# Self-Reported Physical Health Does Not Predict Declining Cognitive Health in Older Adults

Caroline Sloan

Appalachian State University

Abstract

***Objective:*** This study investigated whether abnormal changes in cognition are associated with self-reported measures of physical health in older adults, specifically those meeting criteria for Mild Cognitive Impairment (MCI). ***Method:*** Participants ($n$ = 88) completed one questionnaire on their general health and four cognitive tests. To identify abnormal cognitive decline, two methods were used. Participants' standardized crystallized intelligence was subtracted from their standardized fluid intelligence to show premorbid cognitive ability. The other method statistically corrected for the participants' current memory performances by using a measure of premorbid cognitive ability. These methods were then correlated with measures of physical health. ***Results:*** Results showed that there was no significant correlation between the self-report measure of physical health and the cognitive health indices. There were, however, significant correlations between the cognitive health indices and two scales from the general health questionnaire: social functioning and emotional well-being. ***Conclusions:*** Overall, these results do not support the idea that declining physical health could be used as an indicator to predict declining cognitive health in older individuals. These findings have clinical implications.

*Keywords:* physical health, cognitive health, Mild Cognitive Impairment, Alzheimer's Disease, older adults

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As people age, they experience decline in several domains of their lives. People may find doing their everyday tasks more difficult than they used to be. Carrying groceries inside from the car may be too physically straining. It might be more difficult to remember one's grandchildren's birthdays. Walking up and down the stairs might feel like a dangerous task. One may start to forget to take their medications every day. These are some examples of how older adults' lives can be impacted by their declining physical and cognitive health.

A growing body of research suggests that aging-related changes in cognitive and physical function are related. Much of this research has roots in the "common cause" hypothesis (Baltes & Lindenberger, 1997), which posits that sensory and cognitive changes both reflect underlying changes in neural function. This hypothesis has been broadened in recent years to include other physical functions such as gait speed and handgrip strength (Fritz, McCarthy, & Adamo, 2017; McGough et al., 2013). Some researchers suggest that unusual declines in these latter functions may be indicators of more severe cognitive problems, and may serve as biomarkers for the early stages of dementia.

In the current thesis, I investigated whether abnormal cognitive changes are associated with self-reported problems in physical health in older adults. To identify people who may be having abnormal cognitive problems, I used previously validated techniques that measured discrepancies between crystalized intelligence and other cognitive abilities. I then examined whether these discrepancies were related to self-reports of how people's physical health impacted their daily lives.

## Normal and Abnormal Cognitive Changes

Many individuals experience some age-related cognitive decline as they get older. For example, Park et al. (2002) investigated visuospatial and verbal memory processes in short-term, working, and long-term memories in 345 adults, ranging in age from 20 to 92 years-old. Each participant completed a series of tasks on a computer that measured visuospatial and verbal short-term, working, and long-term memory as well as speed of processing, sensory function, and verbal ability. The researchers found that from age 20 onward, working memory, short-term memory, long-term memory, and speed of processing correlated negatively with age. The only cognitive function that was not negatively associated with age was verbal knowledge, which instead gradually improved.

While some age-related cognitive decline is normal, some adults experience more significant decline in their cognitive abilities. In particular, older adults often fear that cognitive declines may be a symptom of Alzheimer's Disease (AD). AD is a slow, progressive neurocognitive disorder with no set points that define its onset. The 5th Edition of the Diagnostic and Statistical Manual of Mental Disorders (DSM-5) defines major neurocognitive disorders (NCDs) as a group of disorders whose main clinical deficit is cognitive function, which is acquired instead of being developmental (American Psychiatric Association, 2013). Major NCD can be due to various etiologies, one of those being AD. As of 2019, 5.8 million Americans are living with AD or other dementias (Alzheimer's Association, 2019). Since the population of people over age 65 is increasing, so is the diagnosis of AD. With AD, the disease can be present 20 years before any symptoms appear (Alzheimer's Association, 2019). Eventually, enough changes in the brain cause substantial symptoms of memory loss and difficulty with language. Symptoms occur because neurons in the brain that are involved in thinking, learning, and memory have become damaged or destroyed. This is thought to be due to the accumulation of the proteins beta-amyloid and tau (Alzheimer's Association, 2019). Beta-amyloid cause plaques *outside* of the neurons which may contribute to cell death by interfering with communication between neurons. The protein tau cause tangles *inside* the neurons which block the transportation of nutrients.

People will typically live with AD and other major NCDs for years. Over time, the symptoms from these disorders will worsen and begin to impact people's ability to perform their every day tasks, also known as activities of daily living. Activities of daily living have two categories: basic activities of daily living (ADL) and instrumental activities of daily living (IADL). ADL refers to activities of self-maintenance like eating, dressing, and bathing. IADL refers to more complex behaviors like preparing food, transportation, taking care of the house and one's family, managing finances, and many more. Diagnosis with AD or other major NCDs require that one's ADLs or IADLs be impacted by the cognitive changes (American Psychiatric Association, 2013).

