Running Head: PREDICTORS AND CONSEQUENCES OF LONELINESS

Predictors and Consequences of Loneliness in Older Adults and the Power of Positive Emotions

by

Nancy E. Newall

B.Sc. University of Victoria

M.A. University of Manitoba

A Thesis submitted to the Faculty of Graduate Studies of

The University of Manitoba

in partial fulfilment of the requirements of the degree of

DOCTOR OF PHILOSOPHY

Department of Psychology

University of Manitoba

Winnipeg, Manitoba, Canada

Table of Contents

Listing of Tables

Listing of Figures

Listing of Appendices

Dedication

For those who love to learn.

Acknowledgements

To all the participants who volunteered their time and thoughts as part of the Aging in Manitoba Studies.

To the Canadian Institutes of Health Research for providing me with financial support through a Canada Graduate Scholarship Doctoral Research Award.

I want to give thanks….

To my advisor, Dr. Judy Chipperfield, and my committee members, Drs. Dan Bailis, Ray Perry, and Malcolm Smith, as well as my external, Dr. Pearl Dykstra.

To all of the members of the Emotion, Motivation and Control Research Group and especially to Steve Hladkyj for our many enlightening conversations and to the "lab kids," Lia Daniels, Tara Stewart, and Rob Stupnisky, as well as Audrey Swift. We've done it!

To Susan Chelini and Celeste Asselbora who have been a great moral support and who I am happy and grateful to have as my best friends.

To my brothers, Colin and Graeme Newall, and Sister-in-Law Lisa Van Bruggen, and to my nephew Peter and my niece Anna---thank you clan!

To my stepsons, Owen and Eric Gaber, who I love playing and talking with and who unknowingly helped to provide balance in my life—that same sense of balance that I strive to teach you about!

To my parents, Mavis Elaine Newall and Donald Roy Newall, who have always allowed this "late bloomer" to take my own time on things ("me do") and helped me to follow my dreams. I am extremely lucky and privileged to have such wonderful parents. It is simply not possible to word my thanks…

To my life partner Felix Emil James Gaber who has been incredibly supportive and caring, and who has been my intelligent "lay" audience. Not once did you ask 'are we there yet?' which is an unbelievable feat! I want you to know how much I have appreciated your unwavering confidence in me and "we." You are amazing.

Abstract

Social isolation and loneliness are problems that affect the quality of life of many older adults. As the proportion of older people increases in Canada and other nations, studying factors that could improve the quality of life of older people becomes even more crucial. Two studies were conducted drawing on longitudinal data (1996 and 2001) from the Aging in Manitoba Project (Study 1 N = 760) and the Successful Aging Study 2003 (Study 2 N = 228). The main objective of Study 1 was to identify the characteristics of older individuals who differed in their *loneliness trajectories* over time, allowing for a comparison of those who *became lonely, overcame loneliness,* were *persistently lonely,* and were *persistently not lonely*. A discriminant function analysis examined the social, demographic, physical, and psychological factors as potential discriminators of the loneliness trajectories. When compared to those who were neither lonely at time 1 or time 2, the most important discriminators of *persistent* loneliness were: living alone, being in poor health, and having low perceptions of control. These predictors were found to be more important than people's friendships or social activities, highlighting the complexity of loneliness in later life. Study 2 examined the longitudinal relationships between loneliness, health, physical activity, and mortality, and tested Fredrickson's Broaden and Build Theory that positive emotions (happiness) might serve to "undo" the detrimental effects of negative emotions like loneliness. Regression analyses showed that loneliness longitudinally predicted health, physical activity, and mortality, underscoring the importance of socioemotional variables to health. Moreover, happiness moderated the relationships between loneliness and physical activity and loneliness and mortality. Thus,

in support of Fredrickson's hypothesis, results suggested that happiness has the power to "undo" the detrimental effects of loneliness on physical activity and even on mortality. Being happy may indeed offset the negative consequences of being lonely. Based on these two studies, it was concluded that future interventions could target positive emotions, perceptions of control, and loneliness as ways of ultimately enhancing the lifespan, healthspan, and wellspan of older adults.

Predictors and Consequences of Loneliness in Older Adults and the Power of Positive Emotions

It has been well established that as people enter retirement and grow older, their social contacts and interactions diminish (Charles & Carstensen, 1999). This observation was explained by disengagement theory (Cumming & Henry, 1961) as being part of a process whereby older individuals socially and emotionally disengage from society, and society mutually withdraws from the older person. However, more recently, Carstensen proposed the theory of socioemotional selectivity to explain the observation that social contacts decrease in later life (Carstensen, Isaacowitz, & Charles, 1999). This theory states that older people are not disengaging but are *actively* selecting only those relationships that are more emotionally important to them, thus letting other less important relationships go. This theory has been supported in that older individuals appear to find more satisfaction in close relationships than when younger (e.g., Field & Minkler, 1988, as cited in Charles & Carstensen, 1999) and that a decrease in contacts occurs but in older people's "outer circle" or peripheral relationships rather than the "inner circle" or emotionally close relationships (Ajrouch, Blandon, & Antonucci, 2005; Fung, Carstensen, & Lang, 2001).

Although Carstensen's theory paints a more proactive and positive picture of the social processes of later life, nonetheless, an extensive body of research indicates that between 20-40% of older adults report moderate *loneliness* (Pinquart & Sorensen, 2001; Wenger & Burholt, 2004; Weeks, 1994). In congruence with these findings, about one in

three older Manitobans (72+ years) identified themselves as being moderately lonely (Newall, Chipperfield, Clifton, Perry, Swift & Ruthig, 2008). Thus, in general, approximately one third of older people appear to be *not satisfied* with their social relationships.

Identifying the Problem: Why is Studying Loneliness Among Older People Important?

There are several reasons that make loneliness in older adults an especially important area of study. First, loneliness is important for good quality of life. Older adults (50+ years old) participating in focus groups spontaneously identified loneliness, isolation, and the loss of a loved one as major factors having a detrimental effect on quality of life (Richard, Laforest, Dufresne, & Sapinski, 2005). Moreover, loneliness was identified as a factor that could erode people's sense of personal control and determination to remain active (Eloranta, Routasalo, & Arve, 2008). Second, loneliness is associated with poorer physical health and is related to mental health problems like depression (e.g., Cacioppo, Hughes, Waite, Hawkley, & Thisted, 2006; Wenger, Davies, Shahtahmasebi, & Scott, 1996). Thus, if our goal as gerontologists is to improve the health and quality of life of older people, then the study of loneliness appears to be an important avenue of research.

As the proportion of older people in Canada and in many countries around the world increases, studying factors that could improve the quality of life of older people becomes even more crucial. In 2005, people over the age of 65 years made up 13.1% of the Canadian population, an increase from 9.6% in 1981 and from less than 8% in the 1950's and 1960's (Statistics Canada, 2006). Because of the baby boom trend, low fertility rates,

and longer life expectancies, the proportion of older people aged 65+ years is expected to almost double, increasing from 13% to 24.5% of the Canadian population (or to a total of 9.8 million people) by the year 2036. Moreover, the number of people aged 85+ years and older has increased substantially in the past several decades and is expected to continue to increase, especially as the baby boomers enter this age group. In Manitoba, the picture is very much the same as the rest of Canada: 13.5% of the population was 65 years and over in 2005 and this segment of the population is projected to increase to 21.7% by 2031 (Statistics Canada, 2006).

The importance of loneliness and constructs related to loneliness such as social isolation and social support is implied in such Canadian policy initiatives as *Aging in Place, Age-Friendly Communities*, and the *National Framework on Aging*. Within these initiatives is the idea that older persons' quality of life and health is tied to their social relationships and participation in the community. For example, the National Framework on Aging outlines three "Pillars of Seniors' Wellness": 1) Health, wellness, and security; 2) Continuous learning, work and participation; and
3) Supporting and caring in the community which includes the aspects of loneliness and social isolation (Statistics Canada, 2006).

More locally, the issue of social isolation and loneliness among older individuals has been identified as a major concern amongst Manitoba community, government, research, and health organizations. For example, the Active Living Coalition for Older Adults (ALCOA) of Manitoba organized a workshop in March 2008 to develop priorities and strategies to address social isolation amongst older Manitobans (Active Living Coalition

for Older Adults, 2008). As another example, in 2006, Aging in Manitoba held a workshop that brought together seniors, policy makers, program planners, service providers, researchers, and students to share research and discuss and develop solutions to social isolation and loneliness in older Manitobans (Newall, Hall, & Payne, 2006). One of the major messages aimed at researchers was to demonstrate "proof of problem." That is, it was argued that it is difficult for service providers or policy makers to secure funding or demonstrate need for services without more research examining the health consequences of social isolation and loneliness. In sum, these national and local initiatives demonstrate the importance of studying social isolation and loneliness amongst older adults.

Why Another Project on Loneliness: Research Gaps and General Research Questions

As noted by Perlman (2004), loneliness was not commonly investigated until the 1970's when Weiss (1973) published a book on the phenomenon of loneliness and when researchers began to develop short scales to measure the construct (e.g., de Jong Gierveld & Kamphuis, 1985; Russell, Peplau, & Ferguson, 1978). Since that time, there has been a plethora of studies on loneliness, including loneliness in later life. So why do we need yet another research project on loneliness?

The present project involved two studies that examined the phenomenon of loneliness in older adults. It is argued that, although much is known about loneliness in older adults, questions remain about the *predictors* (emergence, persistence) and *consequences* of loneliness in later life. This section provides a *brief* account of the purposes of Studies 1

and 2 with a more thorough background and rationale for each study provided in later sections.

Predictors of Loneliness

Study 1 came out of an interest in understanding what factors might discriminate between those older people who are lonely vs. not lonely at one point in time, as well as between those people who are lonely or not *over two points in time*. For example, what factors can help explain the emergence of loneliness in older adults (going from being not lonely to lonely over time)? How about people who remain persistently lonely? What differentiates those people who remain persistently *not* lonely? How many people overcome loneliness and go from being lonely to not lonely and what can we learn from these people? As will be elaborated upon later, little research has examined loneliness patterns or trajectories among older adults and even fewer have examined what variables might predict different patterns of loneliness. Study 1 was exploratory in nature as it was uncertain which combination of demographic, social, health, and psychological factors would emerge as the most important discriminators of lonely vs. not lonely older adults. It is argued that filling this "research gap" is important in that it may help to untangle some of the roots of what allows loneliness to emerge or persist in older adults.

Study 1 therefore addressed the following research questions:

1. What demographic, social, health, and psychological factors can discriminate between people who are lonely vs. not lonely at one point in time?

2. What demographic, social, health, and psychological factors can discriminate between people who present different patterns of loneliness over two points in time

over a period of five years?

Consequences of Loneliness

In order for loneliness to receive attention from policy-makers and health practitioners, researchers may need to go beyond examining the predictors of loneliness to examining potential *consequences* of loneliness in later life. Study 2 therefore examined loneliness in relation to *health*, as well as *physical activity* and *mortality*. In terms of health, as elaborated upon in a later section, past research generally supports a relationship between loneliness and health (though less research has focused on the 'older-old'), which is not entirely surprising as the pain of being *socially rejected* has been found to be similar to *physical* pain (e.g., Panksepp, 2003). In terms of physical activity, little research has focused on loneliness and physical activity; however, it is possible that loneliness may serve as a 'deactivating' emotion that reduces people motivation to be active. In terms of mortality, there is only a small body of research that has examined the relationship between loneliness and mortality and even less literature on what variables might possibly mediate this relationship. In sum, it is argued that filling these "research gaps" may prove informative for public policy initiatives aimed at enhancing the physical activity and general quality of life of older adults.

Study 2 also came out of an interest in delving into the relatively new realm of *positive psychology* to determine what might be the 'power of positive emotions' in terms of protecting older people from any detrimental consequences of loneliness. In particular, drawing on Fredrickson's (1998) Broaden and Build Theory, Study 2 examined whether positive emotions might *moderate* any relationships found between loneliness, health,

physical activity, and mortality. Past research has not examined loneliness in the context of Fredrickson's Broaden and Build Theory. Thus, Study 2 provided a unique test of this theory. It is argued that filling this "research gap" might provide insight into the power of positive emotions in later life.

Study 2 therefore addressed the following general research questions:

1. Does loneliness predict poorer health and physical activity?

2. Does loneliness predict mortality?

3. To the extent that loneliness predicts mortality, does health and activity *mediate* this relationship?

4. Do positive emotions moderate the relationships between loneliness, health, physical activity, and mortality?

The next section provides a detailed description of the Study 1 background, rationale, methodology, results and conclusions.

Study 1 Introduction

Based on past research, including research that has been done in Manitoba, we know that at a given point in time, approximately 20-40% of older adults report feeling moderately to extremely lonely. This can be compared to younger ages in which approximately 30-50% of younger adults (aged 15-24) report feeling lonely (Dykstra, 2009). Research also indicates that loneliness trends in later life are U-shaped (Pinquart & Sorensen, 2001) such that loneliness *decreases* with age for the youngest subgroup (M age <=60 yrs), has no relation with age for the next oldest subgroup (M age 60.1-80 yrs), and *increases* with age for the oldest subgroup (M age > 80.1).

However, beyond these general trends, are perhaps more nuanced patterns of loneliness. For example, what proportion of older people generally experience *persistent* loneliness over time? What about people who are persistently *not lonely*? And what can we learn from people who *overcome* loneliness or those that *become* more lonely over time (*emergence)*? As stated by Victor, Scambler, Bowling, and Bond (2005):

"By distinguishing the different trajectories or pathways into the experience of loneliness in later life using biographical approaches, we may begin to develop and evaluate a more sophisticated repertoire of interventions to combat loneliness, and at the same time enhance our theoretical and conceptual understanding" (p. 361). Little research has examined loneliness patterns or trajectories among older adults, no doubt because of the longitudinal data that this research requires. And even fewer have examined what variables might predict different patterns of loneliness. This may be important to be able to untangle some of the factors that allow loneliness to emerge or persist in older adults.

In one study, Tijhuis, de Jong Gierveld, Feskens, and Kromhout (1999) examined loneliness over a ten-year period in older men (75+ years old) living in the Netherlands. Using a continuous loneliness scale, they found a general increase in loneliness only for the "oldest" men (aged 80-84 at baseline). They also found *change* in partner status, institutionalization, and poorer perceived health was related to being lonely at Time 2. However, this study did not address how these changes in life circumstances might influence *changes* in loneliness over time.

A sophisticated study by Dykstra, van Tilburg, and de Jong (2005) involved a multilevel analysis to study loneliness over a seven-year period among a representative sample of older people living in the Netherlands. Results showed that loneliness, measured with a continuous loneliness scale, generally increased slightly for the entire sample. The increase was the most pronounced for the oldest adults. The authors also examined loneliness trends among particular groups of individuals and found that loneliness increased substantially for those who were *partnered* at baseline and those who had *better functional status* at baseline, suggesting that these groups of people had the most to *lose*. Loneliness also *decreased* for those who improved their functional capacity and social networks over the time period.

Rather than look at *general trends* in loneliness, other researchers, taking more of a person-centered or group-centered approach rather than a variable-centered approach (Bosworth & Schaie, 1997), identified different *groups* of older adults who displayed different patterns of loneliness over time. These studies typically have used variants of loneliness *categories* to be able to group people as either being lonely or not. An example is Victor, Scambling, et al.'s (2005) national study of older people living in Great Britain (aged 65+ years) that examined people's loneliness patterns by asking participants to compare their current level of loneliness with their loneliness experienced a decade earlier. Using this retrospective self-reported measure of change in loneliness, the results showed that, among the 973 respondents, 54% rated themselves as not lonely at both times, 15% as lonely (often/always) at both times, 21% as *more* lonely over time, and 10% as *less* lonely over time.

Wenger and Burholt (2004) examined changes in loneliness and social isolation over a 20-year period among rural-dwelling older adults (aged 75+) living in Wales. They used an 8-item measure of loneliness and categorized people as being not lonely, moderately lonely, and very lonely, based on cut-off points set by the researcher. Although only a small sample was tracked over three points in time ($N = 47$), results showed that 26% of participants became more lonely, 6% overcame their loneliness, 15% were "stable" at each point (that is, were either persistently lonely or persistently not lonely), and 26% fluctuated in their loneliness. Using case studies and qualitative data to help interpret the quantitative results, the authors identified several variables that contributed to changes in loneliness and isolation including: widowhood, moving to a new community, health deterioration, lifestyle changes, and personality.

Most relevant to the present study, Jylha (2004) assessed changes in loneliness over a 10-year time period by asking participants (ages 60+ years) of Tempere, Finland, the question, "how often do you feel lonely?" (often, sometimes, never). This variable was dichotomized (never vs. often/sometimes) and people were classified into four categories based on the two data points of longitudinal data (e.g., lonely at each point in time; no loneliness at either point in time). At the 10-year follow up, the largest proportion did not feel lonely over the two time periods (51%), and a much smaller proportion continuously felt lonely (17%). Nineteen percent *became* lonely (named "incident" loneliness) and 13% *overcame* or "recovered" from loneliness.

In this study, Jylha also examined how certain baseline characteristics (e.g., gender and marital status) related to the different groups of older adults. She found that the

majority of people who did not report loneliness at any time point had good functional ability at baseline. There were no significant differences between the groups in baseline gender or social participation.

The present study takes a similar approach as Jylha (2004) in categorizing older adults into groups based on patterns of loneliness and then examining how baseline characteristics relate to the different groups. However, in contrast to the present study, Jylha was not able to examine health or social ties, like friendship, nor did she examine how *changes* in life circumstances (e.g., in marital status) might have related to changes in loneliness. The ability to examine *changes* in life circumstances could have helped explain some at-first-glance counter-intuitive results found by Jylha, such as the finding that participants who were married at Time 1 were more likely to be lonely at Time 2. Jylha acknowledged it was probably *changes* in marital status (e.g., widowhood) that occurred after baseline, rather than the baseline situation itself, that influenced the feelings of loneliness expressed at the end of the study.

In the present Study 1, these same trajectory groupings were created based on data collected at two points in time, five years apart. Specifically, the following four groups were identified: 1) Participants who were not lonely at either point in time; 2) Participants who were lonely at both points in time; 3) Participants who became lonely over time; and 4) Participants who changed from being lonely to not lonely over time. These longitudinal data provided an opportunity to examine the ideas of *emergence, persistence* (of being lonely or not) and *overcoming* of loneliness. By examining possible variables that discriminate between these groups of older adults, we might learn, for example, that

the variables important in the *emergence* of loneliness are different than the variables important for the *persistence* of loneliness.

Guided by past research, the present study examined demographic, social, and health variables as discriminators of whether older adults are lonely vs. not lonely. Moreover, the present study also differed from past research in two ways: 1) The inclusion of a psychological variable, perceived control; and 2) An examination of baseline as well as *changes* in variables in relation to *changes* in loneliness. Although this is not the first longitudinal study on loneliness to incorporate change variables (e.g., see Dykstra et al., 2005), it is unique in examining how change variables may predict different groupings of older adults based on their loneliness trajectories. Before turning to the rationale for including the particular discriminating variables in Study 1, a discussion of the definition and measurement of loneliness is provided.

Definition of Loneliness

Loneliness, like any negative emotion, can be seen to be adaptive (e.g., fear can mobilize physical resources in the face of danger; regret may help guide future behavior). Loneliness, for example, can highlight and bring to our attention important deficits in our social relationships. In talking about how loneliness may be adaptive and how this emotion may have evolved in humans, Cacioppo and Patrick (2008) used a compelling image: that of the !Kung San people living in Africa. They put it this way:

> "Even though the !Kung live in the midst of seemingly limitless real estate, a !Kung Village is half a dozen huts tightly clustered around a small, cleared circle. Despite any desire for privacy, all doors face in toward the communal space. If you were to

> spend the night in such a village and see lion's eyes gleaming in the darkness just outside the ring of cooking fires, you might begin to appreciate why, for early humans, feelings of isolation were linked with fear, the fear that still remains at the core of our experience of loneliness" (Cacioppo & Patrick, 2008, p. 58).

Notwithstanding the potential *adaptiveness* of loneliness, it is difficult to find theories of loneliness which would describe it as a *positive* experience. The only exception may be Moustakas (1961), who, taking an *existential* approach, argued that loneliness is part of the human condition and is simply the realization that we are all inherently separated from one another. For the most part, however, scholars would agree that feeling lonely, like feeling other negative emotions, is an unpleasant emotional experience.

In thinking about the definition of loneliness, it can be useful to consider that loneliness is different from simply *being alone* or *living alone*. That is, a person may be quite content with solitude. On the other hand, many of us will have experienced the phenomenon of feeling "lonely in a crowd." Moustakas (1961) wrote, "being alone without the explicit condition of loneliness, is an act of conscious control, volition, thought, and determination. Being alone is a necessary pause; being lonely is an ultimate condition" (p. 22).

Loneliness is also distinct from *social support* and *social isolation. Social support* typically refers to *structural* characteristics of people's network (e.g., the number and types of social relationships such as family and friends, amount of contact with network members, interconnectedness of network) and *functional* characteristics of people's network (e.g., the type of support provided such as belonging, tangible, emotional, and

informational support) (Uchino, 2004). *Social isolation* reflects an *objective lack* of a social network and is also typically measured with structural measures such as the amount of contact with others, living alone, being widowed, rarely visiting with close friends or relatives, or being geographically distant from close to friends or relatives (e.g., Wenger & Burholt, 2004).

Loneliness is also conceptually different—and has been shown to be empirically distinct—from *depression* (e.g., Russell, Peplau, & Corona, 1980). For example, a factor analysis showed different factor loadings for loneliness and depression (Cacioppo, Hawkley, et al., 2006). Loneliness has also been shown to be related to, but also distinct from, other emotional states such as boredom (Russell et al., 1980).

So what is loneliness? Loneliness, in contrast to being objectively isolated, is the *feeling* of being isolated. It is a *negative emotion* that has been characterized as a negative *social emotion* together with embarrassment and shame arising as a result of interpersonal situations and events (Leary, Koch, & Hechenbleikner, 2007). Marangoni and Ickes' (1989) noted that there are at least three points of convergence between different perspectives on loneliness and, for the purposes of the present project, this general definition of loneliness will be used:

> "(a) loneliness is a subjective experience that may be uncorrelated with objective social isolation; (b) this subjective experience is an aversive psychological state for the lonely individual; and (c) the onset and origin of loneliness can be traced to some form of social relationship deficit" (p. 93).

Although most theoretical perspectives take a similar stance on the idea that

loneliness is the *feeling* of a *deficit* or lack of personal relationships, the source or nature of this feeling of deficit appears to differ among theorists (Dykstra & Fokkema, 2007). For example, the *social needs perspective* assumes a *lack of certain types of relationships*. From a *social needs* approach (e.g., Weiss, 1973), when the needs for intimacy or for companionship are not met this results in feelings of loneliness. This perspective assumes that different types of relationships serve different or unique functions. In Weiss's (1973) relational theory of loneliness, he argued that loneliness comes from social isolation or emotional isolation. Specifically, social loneliness is thought to be caused by deficits in the quantity of *social relationships with a peer group*; whereas emotional loneliness stems from a deficit of *a close or intimate social tie* (such as a spouse, friend, child). Therefore, according to Weiss, one could be emotionally lonely but not socially lonely or vice versa because both types of loneliness result from different *types of social deficits*. In support of this theory, studies have shown that *social loneliness* is more common among people with a small social network and whose network includes few or no friends. In contrast, *emotional loneliness* has been shown to be more common among divorcees and people without a partner (Dykstra & Fokkema, 2007).

On the other hand, whereas the *social needs perspective* assumes a *lack of certain types of relationships* the *cognitive approach* (de Jong Gierveld, 1987; Peplau & Perlman, 1982 from Marangoni & Ickes, 1989) assumes a *lack of satisfaction* with existing relationships. The cognitive approach is concerned with the *psychological processes* that mediate social networks and the subjective experience of loneliness (see

Perlman, 2004). This perspective focuses on the expectations, desires and preferences of people and addresses how actual relationships meet these expectations. Thus, the focus is primarily on the perceived differences between desired relationships and those actually achieved, rather than merely the objective absence of relationships (Perlman, 2004).

Peplau and Perlman formulated what they called a discrepancy model of loneliness (e.g., Peplau & Caldwell, 1978; Perlman, 2004), proposing that loneliness reflects an unacceptable discrepancy between individuals' desired vs. achieved social network. That is, according to this definition, loneliness is experienced when a person's social relations are perceived to be either quantitatively or qualitatively insufficient (de Jong Gierveld, 1987). In this way, the theory can account for the difference between loneliness and social isolation. For example, a person can be considered socially isolated by others by having few (achieved) social contacts; however, if that person only desires few relationships, it would not be expected that s/he would be lonely. Indeed, research has shown social isolation and loneliness to be relatively distinct constructs with different predictors (e.g., Wenger & Burholt, 2004). In contrast to Weiss's theory, therefore, the focus is not only on people's actual networks but their network preferences or perceptions (Dykstra & Fokkema, 2007). In support of this perspective, Dykstra and Fokkema (2007) found that partner-centeredness, that is, the idea that having a partner is *important* or that living alone is *not* preferred, was an important predictor of emotional loneliness among those who lacked a close emotional partner (i.e., were divorced).

Note that the *cognitive* and *social needs approaches* are not necessarily in conflict with one another. Dykstra and Fokkema's (2007) results supported both the social needs

perspectives (i.e., having no partner predicted emotional but not social loneliness; smaller network predicted social but not emotional loneliness) and the cognitive perspectives (i.e., those divorcees with greater partner-centeredness and those married people with more marital conflicts had greater emotional loneliness).

Measuring Loneliness

Typically, researchers measure loneliness in one of two ways (Pinquart & Sorensen, 2001): First, one-item measures basically ask how frequently a person feels lonely, or whether they would categorize themselves as being lonely. Second, multi-item scales have been developed that do not as explicitly refer to loneliness. Examples include the UCLA loneliness scale (Russell, Peplau & Cutrona, 1980; Russell, Peplau, & Ferguson, 1978) and de Jong Gierveld and Kamphuis's (1985) loneliness scale.

There are both strengths and limitations to the 1-item self-report measures and multi-item scales. Victor, Scambler, et al. (2005) noted that 1-item self-report measures have been used in research for decades, are easy to use, and ask directly about loneliness. By this same token, the authors noted that directly asking about loneliness presumes a common definition of the construct by all participants. Further, as acknowledged by many researchers studying loneliness, because of its negative stigma in society, people– especially men (Perlman, 2004)– may possibly under-report their level of loneliness due to reasons of social desirability (e.g., Pinquart & Sorensen, 2001). This may be particularly the case in studies which directly ask participants about their level of loneliness. Although a draw-back may be that people under-report their loneliness, Pinquart and Sorensen (2001) noted that direct questions appear to better tap into the

emotional aspects of negative relationship quality (e.g., feeling misunderstood) than loneliness scales.

Strengths of the loneliness scales include their inclusion of multiple indicators of loneliness that may or may not directly refer to being lonely. However, in selecting indicators, researchers make assumptions about definitions and meanings of loneliness (Victor, Grenade, & Boldy, 2005). For example, de Jong and Kamphuis's (1985) loneliness scale measures and defines loneliness in terms of a discrepancy between the social relationships a person wants and needs and uses the dimensions of belonging (social loneliness) and missing relationships (emotional loneliness). Multi-item loneliness scales may be particularly useful in measuring the *degree* of loneliness; however, determining groups of "lonely" vs. "not lonely" may be harder to do with scales. For example, participants scoring 3 or more on de Jong and Kamphuis' loneliness scale may be considered as lonely (Lauder, Sharkey, & Mummery, 2004), but this cut-off point is set by the researcher and may not reflect the subjective experience of the participants themselves.

Because Study 1 required participants to be categorized, it was decided that a one-item indicator of loneliness be used to create groups of (self-identified) lonely vs. not lonely older adults. This follows the lead of researchers taking a person-centered approach to studying loneliness (e.g., Victor, Scambling, et al., 2005). Despite drawbacks to utilizing 1-item measures (e.g., an inability to calculate psychometrics such as internal reliability), it is argued that to *categorize* participants into groups, using this item was preferable over setting a cut-off point on a loneliness scale.

Now that the definition and measurement of loneliness has been discussed, we turn next to the description and rationale for the predictor variables used in Study 1 to discriminate the different groups (lonely vs. not) of older adults.

Predictors of Loneliness

Demographic variables. Socio-demographic predictors included in Study 1 were: age, gender, education level, and income. In considering research which has focused on *age* differences in the prevalence of loneliness, some studies focusing on *older age groups* have found that loneliness increases with age (e.g., Dykstra et al., 2005; Savikko, Routasalo, Tilvis, Strandberg, & Pitkala, 2005). In their meta-analysis of correlates of loneliness in older adults, Pinquart and Sorensen (2001) found the relation between age and loneliness was U-shaped such that loneliness *decreased* with age for the youngest subgroup (M age <=60 yrs), had no relation with age for the next oldest subgroup (M age 60.1-80 yrs), and *increased* with age for the oldest subgroup (M age > 80.1). Ultimately, it is not age per se that is thought to influence loneliness in older adults, rather age-related factors such as widowhood or physical incapacity (e.g., Jylha, 2004; Perlman, 2004; Pinquart & Sorensen, 2001). Some of these age-related predictors of loneliness are discussed next.

Studies have generally found *gender* differences in that older women are more likely to be lonely than older men (e.g., Jylha, 2004; Pinquart & Sorensen, 2001). However, several researchers have noted that this trend may be partially accounted for by a greater willingness of women to admit to feeling lonely and results thus may depend on how loneliness is measured (Perlman, 2004).

Moreover, the finding that women are more lonely than men may also be accounted for by factors that covary with gender (e.g., women being older in age, living alone, or in poorer health). Savikko et al. (2005) discussed three reasons for why females could be more lonely: social relations may be more important for females, females live longer, and females express feelings more openly than males. Interestingly, spending more time with women appears to protect both men and women against loneliness (Wheeler, Reis, & Nezlek, 1983). This could be because interactions with women are more intimate and positive (Hawkley, Burleson, Berntson, & Cacioppo, 2003) and may help explain why men derive more benefit in terms of quality of life from being married than women (e.g., Chipperfield & Havens, 2001). In the present study, it was possible to examine gender differences in loneliness, while accounting for other variables that may relate to gender.

The *socioeconomic status* of older adults has been found to relate to social isolation (e.g., Wenger et al., 1996). Individuals from higher social classes typically have more resources and opportunities available to them that could prevent isolation and loneliness (Pinquart & Sorensen, 2001). The present study examined perceived adequacy of income as well as education level as indicators of socioeconomic status. Researchers have found an association between loneliness and self-reported adequacy of financial resources in older people (Cohen-Mansfield & Parpura-Gill, 2007; Mullins, Sheppard, & Andersson, 1991). Indeed, self-reported socioeconomic status has been found to be as important as objective socioeconomic status, for example, in relation to health outcomes (Cohen, Alper, Doyle, Adler, Treanor, & Turner, 2008). According to Pinquart and Sorensen's (2001) meta-analysis of the correlates of loneliness among older people, both income and

education level were associated with loneliness, but income was more strongly related than education.

Social variables. Social variables included in Study 1 were: marital status, living arrangements, duration in the community, number of friends, and social vs. solitary activities. The research results appear to be mixed in terms of *marital status* being associated with loneliness. Rokach, Matalon, Rokach, and Safarov (2007) found in their study of qualitative dimensions of loneliness that there were little differences between married and unmarried older adults. An exception was that unmarried men experienced greater 'interpersonal isolation' than married men. The authors speculated that this was due to women more often playing the role of mobilizing social network members.

Living alone is probably one of the most consistent risk factors for loneliness in older adults (e.g., de Jong Gierveld, 1987). This is an especially important observation as in many cultures around the world the trend is for older people to live by themselves, rather than with family. Moreover, because of increasing lifespans, it is likely that people, and especially older women, will live by themselves *longer*. Of course, others have discussed the *positive* implications of living alone, pointing especially to people who may value independence and privacy (Yeh & Lo, 2004). *Duration in the community* was also included as a potential predictor in Study 1 because the length of time living in the community might represent a community-connectivity that could be relevant for loneliness. Someone with greater community-connectivity could be contrasted with someone who just moved to a new community and who may not have any long-term community ties.

Whether one lives with others or lives alone or has just moved to a new community, a person could have an extensive (or not) social network. Study 1 included measures of *friendships* and *activity participation*. Who one interacts with (e.g., friends or family) has been found to be an important factor for loneliness. For example, Pinquart and Sorensen (2001), in their meta-analysis of the correlates of loneliness in older adults, found that for older adults, having more contact with *friends* and neighbours was more important for loneliness than contact with family, perhaps because friends may be more likely to provide emotional support that could reduce loneliness. In the present study, whether a person has a close friend or not was considered in relation to loneliness.

General *social participation* has also been found to relate to loneliness (e.g., Jylha, 2004; Newall, Chipperfield, Clifton, Perry, Swift, & Ruthig, 2009). For example, Newall, Chipperfield, Clifton, et al. (2009) found that participating in a greater number of social activities in the past week was associated with less current loneliness as well as subsequent loneliness, measured five years later. The present study will extend this research by examining social participation as a potential discriminating factor of lonely vs. not lonely older adults. Moreover, the present study will also consider *solitary activities* and loneliness. That is, it will be possible to explore whether participating in a greater number of activities (be they social or solitary) discriminates lonely vs. not lonely people.

Functional status and health variables. *Functional ability or independence* as well as *health status* were also included as predictors of loneliness in Study 1. Functional ability (also called physical independence, functional status, physical functioning, etc.) is

considered integral to the health and well-being of older Canadians (Health Canada, National Framework on Aging, 1998). It is typically measured by asking participants or their caregivers whether they are capable of doing certain instrumental and basic activities of daily living on their own. Based on the logic that people who are more functionally independent would be able to participate more in social activities and connect with friends and family more easily, it follows that greater functionally ability would be associated with less loneliness. In their meta-analysis of the correlates of loneliness, Pinquart and Sorensen (2001) found that greater functional ability was related to being less lonely. Newall, Chipperfield, Clifton, et al. (2009) found, in a representative sample of older Manitobans living in the community, that people's functional ability related indirectly to loneliness: better functional ability related to greater social participation, which, in turn, related to less loneliness.

