 1 = *never* to 5 = *most of the time* (highest score possible = 35)

to other seniors in Canada. With respect to income, only 20% of the sample lived on less than $20,000 per year, compared to almost 72% of Canadian seniors (Statistics Canada, 1994). Approximately 35% of the participants reported incomes between $20,000 to $40,000 per year, and over 34% received more than $40,000 income per year; in comparison, only 28% of Canadian seniors had incomes in excess of $20,000 per year (Statistics Canada, 1994). The present sample was slightly above average on life satisfaction: less than 3% reported feeling dissatisfied with their lives, approximately 35% were somewhat satisfied with their lives, and over 60% reported being more than satisfied with their lives. Comparatively, 5% of Canadian seniors were dissatisfied with their lives, and 95% were satisfied to some degree (Statistics Canada, GSS-6, 1994). In terms of health compared to others of a similar age, the participants in this sample reported levels above the national figures: almost 84% reported their health was excellent or good compared to others their own age, while nearly 17% felt their health was fair or poor. In comparison, only 73% of Canadian seniors rated their relative health as excellent or good, and approximately 28% reported their relative health as fair or poor (Statistics Canada, GSS-6,1994). Differences between the relevant proportions, determined by z-score computations, indicated that almost all z-scores were significant at $p < .01$; the only non-significant difference in proportions was for Life Satisfaction. These results indicate that the sample from the present study is a relatively select sample of older adults and not representative of the population of seniors in Canada as a whole.

One of the purposes of the Baseline Study was to obtain representational data on seniors in the Capital Regional District. To determine if the present sample was, in fact, representational of area seniors, further analyses were conducted on the differences between proportions from the Baseline Study sample and census data from the Victoria region (comparable data for the Capital Regional District was not available). As indicated by z-scores, analyses of the proportions for gender and marital status distributions revealed no significant differences between the present sample and seniors in the Victoria area, and marginally significant differences in proportions within the selected age groupings. However, there were significant differences in education levels attained. Overall, the proportion of seniors in the present study who had attained a high school diploma (40%) was significantly greater ($p < .01$) than the proportions of seniors from the Victoria area (30%). Further, there was a significant difference ($p < .01$)in the proportions of seniors in the present sample who had a B.A. or above (20%) compared to Victoria area seniors (11%). These results suggest that the sample from the present study is somewhat more select than the population of seniors in the Victoria region, at least in terms of education levels. However, it is important to note that the sample is still less select than most samples of convenience.

Measures

The measurement battery consisted of indicators of both cognitive and noncognitive subject-related variables. Included were three tests designed to measure different aspects of cognitive ability: verbal memory, vocabulary, and inductive reasoning. There were also a number of questionnaires designed to measure noncognitive variables such as physical and mental health, quality of life, and activity participation. Tests and questionnaires were designed or adapted for use in a large, time-constrained interview. Thus partial components of measures were sometimes used, whereas other measures did not encompass the entire range of possible responses. This is noted where applicable.

Cognitive Measures

Word Memory. The measure of verbal memory consisted of immediate free recall of a word list. Participants were read a list of 20 common words (e.g., arm, forest, coffee) presented at two-second intervals. The participants were then asked to recall aloud, in any order, as many words as possible within a three-minute time-span (Colsher & Wallace, 1992). The score for this measure was the number of words correctly recalled. The reliability of this measure, obtained using Cronbach's alpha, was .55.

Vocabulary. This measure consisted of performance on an 18-item recognition vocabulary task from the ETS Kit of Factor Referenced Tests (Ekstrom, French, Harman, & Dermen, 1976). The words to be defined ranged from relatively easy (e.g., mumble) to difficult (e.g., ignominious). Participants were given five alternative word meanings from which to choose the correct answer. Participants were given four minutes to complete the task. The score used was the number of correct responses across the 18 items. Cronbach's alpha for this measure was .88.

Letter Series. This measure of inductive reasoning is designed to see how well participants can identify a rule defining a series of letters (Thurston, 1962). Participants were asked to look at a series of letters, determine the pattern within each series, then decide which letter would come next in each series (e.g., g a f a e a d a c a..........a b c d e). Participants were allowed six minutes to complete 20 series of letters. Performance on this measure was based on the number of correct answers. Reliability for this measure, assessed with Cronbach's alpha, was .86.

Metamemory. Participants responded verbally to questions regarding their feelings about their memory (e.g., I am good at remembering names; The older I get the harder it is to remember clearly). The scale ranged from 1 = disagree strongly to 4 = strongly agree. A total score was calculated for each participant by summing the responses across the 8 items (reverse coded when necessary). The reliability for this measure, obtained using Cronbach's alpha, was .74.

Activity Measure

This measure examined the types of leisure activities participants engaged in and how often they engaged in these activities. The list consisted of 15 types of activities tapping into a number of different activity domains (e.g., go for walks; watch TV; participate in physical exercise like jogging, swimming, tai chi, cycling). Frequency of participation in each of the activities was measured on a 9-point scale (0 = never to 8 = daily). Studies using similar measures of activity lifestyle have reported reliabilities ranging from .63 (Holohan, 1988) to .71 (Stones & Kozma, 1986).

One of the problems encountered with the activity scale was the breadth of the questionnaire items. The global nature of the questions did not allow for an indepth investigation of participation in specific activities, and the breakdown of the listed activities into meaningful groups was difficult. As will be described in the Results section, the scale was subjected to a confirmatory factor analysis in order to categorise the items.

Self-Reported Physical Health Measures

A number of measures related to physical health were collected using both self-ratings and self-report techniques. Participants were asked about various aspects of their health, ranging from overall health to specific health problems. A self-report measure of nutrition was also included, as was a measure of bodily pain and a measure of proactive health practices.

Chronic Conditions. Participants were asked to report the presence of 19 chronic illnesses from 13 categories: infirmities (e.g., osteoporosis); respiratory (e.g., asthma); circulatory (e.g., angina); digestive (e.g., bowel problems); nervous system disorders (e.g., Parkinson's); glandular disorders (e.g., diabetes); cancer; eye problems; hearing problems; Alzheimer's disease; serious memory problems (other than Alzheimer's); mental or emotional distress; or drinking problems. Responses were summed across items to obtain a score for each individual. Obtaining reliabilities can be problematic with measures like this, where responses on one item do not necessarily relate to responses on a different item. In addition, chronic health conditions do not always show stability over time, which increases the difficulty of obtaining a reliability measure.

Current Health. Participants were asked to rate their overall health in general. Responses were based on a rating scale ranging from 1 (poor) to 4 (excellent). The score for this measure was the actual value of the response. Reliabilities on self-reported health indices which include both Current Health and Relative Health (below) range from a Cronbach's alpha of .77 to a Cronbach's alpha of .89 (e.g., Holahan, 1988).

Relative Health. In this measure, participants' current state of health was self-rated in comparison to other adults of similar ages. Responses were based on a rating scale ranging from 1 = (poor compared to others my age) to 4 = (excellent compared to others my age). The score for this measure was the actual value of the response.

Proactive Health. Participants were asked to indicate what things they did on a daily basis to remain healthy. Five of the items focused on specific practices: (1) eat a balanced diet; (2) get enough rest and sleep; (3) keep physically active; (4) avoid smoking; and (5) avoid alcohol or drink in moderation. A sixth item was included to allow for other means of keeping healthy (e.g. taking vitamins). Responses were summed across the six items to obtain a total score for each participant. Reliability of this health measure, and the following four health measures, proves difficult to obtain because individual items are not strongly related to each other, affecting the internal consistency of the scale.

Days Ill. This measure consisted of one item. Participants responded to the question About how many days have you spent sick at home (most of the day) during the last 6 months?. The number of days was used as the score for this measure.

Illnesses Per Year. Participants were asked to report whether they had experienced a number of different health problems, such as the flu, colds, infections, injuries, or short-term, acute illnesses over the past year. The score for this measure was the total number of health problems experienced.

Nutrition. Participants responded yes or no to 10 items referring to nutritional habits. The items covered areas such as physical capability for preparing meals, influence of prescription medication, influence of dental problems, the social aspects of eating, and physical illness. Responses were summed across items to obtain a total score for each participant.

Bodily Pain. Participants were asked to report how much bodily pain they had experienced during the past 4 weeks. Responses ranged from 1 = none to 8 = very severe. The score for this variable was the actual value of the response.

Self-Reported Mental Health Measures

CES-D (Centre for Epidemiology Scale of Depression). This measure used seven items from the CES-D (Radloff, 1977) that have been identified through confirmatory factor analyses as measuring depressive affect (Hertzog, Van Alstine, Usala, Hultsch, & Dixon, 1990; Radloff, 1977). Participants responded verbally to questions regarding how they had felt during the past week (e.g., During the past week did you think your life has been a failure?). Responses were based on a 5-point scale ranging from 1 = never to 5 = most of the time. Responses were summed across items to obtain a total score. Higher scores reflect a higher level of depressive affect. Reliability of this measure, using Cronbach's alpha, was .77.

