THREE STUDIES OF THE ASSOCIATIONS OF COGNITIVE ABILITY, HEALTH, AND WEALTH AMONG THE ELDERLY

by

FREDERICK RAY FERNATT

B.S., Illinois State University, 1976
M.A., University of Iowa, 1986
M.S., College for Financial Planning, 1996
M.S.F.S., The American College, 2009

AN ABSTRACT OF A DISSERTATION

submitted in partial fulfillment of the requirements for the degree

DOCTOR OF PHILOSOPHY

The School of Family Studies and Human Services
College of Human Ecology

KANSAS STATE UNIVERSITY
Manhattan, Kansas

2016

Abstract

This dissertation consists of three studies exploring the relationship between cognitive abilities, health, and wealth related variables among the elderly. For all three studies, the life cycle hypotheses provided the basis of the theoretical framework and utilized data from the 2000 through 2010 panels of the Health and Retirement Study (HRS). The first study compared the cognitive abilities of non-married households with the cognitive abilities of married households in order to examine the effect of marital status on household wealth. The second study examines the relationship of two aspects of cognitive ability (fluid intelligence and crystallized intelligence) and wealth for couples married to the same spouse for all HRS panels for 2000 to 2010. The third study examines the relationship of cognitive ability, emotional health, physical health, and wealth for couples married to the same spouse for all HRS panels for 2000 to 2010. Results identified significant associations among marital status, cognitive abilities, and health with wealth. These findings contribute to the field of financial planning by providing useful information about how marital status, cognitive functioning, and health affect the household wealth of the elderly. Financial service practitioners, regulators, researchers, and caregivers can apply these findings to develop approaches to assist the elderly manage their household wealth.

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Major Professor
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Certain events in our lives become landmarks by which other occasions are measured. The development of the dissertation is certainly one such milestone in my life. Such a project is a mosaic of thousands of thoughts and deeds that evolve into a cohesive work. Many, many hands have set a few stones along the way.

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Dedication

To my parents, Pooch and Phyllis

For their guidance and love.

They instilled is us the importance of

family, hard work, and helping others

To my daughters Alicia, Ana, and Ayla

You have filled my life with love and are a source of great pride

To my granddaughters, Celia and Zariah

I love you beyond words and am eager for what the future may bring

To my wife, Lavonne

Forty- four years ago a chance meeting led to us walking hand in hand

from Firemen's Park to forever together

All my love

Chapter 1 - Introduction

As the population ages, the effect of deteriorating physical health and mental capacities of the elderly is increasingly becoming a concern (Allen, 2013). There is a strong association between the deterioration in physical capability and mental deficits (Freedman, Aykan, & Martin, 2001). The anxiety from dealing with declining cognitive ability and physical health result in financial strain in elderly households (Palgi, 2012). These diminished abilities often occur at a time in life when financial resources decline and financial needs escalate. Those with declining physical abilities and cognitive functions are some of the most vulnerable members of society and are at high risk of economic exploitation. Health and cognitive abilities should be considered by policymakers, family members, financial service professionals, and other stakeholders interested in projecting medical and social service needs and the availability of resources to meet those needs (Freedman et al., 2001).

The life cycle hypothesis assumes that wealth is accumulated during the working years to draw down the assets during retirement. Health, education, and cognitive abilities are factors of human capital engaged to produce income and accumulate wealth. Health is an undiversifiable risk and it varies systematically over the life cycle. Deterioration in cognitive functions not only adversely impacts the ability to manage assets but may also affect the needs for expenditures and thereby directly impacts the utility function (Edwards, 2008; Kim, 2012). Declines in health and cognitive abilities with age affects both the ability to manage wealth and the demands on financial assets.

Potential exploitation of the elderly is becoming more of an issue due to longer life expectancies, mobility of adult children away from parents, and brokerage management of funds. Members from all aspects of the financial services profession have responded with increased

attention to the health and cognitive abilities of elderly clients. Failing to plan for deteriorating cognitive functioning and health may result in elderly individuals becoming financially vulnerable. Advisors not recommending that clients address possible weakening cognitive capability may be potentially liable for damages. Uncertainty regarding standards of cognitive functioning further complicates the issue (Correia, 2014). Many prior studies examining the association of cognitive abilities, health, and wealth remark about need for further research (Delvande, Rohwedder, & Willis, 2008; Fisher, Hassan, Rodgers, & Weir, 2013; Hurd, Martorell, Delavande, Mullen, & Langa, 2013; Kim, Hanna, Chatterjee, & Lindamood, 2012; Smith, McArdle & Willis, 2010

Description of Studies

This dissertation examines the relationship of cognitive abilities, health, and wealth among the elderly. Data from the Health and Retirement Study are used for each of the three independent studies. Married and non-married households surveyed in 2000 and 2010 were tested in the first study. Couples consisting of the same spouse for each of the six waves from 2000 through 2010 examined in the second and third studies.

The key elements in this study which highlight the contribution to the literature include:

1. In Study 1 and Study 2 the fluid intelligence and crystallized aspects of cognitive ability are examined separately. Fluid intelligence and crystallized intelligence measure different characteristics of cognitive ability, have different trajectories over the life-cycle, and may have different wealth associations. Many studies use a combined measure so separating the two aspects enables a clearer understanding of the results.

2. This longitudinal analysis in Study 2 and in Study 3 evaluates the responses of the same couples over six consecutive waves of data. Most studies utilize a single wave or a cross-sectional sample between waves.
3. In most studies, education is treated as a continuous variable. Levels of education can demarcate distinct categories of socio-economic status. By analyzing each level of attained education separately, we are better able to understand results within each socio-economic class and between classes.

The first study, Chapter 2, compares the associations of cognitive abilities and wealth of married households with non-married households. The purpose was to compare married households and non-married households of the same level of attained education in order to isolate the effect of marriage on accumulation of household wealth. These comparisons were done for the 2000 panel of data, for the 2010 panel and then the panels were compared to one another.

The second study, Chapter 3, examines the relationship of mental status and memory with wealth for couples married to the same spouses for all six biennial panels from 2000 to 2010. The purpose was to evaluate the relationships of mental status and wealth and the relationships of memory for each category of attained education. This method also enables examining the trajectory of mental status, memory, and wealth through each of the six panels.

The third study, Chapter 4, broadens the scope of the second study by examining the relationships of three broad measures of health (cognitive ability, mental health, and physical health) and wealth. In this study, mental status and memory are combined into a single measure of cognitive ability. The relationships of cognitive ability, emotional health, and physical health with wealth for couples married to the same spouses for all six biennial panels from 2000 to

2010 were examined. This method provided comparisons of the relationships of cognitive ability and wealth to similar relationships with physical heath and emotional health, and enabled comparison of the relative strengths of those relationships.

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Chapter 2 - The Associations of Cognitive Abilities and Wealth: A Comparison of Married and Non-Married Households

Introduction

The focus of this research is to evaluate associations of cognitive abilities and household wealth accumulation among married and unmarried households. Households of different marital status may also display differences in race, age, gender, cognitive ability, and wealth. This study will examine the demographic differences in married and unmarried households and the influence of those characteristics on wealth.

Marriage is a wealth-enhancing institution in a number of ways. Married households can enjoy economies of scale in consumption thereby freeing resources for savings. The marital relationship partially mitigates against life risks as the spouses act to support one another against life cycle shocks. Finally, married individuals have longer life expectancies than non-married individuals and therefore have additional incentive to accumulate wealth in order to maintain consumption (Ulker, 2009).

Marital status is a significant factor in that being single is the most consistent predictor of declines in cognitive functioning (Banks & Oldfield, 2007; Karlamangla et al., 2009). Cognitive decline increases the vulnerability of the elderly. It is therefore important to understand the economic effects of cognitive ability among the elderly. Marriage may mitigate the effects of cognitive decline and it is valuable to understand the association of wealth and cognitive ability within the marriage dynamic (Choi & Marks, 2011).

Cognitive ability is a strong predictor of financial and social outcomes (Borghans, Duckworth, Heckman, & Wee, 2008). Those with higher cognitive ability tend to earn more over

time (Adams, Hurd, Merrill, & Ribeiro, 2003) and individuals with greater wealth are able to develop higher levels of cognitive ability (Hanushek & Woessmann, 2012).

Need for Study

The synergy of spouses' abilities combines to form a marriage dynamic that may affect wealth in ways not experienced by unmarried households. In a married household, financial resources may be combined to form household wealth and each individual spouse's cognitive ability may play the principal role of acquiring and managing the household wealth at different times during the marriage (Wu, 2003). The magnitude to which marital status affects household wealth should be further explored in order to examine the synergies afforded by marriage that are not available to non-married households (Willoughby, Hall, & Luczak, 2015).

Many aspects of cognitive ability are utilized early in life in order to attain education. The associations of cognitive ability with wealth may also be changing during life stages before and after retirement. Aspects of cognitive functions are interrelated but the aspects of cognitive ability may be associated with wealth in different ways. Although the level of education attained rarely changes after early adulthood, the cognitive tools and skills derived from education continue to have lifelong influence on the ability to earn income and accumulate wealth. Changes in cognitive ability would best be described by a family of curves over time. Fluid reasoning as measured by memory variables and accumulated crystallized knowledge as measured by mental status variables change along different patterns. McArdle, Smith, and Willis, (2009) suggested further research be conducted to determine the strength of the relationship of cognitive ability and wealth.

Review of Literature

Introduction

Married households amass higher wealth than unmarried households. Although the dynamic of marriage facilitates the accumulation of wealth, many other factors affect the marriage decision and wealth generating behaviors. Married adults report better health than non-married adults (Hughes & Waite, 2009) and married couples amass twice the wealth of non-married households (Poterba, Venti, & Wise, 2011b).

Theoretical Framework

A basic premise of the life cycle theory (LCH) is that households save during prime working ages of their members in order to smooth marginal utility of consumption over their life expectancy (Modigliani & Brumberg, 1954). The modified life cycle model considers the potential effects of bequest motive, longevity risk, and concern for out of pocket medical costs. Using data from the HRS 1992 survey Scholz, Seshadri, and Khitatrakun (2006) tested for optimal savings rates and found that the LCH closely accounted for variations in optimal target wealth accumulation across categories of households. Scholz and Seshadri (2011) compared actual financial behaviors to optimal savings decisions and found that over 80% of households had accumulated more than their optimal wealth target and under-savers were concentrated in the lower income households.

Similarly, Love, Palumbo and Smith (2008) used HRS waves 1996 – 2006 to compare observed wealth patterns with wealth patterns predicted using a stochastic life cycle model. They found a positive and significant correlation of age and wealth indicating that wealth was increasing as individuals age. The LCH would predict that household consumption would reduce wealth from retirement through the remaining life expectancy. However, Love, Smith, and McNair (2008) found that households were not spending down their wealth as quickly as would be predicted by remaining survival probability. Kim, Hanna, Chatterjee, and Lindamood (2012)

postulated that reasons for not depleting wealth may include a bequest motive and that individuals may understand their longevity risk.

Influences of Marriage

The married couples benefit from relationship dynamics not experienced by non-married households. Spouses rely on one another for financial and emotional support. The support results in lower perceived personal risk. Spouses in a married couple have higher risk tolerance than similar unmarried individuals. Also, married individuals experience slower declines in mental and physical health than their single counterparts (Karraker & Latham, 2013).

Couples in the HRS are well suited for studies on the relationship of health and marriage. The respondents are in mid-life and so have decades of marital history. Currently, married individuals who have never been divorced or widowed show better health than those married individuals who had experienced a marital loss. Remarried individuals reported poorer health than continuously married individuals. Poor health, especially poor mental health, can lead to marital dissatisfaction and divorce. Hughes and Waite (2009) found that both married men and married women have better physical health, better mental health, and lower mortality than their unmarried counterparts. The longer the continuous marital history, the more pronounced the effects. The health of both spouses is strongly related to household wealth. The results of the initial HRS survey in 1992 indicated that median household wealth was over $400,000 when both spouses were in excellent health but less than $32,000 when both spouses were in poor health (Ofstedal, Fisher, & Herzog, 2005).

Individuals who remain married throughout the life course have significantly higher wealth, higher income-to-needs, and better health than widowed, divorced, or never married individuals. Some reasons for the higher wealth include economies of scale, task specialization

and lower socialization seeking costs. Factors such as declining physical health or deteriorating cognitive ability may precede the death of a spouse, exacerbate martial tensions resulting in divorce, or preclude individuals from getting married. The LCH predicts that individuals can compensate for the deleterious financial results from marriage termination by reducing consumption but this might not be feasible in many cases (Wilmoth & Koso, 2002).

The marriage paradigm encompasses beliefs about getting married and beliefs about staying married. When assessing candidates as potential mates, individuals consider compatibility of attitudes toward gender roles, child rearing, importance of spiritual matters, and other factors. Often the individual and the potential mates have similar socioeconomic status, education, and family marital history. Many of the same factors utilized in the decision to marry are also employed considering whether to stay married (Willoughby, Hall, & Luczak, 2015).

Individuals' attitudes, values, motivations, and behaviors blend to form their personality traits. Those personality traits associated with time perspective, desire for self-satisfaction, conscientiousness, and self-control are most predictive of economic outcomes. Both cognitive ability and personality traits develop over individuals' life cycles. The cognitive abilities of processing speed and memory peak in early adulthood. Awareness and concern for others, conscientiousness, tends to grow throughout life (Borghans et al., 2005). An individual's personality traits can act independently both on the marriage decision and economic outcomes but are often integral to both.

Married couples report higher average risk tolerance than similar non-married individuals because spouses often provide care for one another thereby mitigating uncertainty from deleterious life style events such as loss of earnings or health shocks (Finke & Huston, 2003). This perception of reduced risk could mean that couples are more tolerant of other risks. Modern

portfolio theory predicts that higher risk tolerance results in greater long term wealth (Markowitz, 1952). Married households tend to accumulate greater household wealth than non-married households of comparable education and cognitive ability (Choi & Marks, 2011).

Some of the changes in cohort wealth are the result of savings, withdrawals and returns on financial assets. Other changes are the result of attrition of couples being studied. When researching the longitudinal changes in assets for married couples a factor to consider is the sample bias resulting from couples with higher wealth having a higher likelihood of remaining in the study (Poterba et al., 2012). A similar study (Poterba, Venti, & Wise, 2010) using data from HRS 1992 through 2006 found that those couples continuing to remain married over the seven two year intervals of the study experienced an increase in assets for each interval in the study. Most spouses in couples which either divorced or experienced the death of a spouse had assets grow at slower rates and many experienced a sharp decline in assets. Nearly all the decline in home ownership can be attributed to one spouse either dying or moving to a nursing home. Those couples in continuing marriages withdrew on average less than 2% per year from discretionary retirement plans. Individuals who lost a spouse through death, divorce, or from admission to a nursing home had substantial withdrawals from discretionary retirement funds

Several studies have noted a strong relationship between health and wealth and found that wealth at the end of life was highest for couples married the longest (Cagney & Lauderdale, 2002; Scheider, 2011; Ulker, 2009). In a longitudinal study, some of the changes in cohort wealth are the result of savings, withdrawals and returns on financial assets. Other changes are the result of attrition of couples from the study. The combined wealth of the former spouses in a marriage that dissolved between 1998 and 2000 was much lower than the household wealth of couples that remained married.

The Influence of Cognitive Ability on Wealth

The preponderance of formal education is attained relatively early in life but the effects of education have a strong influence on cognitive ability and wealth throughout life. Education, mental health, and wealth are interrelated throughout life in that those from a higher socio-economic status can commit resources early in life. Greater attained education is associated with higher lifetime income and better health (Adams, Hurd, McFadden, Merrill, & Ribeiro, 2003).

Bosma, van Boxtel, Ponds, Houx, and Jolles, J. (2003) postulated that the mental stimulation of the occupations attained though more education is a mechanism to sustain higher levels of cognitive ability throughout life. In a similar study, Dannefer (2003) concluded that the effects of education early in life result in skills and lifestyle habits that effect health and wealth throughout life.

Wealth during retirement largely depends on choices made well before retirement. Financial capital accumulated prior to retirement is strongly related to education. The education-wealth relationship after retirement may differ from that before retirement because many of the wealth-building mechanisms that operate at earlier ages are different from those at older ages (Poterba et al., 2013a). Education may affect portfolio choice by instilling an understanding of the benefits of diversification and increasing risk tolerance though an understanding of the risk and reward tradeoffs of asset allocation (Edwards, 2008).

Ulker (2009) found education attainment to be a significant determinant of risk tolerance for both husbands and wives and that married couples may display higher financial risk tolerance because mutual support between spouses mitigates against potential losses due to life cycle shocks. A study by Choi and Marks (2011), found that couples married continuously for at least five years reported higher income and wealth than would be expected given the spouses'

education and that there was no significant relationship between education and marriage status stability.

Education generally occurs early in the life cycle but education attainment can significantly affect individuals late in the life cycle. Differences in education may explain why individuals exhibit different changes in cognitive function over time. The educational attainment of an individual cannot explain why his or her cognitive function is declining because the level of education does not vary within persons. Individuals with low education are more likely to drop out of a panel study sooner than individuals with high education attainment. The effect of lower education may be underestimated in longitudinal studies because those who may be at risk for decline may be at risk for dropping out sooner (Sliwinski & Buschke, 1999). In a study of participant attrition from the HRS, Cao and Hill (2005) found that attritors tended to have less education. When responding to questions from an HRS interviewer, each household designates a financial respondent to address questions regarding household finances. According to Smith, McArdle, and Willis (2010), there is a strong association of education and designation of the financial respondent.

Relationship of Cognitive Ability and Wealth

A recent study by the National Council of Aging (2014) found that only 5% of elderly respondents indicated financial security as their top concern but that does not mean there is no reason for worry. Many of the results appear to be incongruous. Over 64% of the elderly responded that it was currently easy to pay bills, but 53% are concerned that income and savings will not be sufficient to pay bills long term. Sixty-five percent of seniors report at least 2 chronic health conditions, whereas 6 in 10 consider their health to be normal.

Cognitive decline exacts an enormous toll on older adults, their families, and society. Although gradual decline is common in late life the rate of cognitive decline varies substantially. A study by Karlamangla et al. (2009) used word recall and mental status responses to examine associations of cognitive function and demographic and socioeconomic status predictors. The authors concluded that cognitive decline in late life depends more on the peak level of cognitive functioning achieved earlier in the life course than on wealth in the later years of life.

Design of the Study and Methods

The LCH postulates that human capital developed through education early in life enables the accumulation of wealth to be consumed late in life. Cognitive abilities are important factors for accumulating wealth during working years and the management of assets during retirement. Fluid intelligence and crystallized intelligence represent different aspects of cognitive abilities and have disparate lifetime trajectories. Marital status has a profound influence on household wealth. The research questions address the differences in wealth based on marital status as differentiated by education and cognitive ability.

Research Questions

1. For each selected wave, to what extent does marital status influence the magnitude to which the fluid intelligence memory is associated with household wealth?
2. For each selected wave, to what extent does marital status influence the magnitude to which the crystallized intelligence is associated with household wealth?
3. How do the associations of cognitive abilities and wealth in HRS 2000 compare to the associations of cognitive abilities and wealth in HRS 2010 for each marital status?

Sample Selection

The University of Michigan Health and Retirement Study (HRS) is a biannual longitudinal panel study that surveys a representative sample of approximately 20,000 people over age of 50 in order to collect data on health and wealth of participants as they approach retirement and the years that follow. Individuals selected as part of the sample are resurveyed during each subsequent wave. Each survey is referred to as a wave beginning the first wave denoted as HRS 1992, the second wave as HRS 2010, and so on.

The focus of study is the longitudinal association of cognitive ability and wealth for the elderly. The samples will be selected from HRS panels. Each participant must be part of a household in which at least one member was age 65 or older. Additionally, at least one member of the household must have reported the level of education attained. The sample includes households from HRS 2000 and from HRS 2010. Participants are separated into non-married household and married households. Participants are not tracked between waves. Participants may be added or dropped between waves and participants may be in a married household in one wave and non-married in the other wave.

When responding to household level financial questions, married couples designate one spouse to be the financial respondent. The designation of a spouse as financial respondent is only for the survey being conducted at the time. The designation may alternate between spouses for subsequent HRS waves as each couple desires. Interviewers ask cognitive functioning questions of each spouse separately. Responses from the financial respondent were used to determine household wealth. The financial respondent's responses to memory and mental status questions were used to determine household cognitive ability.

Operationalization of Concepts

Individuals' cognitive ability progress in a dynamic of development and decay throughout their life cycles. Early in life individuals' cognitive ability are primary determining factors in developing their human capital through educational attainment. During the working years, cognitive functioning affects the level of earning and influences savings decisions. The level of cognitive function in later working years can affect the ability to maintain a level of mental competence sufficient to continuing working and therefore influences the timing of retirement. As individuals age, a decline in physical health may result in degenerating cognitive functioning and in turn a deteriorating mental capacity may be a factor in physical ability or vice versa. The rates of physical and mental decline are likely factors of remaining life expectancy (Freedman, Aykan, & Martin, 2001). Decline in cognitive functioning is a prime factor in the eventual inability of individuals to perform the activities of daily life (National Institute on Ageing, 2007). Decline in that ability result in increased health care costs and directly affect the individual's ability to manage financial assets and thereby influence level of wealth (Ofstedal, Fisher, & Herzog, 2005).

The array of cognitive ability can be classified into two broad categories: fluid intelligence and crystallized intelligence. Fluid intelligence is based on basic physical processes in which decline is more apparent with age. Recall memory is a prime aspect of fluid intelligence. While some facets of crystallized intelligence actually increase throughout life, most aspects of crystallized intelligence decline but at a slower rate than the decline in fluid intelligence. Mathematical aptitude, knowledge of current affairs, and vocabulary are the prime determinants of crystallized intelligence.

Measurement of Wealth

Wealth will be defined as the sum of the following accounts: checking and savings, certificates of deposit, stocks, bonds, life insurance, IRA & Keoghs, residences (up to two) less mortgages, other assets and vehicles, less debts. The RAND Center for the Study of Aging (RAND) has cleaned the HRS data files and the RAND data sets were used to determine wealth values. The frequency distribution of household wealth indicates both positive and negative outliers. This research attempts to mitigate against extreme outliers by using 5% trimmed means for the analysis.

When conducting the survey, the HRS interviewer asks married couples to designate one spouse to be the financial respondent to answer financial questions for the household. Respondents are sometimes reticent to answers interviewers' questions either due to an unwillingness to reveal sensitive information or uncertainty as the answer (Hurd, 1999). If the respondent does not know or does not want to provide an answer to a dollar denominated question, the interviewer asks a series of questions as to whether the amount is greater than or less than a specific value. The process is continued until an acceptable answer is obtained. The values are still uncertain and in some cases, must be imputed but the responses with missing values are greatly reduced (Marshall, McGarry, & Skinner, 2010).

Measurement of Cognitive Ability

Individuals are asked about their highest attained level of education only in the year they first participate in the survey. The attained education for each spouse in the HRS 2000 married couples will be determined by tracking the individuals through earlier waves until the reported education is ascertained. For married households, the highest attained category of education for either spouse will be selected when examining the association with household wealth.

Evaluating financial alternatives is challenging for many individuals and may engage several facets of cognitive ability. Crystallized intelligence is required for evaluating the alternatives based on accumulated knowledge and skill. Fluid intelligence is engaged in retrieving relevant financial information from memory.

Crystallized intelligence can be measured by mental status questions regarding mathematical aptitude, current knowledge, and vocabulary. In non-married households, the participant's scores are used. In married households, the mental status score of the financial respondent will be selected for the study. The scale for mental status is widely used by other studies and has a range of possible correct responses of 0 to 15.

Fluid intelligence (memory) can be measured by the immediate word recall and delayed word recall survey questions. These questions are asked of every study participant for each wave. In order to evaluate memory, respondents are read a list of 10 nouns and then immediately asked to repeat as many as they can. After approximately five minutes the respondents are again asked to repeat the words. The correct number of answers for each of the immediate and delayed word recall tests range from 0 to 10. The combined score can range from 0 to 20. The combined memory score of the same spouse for which mental status score was selected will be selected as the household score.

Analyses Conducted

The research includes single and married households in HRS 2000 and HRS 2010 in which at least one member is age 65 or older. Each marital status will be further sub-categorized by education attained

Crystallized intelligence will be measured by mental status using a 15-point scale developed from a group of HRS survey questions regarding mathematical ability, knowledge of

current affairs, and vocabulary. Memory is a primary component of fluid intelligence and will be measured using a 20-point scale. For each stage of the research the associations of mental status and wealth and memory and wealth will be categorized by education.

Education attained is an important determinant of household wealth. James (2011) found a significant relationship between education and cognitive ability. The level of education attained does not change over the range of HRS waves under study. Education will be considered a categorical predictor variable. Separate regressions will be run to examine the associations of cognitive ability and wealth for households for each level of attained education.

