Retirement and Cognitive Function

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Abstract

We survey the recent literature on the effects of retirement on cognitive functioning at older ages. We describe results from studies using similar data sets (HRS, SHARE and ELSA), definitions of cognition, and instruments to capture causal effects. The studies yield widely varying results. Most papers find that being retired leads to a decline of cognition, controlling for different specifications of age functions and other covariates. However, richer specifications using fixed effects, dynamic specifications, or alternative specifications of instrumental variables often lead to large changes in the size and significance of the estimated effects. We replicate several of these results using the same data sets. We discuss the factors that are likely causing the differences across specifications, including endogeneity of right hand side variables, and heterogeneity across gender, occupation or skill levels.

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The literature on the effect of retirement on cognitive function has attracted economists' attention during the last decade. There are many reasons why the topic is of interest. Two key reasons are the desire for a better understanding of the effect of prolonging working life at older ages on well-being and the policy implications that these effects could have on countries dealing with underfunded retirement plans and aging populations. Encouraging individuals to delay retirement decisions with different policies could have important health costs if this affects their cognitive capacity. Effects of such policies could have significant financial and non-financial (e.g. health and well-being) implications for individuals and societies. Given the importance of this topic, we survey the recent literature on the effects of retirement on cognitive functioning at older ages.

There is not a clear consensus in the literature on the effect of retirement on cognitive functioning. Although most papers find that being retired leads to a decline in cognition, richer specifications (i.e., including fixed effects, dynamic specifications, or alternative specifications of instrumental variables) often lead to large changes in the size and significance of the estimated effects. Some papers find a negative effect of retirement on cognition (e.g. Rohwedder and Willis 2010; Bonsang et al. 2012, Mazzonna and Peracchi 2012, 2014) while other studies find a positive effect, especially when these disaggregate by different types of occupations (e.g. Coe et al. 2012 and Bianchini and Borella 2014). Other papers find no significant effects for men (see Coe and Zamarro 2011).

Using similar data sets (i.e. HRS, SHARE and ELSA), we replicate several of these results in an exercise aiming to get a better understanding on the sources of the differential effects found in the literature. Our study shows that results are very sensitive to differences in econometric specifications. In particular, the use of country fixed effects, to control for unobserved country differences, tends to reduce the estimated effect of retirement on cognition dramatically. This is also true even if we focus our analysis in different subgroups defined by different types of occupations (i.e. blue collar/ white collar jobs; physically demanding jobs; or high skilled jobs).

The structure of the remainder of this chapter is the following. We first survey the empirical literature on aging and cognitive functioning. Secondly, we summarize the results found in the empirical literature that focuses on the effect of retirement on episodic memory. We describe results from studies using similar data sets (HRS, SHARE and ELSA), definitions of cognition, and instrumental variables to capture causal effects. Third, we replicate several of these results using the same data sets. We discuss the factors that are likely causing the differences found across papers that use different specifications, including endogeneity of right hand side variables, and heterogeneity across gender, occupation or skill levels. Finally, we conclude.

2. Measuring Cognitive Function and its Determinants

Our goal is to understand whether being retired affects cognitive functioning. First, we briefly describe the different measures of cognitive functioning used in the literature we survey. Then, we summarize the main findings in the literature on aging and cognition, as well as the main factors affecting cognitive abilities and its decline.

Cognitive functioning

Following the classification in psychological theory on cognition, we briefly describe two types of cognitive functioning: fluid abilities and crystallized abilities, as described by the Cattel-Horn-Carrol theory. [1] Fluid abilities include processes related to recall, in particular, episodic memory, i.e working memory, including long-term memory and how fast we process information (perceptual speed). [2] The crystallized abilities relate to our knowledge and verbal learning. Education primarily affects the latter type of cognitive functioning. Crystallized abilities seem to be rather stable over time and can even improve with age (i.e., Hertzog 2008; Hertzog et al. 2008; Dixon et al. 2004; Park et al. 2002; Schaie 1994), while fluid abilities are more likely to decline with age (e.g., Anderson and Craik, 2000; Prull et al. 2000). The environment can affect memory at older ages as well as the intellectual stimulus that individual faces routinely (i.e., Salthouse 2006, 2009; Small 2002; van Praag et al. 2000). Most of the studies on cognitive function in economics focus on fluid abilities that are likely to affect dementing illnesses (i.e., Morris et al. 2001; Adam, Van der Linden, et al. 2007), such as memory or attention. The decline in fluid cognition may affect individual decision-making and adversely affect well-being. The papers discussed in this chapter all use similar measures of cognitive functioning; in particular they focus on immediate and delayed recall abilities.

Empirical Evidence on Cognitive Functioning, Aging and Determinants Other Than Retirement

In order to get a better understanding on how the process of aging can affect cognitive functioning we describe findings across several disciplines, including psychology, epidemiology, gerontology, neuroscience and economics.

Schaie 1989, using a review of findings from the Seattle Longitudinal Study on adult cognitive development, finds an important decline in cognitive functioning after late adult ages. This decline in cognitive abilities with age is also documented in Hertzog et al. 2008; Bäckman et al. 2005; Dixon et al. 2004; Peterson et al. 2002; Anderson and Craik 2000; Prull et al. 2000 and Schaie 1994, among others. Demographic variables such as gender and marital status are correlated with cognitive functioning (e.g., Lei et al. 2013; Halpern, 2012; Johnson and Bouchard, 2007).

Several studies also emphasize the importance of childhood experiences and parental background on cognition. This may include nature and/or nurture, genetics and/or the parents' education. One proxy for the intellectual environment in childhood sometimes used is the number of books at home when growing up, which is found to have a positive effect on cognition (e.g., Brunello et al. 2012). Some empirical evidence for genetics and nature can be found in Guven and Lee 2013.[3]

Health outcomes such as chronic conditions may affect cognitive functioning (Meyer et al. 1999). Limitations in activities of daily living and instrumental activities of daily living are also related to cognitive abilities (e.g., Barberger-Gateau et al. 1992 and Castilla-Rilo et al. 2007). Other health variables related to cognition are the baby's height and weight (e.g., Richards et al. 2002), or handgrip and strength test at older ages (e.g., Bohannon 2008; Case and Paxson 2008). Measures of cognitive decline have been used as a predictor for Alzheimer's disease in Evans et al. 1993; Schooler et al. 1999 and Stern et al.1994; Scarmeas and Stern 2003 and Case and Paxson 2005.

Cognitive reserve refers to the phenomenon that people with brains showing extensive Alzheimer's pathology may have manifested very little clinical cognitive impairment when alive Evidence suggests that education, activities and occupation could affect an individual's cognitive reserve (i.e., Stern 2002, 2003). The role of education in cognition has been studied in Banks and Mazzonna 2012; Maurer 2010; McFadden 2008; Evans et al. 1993, among others. Leisure activities, lifestyle and social networks are seen as determinants of cognitive functioning. The idea behind this is that engaging in activities that stimulate an individual's brain may maintain or repair his (her) cognitive functioning. The same goes with social networks, increasingly at older ages where social contacts could be an important stimulus. Some evidence of this can be found in Flicker 2009; Hertzog et al. 2008; Salthouse 1991, 2006; Scarmeas and Stern 2003; Fratiglioni et al. 2004; Börsch-Supan and Schuth 2013 among others. [4] Finally, some studies relate personality traits like patience and risk aversion to cognition (e.g., Frederik 2005; Benjamin et al. 2006; Dohmen et al. 2007; Midanik et al. 1995; Yates 1990).

3. Does retirement affect Cognitive Functioning? A Review

There is a consensus in the literature that episodic memory declines with age. Previous studies also suggest employment status is an important determinant of health and cognitive functioning. There exists a large related literature studying the effects of retirement on health. These studies vary in methodology, samples and health outcomes studied. The findings also vary widely. A large number of studies find a positive effect on general health (e.g., Ekerdt et al. 1983; Evenson et al. 2002; Charles 2004; Neumann 2008; Coe and Lindeboom 2008), others a negative effect (e.g., Dave et al. 2008; Behncke 2012; Calvo et al. 2013, among others).[5] Meanwhile other papers find no effect (e.g. Bound and Waidmann 2007). There is also a growing literature focussing on the influence of retirement on mortality, often with contrasting results (e.g. Kuhn et al 2010, Snyder and Evans 2006; Blake and Garrouste 2012; Hernaes 2013). In this chapter, we will discuss (and reanalyze) results obtained in a number of papers that relate retirement to cognitive function.

One of the main interests in answering the question « does retirement affect cognitive functioning? » is the prospect of understanding how retirement might affect well-being at older ages and the possibility of extending working lives of employees. During recent decades, countries have been facing challenges in ensuring the financial sustainability of their pension systems. Some countries have increased retirement eligibility ages for public pensions or/and are switching from defined benefits to a defined contribution pension systems. These reforms can have different effects upon countries and individuals, including individuals' employment status decisions. If employment status were to have an effect upon the cognitive reserve of individuals, the implications for policy-making would differ depending on the direction of the effect (that is, positive, negative or no effect).   Several arguments have been provided in the literature to support either a positive or a negative influence of retirement. For instance, if staying longer in the labor market is thought to be protective of memory capacity, encouraging workers to stay longer in the labor market:

(1) Would support the financial sustainability of pension systems. (Dave et al. 2008 ; Bonsang et al. 2012 ; Lei et al. 2012)

(2) Could reduce health care related expenditures and long-term care expenditures, assuming that implied memory loss is related to increased risk of dementia and increases in disability (Albert et al. 2002; Ernst and Hag 1995; Lyketsos et al. 2002; Tabert et al. 2002).

(3) Would aid autonomy and the capacity for sound financial decisions, including saving decisions. (Christelis et al. 2010; Banks et al. 2010; Brown et al. 2012)

(4) Could enhance well-being and quality of life at later ages. (OECD 2013).

We take another look at the effects of retirement on cognitive function. In particular we investigate the effect of retirement on episodic memory, which is the outcome variable widely used in the literature.

The studies

Existing studies reach conflicting conclusions on the effects of retirement on memory, both with respect to the sign of the effect and as to whether there is an effect at all. The following literature review discusses studies that have used similar data sets in recent years. They differ in methodology, yet they all aim to arrive at causal estimates of the effect of retirement by using instrumental variable methods (as we further explain in the next section). The studies discussed here use comparable measures of cognitive abilities, though they differ in their definitions of retirement. The most commonly used datasets are: (1) the Health and Retirement Study (HRS) for the U.S.; (2) the English Longitudinal Study of Ageing (ELSA) for England; and (3) the Survey of Health, Ageing and Retirement (SHARE) for Europe (see Table 1). More details about the data sets and variables can be found in Appendix A.

One of the first papers studying the effect of retirement on cognitive function is by Adam et al. 2007. Using HRS, SHARE and ELSA data for the year 2004, they find a negative effect of retirement on cognitive abilities. Their methodological approach—that is, a stochastic frontier analysis—differs from the ones used in the rest of the papers that we analyse in this chapter. However, they were the first to document a drop in cognitive abilities as individuals retire from the labor market. Adam et al. 2007 use the performance on a word recall test (the sum of the number of correct answers on an immediate ten item recall test and the number of correct answers to the same test, about 10 minutes later). They consider both if an individual is retired and how long (s)he has been. Their analysis does not provide a causal interpretation of retirement on cognitive abilities.

