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Retirement and Cognition: A Life Course View

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Abstract

This study examines the relationship between retirement and cognitive aging. We build on previous research by exploring how different specifications of retirement that reflect diverse pathways out of the labor market, including reason for leaving the pre-retirement job and duration spent in retirement, impact three domains of cognitive functioning. We further assess how early-life factors, including adolescent cognition, and mid-life work experiences, condition these relationships. To do so, we draw on longitudinal data from the *Wisconsin Longitudinal Study*, a cohort study of Wisconsin high school graduates collected prospectively starting in 1957 until most recently in 2011 when individuals were aged 71. Results indicate that retirement, on average, is associated with improved abstract reasoning, but not with verbal memory or verbal fluency. Yet, when accounting for the reason individuals left their pre-retirement job, those who had retired for health reasons had both lower verbal memory and verbal fluency scores and those who had retired voluntarily or for family reasons had improved abstract memory scores. Together, the results suggest that retirement has an inconsistent effect on cognitive aging across cognitive domains and that the conditions surrounding the retirement decision are important to understanding cognitive functioning at older ages.

Keywords

Retirement; life course; cognitive aging; longitudinal model

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1. Introduction

The life course is commonly delineated by economic activities: early life is spent in school, mid-life in work, and old age in retirement (Settersten, 2003). Such patterning almost inextricably links working, or leaving work, to the process of aging. At the same time, developmental research shows that most cognitive abilities develop along a similar path, expanding in early life, plateauing in mid-life, and beginning to decline as early as age 45 (Richards & Deary, 2014; Richards, Shipley, Fuhrer, & Wadsworth, 2004; Singh-Manoux et al., 2012). Given the coincidence of these patterns, scholars have turned to examining whether retirement – a key life course transition marking the onset of old age – hastens cognitive aging.

This growing body of research proposes that retirement constitutes a period of "disuse," wherein workers leave the labor force, and as retirees, cease using their full cognitive capabilities. While this account is compelling, it conceptualizes retirement as a single and standard transition out of the labor force. Recent evidence on the life course of retirement itself suggests that the retirement transition is increasingly destandardized, producing wide unevenness in the timing of and reasons for exit from the labor force later in life (Raymo, Warren, Sweeney, Hauser, & Ho, 2011; Szinovacz & Davey, 2005; Warner, Hayward, & Hardy, 2010). Those who choose to retire may be fundamentally different from those who cannot afford to retire or those who cannot expect to retire. To date, little research has examined how associations between retirement and cognitive aging might vary across different specifications of retirement that reflect the diverse pathways and contexts under which people make their final exit from the labor force.

This study aims to fill that gap. To do so, we draw from data on a cohort of Wisconsin high school graduates in the Wisconsin Longitudinal Study (WLS) and examine the longitudinal association between retirement and cognitive aging. We conceptualize retirement status in terms of participation in paid work, main reason for leaving pre-retirement employment (e.g. family/health/job loss), and duration of retirement. In addition to elaborating which aspects of the retirement transition are associated with cognitive aging, our use of the WLS offers important improvements over analyses of other common data. The WLS contains rich life course data beginning in adolescence across a broad range of measures relating to cognition and labor force engagement. This allows us to explore how early- and mid-life events condition the relationship between retirement and cognition in later life in a way that is not susceptible to recall bias. As a fairly age-homogenous cohort study, it also does not confound cohort- or period-effects, known to influence both retirement behavior and cognitive abilities, with age-effects (Flynn 1987). We proceed by reviewing the literature on cognition and retirement.

1.1 Retirement and cognitive aging

Two separate bodies of research speak to the connections between retirement and cognitive aging. The first, largely conducted by economists, has been overwhelmingly concerned with identifying the *causal* effect of the retirement transition in precipitating cognitive decline. The second, largely conducted by psychologists, concerns understanding the age trajectory of cognition and then examining how retirement is associated with that trajectory. The focus in the economics literature on causality has led to identification strategies (paramount among them the use of instrumental variables to proxy retirement status) that differ from those employed in the psychology literature (primarily longitudinal growth curve analysis). We discuss each in turn below.

Early treatments in the economics literature identified large effects of retirement on cognition. In a seminal paper, Rohwedder and Willis (2010) drew on cross-sectional data from the United States (U.S.) and Europe, exploiting cross-national variation in pension eligibility ages to provide instruments for retirement status. With this approach, the authors found that not working is associated with a 37% reduction in a combined measure of immediate and delayed word recall. Bingley and Martinello (2013) demonstrated that this effect is biased by a failure to control for education, as pension eligibility ages are correlated with cross-national variation in educational attainment. Cross-sectional studies accounting for education show smaller negative effects (Mazzonna & Peracchi, 2012). Mediation may also be due, in part, to variation in association between retirement and cognition by occupational class. Coe, von Gaudecker, Lindeboom, and Maurer (2012) showed using pooled cross-sections of the U.S. Health and Retirement Study (HRS) that duration spent in retirement has no impact on a number of measures of cognition for white-collar workers, and that retirement may actually benefit cognitive function for blue-collar workers. Evidence from longitudinal data adds further nuance to this picture. Using Social Security eligibility ages as instruments for retirement to analyze six waves of the HRS, Bonsang, Adam, and Perelman (2012) find that not working is associated with a 9% reduction in verbal memory, and that the effect occurs shortly after retirement (exhibiting duration effects only in a logarithmic rather than linear specification of years since retirement). Celidoni, Dal Bianco, and Weber (2013) use longitudinal data from the Survey of Health, Ageing, and Retirement in Europe (SHARE), and find that duration spent in retirement, not retirement status per se, was associated with an increased likelihood of large (>20%) declines in verbal memory. At the same, time, Bianchini and Borella (2015) find that retirement has a *positive* effect on verbal memory when allowing for a non-linear effect of age on cognition, using the same SHARE data. Together, economic research on the links between retirement and cognition is mixed, but generally shows that there are small and negative effects of retirement on verbal memory, in particular. Most of this research has relied on surveys of individuals at older ages, precluding analysis of longer trajectories. As such, it also does not consistently take into account how life course events, especially those that occur in early life, relate to cognition, or mediate the relationship between retirement and cognition, at older ages.

Mapping cognitive change over the life course has been a central aim of a large body of research in psychology (Hofer & Clouston, 2014; Hofer & Sliwinski, 2001; Sliwinski, 2010). Understanding cognition at older ages has thus led scholars to study retirement as one, among many, possible changes in daily activity patterns that shape *trajectories* of cognitive aging. As such, this research employs primarily longitudinal methods. Roberts, Fuhrer, Marmot, and Richards (2011) for instance, examined the Whitehall II cohort of U.K. civil servants and found that retirees showed lower growth in scores on cognitive tests than those who remained working. Wickrama and O’Neal (2013) use the 1998–2006 HRS to model how a change in work status from 1998 to 2002 impacted subsequent cognitive aging. Their growth curve analysis shows that individuals who transitioned to retirement displayed greater deterioration in verbal learning, but not verbal memory, than those who continued to work.

While studies in both fields suggest that retirement influences cognition, the characteristics of retirement that are meaningful to cognitive health remain unclear, at least in part because of variability or lack of specificity in the definition of retirement across studies. Research often specifies retirement as a "lack of work," equating retirees with those not working for any other reason (Bonsang et al., 2012; Rohwedder & Willis, 2010). As discussed in the next section, non-employment is a poor proxy for retirement: labor force participants are often healthier than non-participants because unhealthy people have fewer opportunities to, and more barriers involved in, working. Even when researchers use a more fine-grained definition of retirement (e.g, Wickrama and O'Neal 2013), few studies have accounted for the reasons individuals retire, which may provide insight into their subsequent cognitive health. In the next section we discuss the meaning of retirement in contemporary labor markets and how it may impact understanding of aging-related processes.