For single participants, their education attained will be considered. For married households, the highest education attained by either spouse will be considered as the household education value. For this study, the years of education will be categorized as: *less than high school, high school graduate, some college, college graduate,* and *graduate school*. For each stage of the study, the association of education by category and wealth will be evaluated. Households in each sample will be divided by education category in order to facilitate comparisons by marital status within waves and between waves.

Memory scores are relatively normally distributed. Mental status scores, however, are highly negatively skewed. The general linear model (GLM) is a variant of regression that allows variables to have non-normal distributions and allows the magnitude of each measurement to be a function of the predictor variables. GLM was be used to evaluate the strength of the association of mental status and wealth and of memory and wealth.

Individuals engage cognitive abilities and utilize resources early in life in order acquire education that results in higher income and greater accumulated wealth throughout life. Those with higher level of education have higher levels of cognitive ability and lifelong health. Fluid

intelligence as measured by memory peak early in life and declines thereafter. Crystallized education as measured by mental status continues to develop and declines at a slower rate. The life cycle hypothesis assumes wealth is accumulated through the working years and is exhausted during retirement. Marital status has a profound impact of household wealth regardless of education.

For each analysis, results for married and non-married households are compared. We begin by considering general demographic characteristics of age, race, and gender and comparing the samples for each level of education and by marital status. For each wave, we examine the assumption that households with higher education have higher cognition scores and greater accumulated wealth. For each level of attained education, we examine the assumptions of declining cognitive abilities and declining wealth. For each level of education, we examine how well cognitive abilities explain variance in wealth and display the results graphically and through summaries of the regressions.

Results

Table 2.1

Demographic Characteristics by Marital Status

HRS 2000 - Non-Married Households

	N		Median	Gender		Race		
	#	%	Age	Male	Female	White	NonWhite	Wealth
Less than High School	1534	38.4%	77	23.8%	76.2%	67.4%	32.6%	$ 26,900
High School	1331	33.3%	76	18.5%	81.5%	86.2%	13.8%	$ 98,000
Some College	652	16.3%	76	23.2%	76.8%	89.1%	10.9%	$139,400
College Graduate	226	5.7%	77	27.4%	72.6%	84.1%	15.9%	$242,950
Graduate School	256	6.4%	75	33.2%	66.8%	85.9%	14.1%	$291,000
Total Non-Married	3999	100.0%		22.7%	77.3%	79.3%	20.7%	$ 74,500

HRS 2000 - Married Households *

	N		Median	Gender		Race		
	#	%	Age	Male	Female	White	NonWhite	Wealth
Less than High School	854	25.2%	71	50.6%	49.4%	78.5%	21.5%	$ 84,000
High School	1222	36.1%	70	38.6%	61.4%	92.6%	7.4%	$ 220,000
Some College	616	18.2%	71	42.4%	57.6%	91.1%	8.9%	$ 290,250
College Graduate	351	10.4%	71	55.6%	44.4%	92.0%	8.0%	$ 421,506
Graduate School	340	10.1%	70	64.1%	35.9%	93.8%	6.2%	$ 542,000
Total Married	3383	100.0%		46.6%	53.4%	88.8%	11.2%	$ 221,050

* For the household financial respondent

HRS 2010 - Non-Married Households

	N		Median	Gender		Race		
	#	%	Age	Male	Female	White	NonWhite	Wealth
Less than High School	1202	29.2%	76	24.5%	75.5%	64.0%	36.0%	$ 29,347
High School	1477	35.9%	76	21.1%	78.9%	81.7%	18.3%	$104,952
Some College	816	19.8%	76	23.9%	76.1%	80.8%	19.2%	$158,050
College Graduate	299	7.3%	76	31.1%	68.9%	82.3%	17.7%	$325,000
Graduate School	323	7.8%	75	31.3%	68.7%	85.8%	14.2%	$388,000
Total Non-Married	4117	100.0%		24.1%	75.9%	76.7%	23.3%	$100,224

HRS 2010 - Married Households *

	N		Median	Gender		Race		
	#	%	Age	Male	Female	White	NonWhite	Wealth
Less than High School	854	18.6%	72	49.1%	50.9%	77.2%	22.8%	$ 103,600
High School	1222	34.3%	72	38.2%	61.8%	87.6%	12.4%	$ 253,000
Some College	616	22.6%	72	42.7%	57.3%	86.6%	13.4%	$ 340,750
College Graduate	351	11.4%	72	55.7%	44.3%	88.6%	11.4%	$ 538,000
Graduate School	340	13.1%	72	63.1%	36.9%	89.0%	11.0%	$ 723,500
Total Married	3383	100.0%		46.5%	53.5%	85.7%	14.3%	$ 291,000

Married households report higher levels of education than the education reported by non-married households. In HRS 2000, 38.4% of non-married households reported attained education as *less than high school* but only 25.2% of married households did not finish high school. In HRS 2010, the percentage of non-married households that had not finished high school dropped 29.2% and the percentage of married households dropped to 18.6%. For HRS 2000 and HRS 2010, married households reported 10.1% and 13.3% had completed *Graduate School* but only 6.4% and 7.8% of non-married households had completed *Graduate School.*

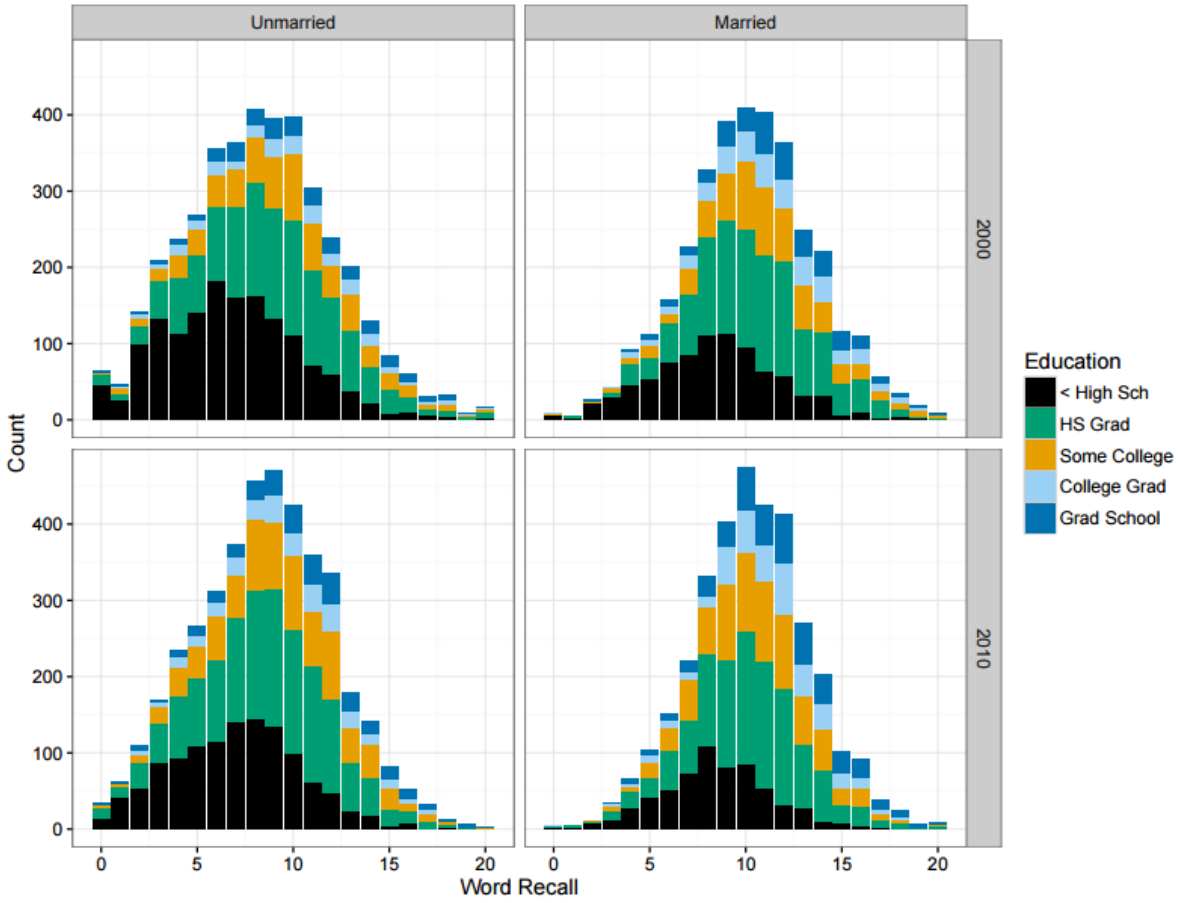
For both HRS 2000 and HRS 2010, non-married households are 5 to 6 years older than married households. Within each wave, ages are remarkably consistent among level of attained education. Non-married households range from 75 to 77 for in HRS 2000 and 75 to 76 HRS 2010. Married households range in age from 70 to 71 in HRS 2000 and are all 72 in HRS 2010.

Generally, the higher the level of household attained education, the greater the percentage of households are headed by men. For both married and non-married households, the percentage of households headed by men for *less than high school* is greater than *some college* and less than *college graduate.* In HRS 2000, 76.2% of *less than high school* non-married households were headed by females, but only 49.4% of married households were headed by females.

For both HRS 2000 and HRS 2010, a higher proportion of non-married households are headed by non-white individuals than white individuals. With the exception of *less than high school*, that remains consistent across attained education. Households with l*ess than high school* to be headed by non-white individuals. In HRS 2000, 32.6% of non-married households in the *less than high school* category were headed by non-whites but only 21.5% of married households were headed by non-whites. For other levels of attained education in HRS 2000, the portion of households headed by non-whites ranged from 10.9% to 15.9% non-married households and

from 6.2% to 8.9% for married households. For each category of education and for non-married households as well as married households, the portion of households headed by non-whites was higher in HRS 2010 was higher than HRS 2000.

Figure 2.1
Frequency Distribution of Memory Scores by Marital Status

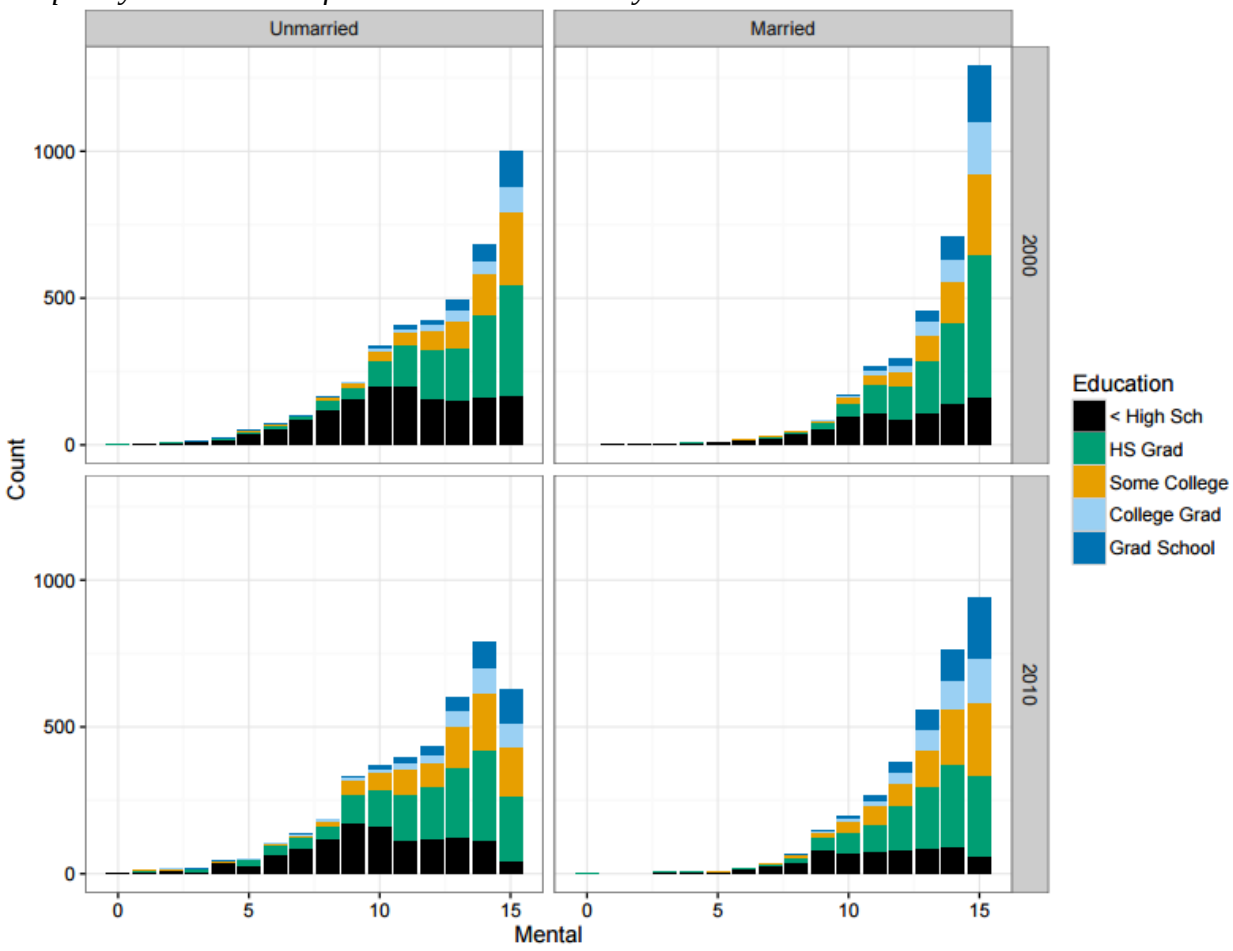


During the HRS survey, the interviewer read from a standardized list of 10 nouns and the asked to respondent to recite as many of the nouns as they can remember. After about five minutes and after several other questions, the interviewer again asks the respondent to recite as many of the nouns as they can recall. The maximum possible correct answers both immediate word recall question and delayed word recall question is 10 each. The range of correct answers to combined assessment of both questions is 0 to 20. Memory scores are somewhat normally distributed. Distributions for married households for both HRS 2000 and HRS 2010 were more

leptokurtic than distributions for non-married households. Households with higher attained education produced higher memory scores.

Figure 2.2

Frequency Distribution of Mental Status Scores by Marital Status



In order to assess mental status, the interviewer asks a series of questions ranging from asking the participant naming the president and vice president to counting backwards from 20. Possible correct answers range from 0 to 15. The frequency distributions are highly negatively skewed with married households more severely skewed than and non-married households.

Table 2.2

Memory and Mental Status Scores by Marital Status

Non-Married Households

	HRS 2000			HRS 2010		
Attained Education	n	Memory	Mental Status	n	Memory	Mental Status
Less than High School	1534	6.80	10.74	1202	7.01	9.87
High School	1331	8.92	12.81	1477	8.62	12.02
Some College	652	9.44	13.29	816	9.29	12.52
College Graduate	226	9.66	13.35	299	9.78	12.98
Graduate School	256	10.16	13.71	323	10.33	13.46
Total Non-Married	3999			4117		
Range		0 - 20	0 - 15		0 - 20	0 - 15

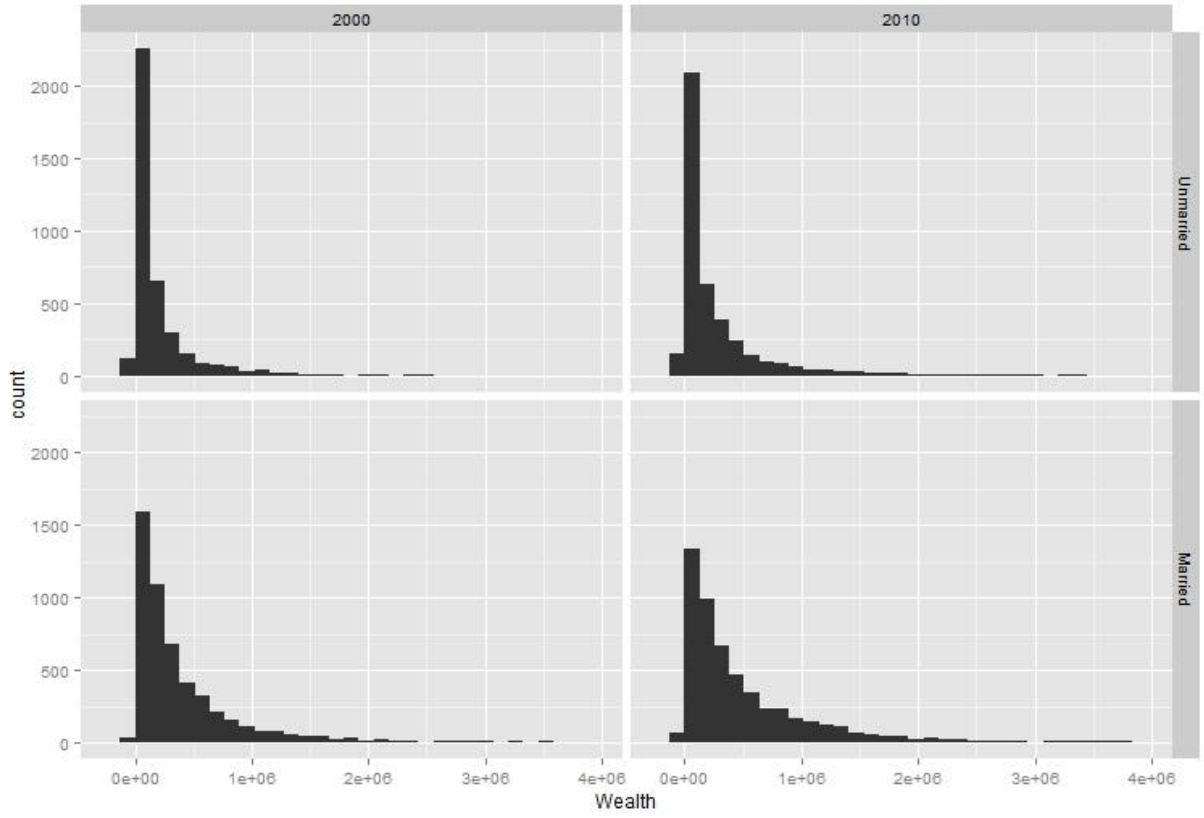
Married Households*

	HRS 2000			HRS 2010		
Attained Education	n	Memory	Mental Status	n	Memory	Mental Status
Less than High School	854	8.45	11.90	631	8.47	11.15
High School	1222	10.45	13.54	1161	10.20	12.94
Some College	616	10.91	13.72	766	10.50	13.31
College Graduate	351	11.40	14.00	386	11.20	13.70
Graduate School	340	11.65	14.19	445	11.75	13.89
Total Married	3383			3389		
Range		0 - 20	0 - 15		0 - 20	0 - 15

* For the household financial respondent

For each level of attained education, the higher the education the higher the household scores for both memory and mental status. Married households received higher memory scores and mental status scores than the scores received by non-married households. There were no significant differences between the scores received in HRS 2000 and the scores received is HRS 2010.

Figure 2.3
Histogram of Household Wealth by Marital Status



The histogram illustrates that household wealth is severely positives skewed. Higher frequencies of household report having lower levels of wealth but outlying households report very high levels of wealth. Married households report higher wealth and a greater range of wealth than the wealth reported by non-married households.

Table 2.3
Household Wealth by Marital Status

Non-Married Households

	HRS 2000		HRS 2010	
Attained Education	n	Wealth	n	Wealth
Less than High School	1534	$ 26,900	1202	$ 29,347
High School	1331	$ 98,000	1477	$ 104,952
Some College	652	$ 139,400	816	$ 158,050
College Graduate	226	$ 242,950	299	$ 325,000
Graduate School	256	$ 291,000	323	$ 388,000
Total Non-Married	3999	$ 74,500	4117	$ 100,224

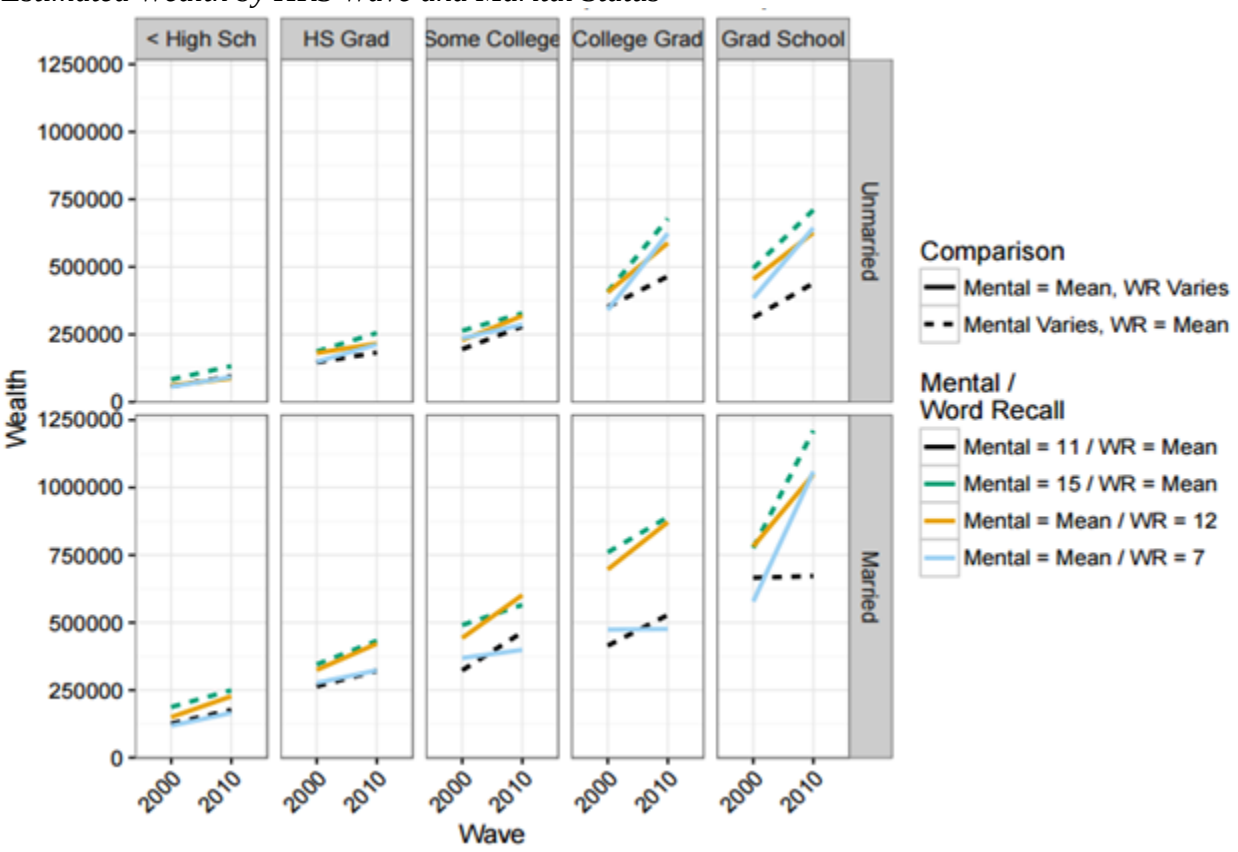
Married Households

	HRS 2000		HRS 2010	
Attained Education	n	Wealth	n	Wealth
Less than High School	854	$ 84,000	631	$ 103,600
High School	1222	$ 220,000	1161	$ 253,000
Some College	616	$ 290,250	766	$ 340,750
College Graduate	351	$ 421,506	386	$ 538,000
Graduate School	340	$ 542,000	445	$ 723,500
Total Married	3383	$ 221,050	3389	$ 291,000

The higher the attained education the higher the household wealth. Married households reported higher wealth for each level of attained education. Wealth reported in HRS 2010 was higher than the household wealth reported in HRS 2000 for every category of attained education.

Figure 2.4

Estimated Wealth by HRS Wave and Marital Status



The above graph illustrates associations of memory scores, mental status scores and wealth. The black line assumes a 3rd quartile mental status score (11) and memory score equal to the mean. The green line assumes a 1st quartile mental status score (15) and memory score equal to the mean. The orange line assumes a 1st quartile memory score (12) and mental status score equal to the mean. The blue line assumes a 3rd quartile memory score (7) and mental status score equal to the mean.

Several inferences can be drawn from the graph. The higher the attained education the higher the household wealth and the more variance in household wealth. Difference in cognitive ability results in greater differences in wealth for married households more than for non-married households. Differences in mental status result in greater differences in wealth than the differences in wealth associated with differences in memory.

