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Mental Retirement

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The phrase "use it or lose it" reflects a hypothesis contained in a large popular and scholarly literature to the effect that a person can stave off normal cognitive aging—the decline of reasoning ability and speed of mental processing with age—or even dementia by engaging in cognitively demanding activities that exercise the mind. Conversely, this hypothesis holds that an undemanding environment will fail to impede and may even accelerate the process of cognitive decline. Based on this hypothesis, retirees are urged to maintain an "engaged life style," involving active, intellectually stimulating activities such as reading, playing bridge, or doing crossword puzzles.[1]

The hypothesis that people can maintain their cognitive abilities through "mental exercise" has not been unequivocally proven. Hultsch, Hertzog, Small, and Dixon (1999), for example, find a statistical association between leading an "engaged life style" and smaller declines in cognition among middle-aged and older adults but note that they are unsure of the causal direction. Salthouse (2006), after a thorough and thoughtful review of the mental-exercise literature, reaches the skeptical conclusion that "at the present time the mental-exercise hypothesis

[1] As one example, see the advice posted at the Consumer Reports website in October 2009, "Your Brain: Use it or Lose It," at ⟨http://www.consumerreports.org/health/medical-conditions-treatments/the-brain-use-it-or-lose-it/overview/the-brain-use-it-or-lose-it-ov.htm⟩.

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is more of an optimistic hope than an empirical reality." In addition to questions about causal direction, he argues that much of the literature fails to distinguish correlations between mental exercise and the *level* of cognition and correlations with the *rate of increase or decline* of cognitive powers, in part because cross-sectional data or short panels have little power to make such a distinction. He also finds little evidence of differential rates of cognitive aging in comparisons of experts and amateurs—for example, chess players—or between occupational groups.

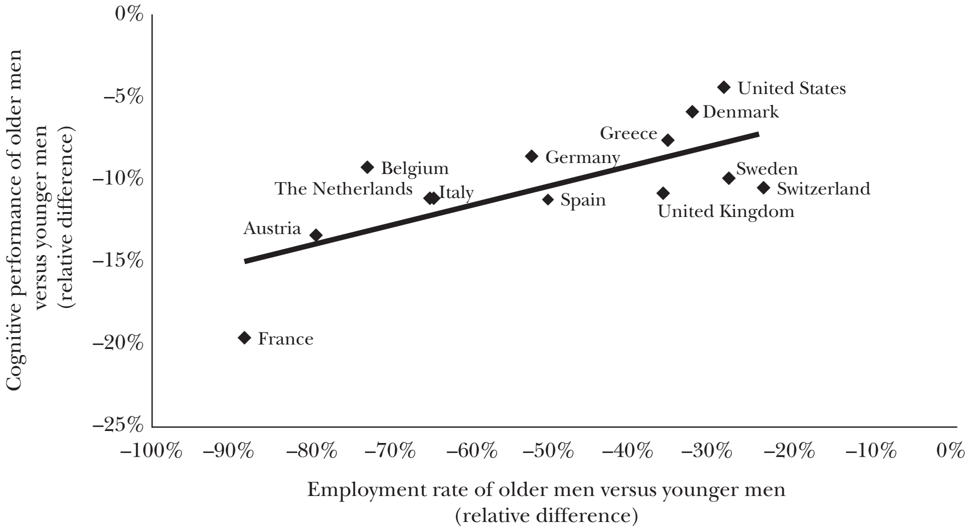
In this paper, we address the question of whether retirement leads to cognitive decline using cross-nationally comparable surveys of older persons in the United States, England, and eleven European countries in 2004.[2] Our paper is motivated by the data presented in Figure 1, which is based on these data.[3] Each data point in the figure represents a country-specific ratio of means. The horizontal axis shows the mean labor force participation rate of men age 60–64 relative to that of men age 50–54. This measure of relative employment rates by age exhibits striking variation across countries. In the United States and Denmark, the employment rate of men in their early 60s is 30 to 35 percent lower than that of men in their early 50s, while in France and Austria the difference is 80 to 90 percent lower. Similarly, the vertical axis measures the mean performance on a cognitive test of immediate and delayed word recall of 60–64 year-olds relative to the performance of 50–54 year-olds.[4] The scatter plot shows a clear correlation in this cross-section of countries, indicating that in countries in which men tend to stay in the labor force longer, they perform substantially better on the cognitive test. According to the regression line in Figure 1, the relative difference in cognitive performance is about twice as great in countries with early ages of retirement like France, Austria, Belgium, and the Netherlands as it is in countries with later retirement such as the United States, Denmark, Sweden, and Switzerland.

[2] These data come from public use files of the U.S. Health and Retirement Study (HRS), the English Longitudinal Study of Ageing (ELSA), and the Survey of Health, Ageing and Retirement in Europe (SHARE), which have been designed collaboratively by the researchers responsible for each study to be as comparable as possible. Data and additional information about each survey can be obtained at their websites: ⟨http://hrsonline.isr.umich.edu⟩, ⟨http://www.ifs.org.uk/elsa⟩ and ⟨http://www.share-project.org⟩. The HRS data are readily available for public use, while using the ELSA and SHARE data requires applying for permission to the principal investigators.

[3] This figure, which provided the inspiration for this paper, is reproduced with the permission of the authors from Adam, Bay, Bonsang, Germain, and Perelman (2007). A causal interpretation of this figure was suggested by Susann Rohwedder in her discussion of Adam et al. at the "Workshop on Comparative International Research Based on HRS, ELSA and SHARE," at RAND, July 10–11, 2006. In a paper independent of ours, Bonsang, Adam, and Perelman (2009) investigate the causal effect of retirement on cognition.

