Cognitive functioning and retirement in Europe

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Abstract

We investigate the effect of retirement on cognitive functioning using the Survey on Health, Ageing and Retirement in Europe (SHARE). The availability of a panel dataset allows controlling for individual heterogeneity when estimating the effect of transitions into retirement on a commonly employed memory measure, word recall. We control for endogeneity of the retirement decision applying an instrumental variable technique to our fixed effects transformation. Our main finding is that, conditional on the memory average age path of the typical individual, time spent in retirement has a positive effect on word recall. College educated or highly skilled workers benefit more than average from retirement, as do those individuals who declare to spend time reading books.

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Introduction

As demographic trends induce societies to ask individuals to work longer, the effect of retirement on cognitive abilities has attracted increasing attention in the literature. The increased longevity most developed societies are facing poses sustainability problems to public pension systems, and a common response has been an increase in the legal retirement ages. The effect of a longer working career, or of a delayed retirement, on health, mental health, and cognitive abilities has been studied in the economic, medical and psychological literature, and the debate is far from been concluded. While descriptive evidence typically supports the idea that retired individuals suffer worse health and cognitive functioning than workers, retirement is an endogenous choice and individuals with worse health or cognitive abilities may retire earlier than healthier individuals. In other words, causality may run in both directions, and it is an empirical task to separate causality from simple correlation.

From a theoretical point of view, the effect of retirement on investment in cognitive ability is ambiguous. Using the Grossman (1972a, 1972b, 2000) model for human capital as a framework to model the individuals' maximization problem when utility depends on consumption and on generic cognitive capital, as Mazzonna and Peracchi (2012) propose, an increase in free time upon retirement may lead individuals to raise their investment in cognitive abilities after retirement, because of its effects on life satisfaction captured by the utility function. On the other hand, while total labour market earnings are positively affected by cognitive capital, investment in cognitive capital is not reflected into higher income after retirement, and should therefore be lower. The effect of retirement on the incentives to invest in cognitive capital is therefore theoretically ambiguous.

In the psychological literature, it has been highlighted that the available evidence favors the hypothesis that maintaining an engaged and active lifestyle reduces or even reverses cognitive decline at older ages (Hertzog et al., 2008). A major change in daily activities and lifestyle, such as retirement from work, may result in disuse and decline of cognitive abilities; alternatively, the additional free time may be spent in leisure activities that can preserve cognitive functioning or delay decline. Therefore, it is an empirical question to sort out which effect prevails.

From an empirical point of view, previous studies that relate cognitive functioning and retirement found mixed results. Rohwedder and Willis (2010), Bonsang, Adam and Perelman (2012), Mazzonna and Peracchi (2012) all found a negative causal effect of retirement on cognitive abilities; other studies such as Coe et al. (2012) and Coe and Zamarro (2011) do not find a causal relationship between retirement and cognitive functioning.

In this work we study the evolution of cognitive functioning for individuals aged 50 to 70, testing whether retirement from work has an effect on cognitive abilities using the three-wave panel available in the Survey on Health, Ageing and Retirement in Europe (SHARE). As a measure of cognitive ability we use word recall, a memory indicator frequently used in the literature (e.g. Bonsang, Adam and Perelman, 2012). While the SHARE dataset has already been used in the literature to estimate the causal impact of retirement on cognitive abilities, in this work we exploit its panel dimension to perform our investigation.

Conducting the analysis on a longitudinal sample allows controlling for fixed effects, that is for unobservable but fixed over time omitted variables, such as innate ability or family background, which may influence retirement as well as word recall. As retirement may be correlated also with time varying factors that influence cognitive ability, such as health, we apply an instrumental variable (IV) technique to the fixed effects transformation, using country-specific retirement rules as an instrument. As highlighted in Bonsang, Adam and Perelman (2012), fixed-over-time unobservable characteristics, such as country background, may be correlated with country-specific retirement rules. Hence, performing an instrumental variable estimation on a panel, which allows controlling for time-invariant heterogeneity, strengthens the validity of the conditional independence and exclusion restrictions underlying IV estimation.

Using the panel dimension of SHARE, we find no short term effect of retirement on cognitive abilities. When estimating the long term effect of retirement, we find a positive causal effect of years spent in retirement on word recall. This effect is higher for individuals with a college degree, high-skilled workers, and individuals engaging themselves in stimulating activities such as reading books. While we cannot interpret in a causal way this heterogeneity in the effect of retirement on word recall, there seems to be a clear indication that individuals with a higher cognitive reserve benefit more, on average, from retirement. This finding is in line with many psychological studies (e.g. Schaie, 1996) highlighting the preserving role of cognitive reserve in intellectual decline.

The rest of the paper is organized as follows. The next section reviews the previous empirical evidence. We then describe our empirical strategy and, in the data section, the data set we use. In the result section we report our baseline results and in the subsequent section we test for heterogeneity in the effect of retirement on word recall. The final section concludes the paper.

Previous empirical evidence

The evolution of adults' cognitive capital over the life cycle has attracted considerable attention in both the psychological and, more recently, the economic literature.