Table 2.4

Coefficients of Determination by Marital Status

	Overall	Non - Married		Married	
	R^2	Eta	Eta	Eta	Eta
Attained Education		Mental Status	Memory	Mental Status	Memory
Less than High School	0.167	0.063	0.035	0.081	0.062
High School Graduate	0.124	0.043	0.026	0.033	0.033
Some College	0.106	0.021	0.015	0.026	0.043
College Graduate	0.104	0.046	0.034	0.042	0.064
Graduate School	0.117	0.069	0.042	0.045	0.032

Wealth = Wave + Mental + Wave*Mental+ Word Recall + Wave*Word Recall + error

Wealth = Wave + Mental + Wave*Mental + error

Wealth = Wave + Word Recall + Wave*Word Recall + error

The regression model seeks to explain how much of the variance in household wealth is explained by the mental status and word recall. The partial eta squared coefficient measures the extent to which each independent variable individually (mental status and memory) is a meaningful predictor of wealth. The regressions were performed separately for married and non-married households.

The combination of memory scores and mental status scores predict 16.7% of wealth for *less than high school* households. The predictive power of cognitive abilities and wealth for other households ranges from 10.04% to 12.4%. Regression coefficients for mental status range from .021 to .069 for non-married households and .026 to .081 for married households. Memory scores for married households have more explanatory power of wealth than the explanatory power of non-married households.

Table 2.5

Effect Size of Demographic Factors

Attained Education	R sq	Marital Status	Gender	Race	Age
		Eta	eta	eta	eta
Less than High School	0.167	0.296	0.142	0.039	0.042
High School Graduate	0.124	0.274	0.106	0.026	0.017
Some College	0.106	0.269	0.079	0.040	0.085
College Graduate	0.104	0.226	0.078	0.083	0.082
Graduate School	0.117	0.101	0.059	0.078	0.232
Overall	0.090	0.240	0.108	0.028	0.033

Effect size	
Small Effect	< .25
Medium Effect	.25 to .40
Large Effect	> .40

Partial eta squared measures the proportion of the variance in wealth that is explained by each of the listed demographic variables. Eta is determined by taking the square root of partial eta squared and measures the general magnitude of the effect on the dependent variable.

With the exception of *graduate school* households, marital status has the largest effects on household wealth. The marital status of *less than high school, high school graduate*, and *some college* households had medium effect on household wealth and the marital status of *college graduate* households had a small effect on household wealth. The age of *graduate school* households had a small effect on household wealth.

Discussion

The low coefficients of determination may be partially explained by the characteristics of the subdivision of the sample. There is much more variability in the high-education groups

relative to the low education groups. By conducting regressions for each level of attained education separately we mitigate against the variance between data groups. The households in each education/wave combination consist of households married to the same spouse for the range of waves, have the same level of attained education, are approximately the same age, and the calculations pertain to the same HRS wave. Given the like characteristics, small variance within the group might be expected. Accordingly, the explanatory variances determined by R^2 and partial eta^2 coefficients may be more consequential than might otherwise be considered. There is much more variability in the high-education groups relative to the low education groups. By conducting regressions on each level of attained education separately we mitigate against the variance between data groups.

The demographic factors of education, age, gender, race, and marital status each influence household wealth to varying degrees. The factors may be interrelated and are associated with wealth in different magnitudes based on the combination of those factors.

Love, Palumbo, and Smith (2008) found that wealth generally increases with age. The older households in this study had lower wealth than the younger households. This disparity may be a result of non-married households having an average age of five to seven years older than married households. Therefore marital status rather than attained age may be the precipitating reason that younger households report higher wealth than married households.

Race can have significant influence on household wealth. Kington and Smith (1997) found racial identity to be a significant factor in socio-economic status. Langa et al. (2001) found that lower levels of education among African-Americans was a strong predictor of lower household wealth. We found that Non-White household had the highest relative representation in the *less than high school* category. Also in HRS 2000, 20.7% non-married households were Non-

White and 11.7% of married households were Non-White. In HRS 2010 the proportions were 23.3% and 14.3% respectively.

The gender of the financial respondent has a strong influence on household wealth. The lower the level of education and the lower the household wealth, the higher the proportion of household financial respondents were female. For each education category, a higher proportion of non-married households are headed by females than married households are headed by females.

Marital status has the greatest impact on wealth of any factors examined. For each education category for both HRS 2000 and HRS 2010, married households accumulated higher wealth than non-married households. Both married men and married women have better mental health and physical health than their non-married counterparts (Hughes & Waite, 2009) and this better household health results in higher household wealth. Economic well-being later in life is linked to marital status so that married households amass higher wealth than non-married households (Palgi, 2012). This study found that married households scored higher than non-married households on memory and mental status measures. We also found that married households accumulated higher wealth than non-married households for every level of attained education. McArdle et al. (2009), however, found that education was predictive of cognitive functioning but had little relation to SES.

Although not directly tested by this study, a change in marital status from married to non-married due to the divorce or death of a spouse can dramatically affect wealth (Karraker & Latham, 2013). After becoming a widow, women lose significant wealth (Hughes & Waite, 2009). Losing a spouse due to death or divorce significantly increases withdrawals from retirement funds, resulting in lower wealth (Poterba, Venti, & Wise, 2010a).

Limitations

This study is based on two waves without tracking participants between waves. The results provide a general comparison of differences within each wave and between waves but longitudinal studies are critical for understanding of the development of changes in individuals as they age (Collins, 2006; Hauser & Weir, 2010). This research examines the associations of wealth and cognitive abilities within each wave but does not test the trajectories of those associations or in changes in the relationships.

The results of this study may not be generalizable to the general population. The HRS selects for interview only those households with one member at least 51 years old. Once selected, participants are then re-interviewed by the HRS for each biennial wave. Some survey questions designed to assess cognitive functioning are only asked when a participant is first selected for the sample and in years after the participants reaches age 65. Participants in the HRS data set are older, score lower on memory measures, and amass higher wealth than the general population (Venti, 2011).

Analysis for couples based on the cognitive ability of one spouse. The associations of cognitive abilities and household wealth may yield very different results based on one cognitive ability measure for the household than if the two spouses were examined as individuals

The measures of cognitive ability have limitations. Measures of mental status are highly negatively skewed and therefore not very discriminating. Interviewers occasionally note that some participants write down the words during the word recall portion on the survey. This would artificially increase memory score. On other occasions, interviewers note that participants seem to have trouble hearing or understanding the questions. This would tend to suppress scores.

There is significant measurement error in the Health and Retirement Study data pertaining to household wealth. All assets and liabilities are self-reported and subject misreporting may be due to errors from reluctance to divulge personal information to the interviewer. The value of retirement assets may be misreported because the HRS does not provide information on 401(k) accounts. IRA accounts are reported so when a 401(k) is rolled over into an IRA account the results will show an increase in reported assets by the amount of the rollover when there was no actual increase in wealth.

Many participants are an age in which their parents or other family members pass away or make gifts. Receipt of such inheritance or gifts may significantly impact household wealth without regard to cognitive ability, education of other aspects of the participants.

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Chapter 3 - The Longitudinal Associations of Cognitive Ability and Wealth among Elderly Married Couples

Introduction

As the population ages, the effects of cognitive impairment among the elderly are increasingly becoming a concern. These diminished abilities often occur at a time in life when financial resources decline and financial needs escalate. The combination of the degeneration of these factors results in the elderly being some of the most vulnerable members of society and at high risk of economic exploitation (Freedman, Aykan, & Martin, 2001). Many prior studies examining the association of cognitive ability and wealth remark about need for further research (Smith, McArdle, & Willis, 2010; Kim, Hanna, Chatterjee, & Lindamood, 2012). Recent research by financial planners has also emphasized that cognitive ability is critical for financial decisions affecting financial health (Browning & Finke, 2015; Carr et al. 2014).

Education, cognitive abilities, family SES, and a myriad of other household variables act in concert to affect household wealth (Beutler, 2014). The links among education, wealth and cognitive ability remain largely unexplored and research should be conducted to study the long-term trajectories (Xu, Liang, Bennett, Botoseneanu, & Allore, 2014). Long term longitudinal studies facilitate the evaluation of the extent to which differences in socioeconomic status influence the relationship of health and wealth of older individuals (House et al., 1994).

We differentiate participants by education category and then evaluate the relationship of wealth, and cognitive ability. Most prior studies use a singular measure of cognitive ability. Our study adds depth to understanding by dividing cognitive ability into fluid intelligence and

crystallized intelligence and conducting analysis on each measure separately (McArdle, 2009; Ferrer & McArdle, 2004).

Literature Review

Members from all aspects of the financial services profession have responded with increased attention to the cognitive ability of the elderly. Advisor conflicts of interest become more important for those individuals with compromised judgement due to diminished cognitive ability (Bearden, 2015). Failing to plan for deteriorating cognitive functioning may result in elderly individuals becoming financially vulnerable. Uncertainty regarding standards of cognitive functioning further complicates the issue (Correia, 2014). In order to deal with the growing concerns regarding the diminished mental capacity of elderly clients, some financial services providers have established units to provide input regarding senior concern to all aspects of company operations from product development to marketing (Knutson, 2014).

Until recently most research on aging has focused on the study of cross-sectional differences in cognitive function rather than age-associated change over time (Sliwinski & Buschke, 1999). Aging is fundamentally a process that occurs over time, so longitudinal studies have been critical to advancing knowledge about aging. In recent years, studies of the long-term relationship of health and wealth have increasingly become interdisciplinary and biosocial (Hauser & Weir, 2010; Poterba, Venti, & Wise, 2011). The mutual support of spouses in long term marriages imbues elements of financial stability that tends to insulate the couple from the effects of changes in cognitive ability (Cummings & James III, 2014; Huang, Xu, & Chiang, 2016).

Cognitive abilities are critical yet often underappreciated determinants of a household's ability to manage financial resources and vary in importance as individuals pass through the life

cycle stages. Based on data gathered in HRS 2010, Hurd, Martorell, Delavande, Mullen, and Langa (2013) found that elder individuals experienced progressive declines in cognitive ability that interfered with their ability to function independently. Difficulties associated with the decline in cognitive ability are compounded as individuals become more responsible for the management of their financial assets and retirement decisions (Smith et al., 2010). Self-awareness of declines in cognitive abilities maybe a factor for the increased risk aversion among the elderly (Griesdorn et al., 2014; Guillemette, Yao, & James, 2015).

Methods

Research Questions

This study examines both the trajectories of cognitive abilities and wealth and the impact of cognitive abilities on wealth of elderly married couples.

1. What are the longitudinal trajectories of cognitive abilities and wealth?
2. How do the cognitive abilities and wealth compare across categories of education?
3. To what magnitude do cognitive abilities predict wealth?

Sample Selection

The University of Michigan developed and continues to administer the Health and Retirement Study (HRS) with the express purpose of gathering information regarding participant employment, finances and health. The surveys began in 1992 and have been administered every two years since. Each administration is referred to as a wave; HRS 1992, HRS 1994, and so on. The HRS is based on a sample in excess of 26,000 individuals age 51 and older. Individuals selected as part of the sample are resurveyed during each subsequent wave.

The focus of study is the longitudinal association of cognitive ability and wealth for elderly married couples. Participant households were tracked through each succeeding HRS wave and only those couples consisting of the same paired spouses for all waves from HRS 2000 through

HRS 2010 were included in the sample. Each participant must be part of a household in which at least one member was age 65 or older. Additionally, at least one member of the household must have reported the level of education attained.

When responding to household level financial questions, married couples designate one spouse to be the financial respondent. The designation of a spouse as financial respondent is only for the survey being conducted at the time. The designation may alternate between spouses for subsequent HRS waves as each couple desires. Interviewers ask cognitive functioning questions of each spouse separately. Responses from the financial respondent were used to determine household wealth. The financial respondent's responses to memory and mental status questions were used to determine household cognitive abilities.

Measurement of Cognitive Abilities

The array of cognitive abilities can be classified into two broad categories: fluid intelligence and crystallized intelligence. Fluid intelligence is based on physical processes in which decline is more apparent with age. Recall memory is a prime aspect of fluid intelligence. Crystallized intelligence is the knowledge base built upon formal education and informal experience. While some facets of crystallized intelligence actually increase throughout life, most aspects of crystallized intelligence decline but at a slower rate than the decline in fluid intelligence.

This study utilized survey questions pertaining to three aspects of mental status. Questions evaluating working memory included asking the participant to count backward for 100 by 7s and counting backward from 20 (7 points). Questions evaluating current knowledge included asking the current day as well as the names of the president and vice president (6 points). In order to evaluate vocabulary, questions were asked for which the correct answers are

scissors and *cactus* (2 points). The mental status questions have a possible range of 0 to 15 points.

Fluid intelligence memory can be measured by the immediate word recall and delayed word recall survey questions. These questions were asked of every study participant for every wave within the HRS 2000 to HRS 2010 range. In order to evaluate memory, respondents were read a list of 10 nouns and then immediately asked to repeat as many as they can. After approximately five minutes the respondents were asked again to repeat the words. The correct number of answers each of the immediate and delayed word recall tests range from 0 to 10. The combined score can range from 0 to 20. The combined memory score of the same spouse for which mental status score was selected as the household score.

Measurement of Wealth

Wealth was defined as the sum of the following accounts: checking and savings, certificates of deposit, stocks, bonds, life insurance, IRA and Keoghs, residences (up to two) less mortgages, other assets and vehicles, less debts. The RAND Center for the Study of Aging (RAND) has cleaned the HRS data files and the RAND files were accessed for this study.

This research attempts to mitigate against possible misreported data by using trimmed means for the analysis. Trimming means eliminated the top five percent and bottom five percent of residuals.

Analysis Conducted

The general linear model (GLM) was used to evaluate the strength of association of mental status and wealth and of memory and wealth. (GLM) is a variant of regression that allows variables to have non-normal distributions. The associations of mental status and wealth and memory and wealth was determined for each of the six waves using GLM.

Individuals engage cognitive abilities and utilize resources early in life in order acquire education that results in higher income and greater accumulated wealth throughout life. Those with higher level of education have higher levels of cognitive ability. Fluid intelligence as measured by memory peak early in life and declines thereafter. Crystallized intelligence as measured by mental status continues to develop and declines at a slower rate. The life cycle hypothesis assumes wealth is accumulate through the working years and is exhausted during retirement.

We begin the analysis by considering general demographic characteristics of age, race, and gender and comparing the samples for each level of education. For each wave, we examine the assumption that household with higher education have higher cognition scores and greater accumulated wealth. For each level of attained education, we examine the assumptions of declining cognitive abilities and declining wealth. For each level of education, we examine how well cognitive abilities explain variance in wealth display the results graphically and through summaries of the regressions.

Individuals engage cognitive abilities and utilize resources early in life in order acquire education that results in higher income and greater accumulated wealth throughout life. Those with higher level of education have higher levels of cognitive ability. Fluid intelligence as measured by memory peak early in life and declines thereafter. Crystallized education as measured by mental status continues to develop and declines at a slower rate. The life cycle hypothesis assumes wealth is accumulate through the working years and is exhausted during retirement. Marital status has a profound impact of household wealth regardless of education.

For each analysis, we compare results for married and non-married households. We begin by considering general demographic characteristics of age, race, and gender and comparing the

samples for each level of education and by marital status. For each wave, we examine the assumption that households with higher education have higher cognition scores and greater accumulated wealth. For each level of attained education, we examine the assumptions of declining cognitive abilities and declining wealth. For each level of education, we examine how well cognitive abilities explain variance in wealth display the results graphically and through summaries of the regressions.

Results

Table 3.1

Demographic Characteristics of Sample of Long Term Married Couples

		Total	**Less Than High School**	**High School Graduate**	**Some College**	**College Graduate**	**Graduate School**
Sample size		1162	236	396	210	142	178
Age							
	HRS 2000		70.7	69.7	70.0	70.7	70.6
	HRS 2002		71.9	71.4	71.6	72.7	73.3
	HRS 2004		73.3	73.2	73.3	74.5	74.3
	HRS 2006		75.2	75.0	75.3	76.4	75.9
	HRS 2008		77.0	76.9	76.8	78.6	77.9
	HRS 2010		79.0	79.1	79.0	80.7	79.9
Race percent in HRS 2000							
- White		90.6%	80.9%	92.7%	91.4%	93.7%	95.5%
- Black		6.7%	15.7%	4.5%	7.6%	3.5%	1.1%

- Other		2.7%	3.4%	2.8%	1.0%	2.8%	3.4%
		100.0 %	100.0%	100.0%	100.0%	100.0%	100.0%
Household Financial Respondent							
HRS 2000							
	- Male		77.5%	60.4%	70.0%	84.5%	88.8%
	- Female		22.5%	39.6%	30.0%	15.5%	11.2%
HRS 2002							
	- Male		71.4%	56.2%	64.7%	86.6%	84.8%
	- Female		28.6%	43.8%	35.3%	13.4%	15.2%
HRS 2004							
	- Male		69.4%	53.9%	62.9%	86.0%	83.6%
	- Female		30.6%	46.1%	37.1%	14.0%	16.4%
HRS 2006							
	- Male		69.5%	53.8%	63.9%	84.8%	83.6%
	- Female		30.5%	46.2%	36.1%	15.2%	16.4%
HRS 2008							
	- Male		68.2%	53.1%	60.3%	84.9%	81.9%
	- Female		31.8%	46.9%	39.7%	15.1%	18.1%
HRS 2010							
	- Male		62.7%	50.9%	56.9%	81.1%	79.1%
	- Female		37.3%	49.1%	43.1%	18.9%	20.9%

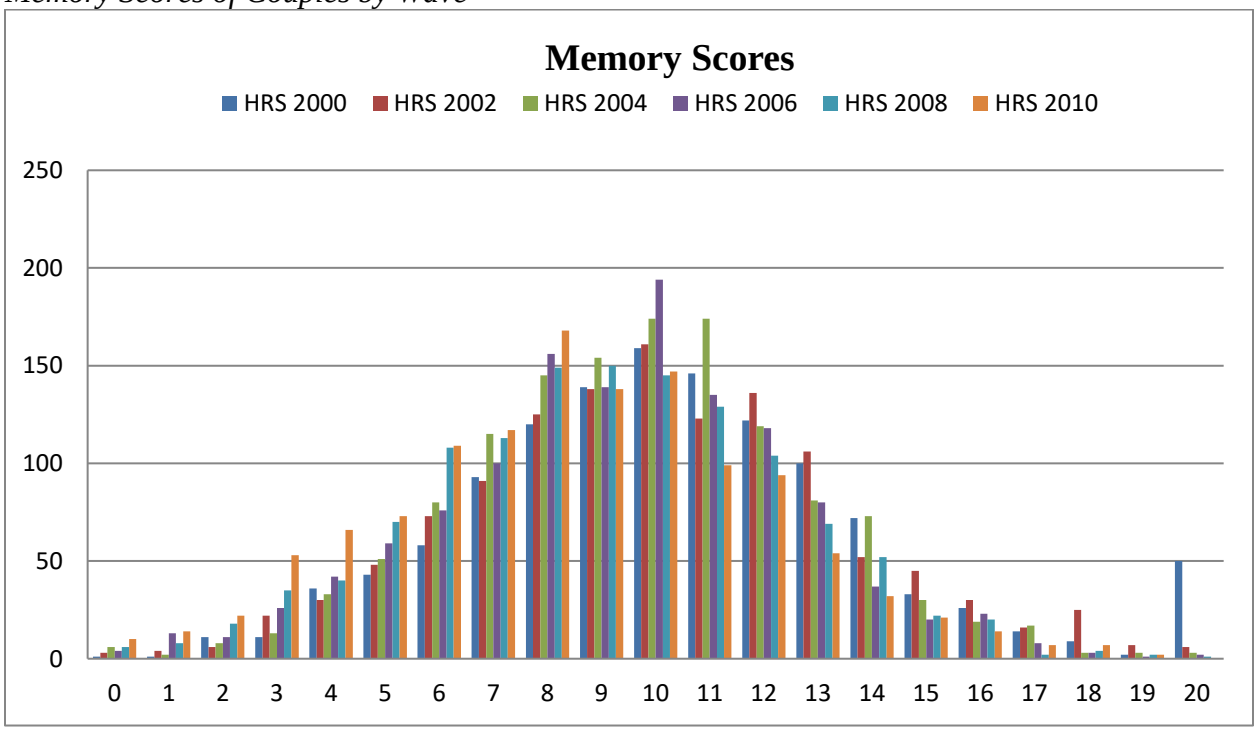
In HRS 2000 the ages of the financial respondents for each of the categories of attained education are within one year of 70. The ages increase as expected and in HRS 2010 the financial respondents for each of the categories of attained education are within one year of age 80. There is not a significant difference in the ages among respondents across education categories.

Less than high school couples designated a White financial respondent in 80.9% of the households. The proportion of couples with other levels of attained educations were consistent with one another and significantly higher than *less than high school*, *high school graduate* (92.7%), s*ome college* (91.4%), c*ollege graduate* (93.7%), and g*raduate school* (95.5%). Race

has an effect on wealth only when comparing *less than high school* to the other levels of attained education.

No observed education category was represented by a majority of female financial respondents. Generally, the higher the education the lower the proportion of households with female financial respondents. For all waves, *high school graduate* households have the highest portion of female financial respondents ranging from 39.6% in HRS 2000 to 49.1% in HRS 2010 and *college graduate* households have the lowest proportion of female financial respondents ranging from 11.2% in HRS 2000 to 20.9% in HRS 2010. For all education categories, as couples age the greater the proportion of female financial respondents. *College graduate* had a small increase from 15.5% to 18.9% but *graduate school* nearly doubled from 11.2% to 20.9%.

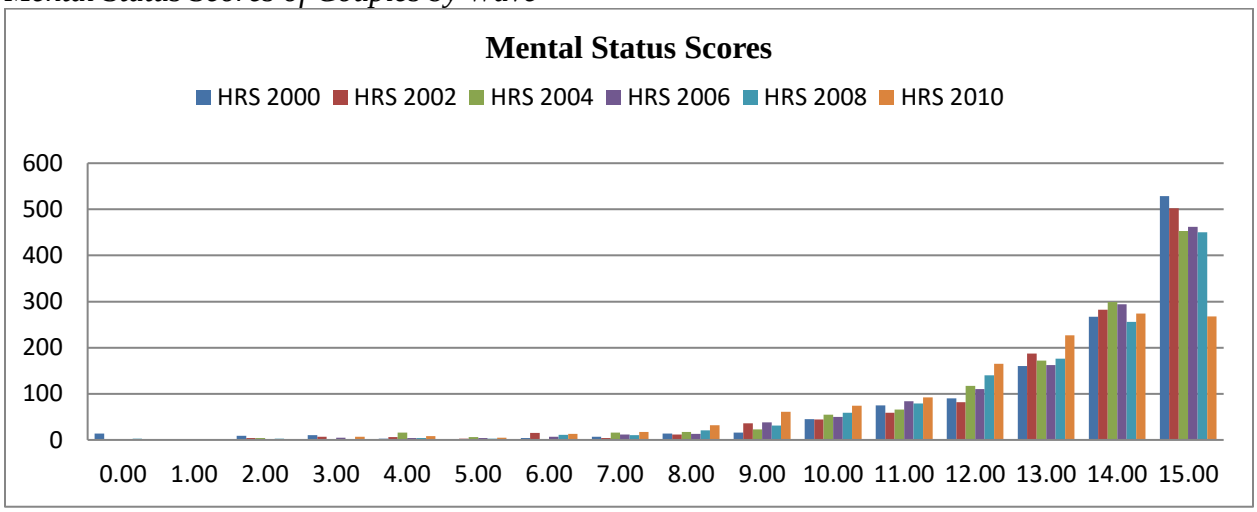
Figure 3.1
Memory Scores of Couples by Wave



Word recall scores for fluid intelligence memory are somewhat normally distributed for all waves. There is little apparent difference in the distribution among waves other than a spike in participants scoring a perfect 20 of a possible 20 words recalled in HRS 2008.

Figure 3.2

Mental Status Scores of Couples by Wave



Mental status scores are highly negatively skewed. There is little apparent difference among waves with the exception that in HRS 2010 the participants had fewer scores of 15 and 14 than in other waves.