MUNSH (Memorial University Scale of Happiness). This is a measure of psychological well-being obtained by assessing the balance between positive and negative affect (Kozma & Stones, 1983). Participants responded yes or no to 10 questions regarding how they had been feeling in the past month (e.g., On top of the world; Depressed or very unhappy) and to 11 questions regarding general life experiences (e.g., Things are getting worse as I get older; I am as happy now as when I was younger). Responses were summed across the 21 items (reverse coded where required) to obtain a total score for each participant. A test-retest correlation of .71 has been reported by Stones & Kozma (1986).

Life Satisfaction. Participants were asked to rate their feelings about different aspects of their life (e.g., health, job, friendships, family relationships, living conditions) on a 4-point scale, ranging from 1 = very dissatisfied to 4 = very satisfied. These ratings were summed to obtain a total score. Also included were ratings for no opinion and not applicable, however these were not included in the total score. Reliability of the scale, measured by Cronbach's alpha, was .75.

Procedures

Most participants were tested on an individual basis in their own homes in a single session by a trained interviewer. A small percentage of participants were tested at a university facility (< 2.0 %), and a small percentage (< 3.0 %) required more than one testing session. There was no time limit for the testing sessions; however, an average session lasted approximately 2 hours. At the beginning of the session, participants were advised of their rights to withdraw at any time or to refuse to answer a question. When the sessions were over participants were informed about the purpose of the study and thanked for their efforts .

Chapter V

RESULTS

The data analyses consisted of five major parts. First, confirmatory factor analyses were conducted separately on the health and activity variables to determine if the measures coalesced into a smaller set of indicators. The resulting factor scores were used to construct standardized factor scores for use in the multiple regression analyses. Next, an examination of gender and age differences in the predictor and criterion variables was conducted through a series of multivariate analyses of variance (MANOVA). Because a substantial number of participants refused to complete one of the cognitive tasks (Letter Series) an individual analysis of variance (ANOVA) was conducted on this measure.

The main analyses consisted of two sets of hierarchical multiple regression analyses (Scialfa & Games, 1987). The first set of regressions looked at the predictive relationship between the activity and health variables and the cognitive measures. The second set of regressions examined whether attenuation in age-related variance would occur in the cognitive measures after accounting for individual differences in mental and physical health status, and activity lifestyle.

Finally, an attrition analysis was undertaken to determine if there were certain factors which contributed to the large drop out effect on the Letter Series task. Again, separate MANOVA's were run on the remaining cognitive measures, the health measures, and the activity measures to see if there were significant differences between those individuals who completed the task and those who refused to participate.

Measurement Model

To determine if the number of independent variable measures could be reduced into smaller sets of hypothesized latent constructs, separate confirmatory factor analyses, using LISREL 8.10, were run on the activity questionnaire variables and on the self-reported health measures. Using a specified factor structure as reference, LISREL generates a covariance matrix which is accepted by LISREL when only small differences are observed between the actual and estimated covariance matrices. The following criteria were used to evaluate the model fit for both the activity variables and the health variables: (a) chi square (χ^2), (b) the comparative fit index (CFI), (c) the root mean square error of approximation (RMSEA), and (d) the goodness-of-fit index (GFI). Chi square is known to be relatively unreliable when a large sample has been used, as in the present analyses. With a large sample, otherwise reasonable models are likely to produce statistically significant χ^2 values (Hu & Bentler, 1995). It is therefore recommended that other indices of fit, such as those utilized in the present study, be calculated in conjunction with χ^2 to determine how well the model fits the data. The CFI (Hu & Bentler, 1995) is a more robust index than chi square, in that it is not biased by sample size. Values range between 0 and 1, with values closer to 1 indicating a better fit of the model. The GFI (Jöreskog & Sörbom, 1981) measures the relative amount of observed variances and covariances accounted for by the model, and is analogous to R^2 in multiple regression. It is very sensitive to sample size, with unreliable results occurring with smaller sample sizes (Hoyle & Panter, 1995). Finally, RMSEA indicates the discrepancy per degree of freedom for the model. The lower limit of RMSEA is 0, and indicates a perfect fit. Values less than or equal to .05 are indicative of good model fit relative to the degrees of freedom; however, it has also been suggested that values up to .08 can represent reasonable errors of approximation (Browne & Cudek, 1995).

Activity Measure When submitted to the confirmatory factor analysis, the activity questionnaire variables coalesced into three factors labeled Physical Activity, Social Activity, and Intellectual Activity. The intercorrelations of the activity variables can be seen in Table 2. The initial fit indices indicated that the model fit the data quite well, but that the fit could be improved. Subsequently, of the 14 variables entered, three (Listen to Music, Watch TV, and Hobbies/Arts/Crafts) were dropped when it was determined that removing them improved the fit of the model.

The final 3-factor model fit fairly well for the sample: $\chi^2(41, N = 1261) = 140.13$, $p < .001$, GFI = .98, RMSEA = .044, CFI = .91. The factor loadings ranged from poor (.18) to excellent (.79), with a median loading of .37; however, they were all statistically reliable at $p < .05$. Table 3 shows the values for these factor loadings. The low loadings may be attributable to the nature of the activity scale, and the homogeneity of the answers given by participants to the variables in the analysis (Tabachnik & Fidell, 1989). The activity questionnaire covered general areas of activity participation that would appeal to most older adults. As a result, the range of answers given for the items in the questionnaire tended to be small and provided little variance. The factor loadings resulting from the analysis were used to compute standardized factor scores for each participant, and composite Activity Lifestyle factor scores. The composite Physical, Social, and Intellectual activity factor scores were used as predictor variables in the MANOVA's and hierarchical regression analyses.

Self-Reported Health Measures The seven health variables entered into a confirmatory factor analysis coalesced into a 3 - factor model. Table 4 indicates the intercorrelations of the health variables used in the analysis. The three factors were

Table 2
Intercorrelations of Activity Questionnaire Items[a]

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1. Walks	1.00													
2. Physical exercise	.08**	1.00												
3. Recreation activity	.03	.16**	1.00											
4. Cultural events	.13**	.20**	.16**	1.00										
5. Out to movies	.10**	.17**	.15**	.36**	1.00									
6. Museums/lectures	.19**	.17**	.17**	.53**	.26**	1.00								
7. Meetings/volunteer	.12**	.12**	.06*	.30**	.11**	.26**	1.00							
8. Cards/games-group	.01	.04	.19**	.14**	.11**	.06*	.08**	1.00						
9. Watch TV	.04	-.11**	.02	-.05	-.03	-.06*	-.00	.02	1.00					
10. Puzzles/games-solitary	-.06*	.02	.02	.04	-.01	.07*	.04	.22**	.05	1.00				
11. Reading	.03	.09**	.10**	.16**	.09**	.14**	.06*	.10**	.15**	.13**	1.00			
12. Listen to music	.11**	.04	.04	.19**	.07*	.16**	.12**	.05	.04	-.00	.03	1.00		
13. Hobbies/crafts	.00	.09**	.04	.12**	.03	.17**	.14**	-.01	-.02	.06*	.07*	.11**	1.00	
14. Gardening	.04	.04	.11**	.11**	.07*	.10**	.03	-.00	.07*	-.01	.06*	.06	.16**	1.00

[a] Listwise N = 1261

** $p < .01$

* $p < .05$

Table 3
Factor Loadings for Activity Questionnaire Items

	Factors		
Variables	Physical Activity	Social Activity	Intellectual Activity
Walks	.23		
Physical exercise	.37		
Recreational exercise	.35		
Gardening	.18		
Attend cultural events		.79	
Go out to movies		.44	
Visit museums/lectures		.66	
Attend meetings/Volunteer		.37	
Play cards with others			.49
Play cards/puzzles alone			.37
Read			.33

Table 4
Intercorrelations of Self-Reported Health Variables[a]

Variable	1	2	3	4	5	6	7
1. CES-D[b]	1.00						
2. Life Satisfaction[c]	-.38**	1.00					
3. Well Being[c]	-.52**	.58**	1.00				
4. Days ill/past 6 months	.14**	-.14**	-.13**	1.00			
5. Illnesses per year	.08*	-.12**	-.07*	.19**	1.00		
6. Chronic conditions	.26**	.45**	-.34**	.15**	.17**	1.00	
7. Self-rated health	-.23**	-.52**	.40**	-.21**	-.16**	-.47**	1.00

[a] Listwise deletion N = 1191

[b] CES-D: higher scores = more depressive affect

[c] Life Satisfaction and Well Being: higher scores = higher levels of each measure

** $p < .001$

* $p < .01$

labeled Mental Health, Physical Health, and Illness Episodes. Table 5 shows the factor loadings of the self-reported health measures. The indices of fit suggested that the 3-factor model fit well, χ^2 (11, N = 1191) = 73.05, p<.01, GFI = .98, RMSEA = .069, and CFI = .96. The factor loadings were relatively high, ranging from .40 to -.82, with a median of .64. The factor loadings were again used to compute standardized factor scores for each participant, and composite scores for each of the three Self-reported Health factors. These composite scores were then entered as predictor variables in the hierarchical regression analyses.