In the last few decades, clinicians and researchers have begun to recognize a third type of cognitive decline in older adults, situated between normal cognitive changes and the severe impairments of major NCDs. The clinical diagnosis of either Mild Cognitive Impairment (MCI; Albert et al., 2011) or Mild Neurocognitive Disorder (mNCD; American Psychiatric Association, 2013) captures these cases; the diagnostic criteria for MCI and mNCD are largely overlapping, and so will be described together here. The DSM-5 defines mNCD as experiencing a gradual onset and progression of impairment in memory, learning, and cognition (American Psychiatric Association, 2013). There must be evidence of some cognitive decline from a previous level of performance in the various cognitive domains, and the cognitive decline cannot be due to another etiological factor, like cerebrovascular disease (Albert et al., 2011). Importantly, although the cognitive changes in MCI/mNCD are noticeable, people with these disorders are able to function independently and do not need assistance with ADLs or IADLs. Approximately 15 to 20 percent of people over the age of 65 have MCI (Alzheimer's Association, 2019). People with MCI develop AD or other major NCDs at a higher rate than age-matched controls without MCI (Peterson et al., 2018). This suggests that at least some people with MCI are in a symptomatic predementia phase of Alzheimer's Disease (Albert et al., 2011).

**Physical Biomarkers of Early Cognitive Decline**

Due to the difficulties with diagnosing neurocognitive disorders before they significantly impair an individual, there is a push from clinicians to find a method to detect abnormal cognitive decline in the earliest stages. In the mid-2000s, researchers discovered Pittsburgh Compound B (PiB; Klunk et al, 2004), a tracer that binds to beta-amyloid in the brains of living individuals and allows imaging of amyloid plaques through Positron Emission Tomography (PET). This discovery led to an increase in the search for additional *biomarkers* of NCDs. Biomarkers are measurable traces of an underlying disease process. There are different types of biomarkers: those that directly reflect the pathology of AD, such as a biomarker that detects the presence of proteins deposited in the brain, and biomarkers that provide less direct evidence of AD by tracking signs of neuronal injury (Albert et al., 2011). Because brain-based biomarker methods are expensive and difficult to obtain, researchers and clinicians look for other measures like neuropsychological tests or physical markers of cognitive decline.

A particularly influential model driving biomarker research of NCDs was developed by Jack et al. (2013). This model shows the developmental phases of AD in terms of when different biomarkers develop. Deposits of the proteins beta-amyloid and tau both increase in the brain while one is still cognitively normal, meaning they go undetected. Brain structure and memory start to deteriorate as people move onto the MCI phase. Finally, clinical function (meaning one's ability to live independently) only begins to decline in the late MCI phase, while it rapidly declines in the dementia phase. The task facing researchers, then, is to identify signs that are associated with abnormal cognitive decline at the earliest point possible.

One way of approaching this problem is to look for simple physical changes that are associated with cognitive decline. Pre-dating the discovery of PiB, Lindenberger & Baltes (1994) developed the "common cause" hypothesis to explain age-related cognitive changes, which has continued to influence researchers looking for these types of physical changes. This hypothesis argues that correlations between sensory and intellectual functioning get stronger in old age because both sets of measures reflect the physiological changes in the aging brain. The declines in sensory and cognitive functioning are said to be caused by a third common factor based on the changing structure of the brain. In support of this hypothesis, Lindenberger & Baltes (1994) found that identifying and measuring visual and auditory acuity in older adults accounted for 93% of the age-related variance in intellectual abilities.

This original finding was replicated in a larger study a few years later (Baltes & Lindenberger, 1997). This study included 506 participants, ranging in age from 25 to 103 years. The participants completed tests that measured their visual and auditory acuity as well as 14 cognitive tests that measured their perceptual speed, reasoning, memory, knowledge, and fluency. Vision and hearing abilities were good at predicting age differences in intellectual functioning across the entire age range of this study. The researchers also found that the relationship between sensory and intellectual functioning was lower in the 25 to 69 age group as compared to the 70 to 103 year age group.

Beyond sensory function, changes in one's ability to perform motor tasks (e.g., grip strength, balance, gait speed) have also been associated with declines in cognition and dementia risk (Fritz, McCarthy, & Adamo, 2017; Li, Lindenberger, Freund, & Baltes, 2001; McGough et al., 2013). For example, Fritz et al. (2017) performed a review to examine the relationship between handgrip strength and cognitive function in older individuals. They included 15 studies, all longitudinal in design. Many of the studies found that reduced grip strength was a risk factor for having cognitive decline, which included MCI and AD. For every 1 pound decrease in grip strength, there was a 1.4% increased risk of developing AD over time. Many of the studies in their review used the Mini–Mental State Examination (MMSE) to measure cognition. They found that those who had declines in their MMSE scores also showed declines in handgrip strength. Conversely, a stronger handgrip seemed to be a protective factor against cognitive decline.