Table 3.1 here

Before entering into the details of this discussion, Table 3.1 shows the differences and similarities in surveys included, years considered, countries included and sample definitions of the data used by various authors. Rohwedder and Willis 2010; Coe and Zamarro 2011 and Bingley and Martinello 2013 conduct a cross-country analysis of the causal effect of retirement on cognition, using data for the year 2004. Coe et al. 2012 and Bonsang et al. 2012 analyse this relationship for one country, the US, using longitudinal panel data from 1996-2008 and 1998-2008, respectively. Rohwedder and Willis 2010 and Bingley and Martinello 2013 use three surveys (SHARE-ELSA-HRS). The rest of the papers use SHARE data, either using a one wave cross-country analysis or panel data analyses with two waves (2004-2006) or three waves (2004-2006-2010). Several studies exclude Greece due to missing variables (Mazzona and Peracchi 2014 and Bianchini and Borella 2014).

Other notable differences relate to sample and variable definitions. These include gender: Some papers analyse men and women together (i.e., Rohwedder and Willis 2010; Coe et al. 2012 or Bonsang et al. 2012), while most of the remaining studies run their analysis separately for men and women. Age: Each study uses a different range of ages in their analysis. While the early studies limit their analysis to the range of 50-59 or 60-64, the rest of the papers extend it to the 50-70 age interval. The effect of retirement is not examined for individuals older than 70, given the very low proportion of working respondents after this age. Occupation: Some studies differentiate between blue and white collar jobs before retirement (i.e., Mazzona and Peracchi 2014 and Bianchini and Borella 2014). In Table 3.1 we summarize the surveys, samples and definitions of the dependent and independent variables adopted in all studies.

The nine papers discussed here define cognitive functioning with a similar measure, i.e. the sum of immediate and delayed recalled words of a list of ten words. All surveys considered in these papers provided a general indicator of cognition by adding the two scores, for a maximum of 20 (10 words from immediate recall and 10 words from delayed recall); thus the indicator ranges from 0 to 20.[6] We will denote the variable as str20 from now on; see Appendix A for details. The data sets also contain other cognitive ability variables, some of which were analysed as well in the papers discussed here.

Three main definitions of retirement can be identified in these papers, which are used alternatively or jointly in the regressions analyses undertaken in the studies. The first definition is related to self-reported labor force status, particularly the retirement status. At times this variable also takes individuals receiving old age pension benefits into account. « Retired » is generally defined as a dummy variable. A different definition often used follows Lazear 1986 by defining being retired as not working. Lazear considers individuals retired if they are permanently out of the labor force. The studies following this definition include in the retired category all individuals who are not working for pay, including those out of the labor force, who will probably not return to the labor market. The third definition is a continuous variable related to retirement duration, captured in different ways by time spent in retirement.[7] Most of the studies use the information of years in retirement, measured as the elapsed time between retirement date and interview date (i.e., Coe et al. 2012) and/or the information on when the last job ended (i.e., Bonsang et al. 2012).

All studies included controls for age in some form. Rohwedder and Willis 2010 and Bonsang et al. 2012 control for age, but do not explore the effect of other covariates. Bingley and Martinello 2013 add years of schooling to the age controls in their analyses. Other studies introduced a broader number of covariates. Coe and Zamarro 2011 use control variables such as demographic, socio-economic status (SES hereafter) and different health variables. They also include country dummies. Coe et al. 2012 include demographic and SES variables as well as wave dummies. Mazzonna and Peracchi 2012 control for demographic, SES and health as well as country, cohort and regional dummies. In a companion paper, Mazzonna and Peracchi 2004 control for demographics, SES and health variables similarly to Celidoni et al. 2013. To these, Bianchini and Borella 2014 add behavioral variables and informative variables where the same cognition questions were asked over time, [8] in order to capture the learning and contextual factors in the different waves of the SHARE survey.

Some papers address a “honeymoon phase” (Atchley 1976, 1982). This “honeymoon phase” refers to the fact that when first retired, individuals often start to spend more time engaging in activities that they did not have time to do while working, and these activities could have a positive effect on their cognitive abilities or ever delay its decline. However, it seems that this "phase" does not last long (i.e., Ekerdt et al. 1983; Gall et al. 1997; Mein et al. 2003; Mojon-Azzi et al. 2007; Westerlund et al. 2010). Nevertheless, this suggest that when analyzing the relationship between retirement and cognition, one has to take this phase into account, by controlling for the length of time one has been retired (Bonsang et al.2012; (Mazzonna and Peracchi 2012, 2013); Bianchini and Borella 2014). Occupational characteristics such as being a blue-collar worker or having a physically demanding job could affect cognitive functioning differently than being a white-collar worker or having an intellectually engaging job (Dorm et al 1998; Potter et al. 2008). Coe et al. 2012; Mazzonna and Peracchi 2014 and Bianchini and Borella 2014 study the influence of type of occupation when analyzing the effect of retirement on cognitive functioning.

Retirement and Cognitive Function: Causal or Not?

Relationship Between Retirement and Cognitive Functioning

The nine papers we reviewed find a negative relationship between retirement and cognitive capability, while using varying measures of retirement and cognitive functioning. Some studies also find a positive effect of volunteering or social activities on cognition. Other disciplines, for instance neurology, also find a negative effect of inactivity on cognitive abilities. With regard to neurology in particular, we can mention Scarmeas and Stern 2003 who explain the importance of occupation and life style to preserve cognitive reserve.

We now present a description of the findings in the papers we reviewed. Rohwedder and Willis 2010 and Adam et al. 2007 document a positive relationship between working and cognitive functioning. They find a drop in cognitive performance in countries where individuals retire early. In order to demonstrate this, they compare the employment rates of men aged 60-64 relative to men aged 50-54 and then show a relationship with the decline in word recall of men aged 60-64 relative to men aged 50-54 for a number of SHARE countries, ELSA and the US. When Adam et al. 2007 control for occupational activities, they find that not working is negatively and significantly correlated to memory recall. Rohwedder and Willis 2010 use a broad definition of self-reported retirement. They use working for pay versus not working which, following Lazear 1986, includes individuals other than retirees. When they run the regression without controls, they find that on average retired individuals' memory scores decrease by about 4.9 points with retirement. Bingley and Martinello 2013 follow the Rohwedder and Willis 2010's definition of retirement, which is to not have worked for pay in the last four weeks, and they find similar results when they replicate Rohwedder and Willis 2010 's specification.

Coe and Zamarro 2001 also use a broad retirement definition. They consider retired, homemakers, disabled and sick individuals not temporarily out of the labor force as retirees. They define this variable as conditional on having been working for pay at age 50. Coe and Zamarro 2011 confirm a negative effect of retirement on cognition when demographics, SES and health controls are added (the estimated coefficient equals -0.2769, significant at 5%). Coe and Zamarro 2011 also investigate verbal fluency with positive but no significant effect. The cross-country analysis undertaken in the three papers are all based exclusively on data for the year 2004.

The following two papers, Coe et al. 2012 and Bonsang et al. 2012, differ from the previous ones in their use of HRS panel data for only one country, the US. They use a continuous retirement duration variable as an explanatory variable instead of using a retirement dummy. Coe et al. 2012 define self-reported retirement as the elapsed time between retirement and the interview date. Meanwhile, Bonsang et al. 2012 use a broad definition of retired which includes a non-parametric approach for the retirement duration and takes information for the year of the last job into account. They use in their analysis only the retirement dummy variable when the individual was retired for at least one year, and they also add a categorical variable to capture years spent in retirement. Using the word recall measure, Coe et al. 2012 find no significant effect in their regression for blue-collar workers. However, they do find a highly significant negative effect, though small, for white-collar workers (-0.03927). They also explore other cognitive function indicators such as numeracy and self-rated memory, and find similar results; for white collars they still observe a negative effect, however for blue collars they now find a negative correlation between being retired and the self-rated memory variable. Coe et al. 2012 extend their analysis to several indicators such as self-rated memory, working memory and numeracy. Bonsang et al. 2012 use a non-parametric approach. Their regression findings for different ranges of retirement duration are all negative. However, most of the drop happens at the beginning of the period. To deal with unobserved heterogeneity among individuals, they then specify a Fixed Effects (FE) approach. Of course, any time invariant explanatory variable such as gender, education and occupation (if unchanged) cannot be identified separately from the unobserved heterogeneity terms. They find that the estimated effect of retirement duration is reduced substantially once they use the fixed effects specification. The coefficient representing the effect after 1-2 years into retirement is only significant at 10%.

Among the papers reviewed, the only one that does not examine the variable str20 is Mazzona and Peracchi 2012. They examine both immediate and delayed recall separately. Mazzona and Peracchi 2012 also examine an “orientation in time” variable, as well as verbal fluency and numeracy. In a companion paper, Mazzona and Peracchi 2014 also build a cognitive capability index using principal component analysis with all these cognition measures. Mazzonna and Peracchi 2012 define their retirement duration measure as years spent in retirement, being zero when the individual is working. Mazzonna and Peracchi 2012 find a negative effect of retirement duration on both immediate recall and delayed recall [-0.010* to -

0.018***]. Their control variables include an interaction between retirement duration and education.

Other papers include both retirement definitions in their analysis. Mazzonna and Peracchi 2014 include a dummy similar to the one used in Rohwedder and Willis 2010, where the retired are people not working for pay. They also analyze the effect of retirement duration defined as in Mazzonna and Peracchi 2012. In Mazzonna and Peracchi 2014, both the retirement status dummy and the retirement duration are included in the regressions. Their analyses are broken down by subgroups, such as men and women, as well as low physical burden jobs and high physical burden jobs. They do not report OLS results.

In Celidoni et al. 2013, being retired is self-reported conditional on at least 15 years of work experience. They do not include people with long inactivity periods due to disability or long-term unemployment (in contrast to Rohwedder and Willis 2010 and Coe and Zamarro 2011). They include retirement duration similarly to Coe et al. 2012 for SHARE, using SHARELIFE when they report retiree status. Celedoni et al. 2013 concentrate on early retirement and cognitive decline. They first replicate previous results in the literature for the retirement duration variable and the word recall measure. They find no significant effect of the retirement dummy, but do find a negative and significant effect of the number of years in retirement. They also use fixed effects and find a negative and significant coefficient for the retirement duration by controlling for age and time dummies. The coefficients range between [-0.0963, -0.1285] depending on the specification of the age functions.

Bianchini and Borella 2014 use a similar definition of retirement status as Bonsang et al. 2012. They define retirement duration as the age of the individual at the current wave minus the age at retirement. They estimate another specification interacting the number of years of retirement with the retirement dummy for individuals who actually retire during the sample period, so that they are observed both when they are working and when they retire. Retirement is self-reported. The retirement duration variable measures the time elapsed between the year of the interview and the year of retirement differently from the other studies. In order to find the year in which the individual retired, they use the question of when the last job ended. Using an empirical strategy approach with individual fixed effects while controlling for other variables and time effects, they find an insignificant influence of retirement on cognition. Mazzonna and Peracchi 2012 and Bianchini and Borella 2014 are controlling for the number of retests to correct for the possibility of learning when individuals participate in more than one wave in SHARE.

