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Awareness of Memory Ability and Change: (In)Accuracy of Memory Self-Assessments in Relation to Performance

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Abstract

Little is known about subjective assessments of memory abilities and decline among middle-aged adults or their association with objective memory performance in the general population. In this study we examined self-ratings of memory ability and change in relation to episodic memory performance in two national samples of middle-aged and older adults from the Midlife in the United States study (MIDUS II in 2005-06) and the Health and Retirement Study (HRS; every two years from 2002 to 2012). MIDUS (Study 1) participants (N=3,581) rated their memory compared to others their age and to themselves five years ago; HRS (Study 2) participants (N=14,821) rated their current memory and their memory compared to two years ago, with up to six occasions of longitudinal data over ten years. In both studies, episodic memory performance was the total number of words recalled in immediate and delayed conditions. When controlling for demographic and health correlates, self-ratings of memory abilities, but not subjective change, were related to performance. We examined accuracy by comparing subjective and objective memory ability and change. More than one third of the participants across the studies had self-assessments that were inaccurate relative to their actual level of performance and change, and accuracy differed as a function of demographic and health factors. Further understanding of self-awareness of memory abilities and change beginning in midlife may be useful for identifying early warning signs of decline, with implications regarding policies and practice for early detection and treatment of cognitive impairment.

Keywords

Subjective Memory Ability; Subjective Memory Change; Memory self-ratings; Episodic memory; Memory concerns; Memory complaints; Accuracy of self-assessments

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Introduction

Concerns about memory loss and subjective memory complaints seem ubiquitous in the daily lives of middle-aged and older adults (Lachman, 2004), yet surprisingly little is known about how adults in the general population rate their memory ability compared to others their own age or to their own memory at earlier points in time. Moreover, there is a limited understanding of how self-assessments of memory correspond to actual memory performance or change over time. Given the widespread publicity about dementia and the expected increase to over 7.1 million older adults with Alzheimer's disease in the United States by the year 2025 (Alzheimer's Association, 2014), many adults may be worried about their memory, whether or not they are experiencing problems. Although there is evidence for significant objective declines in memory starting in midlife, there are wide individual differences in the amount and rate of change (Agrigoroaei & Lachman, 2011; Albert et al., 1995; Salthouse, 2009; Singh-Manoux et al., 2012; Small, Dixon, & McArdle, 2011). A key consideration with implications for public health is to determine the extent to which adults are aware of their own memory abilities and changes therein throughout the adult years.

The evidence, based largely on small studies with non-representative samples of adults over age 60, suggests that self-ratings of memory are either unrelated or moderately related to actual memory performance (Beaudoin & Desrichard, 2011; Crumley, Stetler, & Horhota, 2014). Results of two meta-analyses examining self-assessments and actual performance showed a small relationship, $r = 0.15$ (Beaudoin & Desrichard, 2011) and $r = 0.06$ (Crumley et al., 2014). The association of subjective and objective indicators of memory varies to some extent depending on factors such as the assessment method and nature of the sample. The goal of the present study was to characterize global memory self-assessments of ability and perceived change in two national samples of middle-aged and older adults. General self-assessments of memory abilities and perceived change were examined in relation to episodic memory, adjusting for key demographic and health factors. The current study extends previous work by also considering the relationship of subjective assessments and objective performance as an indicator of accuracy. Although there is increasing evidence that subjective cognitive decline may be an early indicator of Alzheimer's disease, even without evidence for problems in objective performance (Jessen et al., 2014), this has been primarily investigated among older adults. We were interested in exploring the role of subjective memory with a wider age range, including middle-aged adults. Knowledge about the relationship between subjective and objective memory can be informative at earlier ages than typically studied for early detection efforts.

Accuracy about performance, a central component of self-efficacy theory (Bandura, 1982), refers to ratings of confidence in one's abilities and the degree to which one over or underestimates their abilities. Inaccurate self-assessments in a given domain have consequences for behaviors and actions (Bandura, 1982), such as avoiding activities or over-extending oneself. Past research has examined accuracy or knowledge about memory and cognition, also referred to as metacognition, in terms of specific task performance primarily within lab-based settings and often with undergraduate students (Hertzog & Dunlosky, 2011; Kruger & Dunning, 1999). Results have shown that inaccuracy, i.e. overestimating performance, is common especially among individuals with low cognitive abilities (Kruger

& Dunning, 1999). Our research used a broader approach to examine accuracy in terms of under and overestimation of memory performance and change using general self-assessments of memory in a national sample across the adult lifespan.

Demographic and Health Predictors of Memory Self-ratings and Performance

Research has shown that memory and self-assessments of memory have similar correlates, including age, education, sex, and physical and mental health. Previous work has tied memory self-assessments less to actual performance and more strongly to neuroticism, negative affect (Seidenberg, Taylor, & Haitiner, 1994), and depression (Grut et al., 1993; Merema, Speelman, Foster, & Kaczmarek, 2012). Subjective memory complaints have also been associated with multimorbidity, psychological distress (Aarts et al., 2011) and a lower quality of life (Mol et al., 2007; Mol, van Boxtel, Willems, Verhey, & Jolles, 2009; Waldorff, Rishoj, & Waldemar, 2008).

Self-reported changes in cognitive performance are part of the National Institute on Aging-Alzheimer's Association criteria for pre-dementia states (Albert et al., 2011) and may be among the first signs of AD (Jessen et al., 2014). In clinical samples, self-reports of cognition and memory are related to greater risk of cognitive impairment and dementia (Jonker, Smits, & Deeg, 1997; Kryscio et al., 2014; Mitchell, Beaumont, Ferguson, Yadegarfar, & Stubbs, 2014; van Oijen, de Jong, Hofman, Koudstaal, & Breteler, 2007) and neuropathology characteristic of dementia (Dubois et al., 2007), specifically amyloid deposition (Amariglio et al., 2012). Therefore, self-reports of current memory ability and subjective memory change may serve as an indicator of initial stages of cognitive impairment, and could motivate a memory clinic visit for a mental status evaluation. Collectively, this suggests there are public health implications of gaining a better understanding of factors associated with self-ratings of memory in the general population and understanding the degree of self-awareness of memory across the adult lifespan.

Memory performance has been studied more extensively than subjective assessments in population-based samples. Specifically, previous work with the Midlife in the United States study (MIDUS) has shown (Lachman, Agrigoroaei, Tun, & Weaver, 2014) there are age, gender, and education differences in cognition. A subsample of MIDUS participants from the Greater Boston area were examined longitudinally and this work showed that protective factors, such as control beliefs, social support, and physical exercise, were beneficial for maintaining cognitive functioning over time (Agrigoroaei & Lachman, 2011). Two studies with MIDUS examined self-ratings of memory in relation to self-reports of physical activity, cognitive activities (e.g., reading books), and self-ratings of health (Lee, 2014; Lee, Hsiao, & Wang, 2013), but not in relation to actual performance.

A number of studies have looked at cognitive data in the nationally-representative HRS, and most of these studies (Crimmins, Kim, Langa, & Weir, 2011; Herzog & Wallace, 1997; Karlamangla et al., 2009; Ofstedal, Zimmer, & Lin, 1999; Plassman et al., 2008; Plassman et al., 2011) have examined trends in cognitive functioning among the Aging, Demographics, and Memory study subsample of HRS participants , 70+ years (ADAMS; Langa et al., 2005) or from the older adult sample in the Asset and Health Dynamics Among the Oldest Old Study. This research has documented the prevalence of cognitive impairment among the older adult populations. Research examining the cognitive data in the entire sample of HRS has identified relationships between demographic factors (McArdle, Fisher, & Kadlec, 2007) and depression (González, Bowen, & Fisher, 2008; Langa et al., 2009) in relation to memory performance. We are aware of only one study using HRS data that examined subjective memory in relation to objective performance (Huler, Hertzog, Pearman, Ram, & Gerstorf, 2014), although this study focused on ratings of memory ability and not on subjective ratings of memory change, as we have.

Relationship of Memory Performance and Self-ratings

Assessment method—There are two approaches to measuring memory self-assessments: task specific and global. The former approach examines predictions or postdictions about performance on a test or frequency of different problems with everyday tasks. The latter approach measures general assessments of memory ability and/or change, without regard to a particular type of task. In the current study, we were interested in a general overview or global report about memory abilities (i.e., how would you rate your memory) and memory changes (i.e., how much has your memory changed). Such general self-reports of memory ability and change without reference to specific types of memory tasks or problems have been used as criteria for mild cognitive impairment (Petersen, 2004).

Nature of the sample—Research examining relationships between performance and self-ratings has mainly been conducted in samples of limited size with limited age ranges. Studies typically include only older adults, small convenience samples, clinical samples, or participants who have memory complaints (Bassett & Folstein, 1993; Coley, Ousset, Andrieu, Mathiex-Fortunet, & Vellas, 2008; Comijs, Deeg, Dik, Twisk, & Jonker, 2002; Crane, Bogner, Brown, & Gallo, 2007; Dux et al., 2008; Jorm et al., 1997; Rouch et al., 2008; Slavin et al., 2010; Snitz, Morrow, Rodriguez, Huber, & Saxton, 2008; Turvey, Schultz, Arndt, Wallace, & Herzog, 2000; van Harten et al., 2013). Thus, much of this work may be limited by a restricted range in age and actual memory abilities. Self-reported concerns about memory are common and well-documented among older adults (Reid & Maclullich, 2006). However, few studies have looked at memory concerns in midlife (Lachman, 2004) despite evidence of objective memory decline as early as age 45 (Singh-Manoux et al., 2012) and the presence of neuropathology years before symptoms occur (Braak & Braak, 1997). The inconsistent findings and low correlations between subjective and objective assessments suggest a need for additional work with population-based samples representing adults across the lifespan.

Population-based studies can provide a better understanding of memory concerns across a large range of age, education, and cognitive functioning levels. A recent Centers for Disease Control and Prevention (CDC) report (2013) using data from the Behavioral Risk Factor Surveillance Systems indicated that in the United States, 12.7% of individuals over age 60 self-reported memory loss/confusion. Of those who reported memory loss, 35.2% reported everyday functional difficulties as a result of this memory loss. However, population-based studies that have examined self-ratings of memory have not included objective cognitive data (Aarts et al., 2011; CDC, 2013). The inclusion of objective cognitive data could be useful for understanding whether and how self-reports are related to performance in the general population (Zelinski, Burnight, & Lane, 2001).