In psychological studies, the level and evolution of cognitive capital (or cognitive reserve) is studied both in healthy adults and in its relation to the incidence and severity of the Alzheimer's disease (Scarmeas and Stern, 2003). Cognitive reserve and its evolution are influenced by IQ, education, occupation as well as general lifestyle (Schaie, 1996 and references therein). As highlighted by Schaie's (1996) work on the Seattle Longitudinal Study, individuals with high socioeconomic status fully engaged with their environment had the least intellectual decline. Cognitive evolution among healthy adults is also affected by individual lifestyle; in particular, changes in everyday activities may result in disuse and consequent decline of cognitive abilities, as synthesized by the "use it or loose it" hypothesis (Salthouse, 1991, 2006). On the other hand, the same considerations may sustain the hypothesis that an engaged lifestyle, attained through common leisure activities, would result in stable performance or may even reverse age-related changes in cognitive abilities. For example, it has been found that the stimulation provided by typical everyday activities serves to buffer individuals against decline (Hultsch et al., 1999). The authors highlight that causation could run either way, so that high-ability individuals may lead intellectually active lives until cognitive decline in old age limits their activities. Similarly, Wilson et al. (2002), found that participation in common cognitive activities (in particular reading newspapers or books) was associated with a slower rate of cognitive decline. Using the SHARE dataset, Leist et al. (2013) also find that the cognitive function depends on the activities undertaken. They study the effect of periods away from work on cognitive functioning, and find that periods of self-reported unemployment or sickness are associated with lower cognitive function, while maternity and training spells are associated with better late-life cognitive function. In their review on the cognitive development of adults, Hertzog et al. (2008) conclude that, "on balance, the available evidence favors the hypothesis that maintaining an intellectually engaged and physically active lifestyle promotes successful cognitive aging". While these works do not explore the direct effect of retirement on the evolution of cognitive capital, they point out how healthy adults may shape the evolution of their cognitive abilities also in the second half of their life cycle.

In the economic literature, a few recent studies estimate the relationship between cognitive functioning and retirement. These studies differ in the data used and in the sample definitions, while they all use memory (i.e. word recall) as a measure of cognitive abilities, either alone or in combination with other cognitive indicators. The most important distinction is based on the data used to estimate the causal effect of retirement on cognitive functioning: studies based on cross-sectional data typically rely on the use of an IV technique to estimate the causal effect of retirement on cognitive abilities, using cross-country differences in the eligibility age for retirement benefits as instruments. Such an instrument, however, may be correlated with unobserved characteristics that also influence cognition, such as institutional settings and cultural differences which are likely to be heterogeneous across countries. As highlighted in Bonsang, Adam and Perelman (2012) conducting the analysis on a longitudinal sample, on the other hand, allows controlling for time-invariant heterogeneity and thus strengthens the validity of the conditional independence and exclusion restrictions underlying instrumental variable estimation.

Among the studies using cross-sectional data, Rohwedder and Willis (2010) use data drawn from the US Health and Retirement Study (HRS, year 2004) and from SHARE wave 1 (also collected in the years 2004-5), and they find a negative effect of retirement on word recall. Coe and Zamarro (2011) use data drawn from SHARE wave 1, and, while they find a positive effect of retirement status on health, they find no effect on cognition, measured by total word recall or by verbal fluency. While they use cross-sectional data, they control for many individual characteristics, including household income, education and a second order polynomial in age.

Also the study by Mazzonna and Peracchi (2012) is based on data from SHARE wave 1, but interestingly they argue that retirement may take time to display its effects, and estimate the causal effect of years spent in retirement instead of a binary variable capturing whether an individual is retired. Conditioning on a linear age profile, in most specifications they find a negative effect of retirement duration on cognitive performance.

More recently, Börsch-Supan and Schuth (2013) use all the available waves in SHARE to create a longitudinal dataset to estimate the relationship between early retirement, cognitive functioning, and the size and composition of social networks. They also use an IV estimator based on early and normal legal retirement ages and find that early retirement reduces cognitive functioning as well as social networks, and reduced social networks in turn negatively influence cognitive functioning. The study compares early and normal retirement pensioners, while working individuals are excluded from the sample, hence identification relies only on the differences between individuals in the number of years spent in retirement at any given age, rendering it difficult to separate the age effect from the time-spent-in-retirement effect.

Bonsang, Adam and Perelman (2012) use the US panel dataset HRS to perform fixed-effects instrumental-variable estimates of the effect of retirement on word recall, with instruments based on legal ages of retirement. They find a significant drop in cognitive abilities, measured by word recall, occurring one year after retirement. Coe et al. (2012) also use panel data drawn from the HRS, but they use instruments based on unexpected early retirement windows offers, which are required by law to be unrelated to individuals' health. Using a statistical model to explicit the difference between permanent and transitory shocks, they find no effect of retirement on cognitive performance. When they distinguish among white and blue collar workers, they find a positive effect of retirement only for blue collars.

Empirical strategy

Our empirical strategy rests on the use of a panel data set including both pensioners and non-pensioners. In particular, identification of the coefficients of interests (retirement status or duration) relies on the observation of individuals who actually retire during the sample period, so they are observed both when they are working and when they are retired. In our sample, we observe about 1,800 such transitions.

We first estimate the specification in equation (1):

$$WR_{it} = \alpha_1 R_{it} + \beta_1 X_{it} + \varepsilon_{1it} + \nu_{1t} + \mu_{1i} \tag{1}$$

where WR_{it} is word recall, R_{it} is a dummy variable equal to 1 if the individual is retired and zero otherwise, and we include a common time effect (ν_{1t}), an individual-specific time-invariant effect (μ_{1i}), and an idiosyncratic shock (ε_{1it}). Both μ_{1i} and ε_{1it} might in principle be correlated with R_{it} thus biasing our estimate of α_1. We control for individual-specific effects by demeaning. Moreover, we instrument R_{it} in the demeaned equation by the variables discussed below.

As the literature has emphasized that retirement may take time to display its effect, in equation (1) we alternatively define retirement status as a dummy variable equal to 1 if the individual has been retired for at least one year, and zero otherwise (as in Bonsang, Adam and Perelman, 2012). In equation 2, we estimate a specification in which the retirement effect is captured by time spent in retirement, or retirement duration (as in Mazzonna and Peracchi, 2012), computed as age of individual *i* at time *t* minus age of individual *i* at retirement, interacted with the retirement dummy:

$$WR_{it} = \alpha_2 (age_{it} - age_i^R) R_{it} + \beta_2 X_{it} + \varepsilon_{2it} + \nu_{2t} + \mu_{2i} \tag{2}$$

In both equations (1) and (2), the X variables represent time-varying demographic variables which may influence word recall. In our basic specification, we include a polynomial in age, a dummy variable indicating whether there were contextual factors disturbing the respondent during the cognitive test, and a variable indicating if the respondent has been interviewed in the past, in order to capture learning effects.