The relationship between loneliness and health will be considered in greater detail in a later section in terms of how loneliness may lead to poorer health (Study 2). However, health was also included as a predictor of loneliness in Study 1. Health will thus be considered as both a potential cause and a consequence of loneliness, together in both studies. The logic behind this is that there appears to be a reciprocal relationship between health and loneliness (e.g., Fees, Martin, & Poon, 1999). Health consistently correlates with loneliness (e.g., Wenger et al., 1996), although the relationship may become weaker at older ages (Dykstra et al., 2005; but see Hawkley & Cacioppo, 2007).

Psychological resources: Perceived control and loneliness. The above discussion of predictors or discriminators of loneliness has focused mainly on the demographic

approach to aging, loneliness, and social support (Schnittker, 2007). This approach emphasizes sociodemographic trends and role changes such as loss of friends and living alone that put older people *at risk* for social isolation and loneliness. However, a complementary approach emphasizes the emotional or psychological aspects to aging, loneliness and social support. The inclusion of perceived control is consistent with this approach. This psychological approach can help address why most older people are *not* lonely even in the face of these sociodemographic trends (Schnittker, 2007). That is, a more psychological approach can help bridge the gap between objective and subjective characteristics of our social relationships.

Psychological interpretations can also help highlight the *motivational* forces behind relationships. For example, Carstensen's (1992; 1995) socioemotional selectivity theory would suggest that, although people's social contacts diminish in later life, people *actively select* those relationships that are most important to them. Further, psychological approaches suggest that people may *interpret* relationships differently. For example, some research has shown that lonely vs. non-lonely college students have similar numbers of friends, but that lonely students perceive their social relationships to be more stressful and threatening than non-lonely students (Hawkley et al., 2003). In sum, psychological interpretations can complement the demographic approach and can help unravel the complexities surrounding social support and loneliness.

In the present study, the psychological approach was used to explore a personal resource that may account for why some people are lonely and some people are not, given similar *objective* social environments or demographic trends. The psychological

resource of potential importance that will be explored is people's *perceived control* over events and important domains in their lives.

Maintaining a *sense of control* or *perception of control* over important aspects of one's life has been long recognized as one of the cornerstones of successful aging. Scholars have long argued that maintaining a belief in the ability to exercise control over one's life is crucial for psychological and physical health (Rodin, Timko, & Harris, 1985). Empirically, perceived control has consistently been shown to predict health and well-being. Studies have shown that people having high levels of perceived control over significant aspects of their lives participate more in exercise and leisure activities (Menec & Chipperfield, 1997), use fewer health care services (Chipperfield, Campbell, & Perry, 2004), and even live longer (Chipperfield, 1993; Penninx et al., 1997). Although there is variability in preferences for control (Burger, 1992; Rodin, 1986), the general expectation in this study will be that a *greater* degree of perceived control will generally have beneficial effects on well-being.

Less empirical research has examined the relationship between sense of control and loneliness. It seems that this could be a critical area of research, especially in light of the potential to *modify* people's perceptions of control. That is, in contrast to the more static demographic variables such as income level or living arrangements, it is potentially more feasible to focus on changing people's perceptions and beliefs, which could, in turn, reduce loneliness.

Moreover, it appears that by focusing on a perception of control this may also help elucidate some of the complexities of the construct of loneliness itself. It is possible, for

example, that older people may not feel lonely when they feel that they have *personal control* over their social situations. For example, considering personal control may be one way to differentiate the two ideas of being alone vs. being lonely. In *deciding* to be alone, one would not be expected to feel lonely. However, the situation is different if a person does not feel that they have any control over being alone or being with others. Put in terms of the discrepancy theory of loneliness (Perlman, 2004), perceived control may allow people a sense of confidence that they can align their actual and desired relationships (Newall, Chipperfield, Clifton, et al., 2009). Although in the present study it will not be possible to focus on people's *decisions* to be alone or spend time with others, it will be possible to examine participants' sense of control over their life in general as well as over more specific domains such as the things that they do for enjoyment, their health, and managing their daily tasks.

The present study will complement the small number of studies which suggest that personal control, or related constructs, relate to feelings of loneliness, with greater personal control predicting less loneliness (e.g., Moore & Schulz, 1987; Solano, 1987). For example, Kramer, Kapteyn, Kuik, and Deeg (2002) found strong correlations between loneliness and mastery and self-efficacy in their sample of older adults (ages 55+) suffering from a hearing impairment. Similarly, self-efficacy beliefs of older persons have been shown to be strong predictors of loneliness (Fry & Debats, 2002).

Interestingly, in a qualitative study involving older clients using home care (ages 75+), the two most important personal resources identified by participants was a sense of personal control and a determination to remain active (Eloranta et al., 2008). In addition,

the factors that were identified as threatening these resources were loneliness, deteriorating health and conditions of living imposed by others; whereas the factors that enhanced these resources were social network and leisure activities. Although the present study focused on how perceived control may impact feelings of loneliness, clearly a reciprocal relationship may exist in which loneliness, in turn, can threaten personal control.

Other research has shown that people who are lonely are likely to see their interpersonal failures as being due to *uncontrollable* causes (Anderson & Riger, 1991). Also relevant to the present study is the recent study on older Manitobans (aged 72+) that examined how people's beliefs about the causes of loneliness and of friendship development related to their social participation and their loneliness (Newall, Chipperfield, et al., 2009). As expected based on Weiner's Attribution Theory (1985), the results indicated that people's general beliefs that new relationships are forged through internal/controllable causes, like effort, are associated with greater social participation and less loneliness; whereas beliefs that making friends is due to the context or to luck (external/ uncontrollable causes) are associated with greater loneliness. The predictive value of endorsing these causal beliefs was demonstrated both immediately and over the longer-term even after accounting for the effects of the socio-demographic and health variables. It was argued that more *internal/controllable* causal beliefs may lead to a *sense of control* over social relationships and can help to motivate people to be more socially active, which, in turn reduces loneliness.

In the present Study 1, which involved participants in this same Manitoban Study,

perceived personal control was considered as a variable discriminating between lonely vs. not lonely older adults at one point in time, as well discriminating between patterns in loneliness over two points in time. Thus, complementing the Newall, Chipperfield, Clifton, et al. study, the present study examined potential antecedents of loneliness but took more of a person-centered approach (Bosworth & Schaie, 1997) in that distinct *groups* of participants were compared and examined.

Summary and general predictions. In summary, for the present Study 1, the following potential discriminators of loneliness were considered: age, gender, income, education level, marital status, living arrangements, duration living in the community, presence of friends, social activity participation, solitary activity participation, ability to perform activities of daily living, health, and perceived control. These variables have been considered as predictors of loneliness in past research and thus general predictions can be made. It is expected that being lonely at a given time will be associated with: being older, being female, having less income and education, being widowed or divorced, living alone, living less years in one's community, participating less in social or solitary activities, having no close friends, being less functionally independent, having poorer health, and having lower levels of perceived control. However, the above predictions correspond only to bivariate associations between a given variable and loneliness at one point in time. What is unique about the present study is that it takes a multivariate approach to examining changes in loneliness over time. It is unclear which variables are the *most important* in discriminating lonely vs. non-lonely people at one point in time and little research has examined how these variables may discriminate between different

patterns of loneliness (e.g., emergence or persistence) over time.

Study 1 Methods

Ethical Approval

Ethical approval for the Aging in Manitoba Studies was received from the appropriate University of Manitoba Ethics Boards and the Health Information Privacy Committee, Manitoba Health, at the time of the data collections. Because the present project was a secondary analysis of data from which all personal identifiers were removed, and because approval for the study was given by the principal investigator, an additional ethical approval process was not required (Appendix A).

Study 1 Participants: Overall Description of Datasets

Study 1 involved an analysis of the AIM 1996 (N=1868) and AIM 2001 (N=1012) study datasets. These datasets were selected because the construct of loneliness was included in the AIM interviews beginning in 1996 and because this allowed an analysis of loneliness over two points in time with a large group of participants.

The AIM studies began in 1971 with a sample of older adults (65+ years) stratified by age, gender, and region. Additional samples of older adults (60+) were drawn in 1976 and 1983, with follow-up studies occurring 2-3 times per decade, until the final data collection in 2006. Important in terms of generalizing study results, the sample selection processes derived a sample representative of the larger population of older Manitobans, both at initial assessment (Mossey, Havens, Roos, & Shapiro, 1981), and at follow-up (Chipperfield, Havens, & Doig, 1997).

The AIM samples (with the exception of AIM 2005/2006) included people living in

personal care homes as well as in the community (rural and urban), people whose first-language was English or another language other than English, and people with cognitive impairment who needed a proxy respondent to either complete the survey for them or help them to complete the survey. Initially undertaken to assess the needs of the older Manitoban population, the AIM studies gathered a variety of information on participants' age, gender, occupation, living arrangements, marital status, income, education level, social networks, life satisfaction, health status, and health behaviours. The longitudinal nature of the datasets provides a unique opportunity to study change over time in the same group of participants. The data collection required a truly impressive amount of resources and time, both from researchers and from the participants.

Study 1 Participants: Sample Selection

Study 1 involved those participants who were in both the AIM 1996 and 2001 studies and who had responded to the question pertaining to loneliness. A total of 1012 adults participated in both AIM 1996 and AIM 2001. Of these 1012 participants, 70 had a proxy complete the interview in 1996 and so had incomplete data for all of the subjective interview questions. Reasons for having a proxy included that the participant was: unavailable (n = 15), unable to hear questions (n = 10), physically incapable of completing interview (n = 14), or mentally incapable of completing interview (n = 30). In one case, the reason for having a proxy was undetermined. These 70 participants were excluded from the analyses, reducing the sample to 942 participants.

In addition, of these 942 participants, 153 participants had a proxy complete the survey for AIM 2001, again resulting in incomplete data for the subjective questions.

Reasons for having a proxy included participant was: unavailable (n=4), unable to hear questions (n=9), physically incapable of completing interview (n=30), and mentally incapable of completing interview (n=99). These 153 participants were excluded from the analyses, reducing the sample to 789 participants.

Additional exclusions (n = 28) were necessary as revealed by participants who had missing information for one or both of the AIM 1996 or 2001 questions about loneliness. Finally, from the remaining 761 people, one person was excluded because s/he was younger than the 60+ years cut-off point for the 1983 recruitment and data collection (aged 56 in 1983). This left a total of 760 people for the Study 1 analyses.

Representativeness of Sample: Gender and Marital Status

Although the initial AIM samples were selected in a way to maximize representativeness of the older Manitoban population in terms of age and gender, it is of interest to examine how representative the *current* sample was compared to the older Manitoban population. Comparing the gender distribution of the sample of 760 participants (40.7% males) with the Statistics Canada 1996 Census data available on older Manitobans aged 75+ years old (37.5% males; Statistics Canada, 1996) revealed no significant gender difference in the proportion of males and females, X^2 (1, 760) = 3.23, p > .05. Similarly, comparing the marital status of the sample (55.7% married or single) with the 1996 Census data available on older Manitobans aged 70+ years old (54.8% married or single; Statistics Canada, 1996), revealed no significant differences, X^2 (1, 760) = .23, p > .05. Although it was not possible to compare the health of the sample to the larger population, it is probable, due to reasons of attrition and due to the participant

exclusions outlined above, that the sample is slightly healthier than the overall population of older Manitobans.

Study 1 Measures

Table 1 shows variable information for the Study 1 sample (N = 760) at both the 1996 and 2001 data collections.

Age. Participants reported their age in years.

Gender. Participants' gender was coded by the interviewer (0 = *females*; 1= *males*).

Education level. Participants reported the total number of years they had completed in school. There were two people who had missing information for both AIM 1996 and 2001. To be consistent throughout, any missing data were replaced with the mean (Tabachnick & Fidell, 2001). This method was chosen as a suitable way to deal with missing values, given there was little missing data for the variables of interest in this large sample. In addition, replacement of missing values was done in order to retain as many participants as possible in the analyses.

Income inadequacy. A measure of income inadequacy was created from participant responses in 1996 and 2001 to the following question: "Can you tell me how well you think your income and assets (including that of your spouse, where applicable) currently satisfy your needs?" (1 = *very well*; 2 = *adequately*; 3 = *with some difficulty*; 4 = *not very well*; 5 = *totally inadequately*). Because of the small number of people who indicated the responses of "*not very well*" or *"totally inadequately"* (*n* = 16 in 1996; *n* = 11 in 2001), these responses were re-coded as 3, together reflecting *not adequate* income. The eight

Table 1

Description of Study 1 Variables for 1996 and 2001

Measures	Anchors	# of items	*M*	*SD*	Skew	Kurt	Range
Age (yrs)	--	1	79.15	4.81	.68	-.04	72-95
			(84.17)	(4.80)	(.67)	(-.08)	(77-100)
Gender	0 = *women* 59.3% 1 = *men* 40.7%	1	--	--	--	--	--
Education (yrs)	--	1	9.25	3.01	-.01	.94	0-21
			(9.25)	(3.01)	(-.01)	(.94)	(0-21)
Income inadequacy	1= very well 2= adequately 3=not adequately	1	1.86	.57	-.01	-.08	1-3
			(1.79)	(.60)	(.14)	(-.42)	(1-3)
Marital status	1 = *marital loss* *44.3* % (54.6 %) 2 = no *marital loss* 55.7% (45.4%)	1	--	--	--	--	--
Living arrangements	1= lives alone 45.7% (54.7%) 2= lives with others 54.3% (45.3%)	1	--	--	--	--	--
Duration in household	1 = < 6 mth 2 = 6 mth – 1 yr 3 = 1-3 years 4 = 3-5 years 5 = > 5 years	1	4.68	.80	-2.89	8.29	1-5
			(4.50)	(1.02)	(-2.06)	(3.31)	(1-5)

(continued)

Measures	Anchors	# of items	*M*	*SD*	Skew	Kurt	Range
Close friend	1 = no friends 20% (28%) 2 = one or more friends 80% (72%)	1	--	--	--	--	--
Social activities (sum)	0= *no* 1= *yes*	14	6.17 (4.89)	2.11 (1.85)	.30 (.39)	.01 (.32)	0-13 (0-12)
Solitary activities (sum)	0= *no* 1= *yes*	6	3.91 (3.36)	1.13 (1.18)	-.26 (-.19)	-.11 (-.31)	0-6 (0-6)
IADL (sum)	0 = *no* 1= *yes, can do*	12	10.10 (8.67)	1.64 (2.72)	-1.18 (-1.12)	2.04 (.70)	2-12 (0-12)
Perceived health	1 = *poor* 2 = *fair* 3 = *good* 4 = *excellent*	1	2.63 (2.60)	.69 (.71)	-.28 (-.33)	-.02 (-.07)	1-4 (1-4)
Health conditions (sum)	0= *no* 1= *yes*	21	3.68 (4.22)	2.50 (2.48)	.88 (.68)	.86 (.26)	0-14 (0-14)
Perceived control	1 = *almost no control;* 10 = *almost total control*	5	8.05 (7.67)	1.70 (1.88)	-1.21 (-.88)	2.02 (.71)	1-10 (1-10)

Note: N = 760. Scores in brackets are from 2001. IADL = Instrumental activities of daily living; Skew = Skewness; Kurt = Kurtosis.

missing cases in AIM 1996 (9/760 or 1.2%) and 20 missing cases for AIM 2001 (20/760 or 2.6%) were replaced with the mean.

A variable reflecting *change in income adequacy* was also calculated by subtracting the 1996 from the 2001 values. More specifically, this variable had three levels: -1 = *less adequate income over time* (*n* = 137); 0 = *no change in income adequacy* (*n* = 441); 1= *more adequate income over time* (*n* = 182) (*M* = .06, *SD* = .64).

Marital status. At each data collection, participants were asked for updated marital status information. In 1996, most participants were married (*n* = 373), and the next largest groups were the widowed (*n*= 319), single (*n* = 50) and divorced (*n* = 18). Because of the small number of single and divorced, it was not feasible to retain these four separate categories. Rather, this variable was dichotomized such that those who had experienced a *loss* in a marital partner (widowed; divorced) could be contrasted with those who had not (married; single).

A variable reflecting *chang*e in marital status over the five years was created with the following three levels: -1 = *became widowed or divorced* (*n* = 83); 0 = *had no change in marital status* (*n* = 672); 1 = *became married* (*n* = 5) (*M* = -.10, *SD* = .32).

Living arrangements. At each data collection, participants were asked the number of people who lived with them (if any) in the same household. In 1996, 45.7% (*n* = 347) lived alone, 47.2% (*n* = 359) lived with one other person, 5.4% (*n* = 41) lived with two others, 0.9% (*n* =7) lived with three others, 0.4% (*n* = 3) lived with four, 0.3% (*n* = 2) lived with five others, and one person lived with six others. This variable was dichotomized to distinguish those who lived alone (1 = *lives alone*; 2 = *lives with others*).

A variable reflecting *change in living arrangements* over the five years was created with the following levels: -1 = *change from living with someone to living alone* (*n* = 90); 0 = *no change in living arrangements* (*n* = 649); 1 = *change from living alone to living with someone* (*n* = 21) (*M* = -.09, *SD* = .37).

Type of housing. In 1996, 72.7% of participants lived in a house, 15.5% in an apartment, 11.8% in a seniors residence, and .7% in a personal care home. In 2001, 62% of participants lived in a house, 13.3% in an apartment, 17.9% in a seniors residence, .5% in supportive housing, 5.9% in a personal care home, and .4% in an unspecified "other" type of dwelling. For subsequent analyses, a *change in PCH* variable was created as follows: 0 = *did not move into a PCH* (*n* = 720); 1 = *moved into a PCH* (*n* = 40) (*M* = .05, *SD* = .22). This variable was created to account for differences in loneliness that may come about through moving into a personal care home, a very different housing setting from an apartment or even supportive housing.

Duration in household. Participants were asked the number of years that they had lived in their present household (1= *over five years*; 2= *3-5 years*; 3 = *1-3 years*; 4 = *less than one year but greater than 6 months*; 5 = *less than 6 months*). Responses were reverse-coded such that higher scores reflected greater number of years in the household. Mean substitution was used for the three missing cases in 2001 (Tabachnick & Fidell, 2001). A *change in household* variable was created such that people had either *not* moved in the last five years (code = 1; n = 574) or moved in the last five years (code = 2; n = 186) (*M* = 1.24, *SD* = .43).

Close friends. Participants were asked in 1996 and 2001 the following question about

friendships: "How many people that you know do you consider close friends, that is, people you can confide in and talk over your personal matters with?" Six missing cases in 1996 and seven in 2001 were replaced with the mean. This variable was then ultimately dichotomized to assess an important distinction: how many people indicated having no close friends versus having at least one close friend (Table 1).

In addition, a *change in friend* variable was created using the 1996 and 2001 variables: -1 = *change from having a friend to not having a friend* (n = 133); 0 = *no change in friend* (n = 555); 1 = *change from not having a friend to having a friend* (n = 72) (M = -.08, SD = .51).

Social and solitary activity participation. Respondents were asked about whether they had participated in a variety of 14 *social activities* during the past week (visiting family; visiting friends; telephone conversation with friends; walking or shopping; playing sports or games; doing church-related activities; doing music, art, or theatre; participating in organized social recreational groups; participating in formal or informal social groups for older adults; participating in service, fraternal or Legion organizations; doing community volunteer work; doing Mass activities like bingo; travelling; working). Affirmative responses were summed to create a measure of social activity participation.

Respondents were also asked about whether they had participated in a variety of six *solitary activities* during the past week (reading or writing or internet; handwork hobbies such as carving; gardening or light housework; yard work or heavy housework; collecting hobbies; listening to radio or watching television). Affirmative responses were summed to create a measure of solitary activity participation.

Change in social and solitary activities was also assessed by subtracting the 1996 responses from the 2001 responses such that higher scores reflected increased activities (social activities: M = -1.28, SD = 2.07, *range* = -10.00 to 7.00; solitary activities: M = -.56, SD = 1.27, *range* = -5.00 to 4.00). Note that 65.7% (n = 499) *decreased* their social activities, 15.5% had no change (n = 116), and 19.1% (n = 145) *increased* their social activities. Approximately 50% (n = 383) *decreased* their solitary activities, 32.2% (n = 245) had no change, and 17.4% (n = 132) *increased* their solitary activities.

Functional status. Participants' *functional status (independence*) was measured by asking whether or not they were independently capable of performing 12 specific instrumental activities of daily living (IADL; e.g., light housework, laundry, and food preparation). Based on similar IADL measures (e.g., Lawton & Brody, 1969), a composite score was created by summing the items so that higher scores reflected greater independence.

A *change in functional status* variable was created by subtracting the 1996 from the 2001 responses such that higher scores reflected an increase in independence (M = 1.44, SD = 2.34; *range* = -11.00 to 5.00). Examining this variable more closely revealed that 59.1% (n = 449) had a loss in functionality, 26.7% (n = 203) had no change, and 14.2% (n = 108) had a gain in functionality.

Health status. Participants' health status was measured in two ways. Individuals' general perceived health was assessed by asking them to rate their health compared to other people their own age. This measure has been shown to predict objective health status, mortality, and health care use (Bailis, Segall, & Chipperfield, 2003; Menec,

Chipperfield, & Perry, 1999; Mossey et al., 1981). Possible responses range on a 5-point scale (1= excellent; 2= good; 3= fair; 4= poor; 5= bad). The small number of "bad" responses (n = 2 for AIM 1996; n = 4 for AIM 2001) were re-coded as "poor" health. In addition, responses were reverse-coded, resulting in scores ranging from 1 (*poor*) to 4 (*excellent*). The missing cases for this variable (three in 1996 and seven in 2001) were replaced with the mean.

In addition, *change in general perceived health* was assessed by subtracting the 1996 values from the 2001 values, such that higher scores reflected a gain in health (M = -.04, SD = .79, *range* = -3.0 to 2.0). Note that 23.7% (n = 180) had a decline in health, 55% (n = 418) had no change, and 21.3% (n = 162) had an improvement in perceived health.

As a second measure of health, individuals were asked whether they currently had, or were still feeling the after-effects of, 21 specific health conditions (e.g., heart and circulation problems, arthritis). These items were summed to create a composite measure, with higher scores indicating poorer health. For *change in chronic conditions*, 2001 scores were subtracted from 1996 scores, such that higher scores reflected better health (decrease in number of conditions) (M = -.54, SD = 2.25, *range* = -7.0 to 8.0). In total, 49.7% (n = 378) had a decline in health (i.e., gain in number of health conditions), 21% (n = 160) had no change, and 29.2% (n = 222) had an improvement in health (i.e., reduction in number of health conditions).

Perceived control. Perceptions of control were assessed in AIM 1996 and AIM 2001 with five questions. Participants were asked: 'Now we would like to know about the influence or control you have over certain aspects of your life. In other words, we want to

know whether you can personally influence things by what you say or do. Indicate the amount of control you feel you have over: your physical health, your thoughts and feelings, the things you can do for fun and enjoyment, managing the usual tasks that need to be done to keep up, and your life in general" (1 = almost no control; 10= almost total control). A composite measure of more "global" perceived control was created by calculating the mean of the items, similar to past research (e.g., Chipperfield et al., 2004; Ruthig & Chipperfield, 2006). For the 1996 control items, 17 people had missing values for all five control items. For 2001, 35 people had missing values for 4-5 of the five items. These missing values for the 1996 (< 3% of total) and 2001 (< 5% of total) measures were replaced with the mean (Tabachnick & Fidell, 2001).

In addition, in keeping with past research (Chipperfield et al., 2004), a *change in perceived control* variable was created by subtracting the 1996 from the 2001 values, such that higher scores reflected a gain in perceived control (M = -.38, SD = 1.98, *range* = -7.0 to 7.2). Looking at this variable more closely, 51.7% (n = 393) had a loss in perceived control, 9.1% (n = 69) had exactly no change, and 39.2% (n = 298) had a gain in perceived control.

Loneliness. Participants were asked, "If we divide people into four categories, where "1" is "the not lonely", "2" is "the moderately lonely, "3" is "the severely lonely" and "4" is "the extremely lonely", what do you consider yourself to be?" (1 = *not lonely;* 2 = *moderately lonely*; 3 = *severely lonely*; 4 = *extremely lonely*). Dichotomized variables were created for both AIM 1996 (1= not lonely, 69.1%; 2 = moderately to extremely lonely, 30.9%) and AIM 2001 (1= not lonely, 72.8%; 2 = moderately lonely to extremely

lonely, 27.2%). The AIM 1996 dichotomized variable was used as the outcome variable (i.e., the two groups to be discriminated) in one of the discriminant function analyses as described below.

As well, another variable which categorized people across time into four groups based on the two dichotomized 1996 and 2001 items was created: 1= *lonely in both 1996 and 2001 (persistently lonely);* 2 = *lonely in 1996 and not lonely in 2001 (overcoming of loneliness);* 3 = *not lonely in 1996 and lonely in 2001 (emergence of loneliness);* 4 = *not lonely in 1996 or 2001* (*persistently not lonely)*. This variable was used as the outcome variable (i.e., the four groups to be discriminated) in the analyses as described more below.

Study 1 Results

Prior to addressing the major research questions, preliminary analyses were conducted to: 1) Examine correlations among variables; and 2) Identify loneliness groupings; and 3) Examine Chi-Square differences between the groups on such variables as marital status and gender.

Correlations Between Study 1 Variables

Correlations between all of the AIM 1996 study variables (Table 2) and AIM 2001 study variables (Table 3) show many expected relationships. For example, focusing on the 1996 correlations (Table 2), a greater level of education was correlated with perceiving adequate income, and older age was significantly related to having less education, being not married, living alone, and being less functionally independent. Somewhat more surprisingly (given a sample of older adults), being female was

Table 2

Correlations Between AIM 1996 Study 1 Variables

Variables	1	2	3	4	5	6	7	8	9	10	11	12	3	14
1. Age	--													
2. Gender	-.06	--												
3. Education	-.17**	-.11**	--											
4. Income inadequacy	-.04	-.04	-.13**	--										
5. Marital status	-.26**	.44**	.08*	-.11**	--									
6. Living arrangements	-.27**	.40**	.03	-.05	.72**	--								
7. Duration in household	-.06	.03	-.02	.05	.05	.08*	--							
8. Close friend	-.03	-.09**	.07	.04	-.02	-.03	.04	--						
9. Social activities	-.10**	.05	.14*	-.07+	.08*	.05	.05	.19**	--					
10. Solitary activities	-.17**	-.05	.11**	-.01	.01	.01	.16**	.08*	.23**	--				
11. IADL	-.26**	.33**	.06	-.09*	.18*	.15**	.14**	.01	.23**	.44**	--			
12. Perceived health	-.02	.04	.14**	-.12**	.01	.03	.03	.05	.16**	.17**	.31**	--		
13. Health conditions	.07+	-.09*	-.07	.09*	-.05	-.07	-.15**	.03	-.06	-.17**	-.35**	-.46**	--	
14. Perceived control	-.04	-.09*	.16**	-.17**	-.04	-.03	.08*	-.02	.17**	.27**	.36**	.34**	-.32**	--

Note. IADL = Instrumental activities of daily living. Pearson correlation coefficients were used for continuous variables; Spearman correlation coefficients were used for dichotomous variables.
+ p = .06-.08. *p < .05. **p < .01.

Table 3

Correlations Between AIM 2001 Study 1 Variables

Variables	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1. Age	--													
2. Gender	-.06	--												
3. Education	-.17**	-.11**	--											
4. Income inadequacy	-.03	-.01	-.12**	--										
5. Marital status	-.24**	.42**	.09*	-.05	--									
6. Living arrangements	-.25**	.38**	.03	.01	.69**	--								
7. Duration in household	-.17**	.08*	.02	.04	.10**	.15**	--							
8. Close friend	-.13**	-.13**	.13**	.03	-.01	.01	.06	--						
9. Social activities	-.09**	-.00	.14**	-.13**	.01	.03	.06	.25**	--					
10. Solitary activities	-.28**	- 05	.11**	-.04	.04	.05	.27**	.12**	.37**	--				
11. IADL	-.40**	.23**	.11**	-.01	.15**	.14**	.35**	.04	.30**	.67**	--			
12. Perceived health	-.03	.04	.13**	-.14**	-.02	-.01	.08*	.04	.22**	.28**	.29**	--		
13. Health conditions	.09*	-.06	-.08*	.10*	-.03	-.03	-.14**	-.01	-.09**	-.29**	-.36**	-.42**	--	
14. Perceived control	-.09*	-.02	.13**	-.11**	-.05	-.06	.13**	.11**	.25**	.43**	.44**	.45**	-.36**	--

Note. IADL = Instrumental activities of daily living. Pearson correlation coefficients were used for continuous variables; Spearman correlation coefficients were used for dichotomous variables.
+ p = .06-.08. *p < .05. **p < .01.

associated with greater education and perceived control in general. Interestingly, having at least one close friend (vs. no close friend) was related to doing more social *and* solitary activities. Moreover, greater participation in either social or solitary activities in the past week was associated with greater independence and health and greater perceived control, with the magnitude of these correlations being stronger for solitary activities.

Lonely Group Categorization

AIM 1996 2-group categorization of loneliness. In 1996, 30.9% of participants were lonely compared to 69.1% who were not. Table 4 shows comparisons of the lonely vs. not lonely adults classified on the categorical variables of gender, marital status, living arrangements, close friends, and age. Women appeared to be more likely to be lonely than men: 35.9% of females were lonely compared to only 23.6% of the males, $X2$ (1, $N = 760$) = 12.98, $p < .001$. In addition, significant differences in *marital status* emerged between those who were lonely vs. not lonely, $X2$ (3, $N = 760$) = 50.55, $p < .001$. The distinction can be seen between those who experienced a loss in marital status (widowed/divorced) and those who did not (single/married). Of the 18 people who indicated being divorced, 55.6% (10/18) were lonely. Similarly, of those widowed, 43.3% were lonely. However, fewer of the married (19.6%) and single (28.8%) indicated being lonely.

More people living alone (44.7%) were lonely compared to those living with others (19.3%), $X2$ (1, $N = 760$) = 56.50, $p < .001$. There was no significant association between having a *close friend* or being lonely or not, $X2$ (1, $N = 760$) = .60, $p > .05$. Similarly,

Table 4

Comparison of Not Lonely and Lonely (1996) on Gender, Marital Status, Living Arrangements, Close friends, and Age

	AIM 1996 Groups			
1996 Variables	Not Lonely	Lonely	Total	X^2
Gender				
Male	236 (76.4% of males)	73 (23.6%)	309	12.98**
Female	289 (64.1% of females)	162 (35.9%)	451	
Marital status				
Married	300 (80.4% of married)	73 (19.6%)	373	50.55**
Single	36 (72.0% of single)	14 (28.0%)	50	
Widowed	181 (56.7% of widowed)	138 (43.3%)	319	
Divorced	8 (44.4% of divorced)	10 (55.6%)	18	
Living arrangements				
Lives alone	192 (55.3% of living alone)	155 (44.7%)	347	56.50**
Lives with others	333 (80.6% of with others)	80 (19.3%)	413	
Close friends				
No close friend	99 (66.4% no close friend)	50 (33.6%)	149	0.60
Has close friend	426 (69.7% close friend)	185 (30.3%)	611	
Age				
70-74	125 (74.4% of age group)	43 (25.6%)	169	5.08
75-79	186 (70.5%)	78 (29.5%)	264	
80-84	153 (66.2%)	78 (33.8%)	231	
85-89	46 (63.0%)	27 (37.0%)	73	
90-95	15 (62.5%)	9 (37.5%)	24	
Age dichotomy				
< 80	311 (72.0% of age group)	121 (28.0%)	432	3.97*
80 +	214 (65.2%)	114 (34.8%)	328	

Note. *$p \leq .05$. **$p \leq .01$.

there was no significant association between the different *age groups* and being lonely or not, X^2 (3, N = 760) = 5.08, $p > .05$. However, there was a trend towards the "older" of the older adults to be more lonely than the "younger" of the older adults, particularly beginning at the 80-85 age group (33.8% lonely). Moreover, when the 80+ was compared to the younger ages (see Table 4), older age was significantly associated with being lonely, X^2 (2, N = 760) = 3.97, p = .05, which parallels past research showing that the "old-old" are lonelier than the "young-old" (e.g., Dykstra, 2009).

AIM 1996-01 4-group categorization of loneliness. Table 5 shows the four groupings of older adults based on their self-reported loneliness at two points in time, in 1996 and 2001. The majority of older adults could be categorized as being persistently "not lonely" at both points in time (n = 430; 56.6%). The next largest groups consisted of those individuals who overcame loneliness (i.e., changed from being lonely in 1996 to not lonely in 2001) (n = 123; 16.2%); those who were persistently lonely (n = 112; 14.7%); and those who became more lonely (i.e., changed from being not lonely in 1996 to lonely in 2001) (n = 95; 12.5%). These results are quite similar to those found by Victor, Scambling, et al. (2005) out of Great Britain and Jylha (2004) out of Finland. For example, they too found that the majority of older adults were *not lonely* over two points in time.

These findings are intriguing as a fairly small proportion (14.7%) of people reported being *lonely at both times* and a similar proportion seemingly "overcame" their loneliness over time (16.2%). Although 56.6% of older adults did not report feeling lonely over time, on the other hand, this means that approximately 43% *did* categorize themselves

Table 5

Four Groups of Older Adults Based on Self-Reported Loneliness at Two points in Time

	AIM 2001		
AIM 1996	Lonely N (%)	Not Lonely N (%)	Total (N (%)
Lonely	112 (14.7%)	123 (16.2%)	235 (30.9%)
Not lonely	95 (12.5%)	430 (56.6%)	525 (69.1%)
Total	207 (27.2%)	553 (72.8%)	760 (100%)

as being lonely *at least once* over two points in time.