Cognitive performance—The limited association between self-assessments and performance, noted in previous meta-analyses (Beaudoin & Desrichard, 2011; Crumley et al., 2014), varies depending on the specific memory indicator that is measured (e.g., episodic memory task, working memory task). The weak relationship between subjective and objective memory assessments may also suggest that standard cognitive tests are not sensitive to early cognitive changes that adults may detect in their own lives. One population-based study of subjective memory (Mewton, Sachdev, Anderson, Sunderland, & Andrews, 2013) that included a cognitive assessment, used a brief dementia screener [i.e., Mini-Mental State Examination (MMSE; Folstein, Folstein, & McHugh, 1975)]., which generally are not sensitive to normal age-related cognitive changes (see Lachman & Tun, 2008).

In a Baltimore-area study that used an episodic memory measure, self-assessments of memory were related to objectively-measured memory performance on delayed recall and recognition tasks, but not to change in objective cognition after adjustment for demographic factors (Podewils, McLay, Rebok, & Lyketsos, 2003). Episodic memory is the memory domain that shows the strongest relationship with memory self-assessments (Beaudoin & Desrichard, 2011; Crumley et al., 2014), and is particularly sensitive to normal and early age-related changes in cognition. A meta-analysis identified that episodic memory deficits years prior to clinical diagnoses are associated with the risk of Alzheimer's disease (Bäckman, Jones, Berger, Laukka, & Small, 2005). Further, declines in episodic memory are associated with increased risk of mild cognitive impairment (MCI), a pre-dementia state of cognitive functioning (Albert, Moss, Blacker, Tanzi, & McArdle, 2007).

Accuracy of Self-Assessments

The weak relationship typically found between subjective and objective memory could signify that some individuals are accurate, and others are inaccurate. This suggests the need to examine variations in self-awareness of memory abilities and change. Some may underestimate or be unaware of their problems while others, often referred to as the "worried well" (Amariglio et al., 2012), may overestimate their memory problems. One study examined the nature of inaccuracy in a clinic-based sample of individuals using a cross-sectional study design (Zandi, 2004). Zandi found that a small and equal number of participants underreported and overreported their memory abilities, although the majority of participants in the study were considered to meet criteria for probable dementia as assessed by the Cambridge Assessment of Mental Disorders in the Elderly (CAMCOG; Roth et al., 1986). It would be beneficial to examine awareness of memory in middle-aged and older cognitively normal, community-dwelling adults in order to understand the utility of self-reports before pathological changes are apparent.

Research has yet to examine to what extent individuals in the general population are accurate in reporting objective memory declines or deficits. Research is needed to better understand the nature of subjective memory ratings in relation to performance level and change across the adult lifespan. Understanding how self-reports of memory are related to performance has public health implications for identifying those at risk of decline who may go undiagnosed in early stages as well as those who may suffer unnecessary emotional distress when their memory is actually in the normal range.

The Current Studies

Using two large national datasets from the United States, the Midlife in the United States study (MIDUS) and the Health and Retirement Study (HRS), we examined factors related to memory performance, self-ratings of memory, and their relationship in middle-aged and older adults in the United States. In Study 1 (MIDUS), we examined memory performance, memory self-ratings (compared to others), and perceived memory change over the past five years at one occasion of measurement. An advantage of the MIDUS study is the inclusion of adults under the age of 50, given the evidence for cognitive declines before 50 (Agrigoroaei & Lachman, 2011; Salthouse, 2009; Singh-Manoux et al., 2012) and that concerns about memory are present and prevalent across adulthood (Lachman, 2004). A key limitation of the MIDUS study is the cross-sectional design, which is addressed with the HRS design. Study 2 (HRS) included longitudinal data assessed every two years from 2002 to 2012 for a total of up to six interviews per person over 10 years. At each occasion, assessments included memory performance, memory self-ratings, and perceived memory change over the past two years.

In both Study 1 and Study 2, predictors of individual differences in objective memory performance and subjective memory were examined, controlling for factors known to be related to memory performance and self-assessments including demographic (age, gender, education, race, marital status, working status) and health (self-reported health, vascular factors, functional limitations, depression) factors, as well as neuroticism in Study 1. When examining performance as an outcome, self-ratings of memory were included as a predictor, and performance was included as a predictor of self-ratings, to examine these relationships when controlling for the demographic and health factors. Based on past work, we expected that older age, worse physical health, and lower education would be related to worse performance and greater declines in performance. Older age, female gender, depression, and higher neuroticism were expected to be related to worse self-ratings and greater perceived decline.

We hypothesized that after controlling for demographic and health factors there would be small associations of memory performance and self-ratings, consistent with past work, and perhaps indicative of limited self-awareness of actual memory abilities. We then conducted an analysis of the accuracy of self-ratings of memory and perceived change and examined what demographic and health factors were associated with accuracy and inaccuracy. In Study 1, we examined the extent to which those who performed at or below average relative to their age-matched peers also rated themselves as average or below in memory, and whether those who performed above average also rated themselves as above average. In Study 2, we examined the extent to which those who showed significant decline in memory over a two year period reported that their memory had declined over that period. We expected a substantial number of participants would be inaccurate about their memory ability level and change. We then examined which demographic and health factors were related to accuracy and inaccuracy.

Study 1 (MIDUS)

Method

Sample—Participants were assessed at the second occasion of the MIDUS study of health and well-being during midlife and old age (Radler & Ryff, 2010). The mortality-adjusted retention rate was 75% from Wave 1 (n=7,100; 1994-6) to Wave 2 (n=4,955; 2005-6). Participants were originally recruited with a random-digit dial (RDD) probability sampling procedure. The MIDUS study included siblings (*N* = 949) of the main respondents, randomly selected from the RDD sample, and a subpopulation of twins (*N* = 1,913) obtained after screening a representative national sample of approximately 50,000 households. At Wave 2, the Brief Test of Adult Cognition by Telephone (BTACT, Lachman et al., 2014) was added to the protocol, and the current study includes the participants (N= 3,581) with complete data on all study variables at Wave 2. Participants not included in the current study were younger, had lower education, greater functional limitations, lower self-rated health, more vascular factors, higher neuroticism, and worse memory performance (p's $< .05$) at Time 1. There were no differences (p's$>.05$) in memory self-ratings (memory compared to others and perceived memory change) for people included versus not included in the current study. Participants in the current study were 56.09 years, on average (*SD*=12.23, Range: 32-85), 55.2% were female, and they completed 14.44 years of education, on average (*SD*=2.63, Range: 6-20).

Measures

Memory performance: Participants completed the BTACT (Lachman et al., 2014; Lachman & Tun, 2008; Tun & Lachman, 2008), which measures fluid cognitive abilities, including episodic memory (Rey, 1964). Participants listened to a list of fifteen words and were asked to recall as many words as possible immediately and after a delay of approximately 12 minutes. A sum was computed (range: 0-30) of the scores for immediate (*M*=6.82, *SD*=2.26) and delayed word recall (*M*=4.49, *SD*=2.61), which were highly correlated [$r(3579)=0.79$, $p<.001$].

Memory self-assessments: They were measured in two ways: current self-rating and perceived change. Participants rated their current memory compared to others their age as (1) ”excellent,” (2) “good,” (3) “average,” (4) “fair,” or (5) “poor.” For perceived memory change, participants rated their current memory compared to their memory five years ago as either (1) “improved a lot,” (2) “improved a little,” (3) “stayed the same,” (4) “gotten a little worse,” or (5) “gotten a lot worse.” Both items were reverse-scored so higher scores reflected a better self-rating.

Demographic factors: Demographic factors included age, gender, years of education, race, marital status, and work status. Race was coded as (0) White or (1) African-American or other race; marital status as (0) non-married and (1) married, and work status as (0) non-working and (1) working.

Health factors: Health factors included number of vascular factors, self-rated health (SRH), functional limitations, and depression. Vascular factors (range: 0-4) were measured as the total number of the following health conditions: diabetes or high blood sugar, heart trouble, stroke, and high blood pressure/hypertension. For SRH, participants rated their physical health as (5) poor, (4) fair, (3) good, (2) very good or (1) excellent. Items were reverse-coded so higher scores indicated better health. To measure functional limitations (Ware & Sherbourne, 1992), participants rated whether their health limits them in with any of the following activities (items were included if the same questions were available in HRS data): lifting or carrying groceries; climbing several flights of stairs; bending, kneeling, or stooping; and walking several blocks. The total number of activities was summed (range 0-4), and higher scores represented a greater number of functional limitations. Depression at MIDUS II was coded as either absence (0) or presence (1) based on the Composite International Diagnostic Interview (CIDI) for clinical depression which has been used in previous work (Wang, Berglund, & Kessler, 2000). Participants reported whether they experienced a two-week period during the last year where they felt either 1) sad, blue, depressed or whether they 2) lost interest in most things. Participants who answered yes to either question then reported how often they felt that way during the two-week period and whether they felt specific symptoms (e.g., “lose your appetite”). Participants were coded as having a presence of depression if 1) they answered yes to either of the two initial questions, 2) they felt that way either “every day” or “almost every day” during the two-week period, and 3) they reported at least four symptoms.

Neuroticism: To measure neuroticism (Lachman & Weaver, 1997), participants reported the degree to which four adjectives describe them (moody, worrying, nervous, calm) on a scale of (1) a lot, (2) some, (3) a little, or (4) not at all. Scores for moody, worrying, and nervous were reverse-scored. The items were averaged so that higher scores indicated higher neuroticism.

