The impact of retirement on executive functions and processing speed: Findings from the Canadian Longitudinal Study on Aging

Catherine Gosselin[abc]* and Benjamin Boller[abd]

[a]Department of Psychology, Université du Québec à Trois-Rivières, Trois-Rivières, Canada; [b]Research Centre of the Institut universitaire de gériatrie de Montréal, Montréal, Canada; [c] https://orcid.org/0000-0002-2041-1347 ; [d] https://orcid.org/0000-0002-6184-1933

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*Correspondence concerning this article should be addressed to Catherine Gosselin, Department of Psychology, Université du Québec à Trois-Rivières, 3351 Bd des Forges, Trois-Rivières, G8Z 4M3, Québec, Canada, Email: Catherine.Gosselin2@uqtr.ca

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We used data from the Comprehensive cohort of the Canadian Longitudinal Study on Aging to compare the cognitive performance of retirees and workers (*n* = 1442), 45 to 85 years of age at baseline. Speed processing and executive functioning were assessed using standardized assessment tools at baseline and at follow-up, measured 3 years later. Retirees and workers were matched for age, sex and education using the nearest neighbor propensity score method with a caliper of 0.02. Mixed ANOVA and post hoc analyses were conducted separately for the English- and French-speaking samples. Results for the English-speaking sample showed a significant decline on both the Stroop and the Mental Alternation tasks for retirees compared to workers from baseline to follow-up. These results support previous cross-sectional studies that have demonstrated a negative effect of retirement on executive functioning. The absence of significant results in the French-speaking sample are discussed in terms of sample size and professional occupation.

Keywords: CLSA; older adults; retirement; executive functions; processing speed

The manuscript contains 6205 words, 38 references and 7 data elements (3 tables, 4 figures).

Introduction

The increase in life expectancy as well as the aging of the population are leading to major demographic changes. Over the next two decades, nearly 1 in 4 Canadians will have reached 65 years old, which is also the expected retirement age in the country (Statistics Canada, 2019). Since aging represents the most important predicting factor of cognitive decline (Cremers et al., 2020), the increase of dementia in the population has become a public health priority (World Health Organization, 2013). Considering demographic aging and its impact on cognition, it is important to identify social factors that may influence cognitive aging.

Cognitive aging is a normal component of advancing in age, which involves changes in cognitive abilities (Rush et al., 2006). During the aging process, modifications in the structure of the brain lead to these cognitive changes (Whalley et al., 2004), with certain functions being more sensitive to cognitive aging, such as executive functioning (Murman, 2015) and processing speed (Salthouse, 1996). Cognitive changes do not occur in a homogeneous manner. Some cognitive capacities, such as processing speed and working memory, begin to decline as early as 30 years of age; and still others do not decline even in advanced ages, such as vocabulary capacity (Hartshorne & Germine, 2015).

Processing speed refers to the rapidity at which information in the environment is identified, analyzed, and acted upon (Horning & Davis, 2012). Based on this concept, Salthouse (1996) proposed the processing speed theory of cognitive aging. According to this theory, which is well supported by empirical evidence, the age-related decline in cognitive function is the result of a loss of speed, resulting in insufficient time to successfully complete cognitive tasks. Alternatively, the prefrontal-executive theory of cognitive aging is another well-established theory used to explain cognitive decline (West, 1996). In more specific terms, executive functioning skills refer to the abilities of planning, attention, inhibition, self-monitoring, self-regulation, and the ability to initiate actions (Goldstein & Naglieri, 2014). The prefrontal-executive theory of cognitive aging argues that local structural and functional changes in frontal cortex areas lead to a specific decline in executive abilities, which in turn lead to more general cognitive deficits (West, 1996). More recent research has challenged the assumption of a unitary process of executive functioning by identifying three unitary components, including mental set shifting, monitoring, and inhibition (Miyake et al., 2000). Specifically, the mental shifting is the ability to switch back and forth between multiple tasks, operations, or mental sets (Monsell, 1996) and the inhibition is the ability to deliberately inhibit a dominant, automatic, or prepotent responses when necessary (Logan, 1994). Furthermore, monitoring and updating operations involve the ability to invest and disinvest in a task, as well as the ability to clear old information in working memory for processing new stimuli (Moris & Jones, 2000).

