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17 Patterns of cognitive ageing

- High school dropouts and retired individuals show a higher cognitive decline
- Decline in health and cognitive abilities are strongly correlated
- Mediterranean countries show a lower cognitive decline over the 4 years period
- Institutional differences only partially explain the convergence in cognitive levels in Europe

17.1 The determinants of cognitive decline

Ageing is often associated with cognitive decline. Schaie (1989) shows that cognitive impairment increases sharply after age 50, but also that cognitive functioning varies substantially across people at all ages. In fact, recent research in neuroscience (see van Praag et al. 2000 for a review) has questioned the idea that cognitive decline is inevitable and fixed.

Understanding whether individuals can at least partly offset "biological" age-related cognitive decline is especially relevant to social scientists. The reason is that cognitive abilities are fundamental for economic decisions and represent an important dimension of human capital, along with education, health and non-cognitive skills. A better understanding of the complex process of age-related neurodegeneration, and the role that individual choices may play, is also central to the agenda for the European Year of Active Ageing in 2012. Recent studies show that education (Banks & Mazzonna 2012) and retirement (Rohwedder & Willis 2010, Bonsang et al. 2012, Mazzonna & Peracchi 2012) causally affect the level of cognitive abilities and their rate of decline at older ages. These findings have important policy implications. For example, they imply that policies aimed at fostering labour force participation of older people may have large spillovers by reducing the loss of cognitive capital caused by early retirement.

The SHARE project represents a precious source of information on cognitive ageing. First, the cross-country dimension of the survey allows determining how cognitive decline varies in different institutional environments. Second, its longitudinal nature allows us to analyse how cognitive decline depends on behavioural and environmental factors while netting out the confounding effects of cohort differences and other time-invariant omitted effects. In fact, being able to observe the same individual over time (not only individuals of different ages in a single wave), allows us to directly relate changes in cognitive function at the individual level to observed behavioural and environmental changes.

The aim of this chapter is to investigate which factors help explain between- and within-country heterogeneity in the age-related decline of cognitive function. We focus on differences in test scores over the four-year period between Wave 2 (2006) and Wave 4 (2010) of SHARE. Consistently with the available literature, we show that gender, education, and employment status are important in explaining heterogeneity in the rate of cognitive decline. We also show that changes in cognitive abilities and changes in health status are strongly correlated, which suggests that a common underlying process of biological ageing may drive both changes (see Dal Bianco et al. in this volume for an analysis of influencing childhood factors). Finally, we show that there are large and systematic differences in the rate of cognitive decline across European countries. In the light of previous work (Mazzonna & Peracchi 2012), this result may be interpreted as evidence that cognitive abilities tend to converge across European countries as people age.

17.2 Cross-country differences in cognitive decline

We use data from the eleven European countries that participated both in Wave 2 and Wave 4 of SHARE. These countries represent different regions of Europe, from Scandinavia (Denmark, Sweden) through Central Europe (Austria, Belgium, Czech Republic, France, Germany, Netherlands, Switzerland) to Mediterranean countries (Italy, Spain). We consider all individuals who participated in Wave 2 and were between 50 and 80 years of age, irrespective of their labour force status. Our outcomes of interest are the level of cognitive test scores in 2006 and 2010 and the change in cognitive test scores between the two waves. We focus on two cognitive domains: recall and fluency. To ensure comparability with previous literature on cognitive decline (Rohwedder & Willis 2010, Banks & Mazzonna 2012, Bonsang et al. 2012), for recall we take the sum of the scores on immediate and delayed recall, while for fluency we take the raw score.