In addition to handgrip strength, walking and gait speed have been used as biomarkers to show the relationship between physical and cognitive health changes in older adults. A study done by Li, Lindenberger, Freund, and Baltes (2001) investigated different patterns of task priority in younger and older adults which was based on the life-span theory of selection, optimization, and compensation (SOC). SOC theory states that throughout people's lives, people are developing adaptively by choosing to maximize their possible gains while minimizing potential losses (Li et al., 2001). They *select* their goals and how to pursue them, *optimize* their means to obtain their goals, and when losses happen, they *compensate* to make up for their losses. Li et al.'s (2001) study had younger and older adults perform two tasks simultaneously while manipulating the difficulty to see which group prioritized which task. One task measured cognitive performance and involved memorizing a list of words; the other task was a sensorimotor task that measured how well an individual walked on a narrow track. Li et al. (2001) found that older adults prioritized walking performance over memory performance. That is, their memory performance, but not their walking speed, declined when they were asked to do both tasks at the same time. This finding illustrates how in old age, people must compensate for their declining abilities by selectively choosing what should be prioritized in order to maintain their goals.

Similar to slow walking speed, McGough et al. (2013) examined the relationship between different dimensions of physical frailty and MCI. Physical frailty includes multiple physiological systems, such as slow gait speed, low physical activity, and low grip strength. Physical frailty is associated with an elevated risk of falling, inability to perform ADLs, increased hospitalizations, and disabilities (McGough et al., 2013). The purpose of this study was to examine whether aspects of physical frailty are associated with severity of cognitive impairment (McGough et al., 2013). Greater than half of the participants met the characteristics for physical frailty. More specifically, the researchers found that slower than usual gait speed was associated with a more severe form of cognitive impairment and those participants performed poorly on the memory, attention, and executive functioning tasks (McGough et al., 2013). The results of this study give support for a relationship between declines in physical health and cognitive impairment.

**Identifying Abnormal Cognitive Changes in Cross-Sectional Samples**

The above studies focus on identifying physical markers associated with cognitive decline. Ideally, cognitive decline should be measured *longitudinally*, in order to show true changes in performance within a person. Often in both clinical and research settings, longitudinal measurement is not possible. Instead, subjective reports of cognitive change, and/or abnormally low performance on standardized tests are used as an approximation of change. An additional approach is to compare a stable measure of baseline cognitive ability to one that is sensitive to age-related cognitive changes.

As stated previously, there are normal cognitive declines that happen as we age, such as the speed in which we process information and our ability to juggle information in our working memory (Park et al., 2002). These measures are part of fluid intelligence, and reflect our ability to think logically and solve new problems. Our verbal knowledge, however, generally remains stable or even increases as we age. Verbal knowledge is part of crystallized intelligence, which reflects our general knowledge that is accumulated over time. Verbal and fluid intelligence tend to be strongly correlated in cognitively normal populations (McDonough et al., 2016). For people showing early signs of AD, however, fluid abilities tend to decline much faster than would be expected based on that person’s crystallized knowledge. One way, then, of identifying abnormal cognitive decline would be to subtract a person’s standardized crystallized abilities from their standardized fluid abilities. Using this method, McDonough et al. (2016) found that older adults who showed larger fluid-crystallized discrepancies also showed more beta-amyloid deposits, despite their overall normal cognitive performance.

Another method for estimating abnormal cognitive decline is to statistically “correct” an individual’s current memory performance using a measure of premorbid cognitive ability like crystallized intelligence. This approach was validated in a study by Rentz et al. (2004). The Rentz et al. (2004) study examined a group of highly intelligent older individuals who scored in the normal range on standardized tests at baseline. Out of the 42 total participants, intelligence-adjusted memory impairments at baseline predicted that 11 individuals were at risk for cognitive decline. After 3.5 years, all participants repeated the same battery of cognitive tests. The results showed that 9 of the 11 at-risk participants did show cognitive decline and 6 of these met the criteria for MCI. In comparison, only 3 of the other 22 participants showed cognitive decline during this time period.

**Current Study**

In the current study, I examined whether abnormal discrepancies in fluid and crystallized intelligence were associated with participants’ self-reports of their daily function in physical domains. Using a previously collected sample of cognitively healthy older adults (Emery, Sorrell, & Miles, 2019), I used the Matrix Reasoning (MR) subscales from the Wechsler Abbreviated Scale of Intelligence – Second Edition (WASI-2; Wechsler, 2011) to reflect my participants’ fluid intelligence. For crystallized intelligence, I used the Vocabulary subscale also from the WASI-2.

As a measure of general health, participants in the dataset had completed a self-report measure, the Short-Form Health Survey (SF-36; Ware & Sherbourne, 1992). The SF-36 includes a multi-item scale assessing various physical and emotional health concepts, including limitations of physical and role activities due to physical health problems. These measured health concepts may be indicators of early problems with ADLs. Based on previous research showing relationships between physical health and abnormal cognitive decline, I hypothesized that older adults' self-reported measures of their physical health would be lower in participants with disproportionately low fluid intelligence.

## Method

### Participants

This study draws data obtained from two previous experimental studies that were conducted in the Adult Cognitive and Emotional Development laboratory over the last three years. Different variables from this dataset have been reported in a prior study (Emery, Sorrell, & Miles, 2019). For my study, I will only be looking at data taken from the older adults (ages 60-85) from those studies. In both studies, participants completed a brief screening measure for dementia as part of the testing procedures (Mini-Cog; Borson, Scanlan, Brush, Vitaliano, & Dokmak, 2000). For any participant who failed the Mini-Cog ($N = 3$ across both studies), testing was discontinued, and data was destroyed, as per the request of the Appalachian State University IRB. There were 61 women and 27 men, for a total of 88 participants ($M$= 69.75 years old, $SD$= 5.14). All participants were recruited from the Boone, NC community and were paid $30 to participate in the studies.