Table 3.2

Memory, Mental Status, and Wealth of Couples by Wave

	HRS 2000			HRS 2002		
Education	Memory	Mental Status	Wealth	Memory	Mental Status	Wealth
< High School	8.16	12.44	$ 223,156	8.45	12.12	$ 226,002
High School	10.14	13.71	$ 421,303	9.98	13.67	$ 429,873
Some College	10.38	13.98	$ 630,754	10.54	13.85	$ 621,081
College Graduate	10.68	14.18	$ 839,596	10.88	14.12	$ 851,390
Graduate School	10.74	14.31	$1,032,097	11.04	14.14	$ 963,212
Overall	9.94	13.65	$ 563,593	10.05	13.53	$ 558,277

	HRS 2004			HRS 2006		
Education	Memory	Mental Status	Wealth	Memory	Mental Status	Wealth
< High School	8.10	12.25	$ 252,507	7.89	12.13	$ 292,589
High School	9.68	13.46	$ 445,167	9.35	13.45	$ 521,918
Some College	9.64	13.86	$ 717,639	9.44	13.76	$ 729,543
College Graduate	10.51	14.31	$1,198,384	9.96	14.07	$ 1,260,640
Graduate School	10.50	14.09	$1,112,407	10.11	13.98	$ 1,259,845
Overall	9.59	13.49	$ 652,258	9.28	13.41	$ 720,391

	HRS 2008				HRS 2010		
Education	Memory	Mental Status	Wealth	Education	Memory	Mental Status	Wealth
< High School	7.69	11.96	$ 296,895	< High School	7.18	11.11	$ 235,461
High School	8.92	13.33	$ 511,585	High School	8.27	12.79	$ 450,963
Some College	9.19	13.51	$ 754,792	Some College	8.52	13.04	$ 628,280
College Graduate	9.42	13.87	$1,217,720	College Graduate	8.69	13.27	$ 964,505
Graduate School	9.91	13.92	$1,198,066	Graduate School	9.35	13.44	$ 1,083,210
Overall	8.96	13.26	$ 709,356	Overall	8.65	12.68	$ 605,320

Memory scores range from 0 to 20 and mental status scores range from 0 to 15. With two minor exceptions, the scores for memory and the scores for mental status were higher for *graduate school* participants than *college graduate* participants, *college graduate* scored higher than *some college*, *some college* scored higher than *high school*, and *high school* scored higher than *less than high school* for all waves under study. The differences in memory scores between categories of attained education range from 2.17 (*graduate school* 9.35 compared to *less than high school* 7.18) within HRS 2010 to 2.59 (*graduate school* 11.04 compared to *less than high school* 8.45) within HRS 2002. The differences in mental status scores between categories of attained education range from 1.84 (*graduate school* 14.09 compared to *less than high school* 12.25) within HRS 2004 to 2.22 (*graduate school* 13.92 compared to *less than high school* 11.96) within HRS 2008. For all waves, the higher the attained education, the higher the household wealth.

Table 3.3
Memory, Mental Status, and Wealth of Couples by Education

	Less than High School				High School Graduate			
	Memory	Mental Status	Wealth		Memory	Mental Status	Wealth	
HRS 2000	8.16	12.44	$	223,156	10.14	13.71	$	421,303
HRS 2002	8.45	12.12	$	333,197	9.98	13.67	$	429,873
HRS 2004	8.10	12.25	$	252,507	9.68	13.46	$	445,167
HRS 2006	7.86	12.13	$	292,589	9.35	13.45	$	521,918
HRS 2008	7.69	11.96	$	296,895	8.92	13.33	$	511,585
HRS 2010	7.18	11.11	$	235,461	8.27	12.79	$	450,963

	Some College				College Graduate			
	Memory	Mental Status	Wealth		Memory	Mental Status	Wealth	
HRS 2000	10.38	13.98	$	630,754	10.68	14.18	$	839,596
HRS 2002	10.54	13.85	$	631,081	10.88	14.12	$	851,390
HRS 2004	9.64	13.86	$	717,639	10.51	14.31	$	1,198,384
HRS 2006	9.44	13.76	$	729,543	9.96	14.07	$	1,260,640
HRS 2008	9.19	13.51	$	754,792	9.42	13.87	$	1,217,720
HRS 2010	8.52	13.04	$	628,280	8.69	13.27	$	964,505

	Graduate School		
	Memory	Mental Status	Wealth
HRS 2000	10.74	14.31	$ 1,032,097
HRS 2002	11.04	14.14	$ 963,212
HRS 2004	10.50	14.09	$ 1,198,384
HRS 2006	10.11	13.98	$ 1,259,845
HRS 2008	9.91	13.87	$ 1,198,066
HRS 2010	9.35	13.44	$ 1,083,210

For all levels of education, the scores for memory and the scores for mental status declined from HRS 2000 to HRS 2002. The decline in memory scores from HRS 2000 to HRS 2010 ranged from .98 for *less than high school* (HRS 2000 8.16 to HRS 2010 7.18) to 1.99 for *college graduate* (HRS 2000 10.68 to HRS 2010 8.69). The decline in mental status scores from HRS 2000 to HRS 2010 ranged from .87 for *graduate school* (HRS 2000 14.31 to HRS 2010 13.44) to 1.33 for *less than high school* (HRS 2000 12.44 to HRS 2010 11.11). For every level of education, household wealth increased from HRS 2000 to HRS 2002 and for each subsequent

wave from HRS 2002 through HRS 2008. Wealth then declined from HRS 2008 to HRS 2010 for every level of education.

Figure 3.3

Estimated Wealth by Education and Wave

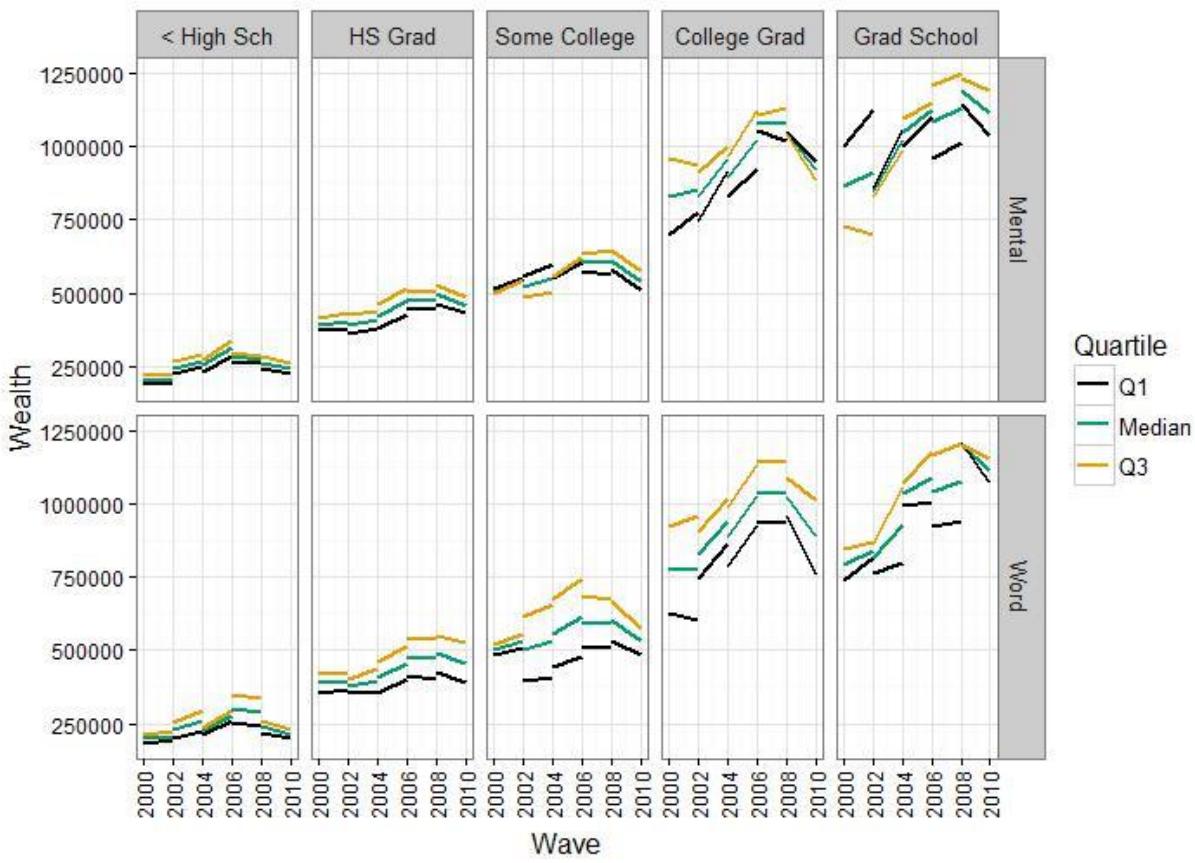


Figure 3 illustrates the relationships of mental status (mental) and memory (word) and wealth for each wave. Q1 are the participants in the lowest quartile of mental status and memory; Q3 are the participants in the highest quartile of mental status and memory. The chart demonstrates that households with higher education accumulate higher wealth. It also shows that within each level of attained education, the higher the memory or mental status scores, the higher household wealth. With each increased level of education, the greater disparity of the wealth of participants with high scores to those with low scores (Q3) and (Q1).

Table 3.4

Model Fit and Variable Contribution

	Less Than High School			High School Graduate			Some College			College Graduate			Graduate School		
	r sq.	*p*	eta	r sq.	*P*	eta	r sq.	*p*	eta	r sq.	*p*	eta	r sq.	*p*	eta
HRS 2000	0.041			0.032			0.002			0.059			0.032		
Mental Status		0.04	0.28		0.07	0.01		0.71	0.05		0.06	0.31		0.01	0.37
Memory		0.01	0.20		0.00	0.02		0.51	0.09		0.02	0.38		0.26	0.12
HRS 2002	0.101			0.043			0.089			0.027			0.010		
Mental Status		<.01	0.45		<.01	0.03		0.08	0.02		0.18	0.20		0.71	0.06
Memory		0.01	0.32		0.02	0.01		<.01	0.59		0.02	0.38		0.19	0.19
HRS 2004	0.073			0.069			0.083			0.024			0.005		
Mental Status		<.01	0.43		<.01	0.03		0.88	0.02		0.34	0.13		0.51	0.09
Memory		0.18	0.14		<.01	0.03		<.01	0.55		0.07	0.26		0.44	0.10
HRS 2006	0.078			0.056			0.057			0.021			0.047		
Mental Status		0.03	0.21		<.01	0.01		0.13	0.15		0.60	0.07		0.03	0.26
Memory		<.01	0.39		<.01	0.04		<.01	0.42		0.04	0.27		0.01	0.30
HRS 2008	0.080			0.060			0.043			0.008			0.001		
Mental Status		<.01	0.42		<.01	0.02		0.05	0.18		0.99	0.00		0.58	0.06
Memory		0.01	0.25		<.01	0.03		<.01	0.32		0.16	0.17		0.99	0.00
HRS 2010	0.088			0.052			0.039			0.118			0.035		
Mental Status		<.01	0.42		<.01	0.02		0.17	0.12		0.01	0.29		0.00	0.37
Memory		0.01	0.26		<.01	0.02		<.01	0.34		<.01	0.58		0.26	0.12

Effect Size

Small	< .25
Medium	.25 to .40
Large	> .40

Table 4 displays the explanatory power of the model as the r squared coefficient. The eta coefficient measures the relative effect of the influence of memory scores or mental status scores on the variance in wealth. Although the use of trimmed means somewhat diminishes the measure of using *p* values as a significance test, only those cases in which the *p* value is .05 or less are considered significant.

Less than high school households reported the least wealth and the lowest variability of wealth, but the model and the cognition variables had relatively high magnitude in predicting wealth. The explanatory power ranged from 4.1% for HRS 2000 to 10.1% for HRS 2002. Eleven of the 12 education/cognition cases had a *p* value of .05 or less. Mental status had eta values indicating large effect in HRS 2002, HRS 2004, HRS 2008 and HRS 2010; medium effect in HRS 2000, and small effect in HRS 2006. Memory had eta values indicating large effect in HRS 2002, HRS 2006, and HRS 2010; and small effect in HRS 2000 and HRS 2008.

High school graduates reported relatively low wealth and low variability of wealth. Mental status had eta values indicating large effect in HRS 2002, HRS 2004, HRS 2008 and HRS 2010; medium effect in HRS 2000, and small effect in HRS 2006. The explanatory power ranged from 4.3% for HRS 2000 to 6.9% for HRS 2004. Although 11 of the 12 education/cognition cases had a *p* value of .05 or less the eta coefficients indicating effect size were very small for both mental status and memory.

Some college had six of 12 cases with *p* value of .05 or less. Mental status had small effect in HRS 2008. Memory had medium effect in HRS 2008 and HRS 2010 and large effect in HRS 2004, HRS 2006, and HRS 2008.

College graduate also had six of 12 cases with *p* value of .05 or less. Mental status had medium effect in HRS 2010. Memory had medium effect in HRS 2000, HRS 2002, HRS 2004 and HRS 2006 and large effect in HRS 2010.

Graduate school had only 4 of 12 cases with *p* value of .05 or less. Mental status had medium effect in HRS 2000 and HRS 2006. Memory had medium effect in HRS 2006 and HRS 2010.

Conclusions

This study generally confirms prior research which found erosion of cognitive abilities over time, but it may be at some variance as to degree of decline. For all waves and for all categories of attained education, the higher the education the higher the memory and mental status scores. Both cognitive ability measures declined between HRS 2000 and HRS 2002 and for each inter-wave period thereafter. Memory scores declined at a faster rate than mental status scores.

In each wave under study, *high school* households accumulated higher wealth than the wealth accumulated by *less than high school* households and that households in each succeeding higher level of education had higher wealth than the category below it. We also concur with other research in finding that wealth increased over time. For each level of education, wealth in 2002 was higher than 2000, 2004 was higher than 2002, 2006 was higher than 2004, and 2008 was higher than 2006. Wealth declined for all levels of attained education from 2008 to 2010.

Implications

In 2008, a financial advisor, Glenn Neasham, recommended an annuity to an elderly client. Even though the recommendation was within industry suitability guidelines Neasham was heavily sanctioned by regulators for unsuitable recommendations after the client later developed dementia even though she did not exhibit signs of cognitive impairment when the recommendation was made (Wood, 2013). Although Neasham was subsequently cleared from all charges of wrong doing, many firms have developed policies and procedures to be considered when advising elderly individuals. This study confirms the importance of those safeguards.

We found that cognitive abilities decline steadily for individuals across all categories of education. Compared to prior cross-section comparison studies, we have established this fact

with much greater certainty and demonstrated that its impact on wealth is greatest among households with the least education. These results can be used by planners and caregivers in anticipating the effects of deteriorating cognitive abilities on household wealth. The financial planning profession should develop systems to measure and monitor the cognitive abilities of those they counsel. Cognitive ability was associated with wealth more strongly among households with high school or less education.

Limitations

There is significant measurement error in the Health and Retirement Study data because both asset ownership and the value of assets are often misreported. The effects of the errors are compounded in a longitudinal study when the change in assets is the variable under consideration since a misreported value affects the change result from the wave before the misreported value and the wave after the misreported value (Poterba, Venti, & Wise, 2013). The value of retirement assets may be misreported because the HRS does not provide information on 401(k) accounts.

Married couples tend to report better health, have higher cognitive ability, and greater wealth than unmarried households. Declining health and strained finances often precede the death of a spouse and continue to affect the surviving spouse after death (Poterba, Venti, & Wise, 2012; Wu, 2003). Each factor in defining the sample narrows the participant eligible for inclusion in the study and the cumulative effect results in selection bias.

Those widowed or divorced in mid-life show cognitive impairment at nearly three times the rate of married people (Hakansson et al., 2009). The nonrandom exclusion of non-married individuals from the sample results in a selection bias and limits the applicability of the findings to the general population (Berk, 1983).

Despite these limitations, a distinct strength of this study remains its longitudinal design. Prior research on cognitive abilities and wealth has mainly been restricted to cross-section age comparisons; older age groups are also selected due to mortality, and vary in marital status and educational composition as well.

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Chapter 4 - The Longitudinal Associations of Cognitive Abilities, Emotional Health, Physical Health and Wealth Among Elderly Married Couples

Introduction

An individual's health is an amalgam of many physical and mental components. For this study, the aspects of individual's health under consideration are (a) cognitive ability, (b) physical health, and (c) depression. Previous research indicates that individuals with higher socioeconomic status (SES) score higher on cognitive ability measures, report lower physical health impairments, and fewer indications of depression (House, Lantz, & Herd, 2005). Some studies find the health advantages of higher SES increase throughout life (Ross & Wu, 1996). Other studies find that the health advantages peak soon after retirement and then diminish over the life course (Willson, Shuey, & Elder, 2007).

Attained education is a significant component of SES. Human capital theory postulates that investment of resources in education results in increased life time earnings and higher accumulated wealth (Dannefer, 2003). Education provides a means to achieve a higher SES and educational attainment is perpetuated within family groups (Willis, 1977). Children of parents with high education attainment tend to seek high education attainment themselves. The National Institute on Aging (2007) found that the reported health of 60-year-old individuals with college degrees is similar to the reported health of 50-year-old individuals with less than a high school education.

This research examines the longitudinal associations of health and wealth for households as stratified by attained education. These associations and examined for each wave with the range under study.

Rationale, Significance, and Need for Study

The variance of health among levels of SES is not well understood (Xu, Liang, Bennett, Botoseneanu, & Allore, 2014). Although health advantage among individuals with higher socioeconomic status (SES) such as education and income is well-established (House, Lantz, & Herd, 2005; Mirowsky, Ross, & Reynolds, 2000; Ross & Wu, 1996), how the socioeconomic stratification of health interacts with age is not well understood. The cumulative advantage theory proposes that the health benefit of higher SES accumulates throughout the life course resulting in greater socioeconomic disparity in health in older ages compared to younger ages (Dannefer, 2003; Ross & Wu, 1996). In contrast, the theory of social stratification of aging and health and the age-as-leveler hypothesis argue that the SES gap in health peaks in early old age, after which it diminishes because of increasing social welfare support such as Medicare or Social Security, "universal" frailty in old age, and early mortality of individuals in the lower SES group (House et al., 2005; Willson, Shuey, & Elder, 2007).

The preponderance of studies on health dynamics examines the extent to which individuals with health and SES advantages early in life preserve those advantages through the life cycle (Prus, 2007). A longitudinal study should be conducted to rule out household cohort effects and enhance understanding of the associations of household socio-economic differences with health and wealth over time (House et al., 1994).

Literature Review

Historical Context

The ability to develop human capital by attaining higher levels of education has been studied for some time (Turner, 1960). Human capital facilitates individuals to build wealth and increase their SES. Those individuals with higher SES derive health benefits that last throughout the life course (Ross & Wu, 1996). In a 1994 study, House et al. found that individuals with lower SES early in life generally have less control of life events, experience greater stress, and have less education opportunities than individuals with higher SES early in life. As a result, those with low SES experience poorer health and accumulate less wealth than those with high SES. Other research also indicates that cohort membership can act as a conduit for SES, health and wealth over the life course (Riley, 1987). Later studies have more closely examined the relationships between health and wealth among the individuals of a range of SES. The strength and significance of the associations varies widely by education and health.

Theoretical Framework

The life cycle hypothesis predicts that an individual's wealth will decline to zero at death. Wealthier people tend to live longer so the less wealthy tend to die first, increasing the average wealth of the surviving population. The negative association of age and wealth is greatest among the oldest old (Lee & Kim, 2008). The life cycle theory does not consider the effects of unexpected health shocks or bequest motives. Some individuals curtail consumption to provide for the potential cost of health shocks (Kim, Hanna, Chatterjee, & Lindamood, 2012). Individuals growing up in families with significant assets might develop positive personal health customs. Within families, different personalities or other individual traits may influence individuals' health and wealth. Health risk is a factor in an individual's overall risk tolerance and

thereby affects asset selection in portfolio allocation. Individuals may seek to maintain a desired level of overall risk by reducing financial risk in order to offset increased health risk. Since mental and physical ability decline, it is important to understand how those weakening abilities affect portfolio decisions (Rosen & Wu, 2004).

Physical and mental well-being are viewed as valuable personal attributes among the elderly and individuals demonstrate a propensity to allocate resources to preserve their good health and to maintain sufficient assets during retirement. The uncertainties regarding needs combined with the desire to maintain adequate financial resources result in a shift from risky assets to less risky assets and suppress consumption in the early years of retirement (Pang & Warchawsky, 2010).

A modified version of the LCH allows for variations in optimal target wealth due to uncertain life spans, potential health shocks, and possible intentions to leave bequests. Some individuals curtail consumption to provide for the potential cost of health shocks. Those in higher socioeconomic classes tend to live longer than those in lower socioeconomic classes (Lee, & Kim, 2008; Poterba, Venti, & Wise, 2011). The resources available and utility of expenditures continually change over the life cycle. Early in retirement an individual's utility function may have placed a high priority on travel or purchasing a luxury car, but economic or health considerations have result in a shift of utility to medical needs or relocating to an assisted living residence (Hurd & Rohwedder, 2013). Many changes result from shifting priorities such as an increased awareness of one's own expected mortality or a growing desire to leave a bequest. Other changes may occur suddenly such as a shift resulting from health shocks (Kim et al., 2012).

One aspect of the advancing through the life course is a pattern of increasing disparity of health and wealth among members of the age cohort (Xu, Liang, Bennett, Botoseneanu, & Allore, 2014). A partial explanation may be that later in life, SES differences influence cumulative health. Less healthy individuals in lower SES strata may die sooner than individuals with higher SES (House, Lepkowski, Kinney, Mero, Kessler, & Herzog, 1994). The cumulative effect of long term exposure to the unhealthy environments experiences by individuals in lower SES can result in severely poor health (Willson, Shuey, & Elder, 2007).

Education, Health, and Wealth

Educational attainment is a primary aspect of socio-economic status and remains constant through much of the life cycle (Ross & Wu, 1996). The connection of health and SES grows stronger over an individual's life time. Building human capital through education results in a compounding return by an increasing health advantage compared to other individuals as they grow older (Willson et al., 2007). Education is mechanism by which SES influences health via biomedical risk factors (House et al., 1994).

Education may affect an individual's wealth which in turn can be foundation for sustaining good health. The influences of education of health such as maintaining a healthy life style range beyond the direct impact of wealth (Xu et al., 2014; Dannefer, 2003). Higher SES resulting from greater attained education indirectly effects health by enabling access to more extensive healthcare, superior nutrition, and better housing. Individuals with higher education haw a lower propensity to engage in unhealthy behaviors such as cigarette smoking (Prus, 2007)

Cognitive Ability and Wealth

As individuals age, a decline in physical health may result in degenerating cognitive functioning and in turn a deteriorating mental capacity may be a factor in physical ability. The

rates of physical and mental decline are likely factors of remaining life expectancy. Decline in cognitive functioning is a prime factor in the eventual inability of individuals to perform the activities of daily life. Decline in these ability result in increased health care costs and directly affect the individual's ability to manage financial assets (Ofstedal, Fisher, & Herzog, 2005). As individuals progress through the life cycle the quality on their investment decisions as they gain knowledge and experience until weakening fluid intelligence results in declining management ability (Browning & Finke, 2007).

Memory, a primary aspect of fluid intelligence, peaks early in an individual's working life and then declines thereafter. Crystallized intelligence continues to grow during much of the life cycle before declining late in life. Deteriorating cognitive ability will influence the capacity to manage assets and degeneration of cognitive function may affect not only the management of assets but consumption demands in order to provide for mental and physical health expenses (Ofstedal, Fisher, & Herzog, 2005).

Investment in human capital comes through the attainment of formal education and the accumulation of lifetime experiences. Education is typically attained early in the lifecycle and requires the commitment of time, expenditure of financial resources, and forgoing income that would have been earned had the individual been in the workforce (Rohwedder & Willis, 2010). Education is strongly related to wealth accumulated at retirement. Wealth building behaviors may begin at an early age and the education-wealth relationship may be different at earlier ages than for those at older ages. Households reporting higher attained education not only have higher retirement wealth but allocated their wealth differently than those with less education (Poterba, Venti, & Wise, 2013b). Investment in human capital results in allocation of financial assets in riskier alternatives and raises lifetime wealth (Delvande, Rohwedder, & Willis, 2008). Increased

human capital enables individuals to understand the choices available amidst a wide variety of investment alternatives and enables more confident decisions (Banks & Oldfield, 2007).

Cagney and Lauderdale (2002) found that early life education has a strong and significant impact on cognitive performance late in life. Much of the relationship among education, wealth and cognitive functioning is in large part due to the process and consequences of the education. An association between SES and cognitive function among elderly adults could be due to risk of chronic and infectious diseases throughout the life course, quality of health care, and lifestyle behaviors. A study by Karlamangla et al. (2009) found that differences in wealth among the elderly were due primarily from differences in education early in life than from declines in cognitive ability later in life. Education and cognitive ability early is life are predictive of cognitive abilities late in life (Plassman et al., 1995).

Individuals with greater wealth often work in occupations requiring greater cognitive efforts and the mental stimulation may result in slower deterioration of cognitive ability late in life (Schooler, Mulatus, & Oats, 1999). A study by Hultsch, Hertzog, Small, and Dixon (1999) also found that those engaging in intellectually challenging work and personal activities experience slower deterioration of cognitive ability. Decreases in the level of intellectually stimulating activities results in acceleration of cognitive decline. Individuals involved in cognitive-directed activities display a propensity to build wealth (Carr, et al., 2014). Attained education is a factor in the mental workload of a job and the mental stimulation of the work affects the rate of the worker's cognitive decline. The greater the mental stimulation, the slower the decline (Bosma et al., 2003).