Data analysis: Descriptive statistics including intercorrelations were computed for all study variables. To examine the factors related to self-assessments and memory performance, three linear regression models were conducted predicting memory performance, self-rated memory compared to others, and perceived memory change, respectively. In all models demographic variables, health factors, and neuroticism were included as simultaneous predictors. In addition, self-ratings of memory were included as predictors of memory performance and vice versa.[1]

To examine the accuracy of self-assessments in relation to memory performance in MIDUS, self-ratings of memory relative to others of the same age were compared to age-matched memory performance. We dichotomized the self-ratings of memory: better than others your age (excellent or good) or average or worse than others your age (average, poor or fair). We also dichotomized each participant's memory performance as: better than average for his/her

[1]Because our total sample also included siblings of the main RDD respondents and a subpopulation of twins, all models were also estimated using the cluster option in STATA (StataCorp, 2009). This option takes dependencies into account using robust standard errors by clustering at the family level. The results of these analyses revealed similar patterns. As sample weights were available for only the random-digit dial RDD sample of MIDUS participants, we did not apply them in the analyses.

age group (determined in 5-year age increments) or equal to the average or worse than average for his/her age group. We then examined the percentage of participants in four groups: 1) accurate high-above average memory performance and self-report above average, 2) accurate low- average or below average memory performance and self-report average or below average, 3) inaccurate underestimation-above average memory performance and self-report average or below average, and 4) inaccurate overestimation-average or below average memory performance and self-report above average. We conducted multivariate analyses of variance with posthoc tests using the Bonferroni correction to determine whether the four accuracy groups differ on demographic and health factors.

Results

Descriptive results

Means, standard deviations, and intercorrelations for all Study 1 variables are reported in Table 1. In Figure 1, the frequency distributions for the self-ratings of current memory and perceived memory change are presented in Panels A and B, respectively. The majority of participants rated their memory as either "average" or "good," compared to others their age, and reported their memory had either "gotten a little worse" or "stayed the same" in the past five years.

Relationship of memory performance and self-ratings

Predictors of memory performance—Model 1 in Table 2 shows the predictors of memory performance (total recall score). Worse memory performance was significantly associated with an older age, male gender, lower education, non-White race, worse self-rated health, higher neuroticism, and lower self-assessments of memory (p's < .05).

Predictors of self-ratings—Models 2 and 3 in Table 2 display the results of regression analyses predicting memory self-assessments. Lower memory ability self-ratings were significantly associated with younger age, lower education, greater functional limitations, worse self-rated health, more depression, higher neuroticism, and worse memory performance (p's < .05). Greater perceived decline was significantly associated with older age, higher education, being married, greater functional limitations, lower self-rated health, fewer vascular factors, more depression, and higher neuroticism ($p's$ < .05). Memory performance was not a significant predictor of perceived decline.

Accuracy of self-ratings—We examined the accuracy of self-ratings (above average versus average or below) in relation to memory performance (age-matched above average versus average or below). Figure 2 shows the breakdown of accuracy and inaccuracy when comparing self-ratings and performance. As shown on the right side of the figure, almost half of the sample (46.9%) was inaccurate about their memory ability relative to others the same age. Among those who were below average in performance (the second and fourth bars), only about half (49.2%) were aware of their standing.

Multivariate analysis of variance showed that the accuracy groups differed on all demographic and health factors (Wilk's Lambda F (33,10992)=27.23, P < .001. [Gender:

F(3, 3741)=72.45, p<.001; Race: F(3, 3741)=6.19, p<.001; Education: F(3, 3741)=60.33, p<.001; Work status: F(3, 3741)=4.12, p=.006; Functional health: F(3, 3741)=64.15, p<.001; Self-rated health: F(3, 3741)=149.51, p<.001; Vascular problems: F(3,3741)=23.23, p<.001; Depression: F(3, 3741)=16.62, p<.001; Neuroticism: F(3,3741)=43.23, p<.001] except Age and Marital Status. Participants who underestimated their performance (those with above average memory performance and self-report average or below average) were more likely to have lower education, worse physical health, higher neuroticism, and depression compared to the high accurate group (those with both memory performance and self-ratings above average). Compared to those who were low accurate, participants who overestimated their memory (average or below memory performance and self-report above average) were more likely to not work, have higher education, better physical health, lower neuroticism, and no depression.

Study 1 Discussion

Study 1 examined the relationship of memory performance and self-assessments in adults ages 32 to 85 in a national sample. Self-assessments of memory ability were related to memory performance, however, subjective memory changes were not significantly related to actual memory change. Furthermore, when we examined the nature and frequency of accuracy in self-assessments of memory compared to others the same age and in relation to objective memory performance, almost half of participants were inaccurate in their self-ratings, suggesting a substantial lack of self-awareness about memory abilities. Among those with average or below memory performance, about 25% did not rate it as such. Furthermore, among those with memory performance better than their age peers, approximately 20% did not acknowledge it, suggesting that among participants with good memory for their age, a substantial number underestimate their ability and may also be unnecessarily concerned or worried. The accuracy groups differed in terms of demographic and health factors, indicating that better physical health and being male is associated with overestimating your memory, and worse physical health, depressive symptoms, and being female is associated with underestimating your memory.

When the predictors of objective performance were compared to those for subjective ratings, the results show that, as expected, older participants had worse memory performance and greater perceived decline, but unexpectedly, younger participants were more likely to rate their memory as worse compared to others their age. The finding that age positively predicted self-rated memory indicates that older adults, more so than younger adults, assume their memory is better than that of their age-matched peers. Lower education was associated with worse performance and worse current self-ratings, but higher education was associated with greater perceived declines similar to past work which has found higher educated individuals may be particularly sensitive to cognitive changes (Caracciolo, Gatz, Xu, Pedersen, & Fratiglioni, 2012). Males had worse episodic memory performance which is consistent with previous work (Herlitz & Rehnman, 2008), although there were no gender differences in self-ratings. Better self-rated health, better functional health, and lower neuroticism were associated with better memory performance and self-ratings. Consistent with previous research, depression was associated with worse self-ratings, although it was unrelated to memory performance.

There was a small but significant correlation between self-ratings and performance as others have found (Beaudoin & Desrichard, 2011; Crumley et al., 2014). Furthermore, when exploring the match between performance and ratings, only half of those who have worse memory performance than their peers actually rated their memory as worse. This could indicate that many adults who have a poor memory are unaware or unwilling to report those deficits. It could also be that in making self-ratings of memory the participants focused on aspects of their daily memory experience other than episodic memory as captured with the objective word list recall test. The criteria for MCI (Albert et al., 2011) include subjective assessments of cognition, and there is evidence that subjective assessments of change without objective changes are indicative of AD (Jessen, et al. 2014). Nevertheless, accurate self-ratings of memory may be important for identifying early signs of change and opportunities for early intervention especially among those in middle age.

Study 2 expanded the goals of Study 1 to include longitudinal changes in memory performance in relation to self-assessments of change. We examined the match between subjective change and actual change in a large representative sample of adults over the age of 50.

Study 2 (HRS)

Method

Sample—Participants from Study 2 were from the HRS, a longitudinal nationally-representative panel survey of individuals in the United States over 50 years of age and their spouses (Heeringa & Connor, 1995; Juster & Suzman, 1995). Data were downloaded from the HRS website (http://hrsonline.isr.umich.edu/). Data collection for HRS began in 1992 (n=12,652), and interviews are conducted biennially in-person and by telephone. Participants who were between 51 and 61 years of age in 1992 were invited to participate and Black and Hispanic individuals and Florida residents were oversampled. Participants over the age of 50 and their spouses have been added to the study in subsequent waves. The response rate from the baseline interview to the first follow-up was 81.6%.

The current study includes data from 2002 to 2012 for participants (n=14,821) who met the following criteria: a) complete data on all study variables at our first assessment point in 2002, b) between 50 and 90 years of age in 2002,[2] and c) no memory-related disease in 2002. Compared to participants with complete data from 2002 to 2012, participants who dropped out after 2002 were older, less educated, had more functional limitations and vascular factors, worse memory performance, and self-rated their memory as worse ($p < .05$). The longitudinal trajectories for memory performance (Figure 3) and self-ratings (Figure 4) as a function of the year of assessment show that the selective attrition was more pronounced for performance than for self-ratings. For performance, although the downward trajectories look similar for those who have partial data, level of memory is better at all occasions for those who have complete data. Participants included in the current study were

[2]Participants 90 and older at baseline were excluded in order to examine longitudinal change in cognitive data and because of the lack of follow-up data available from those aged 90 and older following the 2002 interview.

on average, 67.76 years old (SD = 9.01, Range: 50-89), 60.7% were female, and participants completed on average, 12.34 years of education (SD = 3.16, Range: 0-17).

Measures

Memory performance: Episodic memory was assessed with the sum of immediate and delayed (after five minutes) recall for a list of 10 words (McArdle et al., 2007). Thus, scores could range from 0 to 20. Immediate (M=5.49, SD=1.77) and delayed (M=4.48, SD=2.13) recall were both measured every two years from 2002 to 2012 for a total of up to six occasions per person. Immediate and delayed recall scores were highly correlated [$r(14,819)=0.74$, $p<.001$], at the first occasion. The two-year (2002-2004, 2004-2006, etc.) test-retest correlations for memory performance ranged from r =0.46 ($p < .001$) to r =0.57 ($p < .001$). For more information about the cognitive measures in the HRS see Ofstedal, Fisher, & Herzog (2005) and McArdle et al. (2007).

Memory self-ratings: Self-assessments of memory were assessed in HRS in two ways: current memory rating and perceived memory change. Participants were asked to rate their current memory on the following scale: (1) excellent, (2) very good, (3) good, (4) fair, and (5) poor. Participants also rated their memory compared to their own memory two years ago with answer choices including (1) better, (2) same, and (3) worse. Both items were reverse-scored so higher scores represented better memory and improvement over time. Self-ratings were assessed every two years from 2002 to 2012 for a total of six occasions per person. The two-year (2002-2004, 2004-2006, etc.) test-retest correlations for self-rated current memory ranged from r = 0.60 ($p < .001$) to r =0.57 ($p < .001$), and from r = 0.33 ($p < .001$) to r = 0.38 ($p < .001$) for perceived memory change.

Demographic factors: Age, gender, education, race, marital status, and work status were included as covariates and measured at baseline in 2002. Race was coded as (0) White and (1) African-American or other; marital status as (0) non-married and (1) married and work status as (0) non-working and (1) working.