In subsequent specifications we add, as time-varying variables, indicators of the life style, such as smoking, drinking and physical inactivity. We also experiment including health indicators, of which the SHARE dataset is rich. While health is certainly endogenous to retirement, we may conduct the analysis conditional on health status. In other words, we test whether retirement and retirement duration have an effect on word recall conditional on health status.

In addition to an idiosyncratic shock and individual fixed effects, equations (1) and (2) include time dummies to control for time effects, ν_{*t}. Time effects are extremely important since they allow the intercepts in equations (1) and (2) to vary with time and for a time-varying average of the dependent variable. Differences in the difficulty to memorize different lists of words are captured by the inclusion of year dummies in the estimated equation.

In a fixed effects estimation, when year dummies are included, any variable that varies by one unit in each time period, such as age, is not separately identified, while any non-linear term (such as age squared) is obviously identified. Retirement duration, in equation (2), also increases by one unit each year, like age, but it is interacted with the retirement dummy R_{it}, which takes value zero for individuals who are not retired. Hence identification of this variable relies on the presence in the sample of non-retired individuals.[i]

Retirement, and retirement duration, are clearly endogenous variables in this context. Individuals suffering a bad shock in cognitive abilities may select themselves (or be selected by their firms) into early retirement. Following much of the literature (Rohwedder and Willis, 2010, Mazzonna and Peracchi 2012, Bonsang, Adam and Perelman, 2012) we construct our instruments on the basis of statutory retirement ages. Statutory retirement ages have a great effect on the probability of retirement, while are not linked to cognitive functioning. In our sample, early and normal retirement ages vary according to gender, country, time and cohort, as the first interview year is 2004 and the last one 2011 (with a few observations being collected in 2012). The relevant ages are taken from the tables generated by MISSOC (Mutual Information System on Social Protection), a network generated by the European Commission, integrated by information provided in various years by the OECD publication Pensions at a Glance.[ii]

With the legal early and normal ages of retirement we can construct four instruments, two for the retirement status dummy and two for retirement duration. The two instruments for the retirement status dummy are dummy variables taking value zero if the individual's age is less than the statutory age for either early or regular retirement.[iii] The instruments for retirement duration are equal to the difference between actual age and legal age of retirement (either early or regular).

An important issue that we need to consider is the possibility that retesting may affect our estimates. Practice effects in longitudinal studies of cognition have long been recognized (see Schaie, 1996 for a review), as individuals who take the memory test more than once, as happens necessarily in panel data, may learn how to respond to the test. Additionally, in our dataset, in the first two waves respondents were asked to recall the same list of ten words. Hence, in our estimated equations we always include a variable capturing the learning effect of retesting, adding a dummy variable that takes value equal to one if an individual takes the test for the second or third time.

Data and sample selection

The data are drawn on SHARE. The first wave has been collected in 2004 and 2005, the second in 2006 and 2007, the third in 2008 and 2009, and the fourth in 2011 and 2012. The third wave is called SHARELIFE and it is a retrospective survey and does not collect information on cognition. Hence we use wave 1, 2 and 4 to construct our panel. As we explain later, we also use variables collected in SHARELIFE.

We select individuals aged 50 to 70, who were working at the age of 50, who report themselves as either working or retired, living in Austria, Germany, Sweden, the Netherlands, Spain, Italy, France, Denmark, Switzerland and Belgium. We exclude individuals who returned to work after retirement, since for them the effect of retirement on cognitive abilities could be atypical. As we are interested in the transition between work and retirement, we also exclude individuals who report themselves sick, unemployed or homemaker. In the literature, retirement is often defined in a broader way, including all categories of individuals reporting themselves not working, as this strategy reduces potential sample selection problems. Indeed, using the SHARE dataset, Hospido and Zamarro (2014) found that women in some countries have a higher tendency of describing themselves as homemakers even though they were working at the age of 50. However, for individuals describing themselves as sick, unemployed or homemaker we cannot ascertain whether the separation from the labour force is permanent or transitory, and the effect of these two conditions on cognitive ability is likely to differ. Hence their inclusion in the sample, even in an instrumental variable setting, is not without problems. We present our results using the more stringent definition of retirement; however, when using the broader definition results are unaffected.[iv]

The dependent variable in our analysis is total word recall, given by the sum of immediate and delayed recall of a ten-word list. The list of words is the same in waves 1 and 2, while it has been updated in wave 4. Respondents are asked to memorize the list of words and to recall them both immediately and some time after answering other questions of the questionnaire about numeracy ability and verbal fluency. The value of total word recall ranges from 0 to 20.

We define the two main explanatory variables used in the paper, retirement status and retirement duration, on the basis of self-reported status. Retirement status is a dummy variable that is set equal to zero if the individual reports being employed at the time of the interview and it is set to one if the individual reports being retired. The variable retirement duration measures the time elapsed between the year of the interview and the year of retirement. This variable is set to zero for all the individuals who are still employed.

In order to get the information on the year in which the individual retired, we refer to the question on when the last job ended, that is variable ep050 in SHARE. If the individual was employed at the time of the previous interview and then retired, question ep050 is not asked but instead the question asked is in what year the individual retired, that is variable ep329 in the questionnaire. In addition, when an individual reports a different retirement year across waves, that is to say when panel consistency is lacking, we exclude that individual from the sample (325 individuals). Finally, for all those who are also respondents in SHARELIFE, we verify that the retirement year declared in the normal questionnaire is consistent with the one reported in SHARELIFE. The information reported in SHARELIFE is in fact more accurate since the method used is based on a life history calendar, and the respondent's life is represented graphically by a grid that is filled automatically in the course of the interview.

Our final sample is unbalanced and consists of 21,934 observations. The total number of selected individuals is 9,395. For each of them there are at least 2 observations, and for about 33% there are 3 observations. The number of sampled individuals who participated also to the SHARELIFE wave (the third wave) is lower and, using the information reported in that wave, the total number of observations is 11,484.