Cognitive ability affects an individual's ability to earn income and accumulate wealth throughout life. Wealth also affects the attainment of education early in life and the rate of

degradation of cognitive ability later in life. Using data from a nationally representative sample of 9,237 Americans age 65 or older from seven waves of studies form HRS 1998 through HRS 2010, Xu et al. (2014) found most individuals experienced physical and cognitive decline and that magnitude of decline was associated with education and net worth. Higher wealth was associated with higher cognitive functions and slower deterioration of cognitive ability. Lower wealth correlated with greater cognitive impairment and more rapid decline of mental ability. Wealth contributes substantially to cognitive well-being of the elderly. Variations associated with differences in education lessened in later old age. Health benefits associated with higher income and higher net worth persisted into advanced age.

Deciding how to invest savings involves the collection of information on alternatives and the ability to evaluate and compare the relative risk and returns of the investment alternatives. A degradation of an individual's cognitive functions results in a decline in the ability to gather and process information and leads to investment in lower risk/lower return alternatives. Using the HRS 2008 survey, Christelis, Jappelli, and Padula (2010) found that those with poor cognitive ability are less able to perceive conditional probability and are more risk adverse. Health risks cannot be avoided or diversified away so the elderly may offset high risk by assuming lower financial risk in order to maintain a balance in total risk. A vital area that has not been adequately studied is how households with apparently sufficient wealth to address common financial decisions regarding retirement perceive the risks that they face (Poterba, Venti, & Wise, 2011). Financial risk aversion results in lower investment returns which can in turn adversely impact the adequacy of household wealth. Active stock market investing entails a high level of cognitive functioning to evaluate relative risk and returns of investment alternatives.

Physical Health, Emotional Health, and Wealth

The interaction among the aspects of an individual's health and his/her wealth is varied and complex. Associations of health and wealth begin early in life and are linked with SES. The advantages of those individuals in higher SES over those in lower SES grows throughout the life course (Dannefer, 2003). As people age they experience deteriorating physical health, emotional health, and cognitive abilities. Those individuals with lower wealth are in greater risk of declining health (Xu et al., 2014).

The timing and magnitude of individuals' decline in health is stratified by wealth. Trajectories of deteriorating health arrive later in life for people with a higher SES than people with a lower SES (House et al., 1994). Differences access to health care, stressors, risky behaviors, and similar factors result in an SES-health gradient in which individuals with higher wealth experience more favorable health (Willson et al., 2007).

Efficacy of Longitudinal Studies

Longitudinal studies often need to address possible distortion in the analysis due to sample attrition. The effects and particularly salient for health studies because the participants remaining in each succeeding wave of the study are the healthiest individuals. The effect of this bias is to overestimate both health and wealth as individuals with poorer health or from lower SES are more likely to attrite (Willson et al., 2007; Prus, 2007).

Some studies directly considered the effect of participant attrition of the HRS data (McArdle, Fisher, & Kadlec, 2007), whereas others tested for bias in the sample due to attrition and found none (Rodgers, Ofstedal, & Herzog, 2003). Attrition can be classified as either a result of death or other unavoidable causes (passive attrition) or for reasons within the control of the participant (active attrition). Understanding the reasons for attrition may have implications for

the topic of research, such as participant health, and may also be considered when evaluating the validity of a study. Research by Cao and Hill (2005) found that more than a third of the participants in the HRS 1992 study attrited and were not members of the HRS 2002 cohort. Both passive attrition and active attrition were higher for individuals who were young, lower socioeconomic status, with lower scores for cognitive ability, or poor health. On the average, Female respondents were less likely to attrite that male respondents. Black and Hispanic respondents were more likely to attrite than Whites. Passive attritors had higher education than those remaining in the sample. Health status had no statistical effect on passive attrition. Active attritors were not statistically different from the sample from which they left. Based on the mean comparisons of demographic, economic, and health measures, attrition does not seem to significantly affect the representativeness of the remaining sample and is probably statistically ignorable.

In studies in which married couples are the unit of the study, attrition can occur in several ways. If either spouse dies or the couple divorces, the household is dropped from the study although both spouses may remain participants in the HRS. Also, if neither spouse is willing or able to participate in the survey the couple is removed from the sample. When studying household wealth during retirement, Coile and Milligan (2009) dropped households not staying in the survey in order to have the composition of the sample not change due to attrition of couples. When researching the longitudinal changes in assets for married couples a factor to consider is the sample bias resulting from couples with higher wealth having a higher likelihood of remaining in the study. For those near the end of life, the research found a strong relationship between health and wealth and found that wealth at the end of life was highest for couples married the longest. In a longitudinal study, some of the changes in cohort wealth are the result

of savings, withdrawals and returns on financial assets. Other changes are the result of attrition of couples from the study. The combined wealth of the former spouses in a marriage that dissolved between 1998 and 2000 was much lower than the household wealth of couples that remained married (Poterba et al., 2012).

Education as a Proxy for Socioeconomic Status

Education is a primary component of social of socioeconomic status (SES) and levels of education attainment represent discrete categories of SES. Levels of attained education represent thresholds of SES. Research by Cagney and Lauderdale (2002) treated education as a categorical variable due to the nonlinear threshold effects among the echelons of attained education. Using education as a measurement of SES divides the sample into distinct facets of social stratification that highlight diverse dimensions (Kolenikov & Angeles, 2009). Herd, Goesling, and House (2007) conducted a study using categories of education attainment to postulate that education affects cognitive functioning and health through process of social attainment with healthier living standards and better health care. When conducting a longitudinal study of the financial outcomes among the elderly, using education attainment as a categorical variable statistically significantly better fit the data than using education as a linear variable (Backlund, Sorlie, & Johnson, 1999).

In studies of the health and cognitive functioning of the elderly, education provides a reliable measure of SES due to a number of factors. Education is attained early in life and consequently reverse causation concerns as relative low. Attained education provides an easily identified, logical hierarchy so that cognitive ability, health, and wealth can be examine within clearly defined SES gradients (Grundy & Holt, 2001).

Design of the Study and Methods

Research Questions

The LCH postulates that human capital developed through education early in life enables the accumulation of wealth the be consumed late in life. Cognitive abilities are important factors in the amassing of wealth during working years and the management of assets during retirement. Declines in physical and mental health are key factors in late in life expenditures and mortality.

The research questions address the differences in wealth based on cognitive ability, physical health, and mental health and as differentiated by education.

How do age, race, and financial respondent gender vary by levels of education and by wave?

1. Within each wave, how do cognitive abilities, emotional health, and physical health, and household wealth compare across levels of attained education?
2. Within each level of attained education, how do cognitive abilities, emotional health, and physical health, and household wealth compare across HRS waves?
3. To what extent do the factors of cognitive abilities, emotional health, and physical health affect wealth?

Sample Selection

The focus of study is the longitudinal association of health and wealth for the elderly. Health includes cognitive abilities, physical health, and emotional health. The samples were selected from HRS panels. Each participant must have been part of a household in which at least one member was age 65 or older. Additionally, at least one member of the household must have reported the level of education attained. The married household is the unit of study.

Married couples paired to the same spouses in all six surveys from HRS 2000 through HRS 2010 were eligible for sample selection. Participant households were tracked through each

succeeding HRS wave and only those couples consisting of the same paired spouses for all waves were included in the sample. The household is the unit of study.

When responding to household level financial questions, married couples designate one spouse to be the financial respondent. Responses from the financial respondent were used to determine household wealth the designation of a spouse as financial respondent is only for the survey being conducted at the time. The designation may alternate between spouses for subsequent HRS waves as each couple desires. Interviewers ask health questions of each spouse separately. A key in a longitudinal study is the stability of the method of collecting data over the period. HRS survey questions used in this research have not materially changed materially over the period under study. The financial respondent's responses were used to determine household cognitive ability, physical health and emotional health.

Operationalization of Concepts

Measurement of Wealth

The purpose of the study is to examine the association of cognitive ability and household wealth. Wealth will be defined as the sum of the following accounts: checking and savings, certificates of deposit, stocks, bonds, life insurance, IRA and Keoghs, residences (up to two) less mortgages, other assets and vehicles, less debts. The RAND Center for the Study of Aging (RAND) has cleaned the HRS data files and imputed missing values. In addition to using the RAND files, this research attempts to mitigate against possible misreported data and outliers by using trimmed means for the analysis. Trimming means will eliminate the top five percent and bottom five percent of residuals.

When conducting the survey, the HRS interviewer asks married couples to designate one spouse to be the financial respondent to answer financial questions for the household.

Respondents are sometimes reticent to answers interviewers' questions either due to an unwillingness to reveal sensitive information or uncertainty as the answer (Hurd, 1999). If the respondent does not know or does not want to provide an answer to a dollar denominated question, the interviewer asks a series of questions as to whether the amount is greater than or less than a specific value. The process is continued until an acceptable answer is obtained. The values are still uncertain and in some cases, must be imputed but the responses with missing values are greatly reduced (Marshall, McGarry, & Skinner, 2010).

Measures of Cognitive Ability

Evaluating financial alternatives is challenging for many individuals and may engage several facets of cognitive ability. Crystallized intelligence is required for evaluating the alternatives based on accumulated knowledge and skill. Fluid intelligence is engaged in retrieving relevant financial information from memory.

The HRS survey measures several aspects of crystallized intelligence. Mental status is measured through responses to questions regarding working memory, knowledge, and vocabulary. Mathematical aptitude questions include asking the respondent to count backwards form 100 by 7s and counting backward from 20. Knowledge of current affairs questions include asking the respondent the day's date and ask him/her to name the president and vice president. Vocabulary including asking the respondent the correction identify definitions of scissors and cactus. The mental status score is the correct responses to the three categories of questions with a resulting range of 0 to 15. The mental status score of the financial respondent were selected for the study.

Fluid intelligence (memory) can be measured by the immediate word recall and delayed word recall survey questions. These questions are asked of every study participant for every

wave within the HRS 2000 to HRS 2010 range. In order to evaluate memory, respondents are read a list of 10 nouns and then immediately asked to repeat as many as they can. After approximately five minutes the respondents are again asked to repeat the words. The correct number of answers each of the immediate and delayed word recall tests range from 0 to 10. The combined score can range from 0 to 20. The combined memory score of the same spouse for which mental status score was selected will be selected as the household score. The cognitive ability score for this research is a combination of the mental status and memory scores. The range is 0 to 35 and the variable name is COGN.

Measures of Physical Health

The HRS is a national longitudinal study collecting data on the health and wealth of the elderly. The HRS survey includes a wide array of physical health questions based on the premise that an individual's relative level physical functioning is associated with other facets of well-being such as mental health and wealth (Fonda & Herzog, 2004).

Physical functioning refers to the ability to execute the common tasks associated with independent living. The HRS based their survey questions on the Instrumental Activities of Daily Living (IADL) inventory developed by Lawton and Brody (1969). The aspects of physical health included in this inventory are life maintenance, perception-cognition, physical self-care, instrumental self-care, acceptance, and social behavior. The HRS survey includes question asking as the whether the respondent has difficulty in performing each of 11 IADLs (Spector & Fleishman, 1998). Each question has a dichotomous yes/no answer. This sums the "no" answers in order to determine positive physical results. Scores have a possible range of 0 to 11.

Measures of Emotional Health

An individual's emotional health in a significant factor is his or her overall health and welfare. Depression and anxiety can affect an individual's ability to work, resources used to perform daily life, and physical well-being. The developers of the HRS focused on depression since is the most widespread psychiatric affliction among the elderly. To measure the symptoms of depression the HRS includes portions Center for Epidemiologic Studies Depression Scale (CES-D). The CES-D was first developed in 1977 by Laurie Radloff and is widely used in psychological studies. The HRS survey includes eight CES-D related questions. The study sums the responses indicating an absence of CES-D symptoms. Scores have a possible range of 0 to 8.

Data Analysis

The focus of the research is the association of health and wealth. The three aspects of health examined in this study are cognitive ability, emotional health, and physical health and wealth. Education is an aspect of socioeconomic status and important determinant of household wealth (James, 2011). Individuals are asked about their highest attained level of education only in the year they first participate in the survey. The attained education for each spouse in the HRS 2000 married couples will be determined by tracking the individuals through earlier waves until the reported education is ascertained. For married households, the highest attained category of education for either spouse will be selected when examining the association with household wealth.

Cognitive ability can be broadly divided into crystallized intelligence and fluid intelligence. The crystallized intelligence will be measured by mental status using a 15-point scale developed from a group of HRS survey questions. Memory is a primary component of fluid intelligence and will be measured using a 20-point scale. Overall cognitive ability was measured

by combining the mental status and memory scores. The range of possible scores is 0 to 35 and is named COGN in the analysis.

Emotional health is measured by responses to questions derived from the CES-D survey. The HRS interviewer records positive responses. This research sums the negative responses to determine the participant score for each wave. The range of possible scores is 0 to 8 and is named CES-D in the analysis.

Physical health is measured by responses to questions regarding Instrumental Activities of Daily Living (IADL). The HRS interviewer records positive responses. This research sums the negative responses to determine the participant score for each wave. The range of possible scores is 0 to 11 and is named IADL in the analysis.

Within the measure of cognitive ability measure memory scores are relatively normally distributed and mental status scores are highly negatively skewed. CES-D scores and IADL scores are also highly skewed. The general linear model (GLM) is a variant of regression that allows variables to have non-normal distributions and allows the magnitude of each measurement to be a function of the predictor variable. Regressions for each attained education category for each wave under study were determined in order to assess the strength of associations of health and wealth. Partial eta squared was determined for each attained education category for each wave under study in order to assess the contribution of each aspect on health (cognitive ability, emotional health, and physical health) to the association.

When responding to household level financial questions, married couples designate one spouse to be the financial respondent. The designation of a spouse as financial respondent is only for the survey being conducted at the time. The designation may alternate between spouses for subsequent HRS waves as each couple desires. Interviewers ask health questions of each spouse

separately. The financial respondent's responses were used to determine household cognitive ability, physical health and emotional health.

Individuals engage cognitive abilities and utilize resources early in life in order acquire education that results in higher income and greater accumulated wealth throughout life. Those with higher level of education have higher levels of cognitive ability and better lifelong health. Cognitive abilities peak early in life and declines thereafter. Physical health and mental health also decline during the retirement years. The life cycle hypothesis assumes wealth is accumulate through the working years and is exhausted during retirement. Marital status has a profound impact of household wealth regardless of education.

We begin by considering general demographic characteristics of age, race, and gender and comparing the samples for each level of education. For each wave, we examine the assumption that households with higher education have higher cognition scores, better physical health, better mental health, and greater accumulated wealth. For each level of attained education, we examine the assumptions of declining cognitive abilities, declining health and declining wealth. For each level of education, we examine how well cognitive abilities, mental health, and physical health explain variance in wealth as displayed through summaries of the regressions.

Results

Table 4.1

Demographic Characteristics of Sample of Ling Term Married Couples

	Total	Less Than High School	High School Graduate	Some College	College Graduate	Graduate School
Sample size	1162	236	396	210	142	178
Age						
HRS 2000		70.7	69.7	70.0	70.7	70.6
HRS 2002		71.9	71.4	71.6	72.7	73.3
HRS 2004		73.3	73.2	73.3	74.5	74.3
HRS 2006		75.2	75.0	75.3	76.4	75.9
HRS 2008		77.0	76.9	76.8	78.6	77.9
HRS 2010		79.0	79.1	79.0	80.7	79.9
Race percent in HRS 2000						
- White	90.6%	80.9%	92.7%	91.4%	93.7%	95.5%
- Black	6.7%	15.7%	4.5%	7.6%	3.5%	1.1%
- Other	2.7%	3.4%	2.8%	1.0%	2.8%	3.4%
	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Household Financial Respondent						
HRS 2000						
- Male		77.5%	60.4%	70.0%	84.5%	88.8%
- Female		22.5%	39.6%	30.0%	15.5%	11.2%
HRS 2002						
- Male		71.4%	56.2%	64.7%	86.6%	84.8%
- Female		28.6%	43.8%	35.3%	13.4%	15.2%
HRS 2004						
- Male		69.4%	53.9%	62.9%	86.0%	83.6%
- Female		30.6%	46.1%	37.1%	14.0%	16.4%
HRS 2006						
- Male		69.5%	53.8%	63.9%	84.8%	83.6%
- Female		30.5%	46.2%	36.1%	15.2%	16.4%
HRS 2008						
- Male		68.2%	53.1%	60.3%	84.9%	81.9%
- Female		31.8%	46.9%	39.7%	15.1%	18.1%
HRS 2010						
- Male		62.7%	50.9%	56.9%	81.1%	79.1%
- Female		37.3%	49.1%	43.1%	18.9%	20.9%

In HRS 2000 the ages of the financial respondents for each of the categories of attained education are within one year of 70. The ages increase as expected and in HRS 2010 the financial respondents for each of the categories of attained education are within one years of age 80. Age is not expected to be a significant predictor of wealth.

Less than high school couples designated a white financial respondent in 80.9% of the households. The proportion of couples with other levels of attained educations were consistent with one another and significantly higher than *less than high school: high school graduate* (92.7%), s*ome college* (91.4%), c*ollege graduate* (93.7%), and g*raduate school* (95.5%). Race has an effect on wealth only when comparing *less than high school* to the other levels of attained education.

During the survey accompanying each wave, the couple selects one spouse to be designated the financial respondent. The financial respondent answers the HRS interviewer's questions regarding the couple's income, assets, and liabilities. The financial respondent may be changed from one spouse to the other between waves. No observed education category was represented by a majority of female financial respondents. Generally, the higher the education the lower the proportion of households with female financial respondents. For all waves, *high school graduate* households have the highest portion of female financial respondents ranging from 39.6% in HRS 2000 to 49.1% in HRS 2010 and *college graduate* households have the lowest proportion of female financial respondents ranging from 11.2% in HRS 2000 to 20.9% in HRS 2010. For all education categories, as couples ages the greater the proportion of female financial respondents. *College Graduate* had small increase from 15.5% to 18.9% but *graduate school* nearly doubled from 11.2% to 20.9%.

Table 4.2

Summary of Health Variables by Wave

HRS 2000

Attained Education	COGN	CESD	IADL	Wealth
Less than High School	20.60	5.28	10.65	$ 223,156
High School	23.86	5.39	10.89	$ 421,303
Some College	24.36	5.76	10.91	$ 630,754
College Graduate	24.87	5.77	11.89	$ 839,596
Graduate School	25.05	5.85	10.87	$ 1,032,097
Overall	23.59	5.62	10.84	$ 563,593

HRS 2002

Attained Education	COGN	CESD	IADL	Wealth
Less than High School	20.57	5.18	10.55	$ 226,002
High School	23.65	5.61	10.87	$ 429,873
Some College	24.39	5.72	10.86	$ 621,081
College Graduate	25.05	5.81	10.87	$ 851,390
Graduate School	25.18	5.95	10.85	$ 963,212
Overall	23.58	5.62	10.80	$ 558,277

HRS 2004

Attained Education	COGN	CESD	IADL	Wealth
Less than High School	20.34	5.16	10.45	$ 252,507
High School	23.13	5.74	10.82	$ 445,167
Some College	23.50	5.80	10.84	$ 717,639
College Graduate	24.82	5.98	10.78	$ 1,198,384
Graduate School	24.59	5.96	10.83	$ 1,112,407
Overall	23.08	5.70	10.74	$ 652,258

HRS 2006

Attained Education	COGN	CESD	IADL	Wealth
Less than High School	20.02	5.27	10.43	$ 292,589
High School	22.81	5.66	10.66	$ 521,918
Some College	23.20	5.80	10.76	$ 729,543
College Graduate	24.04	5.98	10.78	$ 1,260,640
Graduate School	24.08	6.16	10.73	$ 1,259,845
Overall	22.69	5.73	10.66	$ 720,391

HRS 2008

Attained Education	COGN	CESD	IADL	Wealth
Less than High School	19.65	5.20	10.28	$ 296,895
High School	22.25	5.60	10.67	$ 511,585
Some College	22.70	5.70	10.71	$ 754,792
College Graduate	23.29	6.01	10.68	$1,217,720
Graduate School	23.83	5.92	10.63	$1,198,066
Overall	22.21	5.64	10.60	$ 709,356

HRS 2010

Attained Education	COGN	CESD	IADL	Wealth
Less than High School	18.29	5.19	9.78	$ 235,461
High School	21.06	5.61	10.52	$ 450,963
Some College	21.56	5.77	10.50	$ 628,280
College Graduate	21.95	6.06	10.43	$ 964,505
Graduate School	22.80	5.89	10.45	$ 1,083,210
Overall	21.01	5.66	10.36	$ 605,320

All Waves	22.70	5.66	10.67	$ 634,866

COGN – Measure of cognitive ability as the sum of mental status scores and memory scores.

Range 0 - 35

CESD – Measure of emotional health by the Center for Epidemiologic Studies Depression Scale responses. Range 0 - 8

IADL – Measure of physical health by Instrumental Activities of Daily Living responses. Range 0 – 11

The higher the attained education, the higher the household cognitive ability (COGN) for all waves. Emotional health (CESD) was lowest for *less than high school.* Scores for all other education categories were not significantly different from one another. Additionally, physical health (IADL) was lowest for *less than high school.* Scores for all other education categories were not significantly different from one another.

Table 4.3

Summary of Variables by Attained Education

Less than High School

	COGN	CESD	IADL	Wealth
HRS 2000	20.60	5.28	10.65	$ 223,156
HRS 2002	20.57	5.18	10.55	$ 333,197
HRS 2004	20.34	5.16	10.45	$ 252,507
HRS 2006	20.02	5.27	10.43	$ 292,589
HRS 2008	19.65	5.20	10.28	$ 296,895
HRS 2010	18.29	5.19	9.78	$ 235,461
Range	0 - 35	0 – 8	0 - 11	

High School Graduate

	COGN	CESD	IADL	Wealth
HRS 2000	23.86	5.39	10.89	$ 421,303
HRS 2002	23.65	5.61	10.87	$ 429,873
HRS 2004	23.13	5.74	10.82	$ 445,167
HRS 2006	22.81	5.66	10.66	$ 521,918
HRS 2008	22.25	5.60	10.67	$ 511,585
HRS 2010	21.06	5.61	10.52	$ 450,963
Range	0 – 35	0 - 8	0 - 11	

Some College

	COGN	CESD	IADL	Wealth
HRS 2000	24.36	5.76	10.91	$ 630,754
HRS 2002	24.39	5.72	10.86	$ 631,081
HRS 2004	23.50	5.80	10.84	$ 717,639
HRS 2006	23.20	5.79	10.76	$ 729,543
HRS 2008	22.70	5.70	10.71	$ 754,792
HRS 2010	21.56	5.77	10.50	$ 628,280
Range	0 - 35	0 - 8	0 - 11	

College Graduate

	COGN	CESD	IADL	Wealth
HRS 2000	24.87	5.77	11.89	$ 839,596
HRS 2002	25.05	5.81	10.87	$ 851,390
HRS 2004	24.82	5.97	10.78	$ 1,198,384
HRS 2006	24.04	5.98	10.78	$ 1,260,640
HRS 2008	23.29	6.01	10.68	$ 1,217,720
HRS 2010	21.95	6.06	10.43	$ 964,505
Range	0 – 35	0 - 8	0 - 11	

Graduate School

	COGN	CESD	IADL	Wealth
HRS 2000	25.05	5.85	10.87	$ 1,032,097
HRS 2002	25.18	5.95	10.85	$ 963,212
HRS 2004	24.59	5.96	10.83	$ 1,198,384
HRS 2006	24.08	6.16	10.73	$ 1,259,845
HRS 2008	23.83	5.92	10.63	$ 1,198,066
HRS 2010	22.80	5.89	10.45	$ 1,083,210
Range	0 - 35	0 - 8	0 - 11	

Cognitive ability (COGN) declined at similar rates for all waves for all levels of education. Emotional health (CESD) remained steady for all waves for all levels of education. Physical health (IADL) for *less than high school* declined from HRS 2000 to HRS 2010 by .87 on an 11- point scale. Physical health of households of other education also declined but more slowly.