Health factors: Health factors, which were also measured at baseline, included self-rated health, functional limitations, vascular factors, and depression. Self-rated health was measured by asking participants to rate their health as (1) excellent, (2), very good, (3), good, (4) fair, or (5) poor. Answer choices were reverse-scored so higher scores indicated better health. Functional limitations were measured by asking participants, "Because of a health problem do you have any difficulty with" the following activities: walking several blocks; stooping, kneeling, or crouching; lifting or carrying weights over ten pounds, like a bag of groceries; and climbing several flights of stairs without resting. The final score was the total number of activities the participants had difficulties doing because of a health problem. Number of vascular factors (range: 0-4) was measured by asking participants whether a doctor ever told them that they had the following health conditions: 1) diabetes or high blood sugar; 2) hypertension or high blood pressure; 3) heart attack, coronary heart disease, angina, congestive heart failure, or other heart problems; and, 4) stroke. Depression was measured using the 8-item version of the Center for Epidemiological Studies Depression Scale (Kohout, Berkman, Evans, & Cornoni-Huntley, 1993; Radloff, 1977), with less than 4 symptoms as (0) no elevated depression and a cutoff of 4 or more symptoms indicative of (1) elevated depressive symptoms (Steffick, 2000).

Data Analysis

Descriptive analyses and intercorrelations were conducted for all study variables. To examine the predictors of self-assessments and performance, three separate multilevel models were run using PROC MIXED and SAS Version 9.2. In three separate models, demographic and health factors were examined as predictors of level and change in self-assessments of memory (current memory rating and self-perceived change across six occasions) and also level and change for memory performance (total recall score on six occasions).[3] An advantage of the use of multilevel modeling to examine change is the ability to examine longitudinal data with participants who do not have complete data across all occasions. Unconditional models were initially conducted predicting the three dependent variables 1) memory performance, 2) memory self-ratings, and 3) perceived memory change from 2002 to 2012 to calculate the intraclass correlation coefficients. Results revealed that for memory performance, 58% of the variation was between-persons and 42% within-persons, and for self-ratings of current memory, 55% of the variation was between-persons and 45% of the variation within-persons. Lastly, for perceived memory change, 32% of the variation was between-persons and 68% of the variation within-persons.

Accuracy of perceived change in relation to actual change in memory performance was examined. We dichotomized perceived memory change in the past two years at the first follow-up as decline (worse) or no decline (same or better). For memory performance, we computed difference scores between each two year pair (2002-2004, 2004-2006, etc.). Mean memory change from 2002 to 2004 was -0.31 (SD = 3.28) and one standard deviation below the change score mean (i.e., −3.59) was rounded to four to determine the cutoff for decline. One standard deviation below the mean on cognitive tests corresponds to neuropsychological definitions of mild memory loss or MCI (Nasreddine et al., 2005). Thus, across all occasions, significant memory decline was operationalized as a decrease of four or more words over two years. The memory change scores from 2002 to 2004 were dichotomized as either decline (decrease of 4 or more words) or no decline (decrease of three words or less), and the same was done for 2004 to 2006, and so on across all years. The percentage of participants in the following four groups was reported: 1) accurate no decline: no memory decline, self-report no decline, 2) accurate decline: memory decline, self-report decline, 3) inaccurate about no decline: no memory decline, self-report decline, and 4) inaccurate about decline: memory decline, and self-report no decline. Sensitivity analyses were conducted to examine different ways of operationalizing change in memory performance (decline operationalized as a difference of one or more words versus zero

[3]Analyses were conducted using sample weights to account for oversampling of Black and Hispanic individuals and Florida residents, and to reflect the United States census population in 2002 at baseline for the current study (Heeringa & Connor, 1995). Results were similar, with a few exceptions. In Model 1, with memory performance as an outcome, the interaction between SRH and time was no longer significant. In Model 3, with perceived memory change as an outcome, the effect of race was no longer significant and the effect of memory performance became significant. Also, due to the nature of the study design, some participants from the same households are included in the HRS. Thus, multilevel models were used to examine three-levels (level 1: within-person, level 2: within-household, and level 3: between-households) to account for the clustering of data and sample dependencies. These findings revealed no differences from the two level model examining within-person and between-person change over time and therefore are not reported.

words for no decline) and also using five words as a cutoff (decline equal to a difference of five or more words versus zero for no decline) which is the equivalent of 1.5 standard deviations from the mean of the change score.[3] We then conducted multivariate analyses of variance with the Bonferonni correction for multiple comparisons to examine what demographic and health factors were associated with the accuracy groups.

Results

Descriptive results

Means, standard deviations, and intercorrelations for all Study 2 variables are presented in Table 3. In Figure 5, Panels A and B display the distribution self-assessments of current memory ability and perceived memory change, respectively. The majority of participants rated their memory ability as “good” and the “same” compared to two years ago.

Relationship of memory performance and self-ratings

Predictors of level and change in memory performance—We initially estimated a model with only time as a predictor of memory performance from 2002 to 2012, and these results revealed a significant decline in memory performance over the ten years [Estimate(Est.)=-0.34, Standard error (*SE*)=0.01, p<.001)]. Demographic and health factors were then added as predictors of memory performance. Model 1 in Table 4 displays the results of multilevel analyses predicting level (main effects) and change (interactions with time) for memory performance from 2002 to 2012. Worse memory performance was significantly associated with being older, male gender, lower education, non-White race, not working, a greater number of functional limitations, lower self-rated health, more vascular factors, more depressive symptoms, and worse self-rated memory (p's < .05). Some predictors were significantly related to change in memory performance as shown in the interaction with time. These results show that older adults, female participants, and those with higher education and lower self-rated health declined more over time (p's < .05). A comparison of the covariance parameters in the unconditional model revealed that Model 1 explained 24% of between-person variation in memory performance.

Predictors of level and change in self-ratings—We first computed a model with only time as a predictor of self-rated memory from 2002 to 2012, and these results revealed a significant decline over time (Est.= -0.04, *SE*=0.00, p<.001). Model 2 inTable 4 illustrates the results of multilevel models predicting both level (main effects) and change (interactions with time) for current memory ratings from 2002 to 2012. Worse memory ratings were significantly associated with younger age, male gender, lower education, non-White race, being married, non-working status, worse self-rated health, and fewer vascular factors and depressive symptoms (p's < .05). Some predictors were significantly related to change in self-ratings over time. These results suggest that older adults, participants with higher education, working participants, participants with better self-rated health, and those with more depressive symptoms report significantly worse self-ratings over time (p's < .05). A comparison of the unconditional model covariance parameters revealed that the current model explains 2% of the between-person variance.

We first estimated a model with only time as a predictor of perceived memory change from 2002 to 2012, and these results revealed that perceptions of decline became more pronounced later in time (Est.= -0.01, *SE*=0.00, *p*<.001). Predictors of level and change in perceived memory change from 2002 to 2012 are reported in Model 3 in Table 4. Greater perceived decline was significantly associated with higher education, White race, being married, greater functional limitations, worse self-rated health, and more depression (*p*<'s . 05). Some predictors were significantly related to change in perceived decline. These results show that older adults and White participants reported significantly greater perceived decline over time. A comparison of the unconditional model covariance parameters revealed that the current model explains 6% of the between-person variance.

Accuracy of self-ratings—To examine accuracy in self-ratings of perceived change, the relation between 2004 self-ratings of perceived change over the past two years (self-rating of decline versus no decline) and actual change from 2002 to 2004 (decline or no decline) was examined.[4] The right panel of Figure 6 shows that a total of 31.9% were not accurate about their performance change. Of the 16% percent (n=2,108) of the sample who declined (4 or more words) from 2002 to 2004 (the second and fourth bars), 75% (12% out of 16%) were inaccurate about this change.

Multivariate analyses of variance identified that there were differences between the accuracy groups for all of the demographic and health measures: Wilk's Lambda F(27, 38274) =20.56, p<.001 [(Age: F(3,13113)=14.09, p<.001; Gender: F(3,13113)=7.49, p<.001; Work status: F(3,13113)=13.40, p<.001; Depression: F(3,13113)=90.04, p<.001; Functional health: F(3, 13113)=78.55, p<.001, Vascular problems: F(3,13113)=18.46, p<.001; Self-rated health: F(3,13113)=95.77, p<.001] except Marital Status and Education. Those who inaccurately reported memory decline amidst no memory decline were more likely to be older, not work, have worse physical health and depression compared to those who were accurate about their memory decline (no memory decline, self-report no decline). Those who experienced decline but did not report it were more likely to work and have better functional health, better self-rated health and fewer depression symptoms compared to those who experienced decline and accurately reported it.

Study 2 Discussion

We examined factors related to memory performance, self-ratings, and their relationship using longitudinal data from HRS. Our analyses identified some differences in predictors of self-ratings versus performance. Furthermore, we found a fair degree of inaccuracy in self-assessments of memory such that only a small percentage of participants who declined over a given 2-year period, actually reported they had declined; furthermore, some who did not show actual declines reported that their memory had declined. As expected, those who had worse memory performance were older in age, although a younger age was associated with lower self-assessments of memory, and age was not related to subjective memory decline.

[4]Memory change was examined in all other years, 2004 to 2006, 2006 to 2008, 2008 to 2010 and 2010 to 2012 in relation to self-ratings of perceived change. There were similar rates of decline (2004-6: 13.3%, 2006-8: 14.3%; 2008-10: 17.5%; 2010-12, 15.1%) and there were similar rates of accuracy and inaccuracy; thus for parsimony only results from the baseline year in Figure 6 are reported.

Thus, as expected, reports of memory problems occur across adulthood, and are not confined to later ages. Men had worse current memory ratings and worse performance than women, but gender was not related to perceived change. As expected, those with lower education had lower current self-ratings and worse performance. Moreover, consistent with past work (Hall et al., 2007), it was higher educational attainment that was associated with greater declines in memory performance over time. Married participants rated their memory as worse and reported more decline, but did not have worse memory performance. Poor health and greater depression were related to both worse ratings of memory and memory performance.

Although 16% of the sample had declines of four or more words over two years, the majority of them were not accurate in their self-ratings of perceived change, as they did not report that their memory had gotten worse. Furthermore, when examining the 84% of participants who did not decline, a quarter of them were inaccurate and reported that their memory had declined. The results indicated that 12% of the population was not aware of or did not acknowledge a significant decline in memory performance as measured by a test of episodic memory. Furthermore, almost 20% of the population could be considered “worried well” as they reported declines even though their memory had not significantly declined. When examining factors associated with accuracy versus inaccuracy in self-reports of memory decline, physical health was found to differentiate among inaccuracy groups. Specifically, those reporting memory decline amidst no decline had worse health than those who did not report actual declines.

