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Research Article

Cross-national Differences in the Association Between Retirement and Memory Decline

Jana Mäcken, PhD,[1,*] Alicia R. Riley, PhD,[2] and Maria M. Glymour, ScD[2]

[1]Institute of Sociology and Social Psychology, University of Cologne, Albertus-Magnus-Platz, Germany. [2]Department of Epidemiology and Biostatistics, University of California San Francisco, USA.

*Address correspondence to: Jana Mäcken, PhD, University of Cologne, Albertus-Magnus-Platz, 50973 Cologne, Germany. E-mail: maecken@wiso.uni-kolen.de

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Abstract

Objective: Retirement is a potential trigger for cognitive aging as it may be a stressful life event accompanied by changes in everyday activities. However, the consequences of retirement may differ across institutional contexts which shape retirement options. Comparing memory trajectories before and after retirement in 17 European countries, this study aims to identify cross-national differences in the association between retirement and memory decline.

Method: Respondents to the longitudinal Survey of Health, Aging, and Retirement in Europe (SHARE; N = 8,646) aged 50+ who were in paid work at baseline and retired during the observation period completed up to 6 memory assessments (immediate and delayed word recall) over 13 years. Three-level (time points, individuals, and countries) linear mixed models with country-level random slopes for retirement were estimated to evaluate whether memory decline accelerated after retirement and if this association differed between countries.

Results: On average, retirement was associated with a moderate decrement in word recall (b = −0.273, 95% CI −0.441, −0.104) and memory decline accelerated after retirement (b = −0.044, 95% CI −0.070, −0.018). Significant between-country heterogeneity in memory decline after retirement existed (variance = 0.047, 95% CI (0.013, 0.168). Memory decline after retirement was more rapid in Italy, Greece, Czech Republic, Poland, Portugal, and Estonia compared to Northern and Central European countries.

Discussion: Memory decline postretirement was faster in Mediterranean and eastern European countries, which are characterized by less generous welfare systems with comparatively low pension benefits. Evaluation of resources that could protect retirees from memory decline would be valuable.

Keywords: Cognition, Country comparison, Europe, Longitudinal, SHARE

Preserving memory is essential for healthy aging. Memory loss is associated with depression, physical health declines, and dementia (Celidoni et al., 2017; Fisher et al., 2014; González et al., 2008; Salthouse, 2012; Xue et al., 2018). Identifying factors associated with memory decline is critical to enable independent living at older ages and to ensure the sustainability of social security systems. Retirement may trigger memory loss because it can be stressful and change everyday activities (Bonsang et al., 2012; Clouston & Denier, 2017; Hessel, 2016; Mazzonna & Peracchi, 2017). Most European countries have recently increased statutory retirement ages, highlighting the importance of evaluating whether delayed retirement affects later life memory trajectories (Bianchini & Borella, 2016). However, institutional contexts that determine retirement options differ across countries and may moderate associations between retirement and memory decline.

The literature offers two primary mechanisms by which retirement may influence cognitive aging. First,

retirement is a major life transition associated with changes in everyday activities and social roles, which might create stress and, in turn, influence memory (Atchley, 1989; Elder, 1994). Second, the "use-it-or-lose-it" hypothesis suggests that departure from the labor force reduces cognitive demands and thereby triggers cognitive aging (Clouston & Denier, 2017; Rohwedder & Willis, 2010). Available evidence on this question is mixed. Many prior studies found that retirement was associated with cognitive decline (Atalay et al., 2019; Bonsang et al., 2012; Clouston & Denier, 2017; Coe & Zamarro, 2011; Mazzonna & Peracchi, 2012, 2017; Xue et al., 2018), but other studies found no or inconsistent effects (Denier et al., 2017; Starke et al., 2019) or even cognitive benefits of retirement (Bianchini & Borella, 2016). These inconsistencies may reflect methodological challenges. Some studies compared retirees with workers, which may introduce bias because people who continue to work at older ages likely differ systematically from those who retire early (Xue et al., 2018). This healthy worker selection effect results in more negative findings for the retiring group (Bonsang et al., 2012; Coe & Zamarro, 2011; Mazzonna & Peracchi, 2012).

Although some research used statutory pension ages as instrumental variables (IVs) for retirement age (Bianchini & Borella, 2016; Celidoni et al., 2017; Coe & Zamarro, 2011; Mazzonna & Peracchi, 2012, 2017), the validity of this method depends on whether cross-national differences in statutory pension ages are correlated with other national differences that affect health (Xue et al., 2018). While previous research on the association between retirement and memory decline has not focused on between-country differences, the retirement–memory association appears to differ across institutional contexts (Bergqvist et al., 2013). Diverse institutional opportunities and the constraints of welfare state regulations may influence the stressfulness of retirement transitions; some countries may offer more flexible retirement options and more supportive social policies affecting retirees (Bergqvist et al., 2013). Hence, retirement may be more stressful in some countries with less generous pensions and such stress might accelerate memory decline.