It is worth mentioning the study by Börsch-Supan and Schuth 2014. This study focuses on early retirement and cognition, although they do not analyse causal effects. They define early retirement as all labor force exits before the pensionable age (taken from OECD 2011) not related to the receipt of disability benefits. Controlling for demographic variables and health variables including disability retirement and years of disability, they find a strong significant and negative effect of retirement on cognition. They find a positive effect for the early retirement dummy, which is significant for the delayed recall measure and for a numeracy measure, yet not significant for immediate recall.

Causal or Not?

However, establishing a causal effect of retirement is far from straightforward. Individuals with a cognitive impairment for reasons unrelated to work may want to retire sooner than others. In that case, the effect could run from cognitive functioning to retirement instead of the other way around. Furthermore, effects may vary by occupation, so one needs to disentangle how working in different types of jobs (e.g., involving different levels of physical and mental effort) could affect cognitive ability.

Retirement entails major life style differences, which may have a variety of effects on cognition. For example, we may decrease our cognitive reserve by replacing work with a less stressful daily activity (Scarmeas and Stern 2003). Retirees may adopt either a more physically active or a more sedentary life and will likely adjust their social networks (e.g., Börsch-Supan and Schuth 2013; Banks and Mazzonna 2012; Hertzog et al. 2008; Rowe and Kahn 1998; Schooler et al. 1999 ; Fillit et al. 2002 ; Fratiglioni et al. 2004). Conversely, remaining at work could help to keep our stock of human capital, i.e. our decision-making skills (Small 2002).

Cognitive endowments could affect both cognitive functioning outcomes and retirement decisions. For instance, low-educated individuals or individuals with more physically demanding jobs may retire at earlier ages than highly-educated individuals (or individuals with more intellectual jobs). In fact, blue-collar workers report lower cognitive scores and may have more incentives to retire. Individuals with white collar jobs may enjoy their work more and may have started their working career later and then decide to retire later, while blue-collar workers may decide to retire earlier to relieve themselves from their physically demanding jobs (e.g. Glymour et al. 2008; Evans et al. 1993; Dorm et al. 1998; Potter et al. 2008). Finally, common factors like preferences, behaviour or health could affect both retirement and cognitive abilities (e.g. Frederik 2005; Benjamin et al. 2006; Dohmen et al. 2007).

To address these issues, the papers discussed here used various econometric strategies and specifications. The reviewed studies discussed here have attempted to disentangle these mechanisms by using plausible sources of exogenous variation in retirement. In particular, they analyze the effect of retirement on cognition using instrumental variable (IV) approaches. Eligibility ages for both early and full pension benefits are typically used as instruments. All of the papers use the institutional information collected in Pension at Glance (OECD) and/or in Social Security Administration in the US. The instruments used capture the timing of eligibility for public pensions, and most of the papers use these policy variables in relation to the interview date and the age of the respondent. An exception is Coe et al. 2012 who use the early retirement windows offered by firms as instrument and exploit an HRS question about offers of an early retirement window before age 60, using the current interview date to infer retirement duration. Mazzonna and Peracchi 2012, 2014 use the statuary retirement ages related to the time when individuals actually retired as opposed to their age.

In order to be suitable instruments, these variables need to be correlated with retirement but only affect cognition through their effect on retirement. This type of policy variables related to statutory retirement ages and rules on Social Security benefits have been used previously successfully for a large number of papers (Hurd 1990; Lumsdaine and Mitchell 1999; Zissimopoulos et al. 2007; Poterba and Venti 2004, and so on). Similarly papers related to the effect of retirement on health have shown that these proposed instruments are very strong predictors of retirement behavior (see e.g. Charles 2004; Coe and Lindeboom 2008; Neuman 2008; Bound and Waidmann 2007, among others), and when multiple instruments were available and tests were possible these variables turned out to be strong and valid instruments.

In this section we review the results of IV approaches. In general, the studies find significant first stage effects of retirement eligibility ages on retirement. Control variables included in first stage regressions vary by study. For the sake of simplicity in the exposition of the results, we will not elaborate on the differences in the first stage regressions.

Our nine reviewed papers follow a similar strategy to deal with the endogenous effect of retirement on cognition. However, there were some important differences.

In table 3.1, we emphasized years included, countries considered, and control variable differences as well as different independent variables included in some studies. We also looked at how studies define retirement differently. We observed that some papers do not capture retirement duration. We summarize the various approaches in Table 3.2.

Table 3.2 here

All papers agree upon a negative causal effect when only controlling for age. Rohwedder and Willis 2010 limit their analysis to one cross section. The coefficient in their analysis is -4.666, significant at one percent. However, this effect disappears in Coe and Zamarro 2011 when they control for country dummies. Coe et al. 2012 use panel data for only the US and find a slightly positive effect; more precisely, they find a significant and positive effect for blue-collar workers with a coefficient of about 0.38. Bingley and Martinello 2013 analyse the relationship that years of schooling has with the statutory age of retirement across countries and gender. In table 3.2 we report their IV estimates when they introduce the years of schooling dimension. The magnitude of the effect of retirement on cognition gets reduced when controlling by years of schooling (-3.014 versus -5.604). They also estimate the model for men and women separately and find a lower effect of retirement on cognitive function of women compared to men. Mazzonna and Peracchi 2012 bring out the importance of cohort effects and learning effects in cognitive functioning scores, draw attention to attrition in the data, and highlight the importance of education and occupational skills. As most of the previous studies, they take the cohort effect into account in their instruments, as they use the eligibility age for early and full retirement at the time individuals retired. They find a negative effect of retirement on cognitive abilities (covering immediate and delay recall separately). They also find large differences between male and female estimates.

As previously noted, some studies deal with unobserved heterogeneity among individuals using a FE approach. The following studies exploit an IV-FE approach. Bonsang et al. 2012 find a significant and negative retirement coefficient of -1.021 in the baseline model. They also control for different age specifications and different retirement durations and find less robust results. Their most striking result is a strong negative effect of retirement immediately after becoming a retiree. Mazzonna and Peracchi 2012 construct a cognitive index and analyze both retirement status and retirement duration, finding a negative effect of retirement duration. This means that more time in retirement implies a larger decrease in cognitive functioning. They also estimate the model by physically demanding job categories, finding a positive effect of retirement on cognition for white-collar jobs and no significant effect for blue-collar jobs, as well as a negative effect of retirement duration for both groups. Celidoni et al. 2013 finds a negative effect of retirement duration on cognition with an IV-FE approach with a coefficient of (-0.1967). In contrast, Bianchini and Borella 2014 find a significant positive effect of retirement duration on cognition using the same approach (with a coefficient of 0.3919).

4. Disaggregating Cognitive Abilities and Reconciling Results

Data and Empirical Strategy

To get a better understanding of the sources of differential effects of retirement on cognition documented in the literature described above, we use the same three surveys mentioned previously; HRS, ELSA and SHARE. See Appendix A for more detail about surveys and key variables definitions. We keep data from 2004 to 2012 and countries with at least three waves (13 countries). [9] Table 4.1 reports descriptive statistics for the baseline samples.

Table 4.1 here

This section presents results of our analysis trying to reconcile different results found in the literature. In particular, as described above, we pooled data from HRS, ELSA and SHARE and estimated possible effects of retirement on cognitive ability using Ordinary Least Squares (OLS), Instrumental Variable Methods (IV), Fixed Effects (FE) and Instrumental Variable Fixed

Effect (IV-FE) methods. We do so, for all countries and all surveys combined and for different surveys (HRS, ELSA and SHARE) separately.

We also present specifications with different sets of controls. In particular, our first specification does not include control variables at all, while our second specification includes only controls for age, cohort and gender effects. Our third specification adds country fixed effects to the set of controls. Finally, our last two specifications include demographic information (marital status and level of education) and health outcomes (self-reported health, number of limitations with activities and medical conditions) as controls. Of course, the last two specifications could raise endogeneity issues. In the former this would be the case because marital status can affect cognitive abilities via social activities as part of the family network. In the latter specification, one may be concerned that health is affected by cognition, while health may also be affected by the retirement decision. We have also conducted various robustness checks, including the incorporation of income, wealth and other social network control variables. Because the main results were not affected qualitatively, they are not included here. More details about the data can be found in Appendix A.2.

Following the literature, we present different specifications of the key independent variable, retirement. The first definition is based on self-reports of current job status (retired_s). Our second definition includes homemakers and those who declare to be sick and disabled into the set of retirees, but conditions the sample on those who were working at the age of 50 (retired_r) as in Coe & Zamarro 2011. Our last definition of retirement is the most inclusive one and defines as retired all those who do not declare to be working as their current job status (retired_w) as in Rohwedder and Willis 2010.

To address the potential endogeneity of retirement, we construct instruments based on two dummy variables, which indicate whether the respondent is eligible for full or early retirement public pensions using the country- and gender-specific pension-eligibility ages described in Table 4.2. The ages for the US refer to Social Security claiming ages rather than retirement ages; 62 is the earliest age at which one can claim Social Security. One can claim Social Security at any time between age 62 and age seventy, with an actuarial adjustment for claiming earlier or later than the full retirement age. Receipt of Social Security benefits has no implications for one's ability to be gainfully employed. For comparison purposes we treat the US early claiming age and full retirement age similarly to the treatment of early and full retirement ages in the European countries.

Table 4.2 here

The next sections will address different factors to understand the differences across studies. We first study the difference between pooling the data sets and analyzing each survey separately.

Differences across countries and surveys

Table 4.3 presents the results for all countries and surveys pooled together. Overall, OLS estimates show consistent significantly negative effects of retirement on cognition scores ranging from -1.28 for specifications without controls to -0.28 for specifications with more detailed controls. The more controls we add, the lower the estimated effect. The size of the effect varies depending on the definition of retirement used. The definition based on the respondent declaring not to be working (retired_w) generates the highest estimated negative effects, followed by retired_r) and self-reported retirement status (retired_s).

Table 4.3 here

Table 4.4 reports the first stage estimates for the baseline model for each of the binary retirement outcomes. In Appendix B, Tables B1 –B3 report the first stage results for various samples broken down by whether jobs are physically demanding, blue or white collar, or vary in required skill level. The first stage results show that the instruments are positively related with the dependent variables of retirement. Their coefficients decrease when controls are introduced but they remain significant at 1% in almost all cases. The second stage estimations are reported in Table 4.3. The exogeneity Sargan-Hansen test statistics are significant.

Table 4.4 here

IV estimation results are quite different in magnitude from the OLS results, although the signs don’t change (see Table 4.3). They mostly imply bigger and highly significant effects. Results change dramatically when country fixed effects are included. In the non-IV specifications with fixed effects the coefficients of retirement become insignificant almost across the board and often change signs. Combining country fixed effects with IV restores the estimated negative effect of retirement on cognition in most cases, but the effects are now mostly small and often insignificant. Including country fixed effects in the instrumental variables approach changes the sources of identification and interpretation of the estimated retirement effects. When country effects are included in the analysis, retirement effects are estimated by comparing individuals in the same country above retirement eligibility age to those who are just below. The estimated retirement coefficient can be interpreted as a weighted average of estimated effects based on this comparison. When country effects are excluded, however, comparisons also use variation across countries and so the cognition of all those above retirement age is compared with the cognition of those below (Coe and Zamarro 2011).