General Discussion

We examined memory performance and self-assessments, their relationship, and their predictors in two national samples with cross-sectional and longitudinal data from participants across adulthood. In both studies, the largest proportion rated their memory as “good,” regardless of where this answer choice was located on a 5-point Likert-type scale (i.e., in MIDUS good was 4 out of 5; in HRS good was 3 out of a 5 point scale). Despite this positive assessment of abilities, when it came to perceived change, 43% reported decline over five years in MIDUS and 24% percent reported decline over a two year period in HRS.

Concerns about memory decline, which are prevalent across adulthood, are not necessarily indicative of true memory problems. Although ratings of memory ability were significantly related to memory performance when controlling for demographic and health covariates, ratings of perceived memory change were not related to level or change in memory performance. Consistent with previous research, the relationship between self-ratings and performance was weak. This is reflected in the large number of participants who were inaccurate in their self-ratings of memory, whether they were rating their memory compared to others their age (in MIDUS) or to themselves two years ago (in HRS).

In both studies, older age, male gender, lower education, non-White race and worse health were all associated with lower memory performance. In HRS, but not in MIDUS, depression was associated with worse memory performance. This is consistent with previous HRS studies (González et al., 2008). The lack of association in MIDUS may be due to the lower prevalence and more clinical nature of the depression variable in MIDUS. Interestingly, in both studies, whereas younger age was associated with better memory performance, a younger age was also associated with lower subjective memory compared to their peers, suggesting that low self-ratings are not restricted to older adults. Predictors of perceived change in both studies included higher education, White race, being married, worse health, and depression. The finding that higher education was related to greater perceived decline is consistent with past work (Caracciolo et al., 2012), suggesting that those with higher education may report declines based on more subtle changes in memory due to their reliance on high level cognitive functioning.

With regard to the inaccuracy of self-ratings of memory, we found that almost half of the MIDUS sample and a third of the HRS sample were inaccurate when subjective ratings were compared to objective performance and that these groups differed in terms of both demographic and health factors. Among the inaccurate participants, there were some who were unaware of deficits or declines in memory, and others who reported deficits or declines when they were not experiencing them (i.e., the "worried well"). Half of participants in the MIDUS study with memory performance that was at the average or below their age-matched peers on a word recall test reported that their memory was better than their peers. This is consistent with findings in other domains which show that Americans typically rate themselves as "better-than-average" (Guenther & Alicke, 2010). When we looked at accuracy in HRS, we found that a large proportion of participants in HRS were "inaccurate" regarding their memory change in the past two years, even with a conservative cutoff of four words as indicative of decline. We adopted a relatively conservative criterion of four words, or approximately one standard deviation from the mean, to operationalize significant decline, based on the criteria for mild memory loss (Nasreddine et al., 2005). Sensitivity analyses revealed that compared to the cutoff of 4 or more words that was used, the overall pattern of accuracy results did not change when any decline (1 word or more) or 1.5 standard deviations from the mean (5 words or more) were used as the cutoff.

Both studies have some limitations that can be addressed in future work. The studies only examined episodic memory, and other domains of memory (e.g., prospective memory) should be examined in relation to self-assessments, as adults may be thinking about other aspects of memory related to daily functioning when they make their ratings. Nevertheless, episodic memory is a useful measure as it is central component of the diagnostic criteria for Alzheimer's disease and show age-related declines (Dubois et al., 2007).

For MIDUS we note that the diabetes variable included in the measure of vascular factors was slightly different from HRS. In MIDUS, participants were asked whether they had been treated for diabetes within the past 12 months (10% reported yes), whereas in HRS participants were asked whether a doctor has ever told them they have diabetes (17% reported yes). This differential time frame may explain why in HRS vascular factors were associated with worse memory performance and in MIDUS vascular factors were not a significant predictor of worse memory performance. Another consideration is that the HRS sample was older, on average, and the effects of vascular factors on cognition may be more prominent in later life. Furthermore, the measures of self-reported health and vascular factors were self-reported single-items that are often used in large scale survey studies, although they may not be not ideal for capturing specific health conditions that could influence memory.

In MIDUS, we examined accuracy in memory performance in relation to self-ratings by determining whether or not participants scored above the mean for performance in 5-year age groups (40-44, 45-49, 50-54, etc.). However, other neuropsychological research has compared performance using age-, gender- and education-matched scores. Because the self-ratings item in MIDUS asks how participants rated their memory “compared to others their age” (and does not specify education level or gender), we chose to match by age only. Future work should examine whether including education and gender in the comparisons could make a difference for degree of accuracy. The low percentage of variance explained by demographic and health factors in relation to self-ratings in the current study illustrates that the predictors were more strongly related to performance than to subjective assessments. Future work should examine the role of other psychosocial factors, such as sense of control or conscientiousness, in relation to self-ratings in population-based studies. Though these analyses were beyond the scope of the current study, MIDUS includes psychosocial variables and in HRS, a subsample of participants completed psychosocial assessments; thus these data sets are suited to examine these questions in future work. This type of research can help to better understand sources of subjective memory ratings and better characterize adults who over versus under report their memory deficits.

Implications and Future Directions

Given the recommendations for early detection of MCI and dementia (Daviglus et al., 2010), subjective reports of memory abilities and early signs of change remain an important aspect of an overall assessment. In some cases, subtle self-reports cognitive changes reported by individuals may correspond to early neuropathological changes (Amariglio et al., 2012) not yet detected by cognitive tests. Awareness of memory losses also has clinical utility as it may result in greater use of compensatory strategies and behaviors (Dixon, 2000; Hahn & Lachman, 2014). This study has added to the previous work that shows that there are inconsistencies in whether memory complaints are associated with cognitive impairment (Mitchell, 2008; Roberts, Clare, & Woods, 2009) by examining awareness of memory performance and memory change in the general population. Given the ethical considerations associated with identifying individuals in pre-dementia states amidst uncertain prognosis of or treatments for future decline (Whitehouse & Moody, 2006) and an overall fear and anxiety of dementia among the aging population (Corner & Bond, 2004), a better understanding of accuracy of self-ratings of memory has potential public health implications. Further, especially among middle-aged adults, inaccurate self-ratings of memory, as our data show, may be more reflective of other aspects of mental health rather than actual memory performance. We found evidence that underestimating memory was related to depression, higher neuroticism, and worse physical health, and overestimating memory was related to fewer depressive symptoms, lower neuroticism, and better physical health. Memory concerns may also reflect general stereotypes and expectations about aging-related memory loss. Future work is needed to investigate other factors that are associated with over or underestimation of memory performance to facilitate meaningful interpretation of self-assessments.

Given efforts to utilize subjective cognitive complaints as part of early risk assessment, in conjunction with cognitive task performance, neuroimaging, and/or biomarkers, results from the current study can help to inform evaluations of memory that include self-reported changes or complaints. A recent CDC (2013) report urges a public health monitoring program to longitudinally track cognitive status. Given that these programs (e.g., BRFS) utilize self-ratings of memory, a careful understanding of the nature and accuracy of self-ratings of memory is needed. A recent study that examined within-person variability in subjective memory, memory performance, and depression in the HRS found that when participants report fewer depression symptoms they also reported above-average subjective memory (Hulur, Hertzog, Pearman, Ram, & Gerstorf, 2014). Our research expanded this work by showing that overestimation of memory abilities is related to fewer depressive symptoms. In future work we plan to build on the current study by examining if accuracy changes over time. We will explore whether people become more or less aware of memory abilities or more likely to over or underestimate their memory abilities as declines become more significant.

A better understanding of self-assessments of memory may facilitate better diagnosis and allow earlier treatment within a system that relies, in part, on family or friends to notice changes or a participant's own assessments of their memory abilities or decline. For those who erroneously report deficits or decline (the "worried well"), there may be underlying psychological problems along with unnecessary costs for visits to memory clinics or doctors. Further examination of subjective memory in conjunction with objective memory performance and change can provide insights into their diagnostic value for early detection of cognitive impairment. Self-assessments may also be useful for deterring unnecessary concerns or costly memory evaluations, especially among middle-aged adults, who may be worried about early signs of dementia when experiencing normal aging-related memory changes.