[4] In the immediate word recall task the interviewer reads a list of ten nouns (for example, "lake," "car," "army," and similar words) to the respondent and asks the respondent to recall as many words as possible from the list in any order. After approximately five minutes of asking other survey questions, the respondent is asked to recall the nouns previously presented as part of the immediate recall task. The total recall score used in Figure 1 and elsewhere in this paper is the sum of the correct answers to these two tasks, with a range of 0 to 20. For details, see Ofstedal, Fisher, and Herzog (2005). These measures from HRS were adapted for use in ELSA and SHARE to be as comparable as possible across countries.

Figure 1
Drop in Cognitive Performance as a Function of Drop in Employment Rate between Men 50–54 and 60–64 Years Old



Source: Adam, Bay, Bonsang, Germain, and Perelman (2007). Reproduced with permission. Data drawn from ELSA for England, HRS for the United States, and SHARE for other countries for 2004. (See footnote 2 for full names of surveys.)
Note: The horizontal axis shows the mean labor force participation rate of men age 60–64 relative to that of men age 50–54. The vertical axis measures the mean performance on a cognitive test of immediate and delayed word recall of 60–64 year-olds relative to the performance of 50–54 year-olds. The ordinary least squares regression line shown estimates the following relationship on 13 country observations:

$$\%CogDifference_j = \beta_0 + \beta_R \%WorkDifference_j + u_j \quad j = 1 \ldots 13.$$

See footnote 4 for details on the cognitive performance test.

We argue in this paper that the slope of the regression line in Figure 1 may be interpreted as showing that, on average, retirement causes a decrease in a person's cognitive ability relative to staying in the labor force. Because of the large cross-country variation in age of retirement, this "mental retirement effect" is quantitatively important.

In the next section, we discuss the identification issues that have posed challenges to estimating the effect of retirement on cognition and present our argument for a causal interpretation of the relationship between cognitive decline and retirement shown in Figure 1. The literature on the determinants of cross-country differences in retirement behavior provides strong evidence that these differences are primarily driven by differences in national pension, tax, and disability policies. As a result, most of the cross-country variation in the relative labor supply of 60–64 year-olds relative to 50–54 year-olds depicted in Figure 1 is a result of national policies. Because it is highly unlikely that these policies have been set in response to observed age patterns in cognitive performance in the respective country's population, we argue that these policies provide valid instruments to identify the causal effect of retirement on cognition even in micro-data, where problems of reverse causation tend to have rendered identification difficult.

We then review some aspects of cognitive psychology and human capital theory that are relevant to mental retirement and suggest two hypotheses that link work and retirement to cognitive decline. We discuss how these mechanisms can be investigated empirically using comparable micro-data from multiple countries. In the conclusion, we suggest some future avenues of research on this topic.

Identification Issues

Traditionally, studies of the effect of retirement on cognition—or the effect of retirement on health and well-being more broadly—have been conducted on individual-level data. Cross-sectional studies compare the cognitive performance of the retired to that of the nonretired, while panel data studies analyze changes in cognitive performance associated with transitions into retirement and compare them to the changes in cognitive performance observed among those without retirement transitions over the same time period. The fact that time of retirement is self-selected has posed the main challenge for identifying the effect of interest in this type of micro-data. For example, cognitive decline or the increased cognitive demands of jobs could lead some people to retire earlier than those who have not suffered (noticeable) cognitive decline. If so, one would find that retirement is associated with lower cognitive performance—even in the absence of any effect of retirement on cognition. Of course, one way of addressing this identification issue econometrically would be to find a suitable instrumental variable—that is, a variable that is correlated with retirement but is itself not determined by cognition.

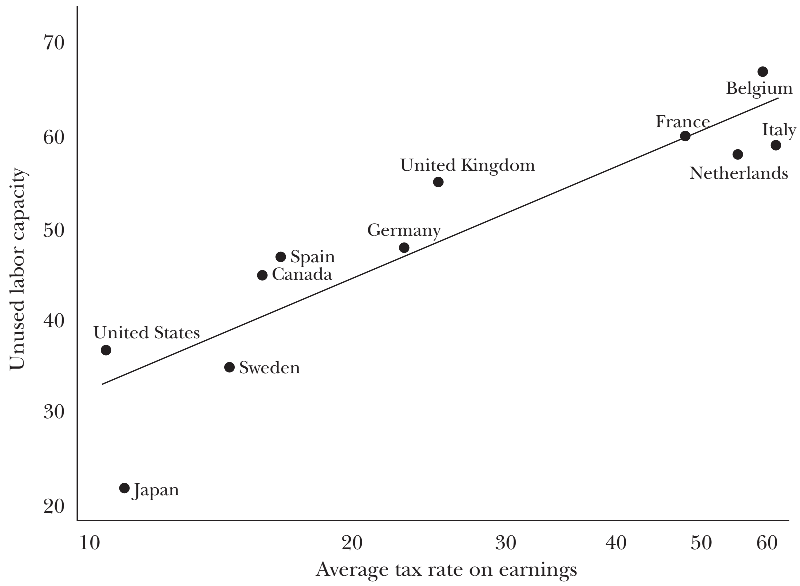
The problem of endogenous retirement makes it difficult to interpret many of the published estimates of the effect of retirement on various measures of health. In an interesting exception, Charles (2004) addresses the question "Is Retirement Depressing?" Reviewing the literature, he notes that there is often a positive correlation in cross-sectional data between symptoms of depression and retirement status—the retired are more depressed. However, using longitudinal data from the HRS and instrumental variable techniques, Charles finds that people who are depressed tend to select into retirement and, more surprisingly, once retired, their depression lessens, a causal effect that is opposite in sign to the correlation. His identification strategy uses policy variations concerning mandatory retirement and Social Security benefits that influence retirement incentives by age and cohort.

Policy variation that affects the timing of retirement is ideally suited as an instrument, but such variation is rarely found, at least *within* a single country, because pension or Social Security reforms are rare. But *across* countries, the policies that influence timing of retirement vary substantially, and the patterns in Figure 1 show convincingly that such differences in national policies lend themselves to the study of the effect of retirement on cognition. The evidence in Figure 1—relating cross-country variation in cognitive performance differences of people in their early 60s and those in their early 50s to cross-country variation in differences in employment rates for the same age groups—does not rely on individual-level data, but uses country-level aggregate statistics instead. This method circumvents the most challenging identification issue inherent in cross-sectional micro-level analysis.