Thus, this study examines (a) how retirement affects memory decline and (b) if this association varies among 17 European countries. The focus is on episodic memory, considered an early harbinger of broader cognitive declines and increased dementia risk (Salthouse, 2012; Starke et al., 2019; Zulka et al., 2019). This study advances previous research in several ways. First, it is among the first studies to investigate country differences in the association between retirement and memory decline. Second, the study is based on longitudinal data from the Survey of Health, Aging, and Retirement in Europe (SHARE) covering a long observation period of 13 years before and after retirement, which enables the possibility to analyze short as well as long-term decline after retirement. Finally, the use of linear mixed models and attention to occupational characteristics allows for analysis of within-person change before and after retirement, which isolates changes related to retirement itself (Zulka et al., 2019).

Retirement as Stressful Life Event

Retirement can be a stressful life event (Elder, 1994). For older adults who have been employed during most of adulthood, retiring from one's job is a milestone, marking a transition into later life and a shift in identity (Kim & Moen, 2002). *Continuity theory* emphasizes that individuals try to maintain consistency in life patterns over time and, to the extent that it disrupts these patterns, retirement stressful (Atchley, 1989). Moreover, from a *role theory* perspective, retirement is a major role transition on the personal level, and in relation to society in that individuals shift from contributing to social security systems to a receiver/beneficiary role. Therefore, retiring and losing one's work identity as well as experiencing changes in everyday activities might be associated with feelings of role loss and psychological distress. Stress may lead to dysregulation of homoeostatic processes and a weakening of neuronal structures, especially in the hippocampal brain region which leads to cognitive impairments and decline (Andel et al., 2015).

The stress mechanism linking retirement to cognitive aging likely varies depending on the institutional context. Individuals from different European countries face diverse institutional opportunities and welfare state regulations, which shape retirement options. Social policies that protect against major vulnerabilities, such as old-age poverty, by providing more generous pensions should make the retirement transition less stressful and hence, might be protective against memory decline. According to the Epsing-Andersen typology, countries can be classified as *liberal*, *conservative*, or a *social-democratic* welfare regimes based on the degree to which "a person can maintain a livelihood without reliance on the market" (also known as de-commodification), the intensity of resource redistribution, and the level of universalism that is imposed by the welfare state (Esping-Andersen, 1990; Kim, 2009). Countries with low levels of de-commodification and limited universalism are classified as *liberal* welfare states (e.g., UK and United States). Most people in *liberal* welfare states may have additional private pensions above the basic pensions (Kammer et al., 2012). *Conservative* welfare states (e.g., Germany, Austria, France, Belgium, Netherlands, Switzerland) encourage family and corporate responsibilities and social stratification is limited to status preservation. They have generous pension schemes, but entitlements are linked to previous contributions and the redistributive effect is low. *Social-democratic* welfare states (e.g., Sweden, Denmark) emphasize comprehensive social protection with egalitarianism (Esping-Andersen, 1990). Extensive public social security pensions are provided leading to higher distributional effects. Esping-Andersen's typology has been extended to include *Mediterranean*

countries (Spain, Portugal, Greece, Italy, Israel) (Ferrera, 1996) and *eastern European* countries (Kääriäinen & Lehtonen, 2006). *Mediterranean* countries are characterized by low degrees of de-commodification and limited universalism. The family is of high importance and minimum income schemes are rare. The welfare system is less developed with low levels of redistribution and pension benefits are determined by wage contributions (Kammer et al., 2012). In *eastern European* states (Czech Republic, Estonia, Poland, Slovenia), universalism is still widespread but the degree of de-commodification is low (Kääriäinen & Lehtonen, 2006). Public pensions are low even with high levels of redistribution.

It follows that the transition to retirement may be less stressful in *social-democratic* followed by *conservative* welfare regimes as they protect against socioeconomic vulnerabilities through more generous benefits, which may in turn protect against memory decline. Thus, it is reasonable to suspect that retirement is a more stressful event in *Mediterranean* and *eastern European* countries where public pensions are less generous and retirement may be more stressful, which might accelerate memory decline.

Previous research has shown that more generous social welfare policies and benefits are associated with better population health (Bergqvist et al., 2013). Other studies found that higher coverage rates and higher social spending are associated with better self-rated health (Álvarez-Gálvez & Jaime-Castillo, 2018; Ferrarini et al., 2014). Yet, to our knowledge, none of these studies analyzed memory decline as an outcome. While other research has shown that country differences in memory decline exist, scholars have yet to investigate how retirement is associated with country differences (Cadar et al., 2017; Formanek et al., 2019). The cross-country comparative design we employ in this study is a promising approach for clarifying the effects of retirement on memory decline. We test the hypothesis that memory decline varies across countries because retirement options and social policies differ among countries in accordance with the Epsing-Andresen typology, making retirement a more stressful event in countries offering fewer options and less support.