While aging appears to affect cognitive abilities in heterogeneous ways, there are also different profiles of cognitive aging that may be associated with social and environmental factors. According to Ylikoski et al. (1999), optimal cognitive aging is associated with superior levels of intellectual and educational achievement. While these results cannot be interpreted as causal, they do highlight the importance of exploring related social factors with cognitive aging.

Retirement is generally defined as the complete withdrawal from the working force (Bowlby, 2007). Indeed, research has indicated that retirement may negatively impact cognitive aging regarding executive functioning. Consequently, a study based on data from the Survey on Health, Aging, and Retirement in Europe (SHARE) demonstrates that retirement status is negatively linked to cognitive functioning in measures of inhibition and updating abilities (Mazzonna & Peracchi, 2012). In addition, based on the Whitehall II study of London-based Civil Servants, it was found that retirees showed a smaller increase in cognitive functioning compared to employed individuals in the performance of inductive reasoning (Roberts et al., 2011). Inductive reasoning also requires components of executive function, including cognitive flexibility, inhibition, monitoring, and updating (Diamond, 2013) More recently, another study revealed that retirement could negatively impact cognitive performance on measures of processing speed, particularly when the retiree has a low level of education (de Grip et al., 2015). Additionally, a study of senior surgeons revealed significantly better performances on measures of processing speed than age-appropriate norms (Bieliauskas et al., 2008). These results support the hypothesis that working at older ages may contribute to less cognitive decline in processing speed during the early stages of aging.

The Canadian Longitudinal Study on Aging (CLSA; Raina et al., 2009) is a national and longitudinal study that collects biological, medical, psychological, economic, social, and lifestyle data from nearly 50,000 Canadians aged 45 to 85 years at baseline. CLSA participants are followed every three years for over twenty years. The CLSA includes the Comprehensive cohort and the Tracking cohort. The tracking cohort participants (n = 21 241) were randomly selected from all ten provinces of Canada and have each completed a battery of cognitive tests as part of the telephone interview. Participants in the Comprehensive Cohort (n = 30 097) were randomly selected within 25-50 kilometers of eleven Data Collection Sites (DCS) located across seven provinces and were interviewed in person. These participants have completed a cognitive test battery during in-home interviews and a neuropsychological test battery in one of the DCS locations. Data collected during the baseline phase (May 2012-2015) and the follow-up phase (July 2015-2018), provides the possibility to measure the evolution of cognitive performance during two different periods on measures of executive functions, such as mental flexibility and inhibition, and measures of processing speed.

In this study, we investigate the impact of retirement on age-related decline in executive functions, and processing speed among CLSA participants. We suggest the following hypotheses:

(1) Retirees experience increased cognitive decline on measures of mental flexibility compared to individuals active in the workplace.

(2) Retirees experience increased cognitive decline on measures of inhibition compared to individuals active in the workplace.

(3) Retirees experience increased cognitive decline on measures of processing speed compared to individuals active in the workplace.

Materials and Procedure

Participants

The CLSA participants provided written consent before participating in the study. The study protocol of the CLSA was approved by 13 research ethics boards across Canada and the present study was also approved by the Institutional Review Board of Université du Québec à Trois-Rivières (CER-21-275-10.02).

Eligibility Criteria of the Study

In the CLSA study, participants with cognitive impairment were excluded at baseline (Raina et al. 2009). For the present investigation, participants were excluded from the analyses if they had ever reported a diagnosis of any of the following neurological disorders: memory problems caused by a head injury, cerebrovascular accident, transient ischemic accident, Parkinson’s disease, or epilepsy. The sample is composed of participants who reported being actively working at baseline. At follow-up, 3 years later, selected participants were asked to report their working status: active or retired. Figure 1 provides an illustration of a flow chart of sorting criteria.