Table 17.1 presents, for each cognitive domain and for each country, the average test scores in Waves 2 and 4 (computed from the cross-sectional sample of respondents in each wave) and the average test score difference over the four-year period (computed from the longitudinal sample of respondents in both waves). For recall, the average test score difference over time is negative and statistically significant for four countries (Austria, Denmark, the Netherlands, and Sweden), positive but not statistically significant for two countries (Czech Republic and Germany), and positive and statistically significant for the other five countries. Similar evidence has been found by Zamarro et al. (2008) who analyse differences in test scores between the first and the second waves of SHARE. This result, which apparently contrasts with the hypothesis of an age-related decline in cognitive abilities, could arise for three not mutually exclusive reasons. The first is composition effects, namely the fact that our table does not take into account cross-country differences in the composition of the sample by age, gender, education, employment status, etc. The second is non-random attrition that selects individuals with lower test scores out of the panel. The third is learning effects due to repeated exposure of SHARE respondents to similar (but not identical, as the word lists to recall is different across waves) cognitive tests. For fluency, the evidence is instead more consistent with the hypothesis of an age-related decline. In fact, the average change is negative and strongly statistically significant for all countries except for the Czech Republic (where it is positive and statistically significant) and Denmark (where it is negative but not statistically significant).

Table 17.1: Average test score in Wave 2 and 4 and average test score difference for the longitudinal sample by country

	Recall				**Fluency**			
	Wave 2	Wave 4	Panel difference	(std. error)	Wave 2	Wave 4	Panel difference	(std. error)
Austria	9.71	8.86	−0.74***	(0.18)	21.57	19.64	−1.32***	(0.38)
Belgium	8.92	9.26	0.32**	(0.08)	20.66	19.94	−0.84***	(0.14)
Czech Rep.	8.44	8.89	0.02	(0.10)	19.23	21.90	−1.81***	(0.25)
Denmark	10.31	10.28	−0.24**	(0.08)	22.71	22.95	−0.03	(0.16)
France	8.33	9.33	0.69***	(0.08)	20.34	19.02	−1.99***	(0.17)
Germany	9.70	9.88	0.07	(0.11)	22.08	20.79	−1.74***	(0.23)
Italy	7.68	7.97	0.33**	(0.08)	15.50	15.07	−0.44**	(0.12)
Netherlands	9.79	9.84	−0.19*	(0.09)	20.70	20.32	−0.78**	(0.16)
Spain	6.48	6.78	0.40***	(0.10)	14.57	14.10	−0.49**	(0.22)
Sweden	9.99	9.77	−0.36***	(0.09)	23.71	22.50	−1.31***	(0.20)
Switzerland	9.62	10.13	0.44**	(0.11)	21.61	19.94	−0.01***	(0.22)
N	23,483	13,011	13,011		23,476	13,005	13,005	

Source: SHARE Wave 2 release 2.5.0, Wave 4 release 1

Table 17.1 also shows evidence of a positive cross-country relationship between initial levels and subsequent changes in average test scores. This largely reflects the fact that the two Mediterranean countries, Spain and Italy, show lower initial levels but also lower declines or larger improvements of test scores for both cognitive domains.

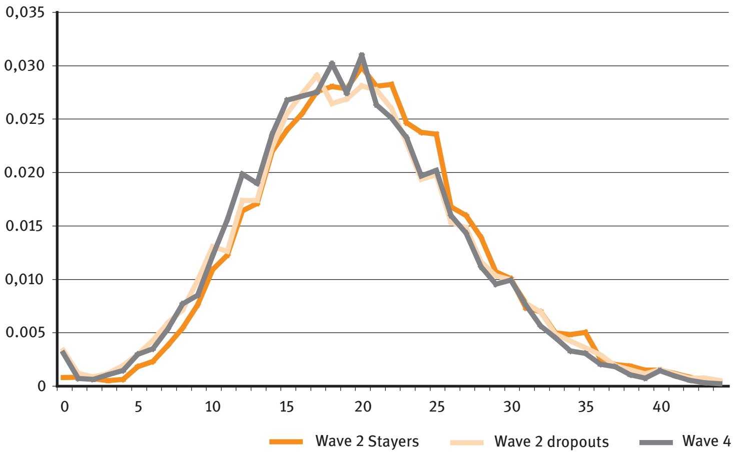
Although interesting, the descriptive evidence reported so far suffers of two main limitations: *i)* it does not take into account differences across countries in the composition of the sample by age, gender, education, employment status, etc., which may drive the cross-country differences in average test scores; and *ii)* just looking at differences in test scores might not be the best way to analyse the changes in cognitive abilities associated with ageing. Looking at differences, either absolute or relative, places too much emphasis on the cardinal interpretation of test scores. Therefore, we prefer to focus on cognitive rank changes, namely changes in the relative position of an individual in terms of test scores. In the next section we address both issues by showing the results from a regression analysis based on cognitive rank changes across waves.