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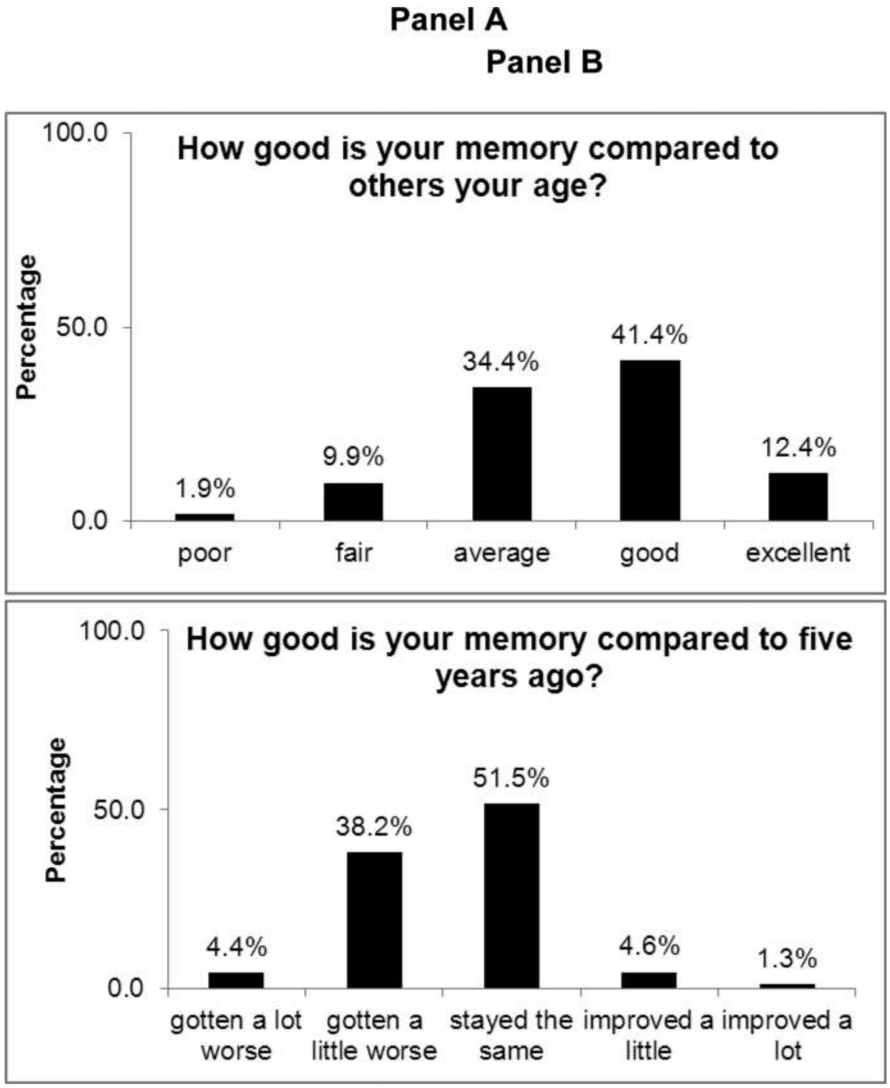
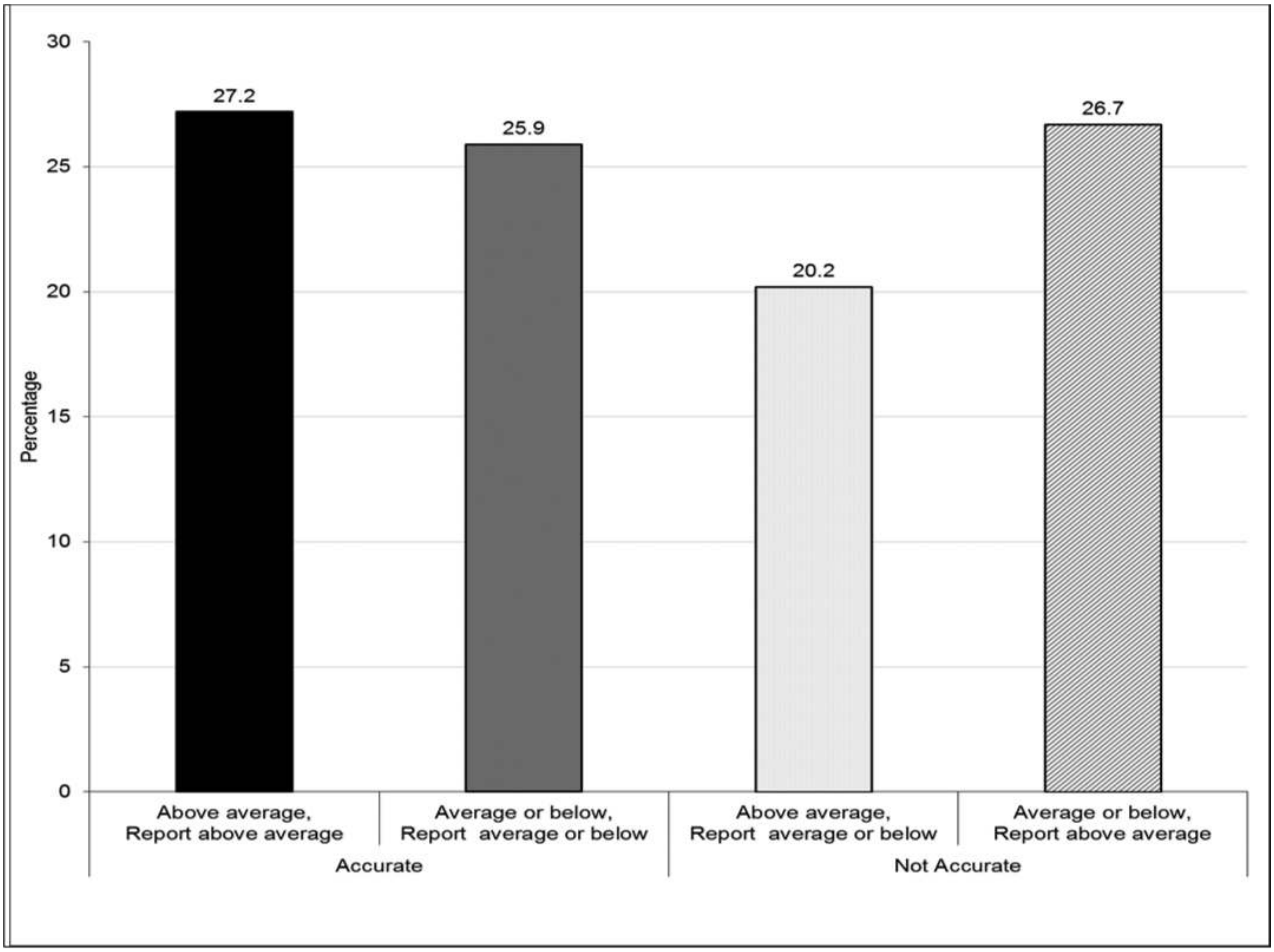


Fig. 1.

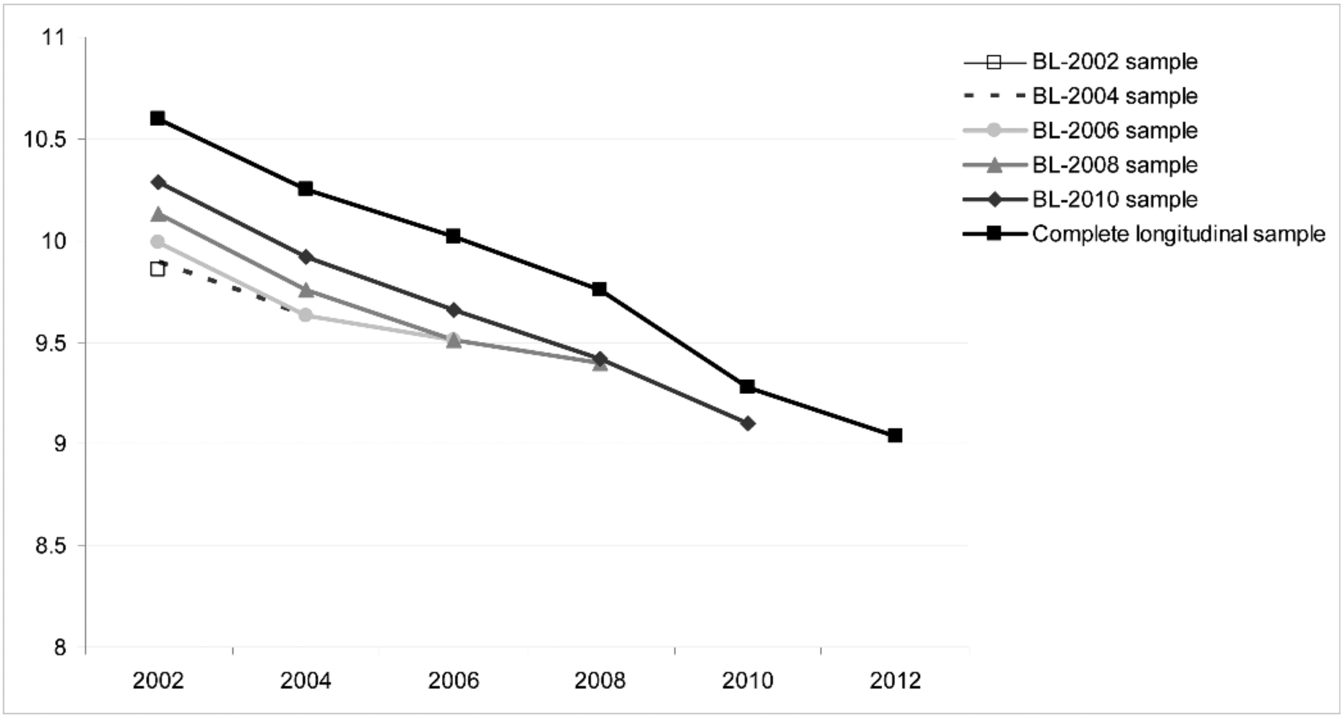
Self-assessments of memory compared to others (Panel A) and perceived change (Panel B) in MIDUS (n=3,581)



Note. Memory was defined as (1) above average versus (2) average or below compared to age-matched participants (determined in 5-year age groups). For memory self-ratings participants rated their memory as (1) better than average versus (2) average or below compared to others your age.

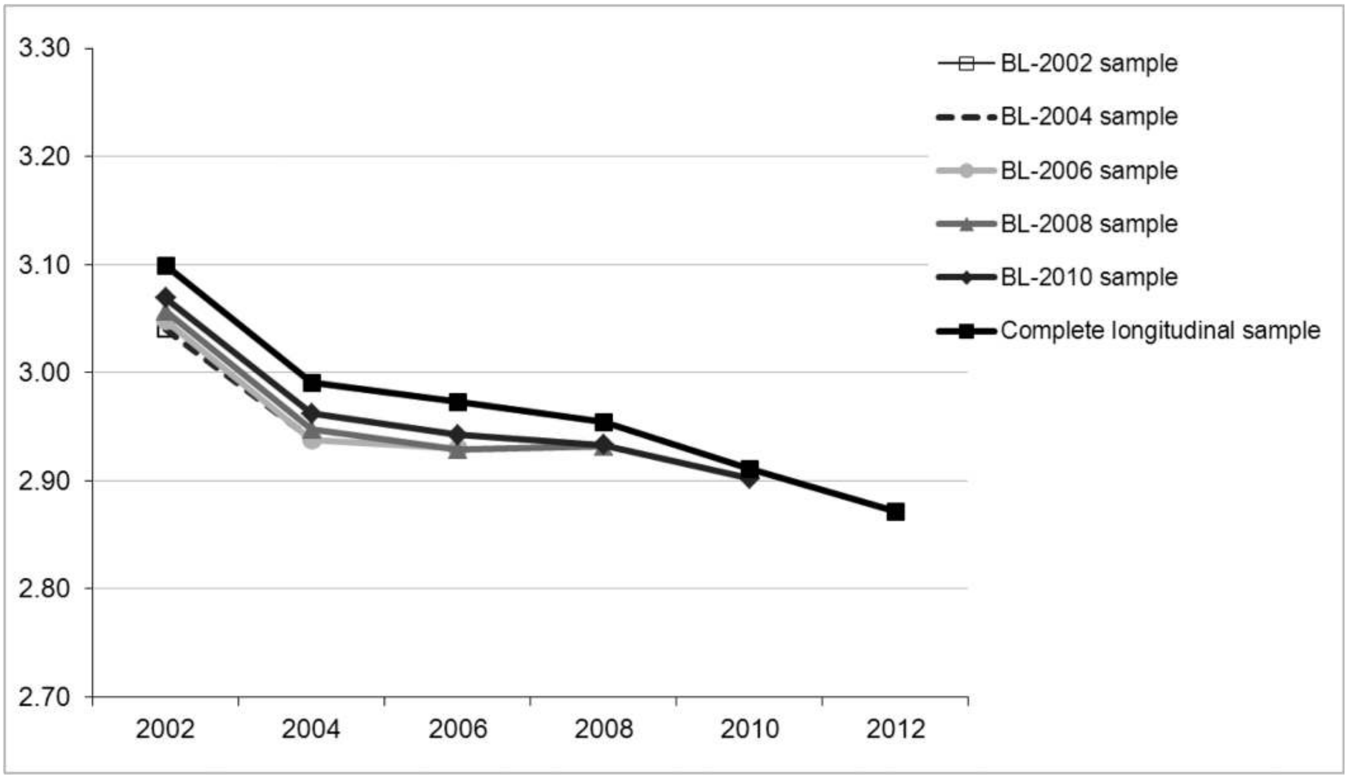
Fig. 2.