Table 6 shows these same four groups differentiated by the categorical variables of gender, marital status, living arrangements, close friends, and age. Again, being female related to being lonely, X^2 (3, N = 760) = 15.92, $p < .01$. Out of 451 females, 17.7% were lonely at both times, and 51.0% were not lonely at either time. Out of 309 males, 10.4% were lonely at both times, and 64.7% were not lonely both times. Interestingly, 18.2 % of females became less lonely over time, in contrast to only 13.3% of males. Of the 373 people married at Time 1 in 1996, only 9.1% were lonely at both times, and 66% were not lonely both times, X^2 (9, N = 760) = 55.75, $p < .01$. This is in contrast to the other marital status groups who had larger proportions lonely at both times and smaller proportions persistently not lonely.

Compared to those living with others, those living alone in 1996 were more likely to be *persistently* lonely (22.2% vs. 8.5%), and yet were more likely to *overcome* (22.5% vs. 10.9%) their loneliness as well X^2 (3, N = 760) = 57.72, $p < .01$. This parallels Jylha's (2004) finding that being without a partner at baseline related to being less lonely at Time 2. Lastly, it is interesting that no significant association was found between the lonely groupings and friendships, X^2 (3, N = 760) = 1.06, p = .79, and age, X^2 (3, N = 760) = 6.37, p = .10.

Table 6

Comparison of Four Groups of Older Adults on Gender, Marital Status, Living Arrangements, Close Friends, and Age

	AIM 1996-01 Groups					
1996 Variables	lonely-lonely	lonely-not lonely	not lonely-lonely	not lonely-not lonely	Total	X^2
Gender						
Male	32 (10.4%)	41 (13.3%)	36 (11.7%)	200 (64.7%)	309	15.92**
Female	80 (17.7%)	82 (18.2%)	59 (13.1%)	230 (51.0%)	451	
Marital status						
Married	34 (9.1%)	39 (10.5%)	54 (14.5%)	246 (66.0%)	373	55.75**
Single	9 (18.0%)	5 (10.0%)	9 (18.0%)	27 (54.0%)	50	
Widowed	63 (19.7%)	75 (23.5%)	32 (10.0%)	149 (46.7%)	319	
Divorced	6 (33.0%)	4 (22.2%)	0 (0%)	8 (44.4%)	18	
Living arrangements						
Lives alone	77 (22.2%)	78 (22.5%)	38 (11.0%)	154 (44.4%)	347	57.72**
Lives with others	35 (8.5%)	45 (10.9%)	57 (13.8%)	276 (66.8%)	413	
Close friends						
No close friend	22 (14.8%)	28 (18.8%)	19 (12.8%)	80 (53.7%)	149	1.06
Close friend	90 (14.7%)	95 (15.5%)	76 (12.4%)	350 (57.3%)	611	
Age dichotomy						
< 80	54 (12.5%)	67 (15.5%)	51 (11.8%)	260 (60.2%)	432	6.37
80 +	58 (17.7%)	56 (17.1%)	44 (13.4%)	170 (51.8%)	328	

Note. *$p \leq .05$. **$p \leq .01$.

Analytical Strategy: Discriminant Function Analysis

Discriminant Function Analysis was used to address the Study 1 research questions that involved discriminating between two groups of older adults (lonely vs. not lonely in 1996) and between four groups of older adults (e.g., lonely in 1996 and 2001; lonely in 1996 and not lonely in 2001, etc.). A major purpose of discriminant function analysis is to allow the researcher to be able to detect and interpret the *combination* of predictors, or *discriminant functions*, that separate various groups from one another (Tabachnick & Fidell, 2001). Briefly, discriminant function analysis addresses these questions: A) Can a set of variables discriminate pre-defined groups? B) Which groups do the variables discriminate between (if any)? C) Which *combination* or patterns of variables best discriminates between groups?

Can a set of variables discriminate pre-defined groups: Number of statistically significant functions. A main goal of discriminant function analysis is to find linear combinations of variables (the *discriminant functions*) that maximize the differences between groups of interest. If a given discriminant function is statistically significant, this indicates that the groups can be reliably differentiated based on the predictor variables. Of course, it is possible that no statistically significant functions be found, meaning that the predictor variables have failed to discriminate between any of the groups.

The number of possible discriminant functions that can be derived in a given analysis is one fewer than the number of groups being examined. Therefore, in a two-group analysis, only one discriminant function can be derived. And in a four-group analysis, only three discriminant functions can be derived, and again, not all of them may be

statistically significant. The first discriminant function provides the best separation among groups, then a next discriminant function, orthogonal to the first, separates groups on the basis of associations not used in the first discriminant function (Tabachnick & Fidell, 2001). With four groups, for example, a function could be derived which separates Group 1 from the other three groups and another function could be derived which separates Group 1 and 2 from Group 3 and 4.

If a discriminant function is found to be statistically significant, then this means there is reliable separation of groups based on the predictor variables in the function. Computationally, the matrix of total variances and covariances is compared to the matrix of pooled *within-group* variances and covariances. Statistical significance is tested using *Wilks' lambda* which is the ratio of the within-groups variance (sum of squares) to the total variance (sum of squares). That is, the Wilks' Lambda ratio is the proportion of the total variance in the discriminant scores *not explained* by differences among groups. Thus, lambda values close to one signify that there is little variability between groups. In sum, significant Wilks' lambda values indicate that the predictor variables can discriminate between the groups.

Which groups do the variables discriminate between (if any): Group centroids. Group centroids indicate which groups are being separated by the predictor variables. Using the unstandardized coefficients associated with each predictor variable in a given discriminant function, the group centroid is calculated by obtaining the predicted score for each participant in a given group, and obtaining the group mean. For a two-group discriminant function analysis, the group centroids represent the group means that would

maximally separate the two groups. So for example, the group centroids for Function 1 could be: Group 1 = .05 and Group 2 = 1.20.

For an analysis involving more than two groups, the group centroids are consulted in order to determine, *for each function*, which groups are being discriminated. For example, for a three-group analysis, the group centroids for Function 1 could be as follows: Group 1 = .05, Group 2 = 1.29, and Group 3 = -.83. Based on these group centroids, it would appear that the function is discriminating between Group 2 (group centroid = 1.29) and Group 3 (group centroid = -.83), as the means for these groups are the most disparate. Continuing with this example, the group centroids for Function 2 could be as follows: Group 1 = 1.25, Group 2 = 1.28, and Group 3 = -.86, suggesting that this function is discriminating Group 1 and 2 from Group 3. In sum, the group centroids are a guide to researchers in identifying which groups are being discriminated with the predictor variables.

Which combination of variables best discriminates between the groups : Structure and Standardized Coefficients. Group centroids tell the researcher how groups are separated; however, they do not reveal which variables are discriminating between the groups. The structure and standardized coefficients can be examined to help the researcher determine which predictors and/or patterns of predictors are *most important* in discriminating groups. First, the structure coefficients (also called structure matrix) represent the correlations between the predictor variables and the discriminant function; thus these coefficients provide an indication of which variables are most closely associated with a given function. Note that there is no specific cut-off point in terms of

the strength of the coefficients. If predictors X, Y, and Z correlate highly with the function, then to understand the function, the researcher can consider what these predictors may have in common with each other (similar to a principle components analysis).

Second, the researcher can also examine the standardized discriminant function coefficients which reflect the *unique* contribution of each predictor to the function, after accounting for the other predictors (similar to a partial regression coefficient or beta weight in multiple regression). Together, the structure and standardized coefficients can therefore provide an indication of which variables are most important in discriminating groups. However, it should be noted that some researchers advocate analysing only the structure coefficients as standardized coefficients can be misleading when there is multicollinearity (Tabachnick & Fidell, 2001).

In summary, interpreting discriminant functions involves: 1) Testing the statistical significance of the different functions; 2) Examining the group centroids to determine which groups are being discriminated; 3) Examining the coefficients for each predictor to determine the importance of the predictor to the function.

Prior probabilities. It should be noted that *prior probabilities* can be set by the researcher as part of the discriminant function analysis. The prior probability is a beforehand estimate of the likelihood that a case (participant) belongs to a particular group. Otherwise, by default, the statistical program will assume that all groups have equal probabilities (e.g., .50 and .50 in a two-group analysis). For example, if a researcher were predicting handedness (left-handed vs. right-handed), and if it was

generally the case that 15% of the population is left-handed, then the prior probabilities for the groups would be set to .15 and .85. Thus, setting prior probabilities is only possible if the researcher has beforehand knowledge of the estimated proportion of participants that generally belong in particular groups. The present study used prior probabilities for the lonely groups, as there was beforehand knowledge that groups would not have equal probabilities.

Multicollinearity Between Variables

Before performing the discriminant function analyses, the issue of multicollinearity or overlap between the predictor variables was examined. In particular, although some degree of correlation between certain variables could be expected, extensive overlap is a concern as this could make it difficult to assess the relative importance of each predictor variable.

Multicollinearity was assessed using tolerance values and variance inflation factors (Tabachnick & Fidell, 2001). Tolerance values for each predictor are computed as $1 - R^2$ as part of a multiple regression analysis, such that a tolerance value of .10 would indicate that 90% of the variance of that predictor variable could be explained by the other predictor variables in the analysis. Generally, multicollinearity is indicated if the tolerance value of a particular predictor is .10 or less (Meyers, Gamst, & Guarino, 2006). The variance inflation factor is calculated as 1/tolerance, and again measures the degree of association between a certain predictor variable and the other predictor variables in the analysis. Generally, multicollinearity is indicated with variance inflation factors of greater than 10.

After examining all of the 1996 predictor variables using these diagnostic tools, multicollinearity was not found to be a concern as all of the tolerance values were greater than .35, and all of the variance inflation factors were less than 2.5 (see Appendix B). Thus, all of the predictor variables in Table 1 were retained for the discriminant function analysis. Further, when all of the *change* variables were examined in addition to the 1996 predictor variables, it was again concluded that multicollinearity was not a concern because all of the tolerance values were greater than .35 and all of the variance inflation factors were less than 2.7 (see Appendix B).

Discriminant Function Analysis: AIM 1996 (2 groups)

Recall that the first major research question was: What sociodemographic, social, health, and psychological factors can discriminate between older adults who were lonely (n = 235) or not lonely (n = 525) in 1996. The means and standard deviations for the potential discriminating (continuous) variables, divided by the two groups, are shown in Table 7. As can be seen, mean group differences were observed for all the variables. Note that the dichotomous variables (gender, marital status, living arrangements, close friends) were not listed here as Chi-square comparisons were previously reported in Table 4.

Discriminant function analysis was used to determine what multivariate combination of the socio-demographic, social, health, and psychological (perceived control) variables distinguished between the two groups. The prior probabilities for the lonely vs. not lonely groups were specified as .31 and .69, respectively, as derived from the AIM 1996 sample results. That is, rather than leave the default that each of the two groups would have 50% of the sample, the known sample groupings were used (e.g., 31% in the lonely group).

Table 7

Two Group Discriminant Function Analysis: Group Means and Standard Deviations

	Not Lonely		Lonely		
Variables	M	SD	M	SD	$F(1, 758)$
Age	78.87	4.71	79.79	4.98	5.98*
Education	9.52	2.97	8.66	3.00	13.59**
Income inadequacy	1.80	.56	1.98	.56	17.12**
Duration in household	4.73	.74	4.58	.91	6.05*
Social activities	6.33	2.11	5.81	2.07	10.06**
Solitary activities	4.00	1.08	3.72	1.21	9.77**
IADL	10.31	1.55	9.65	1.75	27.03**
Perceived health	2.75	.65	2.38	.70	50.12**
Chronic conditions	3.30	2.33	4.53	2.65	41.84**
Perceived control	8.33	1.56	7.43	1.83	48.10**

Note: Group mean differences were examined using analysis of variance. IADL = Instrumental activities of daily living.
*$p \leq .05$. **$p \leq .01$.

This is based on the assumption that the sample is relatively representative of the older population of Manitobans, however, these proportions are also in congruence with past research indicating between 20-40% of older individuals are lonely at any given point in time (Pinquart & Sorensen, 2001; Wenger & Burholt, 2004; Weeks, 1994).

Can the set of variables discriminate the pre-defined groups? Because this was a 2-group discriminant function analysis, only one function was obtained which accounted for 100% of the between-group variability. The overall Wilks' lambda for Function 1 was significant, $\Lambda = .81$, $X^2(14, N = 760) = 159.63$, $p < .01$, indicating that, overall, the predictors reliably differentiated the two groups.

Which groups do the variables discriminate between (if any)? An examination of the group centroids showed that on Function 1 the lonely group (group centroid = -.73) was lower than the not lonely group (group centroid = .33).

Which combination of variables best discriminates between the groups? Structure coefficients and standardized coefficients (Table 8) were examined to determine which variables accounted for the group differences. As can be seen by examining the structure coefficients, Function 1 had strong correlations with *living arrangements*, *marital status, perceived health*, *perceived control*, and *chronic conditions.* Moreover, the standardized coefficients revealed an identical pattern, with these same five predictors having the *largest* coefficients. An examination of these coefficients in the context of the group centroids reveals that lonely adults were *more likely* to live alone and be widowed or divorced, and that lonely adults had *lower* perceived health and perceived control, and a *greater* number of chronic conditions.

Table 8

Two-Group Discriminant Function Analysis: Correlation and Standardized Coefficients

	Function 1	
1996 Variables	Correlation Coefficients	Standardized Coefficients
Living arrangements	**.58**	**.45**
Marital status	**.53**	.24
Perceived health	**.53**	**.32**
Perceived control	**.52**	**.38**
Chronic conditions	**-.48**	-.20
IADL	.39	-.02
Income inadequacy	-.31	-.17
Education level	.28	.16
Gender	.27	.06
Social activities	.24	.07
Solitary activities	.23	.04
Duration in household	.18	.12
Age	-.18	.04
Close friend	.05	.03

Note. IADL = Instrumental activities of daily living.

In summary, the variables included in the analysis *were* able to successfully discriminate the lonely vs. not lonely older adults. Moreover, the results suggest that the *best* discriminators reflect a combination of a *social* (rather than more isolated) living environment, better health and greater personal control. However, beyond discriminating the lonely vs. the not lonely, can these same variables discriminate those who are *persistently* lonely from those who are *persistently* not lonely or who perhaps overcome loneliness? This analysis is presented next.

Discriminant Function Analysis: AIM 1996-2001 (4 groups)

Recall, that the second major research question was: What sociodemographic, social, health, and psychological factors can discriminate between four groups of older adults who showed different patterns of loneliness over five years (i.e., lonely-lonely, $n = 112$; lonely-not lonely, $n = 123$; not lonely-lonely, $n = 95$; not lonely- not lonely, $n = 430$)?

Two discriminant function analyses were performed to address this question. First, a discriminant function analysis was conducted in order to determine whether the 14 *baseline* (AIM 1996) characteristics could discriminate the four groups. Briefly, the results showed that the 14 baseline AIM 1996 discriminating variables were only able to discriminate the AIM 1996 levels of loneliness (Appendix C). Put another way, the pattern of results suggested that the 1996 predictor variables can discriminate 1996 levels of loneliness (lonely vs. not), but not *change* in loneliness over time.

However, this may not be surprising as it would be predicted that *change* in the baseline variables rather than only the baseline variables themselves may be more powerful predictors of *change* in loneliness. Thus, second, a discriminant function

analysis was performed to determine how well the baseline *as well as* the change variables discriminated the four groups. Because *change is relative* to baseline values, it was important that the baseline 1996 variables also be included in the analysis.

Change variables. With the exception of gender, age, and education which were constants, *change* variables were created for each of the 11 discriminating variables, as described previously in the measures section. Note that the *personal care home (PCH) change variable* was also included in the analysis to reflect a change in housing from living in an apartment or house to a PCH. Table 9 shows the percentages of participants who had a change or not for each of these 12 *change* variables. Table 9 also shows whether overall mean differences emerged between AIM 1996 and 2001. It is apparent from this table that for the most part, mean differences in the expected directions emerged. For example, as would be generally expected in this sample of older adults, over time, participants were more likely to have poorer functional status, participate in less social activities, and have a greater number of health conditions. There was no significant mean difference for perceived health. It is interesting that a significant proportion of people *gained* better health over time (e.g., 29% for chronic condition) and greater perceived control (39%).

Can the set of baseline and change variables discriminate the pre-defined groups? Table 10 shows the means and standard deviations for the continuous baseline and change variables, according to the four groups. Note that the dichotomous variables (e.g., gender, marital status, etc.) are not shown, as Chi-Square comparisons for these variables were reported in Table 6. As can be seen, mean group differences were seen for

Table 9

Change Over Time: Percentage Change and Group Means at 1996 and 2001

Variables	% Change	1996 M	1996 SD	2001 M	2001 SD	t-test/ X^2
Income Inadequacy	Less adequate: 18% No change: 58% More adequate: 24%	1.86	57	1.79	.60	2.70**
Marital Status	Became widowed/divorced: 11% No change: 88.3% Became married: .7%	--	--	--	--	470.99**
Living arrangements	Change to living alone: 12% No change: 85% Change to living with others: 3%	--	--	--	--	396.27**
Moved to personal care home	Moved to PCH: 5% Did not move to PCH: 95%	--	--	--	--	--
Duration in household	Moved in last five years: 24% Not moved: 76%	4.68	.80	4.50	1.02	4.36**
Close friend	Change to having no friend: 18% No change: 73% Change to having a friend: 9%	--	--	--	--	53.59**
Social activities	Increased activities: 19% No change: 15% Decreased activities: 66%	6.17	2.11	4.88	1.84	17.10**
Solitary activities	Increased activities: 17% No change: 32% Decreased activities: 50%	3.91	1.13	3.36	1.19	12.14**
IADL	Loss in function: 59% No change: 27% Gain in function: 14%	10.10	1.65	8.66	2.72	16.91**
Perceived health	Loss in health: 24% No change: 55% Gain in health: 21%	2.63	.69	2.60	.71	1.32

(continued)

Variables	% Change	1996 M	1996 SD	2001 M	2001 SD	t-test/ X^2
Health conditions	Loss in health: 50% No change: 21% Gain in health: 29%	3.68	2.50	4.22	2.48	-6.64**
Perceived control	Loss in perceived control: 52% No change: 9% Gain in perceived control: 39%	8.05	1.70	7.67	1.88	5.33**

Note: Age, gender, and education were not included in the table as they are constants (age) or displayed no change (gender, education). IADL = Instrumental activities of daily living. Paired sample t-tests were performed for continuous data and X^2 tests were performed for categorical data.
*$p \leq .05$. **$p \leq .01$.

Table 10

Four Group Discriminant Function Analysis with Change Variables: Group Means and Standard Deviations

Variables	A Lonely – lonely M (SD)	B Lonely – not lonely M (SD)	C Not lonely – lonely M (SD)	D Not lonely-not lonely M (SD)	Group differences *F*(1, 226)	Significant contrasts
Age	80.20 (4.74)	79.41 (5.18)	79.19 (4.60)	78.80 (4.74)	2.69*	a-d*
Education	8.79 (2.73)	8.54 (3.27)	9.05 (2.52)	9.62 (3.05)	5.62**	a-d*, b-d**
Income inadequacy	2.02 (.58)	1.94 (.55)	1.77 (.57)	1.81 (.56)	6.26**	a-d**, a-c**
Duration in household	4.46 (1.01)	4.69 (.80)	4.74 (.67)	4.73 (.76)	3.73*	a-d**
Social activities	5.68 (2.19)	5.94 (1.96)	6.39 (2.07)	6.32 (2.12)	3.66*	a-d*
Solitary activities	3.70 (1.22)	3.75 (1.21)	3.95 (1.10)	4.01 (1.07)	3.37	
IADL	9.53 (1.73)	9.76 (1.77)	10.12 (1.62)	10.35 (1.54)	9.96**	a-d**, b-d**
Perceived health	2.32 (.69)	2.44 (.71)	2.77 (.69)	2.75 (.64)	17.34**	a-d**, b-d**, a-c**, b-c**
Chronic conditions	4.72 (2.64)	4.36 (2.65)	3.61 (2.65)	3.23 (2.25)	15.05**	a-d**, b-d**, a-c**
Perceived Control	7.30 (1.80)	7.54 (1.86)	8.14 (1.48)	8.37 (1.58)	16.93**	a-d**, b-d**, a-c**, b-c*
Change in income	.09 (.67)	.14 (.66)	-.04 (.62)	.04 (.63)	1.59	
Change in marital status	-.13 (.41)	-.05 (.22)	-.25 (.44)	-.08 (.29)	9.10**	a-c*, b-c**, c-d**
Change in living arrang.	-.11 (.41)	-.03 (.25)	-.28 (.48)	-.06 (.35)	11.04**	a-c**, b-c**, c-d**
Change in residence	1.29 (.45)	1.29 (.46)	1.24 (.43)	1.22 (.42)	1.29	
Change in friends	-.14 (.52)	-.05 (.53)	-.07 (.49)	-.07 (.51)	.73	
Change in social activities	-1.05 (2.30)	-1.36 (2.05)	-1.71 (2.24)	-1.23 (1.96)	1.93	
Change in solitary activities	-.65 (1.43)	-.44 (1.21)	-.80 (1.24)	-.51 (1.24)	1.90	
Change in independence	-1.70 (2.43)	-1.42 (2.15)	-2.05 (2.75)	-1.23 (2.25)	3.76*	c-d*
Change in perceived health	.03 (.72)	.05 (.82)	-.35 (.81)	-.01 (.78)	5.93**	a-c**, b-c**, c-d**

(continued)

Variables	A Lonely – lonely M (SD)	B Lonely – not lonely M (SD)	C Not lonely – lonely M (SD)	D Not lonely- not lonely M (SD)	Group differences *F*(1, 226)	Significant contrasts
Change in chronic conditions	-.88 (2.60)	-.01 (2.21)	-1.02 (2.43)	-.50 (2.09)	4.71*	a-b*, b-c**
Change in perceived control	-.60 (2.14)	.01 (2.18)	-1.01 (1.83)	-.30 (1.87)	5.63**	b-c**, c-d**
Change in PCH	.07 (.26)	.06 (.23)	.08 (.28)	.04 (.20)	1.41	

Note. IADL = Instrumental activities of daily living; living arrang. = living arrangements. Group differences were analysed using analysis of variance. The significant post-hoc group contrasts are shown using the letters a to d as corresponding to the four groups of older adults.
*$p \leq .05$. **$p \leq .01$.

most of the variables. Bonferroni post-hoc tests, which take into account the number of comparisons being made, were performed to determine just where the significant group differences were emerging. The significant post-hoc group contrasts are shown in the last column of Table 10 using the letters a to d as corresponding to the four groups of older adults. Given the number of statistical tests in this table in particular, results should be treated with caution; however, for completeness, all the relevant contrasts were included with their significance levels indicated.

Results showed that for *baseline* variables, the main groups that significantly differed from one another were the persistently lonely and the persistently not lonely. As well, in certain cases (e.g., for the health and perceived control variables) the two groups that were lonely at Time 1 differed from the two groups that were not lonely at Time 1. Results showed that for the *change* variables, the group that typically differed from the rest was the group that *became* lonely over time. For example, Table 10 shows that this group differed from the other three groups in terms of perceived health, living arrangements, and marital status. This interesting set of contrast findings will be returned to in a later discussion.

The Discriminant Function Analysis prior probabilities for the four groups were set according to the sample sizes (rather than using the default that all group sizes are equal), again assuming that the sample is relatively representative of the older population. Specifically, the prior probabilities were: lonely-lonely = .147; lonely-not lonely = .162, not lonely-lonely = .125; not lonely-not lonely = .566. That is, rather than leave the default that each of the four groups would have 25% of the sample, the known sample

groupings were used (e.g., 14.7% in the lonely-not lonely group, etc.).

Although theoretically up to three discriminant functions could be obtained, discriminant function results showed that only the *first and the second* functions were statistically significant and therefore only these are discussed and interpreted. Function 1 was significant, Wilks' lambda, $\Lambda = .65$, $X^2(78, N = 760) = 321.09$, $p < .01$, and accounted for 65% of the variance between groups. Function 2 was also significant, Wilks' lambda, $\Lambda = .86$, $X^2(50, N = 760) = 116.79$, $p < .01$, and accounted for 27% of the variance between groups. Thus, together the functions accounted for 92% of the variability between groups.

Which groups do the variables discriminate between (if any)? The first and second functions are considered separately.

Function 1. Based on the function centroids (shown in Table 11), Function 1 separated those who were lonely both times (lonely – lonely) (group centroid = -1.03) from the other three groups as follows: the less lonely over time (lonely – not lonely) (group centroid = -.47), the more lonely over time (not lonely – lonely) (group centroid = -.22), and, even more distinctively, discriminated between those not lonely both times (not lonely – not lonely) (group centroid = .45). Thus, Function 1 could be characterized primarily as reflecting differences between those who were lonely both times and those who were not lonely both times.

Function 2. Based on the group centroids (Table 11), Function 2 separated those people who were *more lonely* over time (not lonely – lonely) (group centroid = -.88) from those who were *less lonely* over time (lonely – not lonely) (group centroid = .42). The

Table 11

Four Group Discriminant Function Analysis with Change Variables: Group Centroids

	Group Centroids	
Four Groups	Function 1	Function 2
Lonely-lonely	**-1.03**	.05
Lonely-not lonely	-.47	**.42**
Not lonely-lonely	-.22	**-.88**
Not lonely-not lonely	**.45**	.06

group centroids for the other two groups were less extreme as follows: not lonely both times (not lonely – not lonely) (group centroids = .06) and lonely both times (lonely – lonely) (group centroid = .05). Function 2, therefore, could be characterized primarily as reflecting differences between those who were *more* lonely vs. *less* lonely over time.

Which combination of variables best discriminates between the groups? The first and second functions are considered separately.

Function 1: Discriminating between the persistently lonely and not lonely. The correlation and standardized coefficients for Function 1 and 2 are shown in Table 12,with the variables ranked according to the magnitude of the Function 1 structure coefficients. Function 1 could be defined by strong correlations with 1996 level *living arrangements, perceived control, chronic conditions, and perceived health*. The standardized coefficients reveal a similar pattern, albeit, with the most emphasis on living arrangements and perceived control. This means that what discriminates these two groups the most is that the "not lonely" group members are more likely to be living with others, have greater perceived control, better health, and are more likely to be married or single rather than widowed or divorced. Thus, the first function appears to reflect primarily one's living arrangements and level of perceived control in 1996.

Function 2: Discriminating between the groups that are more vs. less lonely over time. Function 2 could be defined by *change in living arrangements, change in marital status, change in perceived control, change in perceived health, as well as 1996 perceived health, and 1996 marital status* (Table 12). An examination of the standardized coefficients reveals a similar pattern with the main emphasis being on *change in living*

Table 12

Four Group Discriminant Function Analysis with Change Variables: Structure and Standardized Coefficients

	Function 1		Function 2	
Variables	Correlation Coefficients	Standardized Coefficients	Correlation Coefficients	Standardized Coefficients
Living arrangements	**.48**	**.67**	-.27	.18
Perceived control	**.45**	**.57**	-.19	.11
Chronic Conditions	**-.42**	-.31	.15	.02
Perceived health	**.42**	.26	**-.31**	-.17
Marital status	.39	.06	**-.39**	**-.41**
IADL	.35	.05	-.10	.08
Gender	.26	.06	-.01	.11
Income inadequacy	-.24	-.13	.21	.10
Education level	.24	.13	-.05	.03
Solitary activities	.20	-.07	-.09	.01
Social activities	.19	.03	-.14	-.19
Duration in household	.18	.09	-.05	-.08
Change in independence	.15	.01	.25	.14
Age	-.12	.02	.02	.01
PCH change	-.11	.16	-.12	-.15
Change in household	.10	-.02	.06	.21
Change in living arrangements	.09	.42	**.56**	**.52**
Change in marital status	.09	.07	**.51**	.19
Change in perceived control	.07	.31	**.39**	**.40**
Change in solitary activities	.06	-.13	.22	.10
Change in income	-.06	.03	.20	.09
Change in chronic conditions	.05	.27	.31	.17
Change in social activities	-.01	.08	.17	.05
Change in friends	.05.	.08	.02	-.06
Close friend	.04	.11	-.03	.02
Change in perceived health	.00	.09	**.41**	.25

Note. IADL = Instrumental activities of daily living.

arrangements, change in perceived control, and 1996 marital status (Table 12). This is basically the same pattern of results that was previously outlined. This means that what discriminates these two groups the most is that the group that *became lonely*, was more likely to go from living with others to living alone, was more likely to become widowed or divorced and was more likely to become less healthy over time and show a decrease in perceived control over time. Interestingly, note that these individuals were also more likely to have *better* perceived health and were more likely to be married or single in 1996. Jylha (2004) found a similar at-first-glance counter-intuitive result in regards to partner status: those who had a partner at Time 1 were more likely to be lonely at Time 2 than those who did not. Ultimately, these results make sense because those people with better health or those who were married at Time 1 theoretically have the most to *lose* over time.

Summary

In sum, Functions 1 and 2 appear to tell similar messages: being persistently lonely has to do with one's living arrangements, perceived control, and health (Function 1). Moreover, not surprisingly then, "overcoming" loneliness has to do with changing one's living arrangements, and gaining greater perceived control and better health (Function 2).

Study 1 Discussion: What does this mean? Where do we go from here?

A rather long list of variables were considered as potential discriminating variables based on theory and past research on loneliness among older adults. It is not only interesting to see out of the potential discriminating variables which ones came out as important, but it is also interesting to see which discriminating variables did *not* come out

as important. For example, it seems surprising that the variables attempting to capture more social aspects such as friendships and social activities did not turn out to be critical discriminators, all things considered. More specifically, these variables did not appear to be very useful in separating the groups of older adults examined in this study. It was also surprising that functionality or independence did not turn out to be critical for discriminating the groups of older adults. Of course, that is not to say that these variables are irrelevant in terms of understanding loneliness. It is possible that friendships are indeed significant in understanding older adults' loneliness. However, the results suggest that *in the context of other variables* such as health or perceived control or living arrangements, the ability of the friendship variable to discriminate between groups appears to be limited.

It is also surprising that the chronically or persistently lonely group was not qualitatively different from the other three groups. That is, based on the results, no evidence was found to suggest that this group differentiated in some special way from the other three groups (otherwise a discriminant function would have been found that reflected this difference). In particular, no pre-disposing baseline difference emerged to differentiate the persistently lonely from the other three groups. True, it is possible that other unmeasured variables not considered in the present analyses may have been able to discriminate this persistently lonely group from the others. But in examining a variety of socio-demographic, health, and social variables, the findings from this study suggest that persistently lonely adults are characterized by living alone, being in poor health, and

having lower perceived control. However, *change* any of these variables—for example, *increase* people's perceived control or improve people's health—and people may be able to overcome loneliness.

Deadly Combination

In terms of the variables that *did* come out as being important discriminators—it seems *living alone with poor health and low control* is a very deadly combination in terms of loneliness. So where should we go with this knowledge? Perceived control was shown to be a critical discriminating variable in all three analyses presented above. Perceived control was more important to loneliness than even people's social or solitary activities, having a close friend, having good functional health, or even how long people have lived in the community. Even taking into account living arrangements or health, perceived control still comes out as being essential in terms of discriminating groups of older adults.

Why focus on perceptions of control? It seems that, in terms of *application* of results, focusing on this variable has potential. Just as an example, based on these study results, we would not be set to encourage people to take up more solitary activities as a way to avoid being lonely because this variable did not show up at all as important in discriminating lonely vs. not lonely people. In looking at the other "top two" most important discriminating variables—living arrangements and health—it might be difficult to focus our efforts on changing these aspects among older adults. For example, in our society it would be difficult to say to an older person who is living alone: well you just need to go get a roommate! And it may be difficult and misleading to focus on seeing big

improvements in older people's health: Although this is certainly possible, we would expect a general decline in health as we age. But a psychological variable, like one's perceived control, could perhaps be modified or changed in later life. There may be ways to improve people's sense of control, which could reduce people's loneliness. And so this remains to me an area that we should continue to focus on.

In the end though, these results certainly support the idea that loneliness is complex. Being lonely does not simply relate to one's social activities or friendships or even to how much money one makes. It is not that straightforward. Rather it is a *combination* of physical, psychological, and social variables that matter—perceiving good health, perceiving high control, and cohabitating with other people. These three variables seem to be the important "line of defense" in terms of being lonely. Although it is the *combination* that is deadly, each variable will be explored in turn next.

Why Health?

Some might argue that health can reduce our social activity and hence relate to loneliness, but in this case, even accounting for social activity, health still came out as the more important predictor. It is also possible that poor perceived health represents "unmet needs" (Dykstra et al., 2005). As argued by Dykstra et al. (2005), a decline in health or functional status may affect people's ability to manage their tasks, resulting in unmet needs if help cannot be obtained. She argued that these unmet needs along with feelings of dependency and disappointment could lead to loneliness. Perhaps then, health represents needs from other people that are not being met, leading to loneliness. Of course, the present study results do not preclude the possibility that it is not poor health

that is causing loneliness, but that loneliness causes poor health. And there is some research that suggests such a directional relationship between health and loneliness (Cacioppo et al., 2002). The idea that loneliness may lead to poorer subsequent health is explored in Study 2.

Why Perceived Control?