Table 4.4

Statistical Associations of Health and Wealth

		Less Than High School			High School Graduate			Some College			College Graduate			Graduate School		
		r sq.	*p*	eta sq.	r sq.	*p*	eta sq.	r sq.	*p*	eta sq.	r sq.	*p*	eta sq.	r sq.	*p*	eta sq.
HRS 2000		0.043			0.011			0.060			0.010			0.019		
- Cognitive Ability	COGN		0.0291	0.0213		0.1703	0.0050		0.0065	0.0372		0.2724	0.0091		0.6387	0.0013
- Emotional Health	CESD		0.3271	0.0043		0.1772	0.0049		0.4027	0.0036		0.9705	0.0000		0.7764	0.0005
- Physical Health	IADL		0.2594	0.0057		0.4370	0.0016		0.1074	0.0132		0.5847	0.0023		0.0946	0.0167
HRS 2002		0.093			0.031			0.064			0.002			0.062		
- Cognitive Ability	COGN		0.0002	0.0601		0.0059	0.0202		0.0014	0.0489		0.9901	0.0000		0.0345	0.0197
- Emotional Health	CESD		0.1956	0.0077		0.2072	0.0043		0.6381	0.0011		0.9399	0.0000		0.5566	0.0038
- Physical Health	IADL		0.3178	0.0046		0.1819	0.0048		0.1612	0.0096		0.9077	0.0001		0.0128	0.0294
HRS 2004		0.071			0.039			0.086			0.009			0.105		
- Cognitive Ability	COGN		0.0280	0.0175		0.0002	0.0343		<.0001	0.0717		0.3842	0.0018		0.0545	0.0000
- Emotional Health	CESD		0.0364	0.0154		0.8260	0.0025		0.2656	0.0012		0.8929	0.0076		0.0003	0.0153
- Physical Health	IADL		0.5070	0.0026		0.6090	0.0020		0.8811	0.0047		0.6417	0.0061		0.0131	0.0014
HRS 2006		0.099			0.023			0.021			0.027			0.113		
- Cognitive Ability	COGN		0.0014	0.0471		0.0156	0.0486		0.2499	0.0443		0.0697	0.0992		0.0002	0.1568
- Emotional Health	CESD		0.0062	0.0349		0.2541	0.0247		0.1553	0.0521		0.9582	0.0076		0.0461	0.0796
- Physical Health	IADL		0.7461	0.0005		0.3685	0.0211		0.5296	0.0307		0.9655	0.0048		0.2828	0.0484
HRS 2008		0.059			0.023			0.052			0.036			0.009		
- Cognitive Ability	COGN		0.0098	0.0899		0.0034	0.0598		0.0049	0.0996		0.8653	0.0248		0.0009	0.1415
- Emotional Health	CESD		0.5564	0.0293		0.8736	0.0085		0.5489	0.0298		0.0486	0.1060		0.9909	0.0000
- Physical Health	IADL		0.3008	0.0404		0.4087	0.0199		0.0819	0.0611		0.5140	0.0483		0.1381	0.0624
HRS 2010		0.094			0.054			0.044			0.118			0.005		
- Cognitive Ability	COGN		0.0004	0.1294		0.2324	0.0256		0.1643	0.0486		0.8948	0.0204		0.0001	0.0873
- Emotional Health	CESD		0.0310	0.0736		0.2299	0.0257		0.2583	0.0416		0.0207	0.1197		0.2554	0.0018
- Physical Health	IADL		0.9050	0.0123		0.0710	0.0362		0.3395	0.0371		0.0362	0.1083		0.4680	0.0007

Regression Model

Wealth = Intercept + COGN*(b_c) + IADL*(b_I) + CESD*(b_D) + error_i

The regression model seeks the explain how much of the variance in household wealth is explained by the combination of measures of cognitive ability (COGN), physical health (IADL), and mental health (CES-D). The partial eta squared coefficient measures the extent to which each independent variable individually (COGN, OADL, and CES-D) is a meaningful predictor of wealth.

The model has weak overall explanatory power. Of the 30 wave/education combinations, five have R^2 of .01 or less and four have R^2 of .099 or greater. In no case were all the three variables (cognitive ability, emotional health, and physical health) significant predictors of wealth in the same cell.

Cognitive ability was the most meaningful predictor of wealth both is terms of *p* value and contribution as measured by partial squared. Eighteen of the 30 cells had a *p* value of 5 or less. All six wave of *less than high school* households were significant. Based on partial eta squared, cognitive ability explained 12.9% of the variance in *less than high school* in HRS 2010. Cognitive ability was not a significant in any wave for *some college* households.

Emotional health was a meaningful predictor of wealth both is terms of *p* value and contribution as measured by partial squared in seven of the 30 cells. Based on partial eta squared, cognitive ability explained 11.97% of the variance in *college graduate* households in HRS 2010. Cognitive ability was not a significant in any wave for *college graduate* households.

Physical health was a meaningful predictor of wealth both is terms of *p* value and contribution as measured by partial squared in three of the 30 cells. Based on partial eta squared, cognitive ability explained 10.83% of the variance in *college graduate* households in HRS 2010.

Cognitive ability was not a significant in any wave for less than *high school, high school graduate,* and *some college* households.

Discussion

The low coefficients of determination may be partially explained by the characteristics of the subdivision of the sample. There is much more variability in the high-education groups relative to the low education groups. By conducting regressions on each level of attained education separately we mitigate against the variance between data groups. The households in each education/wave combination consist of households married to the same spouse for the range of waves, have the same level of attained education, are approximately the same age, and the calculations pertain to the same HRS wave. Given the like characteristics, small variance within the group might be expected. Accordingly, the explanatory variances determined by R^2 and partial eta^2 coefficients may be more consequential than might otherwise be considered. There is much more variability in the high-education groups relative to the low education groups. By conducting regressions on each level of attained education separately we mitigate against the variance between data groups.

Education early in life positively effects heath throughout the life cycle. House et al. (1994) found a causal effect of education on long term health. Education has a pronounced effect on wealth. Dannefer (2003) inferred that health to be to central factor in determining household wealth.

Attained education is an important factor in determining SES. Households with a higher SES generally enjoy greater health than households with lower SES. Prus (2007) found that the health of high SES households declines slower than the health of low SES households so than the health inequity between high SES and low SES households increases with age. Ross and Wu

(1996) inferred a similar increasing disparity of health by household SES. Xu et al. (2014) concluded that the health advantage of higher SES diminished with age. In our research, we found little evidence of changes in health disparity over time.

In our research, cognitive abilities have the strongest influence on wealth, decline the most over time, and exhibit greatest disparity among categories of attained education. Dannefer (2003) found cognitive decline to be pervasive among all SES classes and Bosma et al. (2003) concluded that the poorly educated experienced the fastest decline in cognitive abilities. Our research found that cognitive abilities declined for similar rates for all categories of attained education.

Less than high school households have poorer emotional health than households of other educations categories for all waves. There was little difference among other categories or among waves. Only slight variances in physical health were measured among education categories or among waves.

Limitations

The sample selection methods couples used for this study may introduce selection bias in several ways. First, as a longitudinal study only the data of those individuals that remain in the study over the relevant time range are considered for the research. The data of individuals that drop out or enter the study population during the relevant time range are not considered. Those who remain in the study tend to have greater physical health, score higher in cognitive ability measures, and accumulate more wealth than those individuals that attrite (Palgi, 2012).

Second, the HRS selects for interview only those households with one member at least 51 years old. Once selected, participants are then reinterviewed by the HRS for each biennial wave.

Participants in the HRS data set are older, score lower on memory measures, and amass higher wealth than the general population (Venti, 2011).

Third, married couples tend to report better health, have higher cognitive ability, and greater wealth than unmarried households. Poor health and financial strains are often reported as contributing factors to marital dissolution. Declining health and strained finances often precede the death of a spouse and continue to affect the surviving spouse after death (Poterba et al., 2012; Wu, 2003). Never-married individuals accumulate less wealth than married households (Schneider, 2011). Each factor in defining the sample narrows the participant eligible for inclusion in the study and the cumulative effect results in selection bias., those widowed or divorced in mid-life show cognitive impairment at nearly three times the rate of married people (Hakansson et al., 2009). The nonrandom exclusion of non-married individuals from the sample results in a selection bias and limits the applicability of the findings to the general population (Beck, 1983).

Fourth, individuals with higher wealth have a higher likelihood of remaining in the study (Cao & Hill, 2005). Lower wealth individuals have shorter life expectancies (Love, Palumbo, & Smith, 2008). Schneider (2011) found that wealth was a key predictor of the marriage decision and that the greater an individual's wealth the less likely he or she was to enter into a first marriage. The death of lower wealth individuals biases the observed relationship of age and wealth upward (Poterba et al., 2012; Love, Palumbo, & Smith, 2008). Attrition is often due to poor health, escalating mental impairment, or death. Cognitive decline accelerates in advance of these conditions and contributes to attrition (Karlamangla et al., 2009).

Fifth, analysis for couples based on the cognitive ability of one spouse and household wealth may yield very different results than if the two spouses were examined as individuals.

Attrition not only weakens statistical precision but introduces bias in the remaining sample **(**Raudenbush, 2001).

Sixth, the measures of cognitive ability have limitations. Education may have been attained several decades before the period under study and may not be reflective of current relationships with wealth. In many studies, measures of mental status are highly negatively skewed and therefore not very discriminating (Smith, McArdle, & Willis, 2010; Kim, Hanna, Chatterjee, & Lindamood, 2012; Cagney, 2002).

Seventh, measures of physical health and emotional health are based on survey responses and not directly measured. Relatively few impairments are reported and consequently, the results are highly skewed. The financial respondent is often the healthier spouse in the couple and this would tend to understate health impairments (Cao, & Hill, 2005).

Finally, there is significant measurement error in the Health and Retirement Study data because both asset ownership and the value of assets are often misreported. The effects of the errors are compounded in a longitudinal study when the change in assets is the variable under consideration since a misreported value affects the change result from the wave before the misreported value and the wave after the misreported value (Poterba, Venti, & Wise, 2013a). The value of retirement assets may be misreported because the HRS does not provide information on 401(k) accounts. IRA accounts are reported so when a 401(k) is rolled over into an IRA account the results will show an increase in reported assets by the amount of the rollover when in fact there was no increase in wealth.

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Chapter 5 - Conclusions

The three essays in this dissertation examined the different associations between cognitive abilities, health and wealth. The findings in these studies contribute new information regarding how marital status, memory, mental status, physical heath, and emotional health are associated with wealth of households within five different levels of socio-economic status Financial service practitioners, regulators, researchers, and caregivers can apply these findings to develop approaches to assist the elderly manage household wealth.

Essay One

The first study, Chapter 2, compared the associations of cognitive abilities and wealth of married households with non-married households. The purpose was to compare married households and non-married households of the same level of attained education in order the estimate the effect of marriage.

The results indicated that married households accumulated significantly higher wealth than non-married households for every category of attained education. Married households had higher memory and mental status than non-married households for every category of education. Compared with married households, non-married households had a higher proportion of financial respondents that identified as female and a higher proportion of financial respondents that were non-white.

The combination of memory scores and mental status scores predict 16.7% of wealth for *less than high school* households. The predictive power of cognitive abilities and wealth for other households ranges from 10.04% to 12.4%. Regression coefficients for mental status range from .021 to .069 for non-married households and .026 to .081 for married households. Memory

scores for married households have more explanatory power for wealth than the explanatory power for wealth among non-married households

Essay Two

The second study examined the relationship of mental status and memory with wealth for couples consisting of the same spouses for all six biennial panels from 2000 to 2010. The purpose was to evaluate the relationships of mental status and wealth and the relationships of memory and wealth for each category of attained education. The analysis also enabled examining the trajectory of mental status, memory, and wealth through each of the six panels

For every wave, the higher the attained education the higher the household wealth. Memory scores and mental status declined from 2000 to 2002 and for every wave thereafter. Wealth increased from 2000 to 2002, from 2002 to 2004, from 2004 to 2006, and from 2006 to 2008. As expected from the great recession, wealth dropped for all education categories from 2008 to 2010.

For every education category and for every wave the higher the education the higher the memory scores and mental status scores. Mental status and memory declined from 2000 to 2002 and for every wave thereafter.

Regression analysis indicated that for many of the education/wave combinations cognition variables were statistically significant predictors of wealth.

Essay Three

The third study broadened the scope of the second study by examining the relationships of three broad measures of health (cognitive ability, mental health, and physical health) and wealth. In this study, mental status and memory were combined into cognitive ability.

The model has weak overall explanatory power. Of the 30 wave/education combinations, five have R^2 of .01 or less and four have R^2 of .099 or greater. In no case were all the three variables (cognitive ability, emotional health, and physical health) significant predictors of wealth in the same cell.

Cognitive ability was the most meaningful predictor of wealth both is terms of *p* value and contribution as measured by partial eta-squared. Eighteen of the 30 cells had a *p* value of .05 or less. All six wave of *less than high school* households were significant. Based on partial eta squared, cognitive ability explained 12.9% of the variance in *less than high school* in HRS 2010. Cognitive ability was not a significant in any wave for *some college* households.

Emotional health was a meaningful predictor of wealth both is terms of *p* value and contribution as measured by partial eta squared in seven of the 30 cells. Based on partial eta squared, emotional health explained 11.97% of the variance in *college graduate* households in HRS 2010. Emotional health was not a significant in any wave for *college graduate* households.

Physical health was a meaningful predictor of wealth both is terms of *p* value and contribution as measured by partial squared in three of the 30 cells. Based on partial eta squared, physical health cognitive ability explained 10.83% of the variance in *college graduate* households in HRS 2010. Physical health was not significant in any wave for less than *high school, high school graduate*, and *some college* households.

Conclusion

The goal of this dissertation was to examine the relationship of health and cognitive abilities with wealth. The findings from the three studies in this dissertation all provide information that financial service practitioners, regulators, researchers, and caregivers can apply to develop approaches to assist the elderly manage household wealth.

Financial planners can use this information in modifying financial plans of households with similar starting capital and attained education but different marital status. The results from examining the longitudinal association of memory and mental status on the wealth of elderly married couples. Can be used by planners and caregivers in anticipating the effects of deteriorating cognitive abilities on household wealth. For that purpose, the concentration of effects of cognitive ability among low-educated couples should be kept in mind. Finally, the longitudinal findings from the expanded set of predictors may potentially help financial planners in understanding how physical health, emotional health, and cognitive functioning combine to influence household wealth trajectories that may occur in the absence of support for those who have the most disadvantaged combinations.

SAS Code

Data Files

```
libname new 'U:\Documents\AES\Fernatt\datfiles'; * Location of data files;

/* Begin with 2000 data... format of database changed for other years */
/* Specifying the Wave */
%let num=00;

/* A function to Create dataset t1 in SAS workspace as a sorted version of t2
*/
/* t2 format? */
%macro vari(t1,t2);
data &t1;
  set new.&t2;
run;
proc sort;
  by hhid pn;
run;
%mend;

/* a_r, c_r, f_h, etc. are subtables of h00 */
%vari(a&num,h&num.a_r);
%vari(b&num,h&num.c_r);
* %vari(c&num,h&num.f_h); * No PN variable;
* %vari(d&num,h&num.j_h); * No PN variable;
%vari(e&num,h&num.m_r);

/* Merge above tables into one data table */
data com&num;
  merge a&num b&num e&num;
  by hhid pn;
run;



/* Repeat all of the above for 2002-2010 (new formating of database) */
/* This cycles nicely over the years for all the tables */
%macro m1 (varlist);
%local i num;
%let i=1;
%do i=1 %to %sysfunc(countw(&varlist));
  %let num=%scan(&varlist,&i);
  %vari(a&num,h&num.a_r);
  %vari(b&num,h&num.b_r);
  %vari(c&num,h&num.d_r);
  * %vari(d&num,h&num.h_h); * No PN variable;
  * %vari(e&num,h&num.q_h); * No PN variable;
  * %vari(f&num,h&num.r_h); * No PN variable;
  %vari(g&num,h&num.v_r);
  * Merge above a, b, c, and g tables into com02 - com10 data tables;
  data com&num;
    merge a&num b&num c&num g&num;
    by hhid pn;
  run;
%end;
```

```
%mend m1;
%m1(02 04 06 08 10);



/* Save the com00-com10 into the permanent data sets */
%macro datasv (varlist);
%local i num;
%let i=1;
%do i=1 %to %sysfunc(countw(&varlist));
  %let name=%scan(&varlist,&i);
  data new.&name;
    set &name;
  run;
%end;
%mend;
%datasv(com00 com02 com04 com06 com08 com10);
```

Stage 1 - Cognition

```
libname new 'U:\Documents\AES\Fernatt\datfiles'; * Location of data files;

/* A function to Create dataset t1 in SAS workspace as a sorted version of t2
*/
%macro loadcom (varlist);
%local i num;
%let i=1;
%do i=1 %to %sysfunc(countw(&varlist));
  %let num=%scan(&varlist,&i);
  data com&num;
    set new.com&num;
  run;
%end;
%mend;
%loadcom(00 10);


/* Define age, marital status, and Wave.  Delete respondents under 65 or with
no marital status.
Separate data coding for '00 and '10. */
%macro data00(namee, letter);
  data &namee.Mar; set &namee;
    Age = &letter.1101;
      Wave = 2000;
      if Age >= 65; * Delete respondents younger than 65;
    if not &letter.1158 = 0;  * Delete N/A marital statuses;
    if &letter.1158 = 1 then Married=1; else Married=0;
  run;
%mend;
%data00(com00, g);

%macro data10(num, letter);
  data com&num.Mar; set com&num;
      Age = &letter.A019;
```

```
      Wave = 2000 + &num;
      if Age >= 65; * Delete respondents younger than 65;
      if not (&letter.B063=.) AND &letter.B063 < 7.5;  * Delete N/A marital
statuses;
    if &letter.B063 = 1 then Married=1; else Married=0;
  run;
%mend;
%data10(10, m);

/* Add Mental and WordRecall */;
%macro cogn(year, num);
data com&year.mmw;
  merge com&year.Mar(in=a)
  new.cogimp9212a_r (keep = HHID PN R&num.TR20 R&num.MSTOT R&num.COGTOT
rename=(R&num.MSTOT=mental R&num.TR20=wordrecall R&num.COGTOT=cognition));
  by hhid pn;
  if a;
run;
proc sort data=com&year.mmw; by hhid pn; run;
%mend;

%cogn(00, 5); * Wave 5 is 2000;
%cogn(10, 10); * Wave 10 is 2010;

/* Load Tracker file */
data Tracker; set new.Trk2012tr_r; keep hhid pn gfinr mfinr gender race
schlyrs; run;
proc sort data=Tracker; by hhid pn; run;

/* Add Education attained (SchlYrs).  Also add financial respondent
information. */
%macro schlyrs(dataset);
data &dataset.s;
  merge &dataset(in=a) Tracker;
  by hhid pn;
  if a;
run;
data &dataset.s; set &dataset.s;
  if Wave = 2000 then finr = gfinr;
  if Wave = 2010 then finr = mfinr;
  if schlyrs = 99 then Educ=.; * Missing data;
    else if schlyrs = 17 then Educ=5; * Post-college;
    else if schlyrs = 16 then Educ=4; * College grad;
      else if schlyrs > 12 then Educ=3; * Some college;
      else if schlyrs =12 then Educ=2; * HS Grad;
      else Educ=1; * Did not complete HS;
  *drop gfinr mfinr;
run;
%mend;
%schlyrs(com00MMW);
%schlyrs(com10MMW);

/* Save trimmed down dataset for analysis. Combine 2000 and 2010 datasets. */
data AllData;
  set Com00MMWS (keep = hhid pn Gender Race finr Married Age Wave Schlyrs
Educ WordRecall Mental)
```

```
      Com10MMWS (keep = hhid pn Gender Race finr Married Age Wave Schlyrs
Educ WordRecall Mental);
  if finr in (1,2) then finr=1;
  if finr in (3,5,6) then finr=0;
  RAHHIDPN = HHID || PN;
run;
proc sort data=AllData; by hhid pn wave; run;

/* Time Consuming: Loading the Rand data.  In the future, we just load the
abbreviated version: SimpleRand;
libname library 'U:\Documents\AES\Fernatt\datfiles\sas'; * Location of RAND
files;
PROC FORMAT LIBRARY=library CNTLIN=library.sasfmts; * Define RAND formats;

Data new.SimpleRand; set library.Incwlth_n (keep = HHID PN H5WTOTB H6WTOTB
H7WTOTB H8WTOTB H9WTOTB H10WTOTB); run;
*/

data SimpleRand; set new.SimpleRand; run;
Proc Transpose data=SimpleRand out=SimpleRand2; * Switch from wide- to long-
datatable format;
  by hhid pn;
run;
Data SimpleRand2; set Simplerand2 (rename=(col1=Wealth)); * Calculate Wave
year;
  Wave = input(substr(_NAME_,2,1),5.)*2 + 1990;
  drop _NAME_ _LABEL_;
  if WAVE=1992 then WAVE=2010; * Because I used a shortcut above that doesn't
work quite right for Wave 10;
run;
proc sort data=SimpleRand2; by hhid pn wave; run;

/* Combine HRS with Rand data
Drop individuals without wordrecall/mental scores... and a couple without
Education scores. */
data AllWealth;
  merge AllData(in=a) SimpleRand2;
  by hhid pn Wave;
  if a;
  if cmiss(of _all_) then delete; * Drop any entry with missing values;
run;

/* Lastly, a step to take only one member from each household.  As currently
coded, we are filtering on age and
presence of wordrecall/mental scores before selecting the higher cognitive
partner.  We could'be tagged the higher
cognitive partner first and then filtered... take it for what it's worth */

proc sort data=AllWealth; by wave hhid wordrecall mental; run;
data new.Stage1; set AllWealth;
  by wave hhid;
    if last.hhid; * Equivalent to: delete member of each couple with lower
cognitive wordrecall (or mental, if wordrecall is tied);
run;
```