Retirees and Workers Matching Method

To ensure comparable samples among retirees and workers, we used propensity scores to control for possible influences from demographic factors previously associated with differences in cognitive functioning among CLSA participants: language, age, sex, and education level (Tuokko et al., 2017). Propensity scores are estimated with the *Match It* package for *R* (Ho et al., 2007). A logistic regression matching algorithm with a caliper of 0.02 is used to match participants with the 1:1 nearest neighbor method.

Material

Sociodemographic Characteristics

CLSA participants provided sociodemographic information during an in-home interview at baseline. These items were adapted from the Canadian Community Health Survey questionnaire (Béland et al., 2002) and took approximately two minutes to administer. This questionnaire contains conversational speaking variables in English and French (1 = yes, 0 = no), baseline and follow-up ages by year, sex variables (1 = male, 2 = female), and level of education (scale 4- and 11-level scale).

Retirement Status

Information regarding retirement status is provided by social functioning measures included in the in-home interview questionnaire. Both baseline and follow-up measures were taken. To determine the retirement status of participants, we used subjective retirement (1 = retired or 3 = not retired) and currently working status (yes = 1, no = 0). In accordance with the delayed effect of retirement previously identified in epidemiological studies, we also chose participants who had been retired for at least one year at follow-up.

Cognitive and Neuropsychological Tests

The Mental Alternation Test was selected to measure cognitive flexibility (MAT; Teng, 1995). This test comprised two different parts. The A section of the test consists of counting from 1 to 26 and then reciting the alphabet. The B section consists of alternating between alphabet letters (A-Z) and numbers (1-26). Scores range from 0-51 and are based upon the number of correct alternations subtracted from the number of errors during a 30-second period.

Next, we used the Stroop Test (Victoria version; Bayard et al., 2011) in order to quantify both processing speed and inhibition. This test is a measure of executive functions including inhibition, attention, mental speed, and mental control. A French language modification of the Stroop (Victoria version; Bayard et al., 2011) is used for the assessment of francophone participants and comprises three distinct parts. The first section consists of naming the color of each printed dot. The second section consists of reading a list of non-color words written in different colors of ink. For the third section, participants are required to identify the color of the ink without first reading the color word. Scores are based on the mean response time (in seconds) for each section of the task, where a lower average time is indicative of a higher performance. Performances are scored using the mean denomination time (in seconds). Measure of inhibition on the Stroop task is calculated using the difference between mean response time at the first and the third cards of the Stroop (interference card – color-naming card).

Choice Reaction Time (CRT; Gallacher et al., 2013) is a computer-assessed measure of psychomotor speed which requires multiple stimuli (2) and answers (2). The measures used are the latencies of correct answers for presentations. For additional information regarding psychometric properties of cognitive and neuropsychological tests performed by CLSA participants, please refer to Tuokko et al. (2017).

Procedure

During the CLSA Comprehensive, participants are evaluated on episodic memory, processing speed, and executive function. Testing is administered by a trained CLSA staff member using standardized operating procedures. Comprehensive participants have completed a battery of cognitive tests administered during an in-home interview lasting approximately 27 minutes, including the Mental Alternation Task. During Data Collection Site (DCS), participants complete additional neuropsychological tests including the Stroop Test and the Choice Reaction Time.

Data analysis

Matching method

As part of the *Match It* package for *R* (Ho et al., 2011), we used nearest neighbor with a caliper (≤ 0.02) to create a comparable sample of workers and retirees based on sociodemographic characteristics. The matching method has been used in multiple cohort studies and has demonstrated a significant improvement in the balance between potential confounding variables (Rassen et al., 2012). Considering that retired participants may differ from workers in terms of sociodemographic characteristics, nearest neighbor matching can reduce the possible influence of factors that may affect retirement probabilities and cognitive performance. To estimate the propensity score, multiple variables are calculated to estimate the probability of occurrence of a predictive factor using logistic regression. We used a predicting equation of retirement status at follow-up. Conversational language, age at baseline, sex, and level of education were selected as potential confounding variables. The propensity score method was used to establish a criterion of comparability between retirees and workers by reducing the number of confounding variables to one and reducing the variability within an acceptable range by using the caliper. Then, we matched each working participant with a retired participant with similar characteristics, such as language spoken, sex, age, and educational level, such that the difference in propensity scores between the two groups was less than 0.02.