Why would perceived control over various life domains be important in discriminating groups of older adults based on their loneliness over time? This is especially interesting, given that participants were not asked about control over friendships or social activities, but rather about more general domains that are not necessarily affiliative in nature. Perceived control's relation to choice and decision-making in general, and surrounding social activities and access to friends in particular, seems to be one potential explanation. For example, it is possible that having high levels of general perceived control represents the perceived ability to access friends and social support and help *if and when need be*. Thus, this cuts across *actual* numbers of friends or social activities—regardless of the number friends, it is this idea of being able to count on friends when in need that may be important. This comes back to the idea that, framed within the discrepancy perspective of loneliness (Perlman, 2004), perceived control might represent a confidence in bridging the discrepancy between actual and desired social relations (Newall, Chipperfield, Clifton, et al., 2009).

An alternative explanation is that people high in perceived control simply *may not feel they need people to obtain their desires and wishes.* Thus, perceived control represents a perception that ones needs are already taken care of which may protect

people somewhat from feelings of loneliness.

In another related perspective, based on attribution theory (Weiner, 1985), people make controllable or uncontrollable causal explanations for important events. For example, someone may explain their lack of friends as being due to bad luck (uncontrollable attribution) or to lack of effort in making friends (controllable). Different attributions lead to different emotions and behaviours (e.g., putting efforts into making new friends). It appears that making *controllable* causal attributions is associated with being less lonely (Anderson & Riger, 1991; Newall, Chipperfield, Clifton, et al., 2009). Thus, it is possible that those people with higher perceptions of control are simply more likely to be making *controllable* attributions for important events in their lives, which, in turn, protects against loneliness.

Why Living Alone?

Keeping in mind that it is simply not living alone per se that is important for loneliness, but the deadly combination of living alone in poor health and with low perceptions of control, why living alone? Why not some of the variables that could presumably be related to living alone such as social activities, income, or even marital status? Is there something about living alone that simply fails to meet a fundamental need in us as humans? Yet many people who live alone are not lonely; and many enjoy the solitude of living alone. Perhaps further insight could be gained by comparing people who are living alone *by choice* versus those who are living alone due to circumstances beyond their control (such as widowhood) or by examining how long people have lived by themselves (e.g., comparing those who were recently widowed from those who were

widowed and had been living alone for many years). And what about younger people? It is not as likely that a younger person would be living alone due to widowhood, rather there would be other reasons. So would we see the same pattern of results in younger adults? These questions all deserve more attention.

Conclusions

In sum, this study found, like past research, that approximately 30% of older adults are lonely at one point in time; and approximately 15% are lonely at two points in time (persistently lonely). In some ways, we need to decide as a society what kind of numbers are acceptable. Does it seem acceptable that 30% of older adults categorize themselves as lonely at a given point in time or that 43% of older adults report being lonely *at least once* over two points in time? What kind of ramifications does this have on our society or on our older community members? And if these numbers are unacceptable, then it would seem an important endeavor to continue to learn about loneliness among older adults and to try to do something about it.

Of course, not only is loneliness a poor state in its own right, loneliness appears to have consequences for people's health, and a few studies have shown loneliness to be related to mortality. However, less research has studied the potential consequences of loneliness using longitudinal data from a representative sample which can provide a stronger argument for the long-term potential consequences of loneliness. Understanding the potential consequences or ramifications of loneliness can help highlight the importance of developing interventions, strategies, and policies to address loneliness in our older community members. Study 2, which is described next, examines the

relationship between loneliness and subsequent health, physical activity, and mortality outcomes among older Manitobans.

Study 2 Introduction

The pain of *social rejection* has been found to be neurologically similar to *physical* pain (e.g., Chen, Williams, Fitness, & Newton, 2008; Eisenberger, Lieberman, & Williams, 2003; Panksepp, 2003). And loneliness has been described as a feeling of being *physically empty* inside (e.g., Schultz & Moore, 1984; Weiss, 1973). What effect does the pain of being lonely have on our bodies and our health? Does this pain effectively de-motivate us and *slow* us down in terms of our physical activity? Ultimately, does loneliness relate to greater *mortality*? And, if so, what pathways can explain this relationship?

Study 2 has several objectives broadly related to the mind-body connection between loneliness and our bodies. First, the present study attempted to replicate, in a representative sample of older Manitobans, past research which has found loneliness to predict older people's health. Second, this study examined whether loneliness predicts people's levels of *physical activity*. As is explained in greater detail later, the logic here was that loneliness may serve as a *de-motivating* emotion that reduces physical activity.

To the extent that loneliness is associated with poorer health and reduced physical activity, it would not be surprising if loneliness were to have long-term effect on *mortality.* Thus, the third objective was to examine the relationship between loneliness and mortality. Moreover, a mediation model was tested in which loneliness was expected to predict mortality *through* its effect on health and physical activity. Finally, the idea

that *positive emotions* might help us to recover more quickly from the negative effects of loneliness was analysed in the context of Fredrickson's (1998) theory. The hypotheses corresponding to these objectives are outlined following a discussion on how loneliness was measured in Study 2, and a literature review that summarizes research examining how loneliness relates to health, physical activity, and mortality as well as Fredrickson's Broaden and Build Theory of positive emotions.

The literature review will attempt to focus solely on research which has looked specifically at the construct of loneliness, with an emphasis on studies examining loneliness among older adults. It should be noted that a careful reading of past research articles on loneliness and health and mortality reveals that many authors, although discussing *loneliness*, cite studies on *social support* or *social isolation* as supportive evidence of a loneliness-mortality or loneliness-health connection. One paper on loneliness and mortality even operationally defined loneliness 'objectively' using participants' marital status (e.g., Niemi, 1979). This practice is confusing to say the least. More importantly, it may be misleading because loneliness and social support are different constructs. One cannot assume, therefore, that the extensive evidence showing a link between social support and mortality (e.g., Uchino, 2004) thereby provides evidence for a causal connection between *loneliness* and mortality.

Measuring Loneliness: Take 2

Definitions and ways of measuring loneliness were discussed previously in relation to Study 1. Recall that it was decided for Study 1 to measure loneliness using one item that asked participants to think about how they would categorize themselves in terms of

generally being lonely or not. The drawbacks of this measure were discussed; however, it was deemed to be the appropriate method to classify participants into groups. Study 2, in contrast to Study 1, takes more of a variable-centered approach to data analysis by investigating how *variables* relate to one another. Study 2 used de Jong and Kamphuis' (1985) Loneliness Scale to measure loneliness because this enabled a consideration of how participants' *degree* of loneliness (on a scale from 0-11) related to health, physical activity, and mortality. The language therefore changes from 'not lonely' to 'less lonely'.

The 11-item Loneliness Scale was developed out of the Netherlands by de Jong Gierveld and Kamphuis (1985) and can be described as "an indicator of social well-being and pertains to the feeling of missing an intimate relationship (emotional loneliness) or missing a wider social network (social loneliness)" (de Jong Gierveld & van Tilburg, 2006, p. 582). Thus, it draws from both Weiss' (1973) relational theory of loneliness (incorporating emotional and social loneliness) as well as the discrepancy perspective (tapping into the discrepancy between social relations people want and have) (Tijhuis et al., 1999). The scale was developed as a unidimensional measure of loneliness, but has also been used as a bidimensional measure with social and emotional loneliness subscales (e.g., van Baarsen, 2002). The 11-item scale has displayed good internal reliability (e.g., Tijhuis et al., 1999), and, along with the UCLA scale, represents the most commonly used scales of loneliness (Pinquart & Sorensen, 2001). Former Aging in Manitoba director, the late Betty Havens, included the Loneliness Scale in the AIM 1996 data collection. This led to international collaborations that helped to establish the loneliness

scale as appropriate to use in different cultural locations and countries (e.g., van Tilburg, Havens, & de Jong Gierveld, 2004).

Now that the loneliness measure has been described, the next section reviews literature on the relationship between loneliness and health.

Loneliness and Health

"*Mens sana en corpore sano*" -A healthy mind in a healthy body

The subsequent literature review focuses on studies that examine how loneliness relates to physical health in later life, as indicated by self-reported health and number and/or incidence of certain health problems and diseases.

Loneliness and health: Possible mechanisms. But first, it is important to ask: How might loneliness relate to poor health? Researchers have proposed several general pathways by which emotional states such as loneliness may be linked to health. In her essay on the field of health psychology Taylor (1990) stated, "a negative emotional state may produce pathogenic physiological changes; it may lead people to practice faulty health behaviors; it may produce illness behavior (such as visiting a physician) but no underlying pathology; or it may be associated with illness via other factors in some as-yet-undetermined manner" (p. 42). Mayne (1999) and others have argued that it is when there is slow emotional *recovery* from *stressors* that emotions can be detrimental to health. Mayne also cautioned that researchers should not ignore the important function of emotions for adaptation and survival (e.g., loneliness may highlight important deficits in social relationships).

Although positive emotions have been given much less focus in the research literature

than negative emotions (Fredrickson & Branigan, 2001), some research suggests that *positive emotions* can influence health through being associated with health-promoting behaviours and participation in social activities (e.g., Salovey, Rothman, Detweiler, & Steward, 2000). Another pathway through which positive emotions may influence health is through regulating or 'undoing' the effects of negative emotions, as hypothesized by Fredrickson in her Broaden and Build theory of positive emotions (e.g., Fredrickson & Branigan, 2001). As Study 2 considered the "undoing effect" in regards to positive emotions, loneliness, and health, this theory is described in more detail in a later section.

Overall, loneliness is thought to relate directly or indirectly to health outcomes through various means including: *direct physiological effects* such as immune response (Glaser et al., 1985; Kiecolt-Glaser et al., 1984; Pressman et al., 2005) and systolic blood pressure (Cacioppo et al., 2002; Hawkley et al., 2005; Uchino, Cacioppo, & Kiecolt-Glaser, 1996); *health behaviours* such as smoking (Lauder, Mummery, Jones, & Caperchione, 2006; but see Cacioppo et al., 2002); *stress processes* such as perceived stress (Hawkley et al., 2003); and *recovery and maintenance processes* such as sleep quality (Cacioppo et al., 2000; Pressman et al., 2005). In sum, there is theoretical and empirical rationale for a connection between loneliness and health.

Loneliness and self-reported health. Several researchers have found an association between loneliness and poorer self-reported health, assessed using a one-item measure. Not only is this rating easy to administer to participants, but it has been shown to predict mortality, even with other health indicators taken into account (e.g., Idler & Benyamini, 1997; Menec et al., 1999). Russell (1996) found a significant correlation between

loneliness and poorer perceived health among a convenience sample of older adults (65+ years). Fees et al. (1999), in a study focusing on people living in the U.S. state of Georgia in their 60's, 80's and 100's also found an association between loneliness and perceived health, and concluded that with advancing age, loneliness is a cause rather than a consequence of self-rated health affect. Berg, Mellstrom, Persson, & Svanborg (1981) found in a representative sample of 70-year-old Swedes that lonely people had poorer self-rated health than non-lonely people. Furthermore, Mullins, Smith, Colquitt, and Mushel (1996) found, in a sample of adults (44-99 years old) belonging to a congregate meal program, that loneliness correlated with poorer self-rated health. Although the above-reported studies used correlation and cross-sectional design, and most used convenience samples, the fact that the same trend is found across studies using different samples increases one's confidence in the findings.

One study which used a different methodology also found a significant relationship between loneliness and self-reported health. In a seven-year longitudinal study of older adults (65+ years), participating in the Netherlands-based Living Arrangements and Social Networks of Older Adults Research Project, Dykstra et al. (2005) used trend analysis to examine the association between loneliness and various characteristics over time, including functional health status and perceived health. The results showed that adults who were in better health tended to be less lonely than adults in poorer health, however, this difference decreased over time. Thus, they concluded that the protective effects of good health on loneliness diminishes in later life.

Loneliness and morbidity and incidence of health conditions. In addition to self-

reported health, there is some evidence that loneliness relates to both the *number* of chronic diseases (morbidity) and to the *kind of* disease among older individuals. Russell (1996) found that loneliness correlated with greater *number* of chronic conditions in older individuals (65+ years). Tomaka, Thompson, and Palacios (2006) found that loneliness was associated with self-reported diagnosis of certain diseases in a randomly selected sample of U.S. (New Mexico) older adults (60+). The associations differed among ethnic groups such that loneliness predicted hypertension, heart disease, and stroke among Hispanic participants; however, it predicted only emphysema diagnosis in Caucasian participants. A limitation to this study was the low incidences of certain diseases among the different ethnic groups. In a convenience sample of community-dwelling older adults (58+ years), Sorkin, Rook, and Lu (2002) found an association between loneliness and heart disease (as rated by a research team physician) that held even when controlling for other chronic conditions and health behaviours.

In a study of older people (65+) participating in the Longitudinal Aging Study Amsterdam, Penninx et al. (1999) found that greater loneliness was found in people having certain *kinds of diseases*, namely lung disease, peripheral vascular disease, and arthritis. The authors argued that these diseases are episodic in nature, requiring varying degrees of social support over time that may be more difficult for network members to provide. Note that, in congruence with the argument that loneliness is distinct from the structural characteristics of social support, results showed no associations between network size and presence of chronic conditions.

To conclude, several empirical studies suggest that loneliness predicts health.

Moreover, there are theoretical reasons for how loneliness could influence health, and some of which have been empirically supported. However, to increase confidence in the *generalizability* of results, it would seem that additional studies using *representative* samples of community-dwelling older people and longitudinal design is warranted. Given the potential cultural differences in relation to loneliness (e.g., van Tilburg et al., 2004), studies using representative samples of older *Canadians* would also be particularly important to help guide policy and intervention development closer-to-home.

In Study 2, an attempt is made to replicate a loneliness-health relationship in a representative sample of older Manitobans living in the community. In particular, the longitudinal associations between loneliness and perceived general health and number of chronic conditions (morbidity) is examined. In addition to examining health, Study 2 involved examining a health-related *behaviour* relevant for all age groups: *physical activity*. The literature on loneliness and physical activity is reviewed next.

Loneliness and Physical Activity

There appears to be little research on the relationship between loneliness and physical activity. Thus, the present proposed study will add to our knowledge by considering the association of loneliness and physical activity outcomes.

Loneliness and physical activity: Possible mechanisms. Again, it is first important to ask: How would loneliness relate to physical activity? It is possible that some of the mechanisms discussed above in relation to a loneliness-health connection could also theoretically explain a loneliness-physical activity connection. For example, lonely people may be less active because they have a (quantitatively or qualitatively) less-than-

satisfactory social network. They may also have less people in their lives encouraging them to participate in activities which could enhance physical activity and/or less people discouraging them from practicing negative health behaviours (i.e., *social control*; Hawkley, Thisted, & Cacioppo, 2009). This idea of social control may be particularly relevant for older women, as research suggests that simply living with others predicts greater everyday physical activity (Chipperfield, Newall, Chuchmach, Swift, & Haynes, 2008). At the same time, we know that being lonely is different from being alone or socially isolated. Therefore, lonely people may have as many people in their lives as not lonely people and so may be equally influenced by social control processes.

Based on the previously-reviewed research on loneliness and *sleep quality* (e.g., Cacioppo et al., 2000), it is possible that compared to people who are not lonely, lonely people may be less active because they simply have less energy due to less efficient or poorer sleep. Another mechanism may be that loneliness is a *de-motivating* or deactivating (Pekrun, Frenzel, Goetz, & Perry, 2006) emotion that reduces people's motivation to be active (Eloranta et al., 2008) and leads to withdrawal (Leary et al., 2007). Hawkley et al. (2009) furthermore tested the idea that loneliness may serve to impair people's *self-regulatory processes* which could reduce physical activity.

Loneliness and physical activity. Only a few recent studies have investigated the relationship between loneliness and physical activity. Using a cross-sectional design, Lauder et al. (2006) considered how loneliness might effect *attitudes* towards activity and lifestyle variables in a sample of adults (*M age* = 46 years). They found that although there were no differences between lonely and non-lonely in terms of having a sedentary

lifestyle, lonely adults had poorer attitudes towards walking as a form of leisure or recreation.

Lampinen, Heikkenin, Kauppinen, and Heikkenin (2006) examined older adults (65+ years) to consider whether health and activity predicted well-being, operationalized as a composite measure of loneliness, depression, anxiety, mental vigour, and meaning in life. They found that activity and health predicted current as well as subsequent well-being over eight years and concluded that better activity and health should be targeted as preventative measures to improve quality of life. Another study, McAuley et al. (2000) gave a walking or toning treatment to sedentary older adults (65+ years) and examined the effects of physical activity on loneliness as well as life satisfaction and happiness over 12 months. They found that both treatments resulted in gains in life satisfaction and happiness and reductions in loneliness over 6 months, but these gains did not hold at the 12-month follow-up.

Perhaps most relevant to the present discussion is the recently published study that focused on a population-based sample of 229 adults (ages 50-68 years) who were asked about their loneliness and physical activity and tracked for three years (Hawkley et al., 2009). The study's main measure of physical activity required people to answer whether in the past two weeks they had engaged in any of 14 exercises, sports, or physically-active hobbies. This variable was subsequently dichotomized to reflect either the presence or not of *any* physical activity in the past two weeks (89% in the affirmative at baseline). Loneliness was associated with a lower odds of having engaged in any physical activity (Hawkley et al., 2009). Moreover, with the exception of education and income,

none of the covariates (stress, hostility, depression, social support, self-rated health) were associated with physical activity in the cross-sectional study. The longitudinal study results showed a similar pattern; moreover, loneliness predicted a *transition* from being active to inactive over time, leading the authors to conclude support for a prospective relationship between loneliness and physical activity.

The present proposed study also considered loneliness as a potential cause of reduced physical activity by examining how loneliness at one point in time related to subsequent physical activity two years later. However, it should be noted that clearly a reciprocal causal relationship could exist such that lower activity could cause greater loneliness which could lead to less activity and so forth. As discussed later in detail (see methods section), unlike previous research, the present study measured both self-reported as well as objective physical activity (using activity recorders) in a sample of older adults (79+ years), including the old-old.

Loneliness and Mortality

"*The social world in large part defines who we are, how we appraise and relate to events in our lives, and how our biology develops, responds and ages*" (Cacioppo et al., 2000, p. 152)

The subsequent literature review examines studies that have focused on loneliness and mortality. Findings from the (few) relevant studies do indeed seem to suggest that loneliness relates to mortality among older individuals. However, there are few *prospective* studies, that is, studies that control for pre-existing health problems or predictors of mortality. Such studies would provide more compelling evidence for a

causal relationship between loneliness and all-cause mortality.

In one prospective study, Penninx et al. (1997) examined the relationship between mortality and aspects of social support, including loneliness, and personal coping resources such as mastery, self-efficacy, and self-esteem. Using data collected from participants (55-88 years old) of the Longitudinal Aging Study Amsterdam, they found that having greater feelings of loneliness (as well as having less feelings of mastery) were associated with mortality 29 months later even controlling for age, sex, chronic diseases, use of alcohol, smoking, self-rated health, and functional limitations. Moreover, they concluded that the "perceived" aspects of social support (loneliness) may be more important for mortality than the structural aspects of social support (e.g., number in social network; marital status).

Also using prospective design, Stek et al. (2005) studied the relationship between loneliness, depression and all-cause mortality five years later in a representative sample of the 85-year-old Dutch population. Results revealed that, although loneliness was not significantly related to mortality on its own, people who were *both* lonely and depressed had a 2.1 times higher mortality risk, and this relationship held even when controlling for sex, marital status, living arrangements, education, smoking, alcohol consumption, and chronic diseases. This could be compared to a mortality risk of .8 for people who were lonely but not depressed, and a mortality risk of 1.2 for people who were depressed but not lonely.

In another prospective study conducted with patients who underwent coronary artery bypass surgery (Herlitz et al., 1998), reports of feeling lonely predicted survival both one

month and five years after surgery, even controlling for factors known to effect mortality from this surgical procedure (e.g., gender, renal dysfunction). Finally, in contrast to the above pattern of study results, Samuelsson, Andersson, and Hagberg (1998) found no differences in terms of loneliness between those who died and those who did not die over their 13-year study of older adults (67+ years) living in Sweden, although the sample size for survivors was small (n = 69).

What about possible mediators between loneliness and mortality? In one study, Sugisawa, Liang, and Liu (1994) found that loneliness was *indirectly* related to mortality through self-rated health in a study of social networks of older Japanese (60 + years). Thus, self-rated health was identified as an explanatory variable for understanding the relationship between loneliness and mortality. As will be outlined more later, like Sugisawa et al. (1994), Study 2 involved examining health as a potential explanatory or mediating variable. In addition, the present study examined physical activity as a potential mediating variable between loneliness and mortality.

Some studies have examined mortality and *composite* indices of well-being that incorporate loneliness. Abrams (1983) investigated the relationship between various psychosocial constructs and mortality in a sample (N = 432) of 60-year-olds living in England. Although the majority of people indicated not being lonely/depressed (i.e., had low ratings on a scale assessing both loneliness and depression), out of those who were severely depressed and lonely, nearly half were deceased three years later. Note that this study did not use a prospective design, but simply examined associations without controlling for other possible causes of mortality.

Pitkala, Laakkonen, Strandberg, and Tilvis (2004) studied positive life orientation and mortality in a sample of 75-, 80- and 85-year-old people living in Helsinki, Finland. Although they did not examine feelings of loneliness in isolation from other variables, their measure of positive life orientation included a dimension of 'seldom feeling lonely', along with life satisfaction, planning for the future, having zest for life and feeling needed. Results revealed that having a positive life orientation significantly predicted still living in the community (not an institution) five years later and mortality 10 years later, even after adjusting for age, gender, and health measures.

Koivumaa-Honkanen et al. (2000) examined mortality and satisfaction and dissatisfaction with life in a Finnish sample of 18-64 year-olds. Their measure included a dimension of loneliness as well as happiness, and perceptions that life is interesting and easy. They found that being dissatisfied versus satisfied was associated with increased mortality risk from all causes, even when adjusting for age, health, activity, smoking, alcohol consumption, and marital status. They also found this effect to be especially strong for men.

Taken together, there is some evidence that loneliness predicts mortality in older adults, especially based on the few studies using prospective design (Herlitz et al., 1998; Penninx et al., 1997; Sugisawa et al., 1994). However, out of these studies, only the one by Penninx et al. (1997) found a *direct* relationship between loneliness and mortality among a *representative* sample of older people. Thus, it seems more research needs to be done to increase confidence in the reliability of this pattern of findings. The present study will investigate whether there is a direct relationship between loneliness measured in

2001 and mortality assessed in 2008 in a representative sample of community-dwelling Manitobans. More importantly, like Sugisawa et al. (1994), the present study will investigate explanatory variables by considering whether health and physical activity *mediate* this relationship.

The Moderating Role of Positive Emotions: Fredrickson's Broaden and Build Theory

Study 2 also steps into the relatively new realm of positive psychology, which focuses on "flourishing" rather "suffering" (Fredrickson, 2009), by examining the power of positive emotions in older adults. Study 2 examined the potential *moderating* or *recovery* role that positive emotions (specifically *happiness*) may play in the relationships between loneliness, health, physical activity, and mortality. What is guiding this line of thought is Fredrickson's Broaden and Build Theory of Positive Emotions (1998, 2001) which is described below. The study of emotions in older individuals is interesting in many ways, but perhaps especially because emotion regulation appears be an "exception to the rule" of the idea that decline or loss occurs with older age (e.g., decline in health, mobility). Rather, older people appear to be more proficient at regulating their emotions than younger adults (Gross et al., 1997). Moreover, the study of age-differences in positive and negative affect suggests that negative affect decreases with age and positive affect shows stability over time (Pitkala et al., 2004).

Fredrickson's (1998, 2001) Broaden and Build Theory of Positive Emotions focuses on *positive* emotions. As compared to negative emotions, positive emotions have traditionally received little attention by researchers, perhaps because of the focus on

abnormalities or problems in the field of psychology and because negative emotions appear to be more numerous and differentiated (Fredrickson & Branigan, 2001). Indeed Fredrickson and Branigan (2001) propose that there has been a "shoehorning" (p. 127) of positive emotions into general models of emotion.

Fredrickson and Branigan (2001) have discussed the trend by many emotion theorists to associate emotions with urges or *specific action tendencies* (e.g., see Frijda, 1986). For example, fear is associated with the specific action tendency to flee or escape. Fredrickson and Branigan (2001) argue that when researchers have attempted to associate action tendencies with positive emotions, the action tendencies have been vague, e.g., contentment related with general inactivity (Frijda, 1986, cited in Fredrickson & Branigan, 2001). In sum, they argue that, although models based on specific action tendencies have provided "sound and compelling descriptions of the form and function of many negative emotions" (p. 127), these models have failed to satisfactorily account for positive emotions.

To address this limitation of emotion theory, Fredrickson (1998) proposed that positive emotions may *not* be characterized by *specific action tendencies*, but rather by *non*specific action tendencies (Fredrickson, 1998). In support of this, she cites the aimless activity associated with joy. In addition, Fredrickson questioned the notion that emotions instigate physical action, as is typically accepted for negative emotions (e.g., fear with escape, anger with attack). Rather, she put forth that emotions, and particularly positive emotions, may also instigate cognitive action, which could result in certain activities. Thus, she argued for the replacement of the terms *specific action tendencies* with

thought-action tendencies or broader still, *thought-action repertoires* (Fredrickson, 1998).

With these terms described, it is possible to delineate Fredrickson's Broaden and Build Theory (1998; 2001). Specifically, this theory posits that while negative emotions *narrow* one's action tendencies or thought-action repertoires, positive emotions may *broaden* people's momentary thought-action repertoires. In addition, positive emotions also have the function of *building* personal resources–including physical, intellectual, social and psychological. Thus, she argues that the experience of *brief* positive emotions can not only make people feel good in the moment but can bring about *long-lasting* resources that can be drawn on later in other contexts and in other emotional states. The emotion of joy can be used to illustrate this point (see Fredrickson & Branigan, 2001). Joy appears to be associated with a tendency to be playful in a broad sense involving physical, social and mental playfulness such as exploration, or creativity. In this way, joy seems to *broaden* the thought-action repertoire. Furthermore, this playfulness could lead to *building* important social ties, skills, and innovation. Finally, it should be noted that the theory asserts that positive emotions, similar to negative emotions, are evolved adaptations. Specifically, it is argued that positive emotions, by having these *flexibility and building* aspects, have theoretically allowed people to gain crucial survival skills and characteristics.

Predictions from the theory: Beneficial effects of positive emotions or the "undo" effect. Stemming from the Broaden and Build theory, positive emotions have several possible beneficial effects. Most important for the present discussion, based on the idea

of the broaden and build theory that positive emotions serve to broaden one's thought-action repertories, positive emotions could also serve to regulate negative emotions or to "undo" the effect of negative emotions (Fredrickson, Mancuso, Branigan, & Tugade, 2000). That is, the broadening effect of positive emotions could serve to *undo* the hold or focus that negative emotions can have on the mind and body.

A series of experimental studies were performed to examine how this process works in terms of effects on the cardiovascular system (Fredrickson et al., 2000). In this series of studies, participants were anxiety-induced (by being informed that they would need to deliver a speech) and then shown movie clips designed to elicit one of four emotions (joy, contentment, amusement, sadness, and neutrality). Cardiovascular recovery was calculated by the amount of time that it took to return to a baseline level of emotional arousal. The two positive emotions significantly reduced cardiovascular recovery compared to neutrality and sadness. Furthermore, in a next study, positive film clips, when viewed by participants after a resting baseline, elicited no cardiovascular reactivity. This therefore shows that the main effect of positive emotions is in *undoing* and not *eliciting* changes to the cardiovascular system. In sum, these studies appear to support the notion that certain positive emotions may have the ability to undo the effects of negative emotional arousal. Another way of thinking about this might be that positive emotions help people *recover* more quickly from negative emotions.

In the present proposed study, the idea of an undoing effect of positive emotions, specifically, *happiness*, will be examined in relation to loneliness and health as well as physical activity and ultimately mortality among older individuals. To the extent that a

significant loneliness-health, loneliness-activity, or loneliness-mortality connection is observed, the possibility will be tested that experiencing greater happiness may serve to undo or weaken the strength of these relationships. It is argued that happiness is an appropriate positive emotion to consider in this context. This is because it is similar to *joy*, an emotion examined by Fredrickson and colleagues (2000) in the past as a broadening positive emotion.

Study 2 will test Fredrickson's theory using a non-experimental approach. Of course, there are drawbacks to using a non-experimental approach (i.e., correlation vs. causation; less researcher control). However, an advantage of using a non-experimental approach is that we will be able to get a sense if the hypotheses stemming from Fredrickson's theory can be shown to be supported outside of the laboratory. That is, rather than attempting to experimentally manipulate people's emotions such as loneliness and positive emotions, Study 2 involved examining people's experiences of emotions in a "real life" setting.

It should be noted that although past research suggests that positive emotions will not relate *directly* to *health* (Fredrickson et al., 2000), it is possible that positive emotions may relate directly to *physical activity*. For example, it has been suggested that *positive emotions* may be associated with health-promoting behaviours and participation in social activities (e.g., Salovey et al., 2000). Moreover, it is likely, based on past research findings, that happiness may relate to *mortality*. In a recent research article, for example, Koopmans, Geleijnse, Zitman, and Giltay (2010) found in a sample of older adults (65-85 years) that self-reported happiness predicted 15-year all-cause mortality. Although not the main focus of the present study, it is of interest to examine the relationship between

happiness and mortality here in an even *older* sample. More specific predictions are outlined next.

Summary and Hypotheses. In sum, the objective of Study 2 was to examine some of the consequences of being lonely for older adults. In particular, Study 2 examined how loneliness related to health, physical activity, and mortality. The present study was designed to add to knowledge in several ways. For example, this study examined loneliness in a very old (77-96 years in 2001) sample of Manitobans living in their homes in urban cities in and around Winnipeg, Manitoba. Given that most past research has focused on the "younger-old" (e.g., under age 75) this is an important contribution. Moreover, this study used longitudinal design by examining how loneliness measured at one point in time related to outcomes measured at a later point in time, adding credibility (though certainly not proof) of cause-and-effect relationships. In addition, the present study added to past research by investigating how loneliness related to an *objective* measure of physical activity. Moreover, unlike past research, potential *mediators* (health and activity) and *moderators* (positive emotions) of the relationship between loneliness and mortality were investigated. Findings that emerge can be generalized to cognitively-competent, English-speaking, urban-dwelling older adults living independently in a house or apartment.

Based on the above discussion and review of past literature, several hypotheses can be made in regards to Study 2 as follows:

1. Hypothesis #1: Greater loneliness will predict poorer health.

2. Hypothesis #2: Greater loneliness will predict less physical activity (self-reported and objective).

3. Hypothesis #3: Greater loneliness will predict mortality.

4. Hypothesis #4: To the extent that loneliness predicts mortality (Hypothesis #3), it is further hypothesized that *health* (Hypothesis 4a) and physical activity (Hypothesis 4b) will *mediate* this relationship.

5. Hypothesis #5: Based on Fredrickson's Broaden and Build Theory of Positive Emotions, it is hypothesized that happiness will serve to "undo" or weaken the strength of the relationship between loneliness and health (Hypothesis 5a), physical activity (Hypothesis 5b), and mortality (Hypothesis 5c).

Study 2: Methods

Ethical Approval

Ethical approval for the Successful Aging Studies was received from the appropriate University of Manitoba Ethics Boards and the Health Information Privacy Committee, Manitoba Health, at the time of the data collections. Because the present project was a secondary analysis of data from which all personal identifiers were removed, and because approval for the study was given by the principal investigator, an additional ethical approval process was not required (Appendices A and D).

Study 2 Participants: Successful Aging Study 2003

Addressing Study 2 research questions involved examining those respondents of AIM 2001 who had also participated two years later in the Successful Aging Study 2003 (N = 228). While not measuring loneliness, the Successful Aging Study 2003 assessed

participants' health and physical activity (both subjectively and objectively) and mortality information was obtained for the participants of SAS.

The Successful Aging Studies were offshoots of the AIM studies, designed to focus more in-depth on questions related to the psychology of aging and health. The SAS 2003 included those individuals who had participated in the 2001 Aging in Manitoba follow-up study and who met specific eligibility criteria. Importantly, the SAS 2003 differed from previous AIM studies in that it focused only on *urban*-dwelling participants who were able to answer all of the interview questions in English with little assistance from others. As described in more detail elsewhere (Newall, Chipperfield, Blandford, Perry, & Havens, 2004) those eligible for SAS 2003 were participants of AIM 2001 who had not died or moved out of province since AIM 2001 and who met the following criteria: (1) Were living in the community (i.e., not in personal care homes) in the cities of Winnipeg, Brandon, or Selkirk, in the province of Manitoba; (2) Had indicated English as the language of choice for the AIM 2001 interview; (3) Had received no or only some assistance from a proxy for the AIM 2001 interview; (4) Had fully satisfactory, adequate, or fairly satisfactory comprehension, as rated by the AIM 2001 interviewer; and (5) Had indicated they would be willing to participate in future studies at the time of the AIM 2001 interview. Based on these criteria, a total of 339 individuals were eligible for SAS 2003 prior to data collection.

Individuals eligible for the SAS 2003 study were sent a letter that informed them of the study and asked for their participation. Two female interviewers then telephoned individuals to set up in-person interviews. At this time interviewers identified non-

participants, that is, those individuals who either did not wish to participate (n = 11) or could not participate due to another reason (n = 96). The major reasons for non-participation reflected changes in status between AIM 2001 and the SAS 2003 data collection and included the following: Moved to a personal care home (n = 30), deceased (n = 27), too ill (n = 13), hearing impaired (n = 6), severe memory loss (n = 6), moved out of province (n = 4), unable to schedule interview or away for study period (n = 4), hospitalized (n = 3), severe speech problems (n = 1), language difficulties (n = 1), and unable to locate (n = 1). In total, 232 individuals completed SAS 2003 interviews. And, for the purposes of the present study, the SAS 2003 sample was reduced to the 228 participants who had valid information for level of loneliness.