1.2. The retirement life course

Retirement has historically been viewed as a single and irreversible exit from work, in part because statutory pension eligibility ages commonly influence the decision to retire, even defining one's retirement status (Gruber and Wise 1998). Recent economic and policy-related changes away from career employment have meant that retirees experience labor force exits that vary in timing, degree, and income shock. Contemporary research on the retirement life course conceptualizes it as a multi-faceted and dynamic process that comprises interrelated transitions, and may be characterized by considerable heterogeneity in age at first retirement, duration of retirement, and likelihood of re-entry to the labor force (Kail & Warner, 2013; Warner et al., 2010). For instance, Warner et al. (2012) find that over 70% of men's retirement transitions occur outside the framework of Social Security eligibility ages in the U.S., a result supported by Raymo et al. (2011). Individuals increasingly re-enter the labor force after retiring by engaging in "bridge" jobs, especially if they retired earlier than anticipated (Heinz, 2003).

Such differences may be informative to complexity in aging-related processes: not only is involuntary job loss at older ages associated with deterioration in mental health and increased depression, older job losers also experience deterioration in physical health, and engage in worse health behaviors, like drinking (Gallo, Bradley, Siegel, & Kasl, 2000, 2001). The same is true for individuals who perceive their retirement as involuntary (van Solinge & Henkens, 2007). Henkens, van Solinge, and Gallo (2008), for instance, show that involuntary retirees were more likely to increase smoking behaviors and less likely to decrease alcohol use than those that retired voluntarily. Similarly, Dingemans and Henkens (2014) finds that individuals who worked in a "bridge job" following retirement because they enjoyed working actually experienced increased life satisfaction post-retirement. Together these findings suggest substantial differences in the context and timing of retirement, and in the types of activities engaged in during retirement, including both health-related behaviors and re-employment. These types of differences may engage three theories connecting retirement to cognition: 1) engagement, 2) reserve, and 3) disruption/stress; which we explain respectively below.

1.2.1. Engagement—Engagement theories advocate that individuals at the time of retirement experience large changes in daily activity patterns: retirees leave a work life that requires regular "use" of cognitive capacity and enter into a more sedentary retirement lifestyle, in which they "lose" cognitive ability. The "use it or lose it" hypothesis, as originally formulated (Hultsch, Hertzog, Small, & Dixon, 1999), has been used to suggest that individuals lose cognitive abilities because they are not engaged in tasks that demand efficient cognitive function (Rohwedder & Willis, 2010). Further, economists have also highlighted the incentives that labor market participants have to practice cognitive skills, which, as a form of human capital, they will profit from in the labor market – retirees, or those anticipating an impending exit, on the other hand do not (Mazzonna & Peracchi, 2012; Rohwedder & Willis, 2010). This implies that regardless of whether a person is currently working, those individuals planning to work longer will invest in maintaining their cognitive abilities. Outside of cognitive tasks demanded by the work process, the workplace itself may support cognitive function by providing opportunities for social interaction, physical activity, or a structure to orient action. Individuals that believe the latter may also be less likely to retire as an explicit strategy to maintain health at older ages.

1.2.2. Reserve—Education and occupational activities throughout life may work to develop efficient brain processing capabilities resulting in increased cognitive capacity, often called "cognitive reserve" (Clouston et al., 2012; Glymour, Kawachi, Jencks, & Berkman, 2008; (Glymour, Tzourio, & Dufouil, 2012; Richards & Sacker, 2003; Scarmeas & Stern, 2003; Stern, 2002, 2009; Valenzuela & Sachdev, 2005). Reserve is built in a number of different environments, yet schooling and work experiences stand out as prime influences because of relatively large amount of time spent in each. For example, complex occupational tasks require individuals daily to build connections in the brain that may disrupt or delay aging-related processes. While some individuals may be genetically predisposed to (or protected from) degenerative diseases, the development of cognitive reserve can slow the start or pace of cognitive decline (Deary, 2012; Johnson, Deary, & Iacono, 2010). Ceasing occupational activity at retirement halts the growth of reserve, but retirees with varying levels of cognitive reserve may experience different paths of cognitive aging.

1.2.3. Stress/Disruption—Unexpected labor market transitions may induce significant stress, economic hardship, and social isolation, which researchers have posited will be associated with poor health (Lynch, Kaplan, & Shema, 1997; Zunzunegui, Alvarado, Del Ser, & Otero, 2003). For instance, Fryer and Warr (1984) classically argued that unemployment, or the lack of gainful employment when such employment is desired, simultaneously leads to a deficit in stimulation in the absence of work, and stress because it forces individuals to confront unknown problems with dwindling resources and thus consider difficult choices. More recently, Gallo et al. (2000) show that job displacement among older workers is associated with worse self-rated mental health. Similarly, involuntary job loss at older ages is associated with increased depressive symptoms (Brand, Levy, & Gallo, 2008; Gallo et al., 2006), as is retirement that is perceived as involuntary

(Hyde, Hanson, Chungkham, Leineweber, & Westerlund, 2015). Retirement, if unplanned or financially unviable, may constitute a disruptive or stressful transition that precipitates deterioration in cognitive health[1].

Together these theories allow us to formulate the following hypotheses:

1. We expect that retirement is associated with lower cognition, as individuals will experience large changes in their daily activity patterns.
2. The relationship between retirement and cognition may be confounded by early life factors and mid-life work experiences, representing the stock of cognitive reserve built over the life course.
3. We anticipate that the time-variant conditions selecting people into retirement will confound the effect of retirement on cognition, with those who leave work as a result of a job loss or health reasons having lower cognitive scores.

To evaluate these hypotheses, we turn to a cohort study with rich life course data.

2. Methods

2.1 Data

Data come from the Wisconsin Longitudinal Study (WLS), a random sample (N=10,317) of 1/3 of the 1957 Wisconsin high school graduating class who were followed up for cognition at ages 53, 64, and 71 (Hauser, Sewell, & Herd, 2012; Herd, Carr, & Roan, 2014). The WLS design offers two main advantages over other data sources. First, precise measurement of early life events, including concurrent measures of adolescent cognition and family socioeconomic status, and educational attainment in early adulthood, allow us to explore how the development of cognitive reserve early in life affects cognitive aging in a way that is not susceptible to recall bias. Second, age-homogeneous cohort studies do not confound cohort- or period-effects, known to influence both timing of retirement and cognitive capability (Elder & Pavalko, 1993; Flynn, 1984, 2007), with age-effects, resulting in greater specificity (Piccinin et al., 2012).

To account for potential healthy-worker effects, the sample was limited to those employed (n=7,196) at the 1992–1993 interview (average age 53), resulting in a sample of 6,816 men and women who hadn't yet retired. Respondents were further excluded if they left work without indicating retirement in a subsequent interview, as we are unable to ascertain when these respondents stop actively looking for work (n=318). Our second wave of data was collected over 2003–2005 when respondents were on average aged 64, many of whom would already be within the window of first receipt for full Social Security benefits. At age 64, 554 individuals were lost to non-response, and 371 individuals had died. By age 71, the third wave of data collected in 2011, 552 had died since their last interview while 1021 were lost to non-response. After excluding cases with missing data on covariates, we are left with

[1]Clinical studies have demonstrated that exposure to acute stress releases hormones that reach the brain and ultimately affect cognitive functioning, both potentially heightening and diminishing cognitive performance (Lupien, McEwen, Gunnar, & Heim, 2009). Studies that focus on chronic stress, however, particularly those which draw on measures of allostatic load, document deficits in cognitive functioning associated with more prolonged exposure to stress (Evans & Schamberg, 2009; Juster, McEwen, & Lupien, 2010).

an analytic sample of 5,853 at the first interview wave, 4,932 at the second interview wave, and 4,135 in the final interview wave.