### Materials

Participants completed four cognitive tests and one questionnaire on their general health. The cognitive tests included the Verbal Paired Associates I from the Wechsler Memory Scale – Fourth Edition (Wechsler, 2009), Coding from the Wechsler Adult Intelligence Scale – Fourth Edition (Wechsler, 2008), and the Vocabulary and Matrix Reasoning subscales from the

Wechsler Abbreviated Scale of Intelligence – Second Edition (Wechsler, 2011). The Short Form-36 (SF-36; Ware & Sherbourne, 1992) was used to measure the participants' general health statuses.

**Verbal Paired Associates I.** The Verbal Paired Associates I tests associative or episodic memory. This type of memory involves one's past experiences in the context of time, place, and emotions associated with it. In the Verbal Paired Associates I (VPA; Wechsler, 2009) test, participants are given sets of word pairs to remember. The experimenter starts by saying a word, like "sky" and then saying another word like "cloud" that went with it. Some of the word pairs make sense, like "door-open" and other word pairs do not make sense like "paint-big." The experimenter says the whole list of 14 word pairs. When the experimenter finishes saying the list, they then say the first word of each pair and the participant is prompted to say the word that went with it. For example, if the experimenter said "sky," the participant should respond with the word "cloud." For the next three rounds, the experimenter says the same list of word pairs but in different orders each time. With practice, the participant should get better at remembering the word pairs. The participant gets 1 point for every word pair they remembered. After the four rounds, the points were added together for a total raw score out of 56.

It is important to note that this test was given in a format that did not permit calculation of standardized scores. The version of the VPA given in the study was from the Adult version of the WMS-IV, which has norms up to age 69. In clinical settings, adults above this age are given the "Older Adult" version of the test, which has easier items and older normative data.

**Coding.** The coding test (Wechsler, 2009) is a basic measure of processing speed, which declines as people get older (Park et al., 2002). The test involves participants matching a number to a symbol. They were given a form with a code at the top. The code has numbers 1-9 listed with symbols underneath each number. For example, the number 1 has a horizontal line with it and the number 6 is associated with a circle. At the bottom of the page is seven rows of twenty numbers each listed for the participant to fill out with the symbol associated with each number. The participant is given a time limit to fill out as many digit-symbol combinations as possible.

**Vocabulary.** The Vocabulary cognitive test was used to measure participants' crystalized intelligence. Crystalized intelligence relies on knowledge accumulated over the course of one's life, which means older people typically do better than younger adults when tested on it. Crystallized intelligence will tend to still be preserved in older adults, even in those with dementia or who are at risk for dementia (Park et al., 2002; Mcdonough et al., 2016). For this reason, this cognitive test serves as our measure for premorbid cognitive ability. It can show how their cognitive functioning was before they got older.

In the Vocabulary test (Wechsler, 2011), participants are given a list of words that they had to give a definition for. The experimenter reads each word aloud, writing down what the participant says. Each response is given a score from 0-2 points, depending on how complete and accurate the participants' definition was. If they got a 2, their definition was complete and comprehensive. If given a 1, their definition was missing some information. And finally, if given a 0, then their definition did not show that they understood the word. The words are arranged by level of difficulty, and the person administering the test stops if the participant gets three consecutive scores of zero. Afterwards, the experimenter adds up the number of points the participant got for a total possible raw score of 53. Participants' raw scores are then converted to standardized scaled scores (range = 6-19) based on their age.

**Matrix Reasoning.** This test measures fluid intelligence because it does not rely on a person's prior knowledge. Fluid intelligence is thought to be more biologically based as opposed to learned information. Fluid intelligence tends to decline with age. In the MR test (Wechsler, 2011), participants are asked to solve puzzles. They see an incomplete matrix or series and select the response that completes it. Like the Vocabulary test, it starts out easier and gets more difficult as the test progresses. Participants must correctly complete the pattern to get a score of 1 point. After three consecutive scores of 0, the experimenter will end the test. The total possible raw score on MR is 30. Participants' raw scores are then converted to standardized scaled scores (range = 6-18) based on their age.

**Short Form-36.** The Short Form-36 Health Survey (SF-36; Ware & Sherbourne, 1992) was designed to be used by clinicians and researchers as well as for health policy evaluations and general population surveys. The form consists of one multi-item scale that assesses eight health concepts: 1) Physical Functioning, 2) Role Limitations due to Physical Health Problems, 3) Role Limitations due to Emotional Problems, 4) Energy/fatigue, 5) Emotional Well-being, 6) Social Functioning, 7) Pain, 8) General Health.