Age and Gender Differences

To determine if there were age group and gender differences for the variables, a series of multivariate analyses of variance (MANOVA) were conducted. Post hoc univariate tests of significance were performed where significant overall effects were found. Polynomial contrasts (linear and quadratic) were used to examine age effects. To protect against inflated Type I error, a Scheffé (Scheffé, 1953) adjustment was used to produce a more stringent F test. A Scheffé adjustment enables a researcher to make all possible comparisons between individual means as well as between combinations of means and is applicable in situations where there are equal as well as unequal frequencies in the groups or categories of the variables. The Scheffé procedure is very conservative in that it is less likely to show differences between means as significant, and was considered appropriate for a sample of this size. An estimation of the proportion of variance associated with significant effects was obtained through eta squared (η^2).

Cognitive Measures

A 2 (Gender) X 3 (Age) MANOVA conducted on two of the cognitive variables,

Table 5
Factor Loadings for Self-Reported Health Variables

	Factors		
Variables	Mental Health	Physical Health	Illness Episodes
CES-D	.59		
Life satisfaction	-.72		
Well Being	-.82		
Chronic conditions		.48	
Self-rated health		.40	
Days ill			.64
Illnesses per year			-.73

Vocabulary and Word Recall, revealed significant overall main effects for Gender, Wilks'λ = .961, $\underline{F}(2,936) = 19.14$, $\underline{p} < .001$, and Age, Wilks'λ = .887, $\underline{F}(4,1872) = 28.86$, $\underline{p} < .001$. There were no significant interactions. The means and standard deviations for the two variables as a function of age and gender are shown in Table 6.

Univariate tests for Gender revealed that women performed better on the Word Recall task than men, $\underline{F}(1,937) = 34.48$, $\underline{p} < .001$, $\eta^2 = .035$ ($\underline{M}_{women} = 7.83$; $\underline{M}_{men} = 6.62$). There were no univariate effects of gender for Vocabulary.

Univariate tests for Age revealed significant mean differences on Word Recall performance between the age groups , $\underline{F}(2,943) = 55.70$, $\underline{p} < .001$, $\eta^2 = .106$. Polynomial contrasts revealed a significant linear decline, $\underline{F}(1,940) = 115.24$, $\underline{p} < .001$, $\eta^2 = .109$. Post hoc comparisons using Scheffé's tests showed that the younger age group performed better than both the middle age group ($\underline{M}_{younger} = 8.22$; $\underline{M}_{middle} = 7.16$), and older age group ($\underline{M}_{older} = 5.60$). In addition, there were significant differences between the means on Word Recall for the middle age group and the older age group. There were no significant univariate age effects for Vocabulary, and no significant quadratic age trends.

A separate 2 (Gender) x 3 (Age) ANOVA was conducted on Letter Series due to the large drop-out rate of participants from this task. A significant main effect of Age was revealed, $\underline{F}(2,707) = 33.68$, $\underline{p} < .001$. Polynomial contrasts revealed a linear decline with age, $F(1,710) = 49.34$, $\underline{p} < .001$, $\eta^2 = .063$. Post hoc comparisons using Scheffé's test showed both the older and middle age groups performed at significantly lower levels ($\underline{M}_{older} = 5.38$; $\underline{M}_{middle} = 6.44$) than the younger age group ($\underline{M}_{younger} = 8.75$). The means and standard deviations for this variable as a function of age and gender are shown in Table 6.

Table 6

Mean Performance Level on Cognitive Tasks as a Function of Age and Gender

	Age 65-72 years		Age 73-80 years		Age 81-100 years	
	Women	Men	Women	Men	Women	Men
n	248	164	209	146	97	79
Word Recall						
M	8.77	7.39	7.55	6.60	6.03	5.06
SD	2.72	2.66	2.91	2.41	2.74	1.98
Vocabulary						
M	12.08	11.59	11.96	12.34	11.23	11.59
SD	3.72	4.15	3.84	3.71	4.41	3.57
Letter Series	(n=195)	(n=142)	(n=158)	(n=116)	(n=53)	(n=49)
M	8.94	8.49	6.30	6.63	5.42	5.35
SD	4.56	4.67	3.86	4.11	3.87	3.50

Metamemory

A 2 (Gender) X 3 (Age) ANOVA was performed on the Metamemory measure, revealing significant main effects of Gender, F (1,937) = 5.00, $p < .05$, and Age, F (2,937) = 7.02, $p < .001$. Related to gender, women in the sample felt better about their memory than men (M_{women} = 20.50; M_{men} = 20.15). As revealed by polynomial contrasts, there was a significant age-related linear decrease in positive feelings about memory ability, F (1,940) = 9.57, $p < .01$, $\eta^2 = .01$. Post hoc Scheffé tests indicated that the younger age group reported feeling better about their memory ($M_{younger}$ = 20.79) than both the middle age group (M_{middle} = 20.06), and the older age group (M_{older} = 19.94).

Activity Measure

A 2 (Gender) X 3 (Age) MANOVA was conducted on the Physical, Social, and Intellectual activity factors. Significant overall main effects were found for Gender, Wilks'λ = .923, F (3, 935) = 25.85, $p < .001$, and for Age, Wilks'λ = .940, F (6, 1870) = 9.721, $p < .001$. There were no significant interactions. The means and standard deviations by age and gender for the activity measure are presented in Table 7.

Univariate tests related to Gender revealed that women participated in more intellectual activities than did men, F (1,937) = 47.19, $p < .001$, $\eta^2 = .048$, (M_{women} = 5.87; M_{men} = 4.92) and that men engaged in more physical activities than did women, F (1,937) = 21.31, $p < .001$, $\eta^2 = .022$, (M_{men} = 5.64; M_{women} = 5.27). There were no significant univariate gender effects for social activity.

Univariate tests related to Age indicated a significant difference between the means of the three age groups for Physical Activity, F (2,937) = 13.58, $p < .001$, η^2 = .028, and for Social Activity, F (2,937) = 22.95, $p < .001$, $\eta^2 = .047$. Polynomial

Table 7
Mean Activity Level as a Function of Age and Gender

	Age 65-72 years		Age 73-80 years		Age 81-100 years	
	Women	Men	Women	Men	Women	Men
n	248	164	209	146	97	79
Physical Activity						
M	5.44	5.77	5.28	5.71	4.80	5.25
SD	1.23	1.28	1.24	1.33	1.09	1.21
Social Activity						
M	6.95	6.88	6.95	6.59	5.51	5.36
SD	2.47	2.56	2.48	2.31	2.28	2.28
Intellectual Activity						
M	5.92	5.03	5.92	5.05	5.86	4.44
SD	2.16	1.95	2.16	2.05	2.18	2.14

contrasts revealed significant linear decreases for the Physical Activity factor, F (1, 940) = 25.45, $p < .001$, $\eta^2 = .026$, and for the Social Activity factor, F (1,940) = 46.25, $p < .001$, $\eta^2 = .047$. Using Scheffé's tests, post hoc comparisons indicated that the older age group engaged in fewer physical activities (M_{older} = 5.00) than both the middle age group (M_{middle} = 5.46) and younger age group ($M_{younger}$ = 5.57), and participated in fewer social activities (M_{older} = 5.44) than the other age groups (M_{middle} = 6.60; $M_{younger}$ = 6.93). There was no univariate effect of age for Intellectual Activity, and there were no significant quadratic age trends.

Physical Health Measures

A 2 (Gender) X 3 (Age) MANOVA performed on the physical health variables revealed an overall main effect for Gender, Wilks'λ = .951, F (8,930) = 5.981, $p < .001$, $\eta^2 = .951$ and Age, Wilks'λ = .888, F (16, 1860) = 7.127, $p < .001$, $\eta^2 = .888$. There were no significant interactions. The means and standard deviations as a function of age and gender for the physical health measures are shown in Table 8.

Univariate tests related to Gender indicated that there were significant differences between the means for Chronic conditions, F (1, 937) = 16.80, $p < .001$, $\eta^2 = .018$; Body pain, F (1, 937) = 25.83, $p < .001$, $\eta^2 = .027$; and Nutrition, F (1, 937) = 14.03, $p < .001$, $\eta^2 = .015$. Compared to the men in the sample, women tended to report more chronic conditions (M_{women} = 3.44; M_{men} = 2.95) and bodily pain symptoms (M_{women} = 2.21; M_{men} = 1.83), and had better nutritional habits (M_{women} = 8.67; M_{men} = 8.95). There were no significant gender effects for Illnesses per year, Current health, Days ill, Relative health, or Proactive health.