If the causal effect of retirement on cognition is heterogeneous across respondents, then the estimated effect recovered by IV is a weighted average of the effects for those individuals who are induced to change their decisions because of the instrument. In our case, the instruments are based on retirement eligibility and hence the issue is which labor force participants are induced to retire once they reach the eligibility age. This is what is known as the local average treatment effect (LATE; Imbens & Angrist 1994; Angrist & Pischke 2015). Thus, IV studies that estimate the same model with different IVs or using samples from different populations may obtain very different estimates of the causal effect.

To explore this further, we also run models separately for the three surveys HRS, ELSA, and SHARE. Results can be found in Table 4.5. The OLS estimations confirm the same results through the different surveys. The IV and IV-FE results vary across surveys, somewhat but generally retirement is only found to have a significant negative effect on cognition in the models without country fixed effects.

Table 4.5 here

Heterogeneity across Individuals

Retirement Cognitive Abilities by gender

The average cognitive scores are different between men and women. Men recall 9.58 words while women recall 10.39 words. These numbers are quite stable over the period studied. Figure 1 shows that the averages vary across countries, but women always score better than men.

Figure 4.1 here

We also estimated separate models by gender. Results can be seen in Table 4.6. The OLS estimates are similar for men and women. However in the IV models women mostly retain significant and negative coefficients even controlling for all co-variates, while for men the coefficients of interest lose significance once we control for country fixed effects. The IV-FE estimates for men are statistically insignificant, while for women, the effects of retirement on cognition remain negative and mostly statistically significant, even when country fixed effects and covariates are included.

Table 4.6 here

The Role of Occupations.

We define two kinds of variables that capture physically demanding occupations. One variable asks for the physical effort in the current job directly, while a second variable is constructed using the recorded occupational categories and following the ISCO coding for Continental Europe, for UK the categories are from the SOC2010 and the Census coding for the USA to distinguish between blue collar jobs and white collar jobs. Individuals working in physically demanding jobs recall about 10 words, while the ones with less physically demanding jobs recall about 11. We find similar differences when comparing blue-collar jobs and white-collar jobs. More details can be found in Appendix A. In Tables 4.7a and 4.7b we present the results for the subsamples broken down according to the two definitions.

Table 4.7a shows the results when we distinguish by physical effort. The OLS estimates are different across occupations. While for the physically demanding jobs the effect of retirement on cognition is negative and significant only before controlling for country fixed effects or other covariates, for individuals with less physically demanding jobs, the effect is significantly negative even after controlling for more explanatory variables for all retirement definitions. Yet, once we control for country fixed effects and apply instrumental variable estimation the effects for both groups become generally insignificant. The results for blue and white collar jobs show a similar pattern. Once we instrument and allow for country fixed effects the influence of retirement on cognition becomes insignificant.

Table 4.7a here

Table 4.7b here

<u>Heterogeneity by Educational Level</u>

As Bingley and Martinello 2013 argue, the differences in eligibility ages across gender can be correlated with education level. Moreover lower educated individuals show lower cognitive abilities than higher educated individuals. Table 4.8 shows a breakdown of results for two different educational levels. The OLS and IV estimates are similar across the two groups, although the coefficients are smaller for higher educated individuals than for lower educated individuals. However, the IV-FE specifications show generally insignificant results for both groups.

Table 4.8 here

Conclusion

We have reviewed the empirical literature on aging and cognitive function and in particular the empirical literature on the effect of retirement on episodic memory. Results using HRS, ELSA, and SHARE show an enormous variation. We have replicated the main approaches adopted in the literature using the same datasets. Our results show that outcomes are very sensitive to econometric specifications. In particular, the use of country fixed effects tends to reduce the estimated effect of retirement on cognition dramatically. This is also true if we consider subgroups distinguished by blue collar/ white collar; physical demands; or skill level. The upshot of our work seems to be therefore that the results found in the literature are very sensitive to the methods used and hence have to be considered quite fragile.

Appendix A

The data used in the studies reviewed and analysed in our paper come from longitudinal surveys of the over-50 population: the Health and Retirement Study (HRS) for the U.S., the English Longitudinal Study of Ageing (ELSA) for England and the Study of Health, Ageing and Retirement (SHARE) for Europe. Since SHARE was introduced in 2004, we focus our analysis on the year 2004 and subsequent waves of all surveys till 2012. From 2004 onward, we analyse 5 waves for HRS and ELSA (until 2012) and 4 waves for SHARE (wave 3 is SHARELIFE and does not contain cognitive abilities variables).

HRS, ELSA and SHARE cover an equally broad range of topics, including demographics (age, gender and education), labor supply, income, pension benefits, wealth, health and cognitive function. They contain identical question wordings whenever possible.

A.1. Cognitive functioning variables

The three surveys ask several questions about cognitive functioning. Their measures of cognitive abilities are comparable, and follow similar procedures to avoid potential biases from the interviewer or caused by other people being present when the cognitive function questions are asked. We describe below the construction of the cognitive abilities variable that we use in the regressions (which is called “recall summary score of a maximum of 20” (str20)).

HRS: The interviewer read a list of 10 nouns (e.g., lake, car, army, etc.) to the respondent. Immediate Word Recall: After reading the list, individuals were asked to recall as many words as possible. The list could be given in any order. Between waves, the list of nouns may have been changed. Delayed Word Recall: After approximately 5 minutes of being asked other survey questions (e.g., about other cognition items) individuals were asked to recall the list again in any order. The sum of the outcomes of both Immediate Word Recall (10 words) and Delayed Word

Recall (10 words) is used to build a recall summary score of a maximum of 20. The values range from 0 to 20.

ELSA: The list of 10 nouns could be read from a computer screen (e.g., hotel, river, tree, etc.). Ie:*"For the next task the computer will 'read' a list of words which I will ask you to recall. First I'd like to check that you will be able to hear the computer voice - please listen to this short message. If the respondent still cannot hear properly, code that you will read out the list yourself." " List 1 read out by computer, List 2 read out by interviewer"*

"The computer will now read a set of 10 words. I would like you to recall as many as you can. We have purposely made the list long so it will be difficult for anyone to recall all the words. Please listen carefully to the set of words as they cannot be repeated.

When it has finished, I will ask you to recall aloud as many of the words as you can, in any order. Is this clear?" "I will now read a set of 10 words. I would like you to recall as many as you can. We have purposely made the list long so it will be difficult for anyone to recall all the words. Most people recall just a few. Please listen carefully to the set of words as they cannot be repeated. When I have finished, I will ask you to recall aloud as many of the words as you can, in any order. Is this clear?"

After several other questions were asked, the respondent was asked to recall the words again. The summary test recall score is again the sum of both immediate and delayed word recall for a maximum of 20. The values range from 0 to 20.

SHARE: The study is similar. The list of 10 nouns could be read from a computer screen (e.g., hotel, river, tree, etc.). At the beginning of immediate word recall the respondent read this message: *"Please listen carefully, as the set of words cannot be repeated. When I have finished, I will ask you to recall aloud as many of the words as you can, in any order. Is this clear? Have* *booklet ready. Wait until words appear on the screen. Write words on sheet provided. Allow up to one minute for recall. Enter the words respondent correctly recalls."*

As in HRS, for the delayed word recall the respondent was asked to recall the words again after several questions were asked about other cognitive abilities. The summary test recall score is again the sum of both the immediate and delayed word recall for a maximum of 20. The values range from 0 to 20. However, a disadvantage of SHARE is that all respondents in the household and through waves 1 and 2 could receive the exact same test over time. The survey corrected and updated this issue in waves 4 and 5.

A.2. Retirement

The retirement definition for retired_s, retired_r, and retired_w comes from the comparable raw definition of the labor force in HRS, ELSA and SHARE. For retired_r, we defined retired versus working. Meanwhile in the other definitions, the retirement proxy includes homemakers, sick or disabled, non-temporarily away from labor force individuals. However an important difference between these two definitions is that retired_r is conditional on working at age 50. We then build a variable to capture the age when individuals stopped working.

A.3. Other Covariates

The regressions that we presented in section 4 control for different covariates. The second estimations add to the baseline other controls for age and quadratic age forms, year's dummies, cohort dummies and gender. The third estimation includes the previous variables along with country dummies. The next specification adds demographic variables. The demographic variables include being married or in a couple and their interaction with being female. The model also takes into account three education levels, tertiary, secondary, and primary. The omitted variable is the tertiary level. The last specification adds to the previous one the health variables. We include different dimensions. A binary indicator is included for having at least one major chronic condition among cancer, lunge disease, heart attack and stroke. We also control for having at least one minor chronic condition among hypertension, diabetes and arthritis, as well as for a self-reported health variable (=1 if the individual reports bad or poor health and 0 otherwise). ADLA and iADLA indicators are also considered. In the robustness section we also include different age forms, and test the logarithmic variables of income and wealth. We try including social network variables such as living alone, household size or social activities.

The physically engaging jobs sample uses a common variable describing whether the current job requires lots of physical effort. For ELSA, there are four categories: sedentary occupation, standing occupation, physical work, and heavy manual work. We code 1 the "physically engaging jobs" variable for the last two categories, and 0 otherwise. The question in HRS asks directly if the current job requires physical effort and individuals report the answers: whether all/almost all the time, most of the time, some of the time and none/almost none of the time. We categorize 1 for all/almost all the time and 0 otherwise. In SHARE, responses categories are : strongly agree, agree, disagree and strongly disagree. In our analyses the level of job physicality for SHARE is 1 for strongly agree and 0 otherwise.

For the blue-collar and white-collar samples, the definitions are based on the harmonized categories following the SHARE's ISCO coding and the HRS's 1980 and 2000 census coding. We use for ELSA the categories in the SOC2010 volume 3: the National Statistics Socio-economic classification (NS-SEC rebased on SOC2010), which explicitly grades by social class more than the other two. We label as blue collars jobs those that involve routine or manual work, and as white collar jobs managerial and professional occupations or intermediate occupations.

Appendix B

Table B.1. First Stage Results. Physical Demanding jobs sample. All Countries.