Stage 1 Model

```
libname new 'U:\Documents\AES\Fernatt\datfiles'; * Location of data files;

data Stage1; set new.Stage1; run;
proc sort data=Stage1; by Wave Married Educ; run;

/* Extract basic summary statistics */
%macro sumstat(varname);
proc means data=Stage1 n median std min max range mean noprint;
  By Wave Married Educ;
  Var &varname.;
  Output out=&varname. median=Median n=N std=SD range=Range min=Min max=Max
mean=Mean;
run;
proc means data=Stage3 n median std min max range mean noprint;
  By Wave Married;
  Var &varname.;
  Output out=tmpfile median=Median n=N std=SD range=Range min=Min max=Max
mean=Mean;
run;
Data tmpfile; Set tmpfile; Educ=99; Run;
Data &varname.; Set &varname. tmpfile; Variable="&varname."; Run;
%mend sumstat;
%sumstat(Wealth);
%sumstat(Mental);
%sumstat(WordRecall);
DATA Tmpfile; SET WordRecall Wealth Mental; RUN;

PROC EXPORT DATA= WORK.TmpFile
            OUTFILE= "U:\Documents\AES\Fernatt\S1_Demography.csv"
            DBMS=CSV REPLACE;
     PUTNAMES=YES;
RUN;

proc freq data=Stage1;
  By Educ Wave Married;
  Tables Gender*Race / out=GenderRace ;
run;

* To obtain quartiles for output;
proc means data=Stage1 Q1 median Q3 noprint;
  By Educ Wave Married;
  Var Mental WordRecall;
  Output out=MentalWR Q1(Mental)=Q1_M Q1(WordRecall)=Q1_WR
median(Mental)=med_M median(WordRecall)=med_WR Q3(Mental)=Q3_M
Q3(WordRecall)=Q3_WR;
run;

/* Data coding:
finr (financial respondent): 1 - Yes, 0 - No
Married: 1 - Yes, 0 - No
Educ: 1 = 0-11; 2 = 12; 3 = 13-15; 4 = 16; 5 = 17
*/

* Trimmed Means Regression;
* It occurs to me that we should trim means BY Wave-Marital status.
At present, the code does so.  However, if we prefer to trim across
the entire dataset at one time, we can change the BY statement in
```

```
the PROC RANK code to be just BY &byeduc;

%macro tmr(dataset, byeduc, pct, modelstate =);
* Fit model with all data;
proc glm data=Stage1 noprint; * outstat=glmresults&pct;   * noprint
suppresses the output;
  by &byeduc;
  class finr wave married educ;
  model Wealth = &modelstate;
  output out=modelfit residual=residuals;   * Writes data plus residuals to a
file called modelfit;
run;
* This is the step where we trim the topmost and bottommost residuals;
proc rank data=modelfit out=modelfit groups=200;
  by &byeduc. Wave Married;
  ranks ResRanks;
  var residuals;
run;
data modelfit; set modelfit;
  if ResRanks < &pct then delete;
  if ResRanks > 199 - &pct then delete;
run;
* Refit model with trimmed data;
ods select none; * Turns off on-screen output;
proc glm data=modelfit plots=none; * outstat=glmresults&pct; * Type 3 tests
are not valid;
  by &byeduc;
  class finr wave married educ;
  model Wealth = &modelstate / solution ss3 clparm effectsize;
  estimate 'Overall Average Effect of +1 Mental' mental 1;
    * i.e., if you averaged one person from each of the four Marriage-Wave
combinations, this is the mental effect;
  estimate 'Mental Married00 minus Unmarried00' mental*married -1 1
mental*wave*married -1 1 0 0;
  estimate 'Mental Married10 minus Unmarried10' mental*married -1 1
mental*wave*married 0 0 -1 1;
  estimate 'Mental Married10 minus Married00' mental*wave -1 1
mental*wave*married 0 -1 0 1;
  estimate 'Mental Unmarried10 minus Unmarried00' mental*wave -1 1
mental*wave*married -1 0 1 0;
  estimate 'Overall Average Effect of +1 Word Recall' wordrecall 1;
  estimate 'Word Recall Married00 minus Unmarried00' wordrecall*married -1 1
wordrecall*wave*married -1 1 0 0;
  estimate 'Word Recall Married10 minus Unmarried10' wordrecall*married -1 1
wordrecall*wave*married 0 0 -1 1;
  estimate 'Word Recall Married10 minus Married00' wordrecall*wave -1 1
wordrecall*wave*married 0 -1 0 1;
  estimate 'Word Recall Unmarried10 minus Unmarried00' wordrecall*wave -1 1
wordrecall*wave*married -1 0 1 0;
  lsmeans Wave*Married / at Mental=11;
  lsmeans Wave*Married / at Mental=15;
  lsmeans Wave*Married / at WordRecall=7;
  lsmeans Wave*Married / at WordRecall=12;
  ods output Estimates = Ests&pct fitstatistics = R2_&pct LSMeans=LSM_&pct
ModelANOVA = Type3_&pct; * Writes the estimates to a file;
run;
proc sort data=Ests&pct; by Parameter; run;
```

```
data R2_&pct; set R2_&pct; Trim=&pct; run; * Adding the trim percentage to
the R-squared output table;
/* proc sort data=Glmresults&pct; by _SOURCE_; run; */
quit;
ods select all;
%mend;

* %tmr(Stage1, Educ, 1, modelstate = Wave|Married|Mental
Wave|Married|Wordrecall);
%tmr(Stage1, Educ, 5, modelstate = Wave|Married|Mental
Wave|Married|Wordrecall);
* %tmr(Stage1, Educ, 10, modelstate = Wave|Married|Mental
Wave|Married|Wordrecall);
* %tmr(Stage1, Educ, 25, modelstate = Wave|Married|Mental
Wave|Married|Wordrecall);
/* To run tmr() without subdividing on EDUC, just leave the second element of
the tmr() command blank:
%tmr(Stage1, , 25, modelstate = Wave|Married|Mental Wave|Married|Wordrecall);
*/

PROC EXPORT DATA= WORK.Type3_5
            OUTFILE= "U:\Documents\AES\Fernatt\S1_ANOVA_EffS.csv"
            DBMS=CSV REPLACE;
     PUTNAMES=YES;
RUN;

/*
%macro CompileEsts(byEduc);
%let keeplist = &byEduc Parameter LowerCL Estimate UpperCL /*Probt*/;
/*
data Ests_All;
  merge Ests1 (keep=&keeplist.
                rename=(LowerCL=LCL01 Estimate=Est01 UpperCL=UCL01
/*Probt=P01*/))
/*
                        Ests5 (keep=&keeplist.
                rename=(LowerCL=LCL05 Estimate=Est05 UpperCL=UCL05
/*Probt=P05*/));
/*
                        by Parameter &byEduc;
run;
proc print data=ests_all(keep=&byEduc Parameter Est01 Est05); run;
%mend;

%CompileEsts(Educ); * Or, if we haven't broken it down by Education group,
just: %CompileEsts();

data R2_All;
  set R2_1 R2_5; *R2_10 R2_25;
run;
*/
proc print data=ests_all(keep=Parameter Est01 Est05 /*Est10 Est25*/); run;
proc print data=R2_all; run;


/* data GR_All;
  merge Glmresults1 (keep=_SOURCE_ Prob rename=(Prob=Prob01))
```

```
        Glmresults5 (keep=_SOURCE_ Prob rename=(Prob=Prob05))
        Glmresults10(keep=_SOURCE_ Prob rename=(Prob=Prob10))
        Glmresults25(keep=_SOURCE_ Prob rename=(Prob=Prob25));
  by _SOURCE_;
run; */

/* To be parallel to Stage 2, we'd write the following models:
model Wealth2000 = mental*gfinr + wordrecall*gfinr
model Wealth2010 = mental*gfinr + wordrecall*gfinr
with all covariates coming from 2000.  But I don't think that's the
appropriate
strategy for what we're trying to do here.  We want more of an ANOVA approach
than
trying to predict 2010 from 2000 data.
*/



* This is the code for Least-Trimmed Squares regression, which has as its
goal:
fit a model such that the smallest H residuals is minimized;
* This is slightly different from trimmed regression, in which you fit the
OLS model and
the identify the smallest H residuals;
* In LTS, the trimming and model fitting happen at the same time;
* In trimmed means, the model is fit, then the data are trimmed, then the
model is re-fit;

* This code is only here for curiosity at this point.  It's very finicky;

/*
proc robustreg method=lts(h=19030 subgroupsize=1750) fwls data=Stage1
plots=none;
  class finr wave married educ;
  model Wealth = Wave|Married|Wordrecall Wave|Married|Mental /
failratio=0.995; *cutoff=3;
  *id RAHHIDPN;
run;
*/
```

Stage 2 Model

```
libname new 'U:\Documents\AES\Fernatt\datfiles'; * Location of data files;

* Create change variables;
data Stage2; set new.Stage2;
  chWealth = Wealth-prevWealth;
  chMental = Mental-prevMental;
  chWR = WordRecall-prevWR;
run;
proc sort data=Stage2; by Educ Wave; run;

proc means data=Stage2 Q1 median Q3;
  Var chMental chWR;
run;
```

```
/* Extract basic summary statistics */
proc means data=Stage2 n Q1 median Q3 mode std noprint;
  By Educ Wave;
  Var Mental WordRecall Wealth chMental chWR chWealth;
  Output out=MentalWR Q1(Mental)=Q1_Mental mean(Mental)=mean_Mental
median(Mental)=med_Mental Q3(Mental)=Q3_Mental mode(Mental)=mode_Mental
std(Mental)=std_Mental
     Q1(WordRecall)=Q1_WR mean(WordRecall)=mean_WR median(WordRecall)=med_WR
Q3(WordRecall)=Q3_WR mode(WordRecall)=mode_WR std(WordRecall)=std_WR
       Q1(Wealth)=Q1_Wealth mean(Wealth)=mean_Wealth
median(Wealth)=med_Wealth Q3(Wealth)=Q3_Wealth mode(Wealth)=mode_Wealth
std(Wealth)=std_Wealth
       Q1(Age)=Q1_Age mean(Age)=mean_Age median(Age)=med_Age Q3(Age)=Q3_Age
mode(Age)=mode_Age std(Age)=std_Age
     Q1(chMental)=Q1_chMental mean(chMental)=mean_chMental
median(chMental)=med_chMental Q3(chMental)=Q3_chMental
mode(chMental)=mode_chMental std(chMental)=std_chMental
     Q1(chWR)=Q1_chWR mean(chWR)=mean_chWR median(chWR)=med_chWR
Q3(chWR)=Q3_chWR mode(chWR)=mode_chWR std(chWR)=std_chWR
       Q1(chWealth)=Q1_chWealth mean(chWealth)=mean_chWealth
median(chWealth)=med_chWealth Q3(chWealth)=Q3_chWealth
mode(chWealth)=mode_chWealth std(chWealth)=std_chWealth;
run;

/* proc means data=Stage2 n median mode Q1 Q3 noprint;
  By Educ Wave;
  Var Age Wealth Mental WordRecall chWealth chMental chWR;
  Output out=AgeWealth;
run;
*/

proc freq data=Stage2;
  By Educ Wave;
  Tables Gender / out=Gender;
  Tables Race / out=Race;
run;

PROC EXPORT DATA= WORK.MentalWR
            OUTFILE= "U:\Documents\AES\Fernatt\S2_DemographyA.csv"
            DBMS=CSV REPLACE;
     PUTNAMES=YES;
RUN;
PROC EXPORT DATA= WORK.Gender
            OUTFILE= "U:\Documents\AES\Fernatt\S2_DemographyB.csv"
            DBMS=CSV REPLACE;
     PUTNAMES=YES;
RUN;
PROC EXPORT DATA= WORK.Race
            OUTFILE= "U:\Documents\AES\Fernatt\S2_DemographyC.csv"
            DBMS=CSV REPLACE;
     PUTNAMES=YES;
RUN;

/* Data coding:
finr (financial respondent): 1 - Yes, 0 - No
Married: 1 - Yes, 0 - No
Educ: 1 = 0-11; 2 = 12; 3 = 13-15; 4 = 16; 5 = 17
```

```
*/

/* At present, this dataset is all couples who are married to the same
spouse over the six waves.  It is NOT all couples married to the same spouse
for at least one of whom mental/wordrecall is available in every wave.  I'm
inclined to not throw away more data. */

%macro tmrpre(dataset, byeduc, pct, Resp, modelstate =);
* Fit model with all data;
proc glm data=Stage2 noprint; * outstat=glmresults&pct;   * noprint
suppresses the output;
  by Wave &byeduc;
  class wave;
  model &Resp = &modelstate;
  output out=modelfit residual=residuals;   * Writes data plus residuals to a
file called modelfit;
run;
* This is the step where we trim the topmost and bottommost residuals;
proc rank data=modelfit out=modelfit groups=200;
  by Wave &byeduc;
  ranks ResRanks;
  var residuals;
run;
data modelfit; set modelfit;
  if ResRanks < &pct then delete;
  if ResRanks > 199 - &pct then delete;
run;
/* proc sort data=Stage2; By Educ Wave; Run;
proc means data=Stage2 n median Q1 Q3 min max noprint;
  By Educ Wave;
  Var Wealth;
  Output out=Wealth Q1(Wealth)=Q1_Wealth mean(Wealth)=mean_Wealth
median(Wealth)=med_Wealth Q3(Wealth)=Q3_Wealth mode(Wealth)=mode_Wealth
                  Min(Wealth)=Min_Wealth Max(Wealth)=Max_Wealth;
run;
quit;
proc sort data=modelfit; By Educ Wave; Run;
proc means data=modelfit n median Q1 Q3 min max noprint;
  By Educ Wave;
  Var Wealth;
  Output out=TrimWealth Q1(Wealth)=Q1_Wealth mean(Wealth)=mean_Wealth
median(Wealth)=med_Wealth Q3(Wealth)=Q3_Wealth mode(Wealth)=mode_Wealth
                  Min(Wealth)=Min_Wealth Max(Wealth)=Max_Wealth;
run;
quit;
*/
* Refit model with trimmed data;
ods select none;
proc glm data=modelfit plots=none; * outstat=glmresults&pct; * Type 3 tests
are not valid;
  by Wave &byeduc;
  class wave;
  model &Resp = &modelstate / solution ss3 clparm effectsize;
  lsmeans wave / at wordrecall = 9;
  lsmeans wave / at wordrecall = 11;
  lsmeans wave / at wordrecall = 13;
  lsmeans wave / at mental = 13;
```

```
  lsmeans wave / at mental = 14;
  lsmeans wave / at mental = 15;
  ods output lsmeans = LSM_&pct.pre fitstatistics = R2_&pct.pre
             ParameterEstimates = Estimates&pct.pre ModelANOVA =
Type3_&pct.pre; * Writes the estimates to a file;
run;
data R2_&pct.pre; set R2_&pct.pre; Trim=&pct; run; * Adding the trim
percentage to the R-squared output table;
/* proc sort data=Glmresults&pct; by _SOURCE_; run; */
quit;
ods select all;
%mend;

* Predicting current wave with current wave data;
* At present, this is a VERY simple model... for each Wave-Educ combo, we're
predicting Wealth based upon current mental and wordrecall values;
* %tmrpre(Stage2, Educ, 1, Wealth, modelstate = mental wordrecall wave);
* 'wave' is included to trick the LSMEANS statement;
PROC SORT data=Stage2; BY WAVE EDUC; RUN;
%tmrpre(Stage2, Educ, 5, Wealth, modelstate = mental wordrecall wave);
/* %tmrpre(Stage2, Educ, 10, Wealth, modelstate = mental wordrecall wave);
%tmrpre(Stage2, Educ, 25, Wealth, modelstate = mental wordrecall wave);
*/

%macro tmrpost(dataset, byeduc, pct, Resp, modelstate =);
* Fit model with all data;
proc glm data=Stage2 noprint; * outstat=glmresults&pct;   * noprint
suppresses the output;
  by Wave &byeduc;
  class wave;
  model &Resp = &modelstate;
  output out=modelfit residual=residuals;   * Writes data plus residuals to a
file called modelfit;
run;
* This is the step where we trim the topmost and bottommost residuals;
proc rank data=modelfit out=modelfit groups=200;
  by Wave &byeduc;
  ranks ResRanks;
  var residuals;
run;
data modelfit; set modelfit;
  if ResRanks < &pct then delete;
  if ResRanks > 199 - &pct then delete;
run;
* Refit model with trimmed data;
ods select none;
proc glm data=modelfit plots=none; * outstat=glmresults&pct; * Type 3 tests
are not valid;
  by Wave &byeduc;
  class wave;
  model &Resp = &modelstate / solution ss3 effectsize clparm;
  lsmeans wave / at (chWR wordrecall) = (-2 9);
  lsmeans wave / at (chWR wordrecall) = (-2 11);
  lsmeans wave / at (chWR wordrecall) = (-2 13);
  lsmeans wave / at (chWR wordrecall) = (0 9);
  lsmeans wave / at (chWR wordrecall) = (0 11);
  lsmeans wave / at (chWR wordrecall) = (0 13);
```

```
  lsmeans wave / at (chWR wordrecall) = (2 9);
  lsmeans wave / at (chWR wordrecall) = (2 11);
  lsmeans wave / at (chWR wordrecall) = (2 13);
  lsmeans wave / at (chmental mental) = (-1 13);
  lsmeans wave / at (chmental mental) = (-1 14);
  lsmeans wave / at (chmental mental) = (-1 15);
  lsmeans wave / at (chmental mental) = (0 13);
  lsmeans wave / at (chmental mental) = (0 14);
  lsmeans wave / at (chmental mental) = (0 15);
  lsmeans wave / at (chmental mental) = (1 13);
  lsmeans wave / at (chmental mental) = (1 14);
  lsmeans wave / at (chmental mental) = (1 15);
    ods output lsmeans = LSM_&pct.post fitstatistics = R2_&pct.post
               ParameterEstimates = Estimates&pct.post ModelANOVA =
Type3_&pct.post; * Writes the estimates to a file;
run;
data R2_&pct.post; set R2_&pct.post; Trim=&pct; run; * Adding the trim
percentage to the R-squared output table;
/* proc sort data=Glmresults&pct; by _SOURCE_; run; */
quit;
ods select all;
%mend;

* Forecasting next wave with current wave data (modeling the change in
wealth);
* %tmrpost(Stage2, Educ, 1, chWealth, modelstate = mental wordrecall chMental
chWR wave);
PROC SORT data=Stage2; BY WAVE EDUC; RUN;
%tmrpost(Stage2, Educ, 5, chWealth, modelstate = mental wordrecall chMental
chWR wave);
/* %tmrpost(Stage2, Educ, 10, chWealth, modelstate = mental wordrecall
chMental chWR wave);
%tmrpost(Stage2, Educ, 25, chWealth, modelstate = mental wordrecall chMental
chWR wave);
*/

/* To run tmr() without subdividing on EDUC, just leave the second element of
the tmr() command blank:
%tmr(Stage2, , 25, modelstate = Wave|Married|Mental Wave|Married|Wordrecall);
*/




PROC EXPORT DATA= WORK.R2_5post
            OUTFILE= "U:\Documents\AES\Fernatt\Stg2_R2_Post.csv"
            DBMS=CSV REPLACE;
     PUTNAMES=YES;
RUN;
PROC EXPORT DATA= WORK.R2_5pre
            OUTFILE= "U:\Documents\AES\Fernatt\Stg2_R2_Pre.csv"
            DBMS=CSV REPLACE;
     PUTNAMES=YES;
RUN;
PROC EXPORT DATA= WORK.Type3_5post
            OUTFILE= "U:\Documents\AES\Fernatt\Stg2_EffectSize_Post.csv"
```

```
            DBMS=CSV REPLACE;
     PUTNAMES=YES;
RUN;
PROC EXPORT DATA= WORK.Type3_5pre
            OUTFILE= "U:\Documents\AES\Fernatt\Stg2_EffectSize_Pre.csv"
            DBMS=CSV REPLACE;
     PUTNAMES=YES;
RUN;
PROC EXPORT DATA= WORK.Wealth
            OUTFILE= "U:\Documents\AES\Fernatt\Stg2_Wealth.csv"
            DBMS=CSV REPLACE;
     PUTNAMES=YES;
RUN;
PROC EXPORT DATA= WORK.TrimWealth
            OUTFILE= "U:\Documents\AES\Fernatt\Stg2_TrimWealth.csv"
            DBMS=CSV REPLACE;
     PUTNAMES=YES;
RUN;
```

Stage 2 Cognition

```
libname new 'U:\Documents\AES\Fernatt\datfiles'; * Location of data files;

/* A function to Create dataset t1 in SAS workspace as a sorted version of t2
*/
%macro loadcom (varlist);
%local i num;
%let i=1;
%do i=1 %to %sysfunc(countw(&varlist));
  %let num=%scan(&varlist,&i);
  data com&num;
    set new.com&num;
  run;
%end;
%mend;
%loadcom(00 02 04 06 08 10);

/* We first select the people who are married to the same person in all the
waves */
/* This should be equivalent to : subhh=0 AND two people sharing an HHID
   However, some people with subhh=0 are listed as divorced, widowed, never
married...
   I *think* this may have to do with the definition of HH, which includes
unmarried
   people living together...?  Just to be safe, I'm only including clearly
married people. */

/* Technically, this is just people married to the same person throughout the
survey
   Does NOT include people on their second marriage since before 2000 who are
still in that marriage */

/* The dataset structure (variable names and coding) are significantly
different from 2000 versus other years */
/* Code can also define age and Wave. */
%macro data00(num, letter);
```

```
  data com&num.Mar; set com&num;
    if &letter.subhh='0'; * Delete people whose HH has changed;
    Age = &letter.1101;
      Wave = 2000;
      * if Age >= 65; * Delete respondents younger than 65;
      if &letter.1158 = 1; * Delete any unmarried people;
  run;
%mend;
%data00(00, g);

%macro data10(num, letter, marvar);
  data com&num.Mar; set com&num;
    if &letter.subhh='0';
      Age = &letter.A019;
      Wave = 2000 + &num;
      * if Age >= 65; * Delete respondents younger than 65;
    by hhid;
      if not (first.hhid and last.hhid); * Equivalent to: if this is not the
only entry with this HHID;
    if &letter.&marvar = 1; * Delete any unmarried people;
  run;
%mend;
%data10(02, h, marital);
%data10(04, j, B063);
%data10(06, k, B063);
%data10(08, l, B063);
%data10(10, m, B063);

/* Add Mental and WordRecall */;
%macro cogn(year, num);
data com&year.mmw;
  merge com&year.Mar(in=a)
  new.cogimp9212a_r (keep = HHID PN R&num.TR20 R&num.MSTOT R&num.COGTOT
rename=(R&num.MSTOT=mental R&num.TR20=wordrecall R&num.COGTOT=cognition));
  by hhid pn;
  if a;
run;
proc sort data=com&year.mmw; by hhid pn; run;
%mend;

%cogn(00, 5); * Wave 5 is 2000;
%cogn(02, 6); * Wave 6 is 2002;
%cogn(04, 7); * Wave 7 is 2004;
%cogn(06, 8); * Wave 8 is 2006;
%cogn(08, 9); * Wave 9 is 2008;
%cogn(10, 10); * Wave 10 is 2010;

data Tracker; set new.Trk2012tr_r; keep hhid pn gfinr hfinr jfinr kfinr lfinr
mfinr gender race schlyrs; run;
proc sort data=Tracker; by hhid pn; run;

/* Add Education attained (SchlYrs) */
%macro schlyrs(varlist, letterlist);
%local i dataset;
%let i=1;
%do i=1 %to %sysfunc(countw(&varlist));
  %let dataset=%scan(&varlist,&i);
```

```
  %let letter=%scan(&letterlist,&i);
  data &dataset.s;
    merge &dataset(in=a) Tracker (keep = hhid pn gender race &letter.finr
schlyrs rename=(&letter.finr=FinR));
    by hhid pn;
      if a;
  run;
  data &dataset.s; set &dataset.s;
      RAHHIDPN = HHID || PN;
    if schlyrs = 99 then Educ=.; * Missing data;
      else if schlyrs = 17 then Educ=5; * Post-college;
      else if schlyrs = 16 then Educ=4; * College grad;
      else if schlyrs > 12 then Educ=3; * Some college;
      else if schlyrs = 12 then Educ=2; * HS Grad;
      else Educ=1; * Did not complete HS;
  run;
  proc sort data=&dataset.s; by RAHHIDPN; run;
%end;
%mend;
/* Note: the following spits out 'uninitialized variable' warnings, but we
may safely ignore them. */
%schlyrs(com00MMW com02MMW com04MMW com06MMW com08MMW com10MMW, g h j k l m);

/* Trim datasets for analysis. Combine all datasets. */
data AllStage2;
  set Com00MMWS (keep = hhid pn Gender Race RAHHIDPN FinR Age Wave Schlyrs
Educ WordRecall Mental)
      Com02MMWS (keep = hhid pn Gender Race RAHHIDPN FinR Age Wave Schlyrs
Educ WordRecall Mental)
        Com04MMWS (keep = hhid pn Gender Race RAHHIDPN FinR Age Wave Schlyrs
Educ WordRecall Mental)
        Com06MMWS (keep = hhid pn Gender Race RAHHIDPN FinR Age Wave Schlyrs
Educ WordRecall Mental)
        Com08MMWS (keep = hhid pn Gender Race RAHHIDPN FinR Age Wave Schlyrs
Educ WordRecall Mental)
      Com10MMWS (keep = hhid pn Gender Race RAHHIDPN FinR Age Wave Schlyrs
Educ WordRecall Mental);
  if finr in (1,2) then finr=1;
  if finr in (3,5,6) then finr=0;
  RAHHIDPN = HHID || PN;
  label finr = "Financial Respondent";
run;
proc sort data=AllStage2; by RAHHIDPN Wave; run;

/* Tally the number of times somebody appears in the database.
Keep only those who appear in all 6 years. */
proc freq data=AllStage2 noprint;
  tables RAHHIDPN / out=Tally;
run;
proc sort data=Tally; by RAHHIDPN; run;
data AllStage2;
  merge AllStage2 Tally (keep = RAHHIDPN Count);
  by RAHHIDPN;
  if Count=6;  * Keeps just rows for respondents who appear in ALL Waves;
run;
proc sort data=AllStage2; by hhid pn Wave; run;
```

```
/* Time Consuming: Loading the Rand data.  In the future, we just load the
abbreviated version: SimpleRand;
libname library 'U:\Documents\AES\Fernatt\datfiles\sas'; * Location of RAND
files;
PROC FORMAT LIBRARY=library CNTLIN=library.sasfmts; * Define RAND formats;

Data new.SimpleRand; set library.Incwlth_n (keep = HHID PN H5WTOTB H6WTOTB
H7WTOTB H8WTOTB H9WTOTB H10WTOTB); run;
*/

data SimpleRand; set new.SimpleRand; run;
Proc Transpose data=SimpleRand out=SimpleRand2; * Switch from wide- to long-
datatable format;
  by hhid pn;
run;
Data SimpleRand2; set Simplerand2 (rename=(col1=Wealth)); * Calculate Wave
year;
  Wave = input(substr(_NAME_,2,1),5.)*2 + 1990;
  drop _NAME_ _LABEL_;
  if WAVE=1992 then WAVE=2010; * Because I used a shortcut above that doesn't
work quite right for Wave 10;
run;
proc sort data=SimpleRand2; by hhid pn wave; run;

/* Combine HRS with Rand data. Drop any person with missing mental /
wordrecall.
Will often leave only half-couples in the dataset */
data AllWealth;
  merge AllStage2(in=a) SimpleRand2;
  by hhid pn Wave;
  if a;
  if age=. then age=3.14159; * I don't see any need to throw these out, and
we don't actually
     use age in the model, so I'm coding them uniquely for identification
purposes;
  if cmiss(of _all_) then delete; * Drop any entry with missing values;
run;

/* Now, a step to take only the highest wordrecall / mental member from each
household. */

proc sort data=AllWealth; by wave hhid wordrecall mental; run;
data Stage2; set AllWealth;
  by wave hhid;
    if last.hhid; * Equivalent to: delete member of each couple with lower
cognitive wordrecall (or mental, if wordrecall is tied);
  prevWave=Wave-2;
run;

/* Finally, we merge the dataset to itself -- pairing each wave with the data
from the previous wave by HHID */
data Stage2prev; set Stage2; run;
proc sort data=Stage2prev; by wave hhid; run;

data new.Stage2;
  merge Stage2(in=a)
        Stage2prev(keep = hhid pn wave wordrecall mental wealth
```

```
        rename=(pn=prevpn wave=prevWave wordrecall=prevWR mental=prevmental
wealth=prevwealth));
  by prevWave hhid;
  if a;
run;
```