In our analysis, we also use information on the type of occupation. We define blue/white-collars and high/low-skilled workers by referring to the classification used by Eurostat, which is based on the 1-digit ISCO 88 (COM). [v] In particular, both categories include high-skilled and low-skilled workers, based on the complexity and range of duties involved (ILO, 1990). Armed-force occupations are excluded since they are not classifiable within those two typologies. Unfortunately, this information is available only for those interviewed in the first wave of SHARE, hence results based on these variable are based on the sample including individuals interviewed since the first wave.

In Table 1 we report some descriptive statistics for our main variable, total word recall. The overall average number of words recalled, in our selected sample, is equal to 9.96 with a standard deviation equal to about 3. On average, retired individuals recall one word less than those who are still active in the labour market. Whether there is a causal link between retirement and word recall, however, can only be assessed by estimating equations (1) and (2) described in the previous section. In addition, females and individuals with higher education or in highly skilled jobs tend to recall more words on average.

<Please insert table 1 about here>

In figure 1 we show, for each country included in the analysis, the retirement age distribution for our sample, along with early and normal retirement age windows. While there is a lot of variability in retirement age in our sample, the figure highlights how indeed age spikes at legal ages of retirement can be observed in most countries, a feature that highlights especially the importance of early retirement incentives, as investigated in Gruber and Wise (2004).

<Please insert figure 1 about here>

Results

We start by considering the effect of retirement status and years spent in retirement on word recall for our entire sample of individuals aged 50 to 70. In table 2 we report our basic specifications, where the variable total word recall is regressed either on retirement status, a retirement indicator equal to one if the individual is retired from work, or on the variable "retired at least one year", an indicator equal to one if the individual has been retired for at least one year. In addition, total word recall is regressed on retirement duration, i.e. number of years spent in retirement. As additional basic controls, we add a second-order polynomial in age; contextual factor, an indicator that takes value equal to one if the respondent was disturbed during the cognitive test and zero otherwise: and learning, a variable that captures the learning effect that might arise by participating repeatedly in the panel, equal to one if the respondent has already participated at least once in the survey and zero otherwise. In subsequent analysis we will discuss in more detail the consequences of choosing a different polynomial in age, as well as of including additional explanatory variables.[vi]

All the estimates in table 2 control for fixed effects, hence all time-invariant characteristics are controlled for. To take into account common year effects, we also include year dummies. As a consequence, we are unable to separately identify the linear term in age, which is automatically controlled for in the estimation. In the next table we will show alternative specifications for the age trend. In this context, the variables of interest, retirement status and retirement duration, are identified because our sample includes also non-pensioners. Indeed, identification of both variables rests on individuals who transit from work to retirement in the sample period. In our baseline sample, made of 21,934 person-year observations, there are 1,829 individuals who retire from work.

<Please insert table 2 about here>

In column 1 we report fixed effects estimates of our basic relationship including retirement status as a regressor. Its coefficient is very close to and not statistically different from zero. The variable contextual factor is significant and, as expected, has a negative coefficient, while the variable capturing learning, which is equal to one if the respondent has already taken part to the survey, has a positive effect. In the second column we use our instruments, based on statutory normal and early age of retirement, to obtain fixed-effects two-stage least-squares (FE-2SLS) estimates. The coefficient on retirement status increases, with a high associated standard error. The set of instruments we use always reject the test of under-identification with a P-value of less than 0.01 per cent, hence we do not report it. We report instead the Hansen J statistic, and its P-value, and a weak identification test, to test whether the excluded instruments are only weakly correlated to the endogenous variables. All the specifications in the table pass the diagnostic tests.

As retirement may take time to display its effects, we estimate in column 3 a fixed effects specification including the dummy variable equal to one if the individual has been in retirement for at least one year. Its coefficient is slightly positive but not significantly different from zero. In column 4 we report the FE-2SLS estimates, and in this case the coefficient increases to 0.6, indicating that indeed the effect is delayed, and it is different from zero at the 10 per cent level.

To better capture the effect of time spent in retirement, in column 5 we estimate the effect of retirement duration, measured as years spent in retirement, on word recall. Its coefficient is positive but small and not significantly different from zero. We next treat retirement duration as endogenous turning to the fixed-effects instrumental-variables estimator. In column 6, we report estimates of the basic specification, using normal- and early-retirement ages to construct instruments for retirement duration as explained in detail in the empirical strategy section. The coefficient on retirement duration is positive and significantly different from zero at the 1 per cent level.

According to our results, given the average non-linear age trend, individuals after retirement recall about 0.3 words more than when they were active in the labour market, for each additional year spent in retirement. It is important to underline that these estimates indicate that, in the 50-70 age range, memory as measured by word recall tends to decline, in a non-linear way, for both working and retired individuals. After retirement, individuals display a slower decline in memory, relative to their performance before retirement.[vii]

As the variable retirement duration better captures the effect of retirement on word recall, in the subsequent analysis we propose estimates based on this variable.

<Please insert table 3 about here>

We next check for the robustness of our results experimenting with different polynomials in age. In table 3, column 1, we start by reporting the estimates of a specification that excludes any non-linear term in age. As shown in the first column, the coefficient on retirement duration turns negative and significantly different from zero. Failing to recognize the non-linearity of the average age trend induces a bias in the estimate of the coefficient on retirement duration. In column 2 we add a second and a third order term in age. These coefficients are both significantly different from zero, and the coefficient on retirement duration turns positive and significantly different from zero. Its magnitude is only slightly higher than that found in table 2.

We next test whether retirement duration itself has a non-linear effect on word recall. In column 3 we add its squared value, which turns out to be negative and non-significantly different from zero. In the last column, we experiment with the logarithm of duration. The positive coefficient we find confirms the positive effect of retirement is higher during the first years of retirement.