The Use-It-or-Lose-It Hypothesis

Another mechanism by which retirement may contribute to memory decline is captured in the use-it-or-lose-it hypothesis. According to the "use-it-or-lose-it" hypothesis, intellectual activity and mental challenges are needed to maintain memory functioning (Salthouse, 2012). When retirees leave the labor force—which frequently requires regular "use" of cognitive capacities—and adopt a sedentary retirement lifestyle, they will "lose" cognitive abilities (Denier et al., 2017; Hultsch et al., 1999). This hypothesis assumes that the workplace is a more challenging environment which stimulates cognition, such that retiring implies losing stimulation and potentially triggering memory decline (Rohwedder & Willis, 2010).

The use-it-or-lose-it mechanism may be more influential in countries with larger service sectors as service sector work is more mentally demanding than production industries (Ochel, 2001). The share of people working in mentally demanding jobs, for example, in public, administration, defense, education, human health, and social work activities, is the highest in *social-democratic*, followed by *conservative* welfare regimes (Eurostat, 2017). Physically demanding work, for example, in agriculture, forestry, and fishing, is more common in *Mediterranean* and *eastern European* regimes (Eurostat, 2020).

Previous Findings on Retirement and Memory Decline

Previous evidence on the association between retirement and memory decline is mixed. Starke and colleagues (2019) found no differences in episodic memory decline before and after retirement in England. Xue and colleagues (2018) found that episodic memory decline became faster after retirement among English civil servants, but decline in other cognitive domains did not accelerate. Other studies found that retirement was associated with a more rapid decline in episodic memory in the United States and Australia (Atalay et al., 2019; Clouston & Denier, 2017). In contrast, Denier and colleagues (2017) found no association between retirement and episodic memory, and abstract reasoning was better after retirement compared to before retirement in the United States. Another body of literature has looked at the causal impact of retirement on cognition using an instrumental-variable approach. Bonsang and colleagues (2012) used social security eligibility ages as instrument for retirement within the American HRS and showed a 9% reduction in episodic memory shortly after retirement. Likewise, Mazzonna and Peracchi (2017) found a negative effect of retirement in Europe using early and statutory retirement ages as IVs, and the effects became larger as the number of years spent in retirement increased. In contrast, two other studies using SHARE with 4 years of additional follow-up and using eligible retirement age as an instrument found a positive effect of retirement on episodic memory (Bianchini & Borella, 2016; Celidoni et al., 2017). These differences across studies can be partly attributed to adjustment for prior occupational characteristics, which slightly decreased the effect of retirement on memory decline (Zulka et al., 2019). Moreover, studies based on American data (HRS, WLS) more frequently reported negative results than studies based on the European SHARE. A meta-analysis adjusting for different study designs did not find convincing evidence that differences in the results were due to variations in study characteristics (Zulka et al., 2019). However, none of these studies considered how variations between countries in the relationship of retirement and memory decline might explain the diverse results.

According to both the stressful life event hypothesis and the use-it-or-lose-it hypothesis, retirement should

accelerate memory decline. However, the stressful life event hypothesis might be more suitable for explaining short-term memory decline. Individuals' may adjust to retirement and the resulting change in social roles after a certain period of time. In contrast, the "use-it-or-lose-it" hypothesis might explain more constant, long-term effects in memory decline.

Data and Method

Data

This study used longitudinal data from the Survey of Health, Aging, and Retirement in Europe (SHARE). The survey followed participants aged 50+ (Börsch-Supan et al., 2013). Starting with the first wave in 2004 and 2005 in 11 European countries and Israel, follow-ups were conducted biennially through 2017. Data collection based on computer-assisted personal interviews and sampling strategies varied by country. Further countries and refreshment samples were added constantly to increase sample size and compensate for attrition.

We used data from six waves (1, 2, 4, 5, 6, 7), covering an observation period from 2004 to 2017. Although SHARE has included 28 countries to date, our analytical sample includes 17 countries (two Northern, six Central, four Eastern European, and five Mediterranean countries) who were part of the longitudinal SHARE sample and had a sufficient number of retirement transitions. Respondents in the analytic sample were aged between 50 and 78, were in paid work at the first observation, and retired during the observation period (see Figure 1) so we could assess within-person memory changes both before and after retirement. The analytic sample consisted of 8,646 respondents, 49% female and 51% male, and 35,285 observations with on average 4.1 observations per respondent and 2.2 postretirement observations.