Our contention that the slope of this regression line may be interpreted as the causal effect of early retirement on cognitive decline stems from the well-established result that a substantial part of cross-country variation in retirement comes from public policy. Indeed, it seems highly unlikely that cross-country differences in age or cohort effects or in the rate of self-selection into retirement as a function of cognitive performance could be responsible for the large variation in employment differentials. Also, differences in demographic and socioeconomic composition across European countries in data from the Survey of Health, Ageing and Retirement in Europe (SHARE), have been found to explain only trivial fractions of the variance in outcome variables such as disability rates or retirement rates (for example, Börsch-Supan, forthcoming). Thus, in an informal manner, we are arguing that public policies that affect the age of retirement may be used as instrumental variables to generate cross-country variation in retirement behavior in order to identify the causal effect of retirement on cognition.

The importance of public policy for retirement is powerfully shown by the striking and important finding of a major cross-national research project reported in Gruber and Wise (1999). This project constructed comparable country-specific aggregate variables that measure the labor supply of older men aged 55–64 and the implicit tax rate on labor earnings generated by public policies related to taxes, social security, pensions, and disability. Most of the cross-country variation in early retirement is due to variation in public policies related to taxes and social security, pension, and disability benefits that created large differences in the incentive to continue working in different countries. Figure 2 plots the unused labor capacity in each country against the average tax rate on earnings from age 55 to 69—called "tax force" by Gruber and Wise. Clearly, the implicit tax rates on earnings have a powerful effect on retirement whatever the specific source of that tax. For example, there is an implicit tax on earnings if an additional year of work beyond, say, age 62 does not increase monthly pension benefits upon retirement. In the United States, Social Security benefits are adjusted upward in an actuarially fair manner if an individual delays claiming, while in some other countries benefits are not affected by additional work. Such differences in policies contribute to the large differences in work incentives between countries with low marginal taxes like the United States, Sweden, and Canada and those with extremely high tax rates such as Belgium, Italy, France, and the Netherlands.

Figure 2
Effects of Public Policy on Retirement



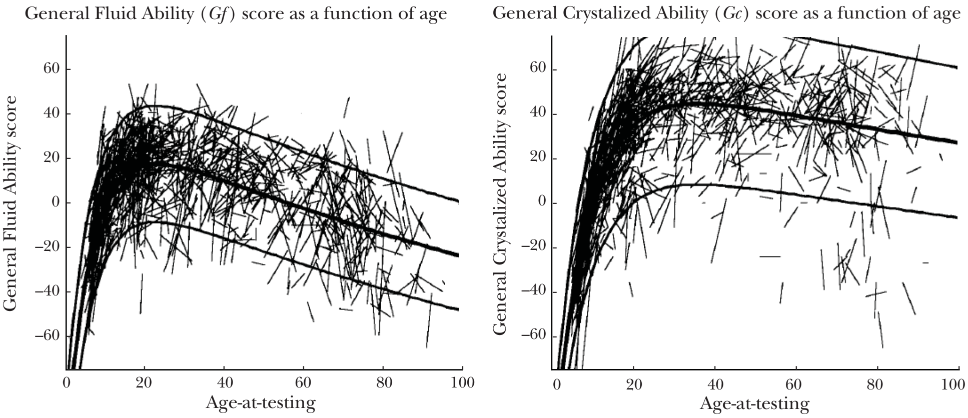
Source: Adapted from Gruber and Wise (1999, table 1).
Note: Figure 2 plots the unused labor capacity between ages 55 and 65 in each country, expressed in percent, against the average tax rate on earnings from age 55 to 69, also expressed in percent, which Gruber and Wise call the "tax force."

The evidence in Figure 2 shows that the cross-country variation in national policies governing retirement is a powerful instrument in an econometric sense that can be used to identify the effect of retirement on cognition in micro-level analysis. Figure 1 does this informally. Our goal is to formalize the estimation and to use variables that describe national retirement policy. We rely on micro-level data from the English Longitudinal Study of Ageing (ELSA), the Survey of Health, Ageing and Retirement in Europe (SHARE), and the U.S. Health and Retirement Study (HRS). Our estimation is feasible because both ELSA and SHARE were designed to yield data closely comparable to the micro-data collected in HRS, so that, in particular, the data on cognition are comparable.

Cognition and Human Capital

Before turning to our empirical estimation, it is important to consider the mechanisms that might drive the causal connection between retirement and cognition. For this purpose, we review some key aspects of cognitive psychology and human capital theory.

Figure 3
Fluid and Crystallized Ability by Age



Source: Figure 9 of McArdle, Ferrer-Caja, Hamagami, and Woodcock (2002). Reproduced with the permission of John J. McArdle.
Note: The figure in McArdle et al. is titled "A comparison of multilevel longitudinal age curves for *Gf* and *Gc* abilities (Rasch *W* units)."

Cognitive psychologists have identified a large number of distinct aspects of intelligence that evolve differentially over the lifecycle. These components have been grouped into the two principal dimensions of "fluid intelligence" (*Gf*) and "crystallized intelligence" (*Gc*). Fluid intelligence captures the thinking part of ability, including memory, abstract reasoning, and executive function—a loosely defined collection of brain processes that controls and manages other cognitive processes. Crystallized intelligence is the knowing part of ability, encompassing the main accumulation of influence from education and lifetime experience (for details, see McArdle, Ferrer-Caja, Hamagami, and Woodcook, 2002). Fluid intelligence and crystallized intelligence display different patterns over the lifecycle. Following a period of rapid development during childhood and adolescence, all components of fluid intelligence (*Gf*), including memory measures similar to those used in HRS, ELSA, and SHARE, tend to decrease from about age 20 until the end of life while components of crystallized intelligence (*Gc*), such as vocabulary, tend to continue increasing into middle age or beyond.