Mixed Design Analyses of Variance Model

Given the language-based differences in CLSA raw scores on cognition, as evidenced by Tuokko et al. (2017), the analyses for English and French speakers were conducted separately. We used a two-factor mixed-model repeated measures ANOVA with time as a within-group factor and retirement status as a between-group factor. Specifications have been provided when homoscedasticity was violated. A planned contrast compared cognitive performance in retirees and workers at baseline and at follow-up, measured three years later. The alpha level for all statistical tests was set to .05, and the Bonferroni correction method was applied to all ANOVA analyses, since multiple comparisons may introduce the possibility of a type I error. However, no correction for multiple hypothesis was applied, given that each analysis was planned a priori. Results of the analyses of English-speaking and French-speaking groups are presented in Table 2 and Table 3, respectively**.** To manage the potential for non-credible performance, we excluded from analysis all scores that contained a value of 0 on each cognitive test. For the CRT, after examining the normality of the distribution, a threshold of 3 standard deviations was applied resulting in the exclusion of the data of 16 participants in the English speakers' sample (retirees, n = 11; workers, n = 5) and of 4 participants in the French speakers' sample (retirees, n = 1; workers, n = 3). For the MAT, scores below the value of 8 were also excluded since the instructions evoke these alternations.

Results

Sociodemographic Equivalence Between Retired and Worker Groups

Table 1 presents the sociodemographic characteristics of the participants based on propensity score matching. The matched samples do not differ in terms of language, age, sex or education. We used the nearest neighbor matching method to compare retirees and workers with similar sociodemographic characteristics such as conversational language, age, sex, and education level. Among matched participants (n = 1442), the median age is 59.90 years (SD = 5.45), of whom 55% are female, and the median educational level is a certificate or diploma below a university degree.

Cognitive Assessments

Choice Reaction Time. For the English-speaking sample, no significant main effect of time between the baseline and the follow-up was found. By contrast, a main effect of retirement status revealed a significant result, F (1, 1064) = 5.63, $p < .05$, $p\eta 2$ = 0.01, with the retirees' group mean performance being higher than the workers' group mean performance. Finally, no interaction effect was found between retirement status and time. On the other hand, no significant main effect of time or retirement status or interaction effect in results of the French-speaking sample was found.

Mental Alternation Test. The performance from the English-speaking sample on MAT revealed a significant main effect for time between baseline and follow-up, F (1, 922) = 19.62, $p < .001$, $p\eta^2 = 0.02$. There was no significant main effect for retirement status. There was, however, a significant interaction between retirement status and time that indicates a decline in performance only among retirees, F (1, 922) = 4.27, $p < .05$, $p\eta^{2\,=}$ 0.01, see Figure 2. Post hoc analyses indicate a significant decrease on retirees' performance by comparing mean scores from baseline to follow-up. For the French-speaking sample, neither of the main effect nor the interaction effect was statistically significant.