For my study, I am focusing mostly on concepts 1 and 2. Limitations in physical functioning and usual role activities because of physical health problems relate mostly to ADLs. ADLs are those basic functions people do every day to maintain their quality of life. As described later in the study, I also chose to look at the Social Functioning and Emotional Well-being scales of the SF-36 (See Appendix B. for items from the Physical Functioning, Role Limitations due to Physical Health Problems, Emotional Well-being, and Social Functioning scales).

**Procedure**

Participants in both studies completed all measures after the experimental portion of their respective studies were complete. Those that failed the dementia screening were excluded from the study. The cognitive tests were given first, followed by the questionnaire measures. Cognitive tests were given in the order: Vocabulary, Matrix Reasoning, Coding, and Verbal Paired Associates. The SF-36 questionnaire was given after the cognitive tests.

**Analysis**

As reviewed in the introduction, I used two different methods for identifying people with possible abnormal cognitive decline. The first method, based on McDonough et al. (2016), was to subtract participants' standardized Matrix Reasoning scores from their standardized Vocabulary scores. In this method, referred to below as the subtraction method, negative scores indicate that people's matrix reasoning scores are lower than would be predicted based on their vocabulary scores. The second method, based on Rentz et al. (2004), statistically adjusted participants' raw Verbal Paired Associates (VPA) scores for their raw Vocabulary Scores scores using regression. That is, first participants VPA scores were predicted from their Vocabulary Scores. This correlation represents the proportion of variance in VPA scores that is accounted for by vocabulary. The standardized residual score (i.e., 1-$R^2$) then represents how much of my participants' memory scores are due to things *other than* their baseline intelligence. To test my hypothesis, both types of scores were then correlated with the Physical Functioning and Role Limitations due to Physical Problems scales from the SF-36.

## Results

Descriptive statistics for all of our cognitive indices are shown in Table 1.

As shown in Figure 1, there is a normal distribution for the two cognitive indices, with a few participants scoring on the low end. For the subtraction method, the average score was negative (*M*= -1.02, *SD*= 3.00), which indicates that on average, participants' scored lower on MR than would be expected based on their Vocabulary scores. In Figure 2, one participant scored three standard deviations below the mean. This indicates that his below average memory score was due to factors other than their baseline intelligence.

We ran a correlation to compare the two cognitive indices with our physical health scales from the SF-36, the Physical Functioning scale and the Role Limitations due to Physical Problems scale. The results fail to support my hypothesis that older adults' declining cognitive health is correlated with their self-report physical health. The subtraction method was not significantly correlated with either the Physical Functioning scale (*M*= 74.21, *SD*= 22.66), $r(86) = .012$, $p = 0.91$, or the Role Limitations due to Physical Problems scale (*M*= 64.77, *SD*= 38.77), $r(86) = .028$, $p = 0.80$. Our other cognitive health index, the adjusted memory score, was also not correlated with either the Physical Functioning scale, $r(86) = .101$, $p = 0.36$, or the Role Limitations scale, $r(86) = .015$, $p = 0.89$.

Upon further investigation, I did notice that my cognitive health indices were significantly correlated with the Social Functioning and Emotional Well-being scales of the SF-36. Older adults' self-reported Emotional Well-being (*M*= 79.64, *SD*= 15.51) is significantly correlated with my subtraction method, $r(86) = .224$, $p = 0.04$, but not with the adjusted memory score, $r(86) = .215$, $p = 0.05$. Opposite of this, the Social Functioning scale (*M*= 82.67, *SD*= 19.27) is not significantly correlated with the difference score, $r(86) = .209$, $p = 0.05$, but is significantly correlated with the adjusted memory score, $r(86) =.236$, $p = 0.03$. Also worth noting, the Pain scale of the SF-36 was significantly correlated with the difference score ($M$= 66.79, $SD$= 22.32), $r(86)$ =.215, = 0.04.

## Discussion

Previous research has indicated that cognitive and physical function are related. Much of this research has been based on the common cause theory (Baltes & Lindenberger, 1997) which states that sensory and cognitive changes both reflect the underlying changes of neural functioning. A growing body of research suggests that aging-related changes in cognitive and physical function are related. Other research added upon this concept to include other physical functions such as gait speed and handgrip strength (Fritz, McCarthy, & Adamo, 2017; McGough et al., 2013). The researchers from these studies suggested that unusual declines in these types of physical functions may be indicators of more severe cognitive problems, and may serve as biomarkers for the early stages of dementia.

The goal of my present study was to determine if older adults' self-reported physical health would predict their declining cognitive health. Based on prior research, there should be a link between these two variables. The results of my thesis, however, do not support this hypothesis. While the physical health scores from the SF-36 did not correlate with my participant's cognitive health, the social and emotional well-being scores did show a correlation with cognition.

The lack of correlation between self-reported physical health and my cognitive measures could be due to a few factors. First off, my measure of ADLs may have not been sensitive enough to pick up the subtle changes in cognition. ADLs are the basic activities that people do in their daily life, such as cleaning, self-grooming, and eating food. These activities are affected much later in the dementia process, so they would likely not be able to predict cognitive changes in people meeting criteria for MCI. For future research, one could measure IADLs, which are the more complicated activities of daily life. These include planning meals, keeping track of finances, using directions when driving somewhere new, etc. IADLs are more likely to reflect someone's cognitive abilities.