Univariate tests conducted on Age revealed that there were significant differences

Table 8

Means for Self-Reported Physical Health Measures as a Function of Age and Gender

	Age 65-72 years		Age 73-80 years		Age 81-100 years	
	Women	Men	Women	Men	Women	Men
n	248	164	209	146	97	79
Chronic						
M	2.75	2.56	3.80	3.02	4.44	3.63
SD	1.88	1.93	2.23	2.11	2.02	2.24
Days ill						
M	5.43	2.32	4.62	3.81	4.16	1.84
SD	19.55	7.04	12.41	21.41	10.96	4.68
Illnesses per year						
M	1.21	1.10	1.00	.92	.92	.90
SD	.91	.98	.96	.87	.96	.93
Current health						
M	3.07	2.97	2.91	3.04	2.79	2.90
SD	.73	.73	.73	.81	.85	.89

Table 8 continued on next page.

Table 8 (cont'd).

Relative health						
M	3.15	3.07	3.03	3.16	3.22	3.18
SD	.73	.73	.72	.75	.70	.67
Body pain						
M	2.15	1.83	2.25	1.78	2.26	1.92
SD	1.06	.92	1.09	1.01	1.12	1.12
Proactive						
M	5.37	5.36	5.43	5.43	5.56	5.37
SD	.78	.77	.76	.74	.69	.70
Nutrition						
M	8.77	8.95	8.66	8.99	8.42	8.89
SD	1.30	1.24	1.25	1.00	1.25	1.20

in means between the age groups for Chronic conditions, F (2, 943) = 30.25, $p < .001$, $\eta^2 = .061$, Illnesses per year, F (2,937) = 6.05, $p < .001$, $\eta^2 = .013$, and Current health, F (2, 937) = 3.07, $p < .05$, $\eta^2 = .007$. Polynomial contrasts indicated a significant linear increase for Chronic conditions, F (1,940) = 56.82, $p < .001$, $\eta^2 = .057$. Post hoc comparisons with the Scheffé procedure showed the younger age group reported fewer chronic conditions ($M_{younger} = 2.67$) than both the middle age group ($M_{middle} = 3.48$) and older age group ($M_{older} = 4.08$), and the middle age group reported significantly fewer conditions than the older age group. In addition, polynomial contrasts revealed a significant linear decrease for self-reported Illness per year, F (1, 940) = 9.26, $p < .01$, $\eta^2 = .01$. Using Scheffé's tests, post hoc comparisons indicated that the younger age group experienced more illnesses ($M_{younger} = 1.17$) than both the middle age group ($M_{middle} = .96$) and older age group ($M_{older} = .91$). Finally, there was a significant linear decrease in Current health F (1, 940) = 7.38, $p < .01$, $\eta^2 = .01$. Post hoc comparisons with the Scheffé procedure indicated that the younger age group rated their current health better ($M_{younger} = 3.03$) than the older age group ($M_{older} = 2.85$). There were no univariate age effects for Days ill, Relative health, Body pain, Proactive health, or Nutrition, nor were there quadratic age trends revealed for any of the self-reported health measures

Mental Health Measures

A 2 (Gender) X 3 (Age) MANOVA was conducted on the mental health variables, and revealed an overall main effect for Gender, Wilks' $\lambda = .983$, F (3, 935) = 5.54, $p < .001$, $\eta^2 = .983$. Univariate tests indicated significant mean differences for CES-D, F (1,937) = 9.42, $p < .01$, $\eta^2 = .010$. In general, women in the sample reported higher levels of depressive affect than did men ($M_{women} = 9.54$; $M_{men} = 8.83$). There were no significant gender effects for Life Satisfaction or Well-being, nor were there significant age effects for any of the mental health variables. The means and standard deviations for these measures as a function of age and gender are displayed in Table 9.

Regression Analyses

To determine if activity lifestyle, self-reported physical, and self-reported mental health were predictive of individual differences in cognitive performance, a hierarchical multiple regression analysis was conducted using the 3-factor activity model and the 3-factor health model. In addition, measures of nutrition practices, proactive lifestyle practices, body pain, and metamemory were included. With hierarchical regression, it is important to decide a priori the order in which the variables will be entered into the equation. Because age, gender, and education are often strongly correlated with performance on cognitive measures, these were entered first. Thus, the contribution of the health variables and the activity variables to cognitive performance could be assessed after statistical control of these potentially confounding variables. The remaining predictor variables were entered in the following order: mental health, physical health, illness episodes, body pain, proactive health practices, nutrition, metamemory, physical activity, social activity, and intellectual activity. Finally, all interactions of age with the previous measures were entered into the equation. The rationale behind the order of entry was guided by previous empirical findings, logic, and the focus of this study. Research has indicated a relationship between both self-reported physical and mental health and cognitive performance (e.g., Christensen et al, 1994; Perlmutter & Nyquist, 1990). As well, it is a logical possibility that activity choices may be influenced by the perceived physical and mental health of an individual, by their nutrition habits, proactive health

Table 9

Means for Self-Reported Mental Health Measures as a Function of Age and Gender

	Age 65-72 years		Age 73-80 years		Age 81-100 years	
	Women	Men	Women	Men	Women	Men
n	248	164	209	146	97	79
CES-D						
M	9.23	8.76	9.78	8.73	9.82	9.15
SD	3.35	3.07	3.33	3.41	3.96	3.57
Life satisfaction						
M	3.58	3.63	3.52	3.60	3.53	3.54
SD	.44	.36	.41	.42	.41	.38
Well-being						
M	12.76	12.67	11.82	12.16	11.75	11.29
SD	5.68	5.65	5.45	5.97	5.87	6.18

practices, and by the amount of bodily pain they experience. In addition, the focus of this paper is the relationship between activity lifestyle and cognitive performance, and how self-reported health may influence this relationship.

Significant multiple correlations were obtained for all three cognitive measures, with multiple Rs ranging from .15 to .24. These results, summarized in Table 10, suggest that aspects of self-reported health and activity lifestyle are predictive of cognitive performance, independent of age, education and gender. Of the self-reported health measures, mental health was a significant predictor of performance on Vocabulary, Word Recall, and Letter Series, physical health was predictive of Word Recall only, and nutrition was a significant predictor of all three cognitive measures. Regarding the activity lifestyle measures, physical activity was predictive of performance on only Word Recall, social activity was a significant predictor of Vocabulary and Word Recall, and intellectual activity significantly predicted performance on all three measures. Metamemory, a single indicator variable, was a significant predictor for only Word Recall. There were no significant interactions of age with any of the variables.

A second series of hierarchical regressions was computed to determine if age-related variance in two of the cognitive measures, Word Recall and Letter Series, would be attenuated when the self-reported health and activity lifestyle variables were controlled statistically. The Vocabulary measure was dropped from this set of analyses after determining that there was a negligible amount of age-related variance associated with this task. Again, the order of entry was determined a priori by empirical evidence, logic, and focus of the study. A decision was made to eliminate from the analysis those variables that did not predict performance on any of the cognitive variables in the

Table 10

Hierarchical Regression Analysis Predicting Cognitive Performance from Self-Reported Health Factor Scores and Activity Lifestyle Factor Scores (Independent of Age, Education, and Gender)

		Indices				
Criterion	Significant Predictors	Beta	ΔR^2	F	df	p
Word Recall	Age	-.877				
	Education	.139				
	Gender	.208	.180	68.84	3,393	.000
	Mental health	-.117	.004	4.18	4,938	.041
	Physical health	.063	.004	4.92	5,937	.027
	Nutrition	.125	.006	11.71	9,933	.012
	Metamemory	-.039	.010	9.83	10,932	.001
	Physical activity	.049	.008	14.52	11,931	.002
	Social activity	.230	.012	5.65	12,930	.000
	Intellectual activity	.002	.005	2.10	13,929	.018
Vocabulary	Age	-.006				
	Education	.348				
	Gender	.016	.151	55.58	3,939	.000
	Mental health	-.094	.004	3.93	4,938	.048
	Nutrition	.105	.003	3.86	9,933	.050
	Social activity	.220	.025	28.95	12,930	.000
	Intellectual activity	.111	.018	21.11	13,929	.000

Table 10 continued on next page.

Table 10 (cont'd).