These age patterns are illustrated in Figure 3, which is based on estimates by McArdle, Ferrer-Caja, Hamagami, and Woodcock (2002) of a latent random growth model using American data on scores from the Woodcock and Johnson (1989) battery of tests of norming samples of persons who were tested on two occasions. The figure shows that ability variations within a population are large at any given age and that there is considerable variation in individual age trajectories of *Gf* and *Gc*. Fluid intelligence reaches a peak at age 22.8 and declines linearly at a rate of about 5 "*W*-score" units per year, resulting in a loss of about 20 points or 0.8 of a standard deviation in ability on average over the life cycle from age 20 to age 60.[5] In the *W*-score metric, this implies that a given person who could achieve a 50 percent success rate on a test at age 20 would expect only a 10 percent success rate on the same test at age 60. In contrast, crystallized intelligence reaches a peak at age 35 and declines at a very slow pace thereafter.

The "processing-speed" theory of Salthouse (1996) is the most prominent theory in psychology to explain the decline of fluid intelligence with age. He writes (p. 403): "The central hypothesis in the theory is that increased age in adulthood is associated with a decrease in the speed with which many processing operations can be executed and that this reduction in speed leads to impairments in cognitive functioning because of what are termed the "limited time mechanism" and the "simultaneity mechanism." The limited time mechanism is that a combination of slower speed and limited storage capacity can mean that the brain loses information in working memory that is needed as an intermediate product for completion of a stepwise mental task. Within the simultaneity mechanism, speed helps the brain orchestrate and coordinate parallel tasks, such as those involved in executive function or cognitive control. Salthouse (p. 405) argues that it is the slower speed of activating or processing information, rather than a faster rate of information loss or decay, that is primarily responsible for the age-related consequences mediated by the simultaneity mechanism.

The psychological theory of fluid and crystallized intelligence has a clear parallel with economic theories of investment in human capital. In a seminal early contribution to human capital theory, Ben-Porath (1967) introduced the concept of a human capital production function. This function relates the inputs of an individual's ability (which can be viewed as fluid intelligence), current stock of human capital (which can be viewed as crystallized intelligence or knowledge) and effort devoted to schooling or on-the-job training to the output of new knowledge (quantity of investment or learning).[6] In this model, the stock of human capital evolves over the lifecycle of the individual as a rate of investment in human capital at any given time and is counterbalanced to some extent by a depreciation rate of

[5] The *W*-score measured on the vertical axis in the figure is a transformation of the log odds of a correct answer with mean zero and standard deviation 25. A property of the *W*-score is that a given decrease in the test score from any initial level has the same impact on performance. For example, consider a person in the n^{th} ability percentile who is able to succeed on "item *n*" with a 50 percent chance. If this person suffers a 10 point decrease in his *W*-score, his expected success rate falls to 25 percent on item *n*; a 20 point decline reduces the success rate to 10 percent and a 25 point decline reduces it to 6 percent (Jaffe, 2009, p. 7). Similarly, a person whose ability is one standard deviation above (below) the mean would succeed on item 50, with probability .94 (probability .06).

[6] Cunha and Heckman (2007) and other recent work by Heckman and colleagues has made important extensions of the Ben-Porath (1967) model to encompass heterogeneous forms of human capital, dynamic complementarities of investments over time, and the role of noncognitive as well as cognitive abilities in the development of human capital during childhood and adolescence. Ben-Porath's production function also includes "purchased goods" as an input which may be interpreted to include such things as teachers and school quality. Unpriced environmental inputs, such as social interactions and culture, could also be included. In Delavande, Rohwedder and Willis (2008), we discuss the parallels between the relationship between the *Gf/Gc* theory and the Ben-Porath model.

human capital, which in our terminology can be viewed as forgetting crystallized knowledge.

The literature on fluid and crystallized intelligence in psychology and the human capital literature in economics are also parallel in another sense. Until recently, researchers in each discipline have been almost completely unaware of the related literature in the other discipline (although an early exception is Heckman, 1995). For economists, the literature on fluid and crystallized intelligence suggests the need for a more nuanced view of ability than is customary. For example, the "ability" parameter in a Ben-Porath (1967) production function is viewed as a constant, whereas there is clear evidence that fluid intelligence declines with age. On the other hand, Ben-Porath's assumption that the depreciation rate is constant is at least roughly supported by evidence from psychology.

From an economist's perspective, these results suggest that human capital is built through a process that converts a perishable but powerful form of intelligence embodied in fluid intelligence—the ability to reason about novel or unfamiliar problems—into the more durable crystallized form of intelligence. The durability of crystallized intelligence in the brain is augmented by other methods of creating durable knowledge in the form of books, blueprints, institutions and, not least, in the brains of other people. However, a key insight of human capital theory that is missing from the theory of fluid and crystallized intelligence is the notion that the rate of accumulation of human capital is subject to choice, guided by the individual's assessment of the current costs and future benefits of investment in human capital. We believe that these incentive effects may be an important piece of the explanation of the mental retirement phenomenon.

Two Hypotheses about Mental Retirement

Why does retirement cause cognitive decline? One hypothesis is that workers engage in more mental exercise than retirees because work environments provide more cognitively challenging and stimulating environments than do nonwork environments. Indeed, recommendations that retirees maintain an engaged lifestyle, pursuing leisure activities such as playing bridge or doing crossword puzzles—"using it" to prevent "losing it"—implicitly assume that the life of a retiree may lack cognitive stimulation unless deliberate offsetting actions are taken. Thus, we shall call this explanation of the mental retirement effect the "unengaged lifestyle hypothesis."