17.3 Education, retirement and cognitive decline

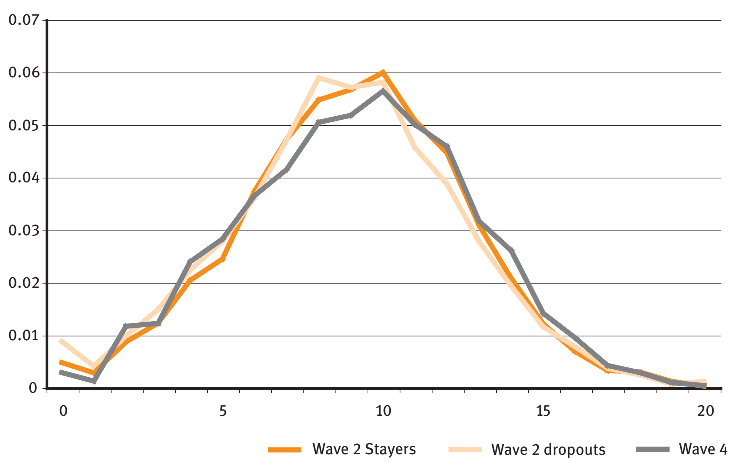
Figure 17.1 separately presents the density of test scores in the two waves, differentiating by cognitive domain. Respondents in Wave 2 are split into those who also participated in Wave 4 ("Wave 2 stayers") and those who left the panel ("Wave 2 dropouts"). Results are different for recall and fluency. In the case of recall, the density in Wave 2 dropouts is to the left of the density in Wave 2 stayers, suggesting non-random attrition that selects individuals with lower test scores out of the sample. For stayers, there is also evidence of a mean-preserving spread in the distribution of test scores as we move from Wave 2 to Wave 4, suggesting increasing dispersion with age. In the case of fluency, instead, we see little evidence of a difference between the density of stayers and dropouts in Wave 2, while the density of stayers shifts to the left between the two waves suggesting an overall worsening of test scores as individuals age.

Figure 17.1 tells us nothing about changes in the rank of individuals over the four-year period. Going from Wave 2 to Wave 4, the rank of each respondent may change: a positive change in rank indicates that his/her relative position improved, while a negative change indicates that his/her relative position worsened.

To simplify the analysis and to ensure comparability across cognitive domains, we look at cognitive rank changes between the two waves and focus on decile rank changes. We investigate which variables (gender, age, education, etc.) help predict decile rank changes and in which direction. Thus, we first classify individuals into ten equally-sized classes, or deciles, depending on their relative position in terms of test scores. We then consider regression models for changes in decile rank between the two waves. Although the outcome variable is discrete, ranging between –9 and 9 (with zero corresponding to no change), little is lost by using ordinary least squares. The results of our regression analyses are shown in Tables 17.2 and 17.3 for recall and fluency respectively.



Panel (A)



Panel (B)

Figure 17.1: Density of fluency (panel A) and recall (panel B) by wave and panel participation: Wave 2 respondents are split between those who also participated in Wave 4 (Wave 2 stayers, N=13,005) and those who left the panel (Wave 2 dropouts, N=10,472)
Source: SHARE Wave 2 release 2.5.0, Wave 4 release 1

Table 17.2: OLS regression for rank changes in the recall test between Wave 2 and 4 (model E and E1 are conditional on being employed in Wave 2)