As reported by Newall et al. (2004), in comparison to the larger AIM 2001 study sample, the SAS 2003 sample was similar in terms of gender and self-rated health; and yet participants were younger, more physically capable, and better educated. This has implications for the generalizability of study findings; however, the differences between samples are not surprising given the SAS study focused on a population of individuals residing in urban communities (and not in personal care homes) who were cognitively and physically capable of completing interviews with little or no assistance from others. Thus, findings should be generalized to older people who are living in urban areas in their own houses or apartments. Notably, when a one sample t-test was performed to determine whether the smaller subsample would differ in terms of level of loneliness (loneliness scale), the SAS participants included for Study 2 (N = 228) were found to be no more lonely than the larger sample of AIM 2001 participants included in Study 1 (N =

760), $M = 2.04$ vs. 2.21, $t(227) = -1.06$, $p = .29$. Thus, this helps alleviate concern that selecting a subsample of AIM participants somehow captured only those participants who were the *least* lonely.

Study 2 Participants: Everyday Physical Activity (EPA) Study 2003

Participants in the SAS 2003 were also asked to take part in the Everyday Physical Activity (EPA) 2003 study and wear an activity recorder for a day. Although this study took place in parallel to the SAS 2003, it can be considered a separate study with its own methods and participation rates which are fully described elsewhere (Chipperfield, 2008; Chipperfield et al., 2006). Briefly, all of the participants of SAS 2003 ($N = 232$) were also asked to give their consent to participate in the EPA component which involved participants wearing an activity recorder for approximately 24 hours and then completing a short follow-up questionnaire. In total, only 12 people refused to wear the activity recorders; however, for some participants who agreed to wear the recorders, activity information was not obtained due to scheduling conflicts ($n = 15$) and unusable activity data ($n = 7$). Thus, in total, activity recorder information was obtained for 198 participants. And, for the purposes of the present study, only the 194 participants who also had valid loneliness information were included in analyses. The process for downloading the actigraph data and creating meaningful activity measures is described later in the measures section.

The EPA study component involved two visits to participants' homes. On Visit 1, before interviewers asked the SAS 2003 interview items, they placed the activity recorders on participants' wrists, recorded the Start Time, and explained to interviewers

how to remove and replace the activity recorder. They also reviewed a hand-out that had spaces for the participant to indicate the reason an activity recorder was removed (e.g., during a bath) and when (e.g., 7 pm). Participants were also encouraged to go about their activities as they normally would. For Visit 2 (typically the day after Visit 1), interviewers collected the activity recorder and hand-out, recorded the End Time, and asked participants a few questions about their activity level and activities on the day they wore the activity recorder.

Study 2 Measures

Table 13 provides information on the Study 2 measures and descriptive statistics (N = 228). Sociodemographic variables (age, gender, education, income, marital status, living arrangements) and functional status were included as potential covariates for the main analyses.

Age. Participants' age in years in 2001.

Gender. Participants' gender (0 = *females*; 1= *males*).

Education level. In AIM 2001, participants reported the total number of years or grades they had completed in school. Using the same method outlined in Study 1, the one missing value was replaced with the mean (Tabachnick & Fidell, 2001).

Income inadequacy. A measure of income inadequacy was created from participant responses in 2001 to the following question: "Can you tell me how well you think your income and assets (including that of your spouse, where applicable) currently satisfy your needs?" (1 = *very well*; 2 = *adequately*; 3 = *with some difficulty*; 4 = *not very well*; 5 = *totally inadequately*). Same as Study 1 the responses of "*not very well*" and *"totally*

Table 13

Description of Study 2 Variables

Measures	Anchors	# of items	M	SD	Skew	Kurt	Range
Age 01 (yrs)	--	1	83.00	4.22	.74	-.15	77-96
Gender	0 = *women* (62.3%) 1 = *men* (37.7%)	1	--	--	--	--	0-1
Education 01 (yrs)	--	1	10.45	2.63	.45	1.74	3-21
Income inadequacy 01	1 = *very adequately* 2 = *adequately* 3 = *not adequately*	1	1.74	.62	.25	-.62	1-3
Marital status 01	1 = *marital loss* (52.6 %) 2 = no *marital loss* (47.4%)	1	--	--	--	--	1-2
Living arrangements 01	1= *lives alone* (53.1%) 2= *lives w /others* (46.9%)	1	--	--	--	--	1-2
IADL 01 (sum)	0 = *no* 1 = *yes, can do*	12	9.33	1.98	-1.23	2.32	1-12
Loneliness 01 (sum)	0 = *no* 1 = *yes, more or less*	11	2.05	2.30	1.09	.41	0-10
Happiness 2001	0 = *rarely or none of time* 3 = *most of time*	1	2.43	.83	-1.26	.55	0-3
Perceived Physical Activity 03	1 = *much less* 7 = *much more*	1	4.53	1.35	.07	-.45	1-7
Mean Day-Time Activity 03	--	--	767.11	317.94	.59	.09	140.99-1745.17

(continued)

Measures	Anchors	# of items	M	SD	Skew	Kurt	Range
Sedentary 03	0 = *not sedentary* (82.0%) 1 = *sedentary* (18.0%)	--	--	--	--	--	0-1
Health conditions 03 (sum)	0= *no* 1= *yes*	21	5.25	2.76	.50	-.08	0-14
Perceived health 03	1 = *poor* 2 = *fair* 3 = *good* 4 = *excellent*	1	2.59	.68	-.30	-.05	1-4
Mortality 08	1 = *alive in 08* (70.2%) 2 = *deceased between 03-08* (29.8%)	1	--	--	--	--	1-2

Note: IADL = Instrumental activities of daily living. For all variables, $N = 228$, with the exception of the objective physical activity measures, $N = 194$.

inadequately" were re-coded as 3, together reflecting generally *not adequate* income.

Marital status. Participants' self-reported marital status (1 = *widowed or divorced*; 2 = *married or single*) was obtained in 2001.

Living arrangements. The number of people (if any) who lived with participants in the same household was obtained in the 2001 interview. This variable was dichotomized to identify those who lived alone (1 = *lives alone*; 2 = *lives with others*).

Functional status. Participants' *functional status (independence*) was measured in AIM 2001 by asking whether or not they were independently capable of performing 12 specific instrumental activities of daily living (IADL; e.g., light housework, laundry, and food preparation). A composite score was created by summing the items so that higher scores reflected greater independence.

Loneliness. Loneliness was measured in AIM 2001 using de Jong Gierveld and Kamphuis's (1985) 11-item *loneliness scale*. Participants are simply asked about their agreement with a series of statements that do not directly refer to loneliness. Although typically used to measure loneliness as a unidimensional construct, it has also been used as a bidimensional measure tapping into social and emotional loneliness (van Baarsen, Snijders, Smit, & van Duijn, 2001). Five of the scale's items measure feelings of belonging or social loneliness (e.g., *"I can call on my friends whenever I need them"*), and six items measure feelings of missing relationships or emotional loneliness (e.g., *"I miss having a really close friend*). Based on participant agreement with the statements (*no = 0*; *more or less, yes = 1*), a composite measure was created by summing item scores such that higher scores reflected greater loneliness. The scale had good internal reliability

(*Cronbach's alpha* = .79).

Positive emotions. Level of happiness was assessed in AIM 2001 by asking participants to report how often they felt they were *happy* in the *past week* (0 = *rarely or none of the time*; 1 =

some of the time; 2 = *moderate amount of time*; 3 = *most or all of the time*).

Physical activity. *Perceived physical activity* was assessed in SAS 2003 by asking participants to rate on a seven-point scale: "In general, compared to others your age, how active are you? When I say active I am not referring to the amount of physical exercise but simply to the amount of physical movement. A person can do very little exercise and still be very active" (1= *much less active*; 4 = *the same*; 7 = *much more active*). Note that an identical measure was created in 2001 and was used as a covariate in selected analyses (*M* = 5.15; *SD* = 1.47).

In addition, participants' *objective everyday physical activity* was assessed using activity recorders. Although described in more detail elsewhere (Bailis, Chipperfield, & Helgason, 2008; Chipperfield, 2008; Chipperfield et al., 2008; Chipperfield et al., 2006) participants were given instructions on how to remove and put on activity recorders that fastened to their wrists like a wrist watch. Participants were asked to wear the activity recorders for 24 hours, to go about their activities like they normally would, and to only remove the activity recorders when necessary (e.g., while taking a bath).

These activity recorders (Actigraph Models AM7164), also called actigraphs or accelerometers, are small devices (weighing 1.5 ounces and measuring 2 X 1.6 X .6 inches) that are enclosed in a metal shield and typically are secured to a velcro strap.

Specifically designed to capture body movement frequencies (.25 to 2.5 hertz), the recorders continuously collect acceleration movement within the vertical and horizontal planes at a rate of 10 signals per second. After a user-defined cycle (1 minute) these acceleration data are summed and recorded (interpreted as the amount of activity per minute), thus combining 600 accelerations (10 X 60 seconds). These acceleration data are then downloaded into statistical packages such as SPSS for data analysis.

Using this raw acceleration data, activity measures can be created in various ways. For example, for the purposes of the present proposed study, participants' *mean* everyday physical activity scores were examined (see Bailis, Chipperfield, Perry, Newall, & Haynes, 2008; Chipperfield et al., 2008). The creation of these scores involves first parsing out any data that was not collected during the day time. Second, for each participant, an average of the acceleration data is calculated. Thus, scores represent participants' average minute-by-minute day-time activity. In addition to mean everyday activity levels, participants were classified as being sedentary or not (0 = *not sedentary*; 1 = *sedentary*). "Sedentary" was defined as having a complete absence of any movement (activity scores of zero) for greater than or equal to 30% of the time (Chipperfield, 2008).

It should be noted that activity recorders have been demonstrated to be *valid* measures of activity. For example, physical activity, as measured by activity recorders, has been shown to relate to energy expenditure and oxygen uptake in adults (Melanson & Freedson, 1995). Past research has also shown activity recorders to be *reliable* devices as well (Welk, Schaben & Morrow, 2004). Because a subset of the EPA 2003 participants (*n* = 68) also participated in a study one year later (Lambert, 2006), it was possible to

examine the test re-test reliability of the activity recorders. The reliability was found to be quite acceptable, as it was found that Time 1 and Time 2 EPA mean activity scores were highly correlated, r (68) = .77, $p < .01$.

Health. Participants' health status was measured by asking whether they currently had, or were still feeling the after-effects of, 21 specific health conditions (e.g., heart and circulation problems, arthritis). These items were summed to create a composite measure of *number of health conditions*, with higher scores indicating poorer health. Note that an identical measure was created in 2001 and was used as a covariate in selected analyses (M = 4.39; SD = 2.62).

Individuals' general *perceived health* was also assessed by asking them to rate their health compared to other people their own age. Possible responses range on a 5-point scale (1= *excellent*; 2 = *good*; 3 = *fair*; 4 = *poor*; 5 = *bad*). The small number of "*bad*" responses were re-coded as "*poor*" health. In addition, responses were reverse-coded, resulting in scores ranging from 1 (*poor*) to 4 (*excellent*). Note that an identical measure was created in 2001 and will be used as a covariate in selected analyses.

Mortality. Mortality information was obtained for SAS 2003 participants from two sources. First, mortality data (date of death), updated up through 2004, was obtained from Manitoba Health. However, it should be noted that the results and conclusions presented are those of the author. No official endorsement by Manitoba Health is intended or should be inferred.

In addition to the information obtained from Manitoba Health, ethical approval was received to perform status checks (by the Laboratory for Aging and Health Research,

University of Manitoba) in 2005 and January of 2009 to determine whether SAS participants had passed away or not. Specifically, these mortality status checks were performed using the Winnipeg Free Press on-line obituaries. Death was deemed to be confirmed through matching a person's *first and last name, gender,* and *date of birth* (year, and, if possible, month and day) in the on-line obituaries. Using the information from Manitoba Health and the 2009 status checks, it was possible to create a variable that reflected mortality as assessed as of the 2008 year end (0 = *alive*; 1 = *deceased*). In total, 68 (29.8%) of the 228 participants had passed away by 2008.

Study 2 Results

Prior to presenting the regression analyses addressing the major research hypotheses, preliminary analyses were conducted to: 1) Examine correlations among variables; and 2) Identify potential covariates.

Correlations Between Study 2 Variables

Table 14 shows the correlation coefficients between all of the Study 2 variables. Several expected correlations were found including those between age and other sociodemographics, independence, and mortality. In particular, as would be expected, being older was associated with being single or widowed (not married), living alone, being less functionally independent, and with being deceased seven years later in 2008. Note that age was also associated with objective, but not *perceived*, physical activity. Other interesting correlations included those involving happiness. Greater happiness was associated with perceiving that one's income is more adequate (or less *in*adequate), ($r(226) = -.14$, $p < .05$), perhaps supporting the facetious conclusion that money really

Table 14

Correlations Between Study 2 Variables

Variables	1	2	3	4	5	6	7	8	9	10	11
1. Age 01	--										
2. Gender 01	-.02	--									
3. Education 01	-.09	-.05	--								
4. Income inadequacy 01	.06	-.07	-.21**	--							
5. Marital status 01	-.20**	.35**	.11	-.14*	--						
6. Living arrangements 01	-.27**	.32**	.03	-.11	.75**	--					
7. IADL 01	-.29**	.24**	.16*	.01	.07	.10	--				
8. Loneliness 01	.12	.04	-.13	.14*	-.20**	-.10	-.08	--			
9. Happiness 01	-.01	-.14*	.17**	-.14*	.00	.00	.11	-.31**	--		
10. Perceived activity 03	-.03	.08	.07	-.06	-.04	-.05	.38**	-.21**	.13*	--	
11. Day-time activity 03	-.27**	-.03	.05	-.01	.12	.11	.21**	-.04	.04	.16*	--
12. Sedentary 03	.12	.11	-.07	.06	-.08	-.09	-.07	-.10	-.01	-.13	-.47**
13. Health conditions 03	.02	-.04	-.10	.08	-.06	-.05	-.39**	.27**	-.10	-.30**	-.14
14. Perceived health 03	.04	.04	.15*	-.06	.04	-.01	.29**	-.22**	.05	.30**	.06
15. Mortality 08	.20**	.13	.01	-.04	-.04	-.08	-.16*	.26**	-.21**	-.20**	-.12

(continued)

Variables	12	13	14	15
1. Age 01				
2. Gender 01				
3. Education 01				
4. Income inadequacy 01				
5. Marital status 01				
6. Living arrangements 01				
7. IADL 01				
8. Loneliness 01				
9. Happiness 01				
10. Perceived activity 03				
11. Day-time activity 03				
12. Sedentary 03	--			
13. Health conditions 03	.08	--		
14. Perceived health 03	-.06	-.38**	--	
15. Mortality 08	.15*	.17*	-.08	--

Note: Pearson correlation coefficients were used for continuous variables; Spearman correlation coefficients were used for dichotomous variables.
IADL = Instrumental activities of daily living.
*$p \leq .05$. **$p \leq .01$.

can buy happiness (but see Myers & Diener, 1995). Lastly, focusing on mortality, it is noteworthy that Spearman correlations revealed that the variables that correlated the strongest with mortality were *loneliness* followed by *happiness, age,* and *perceived physical activity*.

Covariate Selection

To select covariates for subsequent analyses, correlations were examined between sociodemographics and functional status and each of the dependent variables: health, physical activity and mortality. Not surprisingly, *functional independence* was associated with almost all of the dependent variables (Table 14), highlighting the importance of controlling for functional independence in subsequent analyses. *Age*, was associated with mortality as well as most of the objective indicators of activity. Although the correlation between *gender* and mortality (r[226] = -.13, p = .06) did not quite reach statistical significance, based on theoretical considerations involving gender and health and mortality in later life, gender was also controlled for in subsequent analyses. In addition, for theoretical reasons, *income inadequacy* was selected to control for socioeconomic status. In summary, based on empirical and theoretical reasons, the following covariates were included in all subsequent analyses: age, gender, income, and functional independence.

Hypothesis 1: How does loneliness relate to subsequent health in 2003?

Analysis Plan. A series of ordinary least squares (OLS) multiple regression analyses were conducted to address Hypotheses 1 that loneliness predicts health. Because health can be influenced by sociodemographic factors, Model 1 simply held constant the effects

of age, gender, income, and functional status. Model 2 included loneliness which allowed for the examination of the effect that loneliness had over and above the sociodemographic variables. Model 3 held constant the effect of past (2001) health to examine whether loneliness predicted 2003 health beyond this effect. Note that this latter model is conservative given the fact that past health measured only two years prior was strongly related to present health.

Analysis Results. Hypothesis 1 stated that loneliness would be associated with poorer subsequent health. Table 15 shows the results of the multiple regression analyses in which *number of health conditions 2003* is the outcome. In Model 1, that included only the covariates, functional independence (IADL) was a strong predictor of health conditions (β = -.43, p < .01). Together the covariates accounted for 17% of the variance in health conditions. When compared to Model 1, adding loneliness to the model (Model 2) increased the amount of explained variance from R^2 = .17 to R^2 = .23 (*F change* = 16.65, p < .01). Thus, loneliness, together with the covariates, accounted for 23% of the variance in subsequent health with *less* functional independence (β = -.42, p < .01), and *greater* loneliness (β = .24, p < .01), being associated with having a greater number of health conditions two years later. Thus, Hypothesis 1 was supported: greater loneliness was related to a poorer health, measured in terms of number of health conditions. Interestingly, when *both* functional independence and loneliness are held constant (Model 2), being *older* appears to relate to being *healthier* (β = -.13, p < .05).

Model 3 shows the most conservative model including past health conditions measured approximately two years earlier (Table 15). Comparing this model to Model 2,

Table 15

Regression Beta Weights for Covariates (Model 1), Loneliness (Model 2), and Past Health (Model 3) Predicting Subsequent Health Conditions 2003

	Model 1	Model 2	Model 3
Variables	*β*	*β*	*β*
Age 2001	-.11	-.13*	-.07
Gender	.06	.06	.05
Income inadequacy 2001	.09	.06	.01
IADL 2001	-.43**	-.42**	-.12*
Loneliness 2001	--	.24**	.07
Health conditions 2001	--	--	.71**
F	11.59**	13.25**	57.78**
R^2	.17	.23	.61

Note. IADL = Instrumental activities of daily living.
*$p \leq .05$. **$p \leq .01$.

adding past health to the model increased the amount of explained variance in health from $R^2 = .23$ to $R^2 = .61$ (*F change* = 216.23, $p < .01$). As can be seen in Table 15, adding past health eliminates the significant relationship between loneliness and number of health conditions ($\beta = .07$, $p > .05$) and significantly reduces the relationship between functional independence and health ($\beta = -.12$, $p < .05$). This is not entirely surprising, given the extremely strong relationship between health in 2001 and 2003 ($\beta = .71$, $p < .01$).

Table 16 shows the results of the multiple regression analyses in which *perceived health* is the outcome. In Model 1 that includes only the covariates, functional independence was a strong predictor of perceived health ($\beta = .33$, $p < .01$). Together the covariates accounted for 11% of the variance in perceived health. Model 1 can be compared to Model 2 in which loneliness is added. Adding loneliness in Model 2 increased the amount of explained variance in health from $R^2 = .11$ to $R^2 = .15$ (*F change* = 10.35, $p < .01$). Thus, loneliness ($\beta = -.20$, $p < .01$) together with the covariates accounted for 15% of the variance in subsequent health. Results therefore supported Hypothesis 1: greater loneliness predicted poorer health, measured in terms of perceived health.

Model 3 shows the most conservative model including past perceived health measured approximately two years earlier in 2001 (Table 16). Comparing this model to Model 2, adding past health to the model increased the amount of explained variance in health 2003 from $R^2 = .15$ to $R^2 = .22$ (*F change* = 22.04, $p < .01$). even with the addition of past health the relationship between loneliness and health remains significant ($\beta = -.14$,

Table 16

Regression Beta Weights for Covariates (Model 1) and Loneliness (Model 2) and Past Health (Model 3) Predicting Subsequent Perceived Health 2003

	Model 1	Model 2	Model 3
Variables	β	β	β
Age 2001	.14*	.16*	.12*
Gender	-.01	-.00	-.01
Income inadequacy 2001	-.07	-.04	-.03
IADL 2001	.33**	.32**	.23**
Loneliness 2001	--	-.20**	-.14*
Perceived health 2001	--	--	.30**
F	6.52**	7.50**	10.52**
R^2	.11	.15	.22

Note. IADL = Instrumental activities of daily living.
*$p \leq .05$, **$p \leq .01$.

$p < .05$). In sum, Hypothesis 1 was supported by the results for number of health conditions and perceived health.

Hypothesis 2: How does loneliness relate to subsequent physical activity outcomes in 2003?

Analysis plan. The same analysis plan as described for Hypothesis 1 was used to address Hypothesis 2 that loneliness predicts physical activity. Multiple regression analyses were performed to determine whether loneliness predicted physical activity. These analyses were conducted using the 2001 loneliness scale, 2003 perceived physical activity, and the two objective measures of 2003 everyday physical activity as follows: mean everyday physical activity and sedentary levels. In addition to the inclusion of age, gender, income, and functional independence, perceived activity, measured in 2001, was included as a covariate.

Analysis results. Table 17 shows the results of the multiple regression analysis in which *perceived physical activity* was the dependent variable. When including only the covariates (Model 1) functional independence strongly predicted physical activity (β = .42, $p < .01$). Together the covariates accounted for 17% of the variance in physical activity. Adding loneliness to Model 2 increased the amount of explained variance R^2 = .17 to R^2 = .21 (*F change* = 10.26, $p < .01$). Thus, loneliness together with the covariates accounted for 21% of the variance in subsequent physical activity. Table 17 shows that being *less* functionally independent (β = .41, $p < .01$), and *more* lonely (β = -.20, $p <$ .01), was associated with being *less* subjectively physically active two years later. Thus, results supported Hypothesis 2 in terms of the outcome of perceived physical activity.

Table 17

Regression Beta Weights for Covariates (Model 1) and Loneliness (Model 2) and Past Activity (Model 3) Predicting Subsequent Perceived Physical Activity 2003

	Model 1	Model 2	Model 3
Variables	β	β	β
Age 2001	.15*	.17**	.12*
Gender	.01	.01	.03
Income inadequacy 2001	-.07	-.05	-.02
IADL 2001	.42**	.41**	.29**
Loneliness 2001	--	-.20**	-.16*
Perceived activity 2001	--	--	.30**
F	11.10**	11.32**	13.80**
R^2	.17	.21	.28

Note. IADL = Instrumental activities of daily living.
*$p \leq .05$ **$p \leq .01$

Model 3 shows the more conservative model including past perceived physical activity measured approximately two years earlier. Adding past activity to the model increased the amount of explained variance in activity 2003 from $R^2 = .21$ to $R^2 = .28$ (*F change* = 20.95, $p < .01$). Even with the addition of past activity, the relationship between loneliness and activity 2003 remains significant ($\beta = -.16$, $p < .05$).

Table 18 shows the results of the multiple regression analysis in which participants' *mean everyday physical activity level* was the dependent variable. In Model 1 that included only the covariates, age was the strongest predictor of activity ($\beta = -.23$, $p < .01$). That is, being *older* predicted being *less* physically active during the day as measured with the activity recorders. Together the covariates accounted for 9% of the variance in physical activity. Adding loneliness to Model 2 did *not* increase the amount of explained variance in everyday physical activity. Table 18 (Model 2) shows that age ($\beta = -.23$, $p < .01$) predicted physical activity; whereas, loneliness did not ($\beta = -.02$, $p > .05$).

In addition to participants' mean everyday physical activity, another objective physical activity variable (as created from the activity recorder data) was considered as a dependent variable: participants' *sedentary levels*. A separate logistic regression analysis was performed for this outcome (Appendix E). Similar to the outcome of mean day-time activity levels, loneliness failed to predict this objective activity outcome in the context of the covariates as well as when previous activity was accounted for (Appendix E). Thus, results failed to support Hypothesis 2 in terms of the objective outcome measures of physical activity.

Table 18

Regression Beta Weights for Covariates (Model 1) and Loneliness (Model 2) and Past Activity (Model 3) Predicting Subsequent Mean Day-Time Physical Activity 2003

	Model 1	Model 2	Model 3
Variables	*β*	*β*	*β*
Age 2001	-.23**	-.23**	-.25**
Gender	- .05	- .05	-.04
Income inadequacy 2001	.01	.01	.02
IADL 2001	.15*	.15*	.08
Loneliness 2001	--	-.02	.01
Perceived activity 2001	--	--	.17*
F	4.88**	3.89**	4.19**
R^2	.09	.09	.12

Note. IADL = Instrumental activities of daily living.
*$p \leq .05$. **$p \leq .01$.

Hypothesis 3 and 4: How does loneliness relate to mortality?

Analysis plan. A series of binary logistic regression analyses were conducted to address Hypotheses 3 that loneliness predicts the dichotomous dependent variable mortality and Hypothesis 4 that health and physical activity may explain this relationship. Model 1 simply held constant the effects of age, gender, income, and functional status. Model 2 included loneliness, and Model 3 included health and perceived physical activity to evaluate their role as potential mediators of the relationship between loneliness and mortality. *If* a significant relationship between either of these mediators and mortality were observed in Model 3 *and if* the relationship between loneliness and mortality were significantly reduced compared to Model 2, this would provide evidence of a mediation effect (Baron & Kenny, 1986).

As with OLS regression, it is of interest to compare the R^2 between different models. However, in logistic regression there is no exact analogue to the coefficient of determination (R^2). Rather, several options have been proposed that approximate it. Based on recommendations by Menard (1995, 2000), a measure of the *proportion of reduction in error*, R^2_L , was calculated. The measure of R^2_L is basically a "goodness of fit" indicator. Or, put another way, R^2_L indicates "by how much the inclusion of the independent variables in the model reduces the badness of fit D_0 chi-square statistic" (Menard, 1995, p. 22). R^2_L varies between 0 (for a model in which the independent variables do not predict the dependent variable) and 1 (for a model in which the

independent variables predict the dependent variable with perfect accuracy) (Menard, 1995).

Note that interpreting logistic regression results typically involves examining the reported *odds ratios* and their associated significance as indicated by the Walds test. *Odds ratios* show, for example, the odds of dying by a particular time given a *1-unit* increase in a predictor variable. An odds ratio greater than one indicates that the odds of dying *increases* when the predictor increases; whereas, an odds ratio less than one shows that the odds of dying *decreases* as the predictor increases. Thus, the odds ratio associated with age would indicate the odds of dying given an increase in age by one year. Similarly, an odds ratio associated with the 2-level variable, gender, would indicate the odds of dying given that one were female (or male).

Odds ratios are useful and informative, however, it becomes intuitively clear that it can be "treacherous" (Cohen et al., 2003, p. 511) to compare odds ratios *across* predictor variables that have different scales since this is somewhat like comparing apples to oranges. As an example, in Study 2, gender is a two-level variable; however, age is a 19-level variable (age range 77-96 in 2001). Therefore, a 1-unit increase in age only covers a small portion of the range in the scale and makes comparing odds ratios difficult. This is analogous to the comparison of unstandardized and standardized regression coefficients in multiple linear regression. As of yet, there is no straightforward nor universally accepted way to deal with this issue of comparing odds ratios. One solution is to report the odds ratios associated with a *greater than 1 unit* increase in the predictor variable. For example, a researcher could report the odds of dying given a 5-unit or 10-unit increase in

age, rather than only a 1-unit increase (Cohen et al., 2003; Penninx et al., 1997). This method will be used, as appropriate, for the present study.

In addition, for the present study, *standardized* logistic regression coefficients were calculated as outlined by Menard (1995, p. 46) and as recommended by Cohen et al. (2003) to convert predictors to a common scale of measurement (see Appendix F). Here, the standardized coefficients represent the standard deviation change in the predicted (logit) dependent variable given a 1 standard deviation increase in the predictor variable. For a variable such as gender, a 1 standard deviation change is not as meaningful as the difference between females and males; nonetheless, calculating these coefficients allows a researcher to examine the *relative* importance of each predictor variable on mortality (i.e., compare apples to apples).

Analysis results. Hypothesis 3 stated that loneliness (2001) would be associated with mortality (2008), even when controlling for covariates. Hypothesis 4 stated that health and physical activity would explain or mediate this relationship. Table 19 shows the logistic regression Model 1 results in which the covariates predicted mortality 2008. Using R^2_L as an approximate of R^2, the covariates were shown to reduce the model error by 7%. Moreover, age, gender, and functional status predicted mortality. The standardized coefficients show that age ($\beta = .18$, $p < .05$) was the strongest predictor of mortality. Examining the odds ratios, every unit (year) increase in age *increased* the odds of being deceased by 10% [(1.10 – 1) X 100 = 10%]. Moreover, being male *increased* the odds of being deceased by a very substantial 106% [(2.06 – 1) X 100 = 106%]! And every unit *increase* in functional independence *reduced* the odds of being deceased by

Table 19

Odds Ratios (OR) for Covariates (Model 1) and Loneliness (Model 2) and Health and Activity (Model 3) Predicting Mortality 2008

	Model 1				Model 2				Model 3			
Variables	*B*	SE	β	*OR*	*B*	SE	β	*OR*	*B*	SE	β	*OR*
Age 01	.10	.04	.18	1.10*	.09	.04	.16	1.09*	.11	.04	.19	1.12**
Gender	.72	.32	.16	2.06*	.76	.33	.16	2.13*	.78	.33	.15	2.18*
Income inadequacy 01	-.12	.25	-.03	.88	-.31	.26	-.08	.73	-.36	.27	-.09	.70
IADL 01	-.17	.08	-.15	.84*	-.17	.08	-.14	.85*	-.08	.09	-.07	.92
Loneliness 2001	--	--	--	--	.27	.07	.26	1.31**	.24	.07	.22	1.26**
Health Conditions 03	--	--	--	--	--	--	--	--	.05	.07	.05	1.05
Perceived activity 03	--	--	--	--	--	--	--	--	-.24	.14	-.13	.79
Model R^2_L	.07**				.13**				.15**			

Note. IADL = Instrumental activities of daily living; B = unstandardized coefficients; SE = standard errors; β = standardized coefficients and significance levels are the same as corresponding odds ratios; OR = odds ratio; Model R^2_L = reduction in model error explained by the predictors.
*$p \leq .05$. **$p \leq .01$.

16% [(.84 – 1) X 100 = -16%].

Comparing Model 1 to Model 2 which added loneliness (Table 19) showed that the R^2_L increased from .07 to .13, meaning that loneliness helped reduce the model error by an additional 6%. Age, gender and functional status continued to predict mortality. Most importantly, loneliness predicted mortality, even when controlling for these covariates. Indeed, the standardized coefficients revealed that loneliness was the strongest predictor of mortality (β = .26, p < .01)! The odds ratios indicated that every unit increase on the loneliness scale *increased* the odds of being deceased in by 31% [(1.31 – 1) X 100 = 31%]. Put another way, every unit increase on the loneliness scale increased the likelihood of dying by the year 2008 by 1.31 times. We can also examine a 10-unit increase (i.e., from the lowest to the highest loneliness score): Compared to those with the lowest loneliness score (0), those with the highest loneliness score (10) have a 15-fold higher risk of dying by the year 2008 ($1.31^{10} = 14.88$)! Thus, these results strongly support Hypothesis 3 that greater loneliness is associated with mortality.

With the inclusion of potential mediators of health conditions 2003 and perceived physical activity 2003 (Model 3, Table 19), the R^2_L increased from .13 to .15. Age and gender continued to be important predictors of mortality. Most importantly, the relationship between loneliness and mortality held even when including health and perceived physical activity in the model (β = .22, *OR* = 1.26, p < .01). That is, every unit increase in loneliness *increased* the odds of being deceased by 26%. In fact, when loneliness and health and activity were included in the model, loneliness and *not health or activity* showed a statistically significant relationship with mortality. This suggests that

loneliness is independently related to mortality beyond any effects of health or perceived physical activity. Moreover, it appears that this relationship cannot simply be *explained* by loneliness being associated with poor health or activity which is, in turn, associated with mortality.

Hypothesis 5: Does happiness moderate the relationship between loneliness and health and physical activity?

As stated by Aiken and West (1991), researchers often initially attempt to find general direct causal relationships between variables (e.g., loneliness and health). But when such relationships have been established, researchers then typically attempt to specify conditions under which the causal relationship is weakened (moderated) or strengthened (amplified). These relationships are called *interactions*. Hypothesis 5 stated that happiness and loneliness will *interact* such that happiness will serve to "undo" the negative effects of loneliness on health, physical activity, and mortality. That is, it is hypothesized that happiness will *moderate* these relationships such that the relationship between loneliness and the outcomes will become *weaker* at higher levels of happiness. The next section outlines the analysis plan and results for examining the continuous outcomes of health and perceived physical activity. This is followed by an outline of the analysis plan and results for the dichotomous outcome of mortality.

Analysis plan. A series of OLS multiple regression analyses were conducted to address Hypothesis 5 that happiness would moderate the relationship between loneliness and health and physical activity. To address the question of *moderation* with two continuous independent variables (i.e., loneliness and happiness) on the continuous

dependent variables of health and physical activity, multiple regression analyses were performed, and, where appropriate, interaction effects were probed and graphically presented following previously-established procedures (Aiken & West, 1991; Cohen & Cohen, 1983; Jaccard & Turrisi, 2003). To test for interactions between variables, Cohen and Cohen (1983; cited in Jaccard & Turrisi, 2003) recommended the strategy of first multiplying the two predictors (the moderator and the focal predictor) to create an interaction product term and then comparing the Model R^2 with and without the interaction term. This multiplication or product-term approach tests for *bilinear interactions* in which the relationship or slope between the dependent variable (e.g., activity) and the focal predictor (e.g., loneliness) changes as a linear function of the moderator (e.g., happiness) (Jaccard & Turrisi, 2003).