Stroop (Victoria Version). For the English-speaking sample, a main effect of time between baseline and follow-up for the color-naming card (Dot), F (1, 1118) = 102.63, $p < .001$, $p\eta^2 = 0.08$, the word-reading card (Word), F (1, 1121) = 19.25, $p < .001$, $p\eta^2 = 0.017$, and the interference card (Color), F (1, 1118) = 49.79, $p < .001$, $p\eta^2 = 0.04$ were found. These results indicate a significant increase in mean response time from baseline to follow-up. However, simple effect of retirement status is not significant on these three components. There was also a significant interaction effect between time and retirement status for the color-naming card (Dot), F (1, 1118) = 8.80, $p < .01$, $p\eta^2 = 0.01$, see Figure 3, and the interference card (Color), F= (1, 1118) = 5.04, $p < .05$, $p\eta^2 = 0.004$, see Figure 4. Post hoc analyses show a significant increase of mean time response for both retirees and workers that is significantly more pronounced for retirees on these two cards. In order to calculate the measure of inhibition during the Stroop task, the difference between interference and color-naming cards was calculated. For the interference task of the Stroop (interference card – color-naming card), there was a main effect of time for the English-speaking participants, F (1, 1116) = 10.05, $p < .01$, $p\eta^2 = 0.01$. The average response time was significantly higher at follow-up compared to baseline. However, the main effect of retirement status was not significant. The effect of interaction between time and retirement status was also not significant.

For the French-speaking sample, the assumption of homogeneity of variance was violated in the analysis for the color-naming card (Dot). The results should thus be interpreted with caution. There is a significant result for the main effect of time at the color-naming card (Dot) of the Stroop, F (1, 234) = 123.06, $p < .001$, $p\eta^2 = 0.35$. The average response time showed improvement at follow-up compared to baseline. However, there was no main effect of retirement, and no interaction effect between retirement and time were statistically significant. For the word-reading card (Word) of the Stroop, there was a significant main effect of time between baseline and follow-up, F (1, 233) = 88.35, $p < .001$, $p\eta^2 = 0.28$, where the average response time significantly improved at follow-up compared to baseline. However, neither the main effect of retirement nor its interaction effect with time was significant. There was also a significant main effect of time for the interference card (Color) of the Stroop, F (1, 232) = 70.47, $p < .001$, $p\eta^2 = 0.23$. The average response time was significantly longer at baseline compared to follow-up. The main effect of retirement status was not statistically significant and there was also no significant effect of the interaction between time and retirement status. For the interference task of the Stroop (interference card – color-naming card task), a main effect of time for the French-speaking participants was found, F (1, 232) = 19.69, $p < .001$, $p\eta^2 = 0.08$. The average response time was significantly higher at baseline compared to follow-up. However, the main effect of retirement status was not statistically significant, neither was the effect of interaction between retirement and time between baseline and follow-up.

Discussion

The purpose of this study was to identify whether retirement influences cognitive decline on different areas of cognition including mental flexibility, inhibition, and processing speed among older adults from the CLSA sample, with retired participants expected to show more decline than workers across these areas. After adjusting for the principal confounders (language, age, sex, and education) by matching retirees and workers, we found that retirement negatively impacts cognitive aging on measures of mental flexibility and processing speed. However, we found no evidence that retirement significantly impacts cognitive decline on tasks related to inhibition.

Based on the MAT, we found a small effect of retirement for the English-speaking sample. Furthermore, post-hoc analyses indicated that the interaction effect was significant for the retiree group only. This finding is also consistent with a previous study led by Roberts et al. (2011), where they found a negative association between retirement status and measures related to mental flexibility. Additionally, Ryan (2008) also reported a decrease in performance on reasoning tasks requiring mental flexibility among retired participants compared to those who remained employed during the three phases of the longitudinal study. Moreover, we also observe a small negative effect for the English-speaking retirement sample on both color-naming and interference cards of the Stroop task. However, retirement did not have a significant effect on the inhibition component of executive functioning as measured by the interference ratio (Color Task - Dot Task). Consequently, our results suggest that retirement may have an adverse effect on cognitive aging processing speed rather than on the inhibition component of executive functioning.

Similar results have been found regarding the negative impact of retirement on cognitive aging for measures of processing speed. Therefore, Finkel et al. (2009) found that retirement significantly affected cognitive abilities on processing speed assessments for retired participants who had worked in highly complex jobs.

