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COGNITIVE FUNCTIONING AND RETIREMENT IN EUROPE

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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 to use a fixed effect estimator which is crucial to estimate the effect of individual transitions into retirement on our memory measure, word recall. 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.

Keywords: cognitive functioning, retirement, panel estimation

JEL: I12, J24, J26

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1. 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 cognitive functioning is ambiguous. In terms of Grossman (1972a, 1972b) model for human capital, if utility depends on human capital, an increase in free time may lead individuals to raise their investment in cognitive abilities after retirement. On the other hand, if these investments do not reflect into higher earnings any more, the investment in human capital should be lower. The prevailing effect of retirement on cognitive ability 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 contrast or even improve cognitive functioning. Therefore, it is an empirical question to sort out which effect prevails.

Previous studies that relate cognitive functioning and retirement found mixed results. Rohwedder and Willis (2010), Bonsang et al. (2012), Mazzonna and Peracchi (2012) all found a negative 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.

From an empirical point of view, it is important to recognize that not only retirement is endogenous, as individuals with lower cognitive abilities might self-select into retirement, but also it is correlated to other unobservable determinants of cognitive functioning. As a consequence, a longitudinal sample that allows to control for fixed effects is crucial for the analysis, as it allows to isolate the effect of age, retirement and other time varying variables from time invariant observable and unobservable characteristics that influence both retirement and the stock of cognitive abilities, most importantly idiosyncratic cognitive ability, but also cohort, education, family background and so on.

In this work we study the evolution of cognitive functioning for individuals aged between 50 and 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 et al., 2012).

In general, 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 who spend time 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. In addition, we find that individuals engaging themselves in stimulating activities such as reading books benefit more than average from retirement.

The rest of the paper is organized as follows: section 2 reviews the theoretical framework and the previous empirical evidence; section 3 describes our empirical strategy and section 4 the data set we use. In section 5 we report our baseline results and in section 6 we test for heterogeneity in the effect of retirement on word recall. Section 7 concludes the paper.

2. Theoretical framework and previous evidence

Since the seminal works by Schultz (1961), Becker (1964, 1965), and Ben Porath (1967), human capital accumulation has received considerable attention in the literature. Human capital can be broadly described as the stock of knowledge and skills accumulated by individuals; investment in human capital occurs through many channels including formal education, on the job training, self-improvement, nutrition, health, and also non cognitive abilities, such as socialization and motivation. Human capital H follows the usual low of motion for capital:

$$\Delta H_{t+1} = I_t - \delta_t H_t \qquad (1)$$

where I is investment in human capital in period t and δ is the rate of depreciation, which may vary with time.

According to human capital theory, increases in the stock H_t raise an individual's productivity both in the market, and hence his earnings, and in the household sector, to produce commodities that enter the utility function.

Assuming that human capital directly enters the utility function, because it has an effect on satisfaction and happiness, and that it also represents an investment good that raises earnings, leads to a theoretical ambiguity of the effect of retirement on the accumulation of cognitive abilities, as it has already been showed for example by Dave et al. (2006, 2008) and Mazzonna and Peracchi (2012), using the theoretical framework of Grossman's (1972a, 1972b, 2000) human capital model for health. The overall effect depends on the effect of retirement on the marginal cost and the marginal benefit of an individual's human capital. If human (or cognitive) capital provides utility directly, as a consumption good, the marginal benefit from investing in one unit of additional cognitive capital includes not only the effect on wage, which vanishes after retirement, but also the direct effect on utility. As a consequence, the total effect of retirement on the marginal benefit is ambiguous. In addition, retirement may raise or lower an individuals' (marginal) value of time, with an ambiguous effect on the (marginal) cost of investing in human capital. The overall effect of retirement on cognitive ability is therefore theoretically ambiguous and has to be studied empirically.

Childhood accumulation of human capital has been studied extensively in the economic literature, emphasizing the production of skills and of cognitive achievement as a function of innate ability, parental characteristics and of all prior investments (Todd and Wolpin 2003 and 2007). Cuhna and Heckman (2008) and Cuhna et al. (2010) emphasize the joint production of cognitive and non-cognitive skills, estimating a multistage technology for child investment, while Heckman (2007) highlights the additional role of health in the accumulation of skills.

In this view, the adult stock of capability at time t (H_t) is a function of parental characteristics, initial conditions and all investments in cognitive, non-cognitive abilities and health during childhood.

The evolution of the stock H_t once adulthood is reached is much less studied in the economic literature. In psychological studies, the concept of cognitive reserve is used and its level and evolution 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, which is based on longitudinal data, 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 self-defined as 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". Hence, healthy adults may shape the evolution of their cognitive abilities also in the second half of their life cycle. 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 contrast or even improve cognitive functioning.

A few studies directly relate cognitive functioning and retirement. Rohwedder and Willis (2010), Bonsang et al. (2012), Mazzonna and Peracchi (2012) all found a negative 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.

These studies differ in the methodology 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 identification strategy used to estimate the causal effect of retirement on cognitive functioning: studies based on cross-sectional data inevitably found their identification on the difference between workers and retired individuals, that is on the difference between the average cognitive performance of workers and the average cognitive functioning of retired individuals, conditional on observable characteristics. Studies based on longitudinal samples, on the other hand, have the potential to estimate the average individual effect of retirement on cognitive performance, by allowing to observe the individual difference in performance, before and after retirement.