As we discussed at the beginning of the paper, Salthouse (2006) offers reasons to be skeptical of evidence purporting to demonstrate that mental exercise reduces the rate of cognitive decline. Nonetheless, we believe that the unengaged lifestyle hypothesis may be a plausible explanation for the mental retirement effect for several reasons. First, unlike many of the interventions discussed by Salthouse like crossword puzzles and card games, retirement represents a major change in a person's lifestyle and activities and thus affords the potential for a large effect.

Second, the range of cross-country variation in age of retirement due to differences in policy is also large. Finally, the ten-year span between ages 50–54 and 60–64 in Figure 1 is long enough to indicate that the mental retirement effect represents a change in the rate of cognitive decline, rather than a short-term effect of retirement itself.

Human capital theory suggests another mechanism that might produce a mental retirement effect: the prospect of early retirement may bring about a decreased level of mental exercise while still on the job. Since the human capital production function requires a person to combine cognitive ability, stock of knowledge, and effort to produce additional human capital, mental exercise tends to be an increasing function of the volume of investment. For workers late in their careers, the value of continuing to build work-related human capital is very sensitive to the length of the remaining working life. For example, a 50-year-old worker in the United States who expects to work until 65 has a much greater incentive to continue investing in human capital than does a worker in Italy who expects to retire at 57. Thus, we hypothesize that differences in retirement incentives across countries create a reduction in mental exercise at work that may begin well before actual retirement. We call this the "on-the-job" retirement effect.

Taken together, our two hypotheses suggest that variations in mental exercise associated with both the work environment before retirement and the home environment after retirement may causally influence components of fluid intelligence such as the memory recall measures contained in the HRS, ELSA, and SHARE data used in this paper. These hypotheses would lack plausibility under the hereditarian view expressed most famously by Herrnstein and Murray (1994) that intelligence is largely fixed by genetic inheritance and is immutable. There is, however, a large body of evidence in both economics and psychology showing that the education–ability relationship is bi-directional, with education having a causal impact on ability as well as the converse (for example, Neal and Johnson, 1996; Ceci, 1991).

More broadly, beginning with Flynn (1984, 1987), the existence of substantial gains in cognitive test performance across cohorts have been found in many countries, with mean-level gains on the order of one standard deviation in IQ per generation.[7] Dickens and Flynn (2001) have developed a theoretical model to explain these "Flynn effects." In their model, an individual with a small genetic advantage—say, being slightly taller—has a slightly higher chance of entering an environment that would amplify talents associated with that advantage—being picked to play basketball—so that, in effect, genes select their own environment. Feedback loops over the life cycle strengthen this relationship. In an extension of the Dickens-Flynn model to multiple abilities, Dickens (2007) states, "A general

[7] In a recent paper using Swedish data with repeated cognitive measurements over the life cycles of successive cohorts, Rönnlund and Nilsson (2008) find that most gains can be attributed to increased education with somewhat smaller but significant contributions from small size of sibsets (perhaps related to larger parental investment in child quality) and increased height (interpreted as a measure of childhood nutrition).

intelligence factor arises in the model because people who are better at any cognitive skill are more likely to end up in environments that cause them to develop all skills" (see also van der Maas, Dolan, Grasman, Wicherts, Huizenga, and Raijmakers, 2007).

While such selection and feedback effects are clearly critical in early childhood and during formal education, occupational choice and investment in on-the-job training mean that such effects may continue throughout the working life cycle and into retirement. In the next section, we investigate whether a more or less stimulating environment created by variations in retirement policies generates differences in cognitive abilities across countries.

Estimating the Effect of Retirement on Cognition in Cross-Country Micro-Data

The emergence of comparable micro-data from multiple countries makes it possible to take advantage of cross-country variation in pension policies as valid instruments for identifying the effect of retirement on cognition.

As we have described, the data come from three different surveys: the U.S. Health and Retirement Study (HRS), the English Longitudinal Study of Ageing (ELSA), and the Survey of Health, Ageing and Retirement in Europe (SHARE), which interviewed households from eleven countries in its first wave. All are nationally representative surveys of the population age 50 or older (age 51 or older for the HRS) and collect a wide array of information.[8] The HRS was first collected in 1992 and the other two surveys were designed to be closely comparable, with the explicit objective of facilitating cross-country comparisons. The first wave of ELSA was collected in 2002 and the first wave of SHARE in 2004. We use data from 2004, the first year for which we have data available from all three surveys. Sample sizes run about 20,000 individuals in the HRS, a little over 9,000 in ELSA, and between 1,000 and 3,000 in each of the SHARE countries.

Our analysis is cross-sectional, comparing the cognitive performance of the retired with that of the not-retired in 2004 and using national pension policies as instruments to correct the endogeneity bias resulting from retirement's being a self-chosen state. More specifically, we seek to estimate the relationship between cognition of individual i in country j as a function of a constant term and the individual's retirement status plus the error term. We treat retirement status as an endogenous variable and estimate the equation using variables characterizing national policies as instruments, as described later in more detail.

[8] For more detailed information on each of these three surveys and their 2004 data collections, see the HRS Data Book published by the National Institute on Aging (2007), the First Results Books by Banks, Breeze, Lessof, and Nazroo (2006) for ELSA, and by Börsch-Supan, Brugiavini, Jürges, Mackenbach, Siegrist, and Weber (2005) for SHARE.