On the other hand, the lack of a significant effect on the interference component of the Stroop Task cannot support an effect of retirement on the inhibition component of the executive functioning. Our results, however, are consistent with those of a study by de Grip et al. (2015). The authors found that retired individuals showed a significant decline in processing speed, while their inhibition skills were significantly better than those in workers. Contradictorily, results from the Choice Reaction Time (CRT) task do not suggest any effect of retirement on cognitive aging regarding processing speed. However, the lack of statistically significant results for the reaction time task could be explained by the fact that using average reaction times may not be the most appropriate approach for to assess the effect of age on task performance. Accordingly, a meta-analysis reveals greater intra-individual variability in reaction times, which suggests that the use of an average performance score cannot accurately reflect the cognitive changes experienced by aging individuals (Dykiert et al., 2012).

There are several strengths to this study. Firstly, the longitudinal design provides the advantage of analyzing the changes in cognitive abilities of the same sample of participants over a period of two repeated measures in time, and the cognitive tests are validated measures of verbal memory, processing speed, and executive functions (Tuokko et al., 2017). We also use a propensity score matching method to compare groups of retirees and workers with equivalent covariant characteristics.

The study also has some limitations that should be considered. Firstly, cognitive flexibility was measured using only one test. The use of a single test leads us to remain cautious about generalizing results on cognitive flexibility skills as one single score on this cognitive skill can only reflect some aspects of the function. Secondly, another limitation relates to the available data for the MAT in the CLSA study. In the original version of the MAT (Teng, 1995), two distinct measures are provided to distinguish the influence of both processing speed and cognitive flexibility. However, in the CLSA study, there is only one measure that is available which combines both influences. Thus, it is possible that the reduced processing speed was observed on the Stroop task performance explained a part of the observed effect on the MAT performance. In addition, several effects observed among Anglophones were not sustained among Francophones. These findings, however, may suggest interesting hypotheses regarding the existence of other sociodemographic differences between the two groups, such as professional occupation.

In conclusion, our results indicate an effect of retirement on cognitive abilities associated with executive functioning and processing speed. Nevertheless, the endogeneity of performance from groups of retired and working participants remains promising in terms of identifying social and environmental factors that may influence the cognitive aging process. In fact, the unexpected effect of retirement on the cognitive aging profile observed in the group of French-speaking individuals may indicate that other potential factors could possibly explain the heterogeneity of these results such as professional occupation. In this order of thinking, a study has shown a negative effect of retirement on immediate memory skills according to the level of work associated with the professional occupation (Wickrama et al., 2013). Moreover, one study argued that workers who have done hard manual labour may benefit from a positive effect of retirement (Coe et al., 2012). Considering that some studies have found differences in the effect of retirement on groups of workers and the heterogeneity of our results regarding to English- and French speaking samples, future analyses should explore the possible influence of professional occupation in the effect of retirement on cognitive aging.

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Disclosure statement

The opinions expressed in this manuscript are the authors' and do not reflect the views of the Canadian Longitudinal Study on Aging.

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Data availability

Data are available from the Canadian Longitudinal Study on Aging (www.clsa-elcv.ca) for researchers who meet the criteria for access to de-identified CLSA data.

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Table 1

Comparison of sociodemographic characteristics of workers and retirees matched by the nearest neighbor method with 0.02 caliper

	Workers n = 721 *M (SD)* or *n (%)*	Retirees n = 721 *M (SD)* or *n (%)*	p -value t or χ^2
Language			p = .94
English speaking	486 (67.4%)	480 (66.6%)	
French speaking	55 (7.6%)	57 (7.9%)	
Bilingual (English/French speaking)	180 (25%)	184 (25.5%)	
Age (Baseline)	59.92 (5.53)	59.88 (5.38)	p = .92
Sex			p = .92
Male	326 (45,2%)	323 (44.8%)	
Female	395 (54,8%)	398 (55,2%)	
Level of education			p = .91
Grade 8 (Secondary II) or lower	1 (0.1%)	4 (0.6%)	
Grade 9-10 (Secondary III or IV)	2 (0.3%)	5 (0.7%)	
Grade 11-13 (Secondary V)	5 (0.7%)	7 (1%)	
Secondary school graduate	70 (9.7%)	74 (10.3%)	
Post secondary education	59 (8.2%)	54 (7.5%)	
Trade certificate or diploma from a vocational school or apprenticeship training	74 (10.3%)	75 (10.4%)	
Non university certificate or diploma from community college, CEGEP, etc.	149 (20.7%)	150 (20.8%)	
University certificate below bachelor’s degree	25 (3.5%)	27 (3.7%)	
Bachelor’s degree	183 (25.4%)	178 (24.7%)	
University degree or certificate above bachelor’s degree	153 (21.2%)	147 (20.4%)	