Most existing studies are based on cross-sectional data. In particular, 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 negative 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 they estimate the effect of years spent in retirement instead of a binary variable capturing whether an individual is retired. Including a very limited number of controls and only a linear term in age, in most specifications they find a negative effect of retirement duration on cognitive performance. While including endogenous variables in the equation is clearly problematic, omitting to control for them in an estimation based on a cross-sectional sample, that compares the average cognitive performance of retired versus non-retired individuals, may be even more problematic.

More recently, Börsch-Supan and Schuth (2013) use the SHARE dataset to estimate the relationship between early retirement, cognitive functioning, and the size and composition of social networks. They 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.

A solution to these identification problems lies in the use of longitudinal data, which allow to follow the same individuals over time and therefore to observe directly their average cognitive decline when they retire. Bonsang, et al. (2012) use the US panel dataset HRS to perform fixed-effects instrumental-variable estimates of retirement, 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. They use instruments based on unexpected early retirement windows offers, which are required by law to be unrelated to individuals' health.

3. Empirical strategy

Our empirical strategy rests on the use of panel data to control for fixed effects, and of a two stage least squares estimator (2SLS) to take into account the endogeneity of the retirement decision. The fixed effects estimator allows us to identify the individual effect of retirement on our memory measure, word recall. To identify the coefficients of interest on retirement status or retirement duration we include both pensioners and non pensioners in our sample.

We can write the equations that we want to estimate as:

$$WR_{it} = \alpha_1 R_{it} + \beta X_{it} + \varepsilon_{it} + \nu_t + \mu_i \quad (2)$$

$$WR_{it} = \alpha_2 (age_{it} - age_i^R) R_{it} + \beta X_{it} + \varepsilon_{it} + \nu_t + \mu_i \quad (3)$$

where WR_{it} is word recall, R_{it} is a dummy variable equal to 1 if the individual is retired and zero otherwise, and both equations include an idiosyncratic shock, a time effect, and a fixed effect. As in the literature it has been emphasized that retirement may take time to display its effects, we modify this specification in two ways. First, we estimate equation (2) defining 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 et al., 2012). Second, we also estimate a specification in which the retirement effect is captured by time spent in retirement, or retirement duration, computed as age of individual *i* at time *t* minus age of individual *i* at retirement, interacted with the retirement dummy (equation 3). Identification of the coefficients of interests, α_1 and α_2, 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.

The X variables represent time-variant demographic variables that 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/or retirement duration have an effect on word recall conditional on health status.

In addition to an idiosyncratic shock, captured by ε_{it}, and to individual fixed effects, μ_i, we add time dummies to control for time effects ν_t. Time effects are extremely important since they allow the intercepts in equations (2) and (3) to vary with time, that is allow for a time-varying average of the dependent variable. In a fixed effect estimation, when including year dummies any variable that varies by one unit in each time period, such as age, is not separately identified; any non-linear term (such as age squared for example) is obviously identified. However, as the data in SHARE are collected in different years for each wave, as we describe more in detail in the next section, we are able to include wave dummies (i.e. one for each wave of the panel, minus one) in our regression and to identify separately the coefficient in the linear term in age. In this way the estimated equations do not constrain the average amount of recalled words to be the same in each wave: this is particularly important since in the last wave the list of words used for the memory test is different from the one used in the first two waves. Differences in the difficulty to memorize different lists of words are captured by the inclusion of wave dummies in the estimated equation. Alternatively, it is possible to estimate equations (2) and (3) including year dummies and dropping the linear term in age which is no longer separately identified: results on the remaining coefficients are unaffected, as the two estimated equations are equivalent.

Retirement duration in equation (3) 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[1].

Retirement, and retirement duration, are clearly endogenous variables in this context: individuals with poor 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 et al., 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 old 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[2].

With the legal early and old ages of retirement we can construct four instruments, two for the retirement dummy and two for retirement duration. The two instruments for the retirement dummy are dummy variables taking value zero if the individual's age is less than the statutory age for either early or regular retirement[3]. 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 necessarily happens in panel data, may learn how to respond to the test. In addition, in our dataset, in the first two waves respondents were asked to recall the same list of ten words[4]. Hence, in our estimated equations we always include a variable capturing the learning effect of retesting, that is a dummy variable that takes value equal to one if an individual takes the test for the second or third time.

Finally, another important issue we need to consider as we work with longitudinal data is the possibility of a selectivity problem due to non response. Panel attrition in SHARE is indeed present (Blom and Schröder, 2011) and it is likely to be selective in the sense that individuals who stay longer in the survey are probably healthier and with higher

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[1] 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.