Summing up, we find that retirement duration, conditional on the overall non-linear age profile, has a positive effect on word recall. We obtain this result controlling for unobserved heterogeneity and for endogenous retirement (i.e. with a FE-2SLS estimator). In addition, we have shown that including non-linear terms in age in the equation is crucial to obtain the result. To understand why our results differ from Mazzonna and Peracchi (2012), we estimate equation (2) as a pooled regression. In table 4 we show results of pooled regressions, conditional on the same variables as in table 2 but with the addition of country dummies. In the first two columns we include only a linear term in age and find a negative ordinary least squares (OLS) estimate of retirement duration on word recall, and a negative but statistically not different from zero when we perform 2SLS estimation (the P-value is 17%). These estimates are very close to those obtained by Mazzonna and Peracchi (2012), although they use only the first wave of SHARE in most specifications. In the subsequent columns, we add second- and then third-order terms in age, and we find that, while the OLS estimate of the effect of retirement duration on word recall remains negative and significantly different from zero, the 2SLS estimate is instead positive and different from zero. The difference between the estimated average age profiles, which are all declining in the 50-70 age range, is that while in the 50-60 age range the non-linear age profiles are flatter than the linear one, the situation is reversed after age 60, that is when retirement takes place for most people. We conclude that controlling for a flexible polynomial in age and tackling the endogeneity of the retirement decision is crucial to obtain the result we find in this paper.

<Please insert table 4 about here>

Heterogeneity of the effect of retirement

We next try to understand whether other variables influence the relationship between retirement and cognitive functioning and whether the effect of retirement duration is heterogeneous along some dimension. We begin by adding to the relationship three lifestyle indicators, which have often been negatively related to cognition: smoking, drinking and physical inactivity. In particular, the indicator variable smoking is equal to 1 if the respondent is a smoker at the time of the interview. The variable drinking is equal to 1 if the respondent reports drinking more than 2 glasses of alcohol almost every day. Physical inactivity is equal to one if the respondent reports never or almost never engaging in physical activity.

<Please insert table 5 about here>

We report estimates in table 5, where we always include year dummies, a second-order polynomial in age, contextual factor and learning. Estimates are obtained with the fixed-effects instrumental variable estimator described earlier. Column 1 in table 5 shows that indeed being physically inactive hinders word recall. Individuals who stop (start) being physically active recall 0.54 words less (more) than the average.

In column 2 we add some controls for health, as this variable it has been used in previous literature. Coe and Zamarro (2011), for example, do find some effect of health on memory. While we recognize health may be endogenous, we nevertheless want to ascertain if, in a fixed-effects context, changes in health status have an impact on cognition. This impact could in turn affect our estimates of the coefficient on retirement duration. The indicators for health we include are: an indicator variable equal to one if the number of chronic diseases is greater than 2, the number of limitations in activities of daily living (ADL), the number of limitations in instrumental activities of daily living (IADL) and a dummy variable based on self-perceived health (US version) equal to one if perceived health is less than very good. It turns out that none of the indicators we included is statistically different from zero. The coefficient to retirement duration is also unaffected.

We next start considering whether some fixed attributes may have an effect on the coefficient of retirement duration or, in other words, along which dimensions the impact of retirement duration on cognition is heterogeneous. The first factor we test is gender. On average, female score better than males in word recall tests, and they also tend to behave differently than males in the labour market, so it is possible for the coefficient of retirement duration to be heterogeneous among female and males. In order to test this hypothesis, we add to our relationship the interaction between retirement duration and a dummy taking value 1 if the individual is a female. The coefficient to this variable captures the differential effect of retirement duration on word recall for females with respect to the overall coefficient. This interaction variable is instrumented with the interaction of our two instruments (i.e. years since early retirement age and years since normal pension age) with the female dummy. The results, shown in column 3, indicate that while there is a small additional positive effect of retirement on cognition for females, this is not statistically different from zero.[viii]

<Please insert table 6 about here>

We next test whether the response of word recall to retirement duration is heterogeneous with respect to variables capturing the education level of the respondent and his or her occupation before retirement. Higher-educated individuals tend to accumulate more cognitive abilities in the early part of the life cycle. Hence it is possible that their response to retirement is different from less-educated individuals. Our results, reported in table 6 column 1, show that the differential effect of retirement higher-educated workers is positive and equal to 0.05, statistically different from zero at the 10 percent level. In column 2 we isolate the effect of having a college degree. In this case the estimate coefficient is greater, equal to 0.1, and highly significant. While this analysis is descriptive, in the sense that it does not imply a causal relation between education and differential retirement effect, it clearly indicates that individuals with a higher education level, on average, benefit more from retirement in terms of word recall.

We then interact retirement duration with a dummy equal to one if the previous occupation was white-collar, and find a positive coefficient, equal to 0.05, statistically different from zero at the 10 percent level. Finally, we consider the interaction of retirement duration with a dummy equal to one if the previous occupation was in a highly skilled job. The positive differential effect we find in this case is also equal to about 0.05 words per year and it is statistically different from zero at the 10 per cent level.

Given the above results, we exploit the richness of the dataset to deepen our analysis and investigate whether particular job characteristics may explain some heterogeneity of the effect of retirement on cognition. This kind of information is available only in SHARELIFE, hence we restrict our sample to those individuals who participate in SHARELIFE. In the last column of table 6 we show results for the only indicator of job quality for which we found a statistically significant effect, a variable equal to one if the job allowed development of skills. We also experiment with other job quality indicators, capturing whether the job gave little freedom to decide, it gave recognition and if the salary was adequate, but we do not find any significant effect and do not report the results for brevity. Concluding, the only interaction that turns out to be statistically significant is the one capturing individuals who had a job allowing skill development. While again we cannot conclude there is a causal relationship between skilled work and cognitive functioning after retirement, we find that skilled workers benefit more than the average from retirement. The reason for this result may lay in a higher cognitive reserve and/or in a different attitude of these individuals in spending their free time.

In order to shed some light on this point, we first test whether the result is driven by retirees who remain active in the labour market, at least for some time after retirement.[ix] This behavior could result in individuals scoring better essentially because they are still "using their brain". We define a dummy variable equal to one if the retired individual reports to do paid work. As it is shown in table 7, column 1, the interaction of this variable with retirement duration is not significantly different from zero.