Table B.1. here

	Dependent Variables	*Retired_s*	*Retired_r*	*Retired_w*	*Retired_s*	*Retired_r*	*Retired_w*
		Fisrt Stage Physical demanding job			Fisrt Stage: More Intelectual job		
1. No Controls	*Above full*	0 .25***	0 .23***	0 .13***	0 .28***	0 .27***	0 .14***
	retirement age	(0 .014)	(0 .01)	(0 .01)	(0 .007)	(0 .007)	(0 .006)
	Above early	0.24***	0.26***	0.14***	0.20***	0.25***	0.13***
	retirement age	(0 .011)	(0 .01)	(0 .01)	(0 .005)	(0 .005)	(0 .005)
2. Years, Cohorts, Gender	*Above full*	0.024***	-0.03**	0.01	0.08***	0.05***	-0.01
	retirement age	(0.017)	(0.02)	(0.02)	(0.008)	(0.006)	(0.08)
	Above early	0.07***	0.01	0.09***	0.03***	0.06***	-0.001
	retirement age	(0.011)	(0.01)	(0.01)	(0.005)	(0.006)	(0.005)
3. 2 + Country Fixed Effects	*Above full*	0.01***	0.00	-0.03	0.06***	0.04***	-0.007
	retirement age	(0.016)	(0.004)	(0.02)	(0.008)	(0.009)	(0.008)
	Above early	0.05***	0.07***	0.01	0.03***	0.06***	0.01
	retirement age	(0 .013)	(0 .01)	(0 .01)	(0 .006)	(0 .007)	(0 .006)
4. 3 +Demographics	*Above full*	-0.006	0.014	0.05***	0.06***	0.04***	-0.009
	retirement age	(0 .01)	(0 .02)	(0 .02)	(0 .009)	(0 .009)	(0 .008)
	Above early	0.06***	0.07***	0.01	0.03***	0.06***	0.01
	retirement age	(0 .01)	(0 .014)	(0 .01)	(0 .006)	(0 .007)	(0 .006)
5. 4+ Health Controls	*Above full*	0.01***	-0.00	-0.03	0.07***	0.05***	0.002
	retirement age	(0 .02)	(0 .02)	(0 .02)	(0 .009)	(0 .009)	(0 .008)
	Above early	0.06***	0.07***	0.02*	0.04***	0.07***	0.02***
	retirement age	(0 .01)	(0 .01)	(0 .01)	(0 .006)	(0 .007)	(0 .006)

Table B.2. First Stage Results. Occupation sample. All Countries.

Table B.2. here

	Dependent Variables	*Retired_s*	*Retired_r*	*Retired_w*	*Retired_s*	*Retired_r*	*Retired_w*
		Fisrt Stage Blue-collar jobs			Fisrt Stage: White-collar jobs		
1. No Controls	*Above full retirement age*	0 .27***	0 .26***	0 .13***	0 .27***	0 .26***	0 .14***
		(0 .01)	(0 .01)	(0 .009)	(0 .008)	(0 .008)	(0 .007)
	Above early retirement age	0.25***	0.28***	0.16***	0.18***	0.23***	0.11***
		(0 .008)	(0 .008)	(0 .007)	(0 .006)	(0 .006)	(0 .005)
2. Years, Cohorts,	*Above full retirement age*	0.05***	0.03**	-0.04***	-0.26***	0.05***	-0.003
		(0.012)	(0.013)	(0.012)	(0.012)	(0.01)	(0.009)
	Above early retirement age	0.08***	0.10***	0.02***	0.002***	0.04***	-0.02***
		(0.008)	(0.008)	(0.008)	(0.000)	(0.007)	(0.006)
3. 2 + Country	*Above full retirement age*	0.03***	0.02	-0.04***	0.06***	0.04***	0.001
		(0.012)	(0.013)	(0.012)	(0.01)	(0.01)	(0.009)
	Above early retirement age	0.06***	0.08***	0.03***	0.02***	0.05***	-0.02
		(0 .009)	(0 .01)	(0 .009)	(0 .007)	(0 .008)	(0 .007)
4. 3 +Demog	*Above full retirement age*	0.016	0.009	-0.05***	0.06***	0.03***	-0.003
		(0 .01)	(0 .01)	(0 .012)	(0 .01)	(0 .01)	(0 .009)
	Above early retirement age	0.06***	0.08***	0.03***	0.02*	0.05***	-0.03
		(0 .009)	(0 .01)	(0 .009)	(0 .007)	(0 .008)	(0 .007)
5. 4+ Health	*Above full retirement age*	0.02**	0.02	-0.03**	0.07***	0.05***	0.008
		(0 .013)	(0 .013)	(0 .012)	(0 .01)	(0 .01)	(0 .009)
	Above early retirement age	0.06***	0.09***	0.03***	0.03***	0.06***	0.005
		(0 .009)	(0 .01)	(0 .009)	(0 .008)	(0 .008)	(0 .007)

Table B.3. First Stage Results. Skill sample. All Countries.

Table B.3. here

	Dependent Variables	*Retired_s*	*Retired_r*	*Retired_w*	*Retired_s*	*Retired_r*	*Retired_w*
		Fisrt Stage Unskilled workers			Fisrt Stage: Middle and Skilled workers		
1. No Controls	*Above full retirement age*	0 .22***	0 .19***	0 .18***	0 .30***	0 .27***	0 .23***
		(0 .00)	(0 .00)	(0 .00)	(0 .00)	(0 .00)	(0 .00)
	Above early retirement age	0.45***	0.39***	0.29***	0.34***	0.35***	0.25***
		(0 .00)	(0 .00)	(0 .00)	(0 .00)	(0 .00)	(0 .00)
2. Years, Cohorts, Gender	*Above full retirement age*	0.04***	0.04***	0.04***	0.03***	0.03***	0.02*
		(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
	Above early retirement age	0.16***	0.13***	0.08***	0.06***	0.07***	0.03***
		(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
3. 2 + Country Fixed Effects	*Above full retirement age*	0.03***	0.03***	0.02***	0.03***	0.02**	0.02**
		(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
	Above early retirement age	0.12***	0.11***	0.06***	0.05***	0.07***	0.03***
		(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
4. 3 +Demographics	*Above full retirement age*	0.03***	0.02***	0.02***	0.03***	0.01**	0.02*
		(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
	Above early retirement age	012***	011***	0.06***	0.06***	0.07***	0.03***
		(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
5. 4+ Health Controls	*Above full retirement age*	0.04***	0.03***	0.03***	0.04***	0.03***	0.03***
		(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
	Above early retirement age	0.13***	0.11***	0.06***	0.06***	0.08***	0.05***
		(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)

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Endnotes

[1] See Cattell 1941; Horn 1965; Horn and Cattell 1967; Carroll 1993 for details.

[2] We need to keep in mind possible measurement errors in using these variables and the context in which cognitive tests are conducted (Morris et al. 1999). These include re-testing effects: performance tends to improve when individuals repeat cognitive tests (Ferrer et al., 2004; Rabbitt et al. 2001; Schaie 1996; McArdle and Woodcock 1997).

[3] Other studies that support the role of family environment and cultural context are: Schneeweis et al. 2012. Cavopozzi et al. 2011;Cuhna et al. 2010; Case and Paxon 2009; Case et al. 2009; Cuhna and Heckman 2008.

[4] Other evidences can be found in Scarmeas et al. 2001; Wilson et al. 2002; Fillit et al. 2002, among others.

[5] Other more studies finding positive effect on health outcomes are Gall et al 1997, Drentea 2002, Main et al. 2003, Monjon-Azzi et al. 2007, Johnston and Lee 2009, Westerlund et al. 2010, Coe and Zamaro 2011, and Eibich 2013 among others.

[6] Adam et al. 2007 exclude from the analysis the respondents that cannot recall any words [1; 20].

[7] Other researchers as Adam et al. 2007 use five dummy variables to define the retirement status in order to capture the retirement duration. The category of working variables was their reference variable and the other variables were ranges as <5 years retired, [5-9], [10-15], more than 15 years retired and having never worker.

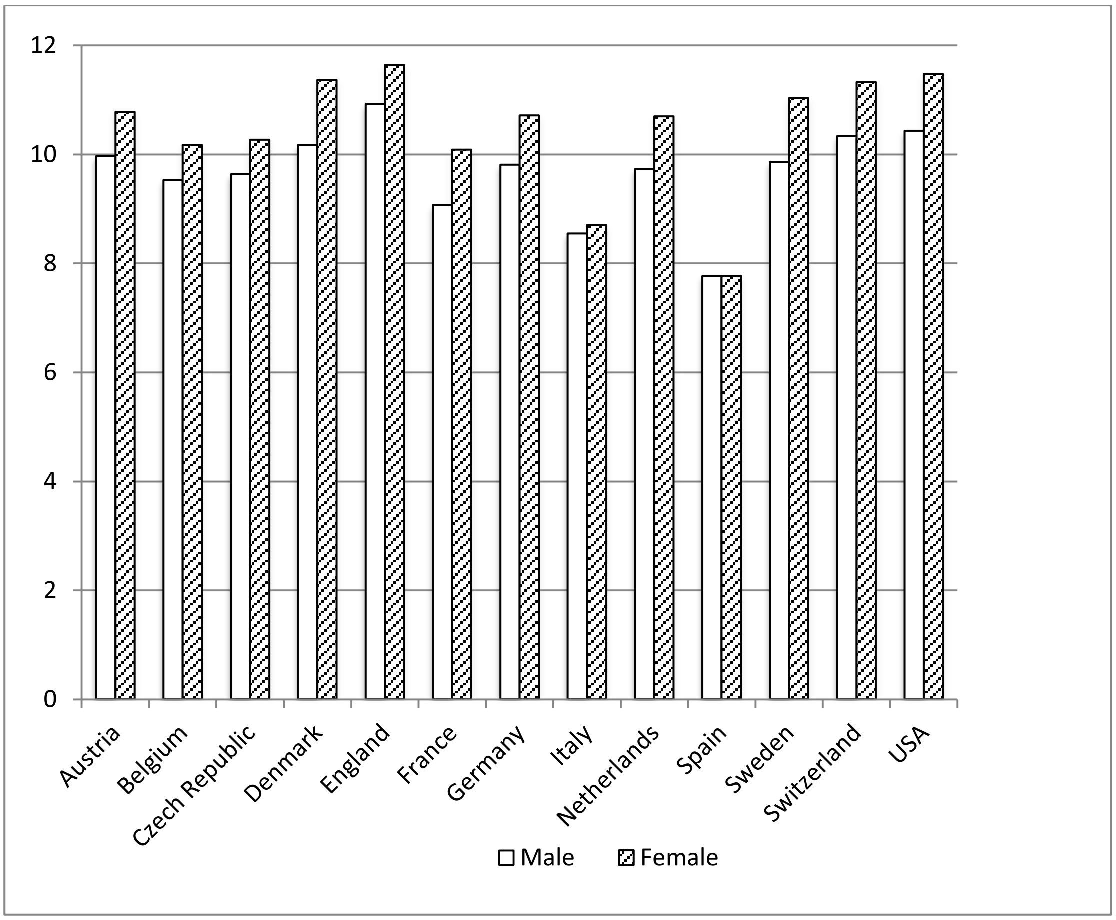
[8] This issue applies only to SHARE because all respondents in the household and through waves 1 and 2 can receive the exact same test over time. The survey corrected and updated this issue in waves 4 and 5.

[9] The thirteen countries are: Austria, Belgium, Czech Republic, Denmark, France, Germany,

Italy, the Netherlands, Spain, Sweden, Switzerland, US and UK.