Another reason for the lack of correlation was that my sample may not have been representative enough of people with dementia-related problems. The participants were all high functioning people in terms of cognitive abilities. Also, since the participants were screened for dementia and excluded from my study if they met the criteria for it, there were less participants with memory problems. If I had deliberately recruited people with memory problems, then this could have raised the correlation.

The way I operationalized my variables may have also contributed to the lack of correlation. The SF-36 questionnaire is a self-report measure. It may not be able to pick up on the subtle physical changes that other measures could pick up on. However, it may be sensitive enough to pick up on other issues, like social and emotional functioning, which I will discuss later. My cognitive health indices also have some flaws in their ability to detect abnormal changes in cognition over time. I used a measure of crystallized intelligence to show premorbid cognitive ability. Instead of just estimating cognitive change, a better method would have been to track participants cognitive abilities in a longitudinal study to see how they decline over time. Longitudinal studies, however, are time-consuming and were not a viable method for my thesis. Future studies could track adults longitudinally to detect changes in cognition before memory problems occur.

Since I failed to support my hypothesis, I decided to look at the correlations between the other SF-36 scales, and found that both Social Functioning and Emotional Well-being showed significant correlations with my cognitive health indices. This could be due to various reasons. If someone scored high on the Social Functioning scale of the SF-36, then this means they performed normal social activities without interference due to physical or emotional problems within the past 4 weeks (Ware & Sherbourne, 1992). Regular social activity would likely require having adequate cognitive resources, since one would be participating in activities with friends or family. Also significantly correlated with older adult's cognitive abilities was the Emotional Well-being scale of the SF-36. The Emotional Well-being scale reflects someone's general mental health. If someone scored high on this scale, then they reported feeling peaceful, happy, and calm all of the time during the past 4 weeks (Ware & Sherbourne, 1992). If someone is not burdened by mental health problems, then they should be able to fully utilize their cognitive resources (assuming they do not have other limitations impacting their cognitive abilities). However, if someone scored low on this scale, they reported feelings of nervousness and depression all of the time. To have a mental illness means that one's symptoms negatively impact or get in the way of one's daily functioning. Having depression, for example, could influence someone's cognitive abilities, so it makes sense that there was a correlation between these two variables.

The findings from my study add to the growing body of research on older adults' with memory problems, declining cognitive abilities, and those with dementia-related disorders. While my results did not support my hypothesis, they could still be useful for health care professionals and those in clinical settings. For example, geriatric occupational therapists (OT) often have clients with AD. Occupational therapists tend to focus on client's abilities to perform their ADL's. However, if a client reported a lack of social functioning or a decrease in their emotional well-being, this could be a sign that their cognitive abilities have been declining. This could prompt an OT to perform a dementia screening.

In summary, as adults get older, they experience declines in various domains of their lives. Prior research has supported the hypothesis that there is a correlation between measures of physical and cognitive health. My study, however, does not support this finding. I found that self-reported physical health of older adults was not found to be correlated with their declining cognitive abilities. In addition to this, I found that older adults self-reported social functioning and emotional well-being were associated with their cognitive health. These findings can be used incorporated into health care professionals' daily practice.

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Table 1

*Range, means, and correlations with age for cognitive measures*

| | Range | *M (SD)* | *r* with age |
|---|---|---|---|
| Vocabulary Raw | 25-27 | 46.06 (4.96) | .06 |
| Vocabulary Scaled | 6-19 | 14.24 (2.70) | .17 |
| Matrix Reasoning Raw | 9-28 | 20.33 (3.88) | -.17 |
| Matrix Reasoning Scaled | 6-18 | 13.22 (2.59) | .14 |
| Verbal Paired Associates I Raw | 9-52 | 62.98 (9.16) | .01 |
| Coding Raw | 36-101 | 35.00 (12.41) | -.22* |
| Subtraction Method | -10-6 | -1.02 (2.99) | -.04 |
| Adjusted Memory | -2.78-1.82 | 0.00 (.99) | -.03 |

Note. * = Correlation is significant at the 0.05 level (2-tailed)

Table 2

*36-Item Short-Form Health Survey Correlations with cognitive health indices*

| | Range | *M (SD)* | *r* with age | *r* with subtraction method | *r* with adjusted memory scores |
|---|---|---|---|---|---|
| Physical Functioning | 5-100 | 74.21 (22.66) | -.10 | .01 | .10 |
| Role Functioning - Physical | 0-100 | 64.77 (38.77) | -.03 | .03 | .02 |
| Role Functioning - Emotional | 0-100 | 82.20 (31.94) | .24* | -.04 | .06 |
| Energy/Fatigue | 5-90 | 57.72 (19.46) | .08 | .19 | .15 |
| Emotional Well-Being | 28-100 | 79.63 (15.51) | .26* | .22* | .22 |
| Social Functioning | 25-100 | 82.67 (19.27) | .06 | .21 | .24* |
| Pain | 0-100 | 66.79 (22.32) | .04 | .22* | .14 |
| General Health | 5-100 | 68.41 (19.91) | .06 | .12 | .11 |