[2] http://www.missoc.org

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

[4] A different issue is represented by the fact that in wave 4 the list of words was different, hence raising the possibility of bias due to a higher or lower degree of difficulty. As we already noted, however, including wave dummies in the regressions controls for this possibility by allowing a different average number of recalled words for each wave.

cognitive abilities than those who drop out. As we include wave 4 in our estimates and conduct our study on the unbalanced panel, however, we benefit of the refreshment sample. In addition, our estimation method is quite robust to panel attrition: Verbeek and Nijman (1992) show that with fixed effects estimates the problem is less severe. Although we base our estimates on the unbalanced panel, we check for attrition bias. We follow Verbeek and Nijman (1992) and construct a quasi-Hausman test comparing estimates from the balanced and unbalanced panel, and find that while selection is indeed present, it does not affect the estimate of the coefficient of interest, that is the response of word recall to retirement.

4. 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, and the fourth in 2011 and 2012. While the first wave was collected in 2004 for most countries, with the exception of Belgium, and the fourth one in 2011, the second one was collected both in 2006 and 2007 in most countries. The third wave, collected in 2008 and 2009, 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 declare 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.

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 after some time, after answering other questions of the questionnaire about verbal fluency and numeracy. The value of total word recall ranges from 0 to 20.

We define the two main explanatory variables used in the paper, that are retirement status and retirement duration, on the basis of self-declared status. Retirement status is a dummy variable that is set equal to zero if the individual declares to be employed at the time of the interview and it is set to one if the individual declares to be 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 it is asked in what year the individual retired, that is variable ep329 in the questionnaire. In addition, when an individual declares a different retirement year across waves, that is to say when there is not panel consistency, 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 21,936 observations, distributed across sample waves and countries as reported in Table 1. 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. As reported in Table 1, 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 11,486.

In our analysis we also use information on the type of occupation. We define blue/white collars and high/low skilled workers referring to the classification used by Eurostat[5], which is based on the 1-digit ISCO 88 (COM). In particular, as reported in table 2, 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 3 we report some descriptive statistics for our main variable, total word recall. The overall average number of words recalled is, in our selected sample, 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 (2) and (3) described in the previous section. In addition, females, individuals with higher education or in a high skill jobs tend to recall more words on average.

In figure 1 we present the age retirement distribution for our sample. While there is a clear spike at age 60, the figure reveals there is a lot of variability in retirement age in our sample.

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

We estimate the fixed effects age profile of total word recall: as shown in figure 2, the total number of words recalled is stable, slightly increasing, up to age 60 where a sharp short decline is present, while it slightly declines after that age.

5. 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 4 we report our basic specifications, were 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 third-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 by taking value 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 adding more explanatory variables[6].

All the estimates in table 4 control for fixed effects, hence all time-invariant characteristics are controlled for. To take into account common wave effects, we also include wave dummies. As each wave of the survey has been carried on in different calendar years, we are also able to separately identify the linear term in age[7]. As in some specifications we find a significant coefficient for the third power of age, we always include a third order polynomial in age; in the next table we will show alternative specifications for the age trend[8]. In this context, the variables of interest retirement status and retirement duration are identified because our sample includes 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.

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

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[6] As we show in the next table, the coefficients on retirement and retirement duration are affected by the degree of the polynomial in age, while they are invariant to the exclusion of the variables contextual factor and learning.

[7] Identification of the age term comes in particular from wave 2, which was carried out in two years in all countries with the exception of the Netherlands. Alternatively, we may control for year effects in our regressions, by adding year dummies instead of wave dummies as explanatory variables, renouncing to separately identify the coefficient in the linear term in age. Results on the remaining coefficients are unaffected.

[8] In particular, results including a second-order polynomial in age are largely unaffected.

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 old and early age of retirement. The coefficient on retirement status increases to zero, with a high associated standard error. The set of instruments we use always reject the test of underidentification 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 effect specification including the dummy variable equal to one if the individual has been in retirement for at least one year: its coefficient turns slightly positive but not significantly different from zero. In column 4 we report the 2SLS estimates, and in this case the coefficient increases to 0.6, indicating that indeed the effect is delayed, but is different from zero only at the 15 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 old- and early-age retirement ages to construct instruments for retirement duration as explained in detail in section 3. The coefficient on retirement duration is positive and significantly different from zero at the 1 per cent level.

According to our results, given the general non-linear age trend, individuals after retirement recall about 0.39 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 higher word recalling, or, in other words, a slower decline in memory, relative to their performance before retirement. Using the estimated coefficients from the age polynomial, we plot the estimated average age trend in figure 3: the estimated time/age profile, common to all individuals, is slightly increasing up to age 57 and declines after that age. According to our estimates, retired individuals benefit in memory relatively to this average profile. 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.

We next check for the robustness of our results experimenting with different polynomials in age: in table 5, column 1, we start by reporting the estimates of a specification that excludes any non-linear term in age. The estimate of the linear effect in age turns to zero, and 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 particular, as age is not properly accounted for, the decline in cognition is completely captured by retirement duration[9]. In column 2 we add a second order term in age: this is significantly different from zero, and captures the declining average age profile of word recall. The coefficient on retirement duration turns positive and significantly different from zero: its magnitude is only slightly lower than that found in table 4. We then experiment with a fourth-order polynomial in age, but it turns out to be imprecisely estimated – and the estimate on retirement duration is mostly unaffected with respect to that obtained in table 4.

We next test whether retirement duration itself has a non-linear effect on word recall: in column 4 we add its squared value, which turns out to be positive and significantly different from zero at the 10 per cent level. As the coefficient is small and the implied profile is very close to a linear one, however, in the subsequent analysis we report the linear effect only.