<Please insert table 7 about here>

A second kind of explanation that we want to test is whether some individuals more than others use their time, after retirement, in activities that enhance cognition. In the SHARE questionnaire in each wave there is a question regarding some common activities in which the respondent may be involved in his or her free time. Activities include voluntary or charity work, training courses, taking part in political or religious organizations and so on. Unfortunately in waves 1 and 2 the question is asked about the activities done in the month prior to the interview, while in wave 4 the question regards the whole year prior the interview. Hence as it stands, we cannot use this variable in our analysis. We therefore experiment with a different strategy. We use information only from wave 4, and on this basis we construct indicator variables – fixed through time – taking value equal to one if the respondent reports having performed any activity in the list (or a subset). In this way, we construct time-invariant indicators capturing the involvement in activities of individuals interviewed in wave 4. We proceed by interacting these indicators with retirement duration, as in previous tables, including in the estimation only individuals interviewed also in wave 4 (that is, dropping individuals present only in waves 1 and 2). As we estimate a fixed effects model, fixed characteristics including participation in organizations or reading books are already controlled for; what we estimate is whether retired individuals who engage themselves in these activities have a different effect from retirement, compared to individuals who do not undertake them. While we cannot state any causality from this exercise, finding an association between retirement and cultural activities would nevertheless be informative about the possible mechanisms shaping the cognitive decline in old age.

We build two indicators. The first one is equal to one if the respondent has engaged in an activity which involves social interactions (e.g. voluntary or charity work; attended an educational or training course; gone to a sport, social or other kind of club; taken part in activities of a religious organization; taken part in a political or community-related organization; played cards or games such as chess). The second indicator includes activities which are typically performed in solitude (e.g. read books, magazines or newspapers; did word or number games such as crossword puzzles or Sudoku).

In column 2 we show estimates of the relationship in which we interact retirement duration with the first indicator variable, "activities social". The additional effect of engaging in this kind of activities is zero. In column 3 we interact retirement duration with the second indicator, "reading books": in this case we find that individuals undertaking this kind of activity benefit from retirement more than the average. This effect is sizeable (about 0.1 words per year) and different from zero at the 5 per cent level. This result is in line with those studies highlighting the role of the lifestyle in shaping cognitive functioning at older ages.

Conclusions

In this paper we use the Survey on Health, Ageing and Retirement in Europe (SHARE) to estimate the effect of retirement on cognition. In particular, as a measure for cognition, we use the variable word recall, which is the total number of words, out of a list of ten, recalled immediately and after some minutes.

The exploitation of a panel dataset enables to control for unobserved heterogeneity which may be correlated with word recall and with the retirement decision, most importantly idiosyncratic cognitive ability, but also cohort, education, family background and so on. We control for the remaining endogeneity of the retirement decision exploiting the exogenous variation in early and normal eligibility ages across time, age, and gender.

Our main finding is that, conditional on the non-linear negative memory average age path of the typical individual, time spent in retirement has a positive effect on word recall. While we find no short-term effect of retirement on cognitive abilities, when estimating the long-term effect of retirement, we find a positive causal effect of years spent in retirement on word recall. Our estimates are based on a fixed-effects 2SLS estimator, with instruments constructed on the basis of early and normal retirement ages.

We also investigate for heterogeneity of the effect of retirement on cognition. We find that the effect is higher for individuals with a college degree, high-skilled workers, and individuals who spend time reading books. While we cannot interpret this heterogeneity in the effect of retirement on word recall in a causal way, there seems to be a clear indication that individuals with a higher cognitive reserve benefit more, on average, from retirement. This finding is in line with many psychological studies (e.g. Schaie, 1996) highlighting the preserving role of cognitive reserve in intellectual decline. In addition, individuals engaging themselves in stimulating activities such as reading books benefit more than average from retirement.