FIGURES

Figure 1 Cognitive Functioning and Gender Differences



TABLES

Table 3.1 Data Set, Samples, Dependent and Independent Variables in the Reviewed Papers

Authors	Countries	Data Set	Year	Sample	Cognitive Abilities	Retirement	Explanatory Variables
Rohwedder, S. and R.J. Willis (2010)	United States, England, and 11 European countries	HRS, SHARE and ELSA	2004	Men&Women together (60-64years)	1. Memory test scores (recall summary score 20)	retired(dummy)	Different age forms
Coe N. and G. Zamarro (2011)	Europe 11 countries	SHARE	2004	Men (50-69 years old)	1. Memory test scores (recall summary score 20) 2. Verbal fluency	retired (dummy) (cond. Working age 50)	Demographic; SES ; Health and Country dummies
Coe et al. (2012)	US	HRS	1996-2008	1. Blue and white collars workers 2. 50-70 years old 3. Men&Women together	1. self-rated memory,2. immediate, delayed and total word recall, 3. working memory and 4. numeracy	retirement duration (years in retirement)-continous variable	Demographic; Education. Wave dummies.
Bonsang et al. (2012)	US	HRS	1998–2008	Men and women together (51-75 years old) working at 50.	1. Memory test scores (recall summary score 20)	retirement duration (non parametric specification) after one year of retirement	Different age forms
Mazzonna, F. and Peracchi, F. (2012)	Europe 11 countries	SHARE	2004-2006	1. 50-70 years old 2. Men&Women separately	1. Immediate memory 2. Delay memory 3. Orientation in time 4. Verbal fluency 5. Numerancy	retirement duration (years in retirement)-continous variable	Demographic; SES; Country, Cohort and regional dummies
Mazzonna, F. and Peracchi, F. (2014)	Europe 10 countries	SHARE	2004-2006	Men and Women separately. Occupations: Physical burden.	1. Memory test scores (recall summary score 20) 2. Verbal fluency 3. Numerancy 4. Cognitivity Index (PCA)	retired (dummy) and retirement duration (years in retirement)-continous variable	Demographic; SES ; Health
Celidoni et al. (2013)	Europe	SHARE	2004-2010	Men and Women separately and all together	1. Memory test scores (recall summary score 20) both delay and imm and 2. high decrease	lag of retired dummy + retirement duration	Demographic; SES ; Health
Bingley, P. and Martinello, A. (2013)	United States, England, and 11 European countries	HRS, SHARE and ELSA	2004	Men and Women and all together	1. Memory test scores (recall summary score 20)	retired(dummy)	Different age forms and Years of schooling.
Bianchini, L. and M. Borella (2014)	Europe	SHARE	2004-2010	Men and women together. 50-70 working at age 50. Blue/white collars workers.	1. Memory test scores (recall summary score 20)	retired (dummy) and retirement duration	Demographic; SES ; Health; Behaviour; learning and contextual factor

Table 3.2. Instrument and IV Results

Authors	Countries	Year	Dependent variable	Instruments	Empirical Strategy	Results
Rohwedder, S. and R.J. Willis (2010)	United States, England, and 11 European countries	2004	str20	Eligible age for early and for full pension benefits	IV	-4.666***
Coe N. and G. Zamarro (2011)	Europe 11 countries	2004	str20	Eligible age for early and for full pension benefits	IV	−0.0390
Coe et al. (2012)	US	1996-2008	str20	The offering of an early retirement window	IV	0.37845*** (Blue-Collars) 0.00521 (White-Collars)
Bonsang et al. (2012)	US	1998–2008	str20	Eligible age for early and for full pension benefits	IV-FE	-1.021***
Mazzonna, F. and Peracchi, F. (2012)	Europe 11 countries	2004-2006	1. Imm. 2. Delay	Eligible age for early and for full pension benefits	IV	MEN: -0.025*** (Imm.) 0.009 (delay) WOMEN: -0.055*** (Imm.) -0.029*** (delay)
Mazzonna, F. and Peracchi, F. (2014)	Europe 10 countries	2004-2006	Cognitivity Index (PCA)	Eligible age for early and for full pension benefits	IV-FE	Ret. Duration: ALL -0.06*** MEN -0.069*** WOMEN -0.057***
Celidoni et al. (2013)	Europe	2004-2010	str20	Eligible age for early and for full pension benefits	IV-FE	-0.1967***
Bingley, P. and Martinello, A. (2013)	United States, England, and 11 European countries	2004	str20	Eligible age for early and for full pension benefits. They valid it controlling for years of schooling	IV	ALL -3.014*** MEN -5.485*** WOMEN -1.607**
Bianchini, L. and M. Borella (2014)	Europe	2004-2010	str20	Eligible age for early and for full pension benefits	IV-FE	0.3919***

Table 4.1. Descriptive Statistics

Variable	ALL COUNTRIES Obs	Mean	Std. Dev.	Min	Max	SHARE Obs	Mean	Std. Dev.	Min	Max
rtr20	169487	10.36	3.38	0	20	91485	9.86	3.41	0	20
retired_s	142545	0.47	0.50	0	1	75733	0.51	0.50	0	1
retired_r	157945	0.52	0.50	0	1	84831	0.56	0.50	0	1
retired_w	173559	0.49	0.50	0	1	92422	0.52	0.50	0	1
Age	174395	60.51	5.70	50	70	93061	60.29	5.73	50	70
Female	174395	0.55	0.50	0	1	93061	0.54	0.50	0	1
Married	171965	0.79	0.41	0	1	90653	0.82	0.39	0	1
Education	167031	1.84	0.72	1	3	89422	1.91	0.63	1	3
Skill: 1 Unskilled	167031	0.64	0.48	0	1	89422	0.75	0.43	0	1
Bad Health	168452	0.24	0.43	0	1	93061	0.26	0.44	0	1
ADLAs	173896	0.08	0.28	0	1	92679	0.06	0.23	0	1
IADLAs	173888	0.03	0.17	0	1	92679	0.02	0.13	0	1
Minor conditions	173884	0.56	0.50	0	1	92623	0.46	0.50	0	1
Mayor conditions	173836	0.22	0.41	0	1	92623	0.17	0.37	0	1
Physcial demanding job	54202	0.22	0.41	0	1	19141	0.20	0.40	0	1
Occupation: 1 Blue-collar	62516	0.39	0.49	0	1	18115	0.47	0.50	0	1

Variable	ELSA Obs	Mean	Std. Dev.	Min	Max	HRS Obs	Mean	Std. Dev.	Min	Max
rtr20	30567	11.33	3.30	0	20	47435	10.70	3.18	0	20
retired_s	26900	0.44	0.50	0	1	39912	0.42	0.49	0	1
retired_r	29965	0.49	0.50	0	1	43149	0.47	0.50	0	1
retired_w	31609	0.48	0.50	0	1	49528	0.44	0.50	0	1
Age	31630	60.57	5.42	50	70	49704	60.89	5.77	50	70
Female	31630	0.54	0.50	0	1	49704	0.57	0.50	0	1
Married	31622	0.78	0.41	0	1	49690	0.74	0.44	0	1
Education	27917	1.96	0.89	1	3	49692	1.64	0.73	1	3
Skill: 1 Unskilled	27917	0.58	0.49	0	1	49692	0.49	0.50	0	1
Bad Health	25687	0.21	0.41	0	1	49704	0.23	0.42	0	1
ADLAs	31612	0.12	0.33	0	1	49605	0.11	0.31	0	1
IADLAs	31612	0.03	0.16	0	1	49597	0.05	0.22	0	1
Minor conditions	31621	0.55	0.50	0	1	49640	0.74	0.44	0	1
Mayor conditions	31621	0.23	0.42	0	1	49592	0.31	0.46	0	1
Physcial demanding job	11612	0.28	0.45	0	1	23449	0.20	0.40	0	1
Occupation: 1 Blue-collar	19851	0.39	0.49	0	1	24550	0.33	0.47	0	1

Table 4.2. Early and Full Retirement Ages (full retirement ages in parentheses)

	2004		2006		2008		2010		2012	
Country	**Males**	**Females**	**Males**	**Females**	**Males**	**Females**	**Males**	**Females**	**Males**	**Females**
Austria	65 (65)	60 (60)	65 (65)	65 (65)	65 (65)	65 (65)	62(65)	60(65)	62(65)	62(65)
Belgium	60(65)	60 (65)	60(65)	60(65)	60(65)	60(65)	60(65)	60(65)	62(65)	62(65)
Czech Republi	60(65)	58 (63)	60(65)	58 (63)	60(65)	60(64)	60(65)	60(64)	64(69)	64(69)
Denmark	65 (65)	65 (65)	65 (65)	65 (65)	65 (65)	65 (65)	67(67)	67(67)	67(67)	67(67)
France	60 (60)	60(60)	60 (60)	60 (60)	61(61)	61(61)	56-60(65)	56-60(65)	60(67)	60(67)
Germany	63(65)	63(65)	63(65)	63(65)	63(67)	63(67)	63(67)	63(67)	63(67)	63(67)
Italy	60(65)	60(65)	60(65)	60(60)	60(65)	60(60)	61(65)	60(60)	62(67)	62(67)
Netherlands	60(65)	60(65)	60(65)	60(65)	60(65)	60(65)	65(65)	65(65)	67(67)	67(67)
Spain	60(65)	60(65)	60(65)	60(65)	60(65)	60(65)	61(65)	61(65)	65(67)	65(67)
Sweden	61(65)	61(65)	61(65)	61(65)	61(65)	61(65)	61(65)	61(65)	61(65)	61(65)
Switzerland	63(65)	62(64)	63(65)	62(64)	63(65)	62(64)	63(65)	62(64)	63(65)	62(64)
England	65(65)	65(65)	68(68)	68(68)	68(68)	68(68)	68(68)	68(68)	68(68)	68(68)
United States*	62(65+)	62(65+)	62(65+)	62(65+)	62(65+)	62(65+)	62(65+)	62(65+)	62(65+)	62(65+)

*Full retirement age depends on birth year

Sources: OECD Pensions at a Glance several years.