An important issue that we need to consider is the possibility that retesting may affect our estimates. Learning or retesting effects may come in two ways, as individuals who take the test more than once, as necessarily happens in our panel data, may learn how to respond to the test, and in addition in the first two waves respondents were asked to recall the same list of ten words[10]. We already presented our results including the variable learning, a dummy variable that takes value equal to one if an individual takes the test for the second or third time. This variable, as previously shown in table 4, column 6, takes value 0.2 and is significantly different from zero. In table 6 we experiment with other ways to tackle this issue[11]. In column 1 we report the benchmark estimate of table 4. In column 2, instead of including the variable learning, we add the variable "number of retest" which takes value equal to 1 the first time an individual takes the test, to 2 the second time and to 3 the third time. As the linear effect of this variable is equal to zero, we add its squared value to the estimated equation, and find a negative and statistically significant second order term (column 3). The estimated second order polynomial (computed for the values 1, 2, and 3) implies a positive learning effect when taking the test the second time, which remains constant when taking the test for the third time. This is in line with the literature (Ferrer et al., 2004) that finds that retest effects are greater the first times the test is taken. In addition, in our sample individuals take the test for the third time at least four years after the previous one, because of the survey design, hence reducing the learning effect. To test the importance of being tested on the same list of words (and relatively close in time), we

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[9] Estimating the specification which includes the retirement dummy instead of retirement duration among its regressors, along with a linear term in age, produces the similar result of a negative coefficient in retirement status (-0.64) statistically significant at the 5 per cent level.

[10] A different issue is represented by the fact that in wave 4 the list of words was different, hence raising the possibility of bias due to a higher or lower degree of difficulty. As we already noted, however, including wave dummies in the regressions controls for this possibility by allowing a different average number of recalled words for each wave.

[11] Excluding it from the estimated equation does not change the estimated coefficient on retirement duration. Results not shown for brevity.

next run our estimates including waves 2 and 4 only (column 4) and find that the coefficient on retirement duration is equal to 0.42; in column 5 we restrict estimates to the refreshment sample only, and find a slightly higher coefficient on retirement duration. Hence, while we find evidence of retest effects, these do not seem to affect our basic result on the effect of retirement duration on word recall.

Another important issue that could affect our results is whether selectivity bias due to panel attrition is present. One way to test for "attrition bias" is to proceed as proposed by Verbeek and Nijman (1992), that is to compare estimates obtained using the unbalanced and the balanced panel with a Hausman-like test. In practice, we first estimate our basic relationship using the full unbalanced panel, and then using only the balanced part of it – that is the panel formed only by those individuals observed over all three waves. Results for the balanced and unbalanced estimates are presented in table 7, while the test statistics are presented in table 8. Inspection of table 7, and in particular of the last two columns, reveals that the differences in the estimated coefficients are never significant but for the last two variables, that are the two dummies for wave 1 and 2, whose coefficients are statistically different. The quasi-Hausman test proposed by Verbeek and Nijman is reported in table 8: in the first row of the table it is reported the test that compares all the coefficients. The null hypothesis that there are no systematic differences among the two sets of coefficients is rejected at the 4 per cent level. When we test the subset of coefficients that excludes the dummy variables for wave 1 and 2, as reported in row 2, the test does not reveal any systematic difference in the coefficients. This evidence proves that attrition bias is indeed present on average, but it does not affect the response of word recall to retirement. Nonetheless, we use the unbalanced sample in our estimates.

6. Heterogeneity of the effect of retirement

We next try to understand whether other variables influence the relationship 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 to drink more than 2 glasses of alcohol almost every day. Physical inactivity is equal to one if the respondent declares to never or almost never engage in physical activity.

We report estimates in table 9, where we always include wave dummies, a third-order polynomial in age, contextual factor and learning. Estimates are obtained with the fixed-effects instrumental variable estimator described earlier. Column 1 in table 9 shows that indeed drinking and being physically inactive hinders word recall: individuals who started (stopped) drinking in the sample period recall on average 0.15 words less (more) with respect to others, other characteristics being held constant, while individuals who stop (start) being physically active recall 0.46 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 effect 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 men and women. 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 (years since early retirement age, years since old 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[12].

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. We treat all these variables as predetermined and we conduct our analysis conditional on them. 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 lower educated individuals. Our results, shown in table 10 column 1, show that the differential effect of retirement of workers who have higher education 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 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.

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

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 0.06, statistically different from zero at the 5 percent level. Finally, we consider the interaction of retirement duration with a dummy equal to one if the previous occupation was in a high skilled job. The positive differential effect we find in this case is also in this case equal to about 0.06 words per year and it is statistically different from zero at the 5 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 to participate in SHARELIFE. In table 11 we show results for four indicators of job quality: these are equal to one if the job allowed development of skills, it gave little freedom to decide, it gave recognition and if the salary was adequate. For this sub-sample of individuals responding to SHARELIFE the average positive effect of retirement on word recall is twice the average effect we obtained for the overall sample: this is probably due to sample selection. Nonetheless, it is interesting to notice that the only interaction that turns out to be statistically significant is the one capturing individuals who had a job allowing skill development. While it not possible to give a causal interpretation to this result, it confirms that retirees who have been skilled workers and in skill enhancing jobs benefit from retirement more than the average. 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 workers who remain active in the labour market, at least for some time after retirement: 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 declares to do paid work. As it is shown in table 12, column 1, the interaction of this variable with retirement duration is not significantly different from zero.