A two-step multiple regression analysis was used to test the direct effects (Step 1) of loneliness and happiness onto the outcomes of health and activity as well as the interaction effects (Step 2). The explained variance R^2 was compared between Step 1 and Step 2 to determine whether adding the interaction term helped to further explain any significant amount of variance in the outcomes.

The interaction term was created by first mean-centering the variables of loneliness and happiness (i.e., subtracting the mean from each participant's score) and then multiplying these centered variables together (Aiken & West, 1991; Cohen & Cohen, 1983; Jaccard & Turrisi, 2003). Mean-centering creates a variable in which the mean becomes zero and is done to reduce multicollinearity problems between the interaction term and the variables used in the interaction term (Aiken & West, 1991; Cohen &

Cohen, 1983; Jaccard & Turrisi, 2003). Note that mean-centering does not affect the regression coefficients. All of the continuous *covariates* were mean-centered as well, as is recommended to aid in interpretation and graphing of any interaction effects (Jaccard & Turrisi, 2003; Preacher, 2003). The mean (zero) becomes the reference point and the procedure basically allows the researcher to interpret the "interaction model" for the case when each continuous covariate is held constant at its mean level (Jaccard & Turrisi, 2003; Preacher, 2003). Based on the same logic, the categorical covariate, gender, was also coded so that female gender (the most common or "average" gender) was the reference point. Thus, the regression analyses consisted of mean-centered covariates and predictor variables on Step 1 followed by the interaction term on Step 2.

It should be noted that Step 1 coefficients were reported and examined as these represent the "main effects" of the predictor variables onto the dependent variable. Only the interaction term coefficient was reported from Step 2. This is because the regression coefficients (in the context of the interaction term) are interpreted as representing *conditional* effects, not "main effects" (Jaccard & Turrisi, 2003).

Analysis results. Table 20 shows the multiple regression results testing the hypothesis that happiness would moderate the relationship between loneliness and *health conditions*, controlling for age, gender, income, and functional status. Step 1 results of the analysis show that age (β = -.13, $p < .05$), functional status (β = -.42, $p < .01$) and loneliness (β = .26, $p < .01$) predicted number of health conditions. Happiness did not directly predict health (β = .04, $p > .05$). Together the variables accounted for 23% of the variance of health conditions. Step 2 results show that no significant interaction was

Table 20

Multiple Regression Coefficients for Loneliness and Happiness (Step 1) and their Interaction (Step 2) Predicting Health and Perceived Physical Activity 2003

	Health Conditions			Perceived Health			Physical Activity		
Variables	B	SE	β	B	SE	β	B	SE	β
(constant)	5.11	.21		2.59	.05		4.53	.10	
Age 2001	-.09	.04	-.13*	.03	.01	.16*	.05	.02	.17**
Gender	.38	.35	.07	-.01	.09	-.01	.03	.17	.01
Income 2001	.28	.27	.06	-.05	.07	-.05	-.08	.13	-.04
IADL 2001	-.59	.09	-.42**	.11	.02	.33**	.28	.04	.41**
Loneliness 2001	.31	.08	.26**	-.07	.02	-.22**	-.11	.04	-.18**
Happiness 2001	.14	.21	.04	-.05	.06	-.06	.05	.10	.03
Loneliness X Happiness	.09	.08	.08	-.00	.02	-.01	.07	.04	.13*
Model R^2		.23**			.15**			.21**	
ΔR^2		.005			.000			.014**	

Note. All continuous variables were mean-centered; IADL = Instrumental activities of daily living; B = unstandardized coefficients; SE = standard errors; *B* = standardized coefficients; Model R^2 = variance explained by the predictors in Step 1; ΔR^2 = incremental variance explained by the addition of the interaction term in Step 2. *$p \leq .05$ **$p \leq .01$

found between loneliness and happiness onto health conditions (β = .08, p > .05, ΔR^2 = .005, p > .05). Therefore, Hypothesis 5 was not supported in terms of the outcome of health conditions.

Table 20 also shows the multiple regression results testing the hypothesis that happiness would moderate the relationship between loneliness and *perceived health*, controlling for age, gender, income, and functional status. Step 1 results of the analysis show that age (β = .16, p < .05), functional status (β = .33, p < .01) and loneliness (β = -.22, p < .01) predicted perceived health. Again, happiness did not directly predict health (β = -.06, p > .05). Together the variables accounted for 15% of the variance of health. Step 2 results show that no significant interaction was found between loneliness and happiness onto perceived health (β = -.01, p > .05, ΔR^2 = .000, p > .05). Therefore, Hypothesis 5 was not supported in terms of the outcome of perceived health.

Hypothesis 5 stated that happiness would moderate the relationship between loneliness and *physical activity*. It should be noted that because loneliness did not relate directly to any of the *objective* measures of physical activity, these were not considered as outcome variables here. Only perceived physical activity was considered as an outcome for these analyses. Step 1 results (Table 20) showed that age (β = .17, p < .01) functional status (β = .41, p < .01), and loneliness (β = -.18, p < .05) predicted perceived physical activity. Happiness did not directly predict perceived physical activity (β = .03, p > .05). Together these variables accounted for 21% of the variance of physical activity. Step 2 results showed that the addition of the interaction term (β = .13, p < .05) increased the amount of explained variance by 1.4% (ΔR^2 = .014, p < .01). This significant

interaction indicates that the relationship between loneliness and physical activity depends on (is moderated by) levels of happiness.

To probe this interaction, simple slopes between loneliness and perceived physical activity were calculated at three representative levels of happiness: low (-1SD below mean), moderate (mean), and high (+1SD above mean). For these calculations, continuous covariates were held constant at their mean levels and categorical covariates (gender) were held constant at their zero reference point (in this case female gender). Simple slope results (Fig. 1) show that at both low (b = -.15, $t(220)$ = -3.48, $p < .01$) and moderate (b = -.09, $t(220)$ = -2.23, $p < .05$) levels of happiness, the expected negative relationship was found between loneliness and physical activity such that loneliness predicted lower levels of activity. However, at high (b = -.03, $t(220)$ = -.443, $p > .05$) levels of happiness, the relationship became non-significant. In sum, the pattern of results are consistent with Fredrickson's "undo" hypothesis: higher levels of happiness serve to "undo" the detrimental effects of loneliness on physical activity.

Hypothesis 5: Does happiness moderate the relationship between loneliness and mortality?

Hypothesis 5 stated that happiness and loneliness will *interact* such that happiness will serve to "undo" the negative effects of loneliness on health, physical activity, and mortality. The present section outlines the analysis plan and results for examining the dichotomous outcome of mortality.

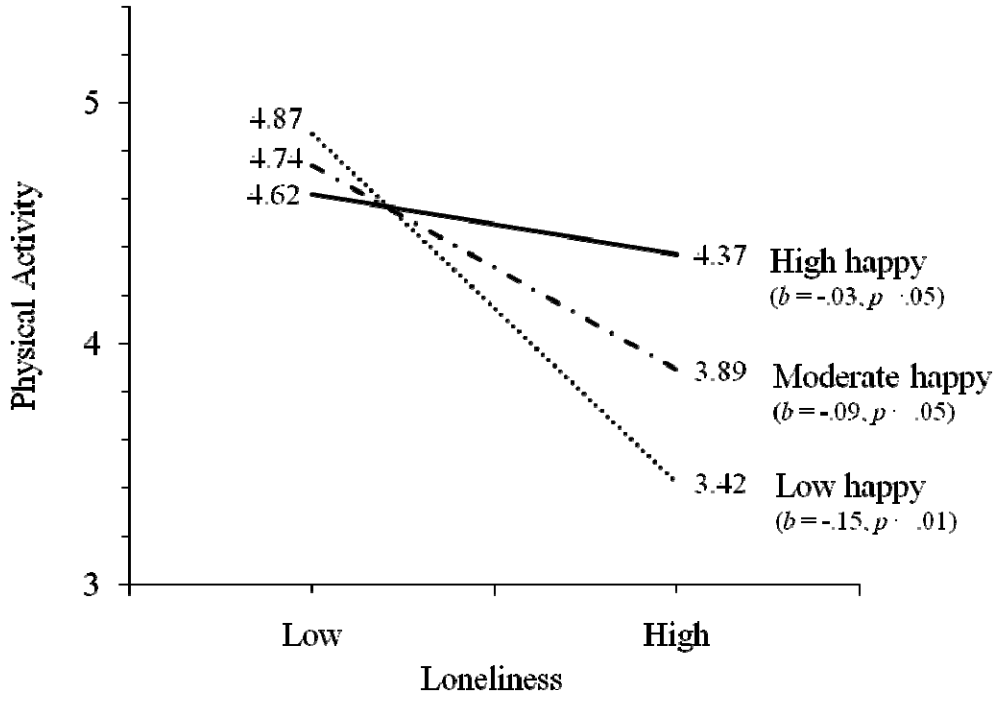

Figure 1. Simple slopes (*b*) for the relationship between loneliness and physical activity. Scores were adjusted for covariates and calculated at representative high (+1 SD above mean), moderate (mean) and low (-1 SD below mean) values of happiness.

Analysis plan. Similar to the previously outlined OLS regression analyses, a series of binary logistic regression analyses were conducted to address Hypothesis 5 that included *mortality* as the outcome. A two-step logistic regression analysis was used to test the direct effects (Step 1) of loneliness and happiness onto mortality (2008) as well as any interaction effects of happiness and loneliness (Step 2). It should be noted that, where appropriate, interaction effects were probed and graphically presented following established procedures (Aiken & West, 1991; Cohen & Cohen, 1983; Jaccard, 2001; Jaccard & Turrisi, 2003).

As with OLS regression, it is of interest to compare the R^2 between Step 1 and Step 2 to determine whether adding the interaction term helped to further explain any significant amount of variance in the outcomes. However, as explained previously, because no exact analogue to the coefficient of determination (R^2) exists in logistic regression, a measure of the proportion of reduction in error (R^2_L) was calculated (Menard, 1995; 2000).

Like OLS regression, the variables of loneliness and happiness were first mean-centered (i.e., the mean was subtracted from each participant's score) and then multiplied to create the interaction term (Aiken & West, 1991; Cohen & Cohen, 1983; Jaccard & Turrisi, 2003). Note that mean-centering does not affect the logistic regression coefficients. All of the continuous *covariates* were mean-centered as well. The mean-centered covariates and predictor variables were entered in Step 1 followed by the interaction term on Step 2. Again, as with OLS regression, the Step 1 "main effect" coefficients were reported and examined. Only the interaction term coefficient was

reported from Step 2.

Interpretation of logistic regression results, as described previously, was done by examining the *odds ratios* for the effect of a 1-unit increase in the predictor onto the dependent variable, as well as the calculated *standardized regression coefficients* (Appendix F) to examine the relative importance of predictors.

Analysis results. Table 21 shows the results for the logistic regression analysis in which *mortality* was the outcome variable. Age, gender, loneliness and happiness predicted mortality in Step 1. Using R^2_L as an approximate of R^2 shows that the predictors reduced the model error by 15%. A significant interaction was found in Step 2 between loneliness and happiness onto mortality (β = -.22, $p < .05$, $\Delta R^2 = .03$, p < .05), indicating that the relationship between loneliness and mortality depends on (is moderated by) levels of happiness.

To probe this interaction, the standardized coefficients and odds ratios between loneliness and mortality were calculated at three representative levels of happiness: low (-1SD below mean), moderate (mean), and high (+1SD above mean). For these calculations, continuous covariates were held constant at their mean levels and categorical covariates (gender) were held constant at their zero reference point (in this case female gender). At both low (b = .38, OR = 1.46, $p < .01$) and moderate (b = .19, OR = 1.21, $p < .05$) levels of happiness, the expected positive relationship was found between loneliness and mortality such that loneliness predicted *greater* odds of dying by the year 2008. However, at high (b = -.003, OR = 1.00, $p > .05$) levels of happiness, the relationship between loneliness and mortality became non-significant.

Table 21

Logistic Regression Odds Ratios for Loneliness and Happiness (Step 1) and their Interaction (Step 2) Predicting Mortality 2008

	Mortality 2008			
Variables	B	SE	β	*OR*
(Constant)	-1.26	.22		.28**
Age 2001	.10	.04	.17	1.10*
Gender	.66	.33	.13	1.93*
Income 2001	-.40	.27	-.10	.67
IADL 2001	-.15	.08	-.12	.86
Loneliness 2001	.23	.07	.22	1.26**
Happiness	-.40	.19	-.14	.67*
Loneliness X Happiness	-.23	.09	-.22	.80*
Model R^2_L	.15**			
ΔR^2_L	.03**			

Note: All continuous variables were mean-centered ; IADL = Instrumental activities of daily living; B = unstandardized coefficients; SE = standard errors; β = standardized coefficients and significance levels are the same as corresponding odds ratios; OR = odds ratio; Model R^2_L = reduction in model error explained by the predictors in Step 1; ΔR^2_L = incremental reduction in model error explained by the addition of the interaction term in Step 2.
*$p \leq .05$. **$p \leq .01$.

These relationships are depicted graphically in Figure 2. Following Jaccard (2001), the predicted log odds were plotted (rather than the probabilities or odds ratios). Like OLS regression, this results in linear functions characterized by non-parallel lines.

As can be seen, at high levels of happiness, the relationship between loneliness and mortality is a flat-line and non-significant. However, the expected positive relationship between loneliness and mortality becomes more and more apparent at moderate and low levels of happiness. In sum, the pattern of results are consistent with Fredrickson's "undo" hypothesis: higher levels of happiness serve to "undo" the detrimental effects of loneliness on mortality.

Study 2 Discussion: What Does this Mean?

A recent Maclean's magazine article came out with the flashy tile: "The Youth Pill: It's closer than you think" (Maclean's, July 2010). On the cover of the magazine was the picture of a pink birthday cake with a 125th birthday candle shining brightly. Anti-aging creams and claims abound. We seem to be a culture obsessed with youth.

The present study focused on mortality or longevity as it related to older people's level of loneliness and so, to some extent, buys into this obsession with youth or number of years on earth. The results of the present study suggested that loneliness increases your odds of dying measured in 2008 even beyond the effects of age. Indeed, the results suggested that moving up on the loneliness scale by one unit increased people's odds of being deceased 7 years later by 31%. That a socio-emotional construct could have such a large impact on one's longevity is remarkable, but what does it really mean?

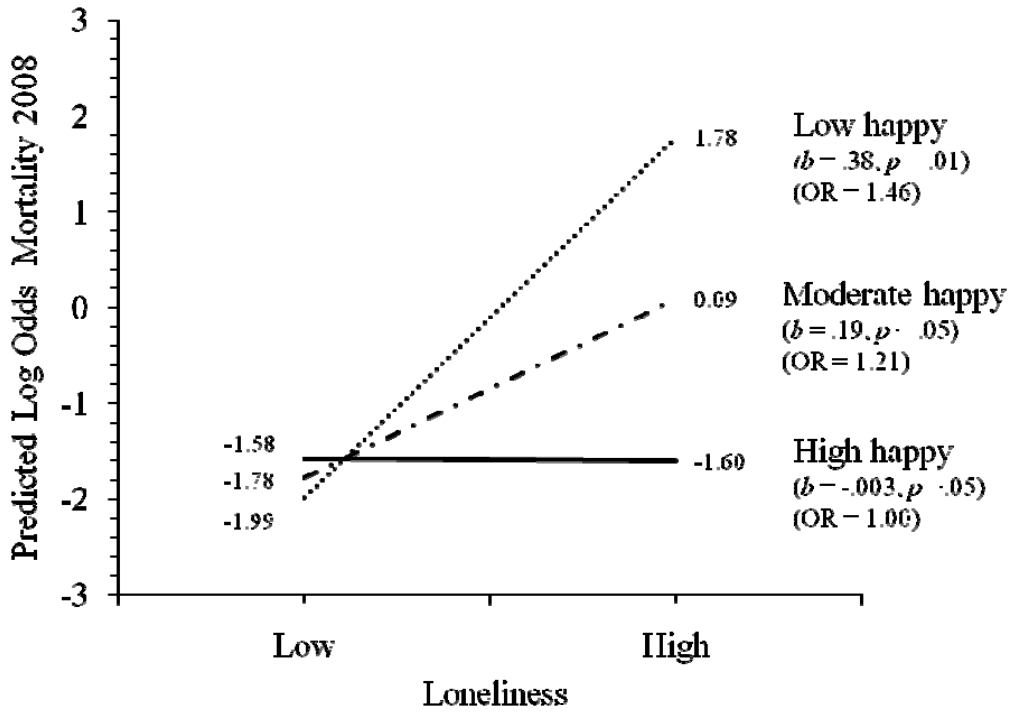

Figure 2. Simple slopes (*b*) and odds ratios (*OR*) for the relationship between loneliness and mortality. Scores were adjusted for covariates and calculated at representative high (+1 SD above mean), moderate (mean) and low (-1 SD below mean) values of happiness.

In some ways, perhaps studying mortality does buy in too much with our obsession to "live forever." To balance out this outlook, some people are smartly differentiating between "lifespan" and "healthspan" (e.g., Warner & Sierra, 2009). On the other hand, rightly or wrongly, longevity is still used by countries to gauge the well-being and quality of life of their people. Researchers and policy-makers are seemingly drawn to mortality as a "gold standard" of health and well-being, as, unlike the nebulous constructs of health and quality of life, mortality is pretty straightforward: you are either alive or dead. Until such a day that health practitioners take the blood pressure *as well as* the "social and emotional pulse" of their patients to assess overall health, health outcomes and longevity will be the outcomes of interest for policy-makers and health practitioners.

The present study examined how loneliness related to lifespan. But at the same time, this study also examined "healthspan." The study results painted the same bleak picture of loneliness: not only does loneliness increase your odds of dying (lifespan), but loneliness is also associated with poorer health and physical activity (healthspan). To top it all off, being lonely itself is an unpleasant emotional experience (wellspan).

The present study examined some of the potential explanatory pathways for the relationship between loneliness and mortality. One obvious route to explain why loneliness predicts mortality is through *health*. The present study replicated past research in finding that among older people loneliness predicted poorer health. Thus, it is logical to speculate that loneliness predicts mortality because it relates to poorer health. However, results showed that health failed to significantly mediate the relationship between loneliness and mortality. Similarly, another obvious contender, *physical activity*,

failed to mediate the relationship between loneliness and mortality. Thus, other (less obvious?) explanations need to be investigated. For example, loneliness may be a strong de-activating (Eloranta et al., 2008; Pekrun et al., 2006) emotion that may erode people's will to be active or engage in the community, or, ultimately, to live. Or loneliness may be an indicator of not having the type of instrumental social support needed in life, albeit, the finding that loneliness predicted mortality even controlling for living arrangements (i.e., living with others) weakens this line of argument.

The present study also tested and adds to knowledge in emotion theory by examining whether *positive emotions*, specifically, *happiness*, moderated the relationships between loneliness, health, physical activity, and mortality. Results supported Fredrickson's "undo hypothesis" in that being happier appeared to weaken these relationships. In particular, at higher levels of happiness, the associations between loneliness and physical activity and loneliness and mortality were weakened considerably. According to Fredrickson's theory, this could be interpreted to mean that happiness somehow serves to *broaden* people's perspective and to reduce the *narrow hold* that negative emotions can have on thought-action repertoires. On the flip side, results show the (rather obvious) double-jeopardy of being *lonely* and *unhappy* at the same time. In sum, it seems to be that if you are lonely, having moments of happiness can be especially important. And interventions could be designed to be double-pronged in trying to reduce people's loneliness and/or increasing people's moments of happiness.

General Discussion

This section contains a discussion of major contributions of the two studies, other significant contributions, and strengths and weaknesses of the studies. The discussion concludes with reflections on future research directions, including application of findings in the form of interventions.

Major Contributions

There were several major contributions of Studies 1 and 2. One major contribution of Study 1, interestingly enough, is a *null finding*[1]. The lack of significant impact of *friendships* on either discriminating the lonely versus the not lonely or on discriminating the four loneliness trajectories is particularly surprising and noteworthy. This is especially because based on Weiss's social needs perspective that a lack of close social contacts leads to social loneliness, it was expected that friendships would discriminate lonely from not lonely people. However, not only did friendships fail to discriminate between groups, friendships consistently were shown to be simply irrelevant in the context of the other social, health, and psychological variables. This underscores the complexity of the concept of loneliness and highlights the distinction found in past research between loneliness and social support or social networks (Penninx et al., 1999).

This null finding furthermore supports framing loneliness within a *cognitive perspective* because what may be more important in explaining loneliness than friendships is people's *preferences*, *expectations*, or *perceptions of control* surrounding social relationships and loneliness. Recall that, according to Perlman's (2004)

[1] I would like to acknowledge Drs. Raymond Perry and Daniel Bailis for stressing the importance of this null result.

discrepancy perspective, loneliness reflects a discrepancy between actual and desired social relationships and networks. It is possible that a person with a close friend simply may or may not feel that this friend is fulfilling their expectations and desires. In future research, it would be of interest to be able to capture a picture of how people's actual and desired relationships line up. It is especially interesting how a "null finding" can reveal so much about loneliness in later life.

Another major contribution of Study 1 was that it showed, in contrast to friendships, that perceived control was extremely relevant for discriminating between the different loneliness trajectories. Even given all of the sociodemographic, social, and health variables considered as predictors in Study 1, perceived control was one of the best discriminators of the lonely and not lonely older adults. This result substantiates past research which examined personal control as a correlate of loneliness (e.g., Moore & Schulz, 1987). The older individuals who were persistently lonely had lower levels of perceived control compared to those who were persistently not lonely. Moreover, those individuals who *became* lonely had a greater decline in levels of perceived control compared to those who *overcame* loneliness. Together, the results suggest that *maintaining* and/or *enhancing* perceived control may be key in addressing loneliness in later life.

Furthermore, the result again points to the idea that it is useful to consider loneliness from a *cognitive perspective*. That our capacity to *perceive that we have control* over different domains in our lives discriminates between being lonely or not—even in the context of social activities, functional status, and adequacy of income— tells us

something about loneliness: it is not whether we participate in activities so much as we feel we have control over the things that we do and our life in general.

Turning to Study 2, a major contribution was to show that loneliness is a strong predictor of mortality, and that its association with mortality is independent of functional status, health and perceived physical activity. These results corroborate past research that showed a linkage between loneliness and mortality in a sample of participants of the Longitudinal Aging Study Amsterdam (Penninx et al., 1997) and in a sample of coronary artery bypass surgery patients (e.g., Herlitz et al., 1998). Furthermore, the finding extends past research in showing this strong association in an even older population of community-dwelling older adults. Unlike Sugisawa et al.'s (1994) study results, however, Study 2 results did not show support for the idea that health *mediates* the connection between loneliness and mortality. That is, Study 2 results did not support two potential processes linking loneliness to mortality: health and physical activity. Thus, further research will need to continue to examine these and other potential processes. Overall, it is remarkable and significant that a socioemotional variable such as loneliness has such a strong association with mortality. As we continue to try and untangle the meaning and nature of loneliness, this is certainly a finding that we should strongly keep in mind.

Another major contribution of Study 2 was to show the moderating effect that happiness has on loneliness. In this regard, the findings complement Stek et al.'s (2005) finding that being lonely and depressed had a significant mortality risk for their 85-year-old participants. The Study 2 results supported Fredrickson's undo hypothesis that *happiness* would weaken or undo the negative effects of loneliness on perceived physical

activity and mortality. More specifically, Fredrickson (2001) postulated that positive emotions like happiness serve to *broaden* our thinking and this broadening can reduce the *narrow* hold that negative emotions like loneliness can have on thoughts and activities. She further postulated that positive emotions can work to reduce the physiological impact of negative emotions. Consistent with Fredrickson's theory, Study 2 results showed greater levels of happiness weakened the relationship between loneliness and physical activity and mortality. This is an important contribution not only because it provides empirical support for theory, but it serves to join two disparate literatures and adds a new dimension by bringing *positive psychology* and the *power of positive emotions* into the discussion of loneliness. Moreover, if Fredrickson is right, it tells us something about loneliness: loneliness has a narrow hold on our bodies and minds that can be broken.

Other Significant Contributions

Other contributions that this project made to the larger literature on loneliness deserve mention. For example, Study 1 supported past research which suggests that living alone is a major risk factor for loneliness in older adults (de Jong Gierveld, 1987). Living alone was consistently one of the best discriminators of lonely and not lonely older individuals. There is clearly something about living alone that goes beyond any association it may have with social participation or friendships or health that is placing it as a major discriminator. So this remains an interesting area of focus for future research.

Study 1 also showed that approximately 15% of older adults are persistently lonely and this finding corroborates past research from Great Britain (Victor et al., 2005) and

Finland (Jylha, 2004). Thus, this gives us a good idea of the proportion of older people who are experiencing persistent or chronic loneliness.

Not only did Study 1 provide a good sense of the proportion of older adults who display different loneliness trajectories, it is also noteworthy and interesting to discuss how the four groups of older adults differed in terms of the baseline and change variables. These results as well as post-hoc comparisons of group differences were shown in Table 10. What was most intriguing from an examination of Table 10 was the group differences for the *change* variables. Given that a *positive change* (e.g., an improvement in health) is indicated by positive change scores, it is interesting that for many of the change variables the mean scores were all *negative* or close to zero. This suggests that, in general, the best state of affairs was to see "no change" or "no decline" in such factors as health or social activities rather than improvement to a better state. Moreover, differences between the four groups of older adults (Table 10) appeared to reflect either more or less *decline*. In this regard, the group that *became* lonely had *more decline* than the other groups. For example, all the groups generally saw a decline or close to no change in perceived health, however, the group that became lonely had the most decline.

This striking pattern of results suggests two things that deserve to be pursued further in future research: 1) First, that *overcoming* loneliness or being persistently *not lonely* can be characterized here more as a "*lack* of decline" or "no change" in such things as health or living arrangements rather than "improvement" per se; 2) Second, because the group that *became* lonely significantly differed from the other three groups on several of the change variables (marital status, living arrangements, and perceived health), it is possible

that the predictor variables may be better able to predict *entry* into loneliness (becoming) rather than *exit* from loneliness (overcoming)[2].

Turning to Study 2, it is noteworthy that results replicated, in a sample of Manitobans including the old-old, past research in finding a relationship between loneliness and health (e.g., Russell, 1996). Study 2 results also supported findings by Hawkley et al. (2009) in their investigation of loneliness and physical activity among a sample of 50-68 year old adults. These similar results were found among samples differing in age, and using different measures of loneliness and physical activity. Although more research that replicates this result is needed, findings support the idea that loneliness reduces people's motivation to be active (Eloranta et al., 2008) and might lead to withdrawal and inaction (Leary et al., 2007).

Although Study 2 results showed support for a loneliness-physical activity association, this association was only found for *perceived physical activity*. No significant relationship between loneliness and *objective* (actigraph) everyday physical activity emerged. Future studies that also incorporate more objective measures of physical activity may help to corroborate and explain this finding. However, it remains an open question whether other socioemotional variables may be associated with everyday physical activity. At this point it can only be concluded that loneliness does not directly predict the fine day-to-day movement of older adults.

Study Limitations and Strengths

Unfortunately, no study is perfect. Major strengths of the studies were that they incorporated relatively *large* and *representative* samples, which can allow

[2] I would like to thank Dr. Daniel Bailis for bringing to attention these important patterns.

generalizability of findings. Another major strength was the use of a rich amount of information on participants, including sociodemographic, health, social and psychological information.

Studies 1 and 2 were limited though in that cause and effect relationships could not be established due to correlational design. Therefore, it cannot be concluded that the predictors of Study 1 *caused* loneliness; nor can it be concluded from Study 2 that loneliness *causes* poor health, poor activity, or mortality. At the same time, the empirical results do support previous studies as well as theory that would support such causal relationships. Moreover, a strength of both studies was the use of longitudinal design which can help establish that a change in a variable at one point in time relates to a change in a variable at another time (a tenet of cause-and-effect). In addition, Study 2 statistically accounted for other important predictors of the outcomes through incorporating covariates.

Examining participants' loneliness at only two points in time can be seen as another limitation. Some researchers have suggested that it may be important to track people more than two points in time (Dykstra et al., 2005). For example, this relates to the issue of measurement error: it is difficult to know whether observed changes in loneliness are simply due to unreliability of the measure. Measuring loneliness at multiple time points would help alleviate the concern that changes in loneliness actually reflected measurement error. On the other hand, tracking people over two points of time retained a large sample size in Study 1. Furthermore, although it is not possible to assess the

internal consistency of a 1-item measure, it is argued that the item used in Study 1 appeared suitable to tap into self-categorization of being lonely or not.

Another limitation was that, based on theory that suggests that *relationship preferences* are important to consider for loneliness (e.g., Dykstra & Fokkema, 2007), it would have been ideal to know about relationship preferences. Because it is not known how many people who lived alone may have *preferred to live alone*, it is difficult to untangle or clarify the social needs and the discrepancy theories of loneliness. At the same time, a strength of Study 2 was that it tested a previously established theory, the Broaden and Build Theory. Moreover, it tested this theory outside of the laboratory, allowing the study results to have greater external validity. The next step would be developing ways to apply these results on positive emotions to help alleviate loneliness in older adults, which is discussed next.

Loneliness: Where do we go from here?

As stated at the outset of Study 1, one reason for investigating what can discriminate between older people displaying different loneliness trajectories is so we may "begin to develop and evaluate a more sophisticated repertoire of interventions to combat loneliness" (Victor, Scambler, et al., 2005, p. 361). The results from Study 1 indicated that loneliness is not necessarily static, but changes over time and is amenable to amelioration (for some). Two of the three key factors to amelioration (or to *never* being lonely) may be difficult to change or control by the individual: loss of spouse (leading to living alone), for example, or, arguably, failing health. These uncontrollable factors may undermine the socio-emotional selectivity processes proposed by Carstensen et al.

(1999). That is, Carstensen et al. (1999) argue that older adults actively choose meaningful social relationships, however, this assumes a level of objective and/or subjective control over maintaining these relationships. Thus, it was concluded in Study 1 that interventions to reduce loneliness should be aimed at important predictors that may be more controllable and amenable to change: such as enhancing and maintaining high levels of *perceived control*. Fostering a perception of control might indeed be important for older adults to be able to successfully select and maintain emotionally meaningful relationships, and thus reduce loneliness.

Interestingly, this Study 1 conclusion is corroborated by Hawkley and Cacioppo (2010) who foreshadowed an unpublished meta-analysis of loneliness interventions. The authors argued that the most promising line of interventions were those based on social cognition. That is, they concluded, similar to Study 1 conclusions, that rather than helping people foster new relationships or friendships or develop their social skills, it may be more effective to change the way people think, especially about their existing relationships (Hawkley & Cacioppo, 2010). The authors also concluded that more interventions simply need to be attempted and documented. They noted, for example, that "the results for social cognitive therapy are promising, but this intervention type appears not to have been widely employed to date relative to other types of loneliness therapy" (p. 225). Thus, there is a clear need for future work in this area to focus on designing and evaluating loneliness interventions, especially those using social cognitive approaches.

In order for health practitioners and policy-makers to invest in addressing loneliness, it is possible that loneliness may need to be connected to outcomes of importance for

health policy. Study 2 empirically showed a linkage between loneliness and health and loneliness and physical activity. Moreover, one of the most compelling findings from Study 2 was that loneliness is a unique and strong predictor of *mortality*. These linkages underscore the importance of focusing on ways in which we can address loneliness, because the benefits of these interventions will not only impact older people's quality of life, but their longevity, health, and physical activity (lifespan and healthspan). In other words, these results give health practitioners one more reason to assess and address "socioemotional health" as well as physical health if they want to increase their patients' healthspan, lifespan, and wellspan.

In addition to establishing a link between loneliness and health-related outcomes, Study 2 investigated a potential *moderator* of these relationships: happiness. And clearly, based on the results of Study 2, it would appear that a promising line of research is to continue to focus on positive emotions in older adults. In her recent book, *Positivity*, Fredrickson (2009) describes the positivity ratio: the ratio between the amount of positive emotions people experience compared to the amount of negative emotions people experience in a given day. So, for example, a 1:1 positive ratio would mean that a person experienced as many positive emotions as negative emotions. Fredrickson (2009) argues that a positivity ratio of 3:1 is a "tipping point" that differentiates those who are flourishing from the rest. Based on this line of thought, Fredrickson (2009) argues that to improve the positivity ratio, a person could either try to bolster their positive emotions or reduce their negative emotions. Similarly, a conclusion of the present project is that both positive emotions and/or loneliness could be the target of interventions: we could target

loneliness directly, or we could try to bolster our positive emotions in order to reduce the negative effects of loneliness on health. Ideally one would want do both: to maximize positive emotions whilst minimizing negative emotions.

But how to do this? It may not be an easy feat. However, certain theories can suggest ways to help people to begin to do this. For example, attributional retraining (Haynes, Perry, Stupnisky, & Daniels, 2009) designed to modify people's causal attributions to enhance achievement and motivation might also have the double-pronged effect of boosting positive emotions (like pride, hope) and reducing loneliness (e.g., Newall, Chipperfield, Clifton, et al., 2009).

As another example, Fredrickson (2009) argued that one way to bolster positive emotion is to *find positive meaning.* Indeed, Newall, Chipperfield, Daniels, Hladkyj, and Perry (2009) examined this general tendency of 'finding the silver lining' as a *secondary control process* in older adults. They found that those people with this greater general tendency had less feelings of regret, greater feelings of life satisfaction, and greater health. Similarly, recent research has shown that, among older adults, this tendency to see the positive in negative situations is associated with enhanced *perceptions of control* and *greater frequency of positive emotions* (Chipperfield et al., 2010). Thus, one promising pathway to bolstering positive and reducing negative emotions (as well as enhancing perceived control) is to help people strive to see the positive in negative situations. Based on the results of Study 2 this may help to moderate any negative effects of being lonely. Moreover, based on Study 1 results, this striving to see the positive might also help people be less lonely through enhancing perceptions of control.