Table 4.3. Effect of Retirement on Cognition. All countries

	Retired_s				*Retired_r*				*Retired_w*			
	OLS	IV	FE	IV-FE	OLS	IV	FE	IV-FE	OLS	IV	FE	IV-FE
1. No Controls	-1.19***	-2.18***	0.05	-0.23*	-1.18***	-2.28***	0.02	-0.34***	-1.27***	-2.74***	-0.08**	-0.41**
	(0.02)	(0.02)	(0.03)	(0.09)	(0.02)	(0.03)	(0.02)	(0.09)	(0.02)	(0.03)	(0.02)	(0.13)
2. Years, Cohorts, Gende	-0.83***	-5.68***	0.006	-0.78	-0.97***	-6.19***	-0.007	-0.78	-1.12***	-8.77***	-0.09***	-1.19
	(0.02)	(0.20)	(0.03)	(0.52)	(0.02)	(0.23)	(0.03)	(0.46)	(0.02)	(0.39)	(0.02)	(1.02)
3. 2 + Country Fixed Eff	-0.60***	-0.70**	0.006	-0.78	-0.69***	-0.61*	-0.007	-0.09***	-0.88***	-0.70	-0.78	-1.19
	(0.02)	(0.26)	(0.03)	(0.52)	(0.02)	(0.26)	(0.03)	(0.02)	(0.02)	(0.44)	(0.46)	(1.02)
4. 3 +Demographics	-0.44***	-0.70**	0.007	-0.80	-0.46***	-0.48	-0.005	-0.77	-0.61***	-0.61	-0.09**	-1.09
	(0.02)	(0.25)	(0.03)	(0.52)	(0.02)	(0.26)	(0.03)	(0.46)	(0.02)	(0.42)	(0.03)	(0.99)
5. 4+ Health Controls	-0.28***	-0.75**	0.007	-0.65	-0.28***	-0.57*	-0.008	-0.08**	-0.41***	-0.81*	-0.65	-0.90
	(0.02)	(0.23)	(0.03)	(0.47)	(0.02)	(0.24)	(0.03)	(0.02)	(0.02)	(0.36)	(0.43)	(0.86)

Table 4.4. First State All Countries

First Stage All countries

	Dependent Variables :	*Retired_s*	*Retired_r*	*Retired_w*
			Fisrt Stage	
1. No Controls	*Above full retirement age*	0 .25***	0 .22***	0 .20***
		(0 .003)	(0 .003)	(0 .003)
	Above early retirement age	0.42***	0.38***	0.29***
		(0 .003)	(0 .003)	(0 .003)
2. Years, Cohorts, Gender	*Above full retirement age*	0.48***	0.04***	0.04***
		(0.004)	(0.004)	(0.004)
	Above early retirement age	0.14***	0.12***	0.08***
		(0.003)	(0.003)	(0.003)
3. 2 + Country Fixed Effects	*Above full retirement age*	0.031***	0.025***	0.022***
		(0.004)	(0.004)	(0.004)
	Above early retirement age	0.10***	0.10***	0.05***
		(0 .003)	(0 .003)	(0 .003)
4. 3 +Demographics	*Above full retirement age*	0.035***	0.025***	0.024***
		(0 .004)	(0 .004)	(0 .004)
	Above early retirement age	0.10***	0.10***	0.05***
		(0 .003)	(0 .003)	(0 .003)
5. 4+ Health Controls	*Above full retirement age*	0.05***	0.04***	0.08***
		(0 .004)	(0 .004)	(0 .19)
	Above early retirement age	0.12***	0.11***	0.03
		(0 .003)	(0 .003)	(0 .02)

Table 4.5 Effect of Retirement on Cognition. By Survey.

HRS	*Retired_s*				*Retired_r*				*Retired_w*			
	OLS	IV	FE	IV-FE	OLS	IV	FE	IV-FE	OLS	IV	FE	IV-FE
1. No Controls	-1.05***	-1.56***	-0.46***	-1.81***	-0.89***	-1.39***	-0.38***	-1.76***	-1.01***	-1.95***	-0.35***	-2.34***
	(0.04)	(0.06)	(0.06)	(0.16)	(0.04)	(0.06)	(0.05)	(0.13)	(0.04)	(0.08)	(0.04)	(0.17)
2. Years, Cohorts, Gender	-0.89***	-0.30	-0.12	0.20	-0.73***	-0,12	-0.08	-0.08	-0.98***	0.25	-0.13**	0.35
	(0.05)	(0.45)	(0.06)	(0.5)	(0.05)	(0.43)	(0.05)	(0.43)	(0.04)	(0.73)	(0.05)	(0.70)
3. 2 +Demographics	-0.65***	0.23	-0.12	0.19	-0.53***	0.48	-0.08	-0.09	-0.66***	1.18	-0.13**	0.35
	(0.05)	(0.45)	(0.06)	(0.49)	(0.04)	(0.42)	(0.05)	(0.43)	(0.04)	(0.76)	(0.05)	(0.70)
4. 3+ Health Controls	-0.37***	0.14	-0.10	0.18	-0.28***	0.29	-0.06	-0.08	-0.40***	0.77	-0.11*	0.29
	(0.05)	(0.43)	(0.06)	(0.49)	(0.04)	(0.40)	(0.05)	(0.43)	(0.04)	(0.67)	(0.05)	(0.69)
ELSA	*Retired_s*				*Retired_r*				*Retired_w*			
	OLS	IV	FE	IV-FE	OLS	IV	FE	IV-FE	OLS	IV	FE	IV-FE
1. No Controls	-0.74	-2.54***	0.03	-1.14*	-0.79***	-2.75***	0.04	-1.64***	-0.90***	-2.94***	0.0002	-1.43**
	(0.05)	(0.1)	(0.06)	(0.48)	(0.05)	(0,11)	(0,05)	(0,50)	(0.05)	(0.12)	(0.05)	(0,46)
2. Years, Cohorts, Gender	-0.83***	-5.68***	0.04	0.03	-0.98***	-6.19***	0,06	0.42	-1.13***	-8.77***	0,01	0,34
	(0.02)	(0.20)	(0.07)	(0.66)	(0.02)	(0.23)	(0,06)	(0,71)	(0.03)	(0.34)	(0.06)	(0,86)
3. 2 +Demographics	0.07	-1.62*	0.07	-0.18	-0.19**	-1,80	0,08	0,16	-0.34***	-2.29*	0,03	0,11
	(0.07)	(0.76)	(0.07)	(0.70)	(0,06)	(0,94)	(0,06)	(0,75)	(0.06)	(1.14)	(0.06)	(0,90)
4. 3+ Health Controls	0.15*	-1.97	0.06	-0.33	-0.28***	-2,49	0,06	-0,15	-0.41***	-3,24	0,05	-0,30
	(0.07)	(1.20)	(0.08)	(0.83)	(0.02)	(1,50)	(0,07)	(0,87)	(0.02)	(1.85)	(0.07)	(1,10)
SHARE	*Retired_s*				*Retired_r*				*Retired_w*			
	OLS	IV	FE	IV-FE	OLS	IV	FE	IV-FE	OLS	IV	FE	IV-FE
1. No Controls	-1.29***	-1.84***	0.38***	0.91***	-1.33***	-2.02***	0.32***	0.99***	-1.43***	-2.31**	0.13**	1.93***
	(0.03)	(0.04)	(0.05)	(0.12)	(0.03)	(0.04)	(0.04)	(0.13)	(0.03)	(0.04)	(0.04)	(0.22)
2. Years, Cohorts, Gender	-0.75***	-2.13***	-0.04	-0.189	-1.04***	-2.38***	-0.02	0.12	-1.15***	-2.49***	-0.07	0.39
	(0.04)	(0.19)	(0.05)	(0.38)	(0.03)	(0.25)	(0.05)	(0.43)	(0.03)	(0.26)	(0.05)	(0.89)
3. 2 + Country Fixed Effects	-0.52***	-0.84***			-0.75***	-0,57			-0.83***	-0.65		
	(0.04)	(0.24)			(0.03)	(0.30)			(0.03)	(0,37)		
4. 3 +Demographics	-0.31***	-0.65**	-0.04	-0.19	-1.03***	-2.38***	-0.01	0.12	-1.15***	-2.49***	-0.07	0.39
	(0.04)	(0.24)	(0.05)	(0.38)	(0.03)	(0.25)	(0.05)	(0.43)	(0.03)	(0.26)	(0.04)	(0.88)
5. 4+ Health Controls	-0.21***	-0.66**	-0.04	-0.28	-0.75***	-0.56	-0.01	-0.03	-0.83***	-0.65	-0.06	0.09
	(0.04)	(0.23)	(0.056)	(0.40)	(0.03)	(0.30)	(0.05)	(0.45)	(0.03)	(0.37)	(0.04)	(0.89)

Table 4.6 Effect of Retirement on Cognition. All Countries. By Gender.

Men	*Retired_s*				*Retired_r*				*Retired_w*			
	OLS	IV	FE	IV-FE	OLS	IV	FE	IV-FE	OLS	IV	FE	IV-FE
1. No Controls	-1.28***	-2.18***	0.03	0.04	-1.21***	-2.09***	-0.001	-0.19	-1.34***	-2.58***	-0.10**	-0.19
	(0.03)	(0.04)	(0.04)	(0.13)	(0.03)	(0.04)	(0.04)	(0.13)	(0.03)	(0.05)	(0.04)	(0.18)
2. Years, Cohorts, Gender	-0.89***	-4.86***	-0.04	0.24	-0.89***	-4.76***	-0.04	-0.20	-1.07***	-6.87***	-0.13**	-0.17
	(0.04)	(0.25)	(0.05)	(0.65)	(0.04)	(0.26)	(0.05)	(0.59)	(0.03)	(0.42)	(0.04)	(1.12)
3. 2 + Country Fixed Effects	-0.65***	0.05			-0.69***	0.11			-0.92***	0.49		
	(0.04)	(0.33)			(0.04)	(0.32)			(0.03)	(0.48)		
4. 3 + Demographics	-0.48***	0.01	-0.01	0.28	-0.49***	0.11	-0.03	-0.15	-0.66***	0.38	-0.10*	-0.05
	0.04	(0.32)	(0.05)	(0.64)	(0.04)	(0.32)	(0.05)	(0.59)	(0.03)	(0.46)	(0.04)	(1.09)
5. 4 + Health Controls	-0.32***	0.04	-0.02	0.34	-0.28***	0.10	-0.01	-0.08	-0.43***	0.29	-0.09*	0.17
	0.04	(0.31)	(0.05)	(0.59)	(0.04)	(0.31)	(0.05)	(0.55)	(0.03)	(0.43)	(0.04)	(1.01)
Women	*Retired_s*				*Retired_r*				*Retired_w*			
	OLS	IV	FE	IV-FE	OLS	IV	FE	IV-FE	OLS	IV	FE	IV-FE
1. No Controls	-1.16***	-2.18***	0.08	-0.51***	-1.29***	-2.44***	0.05	-0.49***	-1.40***	-2.89***	-0.06	-0.61**
	(0.03)	(0.04)	(0.04)	(0.15)	(0.03)	(0.05)	(0.04)	(0.14)	(0.03)	(0.05)	(0.04)	(0.19)
2. Years, Cohorts, Gender	-0.77***	-6.60***	0.05	-2.13*	-1.04***	-7.79***	0.01	-1.46*	-1.17***	-10.02***	-0.07*	-3.05
	(0.04)	(0.35)	(0.05)	(0.83)	(0.04)	(0.41)	(0.04)	(0.71)	(0.03)	(0.65)	(0.04)	(1.88)
3. 2 + Country Fixed Effects	-0.56***	-1.62***			-0.66***	-1.52**			-0.85***	-2.51**		
	(0.04)	(0.44)			(0.03)	(0.47)			(0.03)	(0.88)		
4. 3 + Demographics	-0.4***	-1.57***	0.04	-2.24**	-0.42***	-1.27**	0.01	-1.54*	-0.57***	-2.13**	-0.08*	-2.89
	(0.04)	(0.41)	(0.05)	(0.84)	(0.03)	(0.45)	(0.04)	(0.72)	(0.03)	(0.79)	(0.04)	(1.81)
5. 4 + Health Controls	-0.25***	-1.58***	0.03	-1.83*	-0.26***	-1.39***	-0.005	-1.29	-0.38***	-2.17***	-0.08	-2.38
	(0.04)	(0.37)	(0.05)	(0.73)	(0.03)	(0.42)	(0.04)	(0.66)	(0.03)	(0.64)	(0.04)	(1.44)

Table 4.7a Effect of Retirement on Cognition. All Countries. By Physically Demanding Job