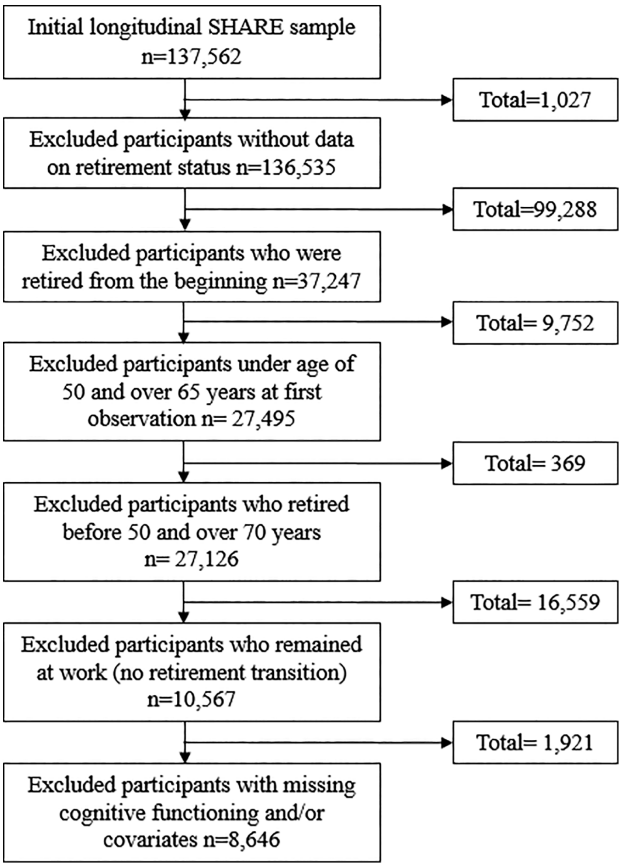

Figure 1. Flowchart of sample selection process.

Memory Functioning

Episodic memory was measured with immediate and delayed 10-word recall (Harris & Dowson, 1982). The test focused on episodic memory abilities and consisted of the verbal registration and recall of a list of 10 words. Respondents listened to the list of words once and were asked to recall them immediately after the encoding phase, and again after a delay time of about 5 min. In Waves 1 and 2, all respondents got the same list of words and from Wave 4 onwards, respondents were randomly assigned one of four different word lists. A sum score over immediate and delayed word recall was built ranging from 0 to 20 (Celidoni et al., 2017; Starke et al., 2019).

Retirement and Retirement Age

The respondent's current job situation was measured by self-report in every wave. Respondents were classified as retired if they exited work. Thus, they could change from paid work to retirement directly or they could report themselves to be unemployed, disabled, or a homemaker at one wave and retired at a subsequent wave. In cases of retirement or unemployment, respondents reported the year of the event. For homemakers and permanently disabled persons, the interview year the employment transition was first reported was used. Retirement age was calculated based on the year of retirement. Retirement transitions were coded with a indicator variable changing from 0 to 1 once a respondent retired. Each respondent's age was centered around that person's individual retirement age (i.e., age at retirement was coded 0 years) and was included as a covariate. Possible period effects were considered by adjusting for the mean-centered birth year.

Covariates

Analyses were adjusted for education and gender which were reported at baseline. Educational categories were classified according to the International Standard Classification of Education (ISCED-97) and recoded into low (ISCED 1, 2), medium (ISCED 3, 4), and high (ISCED 5, 6). We also controlled for respondents' marital status (married vs not married) and having difficulty to make ends meet measured at baseline. Respondents' health status was adjusted with time-varying assessments of: self-reported health status

(SRH), the EURO-D depression scale, and comorbidities. SRH was captured on a 5-point scale ranging from 1 (excellent) to 5 (poor). The EURO-D scale is a count of how many of 12 depressive symptoms the participant endorses (Hoven et al., 2015). Respondents were shown a list of 17 chronic conditions ranging from a heart attack or stroke, to diabetes or hip fractures and asked "Has a doctor ever told you that you had any of the following conditions." We defined the presence of comorbidities as reporting more than one chronic condition.

We also adjusted for preretirement work-related stress, which was measured with the effort–reward imbalance model (ERI) (Siegrist et al., 2004) and the low job control model (Karasek et al., 1998). ERI was assessed with seven items in total, two on effort and five on reward. The ERI was defined by the ratio of the sum score of effort items (numerator) divided by the sum score of reward items (denominator) adjusted for the number of items (Siegrist et al., 2014). A higher score indicated a greater ERI. Low job control was measured with an index of two questions about job autonomy and further training. The index ranges from 2 to 8, with higher scores indicating lower job control. To address missing values in the work-related stress questions due to changed filters in Wave 5, data were imputed based on the values of a previous or later wave. To minimize any influence from practice effects, a dummy was included, which was 0 for the wave when a respondent took the test for the first time and 1 for all subsequent assessments (Vivot et al., 2016).

Statistical Analysis

To analyze the association between retirement and memory decline, we estimated a linear mixed model (LMM). Three different levels were considered: time points (Level 1) were nested in respondents (Level 2), who were nested within countries (Level 3). Respondents' age was centered at the individual retirement age and, thus, measured the within-person change as the person approached retirement and in the years following retirement (range= −13 to 14). The between-person differences were measured by including the retirement age (not centered) in the model (Curran & Bauer, 2011). An interaction between retirement status and respondents' centered age-at-retirement was included to measure the slope after retirement (i.e., this variable was zero for all years prior to retirement and represented the difference in rate of memory change after retirement compared to before retirement). Country differences were analyzed by specifying random slopes for: retirement status, centered age-at-retirement, and the slope after retirement (interaction between Retire*Centered age) at the country level. We visualized between-country differences using caterpillar plots for each country's predicted deviation from the overall average.