	Model A		**Model B**		**Model E**		**Model E1**	
	Coefficients	Std. Error	Coefficients	Std. Error	Coefficients	Std. Error	Coefficients	Std. Error
female	−0.073**	(0.048)	−0.074**	(0.048)	0.162	(0.143)	0.152	(0.142)
age	−0.024***	(0.004)	−0.024***	(0.004)	−0.005	(0.026)	−0.004	(0.026)
age^2	−0.000	(0.000)	−0.000	(0.000)	0.000	(0.002)	0.000	(0.002)
HS	0.051	(0.060)	0.053	(0.061)	−0.001	(0.116)	0.002	(0.116)
college	0.236***	(0.069)	0.241***	(0.069)	0.067	(0.121)	0.062	(0.121)
employed (wave2)	0.153**	(0.072)	0.158**	(0.072)				
SRH			−0.011	(0.054)				
ΔSRH			0.062***	(0.023)			0.302**	(0.141)
still employed					0.318**	(0.141)	0.350**	(0.180)
still employed* female					−0.354*	(0.180)	−0.362***	(0.111)
N	13,011		13,011		3,807		3,807	

Significance: *** = 1 %; ** = 5 %; * = 10 %
Notes: Each regression includes also a full set of country dummies.
Source: SHARE Wave 2 release 2.5.0, Wave 4 release 1

Table 17.3: OLS regression for rank changes in the fluency test between Wave 2 and 4 (model E and E1 are conditional on being employed in Wave 2)

	Model A		**Model B**		**Model E**		**Model E1**	
	Coefficients	Std. Error	Coefficients	Std. Error	Coefficients	Std. Error	Coefficients	Std. Error
female	0.053	(0.046)	0.053	(0.046)	0.200	(0.137)	0.192	(0.137)
age	−0.028***	(0.004)	−0.028***	(0.004)	0.000	(0.022)	0.001	(0.021)
age2	−0.001	(0.000)	−0.001	(0.000)	0.001	(0.001)	0.001	(0.001)
HS	−0.002	(0.058)	−0.000	(0.058)	−0.050	(0.110)	−0.048	(0.110)
college	−0.008	(0.065)	−0.005	(0.065)	−0.029	(0.112)	−0.032	(0.112)
employed (Wave2)	0.011	(0.069)	0.014	(0.070)				
SRH			−0.020	(0.052)				
ΔSRH			0.287***	(0.046)			0.288***	(0.104)
still employed					0.233*	(0.135)	0.217*	(0.129)
still employed* female					−0.133	(0.171)	−0.124	(0.111)
N	13,005		13,005		3,796		3,796	

Significance: *** = 1 %; ** = 5 %; * = 10 %
Notes: Each regression includes also a full set of country dummies.
Source: SHARE Wave 2 release 2.5.0, Wave 4 release 1

Our baseline specification (Model A) includes a constant, a quadratic age term, an indicator for being a female, indicators for high school (HS) and college degree, an indicator for being employed in Wave 2, and a full set of indicators for the country of residence. The estimates from this model show evidence of a negative effect of age for both cognitive domains, implying that older people tend to lose their position relative to younger people over a four-year period. The age effect is stronger for fluency than for recall. Gender and education are important for recall, with men improving their position relative to women and college graduates relative to people with lower education. However, these gender and education effects are not seen for fluency. Finally, the coefficient on being employed in Wave 2 is always positive, but is large in size and statistically significant only for recall.

Model B controls for health status by adding to Model A a binary indicator (SRH) for the initial level of self-rated health (equal to 1 for individuals reporting to be in good or very good health) and its change between the two waves (ΔSRH). This specification provides evidence on the relationship between health and cognitive abilities over time. For both recall and fluency, only changes in health – not their levels in the initial wave – help predict cognitive rank changes across waves. One possible explanation for this result is that a common underlying biological process determines the age-profiles of health and cognitive abilities. In addition, the correlation between health changes and cognitive rank changes appears to be stronger for fluency than for recall.