Physically Demaning Job	*Retired_s*				*Retired_r*				*Retired_w*			
	OLS	IV	FE	IV-FE	OLS	IV	FE	IV-FE	OLS	IV	FE	IV-FE
1. No Controls	-0.33***	-1.81***	-0.19*	-0.32	-0.24**	-1.61***	-0.18*	-0.44**	-0.30***	-2.84***	-0.15*	-0.55**
	(0.09)	(0.18)	(0.08)	(0.17)	(0.08)	(0.16)	(0.07)	(0.16)	(0.08)	(0.29)	(0.07)	(0.19)
2. Years. Cohorts. Gender	-0.47***	-2.86***	-0.18	0.13	-0.31***	-2.81***	-0.13	-0.37	-0.48***	-4.77***	-0.09	1.28
	(0.10)	(0.35)	(0.10)	(1.30)	(0.57)	(0.34)	(0.09)	(1.14)	(0.10)	(0.25)	(0.09)	(2.92)
3. 2 + Country Fixed Effects	-0.17	2.28			-0.07	1.87			-0.34***	3.61		
	(0.11)	(1.93)			(0.09)	(1.50)			(0.10)	(4.32)		
4. 3 +Demographics	-0.14	2.69	0.13	-0.19	-0.05	-0.23*	-0.37	-0.13	2.11	3.21	1.28	-0.09
	(0.11)	(2.17)	(1.30)	(0.10)	(0.09)	(0.10)	(1.14)	(0.09)	(1.59)	(3.16)	(2.92)	(0.09)
5. 4+ Health Controls	-0.03	1.39	-0.17	-0.35	0.05	-0.10	-0.11	-0.75	1.04	4.95	-0.05	-0.07
	(0.11)	(1.79)	(0.11)	(1.33)	(0.09)	(0.10)	(0.10)	(1.14)	(1.43)	(4.10)	(0.09)	(2.46)
Not Physical Demanding job	*Retired_s*				*Retired_r*				*Retired_w*			
	OLS	IV	FE	IV-FE	OLS	IV	FE	IV-FE	OLS	IV	FE	IV-FE
1. No Controls	-0.37***	-1.87***	0.10*	-0.08	-0.29***	-1.61***	0.07*	-0.20*	-0.25***	-3.01***	-0.02	-0.26**
	(0.04)	(0.09)	(0.04)	(0.08)	(0.04)	(0.08)	(0.03)	(0.08)	(0.05)	(0.16)	(0.04)	(0.10)
2. Years. Cohorts. Gender	-0.56***	-3.33	0.14**	0.35	-0.42***	-3.28***	0.12**	0.29	-0.47***	-5.52***	0.02	2.23
	(0.05)	(0.18)	(0.05)	(1.05)	(0.23)	(0 .17)	(0.04)	(0.69)	(0.07)	(0.34)	(0.04)	(2.94)
3. 2 + Country Fixed Effects	-0.20***	-0.39			-0.15**	0.12			-0.36***	7.07		
	(0.05)	(0.90)			(0.05)	(0.71)			(0.05)	6.27		
4. 3 +Demographics	-0.19***	-0.51	0.13*	0.45	-0.12**	0.33	0.12**	0.32	-0.28***	(9.11)	0.03	2.36
	(0.05)	(0.93)	(0.05)	(1.12)	(0.04)	(0.71)	(0.04)	(0.70)	(0.05)	6.65	(0.04)	(2.85)
5. 4+ Health Controls	-0.14**	-0.75	0.12*	0.32	-0.07	-0.10	0.11*	0.22	-0.21***	3.05	0.02	3.70
	(0.05)	(0.78)	(0.05)	(0.90)	(0.04)	(0.66)	(0.04)	(0.62)	(0.05)	(3.18)	(0.05)	(3.49)

Table 4.7b Effect of Retirement on Cognition. All Countries. By Occupation.

Blue-collar workers	*Retired_s*				*Retired_r*				*Retired_w*			
	OLS	IV	FE	IV-FE	OLS	IV	FE	IV-FE	OLS	IV	FE	IV-FE
1. No Controls	-0.27***	-1.46***	0.02	-0.003	-0.23***	-1.37***	0.03	-0.13	-0.20**	-2.40***	0.02	-0.16
	(0.06)	(0.12)	(0.06)	(0.11)	(0.06)	(0.11)	(0.05)	(0.11)	(0.06)	(0.20)	(0.05)	90.13)
2. Years. Cohorts. Gender	-0.35***	-2.51***	-0.04	0.06	-0.21***	-2.23***	0.03	-0.33	-0.35***	-5.48***	0.03	0.56
	(0.07)	(0.37)	(0.07)	(0.84)	(0.06)	(0.32)	(0.06)	(0.68)	(0.07)	(1.01)	(0.06)	(1.59)
3. 2 + Country Fixed Effects	-0.18*	0.034			-0.08	0.90			-0.27***	0.65		
	(0.07)	(0.38)			(0.06)	(0.32)			(0.07)	(0.74)		
4. 3 +Demographics	-0.16*	0.10	-0.003	-0.25	-0.08	0.25	0.06	-0.62	-0.17*	1.80	0.05	-0.07
	(0.07)	(1.28)	(0.07)	(0.89)	(0.07)	(0.89)	(0.06)	(0.70)	(0.07)	(1.91)	(0.06)	(1.54)
5. 4+ Health Controls	-0.10	-0.04	0.002	0.13	-0.04	0.06	0.04	-0.32	-0.09	1.59	0.06	-0.26
	(0.07)	(1.12)	(0.08)	(0.84)	(0.07)	(0.85)	(0.07)	(0.67)	(0.07)	(1.96)	(0.07)	(1.56)
White-collar workers	*Retired_s*				*Retired_r*				*Retired_w*			
	OLS	IV	FE	IV-FE	OLS	IV	FE	IV-FE	OLS	IV	FE	IV-FE
1. No Controls	-0.35***	-2.16***	0.03	-0.26*	-0.27***	-1.76***	-0.01	-0.37***	-0.28***	-3.42***	-0.12**	-0.49***
	(0.05)	(0.11)	(0.05)	(0.10)	(0.05)	(0.09)	(0.04)	(0.10)	(0.05)	(0.19)	(0.04)	(0.12)
2. Years. Cohorts. Gender	-0.48***	-3.45***	0.13*	0.96	-0.33**	-3.35***	0.09	0.85	-0.50***	-5.44***	-0.05	-1.37
	(0.06)	(0.21)	(0.06)	(1.79)	(0.05)	(0.19)	(0.05)	(1.05)	(0.06)	(0.39)	(0.05)	(4.81)
3. 2 + Country Fixed Effects	-0.15*	0.23			-0.09	1.02			-0.30***	-4.29		
	(0.06)	(1.19)			(0.05)	(0.98)			(0.06)	(0.48)		
4. 3 +Demographics	-0.16**	-0.25	0.10	0.75	-0.08	1.03	0.06	0.97	-0.32***	-12.51	-0.04	0.44
	(0.06)	(1.28)	(0.06)	(1.96)	(0.05)	(1.01)	(0.05)	(1.09)	(0.06)	(24.73)	(0.05)	(5.16)
5. 4+ Health Controls	-0.09	-0.76	0.10	-0.20	-0.02	0.06	0.07	0.29	-0.23***	-2.47	-0.04	21.33
	(0.06)	(1.02)	(0.06)	(1.35)	(0.05)	(0.90)	(0.05)	(0.91)	(0.06)	(7.75)	(0.05)	(56.33)

Table 4.8 Effect of Retirement on Cognition. All Countries. By Skill Education.

Middle and Low-skilled workers	*Retired_s*				*Retired_r*				*Retired_w*			
	OLS	IV	FE	IV-FE	OLS	IV	FE	IV-FE	OLS	IV	FE	IV-FE
1. No Controls	-1.07***	-1.91***	0.07	0.05	-1.05***	-2.07***	0.06	-0.04	-1.09***	-2.45***	-0.05	-0.01
	(0.03)	(0.04)	(0.04)	(0.13)	(0.03)	(0.04)	(0.04)	(0.13)	(0.03)	(0.05)	(.0.03)	(0.18)
2. Years, Cohorts, Gender	-0.73***	-2.5***	0.03	-0.09	-0.86***	-2.64***	-0.01	-0.03	-0.95***	-3.01***	-0.03	-0.26
	(0.03)	(0.60)	(0.05)	(0.51)	(0.03)	(0.13)	(0.04)	(0.49)	(0.03)	(0.15)	(0.49)	(1.13)
3. 2 + Country Fixed Effects	-0.52***	-0.62*			-0.61***	-0.39			-0.73***	-0.45		
	(0.03)	(0.28)			(0.03)	(0.30)			(0.03)	(0.51)		
4. 3 +Demographics	-0.04	-0.21	-0.04	-0.21	-0.01	-0.16	-0.01	-0.16	-0.09**	-0.43	-0.09**	-0.43
	(0.05)	(0.53)	(0.05)	(0.53)	(0.04)	(0.50)	(0.04)	(0.50)	(0.04)	(1.13)	(0.03)	(1.13)
5. 4+ Health Controls	-0.04	-0.16	-0.04	-0.16	-0.35***	0.08	-0.35***	0.08	-0.56***	0.37	-0.56***	0.37
	(0.05)	(0.49)	(0.05)	(0.49)	(0.04)	(0.62)	(0.04)	(0.62)	(0.04)	(1.14)	(0.04)	(1.14)
Higher-skilled workers	*Retired_s*				*Retired_r*				*Retired_w*			
	OLS	IV	FE	IV-FE	OLS	IV	FE	IV-FE	OLS	IV	FE	IV-FE
1. No Controls	-0.70***	-1.54***	0.04	-0.66***	-0.60***	-1.51***	-0.02	-0.74***	-0.68***	-1.92***	-0.11*	-0.95***
	(0.04)	(0.05)	(0.05)	(0.16)	(0.03)	(0.05)	(0.04)	(0.15)	(0.04)	(0.07)	(0.04)	(0.19)
2. Years, Cohorts, Gender	-0.39***	-1.55***	0.08	-2.27	-0.36***	-1.69***	0.03	-1.6	-0.55***	-2.09***	-0.07	-2.19
	(0.05)	(0.16)	(0.05)	(1.56)	(0.04)	(0.17)	(0.05)	(1.05)	(0.04)	(0.24)	(0.05)	(2.30)
3. 2 + Country Fixed Effects	-0.39***	-0.03			-0.35***	0.08			-0.56***	0.37		
	(0.05)	(0.75)			(0.04)	(0.62)			(0.04)	(1.14)		
4. 3 +Demographics	-0.39***	-0.06	0.07	-2.27	-0.35***	0.03	0.01	-1.63	-0.55***	0.24	-0.08	-2.02
	(0.05)	(0.75)	(0.05)	(1.57)	(0.04)	(0.61)	(0.05)	(1.05)	(0.04)	(1.11)	(0.05)	(2.21)
5. 4+ Health Controls	-0.26***	-0.34	0.07	-2.04	-0.19***	-0.24	0.01	-1.7	-0.39***	-0.34	-0.06	-2.19
	(0.05)	(0.64)	(0.06)	(1.32)	(0.04)	(0.56)	(0.05)	(0.97)	(0.04)	(0.88)	(0.05)	(1.93)