Sensitivity Analysis

We conducted several sensitivity analyses to assess the robustness of the results. To adjust for time-varying treatment (retirement) and confounding due to changes in health and work-related stress which may precede memory decline, a marginal structural model was used. In this approach, logistic regressions were estimated to predict the probability of retirement at t with time-lagged covariates at $t-1$ for each individual (Robins et al., 2000). The predictive probabilities of these two models were used to generate inverse probability of treatment weights that were applied in the analysis so that the distribution of the confounders was independent of the exposure and to generate an unbiased estimate of the association between retirement and cognitive functioning (Cole & Hernán, 2008; Pool et al., 2018). To assess potential bias to the results due to reverse causality, we also excluded 955 respondents from the analytic sample who retired for health reasons (Xue et al., 2018). In addition, analyses were estimated separately by gender.

Results

Participants' Characteristics

At baseline, the average word recall over all countries was 10 words, with the lowest being 8 words in Portugal and Spain, and the highest being 11 words in Austria and Denmark (see Table 1). Average retirement age was 61.6 years: lowest in Slovenia and highest in Sweden.

Multivariable Findings

In LMMs adjusted for age, gender, education, health, work-related stress, and financial difficulties, retirement was associated with a moderate decline in word recall (β = −0.273, 95% CI −0.441, −0.104) (see Table 2). The centered age-at-retirement indicated that prior to retirement, the age-slope for memory was slightly positive but close to null (β = 0.033, 95% CI 0.004, 0.061), but after retirement the age-slope significantly declined (β= −0.044, 95% CI −0.070, −0.018). Individuals with a later retirement age averaged better word recall with the estimated effect of delaying retirement by a year (β = 0.045, 95% CI 0.026, 0.063) almost equal and opposite the annual effect of being retired.

We found significant between-country variability in the random coefficients for retirement, the age-slope prior to retirement, and the age-slope after retirement (see caterpillar plots of the country-level random-effect estimates in Figure 2). Retirement had a more negative association with memory in most eastern European and Mediterranean countries (with the exception of Poland, Slovenia, and Spain) compared to the overall average effect of retirement (see Figure 2A). No clear pattern in the preretirement age-slope of memory existed across countries, although there was substantial heterogeneity (see Figure 2B) with the fastest decline in Greece and Estonia and the slowest decline in Czech Republic, Belgium, and France.

The caterpillar plot representing the change in the slope before compared to after retirement (see Figure 2C) indicated significant between-country heterogeneity

Table 1. Sample Characteristics at Baseline, by Country

Country	*N*	Word recall *M* (*SD*)	Retirement age *M* (*SD*)	Statutory retirement age (2017) *M*	Baseline age *M* (*SD*)	Low education %	Medium education %	High education %	Female %	Married %
Social-democratic										
Sweden	860	10.6 (2.8)	64.2 (2.4)	65.00	58.6 (3.5)	33.5	33.6	32.9	54.1	82.8
Denmark	637	11.0 (2.9)	62.4 (3.2)	65.00	57.3 (3.7)	8.8	38.3	55.4	53.4	77.4
Conservative										
Austria	504	11.0 (3.6)	60.0 (3.1)	62.50	56.4 (3.5)	14.3	50.8	34.9	53.4	70.4
Belgium	885	10.3 (3.1)	60.4 (3.4)	64.50	55.8 (3.6)	31.1	31.6	37.3	45.2	76.8
Germany	529	10.5 (2.8)	62.6 (3.0)	65.00	57.6 (3.7)	7.0	53.7	39.3	51	84.7
France	811	9.8 (3.1)	60.2 (3.0)	62.00	55.5 (3.3)	23.6	44.8	31.7	49	72.5
The Netherlands	397	10.2 (3.2)	61.7 (3.0)	65.00	57.7 (3.3)	36.0	24.9	39.0	41.1	89.2
Switzerland	549	11.0 (3.0)	63.3 (2.9)	64.50	58.8 (3.7)	20.6	62.7	16.8	48.6	76
Mediterranean										
Greece	465	9.4 (2.9)	63.1 (3.7)	65.00	56.5 (3.8)	39.6	34.8	25.6	33.8	84.1
Israel	354	9.0 (3.0)	63.1 (4.0)	65.00	58.1 (3.6)	24.6	38.1	37.3	59.6	86.7
Italy	445	8.8 (3.0)	60.3 (3.7)	62.50	56.1 (3.7)	53.3	33.5	13.3	39.3	88.1
Portugal	85	8.0 (3.0)	60.9 (3.8)	65.00	58.8 (4.1)	78.8	9.4	11.8	61.2	82.4
Spain	505	8.0 (3.3)	62.1 (3.5)	65.00	57.5 (4.1)	66.3	16.8	16.8	37.2	87.5
Eastern European										
Poland	233	8.7 (3.2)	59.3 (3.5)	62.50	55.0 (3.2)	18.9	67.8	13.3	52.8	87.6
Czech Republic	684	10.1 (3.1)	60.3 (2.8)	64.25	57.2 (3.1)	39.3	47.2	13.5	54.2	77.6
Estonia	518	10.0 (3.2)	62.1 (3.4)	63.00	59.8 (3.4)	14.9	59.7	25.5	55.2	67
Slovenia	185	9.9 (3.2)	59.1 (2.9)	64.00	56.2 (2.7)	16.2	61.6	22.2	47.6	80
Total	8,646	10.0 (3.2)	61.6 (3.5)	63.85	57.2 (3.8)	29.0	41.7	29.4	48.9	79.5