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FIGURES

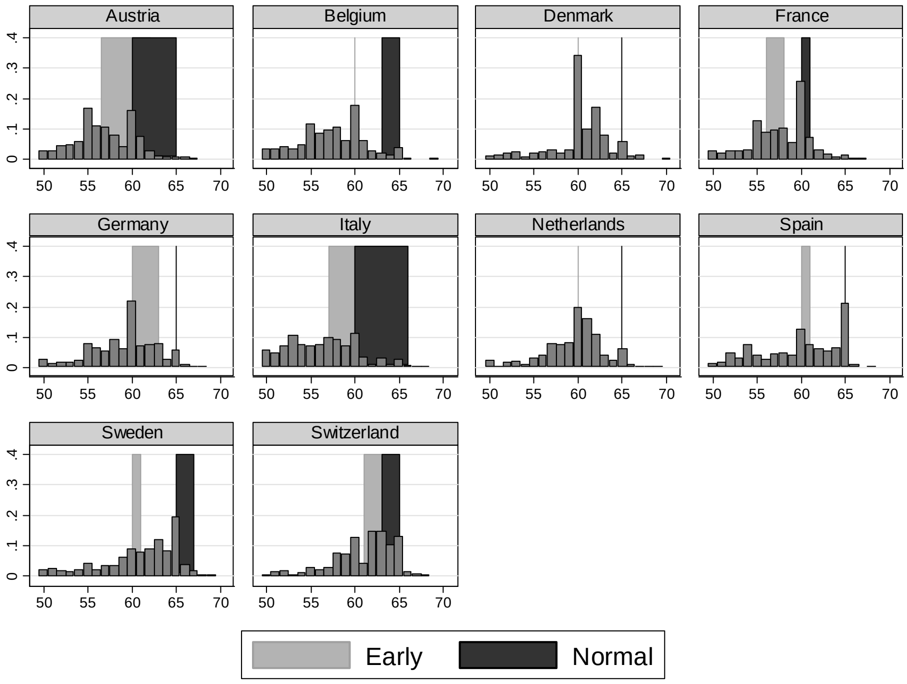

Figure 1 – Retirement age distribution

TABLES

Table 1 – Average number of words recalled by main categories

	Word recall		
	Observation	Mean	Standard deviation
Total Sample	21,934	10.0	3.2
Retired	9,540	9.4	3.3
Employed	12,394	10.4	3.1
Male	11,991	9.4	3.2
Female	9,945	10.7	3.2
White-collar	12,520	10.4	3.1
Blue-collar	4,760	8.4	3.2
High-skilled	10,910	10.1	3.2
Low-skilled	6,370	9.4	3.3
High-school degree or more	14,800	10.5	3.1
No High-school degree	7,136	8.7	3.2
College	6,635	11.1	3.0
No college	15,299	9.5	3.2
Job quality			
-Skill-development	8,920	10.0	3.1
-No Skill-development	2,566	9.0	3.2
-Little freedom	2,875	9.2	3.3
-No little freedom	8,611	9.9	3.1
-Adequate salary*	7,226	9.7	3.2
-No adequate salary*	4,260	9.8	3.2
-Gave recognition	8,508	9.8	3.2
-No gave recognition	2,978	9.6	3.2
Activities last year			
-No social activities	3,379	9.5	3.2
-Social activities	11,512	10.5	3.1
-No reading	1,657	8.7	3.3
-Reading books	13,234	10.5	3.1

*Note: all differences in means are statistically significant at any standard confidence level, being the standard error of the difference in the mean always in the range 0.02 - 0.06, with the exception of adequate/non adequate salary, for which the difference in the means is equal to 0.05 and its standard error is 0.06.

Table 2 – The effect of retirement status and duration on word recall – fixed effects estimates

	FE b/se (i)	FE-2SLS b/se (ii)	FE b/se (iii)	FE-2SLS b/se (iv)	FE b/se (v)	FE-2SLS b/se (vi)
retired	0.0088	0.1876				
	(0.0833)	(0.3478)				
retired at least 1 year			0.0432	0.6111*		
			(0.0825)	(0.3295)		
retirement duration					0.0284	0.2870***
					(0.0220)	(0.0741)
age^2/100	-0.5142***	-0.5393***	-0.5209***	-0.6244***	-0.6220***	-1.6136***
	(0.0784)	(0.0912)	(0.0790)	(0.0980)	(0.1155)	(0.2957)
learning	0.2006**	0.2122**	0.2021**	0.2290**	0.1986**	0.1855**
	(0.0916)	(0.0941)	(0.0915)	(0.0928)	(0.0915)	(0.0922)
contextual factor	-0.5357***	-0.5346***	-0.5354***	-0.5308***	-0.5343***	-0.5208***
	(0.0983)	(0.0982)	(0.0983)	(0.0981)	(0.0984)	(0.0989)
first stage						
normal retirement age		0.1866***		0.1568***		0.3039***
		(0.0109)		(0.0115)		(0.0156)
early retirement age		0.1560***		0.2089***		0.2760***
		(0.0096)		(0.0101)		(0.0176)
Number of obs	21934	21934	21934	21934	21934	21934
Hansen J		0.144		0.209		1.904
P-value		0.704		0.648		0.168
Weak identification		284.038		296.911		301.776

Note: All specifications include year dummies. Weak identification is the Kleibergen-Paap rk Wald F statistic; the critical value at 10% is equal to 19.93. *** 1% significance level; ** 5% significance level; * 10% significance level. Clustered standard errors in parentheses.

Table 3 - The effect of retirement duration on word recall – robustness to age trend

	FE-2SLS	FE-2SLS	FE-2SLS	FE-2SLS
	b/se	b/se	b/se	b/se
retirement duration	-0.0841***	0.3206***	0.2998***	
	(0.0197)	(0.0765)	(0.0909)	
retirement duration^2/100			-0.3015	
			(0.3609)	
Log(retirement duration)				0.7690***
				(0.2608)
age^2/100		4.2744*	-1.4854***	-1.0405***
		(2.3687)	(0.2813)	(0.1952)
age^3/10000		-3.3348**		
		(1.3402)		
Learning	0.2280**	0.2302**	0.1942**	0.2119**
	(0.0914)	(0.0938)	(0.0925)	(0.0920)
contextual factor	-0.5427***	-0.5217***	-0.5226***	-0.5265***
	(0.0984)	(0.0988)	(0.0987)	(0.0983)
Number of obs	21934	21934	21934	21934
Hansen J	0.002	0.0402	4.644	1.142
P-value	0.960	0.8411	0.098	0.285
Weak identification	7286.078	280.4242	158.179	289.329

Note: All specifications include year dummies. Weak identification is the Kleibergen-Paap rk Wald F statistic; the critical value at 10% is equal to 19.93. *** 1% significance level; ** 5% significance level; * 10% significance level. Clustered standard errors in parentheses.

Table 4 – Pooled regressions with retirement duration – robustness to age trend

	OLS	2SLS	OLS	2SLS	OLS	2SLS
	b/se	b/se	b/se	b/se	b/se	b/se
retirement duration	-0.0420***	-0.0246	-0.0314***	0.1815***	-0.0313***	0.1807***
	(0.0083)	(0.0181)	(0.0092)	(0.0482)	(0.0092)	(0.0481)
age	-0.0904***	-0.1007***	0.2502***	1.1693***	-3.8775***	-3.2245**
	(0.0069)	(0.0119)	(0.0964)	(0.2269)	(1.3847)	(1.4084)
age^2/100			-0.2879***	-1.1561***	6.6123***	6.1855***
			(0.0818)	(0.2104)	(2.3099)	(2.3419)
age^3/10000					-3.8252***	-4.0677***
					(1.2794)	(1.2991)
Learning	0.3371***	0.3439***	0.3187***	0.3337***	0.3565***	0.3739***
	(0.0808)	(0.0812)	(0.0811)	(0.0827)	(0.0824)	(0.0840)
contextual factor	-0.8278***	-0.8289***	-0.8267***	-0.8357***	-0.8278***	-0.8368***
	(0.0988)	(0.0987)	(0.0988)	(0.0996)	(0.0986)	(0.0995)
Number of obs	21934	21934	21934	21934	21934	21934
Hansen J		0.130		0.045		1.480
P-value		0.718		0.832		0.224
Weak identification		1610.456		196.591		199.045

Note: All specifications include year and country dummies. Weak identification is the Kleibergen-Paap rk Wald F statistic; the critical value at 10% is equal to 19.93. *** 1% significance level; ** 5% significance level; * 10% significance level. Clustered standard errors in parentheses.