Relationship of objective memory performance and subjective ratings compared to others your age in MIDUS (n=3,581)



Note. BL: Baseline.

Fig. 3.
Recall scores by longitudinal wave



Note. BL: Baseline.

Fig. 4.

Memory self-ratings by longitudinal wave

Panel A
Panel B

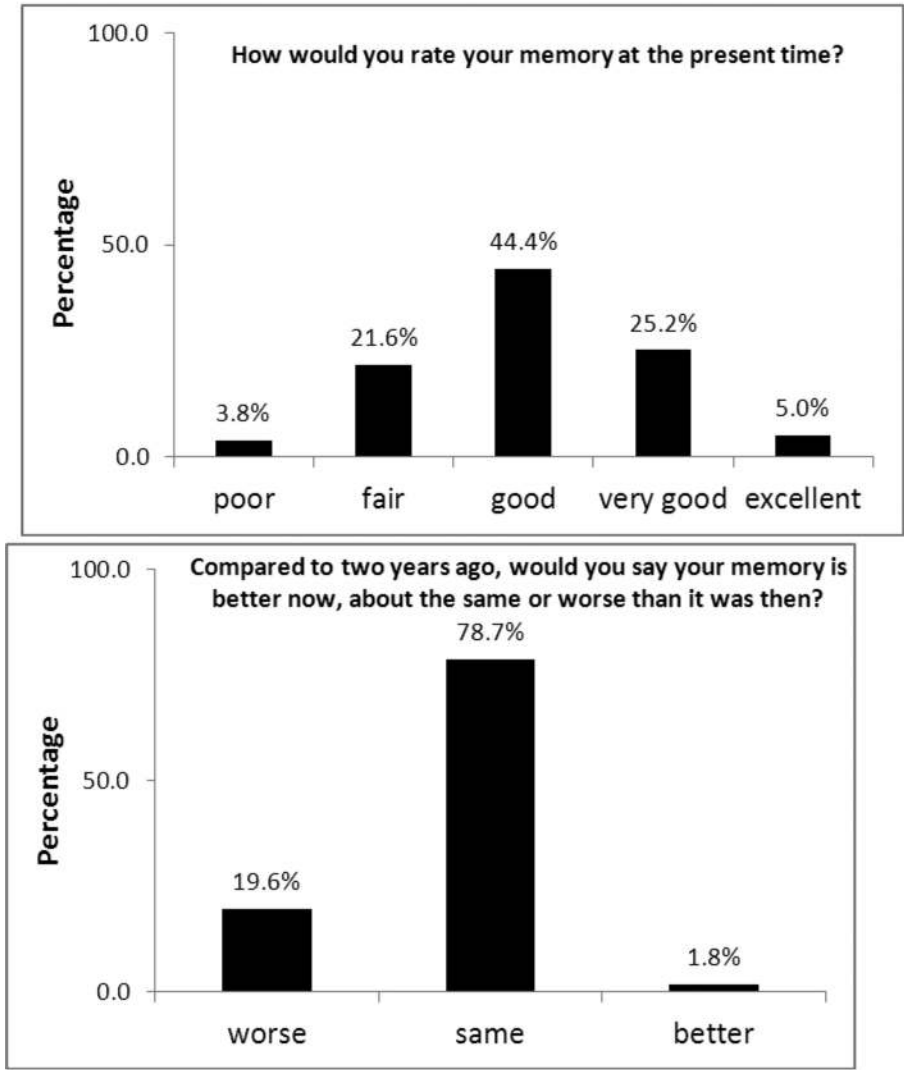
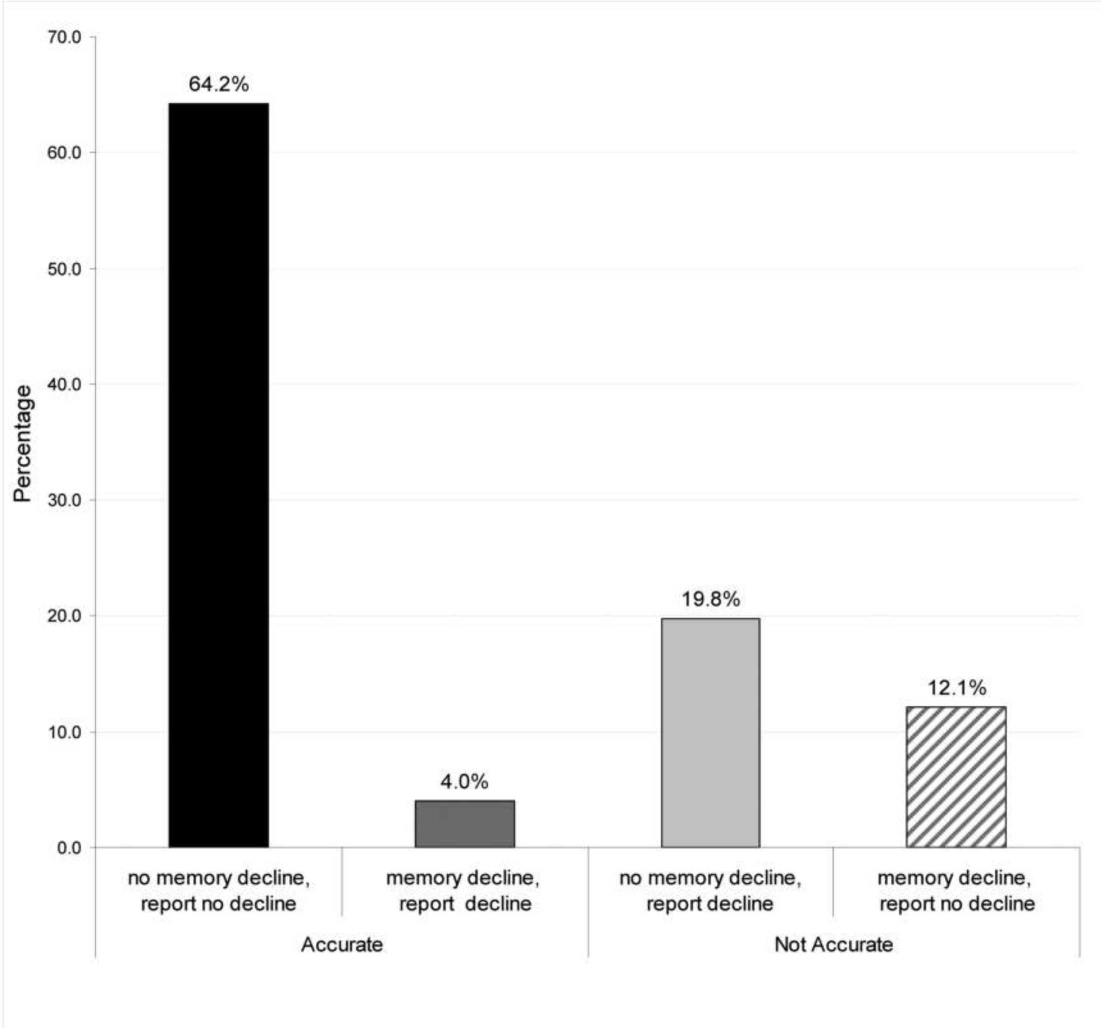


Fig.5.
Self-ratings of memory (Panel A) and perceived change (Panel B) in HRS sample at baseline in 2002 (n=14,821)



Note. [a]Participants (n=13,117) with complete data at both 2002 and 2004 were included in the representation of accuracy of perceived memory change. Memory decline was defined as decline (decrease of four or more words) versus no decline (decrease of 3 words or less) in the past two years from 2002 to 2004. Participants self-reported their perceived memory change in the past two years as declined (gotten worse) or no decline (stayed the same or gotten better)

Fig. 6.