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 declares to have done 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 effect 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 (done 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 one includes activities which are typically done in solitude (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 word 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.

7. 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, that is the total number of words, out of a list of ten, recalled immediately and after some minutes.

The use of a panel dataset allows to use a fixed effect estimator which is crucial to estimate the effect of individual transitions into retirement on word recall. While retirement is clearly endogenous, as individuals with lower cognitive abilities might self-select into retirement, and needs to be instrumented, it is also correlated to other unobservable determinants of cognitive functioning. As a consequence, the availability of a longitudinal sample that allows to control for fixed effects is extremely important as it allows to isolate the effect of age, retirement and other time varying variables from time invariant observable and unobservable characteristics that influence both retirement and the stock of cognitive abilities, most importantly idiosyncratic cognitive ability, but also cohort, education, family background and so on.

Our main finding is that, conditional on the 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 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. 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

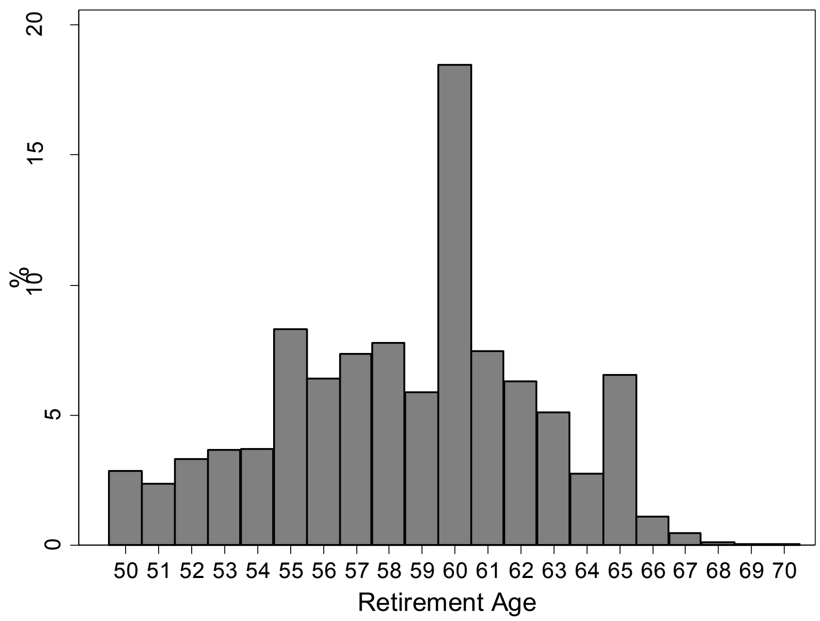
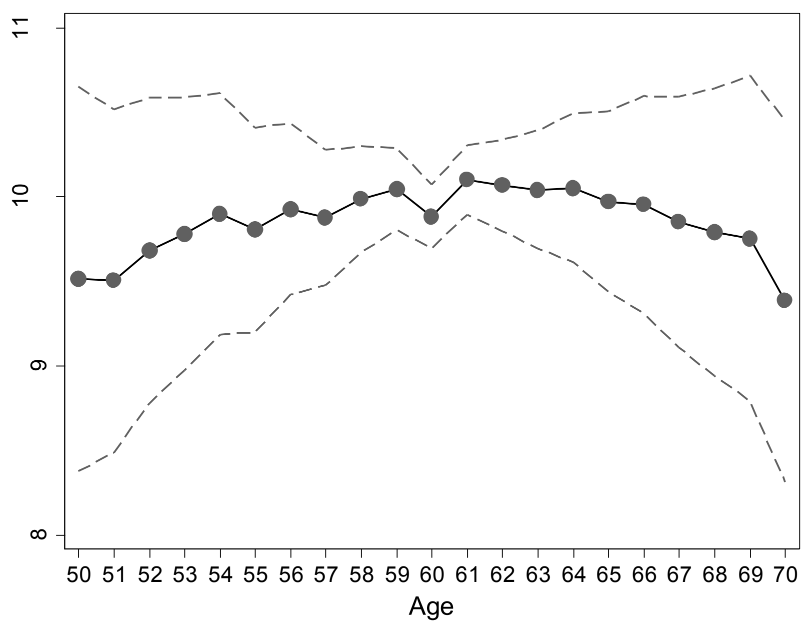
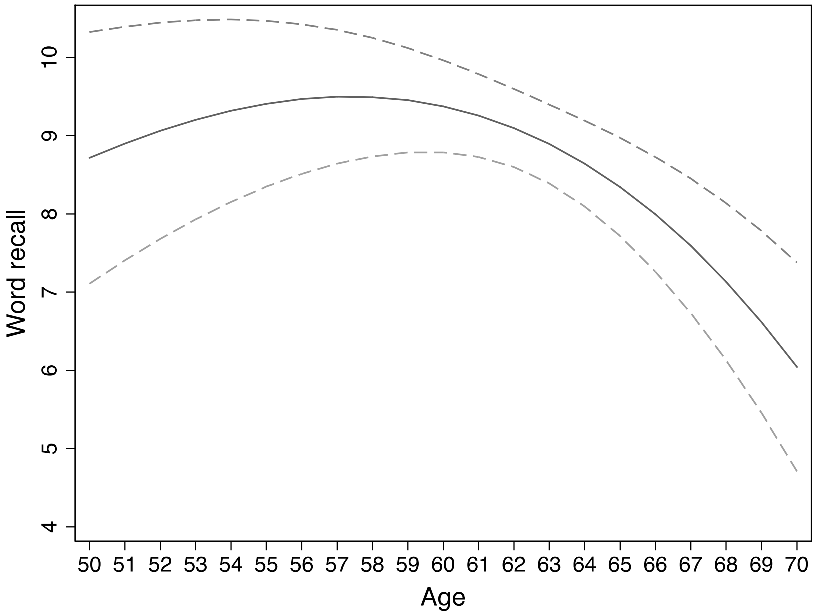