The last two specifications (Models E and E1) study the effect of retiring between the two waves by restricting attention to those who were employed in Wave 2. In addition to the predictors in Model A, Model E includes an indicator for being employed in Wave 4 ("still employed") and its interaction with gender. For both cognitive domains, the effect of age now vanishes while the effect of being still employed in Wave 4 is positive and statistically significant, although only for men. The latter result is consistent with previous cross-sectional evidence based on the first wave of SHARE (Rohwedder & Willis 2010, Mazzonna & Peracchi 2012). The different result for women may depend on the strong selection effect produced by conditioning on being employed in Wave 2 (only 25 % of women were employed). The results from Model E are robust to the inclusion of an indicator for the change in self-rated health over our four-year period in Model E1. Including this variable is important in order to control for the potential bias caused by omitting health shocks.

Although we cannot claim that the coefficients on being still employed in Models E and E1 represent estimates of the causal effect of retirement on cognitive abilities, using the longitudinal dimension of SHARE allows us to control for time-invariant effects whose omission might bias the relationship between retirement and changes in cognitive abilities.

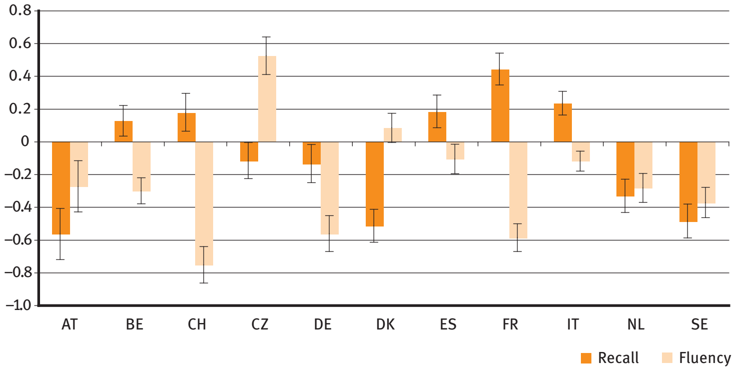


Figure 17.2: Estimated rank changes in test scores by country for a retired aged-65 high-school male dropout
Notes: N=13,011 (Recall); 13,005 (Fluency)
Source: SHARE Wave 2 release 2.5.0, Wave 4 release

Finally, Figure 17.2 shows the coefficients for the countries from Model A. These represent estimates of the cognitive rank changes for the reference individual in each country, namely a retired aged-65 high-school male dropout. The figure confirms the descriptive evidence of a process of convergence in cognitive abilities among countries. In fact, respondents from Scandinavian and (partially) Central European countries – who display higher levels of cognitive abilities in Wave 2 – are also those with a higher probability of lowering their rank over our four-year period.

17.4 Discussion: what policy intervention can(not) do

The longitudinal evidence on changes in cognitive abilities over the four-year period between Wave 2 (2006) and Wave 4 (2010) of SHARE confirms and extends the evidence based on Wave 1 (2004) and on changes between Wave 1 and 2.

Education and employment status are important predictors, not only of the level of cognitive scores as already pointed out in the literature (e. g. Banks & Mazzonna 2012; Mazzonna & Peracchi 2012), but also of their age-related decline. We find some evidence that this decline is stronger for fluency than for recall. The correlation between cognitive rank changes and changes in self-rated health also appears to be stronger for fluency than for recall. Finally, Mediterranean countries show lower rates of cognitive decline relative to other European countries, suggesting a process of convergence across countries as people age.

Our results show that this convergence process is only partially explained by differences in education and retirement status, which are clearly influenced by differences in public policies and institutions (see for instance the cross-country study in Gruber and Wise 1999 on the importance of differences in retirement policies). For this reason, future research should focus on other determinants of the observed differences between and within countries in the age profiles of cognitive abilities, such as differences in behaviour and life-style, or more simply biological processes that lead to a sort of convergence as people age.

Although the longitudinal nature of SHARE has the advantage of allowing us to control for time-invariant omitted effects, more research is needed to uncover causal relationships from the available data. In particular, as for most household panel surveys, attrition in SHARE is an important concern because it may affect the quality of the inference that can be obtained from the data.

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