Country	Self-rated health	Depressive symptoms	Comorbidity	ERI	Low job control	Difficulty to make ends meet
Social-democratic						
Sweden	2.3 (0.96)	1.7 (1.7)	30	0.95 (0.41)	3.8 (1.3)	10.3
Denmark	2.2 (0.98)	1.6 (1.8)	34.5	0.96 (0.40)	3.8 (1.4)	10
Conservative						
Austria	2.5 (0.99)	1.7 (1.8)	28	0.99 (0.44)	4.4 (1.5)	15.9
Belgium	2.6 (0.94)	2.3 (2.1)	33.7	0.98 (0.47)	4.3 (1.4)	21.9
Germany	2.8 (0.96)	1.7 (1.8)	28.9	1.02 (0.47)	4.1 (1.4)	18.3
France	2.7 (0.99)	2.4 (2.0)	27.9	0.97 (0.46)	4.3 (1.6)	29.2
The Netherlands	2.6 (1.0)	1.6 (1.7)	22.9	0.87 (0.31)	3.9 (1.1)	12.8
Switzerland	2.4 (0.93)	1.8 (1.7)	23	0.86 (0.37)	4.0 (1.3)	10

Table 1. Continued

Country	*N*	Word recall	Retirement age	Statutory retirement age (2017)	Baseline age	Low education	Medium education	High education	Female	Married
		M (*SD*)	*M* (*SD*)	*M*	*M* (*SD*)	%	%	%	%	%
Mediterranean										
Greece	2.5 (0.84)		1.5 (1.8)	22.4		1.11 (0.46)	4.7 (1.4)		64.9	
Israel	2.7 (1.1)		2.0 (1.9)	37		0.97 (0.40)	4.5 (1.3)		53.7	
Italy	2.7 (0.96)		2.1 (2.0)	27		1.14 (0.49)	4.7 (1.5)		53.9	
Portugal	3.6 (0.76)		2.7 (2.5)	50.6		1.09 (0.44)	4.5 (1.3)		64.7	
Spain	2.8 (0.91)		1.9 (2.1)	27.5		0.99 (0.39)	4.6 (1.3)		45.3	
Eastern European										
Poland	3.3 (0.92)		2.9 (2.2)	32.6		1.11 (0.44)	5.0 (1.3)		67.8	
Czech Republic	3.0 (0.92)		1.7 (1.9)	33		1.07 (0.43)	4.6 (1.2)		47.2	
Estonia	3.7 (0.81)		2.6 (2.0)	40		1.02 (0.40)	4.6 (1.3)		43.8	
Slovenia	2.9 (0.91)		1.9 (1.6)	25.9		1.05 (0.49)	4.5 (1.2)		51.9	
Total	2.7 (1.0)		2.0 (1.9)	30.2		0.99 (0.44)	4.3 (1.4)		31.1	

(variance = 0.0012, 95% CI 0.0003, 0.005), with the fastest increase in cognitive decline after retirement observed in Denmark, Austria, Belgium, and Sweden, and the slowest decline in Estonia, Israel, and Greece. Few of the country-specific estimates were significantly different from the overall average estimate, however.

Considering both the fixed- and random-effects predictions (Figure 3), words recalled was associated with a deterioration in memory after retirement in all countries, but to different extents. The decline in memory after retirement was moderate in *Social-democratic* and *Conservative* welfare regimes and stronger in *Mediterranean* and *eastern European* countries. In Italy, Greece, Czech Republic, Poland, Portugal, and Estonia words recalled declined by almost one word after retirement, a meaningful decline.

Sensitivity Analysis

Estimated associations between retirement and episodic memory were similar in sensitivity analyses. Results of the marginal structural model revealed the same associations as the unweighted model, with wider confidence intervals (appendix Table 3). Excluding participants who retired due to ill health (appendix Table 4) and estimating separate models for men and women (appendix Table 5) did not change the results.