2.1.1 Cognition—Fluid cognition is susceptible to aging-related declines and is associated with cognitive pathologies such as Dementia (Horn & Cattell, 1967). We use indicators of three domains of fluid cognition: abstract reasoning, verbal fluency, and verbal memory. *Abstract reasoning* was measured using the Weschler Adult Intelligence Scale – Similarities construct and is available in 1992, 2003, and 2011. Respondents are asked to relate two words; for instance, "How are an apple and orange alike?" to which they should respond that both are fruits. *Verbal fluency* was measured by having respondents list as many words in sixty seconds as possible starting with either the letter F or L, depending on version, and is only available in 2003 for an 80% random subsample and in 2011 for the full sample. *Word recall* is constructed by adding verbal learning and verbal memory scores. Verbal learning and verbal memory were measured together: respondents are read a series of 10 words, and then asked to immediately repeat the words to the interviewer. The number correct indicates verbal learning. To measure verbal memory, after about 12 minutes and other cognitive questioning respondents are again asked to recall the full list of words. In both 2003 and 2011, verbal learning and memory were assessed for an 80% random subsample of WLS respondents. All cognition scores are standardized at each measurement wave for comparability.

2.1.2 Retirement and Job Characteristics—Three measures of retirement facilitate evaluation of our hypotheses. Information on retirement is drawn from the respondent's work history. Detailed work episode histories for up to eight employer spells are constructed retrospectively at each survey for the time period between interviews. Reasons for end of spell are given; for each spell respondents additionally report the start and end dates of their job, their industry, occupation, type of work, and whether or not they were working full- or part-time. *Retirement* is indicated first by employment status, with individuals not currently working and reporting a retirement at any point prior to the interview coded as retired.[2] This measure of employment status aids in evaluating the first hypothesis by signaling the respondent's engagement with work activities. We then examine the main *reason for retirement*, for which we note whether the respondent reported leaving their first pre-retirement job for *voluntary*, *family-related*, *involuntary job loss*, or *health-related reasons*. Voluntary reasons include choosing to retire, no longer needing money from employment, travelling, or even working on the house, among others. Family-related reasons involve following a spouse to a new job, staying at home to care for children or grandchildren, and getting married. Involuntary job losses include downsizings, plant relocations, and layoffs.[3] These reasons capture variation in choice over the retirement transition, which has been

[2]Data on retirement may also be gleaned from a separate section of the interview in which people are asked whether they consider themselves completely retired, partly retired or not retired at all. The different modes of collecting information about retirement tap into two distinct parts of the retirement transition – leaving career employment (often upon receipt of a pension) and leaving the labor market. As we are interested in how not working relates to cognitive function, we rely on information about the respondent's current employment status. Sensitivity analyses reveal the two measures produce comparable substantive conclusions.

[3]Voluntary separations may include: retirement; other work related reason; respondent, spouse, transferred/took a new job; no longer needed the income; respondent found new job/changed job; looked for/needed/wanted another job; began own business/became a partner in business; sold own business or farmland; distance to work was too far from home; second job became main job; wanted to work part time or not as much; changed schools; joined or started family business; entered the military; started/ended political career;

associated with whether individuals perceive their retirement as involuntary or voluntary (Szinovacz & Davey, 2005). They further offer insight into how stressful and disruptive events surrounding retirement relate to cognitive decline, shedding light on our third hypothesis. Finally, we also model *duration* of retirement as the natural log of annual time since most recent retirement or job separation. We further conduct sensitivity analysis with a linear specification of retirement duration. These measures specify the temporal impact of disengagement on cognition.

Retirement transitions are often influenced by normative career patterns within occupations, industries, and employment sectors. Different types of jobs may also facilitate development of unique stocks of cognitive reserve over the life course. To evaluate our second hypothesis, looking at how mid-life career experiences relate to cognition at older ages, we used respondent's job in 1992 to provide the following *job characteristics*: goods-producing or service-related industries, as identified by the 1990 Census major industry; upper white collar, lower white collar, and blue collar, based on the 1990 census major occupation; and private employee, government employee, or self-employed. We further took into account the occupational education score, or the percentage of the occupation with at least one year of college, of the 1992 job[4]. As the job the respondent held when they were on average 53 years old, it is often of long duration and, if work tasks are related to the cognition scores, the job that likely exerts the greatest influence on cognition at midlife.

2.1.3 Resources and Health—We measure health with time-varying indicators of serious health conditions or events, including stroke, diabetes, cancer, and heart problems. For respondents who did not respond to the mail survey in 1992 and for the stroke measure, which was not asked in 1992, we follow Raymo et al. (2011) who use year of diagnosis and 2003 health status to impute the 1992 value, and for all others assign a value of zero.

Our analysis considers financial resources in two ways. First, we indicate whether the respondent at the time of the interview was included in an employer provided pension plan. Second, we measure the respondent's net worth in 1992. Net worth represents the assets and debts of the respondent and his/her spouse, including the value and amount owed on homes, real estate, businesses and farms, motor vehicles, as well as any other debts and savings and investments. We measure the respondent's percentile rank in the 1992 distribution of net worth. We do not include time-varying measures of wealth, as a change in wealth may be a function of retirement status as individuals spend down savings, rather than any meaningful differences in consumption across individuals.

moved or relocated; wanted to do something else (took time off); went to school; to do volunteer work; travel, vacation, sabbatical; study (not in school), self-improvement; religious reasons, became a missionary; to build a new home or work on the house; economic or financial reasons/bankruptcy; personal problems or resources; entered a seminary; workplace conflict; other voluntary termination. Involuntary separations include: business/employer closed; business downsized, mass layoff; business relocated; other involuntary termination (help not needed); temporary/seasonal layoff; business sold, bought out, changed owners; temporary job ended, contract completed; lost business or farm; job reorganization/promotion meant moving; needed degree or not enough training. Family reasons include: family reason; stayed home/took care of house/children; get married, have children, raise a family; relative's/unspecified person's health reason; spouse retired or wanted to retire; spouse's illness, health reason or death; babysit grandchildren (with or w/o pay); spend time with family/friends

[4]We further transform the variable to a started logit, as recommended by Hauser and Warren (1997), to account for heteroscedasticity.

2.1.4 Early life factors—Finally, we account for a wide range of early life factors to further evaluate how cognitive reserve built early in life relates to cognition at older ages. In 1957, the WLS interviewed respondents and their parents to provide information on the family background and social status of respondents in childhood and adolescence. Family socioeconomic standing is assessed by 1957 family income, mother's highest level of education in years, and father's occupational attainment, expressed as the 1970 Duncan Socioeconomic Index (0–100 scale). Adolescent cognition (cognition at 16) is taken from the junior year Hemnon-Nelson test of cognitive abilities, available from public school records. Education was measured at age 36, an age at which respondents were likely to have completed most of their schooling. We collapsed this measure into four categories: finishing high school, completing some college, receiving a Bachelor's degree, or receiving a graduate or professional degree.