Figure 4
Identification of Retirement Effect on Cognition

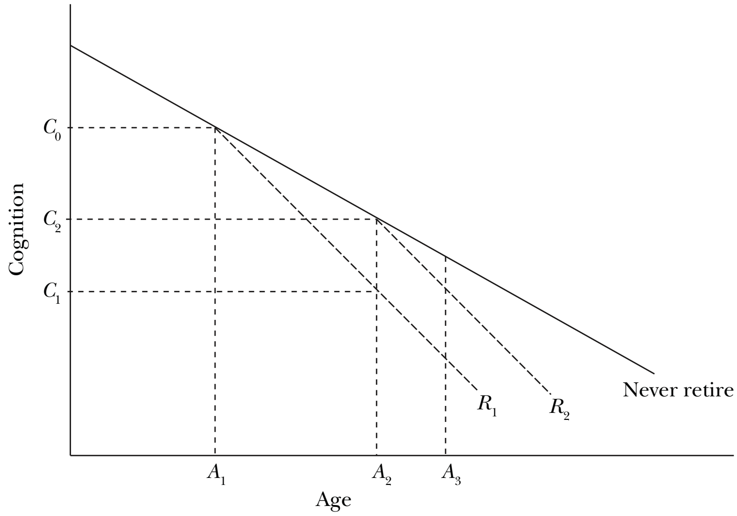
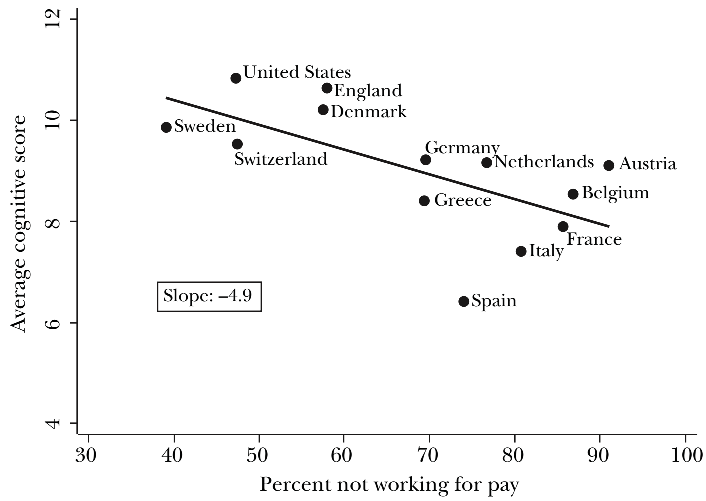


Figure 4 provides intuition for how the estimated relationship identifies the parameter of interest. For the moment, assume that only the "disengaged lifestyle" mechanism is operative. That is, assume that cognitive aging is only affected by the state of being retired, measured by the dummy variable, R_{ij}, which is equal to one if person i in country j is retired and zero otherwise. Figure 4 illustrates the hypothesized relationship. The solid line depicts the path of cognitive aging that would be followed by a person who never retires—or, more realistically, by a person who retires at a late age—and the two dotted lines indicate the paths that would be followed by a person who retires early at age A_1 or at a later age A_2. The steeper slope of the dotted lines reflects the negative effect on cognition caused by leaving the more stimulating work environment.

The data presented earlier in Figure 1 can be interpreted in terms of the diagram in Figure 4. Suppose that A_1 corresponds to age 50–54 and A_2 to age 60–64 and assume that A_1 is the average age of retirement in country 1 and A_2 is the age of retirement in country 2. At age A_1, workers in both countries have the same level of cognitive ability, C_0. However, the cumulative effects of retirement imply that by the time they reach age A_2, the cognitive abilities of workers in country 1 will have fallen below those in country 2.

With a different interpretation, the diagram in Figure 4 can also illustrate the "on-the-job retirement" hypothesis. Imagine that workers cut back on their rate of human capital investment 10 years before they expect to retire, causing an increase in the rate of cognitive decline equal to the difference in the slopes of the solid and dotted lines in Figure 4. We could then interpret A_1 as age 40–44 and A_2 as 50–54. When workers are evaluated at age 60–64 (denoted by A_3 in the

Figure 5
Cognition by Percent Not Working for Pay, 60–64 Year-Old Men and Women, Weighted



Note: See Footnote 4 for details on the test of cognitive performance.

figure), the cognitive score of persons aged 60–64 relative to 50–54 year-olds in country 1 will be lower than in country 2.

Our estimations rely on a comparison between retirees and working individuals. This illustration also shows that our estimation strategy picks up both potential effects of retirement on cognition—the "unengaged lifestyle" effect and the "on-the-job retirement" effect—but that it cannot distinguish between them.

We use the same measure of cognitive performance as Adam et al. (2007)—a score ranging from 0–20 reflecting the total number of words remembered in exercises of immediate and delayed recall of the same 10 words. Retirement status is derived from respondent reports of whether they are currently working for pay. A person is considered "retired" if that person is not working for pay and "not retired" otherwise. We include all men and women, irrespective of prior work history, in view of the fact that the lack of a stimulating work environment would also apply to people with limited or no attachment to the labor force. This implies that we will estimate the average "treatment effect" of retirement (or not working) in the entire population. To get a sense of the magnitude of the effect that is present in the data, Figure 5 shows the average cognitive score for each country by the fraction not working for 60 to 64 year-old males and females pooled. We consider a narrow age-band as a way of conditioning on age in this visual representation. As indicated by the fitted line, there is a systematic relationship between the average cognitive score and the fraction not working across countries, suggesting that on average being retired is associated with a lower memory score of about 4.9 points on a 20-point scale.

To the extent that different levels of cognition across countries might influence the timing of retirement, we cannot attribute a causal interpretation to the patterns shown in Figure 5. We use variation in public pension policies to address this endogeneity issue.

Our instrumental variables estimation, as always, can be viewed as a two-stage process. In the first stage, we use retirement status as our dependent variable and national pension policies as the explanatory variables: whether the individual has reached the age of eligibility for early retirement benefits in the public pension system, and whether the individual has reached the age of eligibility for full retirement benefits. We also investigate specifications that use as additional instruments the number of years to or since reaching the age of eligibility for early retirement benefits (eligibility age minus current age); and the number of years to or since reaching the age of eligibility for full retirement benefits. These distance variables pick up the strong financial incentives to retire inherent in most public pension schemes as shown in Gruber and Wise (1999). All instruments vary across countries and sex (as shown by the table in an on-line appendix available with this paper at ⟨http://www.e-jep.org⟩).