Note. * = Correlation is significant at the 0.05 level (2-tailed)

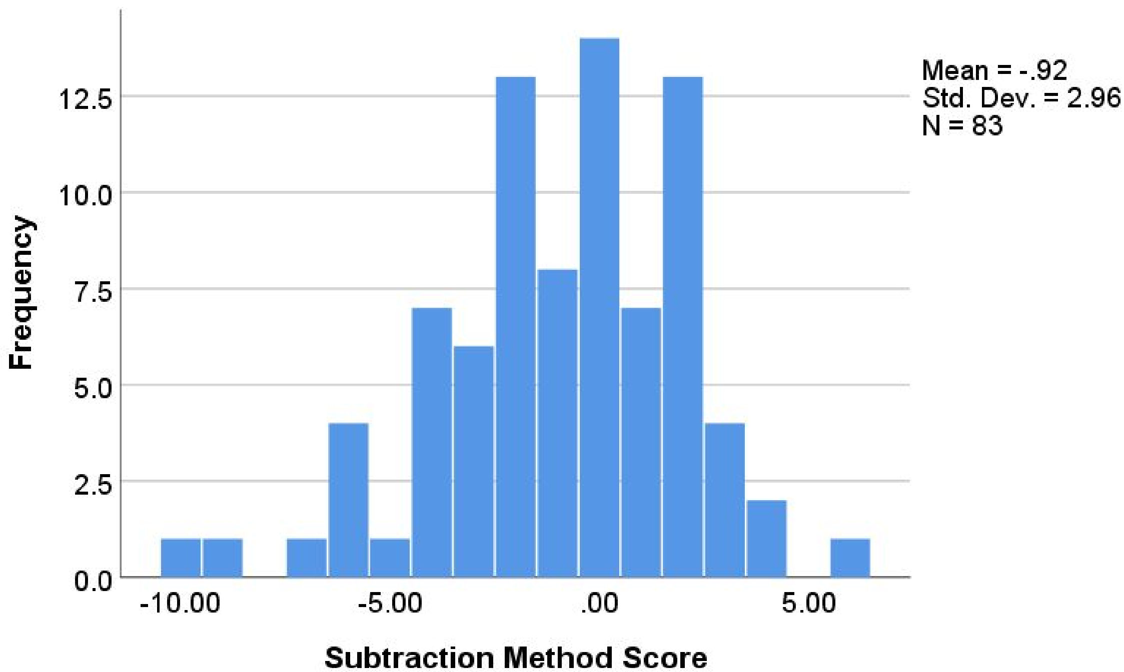


*Figure 1*. Distribution of scores for Subtraction Method

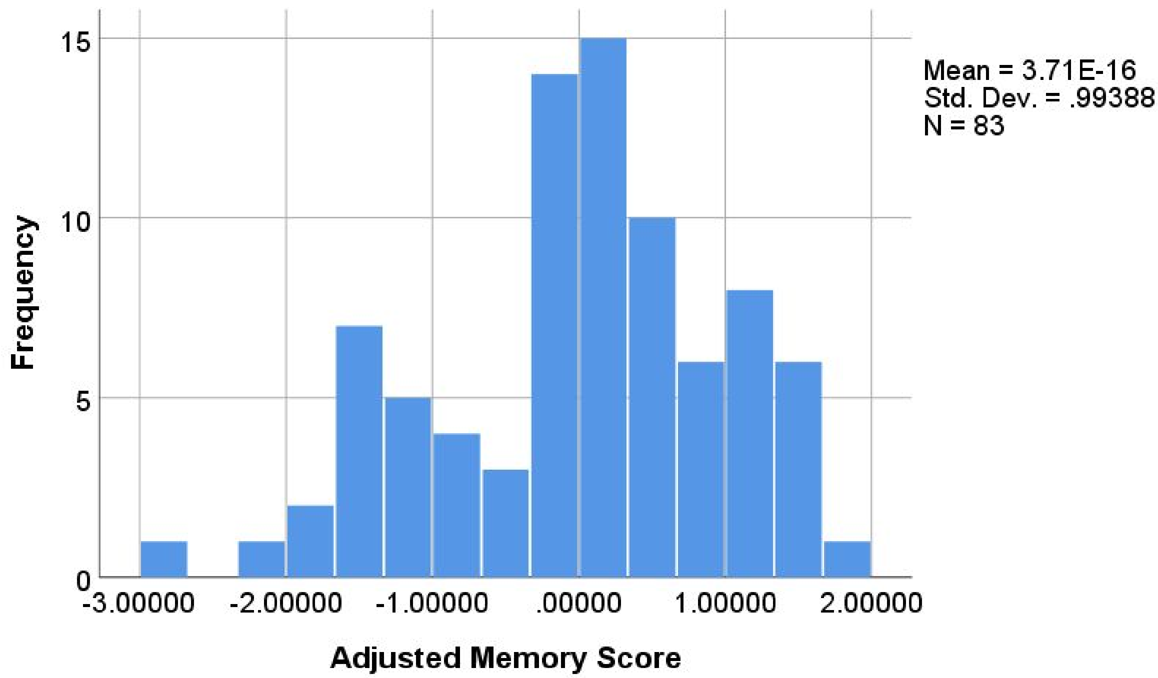


*Figure 2.* Distribution of scores for Adjusted Memory Score

**Appendix A**

IRB Approval

To: Lisa Emery
Psychology

From: Dr. Lisa Curtin, Institutional Review Board Chairperson
Date: 08/20/2015
RE: Notice of IRB Approval by Expedited Review (under 45 CFR 46.110)
Study #: 16-0037
Sponsors: NIH National Institute on Aging (NIA)
Study Title: Mental Time Travel in Context
Submission Type: Initial
Expedited Category: (6) Collection of Data from Recordings made for Research Purposes,(7) Research on
Group Characteristics or Behavior, or Surveys, Interviews, etc.

Approval Date: 8/20/2015
Expiration Date of Approval: 8/19/2016

The Institutional Review Board (IRB) approved this study for the period indicated above. The IRB found that the research procedures meet the expedited category cited above. IRB approval is limited to the activities described in the IRB approved materials, and extends to the performance of the described activities in the sites identified in the IRB application. In accordance with this approval, IRB findings and approval conditions for the conduct of this research are listed below.

Approval Conditions:
Appalachian State University Policies: All individuals engaged in research with human participants are responsible for compliance with the University policies and procedures, and IRB determinations.
Principal Investigator Responsibilities: The PI should review the IRB's list of PI responsibilities. The Principal Investigator (PI), or Faculty Advisor if the PI is a student, is ultimately responsible for ensuring the protection of research participants; conducting sound ethical research that complies with federal regulations, University policy and procedures; and maintaining study records.
Modifications and Addendums: IRB approval must be sought and obtained for any proposed modification or addendum (e.g., a change in procedure, personnel, study location, study instruments) to the IRB approved protocol, and informed consent form before changes may be

implemented, unless changes are necessary to eliminate apparent immediate hazards to participants. Changes to eliminate apparent immediate hazards must be reported promptly to the IRB.

Approval Expiration and Continuing Review: The PI is responsible for requesting continuing review in a timely manner and receiving continuing approval for the duration of the research with human participants. Lapses in approval should be avoided to protect the welfare of enrolled participants. If approval expires, all research activities with human participants must cease.
Prompt Reporting of Events: Unanticipated Problems involving risks to participants or others; serious or continuing noncompliance with IRB requirements and determinations; and suspension or termination of IRB approval by an external entity, must be promptly reported to the IRB.