2.2 Methods

Our analysis centers on examining how retirement alters the path of cognitive aging. We use longitudinal multilevel mixed effects models of the following form to chart the cognitive aging process:

$$Y_{it}=\beta_0+\beta_1 A_0+\beta_3 X_{it}+\gamma_{0i}+(\beta_4+\beta_5 R_{it}+\gamma_{1i})t_{it}+\varepsilon_{it}$$

where A refers to age, X refers to included covariates which may vary both between persons (i) and within persons over time (t), γ_{0i} refers to time-invariant random intercepts that model individuals differences in baseline cognition, and γ_{1i}t refers to individual-specific rates of cognitive change over time (Piccinin et al., 2012). An unstructured covariance matrix was used to account for the association between intercepts and slopes thereby adjusting for regression to the mean over time (Liu, Lu, Mogg, Mallick, & Mehrotra, 2009).

To examine how retirement relates to this trajectory of cognitive aging, we first estimate average associations between retirement (R_{it}) and level of cognition. To examine functional specifications, we entered retirement as a dichotomous indicator (retired/not retired) and as the reason for retirement (voluntary/family related/involuntary job loss/health). This specification restricts the effect of retirement to be constant across the path of cognitive aging. In the second part of our analysis we turn to examining how time spent in retirement is associated with cognition, in effect allowing the impact of retirement to vary over the trajectory of cognitive aging. We model time spent in retirement as both a linear and logarithmic specification, as previous research indicates that the effect varies across these functional forms (Bonsang et al. 2012).

A huge body of prior work has noted that the associations between early life exposures and cognitive aging tend to be solely in improving capability and not slowing aging (Piccinin et al., 2012; Singh-Manoux et al., 2011). As such, early life factors were included as baseline covariates to model capability and selection in the risk of retirement but were not allowed to modify slopes. Because retirement is often associated with concomitant episodic changes in health and activities, as well as lowered overall capability, time-variant indicators of health were included as covariates. Thus, in a baseline model we estimate the relationship between the measure of cognition and retirement conditioning on only age and gender. For all subsequent specifications, we condition the relationship between cognition and retirement on covariates that would likely impact levels of cognitive reserve or the cumulative life course effects of employment, including early life family conditions, adolescent cognition, educational attainment, and job characteristics of mid-career employment, as previously described. Table 1 presents descriptive statistics for these covariates. Although our waves are years apart, respondents could improve cognitive scores by simply learning how the test works (Rast, 2011). To control for learning effects, we include a dummy variable for the first measurement wave. We ran sensitivity analyses where we split the regressions by gender, and make note of any differences in the text.

3. Results

Table 2 presents retirement status and cognition in 1992, 2003, and 2011. Abstract reasoning scores increased on average from 6.22 in 1992 to 6.67 in 2003. Between 2003 and 2011, scores decreased to an average of 6.39. In 2003, respondents could remember an average of 10.19 out of 20 words given in the word recall tests, which decreased to 8.92 words in 2011 (age 71). Verbal fluency declined from 11.49 words to 11.22 words over the same time period.

By 2003 the average age of respondents was 64, approaching the age at which individuals may draw on public pensions in the U.S. without penalty. Yet, 50% of the respondents were still working. By 2011, when respondents were 71 on average, a large minority of respondents remained in work (31%). While many reported leaving for reasons that reflect a voluntary decision to retire, by 2011, 10% of retirees had left their pre-retirement job because of an involuntary job loss and 9% had done so for health reasons. Thus, a substantial proportion of the cohort was working well past statutory retirement age, and of those who had retired a considerable minority had done so under constrained circumstances (~20% of retirees had done so as a result of a job loss or for health related reasons).

We next turn to examining the longitudinal association between retirement and three measures of cognition. Table 3 presents random intercept models predicting word recall between 2003 and 2011. Model 1 shows that retirees had lower word recall scores than those currently working, although the relationship was not significant. Adjusting for adolescent cognition, health, and education and job characteristics further suppressed this relationship (Model 2). Of note, cognition at age 16 has a significant and positive impact on cognition at older ages. Mid-life work experiences were also important predictors of later life cognition, with individuals who had worked in a blue-collar occupation displaying lower word recall scores, even after accounting for education. Similarly, individuals who had suffered a stroke had significantly lower word recall scores. The lack of association between retirement and word recall, on average, masks a countervailing pattern by reason for retirement. Model 3 reveals that individuals who had retired for health reasons displayed lower word recall scores. Finally, retirement duration, specified in both logarithmic and linear form, was not associated with lower word recall scores (Models 4/5). Together, the results suggest that word recall is not sensitive to an individual’s employment status. Some retirees do have lower word recall scores, but this seems to reflect the reasons surrounding selection into retirement rather than lack of work alone.

Table 4 presents random intercept models for verbal fluency. Model 1 indicates that those individuals who were retired had lower verbal fluency scores than individuals who remained working. Adjusting for background characteristics attenuated the association (Model 2). Working in a blue-collar occupation was associated with lower verbal fluency scores, as were some health events/conditions, like having a stroke or diabetes. When considering the reason for retirement (Model 3) we found that those who left for health reasons had significantly lower cognitive scores than those who remained working. Models which interacted gender and reason for retirement (not presented) revealed a positive association between retiring for family related reasons and verbal fluency scores for men. Additionally, retirement duration was negatively associated with verbal fluency in both the linear and logarithmic specifications (Models 4/5).

Finally, we turn to examining abstract reasoning. Table 5 presents mixed effects models for abstract reasoning, for which we have 3 waves of data. Counter to expectations, we find that retirement is associated with better abstract reasoning (Model 1), an association that only strengthens once controlling background characteristics (Model 2). The positive association, however, varies according to reason for leaving pre-retirement employment, with better scores limited to those who left employment for voluntary or family related reasons (Model 3). Finally, retirement duration was correlated with higher cognition, but only in the logarithmic specification, indicating that retirement may lead to a short-term benefit that plateaus over time. Covariate results further suggest that working in a higher status occupation was associated with improved abstract reasoning, as was working in upper white-collar occupations. In these models, both the random intercept and slope were substantially larger than 0, and these negatively covaried indicating that those with higher scores at baseline were expected to age more rapidly than those whose scores were lower, indicating some regression to the mean in cognition scores.

4. Discussion

A contemporary debate suggests that those who retire are debilitated by “mental retirement” (Rohwedder and Willis 2010). Our results present a more nuanced story. We first hypothesized that individuals who were not working would have lower cognitive functioning, as they were not engaged in cognitively stimulating tasks provided by employment. Our analyses found an inconsistent relationship between a dichotomous measure of retirement and cognitive function across cognitive tests. This inconsistency was evident even after adjustment for a rich set of confounders. Whereas retirement, on average, was not associated with word recall or verbal fluency scores, it was positively associated with abstract reasoning. While previous research has shown a possible benefit of retirement for verbal memory (Bianchini & Borella 2015; Coe et al. 2012), this is the first study to show a potential benefit for abstract reasoning scores.

We further found that time spent disengaged from the labor force related to different patterns of cognitive aging across measures. Retirement exhibited a negative dose-response relationship for verbal fluency in addition to the effect of age. We failed to find a duration effect of retirement for word recall, for which we also failed to find an average effect of retirement after adjusting for developmental characteristics. For abstract reasoning, however, we found countervailing patterns, depending on the specification: logarithmic time spent out of work displayed a positive relationship with cognition, while the linear specification was not significant. This specification is consistent with Bonsang et al. (2012), who found that most of the decline associated with retirement occurs in the years directly following labor market exit, and then plateaus at longer durations; however, while Bonsang et al. (2012) found negative effects and with regard to memory, we found a positive association when examining abstract reasoning, which does not compound over time.