Stage 3 Model

```
libname new 'U:\Documents\AES\Fernatt\datfiles'; * Location of data files;

* Create change variables;
data Stage3; set new.Stage2;
  cogn = Mental+WordRecall;
  chWealth = Wealth-prevWealth;
  chMental = Mental-prevMental;
  chWR = WordRecall-prevWR;
  label prevWr = 'prevWR';
  label prevMental= 'prevMental';
run;

proc sort data=Stage3; by HHID PN WAVE; Run;

* Create a CESD dataset from all waves and define a prevWave variable;
Data CESDall;
  set new.CESD00(keep=HHID PN CESD WAVE)
      new.CESD02(keep=HHID PN CESD WAVE)
      new.CESD04(keep=HHID PN CESD WAVE)
      new.CESD06(keep=HHID PN CESD WAVE)
        new.CESD08(keep=HHID PN CESD WAVE)
        new.CESD10(keep=HHID PN CESD WAVE);
  prevWave = WAVE;
Run;
* Create an ADLs dataset from all waves and define a prevWave variable;
Data PhysAll;
  set new.Phys00(keep=HHID PN w5dlsum WAVE rename=(w5dlsum=ADLs))
      new.Phys02(keep=HHID PN w6dlsum WAVE rename=(w6dlsum=ADLs))
      new.Phys04(keep=HHID PN w7dlsum WAVE rename=(w7dlsum=ADLs))
      new.Phys06(keep=HHID PN w8dlsum WAVE rename=(w8dlsum=ADLs))
        new.Phys08(keep=HHID PN w9dlsum WAVE rename=(w9dlsum=ADLs))
        new.Phys10(keep=HHID PN w10dlsum WAVE rename=(w10dlsum=ADLs));
  prevWave = WAVE;
Run;

* Merge Stage 3, CESD, and ADL data using the prevWave variable;
proc sort data=Stage3; by HHID PN prevWave; Run;
proc sort data=CESDall; by HHID PN prevWave; Run;
proc sort data=PhysAll; by HHID PN prevWave; Run;

data Stage3;
  merge Stage3(in=a)
    CESDall (rename=(CESD = prevCESD) drop=Wave)
      PhysAll (rename=(ADLs = prevADLs) drop=Wave);
  by HHID PN prevWave;
  if a;
run;
```

```
* Merge Stage 3, CESD, and ADL data using the Wave variable;
proc sort data=Stage3; by HHID PN WAVE; Run;
proc sort data=CESDall; by HHID PN WAVE; Run;
proc sort data=PhysAll; by HHID PN WAVE; Run;

data Stage3;
  merge Stage3(in=a)
    CESDall (drop=prevWave)
      PhysAll (drop=prevWave);
  by HHID PN WAVE;
  if a;
  chCESD = CESD - prevCESD;
  chADLs = ADLs - prevADLs;
run;

proc sort data=Stage3; by Wave Educ; run;

/* Data coding:
finr (financial respondent): 1 - Yes, 0 - No
Married: 1 - Yes, 0 - No
Educ: 1 = 0-11; 2 = 12; 3 = 13-15; 4 = 16; 5 = 17
*/

/* Demography */

/* Extract basic summary statistics */
%macro sumstat(varname);
proc means data=Stage3 n Q1 median Q3 std min max range mean noprint;
  By Wave Educ;
  Var &varname.;
  Output out=&varname. Q1=Q1 median=Median Q3=Q3 n=N std=SD range=Range
min=Min max=Max mean=Mean;
run;
proc means data=Stage3 n Q1 median Q3 std min max range mean noprint;
  By Wave;
  Var &varname.;
  Output out=tmpfile Q1=Q1 median=Median Q3=Q3 n=N std=SD range=Range min=Min
max=Max mean=Mean;
run;
proc means data=Stage3 n Q1 median Q3 std min max range mean noprint;
  Var &varname.;
  Output out=tmpfile2 Q1=Q1 median=Median Q3=Q3 n=N std=SD range=Range
min=Min max=Max mean=Mean;
run;
Data tmpfile; Set tmpfile; Educ=99; Run;
Data tmpfile2; Set tmpfile2; Wave=99; Educ=999; Run;
Data &varname.; Set &varname. tmpfile tmpfile2; Variable="&varname."; Run;
%mend sumstat;
%sumstat(Wealth);
%sumstat(CESD);
%sumstat(Cogn);
%sumstat(ADLs);
DATA Tmpfile; SET Wealth CESD Cogn ADLS; RUN;

PROC EXPORT DATA= WORK.Tmpfile
            OUTFILE= "U:\Documents\AES\Fernatt\S3_Demography.csv"
            DBMS=CSV REPLACE;
```

```
     PUTNAMES=YES;
RUN;

/*
PROC SORT; data=Stage3; BY WAVE EDUC; RUN;
proc freq data=Stage3;
  By Wave;
  Tables ADLs / out=ADL_Summary;
run;
proc freq data=Stage3;
  By Wave Educ;
  Tables ADLs / out=ADL_Summary_byEd;
run;
DATA ADL_Summary; set ADL_Summary; Educ=99; RUN;
DATA ADL_Summary; set ADL_Summary ADL_Summary_byEd; RUN;
PROC EXPORT DATA= WORK.ADL_Summary
            OUTFILE= "U:\Documents\AES\Fernatt\S3_ADL_Summary.csv"
            DBMS=CSV REPLACE;
     PUTNAMES=YES;
RUN;
*/



/* At present, the Stage3 dataset is all couples who are married to the same
spouse over the six waves.  It is NOT all couples married to the same spouse
for at least one of whom mental/wordrecall is available in every wave.  I'm
inclined to not throw away more data. */

/* The following is a macro to run the model and obtain desired output.  To
run the macro, you must provide:
(i) a dataset,
(ii) the name of an education variable by which to run separate analyses,
(iii) the percentage of data you wish to trim,
(iv) the name of the response variable (aka dependent variable), and
(v) the terms you wish to include in your linear model.
The steps of the macro:
(a) Fit the model defined in (v) above,
(b) Trim the top and bottom residuals according to the percentage from (iii)
above,
(c) Fit the model again using just the trimmed data,
(d) Output predicted Wealth values at pre-defined WordRecall and Mental
levels.
The idea for the output from (d) is that it can be used to plot
'trajectories'.
In order to get estimate statements from Stage 3, we need to write ESTIMATE
statements (like we did in Stage 1).
*/
%macro tmrpre(dataset, byeduc, pct, Resp, modelstate =);
* Fit model with all data -- the exact structure of the model is defined when
it is run;
proc glm data=Stage3 noprint; * outstat=glmresults&pct;   * noprint
suppresses the output;
  by Wave &byeduc;
  class wave;
  model &Resp = &modelstate;
```

```
  output out=modelfit residual=residuals;   * Writes data plus residuals to a
file called modelfit for trimming in the next step;
run;
* The following PROC RANK and DATA steps are where we trim the topmost and
bottommost residuals;
proc rank data=modelfit out=modelfit groups=200;
  by Wave &byeduc;
  ranks ResRanks;
  var residuals;
run;
data modelfit; set modelfit;
  if ResRanks < &pct then delete;
  if ResRanks > 199 - &pct then delete;
run;
* Refit model with trimmed data;
ods select none;
proc glm data=modelfit plots=none; * outstat=glmresults&pct; * Type 3 tests
are not valid;
  by Wave &byeduc;
  class wave;
  model &Resp = &modelstate / solution ss3 clparm effectsize;
/*  lsmeans wave / at wordrecall = 1; * Define the WR and Mental levels at
which we wish to save results;
  lsmeans wave / at wordrecall = 4; * Note: these LSMEANS statements imply
calculation at the CESD and ADL means;
  lsmeans wave / at wordrecall = 8;
  lsmeans wave / at wordrecall = 12;
  lsmeans wave / at wordrecall = 16;
  lsmeans wave / at wordrecall = 19;
  lsmeans wave / at mental = 9;
  lsmeans wave / at mental = 12;
*/
  lsmeans wave / at cogn = 15;
  ods output lsmeans = LSM_&pct.pre fitstatistics = R2_&pct.pre ModelANOVA =
Type3_&pct.pre; * Writes the estimates to a file;
run;
data R2_&pct.pre; set R2_&pct.pre; Trim=&pct; run; * Adding the trim
percentage to the R-squared output table;
/* proc sort data=Glmresults&pct; by _SOURCE_; run; */
quit;
ods select all;
%mend;

* Predicting current wave with current wave data;
* 'wave' is included to trick the LSMEANS statement;
/*
%tmrpre(Stage3, Educ, 1, Wealth, modelstate = mental wordrecall CESD ADLs
wave);
*/
%tmrpre(Stage3, Educ, 5, Wealth, modelstate = cogn CESD ADLs wave);

PROC EXPORT DATA= WORK.Type3_5pre
            OUTFILE= "U:\Documents\AES\Fernatt\S3_ANOVA.csv"
            DBMS=CSV REPLACE;
     PUTNAMES=YES;
RUN;
```

```
PROC EXPORT DATA= WORK.R2_5pre
            OUTFILE= "U:\Documents\AES\Fernatt\S3_R2.csv"
            DBMS=CSV REPLACE;
     PUTNAMES=YES;
RUN;
```

```
/* None of the following is being used any more */


%macro tmrpost(dataset, byeduc, pct, Resp, modelstate =);
* Fit model with all data;
proc glm data=Stage3 noprint; * outstat=glmresults&pct;   * noprint
suppresses the output;
  by Wave &byeduc;
  class wave;
  model &Resp = &modelstate;
  output out=modelfit residual=residuals;   * Writes data plus residuals to a
file called modelfit;
run;
* This is the step where we trim the topmost and bottommost residuals;
proc rank data=modelfit out=modelfit groups=200;
  by Wave &byeduc;
  ranks ResRanks;
  var residuals;
run;
data modelfit; set modelfit;
  if ResRanks < &pct then delete;
  if ResRanks > 199 - &pct then delete;
run;
* Refit model with trimmed data;
ods select none;
proc glm data=modelfit plots=none; * outstat=glmresults&pct; * Type 3 tests
are not valid;
  by Wave &byeduc;
  class wave;
  model &Resp = &modelstate / solution ss3 clparm;
  lsmeans wave / at chWR = -3;
  lsmeans wave / at chWR = 0;
  lsmeans wave / at chWR = 3;
  lsmeans wave / at chmental = -2;
  lsmeans wave / at chmental = 0;
  lsmeans wave / at chmental = 2;
  ods output lsmeans = LSM_&pct.post fitstatistics = R2_&pct.post ModelANOVA
= Type3_&pct.post; * Writes the estimates to a file;
run;
data R2_&pct.post; set R2_&pct.post; Trim=&pct; run; * Adding the trim
percentage to the R-squared output table;
/* proc sort data=Glmresults&pct; by _SOURCE_; run; */
quit;
ods select all;
%mend;
```

```
* Forecasting next wave with current wave data (modeling the change in
wealth);
/*
Note 1: There will be errors for all the Wave=2000 datasets, because we do
not have the 1998 data
with which to do predictions.
Note 2: To run tmrpost() without subdividing on EDUC, just leave the second
element of the tmrpost() command blank:
%tmr(Stage3, , 25, modelstate = Wave|Married|Mental Wave|Married|Wordrecall);
*/

%tmrpost(Stage3, Educ, 1, chWealth, modelstate = mental wordrecall CESD ADLs
chMental chWR chCESD chADLS wave);
/*
%tmrpost(Stage3, Educ, 5, chWealth, modelstate = mental wordrecall CESD ADLs
chMental chWR chCESD chADLS wwave);
%tmrpost(Stage3, Educ, 10, chWealth, modelstate = mental wordrecall CESD ADLs
chMental chWR chCESD chADLS wwave);
%tmrpost(Stage3, Educ, 25, chWealth, modelstate = mental wordrecall CESD ADLs
chMental chWR chCESD chADLS wwave);
*/

proc print data=R2_1pre; run;
proc print data=R2_1post; run;



/* Combines output from all levels of trimming */
data R2current_All;
  set R2_1current R2_5current R2_10current R2_25current;
run;
data R2future_All;
  set R2_1future R2_5future R2_10future R2_25future;
run;

proc print data=R2current_all; run;
proc print data=R2future_all; run;
```

Stage 3 – Physical Functioning

```
libname EXTRACT 'U:\Documents\AES\Fernatt\datfiles'; * Location of data
files;

******* HRS00 / WAVE 5;
data Extract.Phys00;
 set EXTRACT.H00E_R;
* 1 = yes, difficulty;
* 6 = cannot do;
* 7 = do not do;
* 5 = no, difficulty;
* 8 and 9 are refusal or do not know;
*** Re-code and re-name Nagi-type items with skips;
if g2689 ne 5 or g2690 in (1, 6, 7) then w5run = 1;
 else if g2690 = 5 then w5run = 0;
```

```
 else if g2690 in (8, 9) then w5run = .;
if g2689 = 5 or g2692 = 5 then w5block = 0;
 else if g2692 in (1, 6, 7) then w5block = 1;
 else if g2692 in (8, 9) then w5block = .;
if g2701 = 5 or g2704 = 5 then w5stair = 0;
 else if g2704 in (1, 6, 7) then w5stair = 1;
 else if g2704 in (8, 9) then w5stair = .;
*** Re-code remaining Nagi-type items;
array nagis {9} g2689 g2695 g2698 g2701 g2707 g2710 g2713 g2716 g2719;
 do i = 1 to 9;
 if nagis(i) in (1, 6, 7) then nagis(i) = 1;
 else if nagis(i) in (8, 9, .) then nagis(i) = .;
 else if nagis(i) = 5 then nagis(i) = 0;
 end;
*** Assign remaining Nagi-type items intuitive names;
 * Appropriate codes are above;
w5sevblk = g2689;
w5sit = g2695;
w5getup = g2698;
w5stairs = g2701;
w5stoop = g2707;
w5raise = g2710;
w5push = g2713;
w5lift = g2716;
w5dime = g2719;
*** The '.' in the ADLs indicates that people were skipped--believed to have
no ADL problems.
Double-check using Nagisum1, Nagisum2, dress variable, or ADL checkpoint
loop.;
* 1 = yes, difficulty;
* 6 = cannot do;
* 7 = do not do;
* 5 = no, difficulty;
* 8 and 9 are refusal or do not know;
array adls{6} G2723 G2725 G2742 G2752 G2762 G2775;
 do i = 1 to 6;
 if adls(i) in (1, 6, 7) then adls(i) = 1;
 else if adls(i) = . then adls(i) = 0;
 else if adls(i) in (8, 9) then adls(i) = .;
 else adls(i) = 0;
 end;
*** Assign intuitive names;
 * Appropriate codes are above;
w5dress = G2723;
w5cross = G2725;
w5bathe = G2742;
w5eat = G2752;
w5bed = G2762;
w5toilet = G2775;
*** IADLs;
%macro iadls (diffvar,rsnvar,newvar);
 if &diffvar = 1 then &newvar = 1;
 else if &diffvar in (6,7) and &rsnvar = 1 then &newvar = 1;
 else if &diffvar in (8,9,.) then &newvar = .;
 else &newvar = 0;
%mend iadls;
%iadls (G2860,G2862,w5meal);
```

```
%iadls (G2865,G2867,w5groc);
%iadls (G2870,G2872,w5phone);
%iadls (G2916,G2917,w5money);
if g2875 = 1 then w5meds = 1;
 else if g2875 = 7 and G2876 = 1 then w5meds = 1;
 else if g2875 = 6 and G2877 = 1 then w5meds = 1;
 else if g2875 in (8, 9, .) then w5meds = .;
 else w5meds = 0;
if G2851 in (1, 6) then w5map = 1;
 else if G2851 in (5, 7) then w5map = 0;
 else if G2851 in (8, 9, .) then w5map = .;
*** Note: people in certain cohorts and of certain ages were not asked
driving questions.;
*** Driving vars;
if G2847 = 1 then w5drive = 0;
 else if G2847 in (5, 6) then w5drive = 1;
 else if G2847 in (., 8, 9) then w5drive = .;
w5nagia = sum (of w5sevblk w5run w5block w5sit w5getup w5stairs w5stair
w5stoop w5raise
w5push w5lift w5dime);
w5nagib = sum (of w5sevblk w5block w5sit w5getup w5stair w5stoop w5raise
w5push w5lift
w5dime);
w5adl = sum (of w5dress w5bathe w5eat w5bed w5toilet w5cross);
w5iadl = sum (of w5meal w5groc w5phone w5meds w5money);
w5dlsum = w5adl + w5iadl;
WAVE=2000;
run;


******* HRS02-10 / WAVES 6-10;
%macro physfunc(num, wave, letter);
  data Extract.Phys&num.;
  set EXTRACT.H&num.G_R;
* 1 = yes, difficulty;
* 6 = cannot do;
* 7 = do not do;
* 5 = no, difficulty;
* 8 and 9 are refusal or do not know;
*** Re-code and re-name Nagi-type items with skips;
if &letter.G001 ne 5 or &letter.G002 in (1, 6, 7) then w&wave.run = 1;
 else if &letter.G002 = 5 then w&wave.run = 0;
 else if &letter.G002 in (8, 9) then w&wave.run = .;
if &letter.G001 = 5 or &letter.G003 = 5 then w&wave.block = 0;
 else if &letter.G003 in (1, 6, 7) then w&wave.block = 1;
 else if &letter.G003 in (8, 9) then w&wave.block = .;
if &letter.G006 = 5 or &letter.G007 = 5 then w&wave.stair = 0;
 else if &letter.G007 in (1, 6, 7) then w&wave.stair = 1;
 else if &letter.G007 in (8, 9) then w&wave.stair = .;
*** Re-code remaining Nagi-type items;
array nagis {9} &letter.G001 &letter.G004 &letter.G005 &letter.G006
&letter.G008 &letter.G009 &letter.G010 &letter.G011 &letter.G012;
do i = 1 to 9;
 if nagis(i) in (1, 6, 7) then nagis(i) = 1;
 else if nagis(i) in (8, 9, .) then nagis(i) = .;
 else if nagis(i) = 5 then nagis(i) = 0;
 end;
```

```
*** Assign remaining Nagi-type items intuitive names;
w&wave.sevblk = &letter.G001;
w&wave.sit = &letter.G004;
w&wave.getup = &letter.G005;
w&wave.stairs = &letter.G006;
w&wave.stoop = &letter.G008;
w&wave.raise = &letter.G009;
w&wave.push = &letter.G010;
w&wave.lift = &letter.G011;
w&wave.dime = &letter.G012;
*** The '.' in the ADLs indicates that people were skipped--believed to have
no ADL problems.
Double-check using Nagisum1, Nagisum2, dress variable, or ADL checkpoint
loop.;
* 1 = yes, difficulty;
* 6 = cannot do;
* 7 = do not do;
* 5 = no, difficulty;
* 8 and 9 are refusal or do not know;
array adls{6} &letter.G014 &letter.G016 &letter.G015 &letter.G023
&letter.G025 &letter.G030;
 do i = 1 to 6;
 if adls(i) in (1, 6, 7) then adls(i) = 1;
 else if adls(i) = . then adls(i) = 0;
 else if adls(i) in (8, 9) then adls(i) = .;
 else adls(i) = 0;
 end;
*** Assign intuitive names;
w&wave.dress = &letter.G014;
w&wave.cross = &letter.G016;
w&wave.bathe = &letter.G015;
w&wave.eat = &letter.G023;
w&wave.bed = &letter.G025;
w&wave.toilet = &letter.G030;
*** IADLs;
%macro iadls (diffvar,rsnvar,newvar);
 if &diffvar = 1 then &newvar = 1;
 else if &diffvar in (6,7) and &rsnvar = 1 then &newvar = 1;
 else if &diffvar in (8,9,.) then &newvar = .;
 else &newvar = 0;
%mend iadls;
%iadls (&letter.G041,&letter.G042,w&wave.meal);
%iadls (&letter.G044,&letter.G045,w&wave.groc);
%iadls (&letter.G047,&letter.G048,w&wave.phone);
%iadls (&letter.G059,&letter.G060,w&wave.money);
if &letter.G050 = 1 then w&wave.meds = 1;
 else if &letter.G050 = 7 and &letter.G051 = 1 then w&wave.meds = 1;
 else if &letter.G050 = 6 and &letter.G052 = 1 then w&wave.meds = 1;
 else if &letter.G050 in (8, 9, .) then w&wave.meds = .;
 else w&wave.meds = 0;
if &letter.G040 in (1, 6) then w&wave.map = 1;
 else if &letter.G040 in (5, 7) then w&wave.map = 0;
 else if &letter.G040 in (8, 9, .) then w&wave.map = .;
*** Note: people in certain cohorts and of certain ages were not asked
driving questions.;
*** Driving vars;
if &letter.G037 = 1 then w&wave.drive = 0;
```

```
 else if &letter.G037 in (5, 6) then w&wave.drive = 1;
 else if &letter.G037 in (., 8, 9) then w&wave.drive = .;
w&wave.nagia = sum (of w&wave.sevblk w&wave.run w&wave.block w&wave.sit
w&wave.getup w&wave.stairs w&wave.stair w&wave.stoop w&wave.raise
w&wave.push w&wave.lift w&wave.dime);
w&wave.nagib = sum (of w&wave.sevblk w&wave.block w&wave.sit w&wave.getup
w&wave.stair w&wave.stoop w&wave.raise w&wave.push w&wave.lift
w&wave.dime);
w&wave.adl = sum (of w&wave.dress w&wave.bathe w&wave.eat w&wave.bed
w&wave.toilet w&wave.cross);
w&wave.iadl = sum (of w&wave.meal w&wave.groc w&wave.phone w&wave.meds
w&wave.money);
w&wave.dlsum = w&wave.adl + w&wave.iadl;
WAVE=20&num.;
run;
%mend physfunc;

%physfunc(02, 6, H);
%physfunc(04, 7, J);
%physfunc(06, 8, K);
%physfunc(08, 9, L);
%physfunc(10, 10, M);
```

Stage 3 – CESD

```
ibname EXTRACT 'U:\Documents\AES\Fernatt\datfiles'; * Location of data files;

******* HRS00 / WAVE 5;
* Collect the response and identifiers we need;
Data Extract.CESD00;
  set Extract.H00C_R(keep=HHID PN GSUBHH G1669-G1673 G1675-G1677);
  * 1 = yes, difficulty;
  * 5 = no, difficulty;
  * 8 and 9 are refusal or do not know;

  * Compile answers for CES-D.  Recode to 0=Okay, 1=Difficulty;
  array resp {8} G1669-G1673 G1675-G1677;
  do i = 1 to 8;
    if resp(i) = 5 then resp(i) = 0; * 1's are already correct;
    else if resp(i) in (8, 9, .) then resp(i) = .;
  end;
  drop i;
  CESD = sum(of G1669-G1673 G1675-G1677);
  Wave = 2000;
Run;

******* HRS02-10 / WAVE 6-10;
* Collect the response and identifiers we need;
%macro cesdfunc (num, letter);
  Data Extract.CESD&num.;
    set Extract.H&num.D_R(keep=HHID PN &letter.SUBHH &letter.D110-
&letter.D114 &letter.D116-&letter.D118);
    * 1 = yes, difficulty;
    * 5 = no, difficulty;
    * 8 and 9 are refusal or do not know;
```

```
    * Compile answers for CES-D.  Recode to 0=Okay, 1=Difficulty;
  array resp {8} &letter.D110-&letter.D114 &letter.D116-&letter.D118;
    do i = 1 to 8;
      if resp(i) = 5 then resp(i) = 0; * 1s are already correct;
      else if resp(i) in (8, 9, .) then resp(i) = .;
    end;
  drop i;
  CESD = sum(of &letter.D110-&letter.D114 &letter.D116-&letter.D118);
  Wave = 20&num.;
  Run;
%mend cesdfunc;
%cesdfunc(02, H);
%cesdfunc(04, J);
%cesdfunc(06, K);
%cesdfunc(08, L);
%cesdfunc(10, M);
```