We focus our analysis on the age range where we have maximum variation in the instrumental variables. As a result our analytical sample includes persons aged 60 to 64 from the United States, England, and all other European countries included in the first wave of SHARE— that is, Sweden, Denmark, the Netherlands, Germany, Switzerland, Austria, France, Belgium, Spain, Italy, and Greece.

In the second stage, we use the cognition score as the dependent variable, and as the explanatory variable, we use the retirement of each individual as predicted from the first-stage regression. In other words, our explanatory variable in this second stage includes only variation in retirement behavior that can be explained by national policies, which should offer an unbiased estimate of the effect of retirement on cognition.

Before we present the regression results, we provide a graphical representation of our identification strategy. Figure 6 shows to what extent national pension policies drive cross-country variation in the fraction not working for pay and in average cognitive scores. Figure 6A plots for each country the percent of 60–64 year-olds who are not working against the percent of 60–64 year-olds who are eligible for early pension benefits. The slope of the fitted line conveys that the higher the fraction eligible for benefits, the higher the fraction not working for pay. The R-squared of this simple regression is 0.49. The effect is larger for eligibility for early than for full pension benefits (shown in Figure 6C). Similarly, Figures 6B and 6D plot for each country the average cognitive score of 60–64 year-olds against the percent who are eligible for early or full pension benefits, respectively. In this case, the fitted regression line implies that the higher the fraction eligible for pension benefits, the lower the average cognitive score in the population. Again, both the size of the effect and the R^2 of the regression are larger for eligibility for early than for full pension benefits. To arrive at the effect of interest—the effect of retirement on cognition—we can read off the instrumental variables estimate directly from these graphs by dividing the slope coefficient for cognition by the slope coefficient for the fraction working for pay. It is (–0.036/0.523) × 100 = –6.88 (a drop of 6.88 in the cognitive score) when using eligibility for early retirement benefits as the instrument, and it is (–0.011/0.228) × 100 = –4.82 (a drop of 4.82 in the cognitive score) when using eligibility for full retirement benefits as the instrument.[9]

The results from micro-level estimation where we use both eligibility for early and for full retirement benefits as instruments are closely comparable. Table 1 shows the results.[10] As expected, the indicators of eligibility for early and for full pension benefits are very strong predictors for retirement in the first-stage regression.

We find a large and significant effect of retirement (or more precisely of "not working for pay") suggesting that retirement is associated with a reduction in the memory score of about 4.7 points on a scale from 0 to 20 compared to those who continue working. The average score in the sample is just under 10 and the standard deviation is 3.3. So the estimated effect amounts to just under 1.5 times the standard deviation of the cognitive score in our analytical sample. The results are robust to alternative specifications. For example, inclusion of the distance to and from the eligibility age for early and for full pension benefits gives a point estimate of –4.3 for the effect of retirement on the cognitive score. Also controlling for age in the most rigorous manner—that is, by estimating the same relationship separately for each single year of age from 60 to 64 and averaging the five point estimates—we find an effect of –5.7. Extending the age range of our analytical sample to encompass all ages where there is variation across countries in the eligibility for pension benefits, we re-estimated the relationship for all 55 to 65 year-olds. We added controls for age (age and $(\text{age}/10)^2$). We obtain a point estimate of –4.4 (or –4.5 when adding to the instruments the distance to and from the age of eligibility for early or full pension benefits). The estimates are strongly significant at the 1 percent confidence level across all specifications.

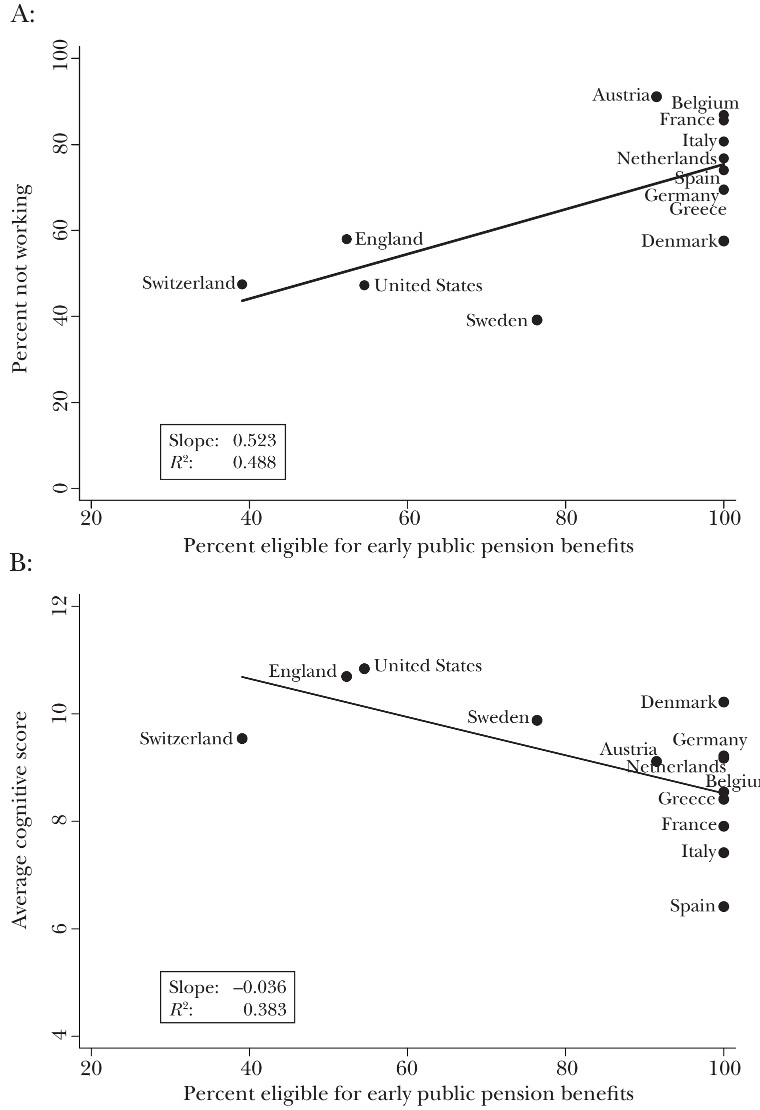
In sum, the estimated effect of retirement on cognition proxied by performance on word recall exercises is very large indeed. It is important to keep in mind that our framework does not measure solely the immediate effect of the onset of retirement. Instead it captures the effect of a much more extended process of retirement that may start—at least for some—already on the job according to our "on-the-job retirement hypothesis" and continue well into retirement. Retired individuals in our sample differ in their timing of retirement and will be at different distances from the path of cognitive decline without retirement. Some may have retired just recently while others may have been retired for many years. We do not investigate the issue of duration here.