Future Directions: Ending on a Positive Note

In addition to investigating two-pronged interventions that target positive emotions and loneliness, other future directions for research on loneliness may be to focus more broadly on how the community and the environment may affect the well-being of older adults. This has been a recent direction taken both globally and nationally in *Age-Friendly* community initiatives. As stated by Cattan, White, Bond, and Learmouth (2005) in their 2005 review of loneliness interventions, "it is well known that the built environment affects health and mental wellbeing, but not one study evaluated an environmental-ecological approach to social isolation and loneliness" (p. 61). Indeed, it may be also possible to think about how communities could be made to foster more happiness. Perhaps places like Bhutan have it right in developing a Gross National Happiness Index.

Given the association between loneliness and health, other future research could examine loneliness in the context of how it might effect recovery or adjustment to chronic diseases among older adults as well as use of health care services. This would again connect loneliness to the language of policy-makers: health care costs money. Moreover, future research may want to examine in more detail some of the social activities (e.g., volunteering) to see their unique effects on loneliness.

Overall, it appears that the field is ripe for interventions on loneliness. Results from this project suggest that addressing loneliness may have repercussions for the quality of life, health and longevity of our older community members. In addition, results suggest that a promising future research direction is for researchers to investigate the "power" of

positive emotions more thoroughly among older adults. After all, one should always end on a positive note.

References

Abrams, M. (1983). *People in their Late Sixties: A Longitudinal Survey of Ageing, Part I, Survivors and Non Survivors*. London: Age Concern Research Unit.

Ajrouch, K. J., Blandon, A. Y., & Antonucci, T. C. (2005). Social networks among men and women: The effects of age and socioeconomic status. *Journals of Gerontology: Social Sciences, 60B*(6), S311-317.

Active Living Coalition of Older Adults. (2008). Engaging socially isolated seniors: An action plan for older Manitobans. Retrieved from the internet December 12, 2008: www. alcoamb.org/ uploads/ ktml/files/ ALCOA%20follow-up5.doc

Aiken, L. S., & West, S. G. (1991). *Multiple regression: Testing and interpreting interactions*. Newbury Park, CA: SAGE Publications.

Anderson, C. A., & Riger, A. L. (1991). A controllability attribution model of problems in living: Dimensional and situational interactions in the prediction of depression and loneliness. *Social Cognition, 9*, 149-181.

Bailis, D. S., Chipperfield, J. G., & Helgason, T. R. (2008). Collective self-esteem and the onset of chronic conditions and activity reduction in a longitudinal study of aging. *Social Science and Medicine, 66,* 1817-1827.

Bailis, D. S., Chipperfield, J. G., Perry, R. P., Newall, N. E., & Haynes, T. L. (2008). Exploring the commonalities between adaptive resources and self-enhancement in older adults' social-comparative judgments of physical activity. *Journal of Aging and Health, 20*(8), 899-919.

Bailis, D. S., Segall, A., & Chipperfield, J. G. (2003). Two views of self-rated general

health status. *Social Science and Medicine, 56*, 203-217.

Baron, R. M., & Kenny, D. A. (1986). The moderator-mediator variable distinction in social psychological research: Conceptual, strategic, and statistical considerations. *Journal of Personality and Social Psychological Psychology, 51,* 1173-1182.

Berg, S., Mellstrom, D., Persson, G., & Svanborg, A. (1981). Loneliness in the Swedish Aged. *Journal of Gerontology, 36*, 342-49.

Bielski, Z. (2010, July 27). Good relationships have direct health benefits: Study. *Globe and Mail*.

Bosworth, H., & Schaie, K. (1997). Relationship of social environment, social network, and health outcomes in the Seattle Longitudinal study: Two analytical approaches. *Journals of Gerontology, 52B*, 197-205.

Burger, J. M. (1992). *Desire for control: Personality, social and clinical perspectives*. New York: Plenum Press.

Cacioppo, J. T., Ernst, J. M., Burleson, M. H., McClintock, M. K., Malarkey, W. B., Hawkley, L. C., Kowalewski, R. B., Paulsen, A., Hobson, J. A., Hugdahl, K., Spiegel, D., & Berntson, G. G. (2000). Lonely traits and concomitant physiological processes: The MacArthur social neuroscience studies. *International Journal of Psychophysiology, 35*, 143-154.

Cacioppo, J. T., & Hawkley, L. C. (2010). Loneliness matters: A theoretical and empirical review of consequences and mechanisms. *Annals of Behavioral Medicine, 40*(2), 218-227.

Cacioppo, J. T., Hawkley, L. C., & Berntson, G. G. (2003). The anatomy of loneliness.

Current Directions in Psychological Sciences, 12(3), 71-74.

Cacioppo, J. T., Hawkley, L. C., Crawford, L. E., Ernst, J. M., Burleson, M. H., Kowalewski, R. B., Malarkey, W. B., Cautier, E. V., & Berntson, G. G. (2002). Loneliness and health: Potential mechanisms. *Psychosomatic Medicine, 64*, 407-417.

Cacioppo, J. T., Hawkley, L. C., Ernst, J. M., Burleson, M., Berntson, G. G., Nouriani, B., & Spiegel, D. (2006). Loneliness within a nomological net: An evolutionary perspective. *Journal of Research in Personality, 40*, 1054-1085.

Cacioppo, J. T., Hughes, M. E., Waite, L. J., Hawkley, L. C., & Thisted, R. A. (2006). Loneliness as a specific risk factor for depressive symptoms: Cross-sectional and longitudinal analyses. *Psychology and Aging, 21*(1), 140-151.

Cacioppo, J. T., & Patrick, W. (2008). *Loneliness: Human Nature and the Need for Social Connection*. New York, NY: W. W. Norton & Company, Inc.

Carstensen, L. L. (1992). Social and emotional patterns in adulthood: Support for socioemotional

selectivity theory. *Psychology and Aging, 7*, 331-338.

Carstensen, L. L. (1995). Evidence for a life-span theory of socioemotional selectivity. *Current Directions in Psychological Science, 4*, 151-156.

Carstensen, L. L. Isaacowitz, D., Charles, S. T. (1999). Taking time seriously: A theory of socioemotional selectivity. *American Psychologist, 54*, 165-181.

Cattan, M., White, M., Bond, J., & Learmouth, A. (2005). Preventing social isolation and loneliness among older people: A systematic review of health promotion interventions. *Aging & Society,25*, 41-67.

Charles, S. T., & Carstensen, L. L. (1999). The role of time in the setting of social goals across the life span. In T. M. Hess and F. Blanchard-Fields (Eds.), *Social Cognition and Aging* (pp. 319-342). San Diego: Academic Press.

Chen, Z. S., Williams, K. D., Fitness, J., & Newton, N. C. (2008). When hurt will not heal: Exploring the capacity to relive social and physical pain. *Psychological Science, 19*(8), 789-795.

Chipperfield, J. G. (2008). Everyday Physical Activity as a Predictor of Mortality. *The Gerontologist, 48,* 348-357.

Chipperfield, J. G. (1993). Perceived barriers in coping with health problems: A 12-year longitudinal study of survival among elders. *Journal of Aging and Health, 5,* 123-139.

Chipperfield, J. G., Campbell, D. W., & Perry, R. P. (2004). Stability in perceived control: Implications for well-being among older individuals. *Journal of Aging and Health*, 16, 116-147.

Chipperfield, J. G., & Havens, B. (2001). Gender differences in the relationship between marital status transitions and life satisfaction in later life. *Journal of Gerontology: Psychological Sciences, 56B*, P176-186.

Chipperfield, J. G., Havens, B., & Doig, W. (1997). Method and description of the Aging in Manitoba project: A 20-year longitudinal study. *Canadian Journal on Aging, 16*(4), 606-625.

Chipperfield, J. G., Newall, N. E., Chuchmach, L. P., Haynes, T. L., Ruthig, J. C., Perry, R. P., & Menec, V. H. (2006). Study of Everyday Physical Activity (EPA) 2003 in Later Life: Methods and Description. Technical Report #HLHPRI112. Health,

Leisure, & Human Performance Research Institute, University of Manitoba, Winnipeg, Manitoba.

Chipperfield, J, G., Newall, N. E., Chuchmach, L. P., Swift, A. U., & Haynes, T. L. (2008). Differential determinants of men's and women's everyday physical activity in later life. *Journal of Gerontology: Social Sciences., 63*, 211-218.

Chipperfield, J. G., Newall, N. E., Perry, R. P., Haynes, T. L., Bailis, D. S., & Ruthig, J. C. (2010). Secondary control beliefs as a predictor of health and survival in later life: Sense of control as a mediator. Manuscript submitted for publication.

Cohen, S., Alper, C. M., Doyle, W. J., Adler, A., Treanor, J. J., & Turner, R. B. (2008). Objective and subjective socioeconomic status and susceptibility to the common cold. *Health Psychology, 27*(2), 268-274.

Cohen, J., & Cohen, P. (1983). *Applied multiple regression for the behavioral sciences, 2nd Edition*. Hillsdale, NJ: Lawrence Erlbaum.

Cohen-Mansfield, J., & Parpura-Gill, A. (2007). Loneliness in older persons: A theoretical model and empirical findings. *International Psychogeriatrics, 19*, 279-294.

Cumming, E., & Henry, W. E. (1961). Growing old. The process of disengagement. New York: Basic Books.

de Jong Gierveld, J. (1987). Developing and testing a model of loneliness. *Journal of Personality and Social Psychology, 53*, 119-128.

de Jong Gierveld, J., & Kamphuis, F. (1985). The development of a Rasch-type loneliness scale. *Applied Psychological Measurement, 9*, 289-299.

de Jong Gierveld, J., & van Tilburg, T. (2006). A 6-item scale for overall, emotional, and social loneliness. Confirmatory tests on survey data. *Research on Aging, 28*(5), 582-598.

Dykstra, P. A., & Fokkema, T. (2007). Social and emotional loneliness among divorced and married men and women: Comparing the deficit and cognitive perspectives. *Basic and Applied Social Psychology, 29*(1), 1-12.

Dykstra, P. A., van Tilburg, T., & de Jong Gierveld, J. (2005). Changes in older adult loneliness: Results from a seven-year longitudinal study. *Research on Aging, 27*, 725-747.

Dykstra, P. A. (2009). Older adult loneliness: Myths and realities. *European Journal on Ageing, 6*, 91-100.

Eisenberger, N. I., Lieberman, M. D., & Williams, K. D. (2003). Does rejection hurt? An fMRI study of social exclusion. *Science, 302*, 290-292.

Eloranta, S., Routasalo, P., & Arve, S. (2008). Personal resources supporting living at home as described by older home care clients. *International Journal of Nursing Practice, 14, 308-314.*

Fees, B. S., Martin, P., & Poon, L. W. (1999). A model of loneliness in older adults. *Journal of Gerontology: Psychological Sciences, 54B*, P231-P239.

Field, D. & Minkler, M. (1988). Continuity and change in social support between young-old, old-old, and very-old, adults. *Journals of Gerontology, Psychological Sciences, 43*, P100-106.

Fredrickson, B. L. (2009). *Positivity*. New York, NY: Random House, Inc.

Fredrickson, B. L. (2001). The role of positive emotions in positive psychology: The Broaden and Build Theory of Positive Emotions. *American Psychologist, 56,* 218-226.

Fredrickson, B. L. (1998). What good are positive emotions? *Review of General Psychology, 2,* 300-319.

Fredrickson, B. L., & Branigan, C. (2001). Positive emotions. In T. J. Mayne and G. A. Bonanno (Eds), *Emotions: Current Issues and Future Directions* (pp.123-151). New York: Oxford University Press.

Fredrickson, B.L., Mancuso, R. A., Branigan, C., & Tugade, M. M. (2000). The undoing effect of positive emotions. *Motivation and Emotion, 24,* 237-258.

Frijda, N. H. (1986). The laws of emotion. *American Psychologist, 43*(5), 349-358.

Fry, P. S., & Debats, D. L. (2002). Self-efficacy beliefs as predictors of loneliness and psychological distress in older adults. *International Journal of Aging and Human Development, 55*, 233-269.

Fung, H. H., Carstensen, L. L., & Lang, F. R. (2001). Age-related patterns of social networks among European Americans and African Americans: Implications for socioemotional selectivity across the lifespan. *International Journal of Aging and Human Development, 52*(3), 185-206.

Glaser, R., Kiecolt-Glaser, J. K., Stout, J. C., Tarr, K. L., Speicher, C. E., Holliday, J. E. (1985). Stress-related impairments in cellular immunity. *Psychiatry research, 16*(3), 233-9.

Gross, J. J., Carstensen, L. L., Pasupathi, M., Tsai, J., Skorpen, C. G., & Hsu, A. Y.

(1997). Emotion and aging: experience, expression, and control. *Psychology and Aging, 12*(4), 590-599.

Hawkley, L. C., Berntson, G. G., Engeland, C. G., Marucha, P. T., Masi, C. M., & Cacioppo, J. T. (2005). Stress, aging and resilience: Can accrued wear and tear be slowed. *Canadian Psychology, 46*, 115-125.

Hawkley, L. C., Burleson, M. H., Berntson, G. G., & Cacioppo, J. T. (2003). Loneliness in everyday life: cardiovascular activity, psychosocial context, and health behaviors. *Journal of Personality and Social Psychology, 85*(1), 105-120.

Hawkley, L. C., & Cacioppo, J. T. (2007). Aging and loneliness: Downhill quickly? *Current Directions in Psychological Science, 16*, 187-191.

Hawkley, L. C., Thisted, R. A., & Cacioppo, J. T. (2009). Loneliness predicts reduced physical activity: Cross-sectional and longitudinal analyses. *Health Psychology, 28*(3), 354-363.

Haynes, T. L., Perry, R. P., Stupnisky, R. H., & Daniels, L. M. (2009). A review of Attributional Retraining treatments: Fostering engagement and persistence in vulnerable college students. In J. Smart (Ed.), *Higher education: Handbook of theory and research* (Vol. 24, pp. 229-275). The Netherlands: Springer Publishers.

Health Canada. (1998). *National Framework on Aging*. Division of Aging and Seniors. Catalogue no. H88-3/21-1998E. Ottawa, Ontario.

Herlitz, J., Wiklund, I., Caidahl, K., Hartford, M., Haglid, M., Karlsson, B. W., Sjoland, H., & Karlsson, T. (1998). The feeling of loneliness prior to coronary artery bypass grafting might be a predictor of short- and long-term postoperative mortality.

European Journal of Vascular and Endovascular Surgery, 16, 120-125.

Idler, E. L., & Benyamini, Y. (1997). Self-rated health and mortality: A review of twenty-seven community studies. *Journal of Health and Social Behavior, 38*, 21-37.

Jaccard, J. (2001). *Interaction effects in logistic regression*. Thousand Oaks, CA: SAGE Publications.

Jaccard, J. & Turrisi, R. (2003). *Interaction effects in multiple regression, 2nd Edition*. Thousand Oaks, CA: SAGE Publications.

Jylha, M. (2004). Old age and loneliness: Cross-sectional and longitudinal analyses in the Tampere Longitudinal Study on Aging. *Canadian Journal on Aging, 23*, 157-168.

Kiecolt-Glaser, J. K., Garner, W., Speicher, C. Penn, G. M., Holliday, J. Glaser, R. (1984). Psychosocial modifiers of immunocompetence in medical students. *Psychosomatic Medicine, 46,* 7-14.

Kingston, A. (2010, February 16). Lonely while surrounded by friends. *Maclean's Magazine.*

Koivumaa-Honkanen, H., Hokanen, R., Viinamaki, H., Heikkila, K., Kaprio, J., & Koskenvuo, M. (2000). Self-reported life satisfaction and 20-year mortality in healthy Finnish adults. *American Journal of Epidemiology, 152*, 983-991.

Koopmans, T. A., Geleijnse, J. M., Zitman, F. G., & Giltay, E. J. (2010). Effects of happiness on all-cause mortality during 15 years of follow-up: The Arnhem Elderly Study. *Journal of Happiness Studies, 11*, 113-124.

Kramer, S. E., Kapteyn, T. S., Kuik, D. J., & Deeg, D. J. H. (2002). The association of hearing impairment and chronic diseases with psychosocial health status in older age.

Journal of Aging and Health, 14(1), 122-137.

Lambert, P. (2006). Physical activity and the oldest-old: A comparison of self-report and accelerometer readings (Master's thesis, University of Manitoba, 2006). Winnipeg, Canada: University of Manitoba, Department of Community Health Sciences Dissertations, Thesis L173.

Lampinen, P., Heikkinen, R. L., Kauppinen, M., & Heikkinen, E. (2006). Activity as a predictor of mental well-being among older adults. *Aging and Mental Health, 10*(5), 454-466.

Lauder, W., Mummery, K., Jones, M., & Caperchione, C. (2006). A comparison of health behaviours in lonely and non-lonely populations. *Psychology, Health, & Medicine, 11*(2), 233-245.

Lauder, W., Sharkey, S., Mummery, K. (2004). A community survey of loneliness. *Journal of Advanced Nursing, 46*, 88-94.

Lawton, M. P., & Brody, E. M. (1969). Assessment of older people: Self-maintaining and instrumental activities of daily living. *The Gerontologist*, *9*, 179–186.

Leary, M. R., Koch, E. J. Heichenbleikner, N. R. (2007). Emotional responses to interpersonal rejection. In M. R. Leary (Ed.), *Interpersonal Rejection*, pp. 145-166. New York, NY: Oxford University Press.

Maclean's Magazine. (2010, July 25). The Youth Pill: It's closer than you think.

Marangoni, C., & Ickes, W. (1989). Loneliness: A theoretical review with implications for measurement. *Journal of Social and Personal Relationships, 6*, 93-128.

Mayne, T. J. (1999). Negative affect and health: The importance of being earnest.

Cognition and Emotion, 13(5), 601-635.

McAuley, M., Blissmer, B., Marquez, D. X., Jerome, G. J., Kramer, A. F., & Katula, J. (2000). Social relations, physical activity, and well-being in older adults. *Preventative Medicine, 31*, 608-617.

Melanson, E. L., & Freedson, P. S. (1995). Validity of the Computer Science and Applications, Inc. (CSA) activity monitor. *Medicine and Science in Sports and Exercise, 27*, 934-940.

Menard, S. (2000). Coefficients of determination in multiple logistic regression analysis. *The American Statistician, 54*(1), 17-24.

Menard, S. (1995). *Applied logistic regression analysis*. Sage University Paper Series on Quantitative Applications in the Social Sciences. Thousand Oaks, CA: SAGE Publications.

Menec, V. H., & Chipperfield, J. G. (1997). Remaining active in later life: The role of health locus of control in seniors' activity level, health, and life satisfaction. *Journal of Aging and Health, 9,* 105-125.

Menec, V. H., Chipperfield, J. G., & Perry, R. P. (1999). Self-perceptions of health: A prospective analysis of mortality, control, and health. *Journals of Gerontology: Series A: Biological Sciences and Medical Sciences, 54B*(2), 85-P93.

Meyers, L. S., Gamst, G., & Guarino, A. J. (2006). Applied multivariate research: Design and interpretation. Thousand Oaks, CA: SAGE publications.

Moore, D., & Schulz, N. R. (1987). Loneliness among the elderly: The role of perceived responsibility and control. *Journal of Social Behavior and Personality, 2,* 215-224.

Mossey, J. M., Havens, B., Roos, N. P., & Shapiro, E. (1981). The Manitoba Longitudinal Study on Aging: Description and Methods. *The Gerontologist, 21*, 551-558.

Moustakas, C. E. (1961). *Loneliness*. Englewood Cliffs, NJ: Prentice Hall.

Mullins, L. C., Sheppard, H. L., & Andersson, L. (1991). Loneliness and social isolation in Sweden: differences in age, sex, labor force status, self-rated health, and income adequacy. *Journal of Applied Gerontology, 10*(4), 455-68.

Mullins, L. C., Smith, R., Colquitt, R., & Mushel, M. (1996). An examination of the effects of self-rated and objective indicators of health condition and economic condition on the loneliness of older persons.

Myers, D. G., & Diener, E. (1995). Who is happy? *Psychological Science, 6*(1), 10-19.

Newall, N. E., Chipperfield, J. G., Blandford, A. A., Perry, R. P., & Havens, B. (2004). *Successful Aging Study 2003 (SAS 2003): Methods and Description.* Technical Report #HLHPRI104. Health, Leisure, and Human Performance Research Institute, University of Manitoba, Winnipeg, Manitoba.

Newall, N. E., Chipperfield, J. G., Clifton, R. A., Perry, R. P., Swift, A. U., & Ruthig, J. C. (2009). Causal beliefs, social participation, and loneliness among older adults: A longitudinal study. *Journal of Social and Personal Relationships, 26*, 273-290.

Newall, N. E., Chipperfield, J. G., Daniels, L. M., Hladkyj, S., & Perry, R. P. (2009). Regret in later life: Exploring relationships between regret frequency, secondary interpretive control beliefs, and health in older individuals. *International Journal of Aging and Human Development, 68*(4), 261-288.

Newall, N., Hall, M., & Payne, B. (2006). *Report on Seniors' Social Isolation Workshop*. Department of Community Health Sciences, University of Manitoba, Winnipeg, Manitoba.

Niemi, T. (1979). Effect of loneliness on mortality after retirement. *Scandinavian Journal of Social Medicine, 7*, 63-65.

Panksepp, J. (2003). Feeling the pain of social loss. *Science, 302*, 237-239.

Pekrun, R., Frenzel, A. C., Goetz, T., & Perry, R. P. (2006). The control-value theory of achievement emotions: An integrative approach to emotions in education. In P. A. Schutz & R. Pekrun (Eds.), *Emotion in Education*, pp. 13-36. San Diego: Elsevier Academic Press.

Penninx, B. W. J. H., van Tilburg, T., Kriegsman, D. M. W., Boeke, A. J. P., Deeg, D. J. H., & van Eijk, J. T. M. (1999). Social network, social support, and loneliness in older persons with different chronic diseases. *Journal of Aging and Health, 11*, 151-168.

Penninx, B. W. J. H., van Tilburg, T., Kriegsman, D. M. W., Deeg, D. J. H., Boeke, A. J. P., & van Eijk, J. T. M. (1997). Effects of social support and personal coping resources on mortality in older age: The longitudinal Aging Study Amsterdam. *American Journal of Epidemiology, 146*(6), 510-518.

Peplau, L. A., & Caldwell, M. A. (1978). Loneliness: A cognitive analysis. *Essence, 2*, 207-220.

Peplau, L. A., & Perlman, D. (1982). *Loneliness: A sourcebook of current theory, research, and therapy*. USA: John Wiley & Sons.

Perlman, D. (2004). European and Canadian studies of loneliness among seniors. *Canadian Journal on Aging, 23*, 181-188.

Pinquart, M., & Sorensen, S. (2001). Influences on loneliness in older adults: A meta-analysis. *Basic and Applied Social Psychology, 23*, 245-266.

Pitkala, K. H., Laakkonen, M. L., Strandberg, T. E., & Tilvis, R. S. (2004). Positive life orientation as a predictor of 10-year outcome in a aged population. *Journal of Clinical Epidemiology, 57*, 409-414.

Preacher, K. J. (2003) A primer on interaction effects in multiple linear regression. Retrieved from the internet June 8, 2010, http: //www.people.ku.edu /~preacher /interact /interactions.htm.

Pressman, S. D., Cohen, S., Miller, G. E., Barkin, A., Rabin, B. S., & Treanor, J. J. (2005). Loneliness, social network size, and immune response to influenza vaccination in college freshman. *Health Psychology, 24*, 297-306.

Richard, L., Laforest, S., Dufresne, F., & Sapinski, J. P. (2005). The quality of life of older adults living in an urban environment: Professional and lay perspectives. *Canadian Journal on Aging, 24*, 19-30.

Rodin, J. (1986). Aging and health: Effects of sense of control. *Science, 233*, 1271-76.

Rodin, J., Timko, C., & Harris, S. (1985). The construct of control: Biological and psychological correlates. In *Annual Review of Gerontology and Geriatrics* Vol. 5, p. 3-55. New York: Springer.

Rokach, A., Matalon, R., Rokach, B., & Safarov, A. (2007). The effects of gender and

marital status on loneliness of the aged. *Social Behavior and Personality, 35*, 243-254.

Russell, D. W. (1996). UCLA loneliness scale (version 3): Reliability, validity and factor structure. *Journal of Personality Assessment, 66*, 20-40.

Russell, D. Peplau, L. A., & Cutrona, C. E. (1980). The Revised UCLA Loneliness Scale: Concurrent and discirminant validity evidence. *Journal of Personality and Social Psychology, 39*, 472-480.

Russell, D. Peplau, L. A., & Ferguson, M. L. (1978). Developing a measure of loneliness. *Journal of Personality Assessment, 42*, 290-294.

Ruthig, J. C., & Chipperfield, J. G. (2006). Health incongruence in later life: Implications for subsequent well-being and health care. *Health Psychology*, *26*, 753-761.

Salovey, P., Rothman, A.J., Detweiler, J. B., & Steward, W. T. (2000). Emotional states and physical health. *American Psychologist, 55*(1), 110-121.

Samuelsson, G., Andersson, L., & Hagberg, B. (1998). Loneliness in relation to social, psychological, and medical variables over a 13-year period: A study of the elderly in a Swedish rural district. *Journal of Mental Health and Aging, 4*(3), 361-378.

Savikko, N., Routasalo, P., Tilvis, R. S., Strandberg, T. E., & Pitkala, K. H. (2005). Predictors and subjective causes of loneliness in an aged population. *Archives of Gerontology and Geriatrics, 41*, 223-233.

Schnittker, J. (2007). Look (closely) at all the lonely people. *Journal of Aging and Health, 19*, 659-682.

Schultz, N. R., & Moore, D. D. (1984). Loneliness: Correlates, attributions, and coping

among older adults. *Personality and Psychology Bulletin*, *10*, 67–77.

Solano, C. H. (1987). Loneliness and perceptions of control: General trait versus specific attribution. *Journal of Social Behavior and Personality, 2*, 201-214.

Sorkin, D., Rook, K. S., & Lu, J. L. (2002). Loneliness, lack of emotional support, lack of companionship, and the likelihood of having a heart condition in an elderly sample. *Annals of Behavioral Medicine, 24*(4), 290-98.

Statistics Canada. (2006). *A portrait of seniors in Canada*. Catalogue no. 89-519-XIE. Ottawa, Ontario.

Stek, M. L., Vinkers, D. J., Gussekloo, J., Beekman, A. T. F., van der Mast, R. C., & Westendorp, R. G. J. (2005). Is depression in old age fatal only when people feel lonely? *American Journal of Psychiatry, 162*, 178-180.

Sugisawa, H., Liang, J., & Liu, X. (1994). Social networks, social support, and mortality among older people in Japan. *Journal of Gerontology, 49*, S3-S13.

Tabachnick, B., G., & Fidell, L. S. (2001). *Using multivariate statistics* (4th Ed.). New York: Harper Collins.

Taylor, S. E. (1990). Health psychology: The science and the field. *American Psychologist, 45*(1), 40-50.

Tijhuis, M. A. R., de Jong Gierveld, J., Feskens, E. J. M., & Kromhout, D. (1999). Changes in and factors related to loneliness in older men. The Zutphen Elderly Study. *Age and Ageing, 28*, 491-495.

Tomaka, J., Thompson, S., & Palacios, R. (2006). The relation of social isolation,

loneliness, and social support to disease outcomes among the elderly. *Journal of Aging and Health, 18*, 359-384.

Uchino, B. N. (2004). *Social Support and Physical health: Understanding the Health Consequences of Our Relationships.* New Haven, CT: Yale University Press.

Uchino, B. N., Cacioppo, J. T., & Kiecolt-Glaser, J. K., (1996). The relationship between social support and physiological processes: A review with emphasis on underlying mechanisms and implications for health. *Psychological Bulletin, 119*, 48-531.

van Baarsen, B. (2002). Theories on coping with loss: The impact of social support and self-esteem on adjustment to emotional and social loneliness following a partner's death in later life. *Journal of Gerontology: Social Sciences, 57B*(1), S33-S42.

van Baarsen, B., Snijders, T. A. B., Smit, J. H., & van Duijn, M. A. J. (2001). Lonely but not alone: Emotional isolation and social isolation as two distinct dimensions of loneliness in older people. *Educational and Psychological Measurement, 61*(1), 119-135.

van Tilburg, T., Havens, B., & de Jong Gierveld, J. (2004). Loneliness among older adults in the Netherlands, Italy, and Canada: A multifaceted comparison. *Canadian Journal on Aging, 23*, 169-180.

Victor, C. R., Grenade, L., & Boldy, D. (2005). Measuring loneliness in later life: A comparison of differing measures. *Reviews in Clinical Gerontology, 15*, 63-70.

Victor, C. R., Scambler, S. J., Bowling, A., & Bond, J. (2005). The prevalence of, and risk factors for, loneliness in later life: A survey of older people in Great Britain. *Aging and Society, 25*, 357-375.

Warner, H., & Sierra, F. (2009). Canadian Institutes of Health Research- Institute of Aging: Profiles. The longevity dividend: Why invest in basic aging research? *Canadian Journal on Aging, 28*(4), 391-394.

Weeks, D. J. (1994). Review of loneliness concepts, with particular reference to old age. *International Journal of Geriatric Psychiatry, 9*, 345-355.

Weiss, R. S. (1973). *Loneliness: The experience of emotional and social isolation*. Cambridge, MA: MIT Press.

Weiner, B. (1985). An attributional theory of achievement motivation and emotion. *Psychological Review, 92*(4), 548-573.

Welk, G. J., Schaben, J. A., & Morrow, J. R. (2004). Reliability of accelerometry-based activity monitors: A generalizability study. *Medicine and Science in Sports and Exercise, 36*(9), 1637-1645.

Wenger, G. C., & Burholt, V. (2004). Changes in levels of social isolation and loneliness among older people in a rural area: A twenty-year longitudinal study. *Canadian Journal on Aging, 23*, 115-127.

Wenger, G. C., Davies, R., Shahtahmasebi, S., & Scott, A. (1996). Social isolation and loneliness in old age: Review and refinement. *Ageing and Society, 16*, 333-358.

Wheeler, L., Reis, H., & Nezlek, J. (1983). Loneliness, social interaction, and sex roles. *Journal of Personality and Social Psychology, 45*, 943-953.

Yeh, S. J., & Lo, S. K. (2004). Living alone, social support, and feeling lonely among the elderly. *Social Behavior and Personality, 32,* 129-138.

Appendix A

Ethical Approval Study 1

Date: Mon, 30 Nov 2009 14:47:43 -0600
From: Bruce Tefft <tefft@cc.umanitoba.ca>
To: Nancy Newall <N_Newall@umanitoba.ca>
Cc: Margaret Bowman <margaret_bowman@umanitoba.ca>
Subject: Re: research ethics query
User-Agent: Internet Messaging Program (IMP) H3 (4.1.3)

Dear Ms. Newall:

1) No ethics application is required if the research question(s) being addressed were identified as part of the approved application.

2) No ethics application is required if the data have been rendered anonymous.

Otherwise, an ethics application is required and should be submitted in the normal way.

Regards,
Bruce

At Mon, 30 Nov 2009 14:36:09 -0600, Nancy Newall wrote:

Dr. Bruce Tefft, Chair
Psychology/Sociology Research Ethics Board
University of Manitoba
Winnipeg, MB, R3T 2N2

November 30, 2009

Dear Dr. Tefft:

I am a PhD student in psychology working under the supervision of Dr. Chipperfield. I am wanting to confirm with you the ethics process
for analysing pre-existing data from a study that has already received ethical approval (Aging in Manitoba Study). It is my understanding
that it is unnecessary for students or researchers analysing pre-existing data to re-submit their proposed research project to the Research
Ethics Board. Could you please outline the usual process that students go through when they are analysing data from a study that has
previously received ethics approval. Thank you very much for your time!

Yours sincerely,

Nancy Newall
PhD Candidate

Psychology Department
University of Manitoba
Winnipeg, MB
R3T 2N2
Date: Sun, 15 Mar 2009 12:22:43 -0500
From: Judy Chipperfield <chipper@cc.umanitoba.ca>
To: Nancy Newall <N_Newall@umanitoba.ca>
Subject: [Fwd: Re: Nancy Newall's dissertation plan]

Hi Nancy,

I'm just cleaning email and thought I'd send this exchange to you.
Perhaps you should keep a copy.

-------- Original Message --------
Subject: Re: Nancy Newall's dissertation plan
Date: Mon, 18 Aug 2008 12:23:44 -0500
From: Barbara J. Payne <payneb@ms.umanitoba.ca>
To: Judy Chipperfield <chipper@cc.umanitoba.ca>

none at all. Good luck.
Barb

----- Original Message ----- From: "Judy Chipperfield" <chipper@cc.umanitoba.ca>
To: "Barbara Payne" <PayneB@ms.umanitoba.ca>
Sent: Monday, August 18, 2008 10:18 AM
Subject: Nancy Newall's dissertation plan

Hi Barb,

It just occurred to me that I should bring you into the loop regarding Nancy Newall's dissertation plans. Several years ago, she received an AIM data set (with Betty's approval) to examine the issue of loneliness. A paper on this has recently been accepted for publication and Nancy is now moving forward with a dissertation plan. Part of the dissertation would involve the interview data from the larger AIM project and part of it would be based on the interview data from my satellite study (SAS). I believe Nancy could work with the same data set that she used for the project she has completed, although I would have to confirm this with her. I assume that she would need to go through the U of M ethics process to obtain permission, although I believe it would be quite simple. Do you see any problems with all this?
Judy

Appendix B

Multicollinearity Diagnostics for Study 1

Table 1

Multicollinearity diagnostic statistics for baseline (1996) Study 1 predictors

	Multicollinearity Statistics	
1996 Predictors	Tolerance	Variance Inflation Factor
Age	.82	1.22
Gender	.69	1.46
Education	.89	1.12
Income adequacy	.93	1.08
Marital status	.43	2.31
Living arrangements	.45	2.21
Duration in house	.95	1.06
Close friend or not	.95	1.15
Social activities	.87	1.35
Solitary activities	.74	1.72
Independence	.58	1.40
Perceived health	.71	1.41
Chronic conditions	.71	1.41
Perceived control 1996	.73	1.36

Note. N = 760. Multicollinearity statistics were obtained using multiple regression in SPSS. The dependent variable used for this analysis was age 2001; however, using different dependent variables does not change the collinearity statistics for the predictor variables.