Our second hypothesis offered that life course events, which would lead to differential development of cognitive reserve over the lifespan, would influence cognitive aging and even impact the relationship between retirement and cognition. Results lend support to this hypothesis, indicating a strong connection between early life cognition, educational attainment and work histories, and cognition later in life. Across all cognitive domains, better cognition at age 16 was related to better cognition in mid- to late-life. Similarly, there was a strong link between educational attainment and higher cognition scores. Work experience measured at mid-life showed a more variable influence on cognition. For instance, for word recall, only blue-collar work was associated with lower scores. Verbal fluency was also lower for individuals that worked in blue-collar jobs, but individuals working in occupations with more highly educated individuals had higher scores, net of their own educational attainment. Abstract reasoning scores were higher for upper white-collar workers, as well as individuals working in occupations with highly educated colleagues. Together, these results suggest that cognitive reserve develops over the life course, even at early ages, and domains like school and work will shape the cognitive aging process and mediate the relationship between work status and cognitive in older ages. At the same time, the impact of these factors varied across cognitive domains.

Finally, we posited that disruptive retirement transitions would be associated with lower cognitive functioning. And while the impact of retirement was inconsistent across cognitive domains, findings consistently showed that *reason* for retirement mattered for cognitive functioning across domains. First, retirement for health reasons was independently associated with lower word recall and verbal fluency scores. This suggests that negative health selection may be important in understanding the relationship between retirement and cognition. In contrast, retiring for family related reasons, such as taking care of a spouse or grandchildren, was associated with higher cognitive scores on tests of abstract reasoning. Caring for family, or transitioning into other activities post-retirement, may be protective for cognition in later life. Further, retiring for voluntary reasons was also associated with improved abstract reasoning. Retiring when financially secure and in relatively good health may alleviate stress associated with work, improving some forms of capability.

Considered together, these results have a number of implications for the role of work in shaping cognitive aging. First, not all cognitive domains respond to work engagement, or absence of it, in the same way. Proscriptions to continue working as a way to maintain cognitive health at older ages may ultimately bear results for some types of cognitive functioning, but have a limited impact on others. Further, the type of work one engages in over the course of their life relates to the development of different types of cognitive reserve later in life; specific career contexts shape what precisely there is to be lost. Second, and perhaps most telling, the impact of retirement on cognition relates strongly to the conditions that select individuals into retirement, with negative effects concentrated in individuals who retire explicitly for health reasons and benefits limited to those leaving for family or voluntary reasons. If the negative impact of disengagement from employment is largely confined to those who feel they cannot continue working because of their poor health, it is unlikely that encouraging a longer work life will provide a reasonable reversal to such health deterioration.

4.1 Limitations

Our data are not generalizable to those that are not 1957 Wisconsin high school graduates, though the homogeneity of the sample also limits bias due to unobserved heterogeneity. These results may therefore be conservative, especially as they show that individuals make retirement decisions based on both education and employment histories, which tend to vary more nationally. Moreover, to improve our characterization of retirement, abstracted from unemployment, we lost individuals who were unemployed or not in the labor force. However, this abstraction represents a clearer picture of what we commonly imagine as being retirement, which is not defined by the lack of work but rather by a decision to leave gainful employment in older age. The small number of measurement waves available for cognition limits results: in particular, verbal fluency and memory were unavailable at midlife, potentially biasing results from these domains and limiting methodological consistency between analyses. There was substantial sample attrition in this study. Longitudinal MLM is unbiased by attrition due to factors incorporated in the model, such as geographic mobility relating to retirement. However, results may be biased if those who attrite were experiencing accelerated cognitive aging. Further analysis investigating retirement and cognitive aging should incorporate both sufficient follow-ups and observe individuals as they retire. Third, we do not have adequate measures of stress for this sample, and as a result cannot directly identify the mechanisms associated with improved abstract reasoning scores in retirement. Future research could benefit from elaborating the linkages between levels and types of work-related stress in modifying the association between retirement and cognition. Notwithstanding these drawbacks, our results offer a thorough analysis of the association between cognition and multiple specifications of retirement. Moreover, our results benefit from adjustment for life course capability, as well as late-life cognitive capability before retirement. Finally, we rely on age-homogeneous data that are not biased by cohort-related change.

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Madison, 1180 Observatory Drive, Madison, Wisconsin 53706 and at http://www.ssc.wisc.edu/wlsresearch/data/. The opinions expressed herein are those of the authors.

References

Bianchini L, Borella M. Retirement and memory in Europe. Ageing & Society. 2015; :1–25. DOI: 10.1017/S0144686X15000434

Bingley P, Martinello A. Mental retirement and schooling. European Economic Review. 2013; 63:292–298.

Bonsang E, Adam S, Perelman S. Does retirement affect cognitive functioning? Journal of health economics. 2012; 31(3):490–501. [PubMed: 22538324]

Brand JE, Levy BR, Gallo WT. Effects of Layoffs and Plant Closings on Depression Among Older Workers. Research on aging. 2008; 30(6):701–721. DOI: 10.1177/0164027508322574 [PubMed: 20011238]

Celidoni M, Dal Bianco C, Weber G. Early retirement and cognitive decline. A longitudinal analysis using SHARE data. 2013 Retrieved from.

Coe NB, von Gaudecker HM, Lindeboom M, Maurer J. The effect of retirement on cognitive functioning. Health Economics. 2012; 21(8):913–927. DOI: 10.1002/hec.1771 [PubMed: 21818822]

Deary I. Looking for "System Integrity" in Cognitive Epidemiology. Gerontology. 2012; 58(6):545–553. [PubMed: 22907506]

Dingemans E, Henkens K. Involuntary retirement, bridge employment, and satisfaction with life: A longitudinal investigation. Journal of Organizational Behavior. 2014; 35(4):575–591. DOI: 10.1002/job.1914

Elder GH, Pavalko EK. Work careers in men's later years: Transitions, trajectories, and historical change. Journal of Gerontology. 1993; 48(4):S180–S191. [PubMed: 8315242]

Evans GW, Schamberg MA. Childhood poverty, chronic stress, and adult working memory. Proceedings of the National Academy of Sciences. 2009; 106(16):6545–6549. DOI: 10.1073/pnas.0811910106

Flynn JR. The mean IQ of Americans: Massive gains 1932 to 1978. Psychological Bulletin. 1984; 95(1):29.doi: 10.1037/0033-2909.95.1.29

Flynn, JR. What is intelligence?: Beyond the Flynn effect. Cambridge: Cambridge University Press; 2007.

Fryer D, Warr P. Unemployment and cognitive difficulties. British Journal of Clinical Psychology. 1984; 23(1):67–68. [PubMed: 6697031]

Gallo WT, Bradley EH, Dubin JA, Jones RN, Falba TA, Teng HM, Kasl SV. The Persistence of Depressive Symptoms in Older Workers Who Experience Involuntary Job Loss: Results From the Health and Retirement Survey. The Journals of Gerontology Series B: Psychological Sciences and Social Sciences. 2006; 61(4):S221–S228.

Gallo WT, Bradley EH, Siegel M, Kasl SV. Health effects of involuntary job loss among older workers: findings from the health and retirement survey. The Journals of Gerontology Series B: Psychological Sciences and Social Sciences. 2000; 55(3):S131–140.

Gallo WT, Bradley EH, Siegel M, Kasl SV. The Impact of Involuntary Job Loss on Subsequent Alcohol Consumption by Older Workers: Findings From the Health and Retirement Survey. The Journals of Gerontology Series B: Psychological Sciences and Social Sciences. 2001; 56(1):S3–S9. DOI: 10.1093/geronb/56.1.S3

Glymour MM, Tzourio C, Dufouil C. Is Cognitive Aging Predicted by One's Own or One's Parents' Educational Level? Results From the Three-City Study. American Journal of Epidemiology. 2012; 175(8):750–759. DOI: 10.1093/aje/kwr509 [PubMed: 22472116]

Hauser, RM., Sewell, WH., Herd, P. Wisconsin Longitudinal Study (WLS): 1957–2012 Version 13.03. 2012. Retrieved from: http://www.ssc.wisc.edu/wlsresearch/documentation/>

Hauser RM, Warren JR. Socioeconomic indexes for occupations: A review, update, and critique. Sociological methodology. 1997; 27(1):177–298.