		Beta	ΔR^2	F	df	p
Letter Series	Age	-.343				
	Education	.259				
	Gender	.020	.167	47.45	3,709	.000
	Mental health	-.084	.016	13.50	4,708	.000
	Nutrition	.059	.009	19.30	9,703	.004
	Intellectual activity	.324	.022	19.30	13,699	.000

previous hierarchical regression. These variables were Body Pain and Proactive Health. In the first model, age was entered alone, to obtain the amount of age-related variance in each cognitive variable. In the second model, education and gender were entered first, followed by age. This model indicated the variance associated with age once the individual differences in the control variables were accounted for. The third model entered the control variables, followed by mental health, followed by age and estimated the contribution of age beyond that of the controls and mental health. The fourth model entered the control variables and mental health, followed by physical health, followed by age, indicating the amount of variance associated with age once the controls, mental health, and physical health had been statistically controlled. The fifth model replicated the fourth, but entered nutrition before age, thus estimating the variance attributable to age once the controls, mental health, physical health, and nutrition had been controlled. The following models replicated the previous model but entered specific variables, each as an individual block, before age: Model 6, Metamemory; Model 7, Physical activity; Model 8, Social activity; Model 9, Intellectual activity; and Model 10, the interactions of age with the previous variables.

The results of the hierarchical regression analyses are shown in Tables 11 and 12. In the Word Recall task, age accounted for 11.5% of the variance; in Letter Series age accounted for 9.2% of the variance. After partialling out the variance attributable to gender and education, the age-related variance was reduced in Word Recall to10.3%, and in Letter Series to 8.2%. The addition of Mental Health into the equation reduced the age-related variance in Word Recall by 3.5% and in Letter Series by 5.4%. In both dependent variables, Physical Health accounted for a large proportion of the age-related

Table 11

Summary of Hierarchical Regression Analysis for Word Recall

Independent Variable	R^2	ΔR^2	F	df	p	% age-related variance remaining
			Model 1 (age only)			
Age	.115	.115	121.96	1,941	.000	100
			Model 2 (controlling for education, gender)			
Education/gender	.084	.084	42.97	2,940	.000	
Age	.186	.103	118.45	1,939	.000	89.56
			Model 3 (controlling for Mental Health)			
Mental Health	.091	.007	7.56	1,939	.006	
Age	.190	.099	114.58	1,938	.000	86.08
			Model 4 (controlling for Physical Health)			
Physical Health	.104	.013	13.87	1,938	.000	
Age	.195	.090	105.09	1,937	.000	78.20
			Model 5 (controlling for Nutrition)			
Nutrition	.110	.005	5.62	1,937	.018	
Age	.200	.090	105.67	1,936	.000	78.20

Table 11 continued on next page

Table 11 (cont'd).

	Model 6 (controlling for Metamemory)					
Metamemory	.124	.014	15.25	1,936	.000	
Age	.209	.085	100.22	1,935	.000	73.90
	Model 7 (controlling for Physical Activity)					
Physical Activity	.141	.017	18.19	1,935	.000	
Age	.217	.076	90.82	1,934	.000	66.00
	Model 8 (controlling for Social Activity)					
Social Activity	.163	.022	24.58	1,934	.000	
Age	.228	.065	78.62	1,933	.000	56.52
	Model 9 (controlling for Intellectual Activity)					
Intellectual Activity	.168	.005	5.76	1,933	.017	
Age	.232	.064	77.57	1,932	.000	55.65

Table 12

Summary of Hierarchical Regression Analysis for Letter Series

Independent Variable	R^2	ΔR^2	F	df	p	% age-related variance remaining
			Model 1 (age only)			
Age	.092	.092	72.43	1,711	.000	100
			Model 2 (controlling for education, gender)			
Education/gender	.089	.089	34.65	2,710	.000	
Age	.171	.082	70.54	1,709	.000	89.13
			Model 3 (controlling for Mental Health)			
Mental Health	.110	.021	16.62	1,709	.000	
Age	.187	.077	67.13	1,708	.000	83.70
			Model 4 (controlling for Physical Health)			
Physical Health	.119	.009	7.20	1,708	.007	
Age	.190	.071	61.98	1,707	.000	77.20
			Model 5 (controlling for Nutrition)			
Nutrition	.125	.006	4.07	1,707	.030	
Age	.198	.073	64.38	1,706	.000	79.30

Table 12 continued on next page.

Table 12 (cont'd)

			Model 6 (controlling for Metamemory)			
Metamemory	.125	.001	.65	1,706	ns	
Age	.125	.072	63.59	1,705	.000	78.30
			Model 7 (controlling for Physical Activity)			
Physical Activity	.127	.001	1.09	1,705	ns	
Age	.198	.071	62.34	1,704	.000	77.20
			Model 8 (controlling for Social Activity)			
Social Activity	.134	.007	5.55	1,704	.019	
Age	.200	.067	58.54	1.703	.000	72.80
			Model 9 (controlling for Intellectual Activity)			
Intellectual Activity	.153	.019	15.81	1,703	.000	
Age	.220	.067	77.57	1,702	.000	72.80

variance, from 8% in Word Recall to 6.5% in Letter Series. When added to the equation, Nutrition accounted for very little variance in either cognitive measure. Metamemory and Physical Activity contributed little to the reduction of age-related variance in Letter Series, but accounted for a further 4.8% attenuation in Word Recall. Social Activity accounted for the greatest reduction of age-related variance in Word Recall, approximately 9.5%, while in Letter Series, it reduced the age-related variance by another 4%. Surprisingly, the addition of Intellectual activity did not reduce the age-related variance by any substantial amount. In fact, in Letter Series, there was no attenuation of age-related variance at all. Overall, almost 45 % of the age-related variance in Word Recall was accounted for by the self-reported health and activity lifestyle variables; in Letter Series, these variables accounted for approximately 27 % of the age-related variance.

Letter Series Attrition Analyses

An intriguing observation from this study was that over one-third of the participants refused to either participate in the Letter Series task or to complete it after attempting only one item. Of the 943 participants in the present sample, only 713 (75.5%) completed the task, while 230 (24.4%) did not. Attrition analyses were undertaken in an attempt to identify differences between those who completed the task and those who did not. The demographic and health characteristics of the two groups are illustrated in Table 13. Tests of significant age and gender differences have been reported previously, thus only significant effects related to participatory status on the Letter Series task will be reported. There was a significant effect of participation status on both education, $\underline{F}\,(1,942) = 41.49$, $\underline{p} < .001$, $\eta^2 = .042$, and income, $\underline{F}\,(1,857) = 27.58$, $\underline{p} < .001$,

Table 13

Demographic and Health Characteristics of Letter Series Attrition Sample

	Participated in task						Did not participate in task					
	Age 65-72		Age 73-80		Age 81-100		Age 65-72		Age 73-80		Age 81-100	
Variable	Women	Men	Women	Men	Women	Men	Women	Men	Women	Men	Women	Men
n	195	142	158	116	53	49	53	22	51	30	44	30
Age												
M	68.87	68.92	76.56	75.66	84.83	84.76	69.30	69.18	76.39	76.00	85.64	84.83
SD	2.07	2.12	2.54	2.25	3.75	3.28	2.02	1.99	2.37	2.38	4.08	3.04
Education[a]												
M	3.94	4.39	3.84	4.36	3.79	4.00	3.00	3.77	3.25	3.33	3.23	3.40
SD	1.52	1.81	1.49	1.76	1.56	1.90	1.47	1.66	1.45	1.69	1.52	1.79
Income[b]												
M	4.68	5.18	4.43	5.16	3.98	4.65	4.12	4.62	4.00	4.68	3.53	4.88
SD	1.28	1.08	1.38	1.13	1.31	1.23	1.40	1.16	1.37	1.31	1.16	1.15
Chronic[c]												
M	2.73	2.51	3.71	3.07	4.28	3.57	2.83	2.86	4.08	2.83	4.64	3.73
SD	1.90	1.87	2.21	2.17	1.91	2.25	1.81	2.29	2.28	1.90	2.15	2.26
Self-rated health[d]												
M	3.12	3.07	3.04	3.11	3.04	3.08	3.07	2.73	2.75	3.07	2.97	2.97
SD	.69	.64	.64	.73	.78	.74	.66	.81	.73	.76	.63	.69

Table 13 continued on next page.

Table 13 (cont'd).

Variable	Participated in task						Did not participate in task					
	Age 65-72		Age 73-80		Age 81-100		Age 65-72		Age 73-80		Age 81-100	
	Women	Men	Women	Men	Women	Men	Women	Men	Women	Men	Women	Men
CES-D[e]												
M	9.31	8.71	9.71	8.27	10.28	8.98	8.94	9.05	10.00	10.50	9.27	9.43
SD	3.47	2.95	3.26	2.76	3.26	2.76	2.87	3.81	3.57	4.88	3.25	3.75

[a] Highest level of school completed on an 7-point scale: 01 = *some elementary school*, through 03 = *completed high school*, to 07 = *a graduate*. [b] Calculated as household or individual income, whichever was greater; rated on a 6-point scale (from 1 = *less than $5,000* to 6 = *$40,000 and above*). [c] Incidence of 20 chronic conditions (higher score = more conditions). [d] Average of current health plus health compared to others of same age, rated on a 4-point scale (from 1 = *poor* to 4 = *excellent*). [e] Rating of depressive affect on a 5-point scale: 1 = *never* to 5 = *most of the time* (highest score possible = 35)

$\eta^2 = .031$. Those participants who completed the Letter Series task reported higher levels of both income and education than those who did not complete the task.