Discussion

The aim of this longitudinal study was to clarify how retirement affects memory decline and to explore whether and how this association varies across 17 European countries. Overall, results indicate that memory declines slightly after retirement, with a pronounced short-term decline after retirement and more subtle change in rate of decline over the long term. Our results support prior findings of a negative association between retirement and episodic memory (Bonsang et al., 2012; Mazzonna & Peracchi, 2017; Starke et al., 2019; Wickrama & O'Neal, 2013). Additionally, we showed that this association varies depending on the country context. The effects of retirement differed between countries in several interesting ways. First, in Italy, Greece, Czech Republic, Poland, Portugal, and Estonia retirement was associated with a more rapid decline in episodic memory shortly after retirement compared to *Social-democratic* and *Conservative* welfare regimes. Memory decline was more rapid in *Mediterranean* and *Eastern European* countries which are characterized by comparatively low pension benefits (Ferrera, 1996; Kammer et al., 2012). We interpret these results as support for the hypothesis that retirement is a more stressful event in *Mediterranean* and *Eastern European* welfare regimes with less generous pensions and lower social spending, which accelerates memory decline after retirement. Our results are in line with previous research showing that countries with

Table 2. Results of the Linear Mixed Model on Word Recall

	β coefficient	*p*-value	95% CI
Retired status (change in memory at the time of retirement)	−0.273**	.002	(−0.441, −0.104)
Years until retirement (age-slope prior to retirement)	0.033*	.026	(0.004, 0.061)
Difference in age-slope following retirement vs prior to retirement	−0.044***	.001	(−0.070, −0.018)
Retirement age	0.045***	.000	(0.026, 0.063)
Year of birth	0.086***	.000	(0.071, 0.102)
Practice effect	0.379***	.000	(0.290, 0.468)
Female	1.066***	.000	(0.975, 1.158)
Married	0.080	.166	(−0.033, 0.192)
Low education	0.000	–	(0.000, 0.000)
Medium education	0.832***	.000	(0.717, 0.947)
High education	1.811***	.000	(1.686, 1.937)
Self-rated health	−0.229***	.000	(−0.265, −0.192)
Depressive symptoms	−0.099***	.000	(−0.117, −0.081)
2+ chronic diseases	0.058	.099	(−0.011, 0.127)
Effort–reward–imbalance	−0.008	.881	(−0.117, 0.101)
Low job control	−0.048**	.004	(−0.081, −0.015)
Difficulty to make ends meet	−0.240***	.000	(−0.348, −0.132)
Constant	6.812***	.000	(5.623, 8.001)
Observations	35,285		
Random-effects parameters	**Variance in coefficients**	***SE* of variance estimate**	**95% CI**
Country-level variance			
Retired status	0.0474	0.031	(0.013, 0.168)
Years until retirement	0.0022	0.001	(0.001, 0.006)
Difference in age-slope following retirement vs prior to retirement	0.0012	0.001	(0.0003, 0.005)
Constant	0.496	0.183	(0.242, 1.021)
Individual-level variance			
Constant	2.980	0.069	(2.849, 3.118)
Residual	5.544	0.048	(5.451, 5.639)

Note: *$p < .05$, **$p < 0.01$, ***$p < .001$.

more generous pensions, such as *Social-democratic* and *Conservative* welfare states, are associated with better pre- and postretirement population health (Álvarez-Gálvez & Jaime-Castillo, 2018; Bergqvist et al., 2013; de Breij et al., 2020).

Second, our results demonstrate that retirement triggers memory decline mainly in the short term. However, our results cannot fully disentangle which of the two theoretical mechanisms might be more important because neither measures of stress during the retirement transition nor measures of cognitively-demanding work were available.

The overall decline in memory after retirement was moderate, indicating that while retirement can be a stressful life event for some individuals, it may be a relief from stressful work or hazardous working conditions for others (Hessel, 2016). Moreover, giving up the role of work can be a relief if retirees have other competing social roles (e.g., within the family) which absorb their attention after retirement. To account for this, we adjusted for preretirement work-related stress, measured as low job control, which was negatively associated with episodic memory.

Further sensitivity checks showed that the positive age-slope prior to retirement is not significant which is in line with previous research (Starke et al., 2019). Furthermore, an older retirement age was positively associated with episodic memory. This result may reflect positive selection if individuals with worse memory are more likely to retire earlier, confirming a likely bias in studies on the effects of retirement that compare people who retired at different ages.

This study contributes to the literature on cognitive aging by showing that not only individual factors, but also the institutional context shapes the association between retirement and memory decline. While the current study did not test specific mechanisms for these cross-national differences

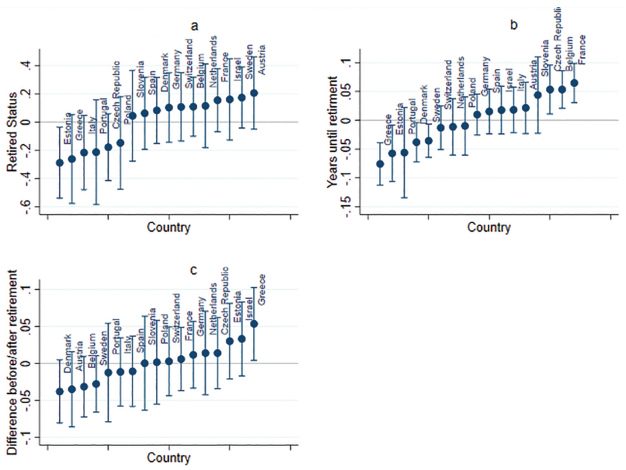

Figure 2. Caterpillar plots of random-effect residuals with 95% CI. Panel **A** displays Deviations from the overall average effect of retirement by country of residence; Panel **B** displays deviations from the overall average preretirement age slope of memory by country of residence; and Panel **C** displays deviations from the overall average change in the slope before compared to after retirement by country of residence. Full color version is available within the online issue.