Table 2
Multicollinearity diagnostic statistics for baseline (1996) and change score Study 1 predictors

	Multicollinearity Statistics	
1996 Predictors and Change Scores	Tolerance	Variance Inflation Factor
Age	.71	1.42
Gender	.63	1.58
Education	.88	1.14
Income adequacy	.64	1.56
Marital status	.38	2.62
Living arrangements	.38	2.65
Duration in house	.91	1.10
Close friends #	.63	1.59
Close friend or not	.47	2.12
Social activities	.37	2.74
Solitary activities	.43	2.31
Independence	.43	2.34
Perceived health	.52	1.94
Chronic conditions	.45	2.24
Perceived control	.66	1.51
Change in Income adequacy	.54	1.87
Change in Marital status	.51	1.95
Change in Living arrangements	.77	1.29
Change in community	.63	1.59
Change in close friend	.52	1.92
Change in Social activities	.39	2.56
Change in Solitary activities	.45	2.24
Change in Independence	.53	1.89
Change in Perceived health	.67	1.49
Change in Chronic conditions	.54	1.85
Change in perceived control	.65	1.55

Note. N = 760. Multicollinearity statistics were obtained using multiple regression in SPSS. The dependent variable used for this analysis was age 2001; however, using different dependent variables does not change the collinearity statistics for the predictor variables.

Appendix C

Discriminant Function Analysis with Baseline Variables Predicting Four Groups

Table 1

Four Group Discriminant Function Analysis with Baseline Predictors Only: Group Centroids

	Group Centroids
Four Groups	Function 1
Lonely-lonely	-.86
Lonely-not lonely	-.61
Not lonely-lonely	.22
Not lonely-not lonely	.35

Table 2

Four-Group Discriminant Function Analysis with Baseline Predictors Only: Correlation and Standardized Coefficients

	Function 1	
1996 Variables	Correlation Coefficients	Standardized Coefficients
Living arrangements	**.58**	**.48**
Perceived health	**.53**	**.31**
Perceived control	**.52**	**.39**
Marital status	**.51**	.18
Chronic conditions	**-.49**	-.20
IADL	.40	-.01
Income inadequacy	-.31	-.18
Social activities	.24	.08
Solitary activities	.23	.04
Gender	.28	.08
Duration in household	.20	.14
Education level	.27	.16
Age	-.20	.02
Close friend	.05	.03

Note. IADL = Instrumental activities of daily living.

Appendix D

Ethical Approval SAS 2003

APPROVAL CERTIFICATE

26 June 2002

TO: **Judith Chipperfield**
Principal Investigator

FROM: **Lorna Guse, Chair**
Education/Nursing Research Ethics Board (ENREB)

Re: **Protocol #E2002:057**
"health and Aging: Study of Adaptive Strategies (2002)"

Please be advised that your above-reference protocol has received human ethics approval by the **Education/Nursing Research Ethics Board**, which is organized and operates according to the Tri-Council Policy Statement. This approval is valid for one year only.

Any significant changes of the protocol and/or informed consent form should be reported to the Human Ethics Secretariat in advance of implementation of such changes.

Appendix E

Loneliness Predicting Sedentary Levels

Table 1

Regression Beta Weights for Covariates (Model 1) and Loneliness (Model 2) Predicting Subsequent Sedentary Levels

		Model 2	
Variables	*B*	SE	OR
(constant)	-4.28	4.24	.014
Age 2001	.06	.05	1.06
Gender	-.69	.39	.50
Education level 2001	.34	.32	1.41
Functional independence 2001	-.12	.09	.88
Loneliness 2001	-.12	.09	.89

Note. IADL = Instrumental activities of daily living.
+ $p = .06$; *$p \leq .05$ **$p \leq .01$

Appendix F

Calculating Standardized Coefficients for Logistic Regression Analyses

Loneliness Predicting Mortality

This is the steps taken for my logistic regression model: Loneliness predicting mortality.

Equation:

Standardized coefficient= *byx = (byx) (Sx) (R) / Slogit (Ypredicted)

***byx** = standardized coefficient

byx = unstandardized coefficient

Sx = SD of X

R = square root of coefficient of determination

-R is equal to Yobserved correlated with Ypredicted
-(or run the regression to get R2)

Slogit (Ypredicted) = SD of logit (Ypredicted), i.e., the SD of the estimated logit (Y) values

Steps:

1. Run the logistic regression to obtain the **byx**, bzx, etc…

2. SAVE the predicted values to obtain Ypredicted.

3. Correlate the Ypredicted and Yobserved to calculate **R**.

4. Use the Ypredicted to calculate **logit(Ypredicted)** by using the equation:

Logit (Ypredicted) = ln[Ypredicted / 1- Ypredicted]

5. Calculate the descriptives of logit (Ypredicted), including the SD, to obtain the **Slogit (Ypredicted)**

6. Calculate the descriptives for your predictor variables to obtain **Sx**, the SD of X, Z, etc.

Model with covariates only predicting mortality

1. Run the logistic regression to obtain **byx**

2. SAVE the predicted Y = **PRE_2**

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)
Step 1[a]	age01_new	.095	.037	6.673	1	.010	1.100
	sex01new_recoded	.721	.315	5.239	1	.022	2.057
	curincAIM2001_new_meanre	-.123	.247	.248	1	.618	.884
	iadl01	-.172	.080	4.677	1	.031	.842
	Constant	-7.301	3.337	4.786	1	.029	.001

a. Variable(s) entered on step 1: age01_new, sex01new_recoded, curincAIM2001_new_meanre, iadl01.

3. Correlate the Ypredicted and Yobserved to calculate **R = .299**

Correlations

		PRE_2 Predicted probability	mort2008 recoded mort 2008 0 = alive 1 = deceased
PRE_2 Predicted probability	Pearson Correlation	1	.299**
	Sig. (2-tailed)		.000
	N	228	228
mort2008 recoded mort 2008 0 = alive 1 = deceased	Pearson Correlation	.299**	1
	Sig. (2-tailed)	.000	
	N	228	228

**. Correlation is significant at the 0.01 level (2-tailed).

4. Use the Ypredicted to calculate **logit(Ypredicted)** by using the equation:

Logit (Ypredicted) = ln[Ypredicted / 1- Ypredicted]

logit Y(predicted) = ln[Ypredicted / 1- Ypredicted] = pre_1ln (variable name)

A. step 1

```
COMPUTE PRE_2division=PRE_2 / (1 - PRE_2).
VARIABLE LABELS  PRE_2division 'PRE_2 / 1 - PRE_2'.
EXECUTE.
```

```
list PRE_2 PRE_2division .
```

B. Step 2 of 2

```
COMPUTE PRE_2ln=LN(PRE_2division).
VARIABLE LABELS  PRE_2ln 'ln (Pre_2/1-Pre_2)'.
EXECUTE.
```

```
list PRE_2 PRE_2division pre_2ln.
```

5. Calculate the descriptives of logit (Ypredicted), including the SD, to obtain the **Slogit (Ypredicted)**

Descriptives for pre_2ln:

```
DESCRIPTIVES VARIABLES=PRE_2ln
  /STATISTICS=MEAN STDDEV MIN MAX.
```

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
PRE_2ln ln (Pre_2/1-Pre_2)	228	-2.17	1.53	-.9247	.66359
Valid N (listwise)	228				

SD of Logit Y predicted = Slogit (Ypredicted) = .66359

6. Calculate the descriptives for your predictor variables to obtain **Sx**, the SD of X, Z, etc.

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
age01_new cleaned age 01	228	77.00	96.00	83.0000	4.21974
sex01new_recoded sex01_new recoded to 0 = females and 1 = males	228	.00	1.00	.3772	.48575
curincAIM2001_new_meanre SMEAN(curincAIM2001_new)	228	1.00	3.00	1.7368	.62337
iadl01 aim 2001 sum of 12 recoded iadl items	228	1.00	12.00	9.3289	1.97822
lonsum01 sum of yes/no dichotomized loneliness 0-11 higher scores more lonely	228	.00	10.00	2.0482	2.30157
chron_s_SAS2003 sum of 21 health conditions - SAS 2003	228	.00	14.00	5.2544	2.76323
soccom13_sas2003_meanre	228	1.00	7.00	4.5439	1.32838
Valid N (listwise)	228				

SOLUTION FOR ALL VARIABLES

R = square root of coefficient of determination = **.299**

Slogit (Ypredicted) = SD of logit (Ypredicted) = **.66359**

A. FOR AGE Standardized Log Regression Coeeficient *b(age)

Equation:

Standardized coefficient= *byx = (byx) (Sx) (R) / Slogit (Ypredicted)

b age = .095

Sx age = SD of X = 4.21974

R = .299

Slogit (Ypredicted) = SD of logit (Ypredicted) = .66359

*b (age) = (.095) (4.21974) (.299) /.66359

***b (age) = .1806**

B. FOR SEX Standardized Log Regression Coeeficient *b(sex)

Equation:

Standardized coefficient= *byx = (byx) (Sx) (R) / Slogit (Ypredicted)

b sex = .721

Sx sex = SD of X = .48575

R = .299

Slogit (Ypredicted) = SD of logit (Ypredicted) = .66359

*b (sex) = (.721) (.48575) (.299) / .66359

***b (sex) = .15780**

C. FOR INCOME Standardized Log Regression Coeeficient *b(income)

Equation:

Standardized coefficient= *byx = (byx) (Sx) (R) / Slogit (Ypredicted)

b income = -.123

Sx income = SD of X = .62337

R = .299

Slogit (Ypredicted) = SD of logit (Ypredicted) = .66359

*b (income) = (-.123) (.62337) (.299) / .66359

***b (income) = -.03454**

D. FOR IADL Standardized Log Regression Coeeficient *b(iadl)

Equation:

Standardized coefficient= *byx = (byx) (Sx) (R) / Slogit (Ypredicted)

b iadl = -.172

Sx iadl = SD of X = 1.97822

R = .299

Slogit (Ypredicted) = SD of logit (Ypredicted) = .66359

*b (iadl) = (-.172) (1.97822) (.299) / .66359

***b (iadl) = -.1533**
//

Model with covariates and loneliness predicting mortality

1. Run the logistic regression to obtain **byx**

2. SAVE the predicted Y = **PRE_2a**

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)
Step 1[a]	age01_new	.090	.039	5.473	1	.019	1.094
	sex01new_recoded	.756	.328	5.321	1	.021	2.130
	curincAIM2001_new_meanre	-.313	.262	1.422	1	.233	.731
	iadl01	-.167	.080	4.370	1	.037	.846
	lonsum01	.268	.068	15.548	1	.000	1.308
	Constant	-7.228	3.471	4.337	1	.037	.001

a. Variable(s) entered on step 1: lonsum01.

3. Correlate the Ypredicted and Yobserved to calculate **R = .399**

Correlations

		PRE_2a Predicted probability	mort2008 recoded mort 2008 0 = alive 1 = deceased
PRE_2a Predicted probability	Pearson Correlation	1	.399**
	Sig. (2-tailed)		.000
	N	228	228
mort2008 recoded mort 2008 0 = alive 1 = deceased	Pearson Correlation	.399**	1
	Sig. (2-tailed)	.000	
	N	228	228

**. Correlation is significant at the 0.01 level (2-tailed).

4. Use the Ypredicted to calculate **logit(Ypredicted)** by using the equation:

Logit (Ypredicted) = ln[Ypredicted / 1- Ypredicted]

logit Y(predicted) = ln[Ypredicted / 1- Ypredicted] = pre_1ln (variable name)

A. step 1

```
COMPUTE PRE_2adivision=PRE_2a / (1 - PRE_2a).
VARIABLE LABELS  PRE_2adivision 'PRE_2a / 1 - PRE_2a'.
EXECUTE.

list PRE_2a PRE_2adivision .
```

B. Step 2 of 2

```
COMPUTE PRE_2aln=LN(PRE_2adivision).
VARIABLE LABELS  PRE_2aln 'ln (Pre_2a/1-Pre_2a)'.
EXECUTE.

list PRE_2a PRE_2adivision pre_2aln.
```

5. Calculate the descriptives of logit (Ypredicted), including the SD, to obtain the **Slogit (Ypredicted)**

Descriptives for pre_2aln:

```
DESCRIPTIVES VARIABLES=PRE_2aln
  /STATISTICS=MEAN STDDEV MIN MAX.
```

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
PRE_2aln ln (Pre_2a/1-Pre_2a)	228	-2.95	1.34	-1.0034	.94279
Valid N (listwise)	228				

SD of Logit Y predicted = Slogit (Ypredicted) = .94279

6. Calculate the descriptives for your predictor variables to obtain **Sx**, the SD of X, Z, etc.

--see above

SOLUTION FOR ALL VARIABLES

R = square root of coefficient of determination = **.399**

Slogit (Ypredicted) = SD of logit (Ypredicted) = **.94279**

A. FOR AGE Standardized Log Regression Coeeficient *b(age)

Equation:

Standardized coefficient= *byx = (byx) (Sx) (R) / Slogit (Ypredicted)

b age = .090

Sx age = SD of X = 4.21974

R = .399

Slogit (Ypredicted) = SD of logit (Ypredicted) = .94279

*b (age) = (.090) (4.21974) (.399) /.94279

***b (age) = .16072**

B. FOR SEX Standardized Log Regression Coeeficient *b(sex)

Equation:

Standardized coefficient= *byx = (byx) (Sx) (R) / Slogit (Ypredicted)

b sex = .756

Sx sex = SD of X = .48575

R = .399

Slogit (Ypredicted) = SD of logit (Ypredicted) = .94279

*b (sex) = (.756) (.48575) (.399) / .94279

***b (sex) = .1554**

C. FOR INCOME Standardized Log Regression Coeeficient *b(income)

Equation:

Standardized coefficient= *byx = (byx) (Sx) (R) / Slogit (Ypredicted)

b income = -.313

Sx income = SD of X = .62337

R = .399

Slogit (Ypredicted) = SD of logit (Ypredicted) = .94279

*b (income) = (-.313) (.62337) (.399) / .94279

***b (income) = -.08257**

D. FOR IADL Standardized Log Regression Coeeficient *b(iadl)

Equation:

Standardized coefficient= *byx = (byx) (Sx) (R) / Slogit (Ypredicted)

b iadl = -.167

Sx iadl = SD of X = 1.97822

R = .399

Slogit (Ypredicted) = SD of logit (Ypredicted) = .94279

*b (iadl) = (-.167) (1.97822) (.399) / .94279

***b (iadl) = -.1398**

E. FOR Lonely Standardized Log Regression Coeeficient *b(lonely)

Equation:

Standardized coefficient= *byx = (byx) (Sx) (R) / Slogit (Ypredicted)

b lonely = .268

Sx lonely = SD of X = 2.30157

R = .399

Slogit (Ypredicted) = SD of logit (Ypredicted) = .94279

*b (lonely) = (.268) (2.30157) (.399) / .94279

*b (lonely) = .2610

Model with covariates and loneliness and health and activity predicting mortality

1. Run the logistic regression to obtain **byx**

2. SAVE the predicted Y = **PRE_2b**

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)
Step 1[a]	age01_new	.108	.040	7.310	1	.007	1.115
	sex01new_recoded	.781	.333	5.489	1	.019	2.184
	curincAIM2001_new_meanre	-.361	.267	1.826	1	.177	.697
	iadl01	-.081	.093	.759	1	.384	.922
	lonsum01	.235	.071	11.046	1	.001	1.264
	chron_s_SAS2003	.047	.066	.512	1	.474	1.048
	soccom13_sas2003_meanre	-.238	.138	2.999	1	.083	.788
	Constant	-8.582	3.679	5.441	1	.020	.000

a. Variable(s) entered on step 1: chron_s_SAS2003, soccom13_sas2003_meanre.

3. Correlate the Ypredicted and Yobserved to calculate **R = .417**

Correlations

		PRE_2b Predicted probability	mort2008 recoded mort 2008 0 = alive 1 = deceased
PRE_2b Predicted probability	Pearson Correlation	1	.417**
	Sig. (2-tailed)		.000
	N	228	228
mort2008 recoded mort 2008 0 = alive 1 = deceased	Pearson Correlation	.417**	1
	Sig. (2-tailed)	.000	
	N	228	228

**. Correlation is significant at the 0.01 level (2-tailed).

4. Use the Ypredicted to calculate **logit(Ypredicted)** by using the equation:

Logit (Ypredicted) = ln[Ypredicted / 1- Ypredicted]

logit Y(predicted) = ln[Ypredicted / 1- Ypredicted] = pre_1ln (variable name)

A. step 1

```
COMPUTE PRE_2bdivision=PRE_2b / (1 - PRE_2b).
VARIABLE LABELS  PRE_2bdivision 'PRE_2b / 1 - PRE_2b'.
EXECUTE.
```

```
list PRE_2b PRE_2bdivision .
```

B. Step 2 of 2

```
COMPUTE PRE_2bln=LN(PRE_2bdivision).
VARIABLE LABELS  PRE_2bln 'ln (Pre_2b/1-Pre_2b)'.
EXECUTE.
```

```
list PRE_2b PRE_2bdivision pre_2bln.
```

5. Calculate the descriptives of logit (Ypredicted), including the SD, to obtain the **Slogit (Ypredicted)**

Descriptives for pre_2bln:

```
DESCRIPTIVES VARIABLES=PRE_2bln
  /STATISTICS=MEAN STDDEV MIN MAX.
```

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
PRE_2bln ln (Pre_2b/1-Pre_2b)	228	-3.54	1.71	-1.0246	1.02068
Valid N (listwise)	228				

SD of Logit Y predicted = Slogit (Ypredicted) = 1.02068

6. Calculate the descriptives for your predictor variables to obtain **Sx**, the SD of X, Z, etc.

--see above

SOLUTION FOR ALL VARIABLES

R = square root of coefficient of determination = **.417**

Slogit (Ypredicted) = SD of logit (Ypredicted) = **1.02068**

A. FOR AGE Standardized Log Regression Coeeficient *b(age)

Equation:

Standardized coefficient= *byx = (byx) (Sx) (R) / Slogit (Ypredicted)

b age = .108

Sx age = SD of X = 4.21974

R = .417

Slogit (Ypredicted) = SD of logit (Ypredicted) = 1.02068

*b (age) = (.108) (4.21974) (.417) /1.02068

***b (age) = .18618**

B. FOR SEX Standardized Log Regression Coeeficient *b(sex)

Equation:

Standardized coefficient= *byx = (byx) (Sx) (R) / Slogit (Ypredicted)

b sex = .781

Sx sex = SD of X = .48575

R = .417

Slogit (Ypredicted) = SD of logit (Ypredicted) = 1.02068

*b (sex) = (.781) (.48575) (.417) / 1.02068

***b (sex) = .15499**

C. FOR INCOME Standardized Log Regression Coeeficient *b(income)

Equation:

Standardized coefficient= *byx = (byx) (Sx) (R) / Slogit (Ypredicted)

b income = -.361

Sx income = SD of X = .62337

R = .417

Slogit (Ypredicted) = SD of logit (Ypredicted) = 1.02068

*b (income) = (-.361) (.62337) (.417) / 1.02068

***b (income) = -.09193**

D. FOR IADL Standardized Log Regression Coeeficient *b(iadl)

Equation:

Standardized coefficient= *byx = (byx) (Sx) (R) / Slogit (Ypredicted)

b iadl = -.081

Sx iadl = SD of X = 1.97822

R = .417

Slogit (Ypredicted) = SD of logit (Ypredicted) = 1.02068

*b (iadl) = (-.081) (1.97822) (.417) /1.02068

***b (iadl) = -.06546**

E. FOR Lonely Standardized Log Regression Coeeficient *b(lonely)

Equation:

Standardized coefficient= *byx = (byx) (Sx) (R) / Slogit (Ypredicted)

b lonely = .235

Sx lonely = SD of X = 2.30157

R = .417

Slogit (Ypredicted) = SD of logit (Ypredicted) = 1.02068

*b (lonely) = (.235) (2.30157) (.417) / 1.02068

*b (lonely) = .219655

E. FOR health conditions Standardized Log Regression Coeeficient *b(health)

Equation:

Standardized coefficient= *byx = (byx) (Sx) (R) / Slogit (Ypredicted)

b health = .047

Sx health = SD of X = 2.76

R = .417

Slogit (Ypredicted) = SD of logit (Ypredicted) = 1.02068

*b (health) = (.047) (2.76) (.417) / 1.02068

*b (health) = .052997

E. FOR activity Standardized Log Regression Coeeficient *b(activity)

Equation:

Standardized coefficient= *byx = (byx) (Sx) (R) / Slogit (Ypredicted)

b activity = -.238

Sx activity = SD of X = 1.328

R = .417

Slogit (Ypredicted) = SD of logit (Ypredicted) = 1.02068

*b (activity) = (-.238) (1.328) (.417) / 1.02068

*b (activity) = -.12912

Loneliness and Happiness Predicting Mortality

This is the steps taken for my logistic regression model with my interaction term: Undo Hypothesis with mortality.

Note: I used the equation *without* the interaction term to calculate the coefficients for main effect. Then I calculated the interaction term coefficient separately.

Equation:

Standardized coefficient= *byx = (byx) (Sx) (R) / Slogit (Ypredicted)

***byx** = standardized coefficient

byx = unstandardized coefficient

Sx = SD of X

R = square root of coefficient of determination

-R is equal to Yobserved correlated with Ypredicted
-(or run the regression to get R2)

Slogit (Ypredicted) = SD of logit (Ypredicted), i.e., the SD of the estimated logit (Y) values

Steps:

1. Run the logistic regression to obtain the **byx**, bzx, etc…

2. SAVE the predicted values to obtain Ypredicted.

3. Correlate the Ypredicted and Yobserved to calculate **R**.

4. Use the Ypredicted to calculate **logit(Ypredicted)** by using the equation:

Logit (Ypredicted) = ln[Ypredicted / 1- Ypredicted]

5. Calculate the descriptives of logit (Ypredicted), including the SD, to obtain the **Slogit (Ypredicted)**

6. Calculate the descriptives for your predictor variables to obtain **Sx**, the SD of X, Z, etc.

Model with covariates and loneliness and happy and their intx predicting mortality

SOLUTION FOR ALL THE VARIABLES EXCEPT THE INTERACTION TERM

1. Run the logistic regression to obtain **byx**

2. SAVE the predicted Y = **PRE_1a**

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)
Step 1[a]	age01new_c	.097	.039	6.157	1	.013	1.102
	sex01new_recoded	.658	.334	3.875	1	.049	1.931
	curincaim2001_centered	-.395	.268	2.174	1	.140	.674
	iadl01_centered	-.147	.081	3.263	1	.071	.863
	lonsum01_centered	.231	.071	10.594	1	.001	1.259
	cesd8aim2001meanre_centered	-.401	.194	4.258	1	.039	.669
	Constant	-1.264	.218	33.597	1	.000	.283

a. Variable(s) entered on step 1: age01new_c, sex01new_recoded, curincaim2001_centered, iadl01_centered, lonsum01_centered, cesd8aim2001meanre_centered.

3. Correlate the Ypredicted and Yobserved to calculate **R = .424**

Correlations

		PRE_1a Predicted probability for logistic model happy and lon without intx	mort2008 recoded mort 2008 0 = alive 1 = deceased
PRE_1a Predicted probability for logistic model happy and lon without intx	Pearson Correlation	1	.424**
	Sig. (2-tailed)		.000
	N	228	228
mort2008 recoded mort 2008 0 = alive 1 = deceased	Pearson Correlation	.424**	1
	Sig. (2-tailed)	.000	
	N	228	228

Correlations

		PRE_1a Predicted probability for logistic model happy and lon without intx	mort2008 recoded mort 2008 0 = alive 1 = deceased
PRE_1a Predicted probability for logistic model happy and lon without intx	Pearson Correlation	1	.424**
	Sig. (2-tailed)		.000
	N	228	228
mort2008 recoded mort 2008 0 = alive 1 = deceased	Pearson Correlation	.424**	1
	Sig. (2-tailed)	.000	
	N	228	228

**. Correlation is significant at the 0.01 level (2-tailed).

4. Use the Ypredicted to calculate **logit(Ypredicted)** by using the equation:

Logit (Ypredicted) = ln[Ypredicted / 1- Ypredicted]

logit Y(predicted) = ln[Ypredicted / 1- Ypredicted] = pre_1ln (variable name)

A. step 1

```
COMPUTE PRE_1adivision=PRE_1a / (1 - PRE_1a).
VARIABLE LABELS  PRE_1adivision 'PRE_1a / 1 - PRE_1a'.
EXECUTE.
```

list PRE_1a PRE_1adivision .

B. Step 2 of 2

```
COMPUTE PRE_1aln=LN(PRE_1adivision).
VARIABLE LABELS  PRE_1aln 'ln (Pre_1a/1-Pre_1a)'.
EXECUTE.
```

list PRE_1a PRE_1adivision pre_1aln.

5. Calculate the descriptives of logit (Ypredicted), including the SD, to obtain the **Slogit (Ypredicted)**

Descriptives for pre_1aln:

```
DESCRIPTIVES VARIABLES=PRE_1aln
  /STATISTICS=MEAN STDDEV MIN MAX.
```

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
PRE_1aln ln (Pre_1a/1-Pre_1a)	228	-3.15	1.68	-1.0155	1.00752
Valid N (listwise)	228				

SD of Logit Y predicted = Slogit (Ypredicted) = 1.00752

6. Calculate the descriptives for your predictor variables to obtain **Sx**, the SD of X, Z, etc.

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
age01new_c centered age01_new m = 83 n = 228	228	-6.00	13.00	.0000	4.21974
sex01new_recoded sex01_new recoded to 0 = females and 1 = males	228	.00	1.00	.3772	.48575
curincaim2001_centered curincaim2001_new_meanre - (mean 1.7368) n = 228	228	-.74	1.26	.0000	.62337
iadl01_centered iadl01 - (mean 9.3289)	228	-8.33	2.67	.0000	1.97822

lonsum01_centered lonsum01 - (mean 2.0482) n = 228	228	-2.05	7.95	.0000	2.30157
cesd8aim2001meanre_centered cesd8aim2001_meanre - (mean 2.4254) n = 228	228	-2.43	.57	.0000	.83358
lonsum01BYcesd8_centered andmultiplied lonsum01_centered by cesd8aim2001meanre_centered updated	228	-14.44	4.97	-.5863	2.37664
Valid N (listwise)	228				

SOLUTION FOR ALL VARIABLES EXCLUDING THE INTERACTION TERM

R = square root of coefficient of determination = **.424**

Slogit (Ypredicted) = SD of logit (Ypredicted) = **1.00752**

A. FOR AGE Standardized Log Regression Coeeficient *b(age)

Equation:

Standardized coefficient= *byx = (byx) (Sx) (R) / Slogit (Ypredicted)

b age = .097

Sx age = SD of X = 4.21974

R = .424

Slogit (Ypredicted) = SD of logit (Ypredicted) = 1.00752

*b (age) = (.097) (4.21974) (.424) /1.00752

***b (age) = .172**

B. FOR SEX Standardized Log Regression Coeeficient *b(sex)

Equation:

Standardized coefficient= *byx = (byx) (Sx) (R) / Slogit (Ypredicted)

b sex = .658

Sx sex = SD of X = .48575

R = .424

Slogit (Ypredicted) = SD of logit (Ypredicted) = 1.00752

*b (sex) = (.658) (.48575) (.424) / 1.00752

*b (sex) = .1345

C. FOR INCOME Standardized Log Regression Coeeficient *b(income)

Equation:

Standardized coefficient= *byx = (byx) (Sx) (R) / Slogit (Ypredicted)

b income = -.395

Sx income = SD of X = .62337

R = .424

Slogit (Ypredicted) = SD of logit (Ypredicted) = 1.00752

*b (income) = (-.395) (.62337) (.424) / 1.00752

***b (income) = -.1036**

D. FOR IADL Standardized Log Regression Coeeficient *b(iadl)

Equation:

Standardized coefficient= *byx = (byx) (Sx) (R) / Slogit (Ypredicted)

b iadl = -.147

Sx iadl = SD of X = 1.97822

R = .424

Slogit (Ypredicted) = SD of logit (Ypredicted) = 1.00752

*b (iadl) = (-.147) (1.97822) (.424) / 1.00752

***b (iadl) = -.12237**

E. FOR Lonely Standardized Log Regression Coeeficient *b(lonely)

Equation:

Standardized coefficient= *byx = (byx) (Sx) (R) / Slogit (Ypredicted)

b lonely = .231

Sx lonely = SD of X = 2.30157

R = .424

Slogit (Ypredicted) = SD of logit (Ypredicted) = 1.00752

*b (lonely) = (.231) (2.30157) (.424) / 1.00752

*b (lonely) = .2237

F. FOR Happy Standardized Log Regression Coeeficient *b(happy)

Equation:

Standardized coefficient= *byx = (byx) (Sx) (R) / Slogit (Ypredicted)

b happy = -.401

Sx happy = SD of X = .83358

R = .424

Slogit (Ypredicted) = SD of logit (Ypredicted) = 1.00752

*b (happy) = (-.401) (.83358) (.424) / 1.00752

*b (happy) = -.14067

//

Model with covariates and loneliness and happy and their intx predicting mortality

SOLUTION FOR INTERACTION TERM

1. Run the logistic regression to obtain **byx**

2. SAVE the predicted Y = **PRE_1**

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)
Step 1[a]	age01new_c	.094	.040	5.556	1	.018	1.099
	sex01new_recoded	.772	.347	4.958	1	.026	2.163
	curincaim2001_centered	-.425	.280	2.301	1	.129	.654
	iadl01_centered	-.175	.083	4.472	1	.034	.839
	lonsum01_centered	.187	.078	5.745	1	.017	1.205
	cesd8aim2001meanre_centered	-.211	.231	.830	1	.362	.810
	lonsum01BYcesd8_centeredandmultiplied	-.228	.093	6.009	1	.014	.796
	Constant	-1.409	.235	35.849	1	.000	.244

a. Variable(s) entered on step 1: lonsum01BYcesd8_centeredandmultiplied.

3. Correlate the Ypredicted and Yobserved to calculate **R = .462**.

Correlations

		PRE_1 Predicted probability for logitic model with interaction	mort2008 recoded mort 2008 0 = alive 1 = deceased
PRE_1 Predicted probability for logitic model with interaction	Pearson Correlation	1	.462**
	Sig. (2-tailed)		.000
	N	228	228
mort2008 recoded mort 2008 0 = alive 1 = deceased	Pearson Correlation	.462**	1
	Sig. (2-tailed)	.000	
	N	228	228

**. Correlation is significant at the 0.01 level (2-tailed).

4. Use the Ypredicted to calculate **logit(Ypredicted)** by using the equation:

Logit (Ypredicted) = ln[Ypredicted / 1- Ypredicted]

logit Y(predicted) = ln[Ypredicted / 1- Ypredicted] = pre_1ln (variable name)

A. step 1

```
COMPUTE PRE_1division=PRE_1 / (1 - PRE_1).
VARIABLE LABELS  PRE_1division 'PRE_1 / 1 - PRE_1'.
EXECUTE.
```

```
list PRE_1 PRE_1division .
```

B. Step 2 of 2

```
COMPUTE PRE_1ln=LN(PRE_1division).
VARIABLE LABELS  PRE_1ln 'ln (Pre_1/1-Pre_1)'.
EXECUTE.
```

```
list PRE_1 PRE_1division pre_1ln.
```

5. Calculate the descriptives of logit (Ypredicted), including the SD, to obtain the **Slogit (Ypredicted)**

Descriptives for pre_1ln:

```
DESCRIPTIVES VARIABLES=PRE_1ln
  /STATISTICS=MEAN STDDEV MIN MAX.
```

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
PRE_1ln ln (Pre_1/1-Pre_1)	228	-2.93	4.22	-.9845	**1.15205**
Valid N (listwise)	228				

SD of Logit Y predicted = Slogit (Ypredicted) = 1.15

6. Calculate the descriptives for your predictor variables to obtain **Sx**, the SD of X, Z, etc.

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
age01new_c centered age01_new m = 83 n = 228	228	-6.00	13.00	.0000	4.21974
sex01new_recoded sex01_new recoded to 0 = females and 1 = males	228	.00	1.00	.3772	.48575
curincaim2001_centered curincaim2001_new_meanre - (mean 1.7368) n = 228	228	-.74	1.26	.0000	.62337
iadl01_centered iadl01 - (mean 9.3289)	228	-8.33	2.67	.0000	1.97822
lonsum01_centered lonsum01 - (mean 2.0482) n = 228	228	-2.05	7.95	.0000	2.30157

cesd8aim2001meanre_centered cesd8aim2001_meanre - (mean 2.4254) n = 228	228	-2.43	.57	.0000	.83358
lonsum01BYcesd8_centeredandmultiplied lonsum01_centered by cesd8aim2001meanre_centered updated	228	-14.44	4.97	-.5863	2.37664
Valid N (listwise)	228				

SOLVE FOR INTX_ Standardized Log Regression Coeeficient *b(intx)

Equation:

Standardized coefficient= *byx = (byx) (Sx) (R) / Slogit (Ypredicted)

b intx = -.228

Sx intx= SD = 2.37

R = .462

Slogit (Ypredicted) = SD of logit (Ypredicted) = 1.15

*b (intx) = (-.228) (2.37) (.462) / 1.15

***b (intx) = -.217**