Heinz, WR. Combining methods in life-course research: A mixed blessing. In: Heinz, WR., Marshall, VW., editors. Social dynamics of the life course: Transitions, institutionalism and interrelations. New York: Aldine de Gruyter; 2003. p. 73-90.

Henkens K, van Solinge H, Gallo WT. Effects of retirement voluntariness on changes in smoking, drinking and physical activity among Dutch older workers. The European Journal of Public Health. 2008; 18(6):644–649. DOI: 10.1093/eurpub/ckn095 [PubMed: 18927184]

Herd P, Carr D, Roan C. Cohort Profile: Wisconsin longitudinal study (WLS). International Journal of Epidemiology. 2014; 43(1):34–41. DOI: 10.1093/ije/dys194 [PubMed: 24585852]

Hofer SM, Clouston S. Commentary: On the Importance of Early Life Cognitive Abilities in Shaping Later Life Outcomes. Research in Human Development. 2014; 11(3):241–246. DOI: 10.1080/15427609.2014.936173 [PubMed: 25309140]

Hofer SM, Sliwinski MJ. Understanding ageing. Gerontology. 2001; 47(6):341–352. [PubMed: 11721149]

Horn J, Cattell R. Age differences in fluid and crystallized intelligence. Acta Psychologia. 1967; 26:107–129.

Hultsch DF, Hertzog C, Small BJ, Dixon RA. Use it or lose it: Engaged lifestyle as a buffer of cognitive decline in aging? Psychology and Aging. 1999; 14(2):245. [PubMed: 10403712]

Hyde M, Hanson LM, Chungkham HS, Leineweber C, Westerlund H. The impact of involuntary exit from employment in later life on the risk of major depression and being prescribed anti-depressant medication. Aging Ment Health. 2015; 19(5):381–389. DOI: 10.1080/13607863.2014.927821 [PubMed: 24946236]

Johnson W, Deary I, Iacono WG. Genetic and environmental transactions underlying educational attainment. Intelligence. 2010; 37(5):466–478.

Juster RP, McEwen BS, Lupien SJ. Allostatic load biomarkers of chronic stress and impact on health and cognition. Neuroscience & Biobehavioral Reviews. 2010; 35(1):2–16. http://dx.doi.org/10.1016/j.neubiorev.2009.10.002. [PubMed: 19822172]

Kail BL, Warner DF. Leaving Retirement: Age-Graded Relative Risks of Transitioning Back to Work or Dying. Population research and policy review. 2013; 32(2):159–182.

Liu GF, Lu K, Mogg R, Mallick M, Mehrotra DV. Should baseline be a covariate or dependent variable in analyses of change from baseline in clinical trials? Statistics in medicine. 2009; 28(20):2509–2530. [PubMed: 19610129]

Lupien SJ, McEwen BS, Gunnar MR, Heim C. Effects of stress throughout the lifespan on the brain, behaviour and cognition. Nature Reviews Neuroscience. 2009; 10(6):434–445. [PubMed: 19401723]

Lynch J, Kaplan G, Shema S. Cumulative Impact of Sustained Economic Hardship on Physical, Cognitive, Psychological, and Social Functioning. Massachuetts Medical Society. 1997; 337(26): 1889–1895.

Mazzonna F, Peracchi F. Ageing, cognitive abilities and retirement. European Economic Review. 2012; 56(4):691–710.

Piccinin A, Muniz G, Clouston S, Deary I, Deeg D, Johansson B, … Hofer SM. Coordinated Analysis of Age, Sex, and Education Effects on Change in MMSE Scores. Journals of Gerontology Series B-Psychological Sciences and Social Sciences. 2012; 68(3):374–390. DOI: 10.1093/geronb/gbs077

Rast P. Verbal knowledge, working memory, and processing speed as predictors of verbal learning in older adults. Developmental psychology. 2011; 47(5):1490. [PubMed: 21574701]

Raymo JM, Warren JR, Sweeney MM, Hauser RM, Ho JH. Precarious employment, bad jobs, labor unions, and early retirement. The Journals of Gerontology, Series B: Psychological Sciences and Social Sciences. 2011; 66(2):249–259. DOI: 10.1093/geronb/gbq106

Richards, M., Deary, I. A life course approach to cognitive capability. In: Kuh, D.Cooper, R.Hardy, R.Richards, M., Ben-Shlomo, Y., editors. A Life Course Approach to Healthy Ageing. Oxford: Oxford University Press; 2014.

Richards M, Sacker A. Lifetime antecedents of cognitive reserve. Journal of Clinical and Experimental Neuropsychology. 2003; 25(5):614–624. [PubMed: 12815499]

Richards M, Shipley B, Fuhrer R, Wadsworth M. Cognitive ability in childhood and cognitive decline in mid-life: longitudinal birth cohort study. British Medical Journal. 2004; 328(7439):552–557. [PubMed: 14761906]

Roberts BA, Fuhrer R, Marmot M, Richards M. Does retirement influence cognitive performance? The Whitehall II Study. Journal of epidemiology and community health. 2011; 65(11):958–963. [PubMed: 20940172]

Rohwedder S, Willis RJ. Mental Retirement. Journal of Economic Perspectives. 2010; 24(1):119–138. [PubMed: 20975927]

Scarmeas N, Stern Y. Cognitive reserve and lifestyle. Journal of Clinical and Experimental Neuropsychology. 2003; 25(5):625–633. [PubMed: 12815500]

Settersten, RA. Age structuring and the rhythm of the life course. In: Mortimer, JT., Shanahan, MJ., editors. Handbook of the Life Course. Springer; 2003. p. 81-98.

Singh-Manoux A, Kivimaki M, Glymour MM, Elbaz A, Berr C, Ebmeier KP, … Dugravot A. Timing of onset of cognitive decline: results from Whitehall II prospective cohort study. BMJ: British Medical Journal. 2012:344.

Singh-Manoux A, Marmot MG, Glymour M, Sabia S, Kivimäki M, Dugravot A. Does cognitive reserve shape cognitive decline? Annals of neurology. 2011; 70(2):296–304. [PubMed: 21563209]

Sliwinski, MJ. Within and Between Person Aging: From Marking time to Measuring Process. Paper presented at the Integrative Analysis of Longitudinal Studies on Aging; Victoria, BC. 2010.