Relationship of change in objective memory performance and perceived memory change in HRS from 2002 to 2004 (n=13,117)[a]

Table 1

Descriptive statistics and intercorrelations for all variables in MIDUS (n=3,581)

Variable	M(SD) or %	1	2	3	4	5	6	7	8	9	10	11	12	13
1. Age	56.09 (12.23)	1												
2. Gender (% female)	55.2	−0.23	1											
3. Education (range: 6-20 years)	14.44 (2.63)	**−0.14**	**−0.10**	1										
4. Race (% White)	92.9	**−0.05**	0.00	−0.03	1									
5. Marital status (% married)	72	**−0.09**	**−0.15**	**0.05**	**−0.10**	1								
6. Working status (% working)	52.4	**0.46**	0.03	**−0.15**	−0.02	−0.01	1							
7. Functional limitations	1.45 (1.54)	**0.34**	**0.13**	**−0.23**	0.02	**−0.12**	**0.28**	1						
8. Self-rated health	3.59 (1.00)	**−0.15**	0.00	**0.26**	**−0.07**	**0.09**	**−0.19**	**−0.52**	1					
9. Number of vascular factors	0.68 (0.83)	**0.37**	**−0.08**	**−0.11**	0.02	−0.01	**0.23**	**0.37**	**−0.39**	1				
10. Depression (% presence)	8.8	**−0.10**	**0.12**	**−0.06**	0.02	**−0.08**	**0.04**	**0.12**	**−0.16**	**0.04**	1			
11. Total Recall Score	11.31 (4.61)	**−0.32**	**0.24**	**0.21**	**−0.07**	0.00	**−0.16**	**−0.16**	**0.17**	**−0.18**	0.03	1		
12. Memory rating	3.53 (0.90)	0.00	−0.03	**0.19**	−0.02	0.03	**−0.07**	**−0.28**	**0.39**	**−0.16**	**−0.18**	**0.12**	1	
13. Perceived memory change	2.60 (0.71)	−0.01	**−0.04**	0.01	0.03	**−0.05**	−0.02	**−0.12**	**0.14**	−0.03	**−0.12**	0.00	**0.48**	1
14. Neuroticism	2.06 (0.62)	**−0.17**	**0.10**	**−0.08**	0.02	**−0.04**	**−0.04**	**0.12**	**−0.19**	0.01	**0.25**	0.00	**−0.23**	**−0.20**

Note. Bolded values are statistically significant ($p< .05$). Gender was coded as (1) female or (0) male, race was coded as (1) non-White or (0) White, marital status was coded as (1) married or (0) not married, working status was coded as (1) working or (0) not working, and depression was coded as (1) presence or (0) absence. Memory rating compared to others their age was coded as (1) poor to (5) excellent. Perceived memory change compared to their memory five years ago was coded as (1) gotten a lot worse to (5) improved a lot .

Table 2

Multiple regressions predicting memory performance and self-assessments of memory in MIDUS (n=3,581)

	Model 1 Memory performance			Model 2 Memory rating[a]			Model 3 Perceived memory change[a]		
	B	**SE**	***p***	**B**	**SE**	***p***	**B**	**SE**	***p***
Intercept	**8.49**	**0.79**	**.001**	**2.29**	**0.15**	**.001**	**3.22**	**0.13**	**.001**
Age	**−0.11**	**0.01**	**.001**	**0.01**	**0.00**	**.001**	**0.00**	**0.00**	**.015**
Gender	**2.34**	**0.14**	**.001**	−0.01	0.03	.753	−0.02	0.03	.363
Education	**0.28**	**0.03**	**.001**	**0.03**	**0.01**	**.001**	**−0.01**	**0.01**	**.008**
Race	**−1.41**	**0.27**	**.001**	0.06	0.05	.237	0.09	0.03	.055
Marital status	−0.07	0.16	.644	−0.03	0.03	.345	**−0.12**	**0.03**	**.001**
Working status	0.05	0.16	.754	−0.01	0.03	.686	0.03	0.03	.332
Functional limitations	−0.04	0.06	.454	**−0.06**	**0.01**	**.001**	**−0.03**	**0.01**	**.002**
Self-rated health	**0.20**	**0.09**	**.026**	**0.24**	**0.02**	**.001**	**0.07**	**0.01**	**.001**
Number of vascular factors	0.01	0.10	.942	−0.02	0.02	.326	**0.04**	**0.02**	**.020**
Depression	0.19	0.26	.453	**−0.24**	**0.05**	**.001**	**−0.16**	**0.04**	**.001**
Neuroticism	**−0.29**	**0.12**	**.015**	**−0.18**	**0.02**	**.001**	**−0.20**	**0.02**	**.001**
Memory performance				**0.01**	**0.00**	**.001**	0.00	0.00	.538
Memory rating	**0.35**	**0.09**	**.001**						

Note. Bolded values are statistically significant ($p < .05$) Gender was coded as (1) female or (0) male, race was coded as (1) non-White or (0) White, marital status was coded as (1) married or (0) not married, working status was coded as (1) working or (0) not working, and depression was coded as (1) presence or (0) absence.

[a]Higher scores indicate a higher memory rating and greater stability (less decline) for perceived memory change

Table 3

Descriptive statistics and intercorrelations for all variables in HRS at Baseline in 2002 (n=14,821)

Variable	M(SD) or %	1	2	3	4	5	6	7	8	9	10	11	12
1. Age (range 50-89)	67.76 (9.01)	1											
2. Gender (% female)	60.7	**−0.03**	1										
3. Education (range 0-17)	12.34 (3.16)	**−0.12**	**−0.07**	**1**									
4. Race (% White)	84.3	**−0.07**	**0.05**	**−0.16**	1								
5. Marital status (% married)	63.5	**−0.22**	**−0.22**	**0.11**	**−0.14**	1							
6. Working status (% working)	29.7	**−0.45**	**−0.06**	**0.16**	0.00	**0.09**	1						
7. Functional limitations	1.32 (1.37)	**0.17**	**0.17**	**−0.19**	**0.07**	**−0.14**	**−0.18**	1					
8. Self-rated health	3.21 (1.10)	**−0.14**	**−0.03**	**0.30**	**−0.14**	**0.14**	**0.17**	**−0.52**	1				
9. Number of vascular factors	1.01 (0.94)	**0.20**	**−0.05**	**−0.14**	**0.11**	**−0.07**	**−0.16**	**0.33**	**−0.39**	1			
10. Depression (% elevated symptoms)	15.1	**0.03**	**0.09**	**−0.18**	**0.06**	**−0.15**	**−0.05**	**0.30**	**−0.31**	**0.13**	1		
11. Total Recall Score	9.97 (3.64)	**−0.34**	**0.15**	**0.34**	**−0.12**	**0.10**	**0.16**	**−0.18**	**0.24**	**−0.19**	**−0.13**	1	
12. Memory rating	1.82 (0.43)	**−0.07**	**0.02**	**0.25**	**−0.10**	**0.04**	**0.11**	**−0.20**	**0.33**	**−0.13**	**−0.17**	**0.22**	1
13. Perceived memory change	3.06 (0.90)	**−0.04**	−0.01	**0.02**	**0.02**	−0.01	**0.05**	**−0.16**	**0.18**	**−0.08**	**−0.15**	**0.07**	**0.34**

Note. Bolded values are significant at $p < .05$ level. Gender was measured as (1) female and (0) male. Race was measured as (1) Non-White and (0) White. Marital status was measured as (1) married and (0) not married, and working status as (1) working and (0) non-working. Functional health was measured as the number of items (0-4) participant reported difficulty with including climbing several flights of stairs, lifting or carrying weights, walking several blocks, and kneeling, bending or stooping. Self-rated health was measured on a 5-point scale from (1) poor to (5) excellent. Vascular factors were the sum (0-4) of the following conditions: diabetes, hypertension, stroke, and heart problems. Perceived memory change was coded as (1) worse, (2) stayed the same, and (3) better. Memory rating was coded as (1) poor to (5) excellent.

Table 4

Multilevel models predicting level and change in performance and self-assessments in HRS from 2002 to 2012 (n=14,821)

	Model 1 Memory Performance			Model 2 Memory rating[a]			Model 3 Perceived memory change[a]		
	Est.	*SE*	*p*	Est.	*SE*	*p*	Est.	*SE*	*p*
Intercept	**11.49**	**0.30**	**.001**	**1.38**	**0.09**	**.001**	**1.85**	**0.04**	**.001**
Main effects									
Self-rating in 2002	**0.35**	**0.03**	**.001**						
Performance in 2002				**0.03**	**0.00**	**.001**	0.00	0.00	.092
Age	**-0.10**	**0.00**	**.001**	**0.00**	**0.00**	**.001**	0.00	0.00	.103
Gender	**1.18**	**0.05**	**.001**	**0.04**	**0.02**	**.005**	0.00	0.01	.727
Education	**0.29**	**0.01**	**.001**	**0.04**	**0.00**	**.001**	**-0.01**	**0.00**	**.001**
Race	**-1.01**	**0.07**	**.001**	**-0.11**	**0.02**	**.001**	**0.02**	**0.01**	**.035**
Marital status	0.03	0.06	.638	**-0.05**	**0.02**	**.001**	**-0.04**	**0.01**	**.001**
Working status	**0.21**	**0.06**	**.001**	**0.09**	**0.02**	**.001**	-0.01	0.01	.388
Functional limitations	**-0.08**	**0.02**	**.001**	-0.01	0.01	.174	**-0.02**	**0.00**	**.001**
Self-rated health	**0.16**	**0.03**	**.001**	**0.21**	**0.01**	**.001**	**0.05**	**0.00**	**.001**
Vascular factors	**-0.10**	**0.03**	**.002**	**0.03**	**0.01**	**.000**	0.00	0.00	.482
Depression	**-0.42**	**0.08**	**.001**	**-0.16**	**0.02**	**.001**	**-0.13**	**0.01**	**.001**
Time effects	**0.78**	**0.07**	**.001**	**0.05**	**0.02**	**.009**	**0.03**	**0.01**	**.029**
Self-rating in 2002	**-0.02**	**0.01**	**.001**						
Performance in 2002				0.00	0.00	.371	0.00	0.00	.979
Age	**-0.02**	**0.00**	**.001**	**0.00**	**0.00**	**.001**	**0.00**	**0.00**	**.001**
Gender	**-0.03**	**0.01**	**.038**	0.00	0.00	.291	0.00	0.00	.978
Education	**-0.01**	**0.00**	**.005**	**0.00**	**0.00**	**.001**	0.00	0.00	.032
Race	0.00	0.02	.956	0.01	0.00	.054	**0.01**	**0.00**	**.004**
Marital status	**0.04**	**0.01**	**.002**	0.00	0.00	.954	0.00	0.00	.898
Working status	0.01	0.01	.654	**-0.01**	**0.00**	**.040**	0.00	0.00	.145
Functional limitations	0.01	0.01	.052	0.00	0.00	.675	0.00	0.00	.904
Self-rated health	**0.01**	**0.01**	**.048**	**-0.01**	**0.00**	**.005**	0.00	0.00	.429
Vascular factors	-0.01	0.01	.063	0.00	0.00	.108	0.00	0.00	.594
Depression	0.03	0.02	.140	**0.01**	**0.01**	**.009**	**0.01**	**0.00**	**.001**

Note. Bolded values are statistically significant ($p < .05$)

[a]Higher scores indicate a higher rating of memory ability and greater stability (less decline) for perceived memory change.