Figure 2 - Total word recall age profile



Note: fixed effects age profile with 95% confidence intervals (dashed lines) are estimated using the following model: $WR_{it} = \beta X_{it} + \gamma D_{it} + \varepsilon_{it} + \nu_t + \mu_i$ where WR_{it} is word recall, D_{it} is a set of age dummies, and X_{it} includes 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.

Figure 3 – Word recall - estimated average age profile



Note: estimated average age trend with 95% confidence intervals (dashed lines) are plotted using the estimated coefficients from the age polynomial as reported in Table 3 column 4.

TABLES

Table 1 – Selected observations in Share waves by country

	Wave				
Country	1	2	4	Total	Share life (wave 3)
Austria	571	573	259	1,403	683
Germany	737	878	543	2,158	1,242
Sweden	1,177	1,242	817	3,236	1,277
Netherlands	685	815	659	2,159	963
Spain	358	431	310	1,099	622
Italy	639	866	600	2,105	1,547
France	941	1,085	811	2,837	1,582
Denmark	619	1,033	861	2,513	1,026
Switzerland	339	593	475	1,407	555
Belgium	1,112	1,150	755	3,017	1,987
Total	7,178	8,666	6,090	21,934	11,484

Table 2 - Type of occupations as defined by Eurostat according to the International classification ISCO-88 (COM), 1-digit level.

ISCO-88 (COM)	**Description**	**Workers**	**Skills**
1	Legislators, senior officials and managers	White Collar	High Skilled
2	Professionals		
3	Technicians and associate professionals		
4	Clerks	White Collar	Low Skilled
5	Service workers and shop and market sales workers		
6	Skilled agricultural and fishery workers	Blue Collar	High Skilled
7	Craft and related trades workers		
8	Plant and machine operators and assemblers	Blue Collar	Low Skilled
9	Elementary occupations		
10	Armed forces	Excluded	

Table 3 – 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 4 – 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	-0.0224	-0.0094				
	(0.0870)	(0.4511)				
retired at least 1 year			0.0194	0.6007		
			(0.0857)	(0.4139)		
retirement duration					0.0357	0.3896***
					(0.0223)	(0.0657)
age	-1.7064	-1.6490	-1.5299	0.8096	-1.6099	-1.6309
	(1.4462)	(2.4191)	(1.4423)	(2.1688)	(1.4024)	(1.4165)
age^2/100	3.3931	3.2984	3.1026	-0.7405	3.3516	4.5516*
	(2.4107)	(4.0029)	(2.4038)	(3.5858)	(2.3422)	(2.3809)
age^3/10000	-2.1674	-2.1159	-2.0101	0.0615	-2.2219*	-3.6374***
	(1.3329)	(2.1894)	(1.3286)	(1.9548)	(1.2998)	(1.3428)
learning	0.1958**	0.1960**	0.1961**	0.1962**	0.1976**	0.2124**
	(0.0899)	(0.0900)	(0.0899)	(0.0902)	(0.0899)	(0.0909)
contextual factor	-0.5368***	-0.5366***	-0.5364***	-0.5301***	-0.5349***	-0.5182***
	(0.0983)	(0.0984)	(0.0983)	(0.0984)	(0.0983)	(0.0992)
first stage						
old age		0.1073***		0.0918***		0.0896***
		(0.0113)		(0.0118)		(0.0223)
early age		0.1182***		0.1547***		0.3395***
		(0.0109)		(0.01135)		(0.0180)
Number of obs	21934	21934	21934	21934	21934	21934
Hansen J		0.003		0.471		0.285
P-value		0.957		0.492		0.593
Weak identification		144.580		175.708		353.417

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

Table 5 - The effect of retirement duration on word recall – robustness to age trend