Closing a study: When research procedures with human subjects are completed, please log into our system at https://appstate.myresearchonline.org/irb/index_auth.cfm and complete the Request for Closure of IRB
review form.

Websites:
1. PI responsibilities:
http://researchprotections.appstate.edu/sites/researchprotections.appstate.edu/files/PI%20Responsibilities.pdf
2. IRB forms: http://researchprotections.appstate.edu/human-subjects/irb-forms

**Appendix B**

Items from the SF-36 that were used in the current analysis.

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**Physical Functioning:**

1. The following items are about activities you might do during a typical day. Does your health now limit you in these activities? If so, how much?

   *(Yes, limited a lot; Yes, limited a little; No, not limited at all)*

   a. Vigorous activities, such as running, lifting heavy objects, participating in strenuous sports
   b. Moderate activities, such as moving a table, pushing a vacuum cleaner, bowling, or playing golf
   c. Lifting or carrying groceries
   d. Climbing several flights of stairs
   e. Climbing one flight of stairs
   f. Bending, kneeling, or stooping
   g. Walking more than a mile
   h. Walking several blocks
   i. Walking one block
   j. Bathing or dressing yourself

**Role Limitations due to Physical Health Problems:**

2. During the past 4 weeks, have you had any of the following problems with your work or other regular daily activities as a result of your physical health? *(Yes or No)*

a. Cut down on the amount of time you spent on work or other activities
b. Accomplished less than you would like
c. Were limited in the kind of work or other activities
d. Had difficulty performing the work or other activities (for example, it took extra time)

**Emotional Well-being:**

3. These questions are about how you feel and how things have been with you during the past 4 weeks. For each question, please give the one answer that comes closest to the way you have been feeling. How much of the time during the past 4 weeks…
   *(All of the time, Most of the time, A good bit of the time, Some of the time, A little of the time, None of the time)*
   a. Did you feel full of pep?
   b. Have you been a very nervous person?
   c. Have you felt so down in the dumps that nothing could cheer you up?
   d. Have you felt calm and peaceful?
   e. Did you have a lot of energy?
   f. Have you felt downhearted and blue?
   g. Did you feel worn out?
   h. Have you been a happy person?
   i. Did you feel tired?

**Social Functioning:**

4. During the past 4 weeks, to what extent has your physical health or emotional problems interfered with your normal social activities with family, friends, neighbors, or groups? *(Not at all, Slightly, Moderately, Quite a bit, Extremely)*
5. During the past 4 weeks, how much of the time has your physical health or emotional problems interfered with your social activities (like visiting friends, relatives, etc.)? *(All of the time, Most of the time, Some of the time, A little of the time, None of the time)*

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