Table 5 - The effect of retirement duration on word recall – more controls and by gender

	FE-2SLS b/se	FE-2SLS b/se	FE-2SLS b/se
retirement duration	0.2821***	0.2836***	0.2441***
	(0.0742)	(0.0743)	(0.0722)
ret. duration*female			0.0188
			(0.0246)
Age^2/100	-1.5873***	-1.5867***	-1.4658***
	(0.2960)	(0.2962)	(0.2836)
couple	0.1611	0.1642	0.1674
	(0.1434)	(0.1436)	(0.1436)
smoke	0.0565	0.0587	0.0563
	(0.0789)	(0.0789)	(0.0789)
drink	-0.1140	-0.1116	-0.1176
	(0.0841)	(0.0841)	(0.0840)
physical inactivity	-0.5405***	-0.5261***	-0.5245***
	(0.1417)	(0.1417)	(0.1416)
learning	0.2017**	0.2042**	0.2062**
	(0.0934)	(0.0936)	(0.0935)
contextual factor	-0.5250***	-0.5244***	-0.5269***
	(0.0987)	(0.0987)	(0.0986)
2 or more chronic dis.		0.0711	0.0724
		(0.0621)	(0.0620)
self-perceived health (us)		0.0217	0.0204
		(0.0568)	(0.0568)
# limitations adl		0.0277	0.0258
		(0.0857)	(0.0855)
# limitations iadl		-0.1085	-0.1052
		(0.0919)	(0.0917)
Number of obs	21934	21919	21919
Hansen J	1.704	1.650	3.303
P-value	0.192	0.199	0.192
Weak identification	301.552	300.958	157.154

Note: All specifications include year dummies . Weak identification is the Kleibergen-Paap rk Wald F statistic; the critical value at 10% is equal to 19.93 (16.87 in column 3). All specifications include wave dummies. *** 1% significance level; ** 5% significance level; * 10% significance level. Clustered standard errors. Standard errors in parentheses.

Table 6 - The effect of retirement duration on word recall – by education and job characteristics

	FE-2SLS b/se	FE-2SLS b/se	FE-2SLS b/se	FE-2SLS b/se	FE-2SLS b/se
retirement duration	0.2365***	0.2466***	0.2380***	0.2408***	0.2258**
	(0.0715)	(0.0702)	(0.0787)	(0.0789)	(0.1053)
ret.dur.* higher edu	0.0451*				
	(0.0250)				
ret.dur.*college		0.1081***			
		(0.0299)			
ret.dur.* white collar			0.0471*		
			(0.0288)		
ret.dur.*high skilled worker				0.0492*	
				(0.0272)	
ret.dur.*skill development					0.0613**
					(0.0301)
Age^2/100	-1.5175***	-1.5587***	-1.4984***	-1.5022***	-1.5245***
	(0.2900)	(0.2868)	(0.3219)	(0.3273)	(0.4116)
Number of obs	21934	21934	17278	17278	11484
Hansen J	2.989	2.214	3.486	3.134	2.742
P-value	0.224	0.330	0.175	0.209	0.254
Weak identification	153.856	153.841	132.931	129.418	72.144

Note: All specifications include year dummies and the variables couple, smoke, drink, physical inactivity, learning and contextual factor as additional controls. Weak identification is the Kleibergen-Paap rk Wald F statistic; the critical value at 10% is equal to 16.87. *** 1% significance level; ** 5% significance level; * 10% significance level. Clustered standard errors in parentheses.

Table 7 - The effect of retirement duration on word recall – by leisure activities

	FE-2SLS b/se	FE-2SLS b/se	FE-2SLS b/se
retirement duration	0.2809***	0.2467***	0.1562*
	(0.0741)	(0.0860)	(0.0845)
ret.dur.*still working	-0.0030		
	(0.0251)		
ret.dur.*activities social		0.0003	
		(0.0358)	
ret.dur.*reading books			0.1066**
			(0.0513)
Age^2/100	-1.5815***	-1.4288***	-1.4553***
	(0.2978)	(0.3238)	(0.3240)
Number of obs	21934	14663	14663
Hansen J	1.864	4.386	2.339
P-value	0.394	0.112	0.310
Weak identification	148.485	127.060	126.784

Note: All specifications include year dummies and the variables couple, smoke, drink, physical inactivity, learning and contextual factor as additional controls. Weak identification is the Kleibergen-Paap rk Wald F statistic; the critical value at 10% is equal to 16.87. *** 1% significance level; ** 5% significance level; * 10% significance level. Clustered standard errors in parentheses.

Notes

[i] In principle, retirement duration may have a non-linear effect on word recall. We test for this hypothesis in estimation. Here it is important to notice that also the linear term is identified.

[ii] See http://www.missoc.org for the MISSOC tables.

[iii] When the retirement dummy is equal to one because the individual has been retired for at least one year, the instruments are adjusted accordingly.

[iv] Results not shown for brevity, but available upon request.

[v] http://epp.eurostat.ec.europa.eu/cache/ITY_SDDS/FR/trng_aes_esms.htm.

[vi] As shown in table 3, the coefficients on retirement and retirement duration are affected by the degree of the polynomial in age.

[vii] We replicated table 2 enlarging our definition of retirement to include all individuals who are out of the labour force (i.e. sick, unemployed or homemaker). Results, not shown for brevity but available upon request, are unaffected.

[viii] We also introduced interaction terms between age and gender, but they turned out to be statistically irrelevant.

[ix] We are referring to all the individuals who describe themselves as retired but report to have done some paid work during retirement.