	FE-IV	FE-IV	FE-IV	FE-IV
	b/se	b/se	b/se	b/se
retirement duration	-0.0443**	0.3591***	0.3963***	0.2769***
	(0.0204)	(0.0638)	(0.0683)	(0.0932)
retirement duration^2/100				0.7612*
				(0.4427)
age	0.0216	2.1595***	-29.4034	-3.9013**
	(0.0559)	(0.2923)	(22.5531)	(1.9213)
age^2/100		-1.8943***	74.4331	8.3756***
		(0.2572)	(56.7018)	(3.2283)
age^3/10000			-81.4385	-5.7651***
			(63.0140)	(1.8071)
age^4/1000000			32.3393	
			(26.1104)	
Learning	0.2099**	0.1621*	0.2200**	0.2235**
	(0.0881)	(0.0891)	(0.0912)	(0.0910)
contextual factor	-0.5420***	-0.5169***	-0.5179***	-0.5194***
	(0.0985)	(0.0992)	(0.0992)	(0.0992)
Number of obs	21934	21934	21934	21934
Hansen J	20.435	3.674	0.378	0.9566
P-value	0.000	0.055	0.539	0.6198
Weak identification	6332.519	383.172	329.317	169.7052

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

Table 6 – Learning/retest effects

	all b/se	all b/se	all b/se	wave2-wave4 b/se	Refresh sample b/se
retirement duration	0.3896***	0.3847***	0.3919***	0.4227***	0.4994**
	(0.0657)	(0.0657)	(0.0657)	(0.0989)	(0.2441)
age	-1.6309	-0.9733	-1.5744	-0.7544	-1.7963
	(1.4165)	(1.3921)	(1.4178)	(2.0663)	(3.2746)
age^2/100	4.5516*	3.4244	4.4599*	3.5219	5.9960
	(2.3809)	(2.3397)	(2.3829)	(3.4664)	(5.6908)
age^3/10000	-3.6374***	-3.0103**	-3.5893***	-3.1650	-4.7246
	(1.3428)	(1.3209)	(1.3438)	(1.9545)	(3.3664)
Learning (0/1)	0.2124**			0.2044**	
	(0.0909)			(0.1004)	
# retest		-0.1282	0.3865		
		(0.1717)	(0.2672)		
# retest^2			-0.1124**		
			(0.0459)		
contex_factor	-0.5182***	-0.5203***	-0.5192***	-0.7283***	-0.8938***
	(0.0992)	(0.0992)	(0.0992)	(0.1609)	(0.2451)
Number of obs	21934	21934	21934	10722	3860
Hansen J	0.285	0.283	0.309	3.308	0.089
P-value	0.593	0.594	0.579	0.069	0.766
Weak identification	353.417	352.315	352.848	199.226	30.311

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

Table 7 - Balanced/unbalanced estimates

	balanced	unbalanced	Difference	Std. Err.
retirement duration	.3608411	.3832616	-.0224205	.0357719
age	-3.317064	-1.039856	-2.277208	1.381816
age^2/100	6.915385	3.534944	3.380441	2.322237
age^3/10000	-4.846928	-3.069771	-1.777157	1.303301
contextual_factor	-.4919052	-.5195596	.0276543	.1058192
Wave=1	-1.573147	-.5115999	-1.061547	.3722287
Wave=2	-.8857052	-.2450162	-.6406889	.243902

Table 8 - (Quasi-Hausman) Verbeek and Nijman (1992) test

	Chi-squared	P-value
All variables	14.35	0.0453
Excluding year dummies	4.07	0.5392

Table 9 - 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	0.3818***	0.3831***	0.3484***
	(0.0657)	(0.0659)	(0.0646)
ret. duration*female			0.0127
			(0.0257)
Age	-1.4523	-1.3633	-1.3556
	(1.4152)	(1.4167)	(1.4142)
Age^2/100	4.2272*	4.0745*	3.9642*
	(2.3791)	(2.3817)	(2.3756)
Age^3/10000	-3.4370**	-3.3516**	-3.2283**
	(1.3420)	(1.3436)	(1.3380)
couple	0.1629	0.1661	0.1678
	(0.1441)	(0.1442)	(0.1442)
smoke	0.0611	0.0636	0.0618
	(0.0792)	(0.0792)	(0.0792)
drink	-0.1037	-0.1014	-0.1060
	(0.0856)	(0.0856)	(0.0856)
physical inactivity	-0.5336***	-0.5202***	-0.5194***
	(0.1422)	(0.1424)	(0.1422)
learning	0.2270**	0.2271**	0.2260**
	(0.0920)	(0.0923)	(0.0921)
contextual factor	-0.5220***	-0.5218***	-0.5238***
	(0.0990)	(0.0990)	(0.0989)
2 or more chronic dis.		0.0605	0.0618
		(0.0628)	(0.0626)
self-perceived health (us)		0.0331	0.0317
		(0.0577)	(0.0577)
# limitations adl		0.0326	0.0307
		(0.0851)	(0.0850)
# limitations iadl		-0.1094	-0.1070
		(0.0906)	(0.0903)
Number of obs	21934	21919	21919
Hansen J	0.285	0.316	4.175
P-value	0.594	0.574	0.124
Weak identification	353.557	352.698	181.578