MANOVA's were conducted on the two remaining cognitive variables, Word Recall and Vocabulary, to see if there were significant gender, age, or participation status differences between the two groups, and to examine any interactions that might occur. Further MANOVA's were conducted on the Activity Lifestyle measures, and the self-reported mental and physical health measures. Post hoc univariate tests of significance were conducted where appropriate, using a Scheffé adjustment, and an alpha level of .05. Tests of significant overall main effects related to age, gender, and interactions essentially replicated the analyses reported previously, thus only significant effects related to participatory status on the Letter Series task will be reported.

Cognitive Measures

A 2 (Gender) X 3 (Age) X 2 (Participation Status) MANOVA conducted on Word Recall and Vocabulary revealed a significant overall main effect for Participation Status, Wilks' $\lambda = .942$, F (2,930) = 28.71, $p < .001$, $\eta^2 = .058$. There were no significant interactions.

Univariate analysis related to Participation Status revealed significant mean differences for both Word Recall, F (1,931) =30.18, $p <.001$, $\eta^2 = .031$, and Vocabulary, F (1,931) = 40.86, $p < .001$, $\eta^2 = .042$. Compared to those who elected to participate in the Letter Series task (P), participants who refused to participate (DNP) did not perform as well on either Word Recall ($M_{DNP} = 6.06$; $M_P = 7.23$) or Vocabulary ($M_{DNP} = 10.41$; $M_P = 12.40$).

Activity Measure

A 2 (Gender) X 3 (Age) X 2 (Participation Status) MANOVA was conducted on the Physical Activity, Social Activity, and Intellectual Activity factors. There were significant overall main effects for Participation Status, Wilks' $\lambda = .987$, F (3, 929) = 4.18, $p < .01$, $\eta^2 = .013$. There were no significant interactions.

There were significant mean differences relating to Participation Status on Social Activity, F (1,931) = 6.61, $p < .01$, $\eta^2 = .007$, and Intellectual Activity, F (1,931) = 6.65, $p < .01$, $\eta^2 = .007$. In general, participants who refused to do the Letter Series task engaged in fewer social activities ($M_{DNP} = 5.94$) than those who completed the task (M_P = 6.45), and in fewer intellectual activities ($M_{DNP} = 5.06$; $M_P = 5.50$). There were no significant univariate effects of participation status for Physical Activity.

Physical Health Measures

A 2 (Gender) X 3 (Age) X 2 (Participation Status) MANOVA was conducted on the physical health variables. Significant overall main effects were found for Participation Status, Wilks' $\lambda = .983$, F (8, 924) = 2.046, $p < .05$, $\eta^2 = .017$. There were no significant interactions.

Related to Participation Status, univariate analyses indicated significant mean differences for Relative Health, F (1,931) = 4.22, $p < .05$, $\eta^2 = .005$, for Current Health, F (1, 931) = 8.57, $p < .01$, $\eta^2 = .009$, and for Nutrition, F (1,931) = 5.73, $p < .05$, $\eta^2 = .006$. Compared to participants who did not complete the Letter Series task, participants who completed the task felt that their health was better relative to others their age (M_P = 3.16, $M_{DNP} = 3.04$), and that their health was better compared to a perfect state of health ($M_P = 3.00$, $M_{DNP} = 2.81$). As well, those who participated in the Letter Series task had better nutritional habits ($\underline{M}_P = 8.86$) than those who refused to participate ($\underline{M}_{DNP} = 8.62$). There were no significant participation status effects for Chronic health, Days ill, Illnesses per year, Proactive health or Body pain.

Mental Health Measures

A 2 (Gender) X 3 (Age) X 2 (Participation Status) on the mental health variables revealed significant main effects of Participation Status, Wilks' $\lambda = .990$, $\underline{F}$ (3,929) = 3.10, $\underline{p} < .05$, $\eta^2 = .010$. There was a significant interaction between Gender and Participation Status, Wilks' $\lambda = .989$, $\underline{F}$ (3,929) = 3.45, $\underline{p} < .05$, $\eta^2 = .011$.

Univariate analyses indicated related to Participation Status indicated significant mean differences for Life Satisfaction, $\underline{F}$ (1,931) = 8.61, $\underline{p} < .01$, $\eta^2 = .009$; and for Well Being, $\underline{F}$ (1, 931) = 5.37, $\underline{p} < .05$, $\eta^2 = .006$. Individuals who refused to participate in the Letter Series task reported lower scores for Life Satisfaction, ($\underline{M}_P = 3.60$; $\underline{M}_{DNP} = 3.50$), and for Well Being ($\underline{M}_P = 12.37$; $\underline{M}_{DNP} = 11.29$).

There was a Gender by Participation Status interaction related to CES-D, $\underline{F}$ (1, 931) = 6.19, $\underline{p} < .05$, $\eta^2 = .007$. Men who refused to take part in the Letter Series task reported higher levels of depressive affect ($\underline{M}_{men\ DNP} = 9.66$) than the men who completed the task ($\underline{M}_{men\ P} = 8.65$), but women who refused to participate in the Letter Series task reported lower levels of depressive affect ($\underline{M}_{women\ DNP} = 9.40$) than those women who took part in the task ($\underline{M}_{women\ P} = 9.77$).

Chapter VI

DISCUSSION

Results from the analyses provide evidence relevant to the questions of interest in this study: (a) will activity lifestyle and self-reported health predict performance on the cognitive tasks independent of potentially confounding variables such as age, gender, and education, (b) do intellectually demanding activities predict performance on cognitive tasks more strongly than do physical or social activities, independent of potentially confounding variables such as age, gender, and education, and (c) will age differences in cognitive performance be attenuated after accounting for individual differences in activity lifestyle and self-reported health?

Activity Lifestyle Measure

The results offer partial support for the first hypothesis that frequent participation in a large number of activities would be related to higher cognitive performance. On all three cognitive tasks, the intellectual activity factor was a significant predictor of performance. The social activity factor was a significant predictor of both Word Recall and Vocabulary, while the physical activity factor predicted performance on Word Recall only.

Although statistically significant, the amounts of variance in the cognitive tasks accounted for by the individual activity lifestyle factors can only be described as modest and, despite the less select nature of the sample, are lower when compared to results from other studies (Arbuckle et al., 1986; Christensen & Mackinnon, 1993). For example, Hill et al. (1995) reported that activity lifestyle, represented in part by social and physical activities, accounted for approximately 10% of the variance in a word recall task, a much higher figure than the amounts of variance (.5% to 1.2%) accounted for in the present study. Similarly, Hultsch et al. (1993) reported higher values from their study which used comparable activity lifestyle factors. In their study, an active lifestyle, characterised by physical activity (e.g.,walks), integrative information processing (e.g., driving a car),and novel information processing (e.g., playing bridge) significantly predicted performance on a word recall task. The amount of variance accounted for by this factor was 1.6%, again higher than the results from the present study.

The modest support offered for the hypothesis that a highly active lifestyle would predict performance on the cognitive tasks may be explained, in part, by the nature of the activity questionnaire itself. As was previously mentioned, the items chosen for the activity questionnaire covered a wide range of activities that would presumably appeal to older adults. Indeed, previous research on the activity lifestyles of seniors indicates that the activities chosen are representative of the kinds of activities commonly engaged in by this population (e.g., Baltes, Wahl, & Schmidt-Furstoss, 1990). However, by constraining the number and type of activities, the ability to examine the activity lifestyle of the sample indepth was restricted. It is possible that there were many alternate activities that would have provided further information about the leisure pursuits of the sample. For example, social activity could additionally have been characterised by visiting with friends or family. Intellectually demanding activities might also have included learning how to play a musical instrument or use a computer. In essence, then, it is possible that the choice of items for inclusion in the activity questionnaire sacrificed variety for commonality, and reduced the predictive power of the measure.

An alternative explanation may be that the results observed in this study indicate a stability among observed effect sizes from various studies. In essence, the variance in cognitive tasks accounted for by activity lifestyle measures is similar whether obtained in studies using highly select samples of convenience or more representative samples. Rather than attributing the small effect sizes in this study to the nature of the sample or the inadequacy of the activity measure, it may be more plausible to view them as additional support for the notion of stable effect sizes.