Stern Y. What is cognitive reserve? Theory and research application of the reserve concept. Journal of the International Neuropsychological Society. 2002; 8:448–460. [PubMed: 11939702]

Stern Y. Cognitive reserve. Neuropsychologia. 2009; 47(10):2015–2028. [PubMed: 19467352]

Szinovacz ME, Davey A. Predictors of Perceptions of Involuntary Retirement. The Gerontologist. 2005; 45(1):36–47. DOI: 10.1093/geront/45.1.36 [PubMed: 15695416]

Valenzuela MJ, Sachdev P. Brain reserve and dementia: A systematic review. Psychological Medicine. 2005; 36:441–454. DOI: 10.1017/S0033291705006264 [PubMed: 16207391]

van Solinge H, Henkens K. Involuntary retirement: the role of restrictive circumstances, timing, and social embeddedness. J Gerontol B Psychol Sci Soc Sci. 2007; 62(5):S295–303. [PubMed: 17906173]

Warner DF, Hayward MD, Hardy MA. The retirement life course in America at the dawn of the twenty-first century. Population research and policy review. 2010; 29(6):893–919. [PubMed: 21170285]

Wickrama KK, O’Neal CW. The influence of working later in life on memory functioning. Advances in Life Course Research. 2013; 18(4):288–295. [PubMed: 24796712]

Zunzunegui MV, Alvarado BE, Del Ser T, Otero A. Social networks, social integration, and social engagement determine cognitive decline in community-dwelling Spanish older adults. J Gerontol B Psychol Sci Soc Sci. 2003; 58(2):S93–s100. [PubMed: 12646598]

Table 1

Sample Description (WLS 1992–2011)

		1992	2004	2010
Personal Characteristics	Male	0.53	0.52	0.52
	Married	0.81	0.79	0.73
	Age	53.22	64.33	71.23
	1957 Family Income	6304.85	6365.33	6373.06
	Mother's Years Schooling	10.55	10.57	10.59
	Father's Occupational Status[a]	34.28	34.55	34.56
	Adolescent Cognition[b]	102.04	102.60	103.02
	High School Degree	0.60	0.58	0.57
	Some College	0.13	0.14	0.13
	College Degree	0.14	0.15	0.15
	Above College Degree	0.13	0.13	0.14
	Stroke	0.00	0.03	0.05
	Diabetes	0.04	0.12	0.17
	Heart	0.05	0.15	0.25
	Cancer	0.03	0.10	0.18
	Net worth ranking[c]	51.98	52.85	53.71
	Pension	0.73	0.53	0.60
Job Characteristics	Occ. Education Score[d]	0.68	0.74	0.76
	Service Producing Industry	0.69	0.70	0.70
Class of Worker	Private	0.63	0.63	0.62
	Government	0.23	0.24	0.24
	Self-employed	0.14	0.13	0.14
Occupation	Professional/managerial	0.27	0.27	0.27
	Sales/clerical	0.43	0.45	0.45
	Crafts/operators/laborers	0.30	0.28	0.28
N		5,853	4,932	4,135

[a]Socioeconomic status is the 1970 Duncan Socioeconomic index (0–100 scale).

[b]Adolescent cognition is the Hemnon-Nelson score.

[c]Networth ranking is the percentile rank for the 1992 distribution of assets.

[d]Occupational education scores represent the percentage of people in the occupation that have completed at least one year of college, transformed to a started logit score.

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Table 2

Retirement and Cognition in the WLS (1992–2011)

		1992	2004	2010
Cognition	Abstract Reasoning	6.22	6.67	6.39
	Word Recall		10.19	8.92
	Verbal Fluency		11.49	11.22
Retirement				
Dichotomous	Working		0.50	0.31
	Retired		0.50	0.69
Reason	(if retired)			
	Voluntary		0.74	0.75
	Family Related		0.07	0.07
	Involuntary		0.09	0.10
	Health Related		0.10	0.09
Duration	(if retired)		4.21	8.39

Table 3

Random Intercepts Models Predicting Word Recall, WLS 1957–2011

		1		2		3		4		5	
		B	**s.e.**	**B**	**s.e.**	**B**	**s.e.**	**B**	**s.e.**	**B**	**s.e.**
Age		−0.109***	0.015	−0.062***	0.015	−0.062***	0.015	−0.058***	0.015	−0.058***	0.015
Retirement Status	Not Retired (ref.)										
Dichotomous	Retired	−0.036	0.025	−0.016	0.025						
Reason	Voluntary					−0.007	0.027				
	Family Related					0.102	0.064				
	Involuntary					−0.006	0.053				
	Health Related					−0.189***	0.057				
Duration	linear							−0.001	0.003		
	ln									−0.005	0.006
Education (ref: High School)	Some College			0.088*	0.041	0.085*	0.041	0.089*	0.041	0.089*	0.041
	Bachelor's			0.118**	0.042	0.113**	0.042	0.117**	0.042	0.116**	0.042
	Graduate/Prof. Degree			0.147**	0.050	0.144**	0.050	0.145**	0.050	0.144**	0.050
Job Characteristics											
Occ. Education Score				0.022	0.018	0.022	0.018	0.024	0.018	0.023	0.018
Class of Worker (ref: Private Worker)	Government			−0.011	0.035	−0.012	0.035	−0.012	0.035	−0.011	0.035
	Self-Employed			0.013	0.040	0.018	0.040	0.011	0.040	0.008	0.040
Occupation (ref: Other White Collar)	Upper White Collar			0.029	0.042	0.030	0.042	0.029	0.042	0.029	0.042
	Blue Collar			−0.109**	0.041	−0.106**	0.041	−0.112**	0.041	−0.111**	0.041
	Service Industries			0.028	0.032	0.032	0.032	0.030	0.033	0.029	0.033
Personal Characteristics	Male	−0.500***	0.026	−0.502***	0.029	−0.500***	0.030	−0.499***	0.030	−0.501***	0.030
	Married			−0.004	0.030	−0.002	0.030	−0.005	0.030	−0.004	0.030
	Father's SEI			−0.000	0.001	−0.000	0.001	−0.000	0.001	−0.000	0.001
	Mother's Education			0.002	0.005	0.002	0.005	0.002	0.005	0.002	0.005
	1957 Family Income			0.032	0.022	0.030	0.022	0.031	0.022	0.031	0.022
	Cognition at 16			0.008***	0.001	0.008***	0.001	0.008***	0.001	0.008***	0.001

		1		2		3		4		5	
		B	**s.e.**	**B**	**s.e.**	**B**	**s.e.**	**B**	**s.e.**	**B**	**s.e.**
	Stroke			−0.232***	0.063	−0.213***	0.063	−0.219***	0.063	−0.218***	0.063
	Heart			0.029	0.031	0.035	0.031	0.029	0.031	0.029	0.031
	Diabetes			−0.018	0.035	−0.010	0.035	−0.013	0.035	−0.012	0.035
	Cancer			0.053	0.035	0.057	0.035	0.056	0.035	0.057	0.035
	Pension Available			0.065*	0.026	0.064*	0.026	0.061*	0.026	0.062*	0.026
	Networth			0.001*	0.000	0.001	0.000	0.001	0.000	0.001*	0.000
First Measurement Wave		−0.763***	0.104	−0.426***	0.103	−0.424***	0.103	−0.405***	0.103	−0.406***	0.103
Intercept		8.020***	1.047	3.363**	1.076	3.376**	1.075	3.145**	1.082	3.127**	1.080
Observations		6717		6717		6717		6687		6687	
SD(slope)		0.546	0.016	0.499	0.017	0.497	0.017	0.502	0.017	0.502	0.017
Residual		0.785	0.010	0.783	0.010	0.783	0.010	0.780	0.010	0.780	0.010
Rho		0.326		0.289		0.287		0.293		0.293	
Likelihood Ratio Test		299.68	0.000	232.87	0.000	230.20	0.000	238.23	0.000	237.71	0.000

Notes:

* $p < 0.05$,

** $p < 0.01$,

*** $p < 0.001$

Table 4

Random Intercepts Models Predicting Verbal Fluency, WLS 1957–2011

		1		2		3		4		5	
		B	s.e.	B	s.e.	B	s.e.	B	s.e.	B	s.e.
Age		−0.085***	0.013	−0.032*	0.013	−0.032*	0.013	−0.029*	0.013	−0.030*	0.013
Retirement Status	Not Retired (ref.)										
Dichotomous	Retired	−0.074**	0.023	−0.046*	0.023						
Reason	Voluntary					−0.020	0.024				
	Family Related					−0.050	0.061				
	Involuntary					−0.076	0.051				
	Health Related					−0.231***	0.054				
Duration	ln							−0.006*	0.003		
	linear									−0.016**	0.006
Education (ref=High School)	Some College			0.132***	0.040	0.131***	0.040	0.131**	0.040	0.131**	0.040
	Bachelor’s			0.242***	0.042	0.238***	0.042	0.243***	0.042	0.241***	0.042
	Graduate/Prof. Degree			0.261***	0.049	0.260***	0.049	0.266***	0.049	0.265***	0.049
Job Characteristics											
Occ. Education Score				0.042*	0.018	0.042*	0.018	0.041*	0.018	0.042*	0.018
Class of Worker (ref=Private Worker)	Government			0.037	0.035	0.032	0.035	0.040	0.035	0.041	0.035
	Self-Employed			−0.026	0.040	−0.020	0.040	−0.028	0.040	−0.034	0.040
Occupation (ref=Other White Collar)	Upper White Collar			−0.063	0.041	−0.060	0.041	−0.062	0.041	−0.062	0.041
	Blue Collar			−0.098*	0.041	−0.094*	0.041	−0.096*	0.041	−0.095*	0.041
	Service Industries			0.050	0.032	0.055	0.032	0.050	0.032	0.048	0.032
Personal Characteristics	Male	−0.274***	0.027	−0.261***	0.029	−0.267***	0.029	−0.261***	0.029	−0.262***	0.029
	Married			−0.009	0.028	−0.011	0.028	−0.012	0.029	−0.010	0.029
	Father’s SEI			0.000	0.001	0.000	0.001	0.000	0.001	0.000	0.001
	Mother’s Education			−0.001	0.005	−0.001	0.005	−0.001	0.005	−0.001	0.005
	1957 Family Income			0.061**	0.021	0.058**	0.021	0.060**	0.021	0.060**	0.021
	Cognition at 16			0.014***	0.001	0.014***	0.001	0.014***	0.001	0.014***	0.001

		1		2		3		4		5	
		B	**s.e.**	**B**	**s.e.**	**B**	**s.e.**	**B**	**s.e.**	**B**	**s.e.**
	Stroke			−0.183**	0.058	−0.167**	0.058	−0.174**	0.059	−0.173**	0.059
	Heart			0.006	0.028	0.011	0.028	0.010	0.028	0.010	0.028
	Diabetes			−0.076*	0.033	−0.068*	0.033	−0.072*	0.033	−0.071*	0.033
	Cancer			−0.017	0.032	−0.013	0.032	−0.017	0.032	−0.017	0.032
	Pension Available			0.036	0.024	0.034	0.024	0.036	0.025	0.037	0.025
	Networth			0.000	0.000	−0.000	0.000	0.000	0.000	0.000	0.000
First Measurement Wave		−0.596***	0.094	−0.224*	0.092	−0.222*	0.092	−0.218*	0.092	−0.224*	0.092
Intercept		6.269***	0.957	0.366	0.967	0.402	0.966	0.183	0.973	0.234	0.970
Observations		7164		7164		7164		7135		7135	
SD(slope)		0.748	0.013	0.670	0.012	0.669	0.012	0.671	0.012	0.671	0.012
Residual		0.633	0.009	0.631	0.009	0.631	0.009	0.631	0.009	0.630	0.009
Rho		0.582		0.530		0.529		0.531		0.532	
Likelihood Ratio Test		1040.00	0.000	833.42	0.000	829.87	0.000	833.18	0.000	834.88	0.000

Notes:

* $p < 0.05$,

** $p < 0.01$,

*** $p < 0.001$

Table 5

Random Intercept Models Predicting Abstract Reasoning, WLS 1957–2011

		1		2		3		4		5	
		B	s.e.	B	s.e.	B	s.e.	B	s.e.	B	s.e.
Age		−0.006**	0.002	−0.005*	0.002	−0.005*	0.002	−0.004	0.002	−0.005*	0.002
Retirement Status	Not Retired (ref)										
Dichotomous	Retired	0.038*	0.019	0.053**	0.018						
Reason	Voluntary					0.051**	0.020				
	Family Related					0.125**	0.048				
	Involuntary					0.040	0.041				
	Health Related					0.025	0.042				
Duration	linear							0.002	0.002		
	ln									0.011*	0.005
Education (ref: High School)	Some College			0.240***	0.029	0.240***	0.029	0.239***	0.029	0.239***	0.029
	Bachelor's			0.352***	0.031	0.352***	0.031	0.351***	0.031	0.351***	0.031
	Graduate/Prof. Degree			0.466***	0.036	0.466***	0.036	0.464***	0.036	0.465***	0.036
Job Characteristics											
Occ. Education Score				0.044***	0.013	0.044***	0.013	0.044**	0.013	0.044**	0.013
Class of Worker (ref: Private Worker)	Government			0.041	0.025	0.040	0.025	0.044	0.025	0.042	0.025
	Self-Employed			−0.045	0.029	−0.045	0.029	−0.051	0.029	−0.046	0.029
Occupation (ref: Other White Collar)	Upper White Collar			0.086**	0.030	0.086**	0.030	0.086**	0.030	0.086**	0.030
	Blue Collar			−0.033	0.029	−0.034	0.029	−0.034	0.029	−0.034	0.029
	Service Industries			0.004	0.023	0.003	0.023	0.001	0.023	0.003	0.023
Personal Characteristics	Male	−0.003	0.022	−0.044*	0.021	−0.042*	0.021	−0.046*	0.021	−0.044*	0.021
	Married			−0.014	0.020	−0.013	0.020	−0.015	0.020	−0.016	0.020
	Father's SEI			−0.000	0.000	−0.000	0.000	−0.000	0.000	−0.000	0.000
	Mother's Education			0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004
	1957 Family Income			−0.020	0.015	−0.020	0.015	−0.019	0.015	−0.020	0.015
	Cognition at 16			0.022***	0.001	0.022***	0.001	0.022***	0.001	0.022***	0.001

		1		2		3		4		5	
		B	**s.e.**	**B**	**s.e.**	**B**	**s.e.**	**B**	**s.e.**	**B**	**s.e.**
	Stroke			−0.084	0.047	−0.081	0.047	−0.073	0.048	−0.076	0.048
	Heart			0.009	0.022	0.011	0.022	0.010	0.022	0.010	0.022
	Diabetes			−0.026	0.025	−0.025	0.025	−0.021	0.025	−0.023	0.025
	Cancer			0.007	0.025	0.008	0.025	0.008	0.025	0.007	0.025
	Pension Available			0.021	0.017	0.021	0.017	0.019	0.017	0.019	0.017
	Networth			0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
First Measurement Wave		−0.025	0.032	0.001	0.032	0.002	0.032	−0.016	0.033	−0.010	0.032
Intercept		0.348 *	0.144	−2.001 ***	0.206	−2.000 ***	0.206	−2.012 ***	0.217	−1.948 ***	0.212
Observations		14542		14537		14537		14499		14499	
SD(slope)		0.016	0.003	0.016	0.003	0.016	0.003	0.016	0.003	0.016	0.003
SD(intercept)		1.201	0.144	1.113	0.153	1.114	0.153	1.105	0.154	1.110	0.154
Corr (Intercept, Slope)		−0.789	0.056	−0.873	0.036	−0.874	0.036	−0.871	0.038	−0.873	0.037
Residual		0.657	0.007	0.656	0.007	0.656	0.007	0.657	0.007	0.657	0.007
Rho		0.770		0.742		0.742		0.739		0.741	
Likelihood Ratio Test		3465.93	0.000	1700.18	0.000	1697.65	0.000	1653.81	0.000	1692.66	0.000

Notes:

* $p < 0.05$,

** $p < 0.01$,

*** $p < 0.001$