Note: 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 10 - 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
retirement duration	0.3341***	0.3489***	0.3031***	0.3099***
	(0.0646)	(0.0635)	(0.0682)	(0.0678)
ret.dur.* higher edu	0.0498*			
	(0.0257)			
Ret.dur.*college		0.1161***		
		(0.0313)		
ret.dur.* white collar			0.0595**	
			(0.0295)	
ret.dur.*high skilled worker				0.0640**
				(0.0279)
Age	-1.3631	-1.3908	-1.9924	-2.1329
	(1.4145)	(1.4144)	(1.6549)	(1.6538)
Age^2/100	4.0209*	4.1285*	4.8829*	5.1376*
	(2.3761)	(2.3756)	(2.7555)	(2.7548)
Age^3/10000	-3.2856**	-3.3760**	-3.6881**	-3.8412**
	(1.3388)	(1.3384)	(1.5359)	(1.5365)
Couple	0.1616	0.1649	0.2370	0.2297
	(0.1438)	(0.1438)	(0.1620)	(0.1621)
Smoke	0.0580	0.0515	0.0695	0.0707
	(0.0792)	(0.0793)	(0.0890)	(0.0891)
Drink	-0.1109	-0.1161	-0.1307	-0.1198
	(0.0854)	(0.0855)	(0.0922)	(0.0921)
physical inactivity	-0.5297***	-0.5366***	-0.5968***	-0.5915***
	(0.1422)	(0.1422)	(0.1609)	(0.1607)
Learning	0.2258**	0.2331**		
	(0.0919)	(0.0920)		
contextual factor	-0.5204***	-0.5244***	-0.4922***	-0.4881***
	(0.0990)	(0.0990)	(0.1083)	(0.1083)
Number of obs	21934	21934	17278	17278
Hansen J	3.797	2.302	1.175	1.189
P-value	0.150	0.316	0.556	0.552
Weak identification	179.736	181.990	171.612	167.965

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

Table 11 - The effect of retirement duration on word recall – by previous job characteristics

	FE-2SLS	FE-2SLS	FE-2SLS	FE-2SLS
	b/se	b/se	b/se	b/se
Retirement duration	0.4112***	0.4510***	0.4464***	0.4294***
	(0.1067)	(0.1072)	(0.1080)	(0.1064)
ret.dur.*skill development	0.0606*			
	(0.0315)			
ret.dur.*little freedom		-0.0323		
		(0.0301)		
ret.dur.*adequate salary			-0.0202	
			(0.0289)	
ret.dur.*gave recognition				0.0375
				(0.0320)
Age	5.2545**	5.0090**	4.9107**	5.1303**
	(2.3344)	(2.3310)	(2.3216)	(2.3363)
Age^2/100	-6.9231*	-6.5634*	-6.4383*	-6.7174*
	(3.6967)	(3.6923)	(3.6805)	(3.6978)
Age^3/10000	2.5831	2.4179	2.3710	2.4696
	(1.9330)	(1.9312)	(1.9268)	(1.9324)
couple	0.4382**	0.4448**	0.4426**	0.4444**
	(0.2126)	(0.2126)	(0.2127)	(0.2135)
smoke	-0.0150	-0.0148	-0.0155	-0.0148
	(0.1099)	(0.1099)	(0.1098)	(0.1099)
drink	-0.0863	-0.0807	-0.0791	-0.0779
	(0.1126)	(0.1125)	(0.1123)	(0.1126)
physical inactivity	-0.5798***	-0.5829***	-0.5869***	-0.5820***
	(0.1818)	(0.1818)	(0.1820)	(0.1821)
learning	0.2397*	0.2344*	0.2358*	0.2352*
	(0.1252)	(0.1252)	(0.1252)	(0.1253)
contextual factor	-0.6077***	-0.6128***	-0.6139***	-0.6062***
	(0.1327)	(0.1326)	(0.1325)	(0.1328)
Number of obs	11484	11484	11484	11484
Hansen J	2.501	0.322	0.675	0.089
P-value	0.286	0.851	0.713	0.957
Weak identification	72.630	72.024	74.440	70.602

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

Table 12 - 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	0.3828***	0.4290***	0.3090***
	(0.0663)	(0.0776)	(0.0783)
ret.dur.*still working	0.0049		
	(0.0277)		
ret.dur.*activities social		-0.0210	
		(0.0371)	
ret.dur.*reading books			0.1268**
			(0.0515)
Age	-1.4347	-2.6681*	-2.7553*
	(1.4211)	(1.6176)	(1.6186)
Age^2/100	4.2022*	6.2284**	6.4303**
	(2.3853)	(2.7471)	(2.7522)
Age^3/10000	-3.4264**	-4.6154***	-4.7553***
	(1.3435)	(1.5652)	(1.5704)
couple	0.1635	0.0487	0.0518
	(0.1442)	(0.1652)	(0.1650)
smoke	0.0610	0.0427	0.0400
	(0.0793)	(0.0994)	(0.0995)
drink	-0.1038	-0.1504	-0.1605
	(0.0856)	(0.1077)	(0.1075)
physical inactivity	-0.5329***	-0.5021***	-0.5082***
	(0.1422)	(0.1909)	(0.1911)
learning	0.2260**	0.2457**	0.2532***
	(0.0923)	(0.0973)	(0.0974)
contextual factor	-0.5223***	-0.4271***	-0.4295***
	(0.0990)	(0.1236)	(0.1237)
Number of obs	21934	14663	14663
Hansen J	0.286	0.943	1.656
P-value	0.867	0.624	0.437
Weak identification	169.449	155.822	154.717

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

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