There was very limited support offered for the second research question that intellectually demanding activities would be stronger predictors of cognitive performance than either social or physical activities. Again, despite the more representative nature of the sample, the magnitude of the effect sizes from the present study is weaker than in previous studies using more select samples (e.g., Arbuckle et al., 1986; Hultsch et al., 1993). Although participation in intellectual activities predicted performance on Word Recall, Vocabulary, and Letter Series (.5%, 1.8%, and 2.2%, respectively), participation in social activities emerged as a stronger predictor of performances on Word Recall (1.2%) and Vocabulary (2.5%). This suggests that intellectual activities such as reading, doing crossword puzzles, and playing cards may be more predictive of performance on a wider range of tasks that tap into different aspects of cognitive functioning than are social activities, but they are not necessarily stronger predictors. Participation in physical activities accounted for a very small percentage of the variance in performance in Word Recall only (.8%), and did not emerge as a strong predictor of cognitive performance.

One factor that may account for some differences in observed effect sizes among studies is the lack of consistency in how components of activity lifestyle are defined. For example, in the Hultsch et al. (1993) investigation, physical activity was included in the active lifestyle factor. When the variance accounted for by the physical activity factor in the present study is added to that for intellectual activity, the resulting value is 1.3% , and is very comparable to that found in the Hultsch et al. study. In the present investigation, both intellectual activity and social activity were significant predictors of performance on the Vocabulary task, accounting for 1.8% and 2.5% of the variance. This differs from the Hultsch et al. study in which only passive lifestyle emerged as a significant predictor, accounting for 1.2% of the variance. Again, differences in the variables composing the factors themselves may account for the discrepancies. In the present study, social activity included a number of activities that could also be considered intellectually demanding, whereas in the Hultsch et al. study, social activities appeared to be characterised by less cognitively demanding pursuits.

The lack of support for the hypothesis that intellectually demanding activities would better predict cognitive performance than would social activities may also be partially explained by the multi-functional nature of some of the activities. The Intellectual Activity factor included three items unquestionably intellectual in nature (reading, playing cards/puzzles alone, and playing cards with others), therefore the question of multi-functionality may lie with the items included in the Social Activity factor. Of the four items that loaded onto this factor, two of them in particular (attend cultural events and visit museums/lectures) could conceivably be identified as intellectual items. With this in mind, it is possible that part of the variance accounted for by the Social Activity factor was not due to the social nature of the factor, but to its intellectual nature.

A second potential reason why participation in social activities emerged as a strong predictor of cognitive performance, relative to other types of activities, is that social interaction may in itself be cognitively demanding. According to Schooler (1984), activities that require complex thought and decision making serve to enhance and maintain cognitive functioning. It is plausible that certain types of interactions with others may place high cognitive demands on an individual. For example, conversations with family members often require complex descriptions and explanations, and navigating through personal finances with bank employees can involve complex decision making.

Controlling for individual differences in Activity Lifestyle resulted in modest attenuation in age-related differences in cognitive performance on Word Recall and Letter Series. The largest reductions were seen in Word Recall, where controlling for Physical Activity resulted in an approximate 8% attenuation of the age-related variance, and controlling for Social Activity accounted for an approximate 10% further reduction. The addition of Intellectual Activity into the equation resulted in less than 1% further attenuation in age-related variance. In the Letter Series task, controlling for Social Activity provided the only significant attenuation in age-related variance, accounting for just over 4% of the variance. Controlling for Physical Activity (1%) and Intellectual Activity (0%) did not reduce the age-related variance to any degree. Again, these results offer only limited support for the environmental complexity hypothesis (Schooler, 1984) and the disuse perspective (Salthouse, 1991), further suggesting that activity lifestyle does not play a strong mediating role in the maintainance of cognitive functioning among older adults.

In sum, the results from the present study provide evidence that individual differences in activity lifestyle account for modest amounts of variance in cognitive performance. However, the results do not provide evidence that these individual differences account for larger amounts of variance in a more representative sample than those seen with highly select samples. Although there were statistically significant results from the hierarchical regressions to suggest that engaging in social and intellectual activities are related to better cognitive performance, the effect sizes were still modest at best and weaker than expected, given the more representative nature of the sample. As previously mentioned, one plausible explanation for these results is that the activity measure itself did not encompass an adequate number, or variety, of activities engaged in by adults in the age-range covered in this study. It may also be that this sample was less representative than is necessary to obtain increased variability in responses. However, an alternative explanation is that the results from this study present evidence of stability among effect sizes, regardless of the activity measure used or sample representativeness.

In addition, the results offer only limited support for both the environmental complexity theory and the disuse perspective. Although the effect sizes are small, it remains true that those individuals who participated in more intellectually demanding activities performed at a higher level than those who did not. This suggests that engaging in cognitively demanding leisure pursuits, reflecting a complex environment, may be related to higher cognitive functioning among older adults, although weakly. It also suggests tht certain types of leisure activities may serve to activate the particular cognitive skills necessary to maintain an optimal level of cognitive performance. However, the direction of the relationship between activity level and cognition remains unclear. We still does not know whether engaging in cognitively complex activities leads to higher cognitive performance, or whether a initial high level of cognitive functioning encourages the selection of intellectually demanding leisure pursuits. Thus, conclusions cannot be made regarding the effectiveness of activity lifestyle as a mediating variable in maintaining cognitive capacity.

Self-Reported Physical Health Measures

The results indicate that individual differences in self-reported physical health were not strongly predictive of individual differences in cognitive performance, supporting the conjecture that this factor does not play a strong role in cognitive functioning of older adults (Salthouse, 1992). Physical health emerged as a significant, but weak (.4%), predictor of Word Recall only. The finding that individual differences in self-reported physical health are predictive of individual differences in Word Recall was slightly puzzling, as other studies have shown no such relationship (e.g., Hultsch et al., 1993). A critical difference between this study and the Hultsch et al. study is the presentation method for the Word Recall task. In the present study, participants had the words read to them at approximately 2-second intervals; they were then given 3 minutes to recall as many words as they could. In the Hultsch et al. study, participants were allowed to read the words themselves and to study them for two minutes, and had five minutes for recall. As well, in the latter study, astute participants could make use of the categorical nature of the word list, and organize words for recall accordingly; the participants in the present study had no such opportunity. Two possible hypotheses arise from these methodological differences: (a) a number of participants in the present study had hearing difficulties that interfered with their ability to hear the words; and (b) that the time spans for presentation and recall were not long enough for the participants, especially the older ones, to encode the words. Post hoc examination of the frequencies for the chronic conditions reveals that over one-third of the participants reported having a hearing impairment, thus it is entirely possible that hearing difficulties were a factor. Further examination of the correlation between hearing impairment and Word Recall shows a negative correlation (-.22) suggesting that individuals with hearing problems performed more poorly on the Word Recall task.

Self-reported physical health did not contribute significantly to performance on either Vocabulary or Letter Series. Self-reported physical health has often been shown to be unrelated to measures of crystallized intelligence such as vocabulary (e.g., Perlmutter & Nyquist, 1990), and this is supported by the findings from this study. Research has also indicated a lack of relationship between self-reported physical health and inductive reasoning (Salthouse et al.,1990) and, again, support is found within the present results. One possible reason for a similar lack of a relationship in this study is that, despite the more representative nature of the sample, the self-reported health was above average compared to other seniors in Canada (Statistics Canada, 1994). It is feasible that in a much less healthy sample, there would be more variance in the responses to the health-related questions, and more robust health-mediated individual differences in cognitive performance. However, although the overall health status of the present sample is relatively homogeneous and may not represent the true range of health problems in an older population, it should be noted that this sample is still less select in terms of self-reported health than most volunteer samples.

Controlling for the health factors resulted in relatively modest attenuation in age-related variance, ranging between 3% to almost 8% in all cases. For Word Recall, controlling for the Mental Health factor resulted in a 3% attenuation in age-related variance; inclusion of the Physical Health factor accounted for almost 8% of the age-related variance. In the Letter Series task, the proportion of attenuation in age-related variance was more equally distributed between Mental Health and Physical Health. The inclusion of Physical Health in the equation accounted for almost 7% reduction in age-related variance, while the Mental Health factor accounted for almost 6% variance. These results again suggest that self-reported health may not be a strong factor in the cognitive performance of older adults.

Nutrition

A measure of nutrition was included in the task battery in part because of a relative lack of empirical data on the relationship between everyday nutritional practices and cognition in samples of older adults. Nutrition emerged as a significant but relatively weak predictor of performance on all three cognitive tasks. The strongest relationship between individual differences in nutrition and individual differences in cognitive performance was seen in the Letter Series task, where nutrition accounted for almost 1% of the variance. This task requires individuals to sustain a certain level of concentration, to think ahead, and to make abstract connections among letters. If, as has been shown in the literature, low levels of certain nutrients like iron and folic acid result in poor concentration (Wahlin, Hill, Winblad, & Bäckman, 1996), it follows that poor performance on a difficult cognitive task may result.. Given the overall healthy nature of the sample, it is not surprising to find a weak relationship between nutrition and cognitive performance. As mentioned earlier, in a less homogeneously healthy sample, nutrition might emerge as a more robust predictor of cognitive performance. Still, the results obtained provided additional information about a poorly understood relationship, and indicate the need for additional research in this area.