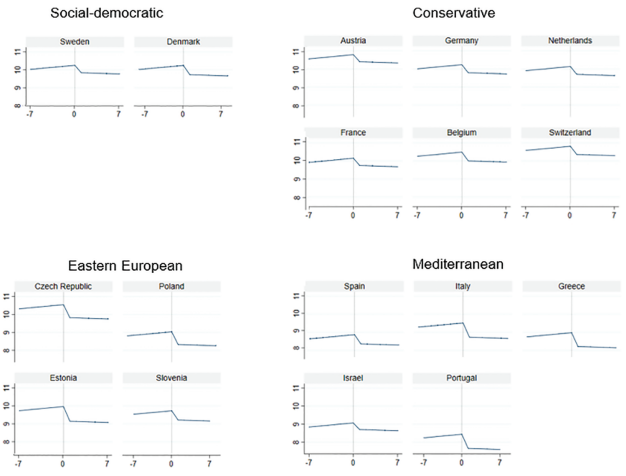

Figure 3. Country-specific predictions of episodic memory trajectories before and after retirement. Predictions for males with average values of all covariates. Full color version is available within the online issue.

in the retirement coefficients, our interpretation of the results generates new hypotheses that should be explored in future research. For example, we found that retirement appears to be more consequential for memory loss in countries with less generous social security systems, such as Portugal, Italy, Greece, Poland, or the Czech Republic. Countries offering more generous social protections, especially *Social-democratic* welfare regimes, may provide older adults with a sense of security during the retirement transition which may, in turn, reduce stress and slow memory decline (Bambra, 2011; de Breij et al., 2020). Our study highlights that larger societal and policy factors moderate the association between retirement and cognitive aging. Future research should investigate the potential for country-specific characteristics and interventions to buffer the association between retirement and memory decline, such as participation in lifelong learning among older workers or active labor market expenditures providing training or employment and recruitment incentives. Additionally, the long observation period of 13 years before and after retirement in our study offered the possibility to analyze short as well as long-term effects of retirement showing that the long-term effect of retirement on memory decline is only marginal in most countries. Applying a within-person change design enabled us to compare memory trajectories before and after retirement within persons and, thus ameliorate bias from the healthy worker effect. Several sensitivity analyses have been conducted to analyze possible reverse causality due to self-selection into retirement showing the robustness of the results.

This study has some limitations. First, bias due to loss-to-follow-up is a challenge when analyzing cognition, because loss-to-follow-up is predicted by low cognitive functioning (Zulka et al., 2019). To minimize this bias, only retired participants with repeated observations before and after retirement were included in this study. Still, some respondents dropped out earlier than others and had fewer measures of episodic memory which might not be randomly distributed. Differential gender norms around formal work may result in some selection into our sample for women, particularly in the southern European countries where fewer women participated in long periods of formal work. The association between retirement and cognition likely varies by cognitive domain, and episodic memory is thought to be among the first cognitive functions that declines with aging (Denier et al., 2017; Starke et al., 2019). This study focused on episodic memory and not on other cognitive measures of fluid cognitive abilities, such as numeracy or verbal fluency, which were not available in every wave of the SHARE. While measuring verbal recall prospectively, as we do in this study, is vulnerable to practice effects, it avoids some of the bias that would come from retrospective self-assessment of memory loss. Additional information on occupational characteristics, such as respondents' occupational class, would have been desirable. Retirement and episodic memory likely depend on other occupational characteristics besides work-related stress (Zulka et al., 2019). Social activities or voluntary work—which may substitute for paid work among older adults—are additional possible modifiers of the association between retirement and memory. While occupational characteristics and social activities are not available in every wave of the SHARE, this is a fruitful area for future research because the pace of memory decline likely depends on postretirement activities (Radl, 2013). Lastly, the current study is based on small sample sizes in some countries, e.g. Portugal, reducing the precision of our estimates. This study is the first to reveal country differences in the association between retirement and memory decline. To further clarify specific mechanisms explaining the decline, future research should draw on more complex

data including information on cultural, economic, political, and individual differences is needed.

In summary, our study evaluates the association between retirement and memory decline across multiple country contexts. Our comparative, longitudinal research design enabled us to provide stronger evidence than was previously available to explore variation between countries with different policy contexts. We found that retirement is associated with memory decline, but the association varies across countries and is stronger in *Mediterranean* and *eastern European* countries. We also found that later retirement ages are positively associated with memory functioning. Our results raise important questions about whether raising retirement ages on a population level might have a positive impact on memory functioning in old age. Further evaluation of individual-level, as well as institutional-level resources that could protect retirees from memory decline is warranted.

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Conflict of Interest

None declared.

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