Coe and Zamarro (2008) use the same SHARE data to investigate the effect of retirement on various health measures, including performance on the word

[9] These estimates give the average effect of retirement on cognition conditional on the average duration of not working observed in our sample of 60 to 64 year-olds.

[10] We used the generalized method of moments (GMM) estimator to adjust for clustering at the country level.

Figure 6
Graphical Illustration of the IV-Estimation
(for 60–64 year-olds)

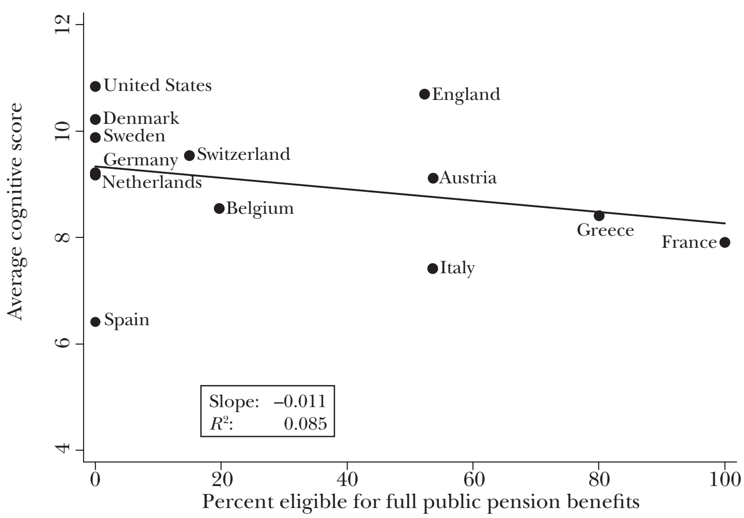


recall test. While they employ the same strategy to deal with the endogeneity of retirement, their analytical framework is very different. They apply a regression discontinuity approach attempting to isolate the effect of the onset of retirement, holding everything else the same, and do not find any effect of retirement on cognition. However, since retirement may take some time to affect cognitive function, their model is answering a different question than ours.

Figure 6—continued

C:

D:



Notes: The top two graphs plot for each country the percent of 60–64 year-olds who are not working against the percent of 60–64 year-olds who are eligible for early public pension benefits (left graph) and full public pension benefits (right graph). The bottom two graphs plot for each country the average cognitive score of 60–64 year-olds against the percent who are eligible for early (left graph) or for full (right graph) public pension benefits. See footnote 4 for details on the test of cognitive performance. On Figure 6A, the points for Germany and Greece are almost the same and so appear as one dot.

Can the very large effects we identify be plausible? Our findings are based on a powerful natural experiment that involves a major change in lifestyle (work to retirement) and that is unmatched in size (populations from multiple countries)

Table 1
Instrumental Variable Estimation of the Effect of Retirement on Cognition

	Coefficient	*p-Value*
First stage		
(Dependent variable: not working)		
Eligible for early benefits	0.191	0.000
Eligible for full benefits	0.163	0.023
Constant	0.438	0.000
Adjusted R^2	0.059	
Second stage		
(Dependent variable: cognition score)		
Not working	−4.660	0.000
Constant	12.592	0.000
N	8,828	

Note: In the first stage, we use retirement status (measured by whether the respondent is working for pay) as our dependent variable and national pension policies as the explanatory variables. In the second stage, we use the cognition score as the dependent variable, and as the explanatory variable, we use the retirement of each individual as predicted from the first-stage regression.

and duration (several decades) when compared to common laboratory experiments conducted on small—usually selected—samples over short periods of time. Therefore we believe that this finding deserves serious attention. One would expect the effect to vary across individuals. Future research will have to investigate the role of education, environment, and other factors.

Conclusions

Early retirement appears to have a significant negative impact on the cognitive ability of people in their early 60s that is both quantitatively important and causal. We obtain this finding using cross-nationally comparable survey data from the United States, England, and Europe that allow us to relate cognition and labor force status. We argue that the effect is causal by making use of a substantial body of research showing that variation in pension, tax, and disability policies explain most variation across countries in average retirement rates.

Further exploration of existing data and new data being collected would allow a considerably deeper exploration of the roles of work and leisure in determining the pace of cognitive aging. For example, the HRS contains considerable information on how respondents use their leisure time that would allow both cross-sectional and longitudinal analysis of changes in cognitive exercise that are associated with retirement. In addition, detailed occupation and industry data could be used to understand differences in the pace of technical change to which workers must adjust during the latter part of their careers. Also, in the 2010 wave, the HRS will be adding measures of other components of fluid intelligence. Future work in this area should be able to separate the effects of the "unengaged lifestyle hypothesis" (that early retirees suffer cognitive declines because the work environment they have left is more cognitively stimulating than the full-time leisure environment they have entered) from the "on-the-job retirement hypothesis" (which holds that incentives to invest among older workers are significantly reduced when they expect to retire at an early age).

During the past decade, older Americans seem to have reversed a century-long trend toward early retirement and have been increasing their labor force participation rates, especially beyond age 65. This is good news for the standard of living of elderly Americans, as well as for the fiscal balance of the Social Security and Medicare systems. Our paper suggests that it may also be good news for the cognitive capacities of our aging nation.

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