Self-Reported Mental Health Measures

The mental health factor emerged as a significant but weak to modest predictor of performance on the three cognitive tasks. The strongest relationship between individual differences in self-reported mental health and individual differences in performance appeared on the Letter Series task, where mental health accounted for almost 2% of the variance. The results from the Letter Series task are comparable to those found by Perlmutter and Nyquist (1990) who report that, after controlling for age, self-reports of depression accounted for approximately 3% of the variance in a composite measure of fluid intelligence. Previous research has indicated that there is a relationship between poor performance on cognitive tasks and aspects of mental health, in particular depression (LaRue, Swan, & Carmelli, 1995; Luszcz, Bryan, & Kent, 1997). Two mechanisms through which depression may affect cognitive performance are lack of interest and reduced attention span (Bäckman, Hill, & Forsell, 1996). In the case of the Letter Series task, both of these factors are important to the performance outcome. The demands of the task are such that both interest and sustained effort on the part of the participant are required; a lack in either area would make completing the task difficult. If lack of both attention and interest were a key factor, however, it is surprising that mental health did not account for more variance in Word Recall, another task which requires sustained attention. In the present study, stronger effects for the Mental Health factor may not have been observed on the cognitive tasks because of the low incidence of self-reported depressive affect among the participants. This may also have influenced the degree of attenuation in age-related variance: controlling for mental health resulted in modest attenuation of age-related variance in Word Recall (3%) and Letter Series (5.5%). It should be noted that low values for self-reported depressive symptoms are not uncommon among studies such as the present one because it is highly unlikely that truly depressed individuals would agree to participate.

Letter Series Attrition Analyses

The attrition analyses provided interesting information about the participants who refused to complete the Letter Series task. In general, these participants had significantly lower performance scores on the remaining two cognitive tasks, Word Recall and Vocabulary, than those who completed the task. As a measure of inductive reasoning, the Letter Series task requires that the participant be able to make sense of logical but complex relationships. Participants who experience difficulties with this type of reasoning may not be able to understand even the instructions for the task or be able to complete and understand the practice items. This may explain in part why so many of the participants who refused to take part in the task did so without attempting a single item. The participants who refused to complete the task engaged in fewer social and intellectual activities, reported their current state of health to be poorer in general and in comparison to others their own age, and had poorer nutritional habits. There were also significant differences between samples in aspects of mental health: the participants who refused to complete the Letter Series task reported feeling less satisfied with their lives and had a poorer sense of well-being, but, interestingly, did not report significantly more depressive affect. However, a significant interaction of gender by participation status on the CES-D measure indicated that men who did not take part in the Letter Series task felt more depressed than their counterparts who completed the task, but women who refused to participate actually felt less depressed than women who completed the task.

An alternative explanation for the high refusal rate on the Letter Series task relates to the testing situation, rather than to characteristics of the participants. It is possible that a tester bias was present such that a particular tester was associated with those participants who refused to take part in the task. The results from a post hoc examination revealed that this was not the case. There was not one tester, or even a select group of testers, associated with those individuals who refused to participate in the Letter Series task.

One of the implications from the attrition analysis is that the participation effect seen here may be indicative of a general cognitive decline among older adults. Not only did those who refused to complete the task show lower scores on other cognitive tasks, but they also participated in activities which are less cognitively demanding. The lower sense of life satisfaction and well-being may be related to poor self-efficacy, which in turn has led to, or resulted from, a cognitive decline. Such causal implications are beyond the scope of this paper. It may also be true, however, that these same individuals have simply decided to participate in tasks and activities that are undemanding or more appealing. Thus, their refusal to participate in the Letter Series task may be indicative of a lack of interest and effort rather than a general cognitive decline. Again, one can only speculate on these suggestions.

Future Research

A possible explanation for the low predictive power of the factors is related to the multiple functions that many activities play in people's lives. Walking, for example, could be viewed as both a physical activity and a social activity. Many people walk for the cardiovascular benefits it affords them; others walk as a form of relaxation and to talk over their daily experiences with friends and partners. The multi-functional nature of this activity is reflected in the factor loadings for the Physical Activity Factor (see Table 3). A similar argument can be presented for the item 'playing cards with others'. Again, there are people who would engage in this activity for the mental stimulation it gives them; others might play cards solely for the social contact. While the factor loading is higher for this item than the loading for Walking, it still may reflect the generic nature of the activity. Reading, while unquestionably an intellectual activity, can also be considered a form of relaxation; there are many people who read themselves to sleep! It is possible, therefore, that individuals who engage in this activity may do so for reasons other than to stimulate their minds. It might be interesting and productive to include a checklist of reasons for participating in an activity with the actual activity questionnaire. By doing so, it might be possible to further understand the nature of an activity lifestyle, and how such a contextual variable might affect cognitive performance.

The results from this study suggest that another area of research which may contribute to understanding cognitive performance in older adulthood is nutrition. While the observed effect sizes were small, it is worthwhile noting that they were significant even though the nutrition measure was inadequate in scope. Given a more comprehensive questionnaire or a more accurate method of measurement, such as a daily record analysis, the effects of nutrition on predicting cognitive performance may prove to be stronger. It is apparent from the literature that nutrition research is under-represented in psychology (Goodwin et al., 1983) yet is appears to be important for determining the overall health of the sample populations, particularly when those samples are representative in nature.

Limitations of the Study

One of the major limitations to the present study was the inadequacy of the activity questionnaire. Although it was very useful in determining general activity preferences and frequencies in the sample, it did not offer enough choices to ensure substantial variance in the responses. As a result, the factor model resulting from the confirmatory factor analysis was relatively weak, and introduces questions of reliability into the results obtained from the hierarchical regressions. In defence of the research, however, it must also be noted that, regardless of these problems, significant effects of activity lifestyle were observed on the three cognitive tasks. This suggests that, had the activity questionnaire been more comprehensive, the effect sizes might have been larger.

A further limitation to the present study involves the sample population. Hypothetically, the more representative nature of the sample should have increased the diversity and variance of the responses on the activity lifestyle, self-reported health, and cognitive measures. However, the results indicate that the expected variability on many of these measures did not emerge, raising the possibility that the sample population was not as representative as anticipated. According to Canadian census data, the sample used in the present study was above average with respect to self-reported health, income, and education (Statistics Canada, 1994), and may not have been representative of Canadian seniors in general. In this respect, the present sample resembled more select volunteer populations, and one could argue that the results from this study are therefore vulnerable to the same criticisms directed at the results from studies using such samples. A counter argument to such claims is that the mean values for self-reported health, education, and income from the present study are lower than those typically reported from studies using non-representative populations (e.g., Hultsch et al., 1993). Thus, although the sample population from the present study may not represent Canadian seniors in general, it does remain more representative than the typical volunteer population. Still, the results from this study should be interpreted with the above information in mind, as should generalizations to other populations of older adults.

Finally, the study is limited in that it is cross-sectional in design. As a result, the study cannot offer information on changes in activity lifestyle, self-reported health, and cognition, or the relationships between these changes. There also cannot be causal conclusions drawn regarding the direction of the relationships. It is possible that lower levels of intellectual stimulation result in cognitive decline; conversely, it may be that a decline in cognitive abilities results in withdrawal from intellectually demanding activities. These questions can only be addressed within a longitudinal study. However, the findings from the study are interesting in their own right because they highlight aspects of activity lifestyle and self-reported health that contribute to performance on cognitive tasks, and that differ between older adults from different age groups.

Conclusions

Overall, the results from the present study offered only weak support for the hypothesis that activity lifestyle and self-reported health would account for modest amounts of variance in the cognitive performance of a more population-representative sample of older adults. There was some support for the hypothesis that engaging in intellectually stimulating activities may have a positive impact on cognitive performance.

However, it appears that participation in certain types of social activities may actually benefit an individual to a greater extent. In either case, the results suggest only limited support for the environmental complexity theory (Schooler, 1984) and the disuse perspective (Salthouse, 1991). For example, a more cognitively complex leisure environment did appear to be related to higher performance on cognitive tasks, but the effect sizes associated with the Intellectual and Social Activity factors indicated that there are other, stronger, factors associated with both predicting cognitive performance and attenuating age-related declines.

The results also offered some support for the hypothesis that self-reported health would predict cognitive performance. However, the findings did not implicate physical health as a strong mediator of cognitive abilities in older adults, a result supported by other research (e.g., Salthouse et al.,1990). Other aspects of self-reported health, such as mental health and nutrition, emerged as more global predictors of performance, and accounted for more age-related variance in the cognitive measures than did physical health.

Finally, there was only weak support for the hypothesis that partialling out individual differences in activity lifestyle and self-reported health would result in modest attenuation of age-related variance in Word Recall and Letter Series. Again, this suggests that factors other than these particular contextual variables are responsible for the majority of age-related decrements in cognitive performance observed in this and other studies.

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