Notes. *M* = Mean; *SD* = Standard deviation; CEGEP = Collège d’enseignement général et professionnel.

Table 2

Baseline and follow-up comparison between groups (workers and retirees) of English-speaking participants

Measures	*N*	Baseline Mean (*SD*)	Follow-up Mean (*SD*)	Time		Time X Group	
				F	*p*	*F*	*p*
MAT							
Workers	471	28.61 (7.32)	28.20 (7.21)	19.62	.001***	4.27	.04*
Retirees	453	28.62 (6.62)	27.48 (7.02)				
STROOP - Dot							
Workers	570	11.85 (2.44)	12.36 (2.67)	102.63	.001***	8.80	.003**
Retirees	550	11.75 (2.37)	12.69 (2.75)				
STROOP - Word							
Workers	571	14.95 (3.29)	15.36 (3.48)	19.25	.001***	0.83	.36
Retirees	552	14.97 (5.54)	15.59 (3.86)				
STROOP - Color							
Workers	570	24.02 (6.38)	24.88 (7.14)	49.79	.001***	5.04	.03*
Retirees	550	23.80 (6.08)	25.46 (7.83)				
STROOP - Inhibition							
Workers	570	12.17 (5.70)	12.52 (6.15)	10.05	.002**	1.34	.25
Retirees	548	12.07 (5.50)	12.81 (6.87)				
CRT							
Workers	547	778.86 (136.48)	781.50 (132.98)	0.08	.78	0.11	.74
Retirees	519	796.90 (143.35)	796.64 (123.37)				

Note. MAT: Mental Alternation Test; CRT: Choice Reaction Time. *$p < .05$; **$p < .01$; ***$p < .001$.

Table 3

Baseline and follow-up comparison between groups (workers and retirees) of French-speaking participants

Measures	*N*	Baseline Mean (*SD)*	Follow-up Mean (*SD*)	Time		Time X Group	
				F	*p*	*F*	*p*
MAT							
Workers	90	28.86 (7.55)	28.79 (7.30)	0.94	.33	0.64	.43
Retirees	115	29.14 (7.07)	28.46 (6.29)				
STROOP – Dot							
Workers	106	12.41 (2.76)	9.97 (2.89)	123.06	.001***	0.77	.38
Retirees	130	12.02 (2.87)	9.95 (3.41)				
STROOP - Word							
Workers	105	15.06 (3.16)	12.69 (4.20)	88.35	.001***	0.06	.81
Retirees	130	15.35 (3.56)	13.09 (4.92)				
STROOP - Color							
Workers	105	25.52 (6.34)	21.25 (8.47)	70.47	.001***	0.19	.66
Retirees	129	25.36 (6.28)	21.50 (8.87)				
STROOP - Inhibition							
Workers	105	13.18 (6.09)	11.27 (6.75)	19.69	.001***	0.04	.84
Retirees	129	13.33 (5.67)	11.57 (6.48)				
CRT							
Workers	104	777.35 (133.37)	769.03 (132.96)	0.01	.93	1.18	.28
Retirees	130	768.38 (136.44)	778.18 (134.17)				

Note. MAT: Mental Alternation Test; CRT: Choice Reaction Time. *$p < .05$; **$p < .01$, ***$p < .001$.

Figure 1

Flow chart explaining inclusion and exclusion criteria of the study

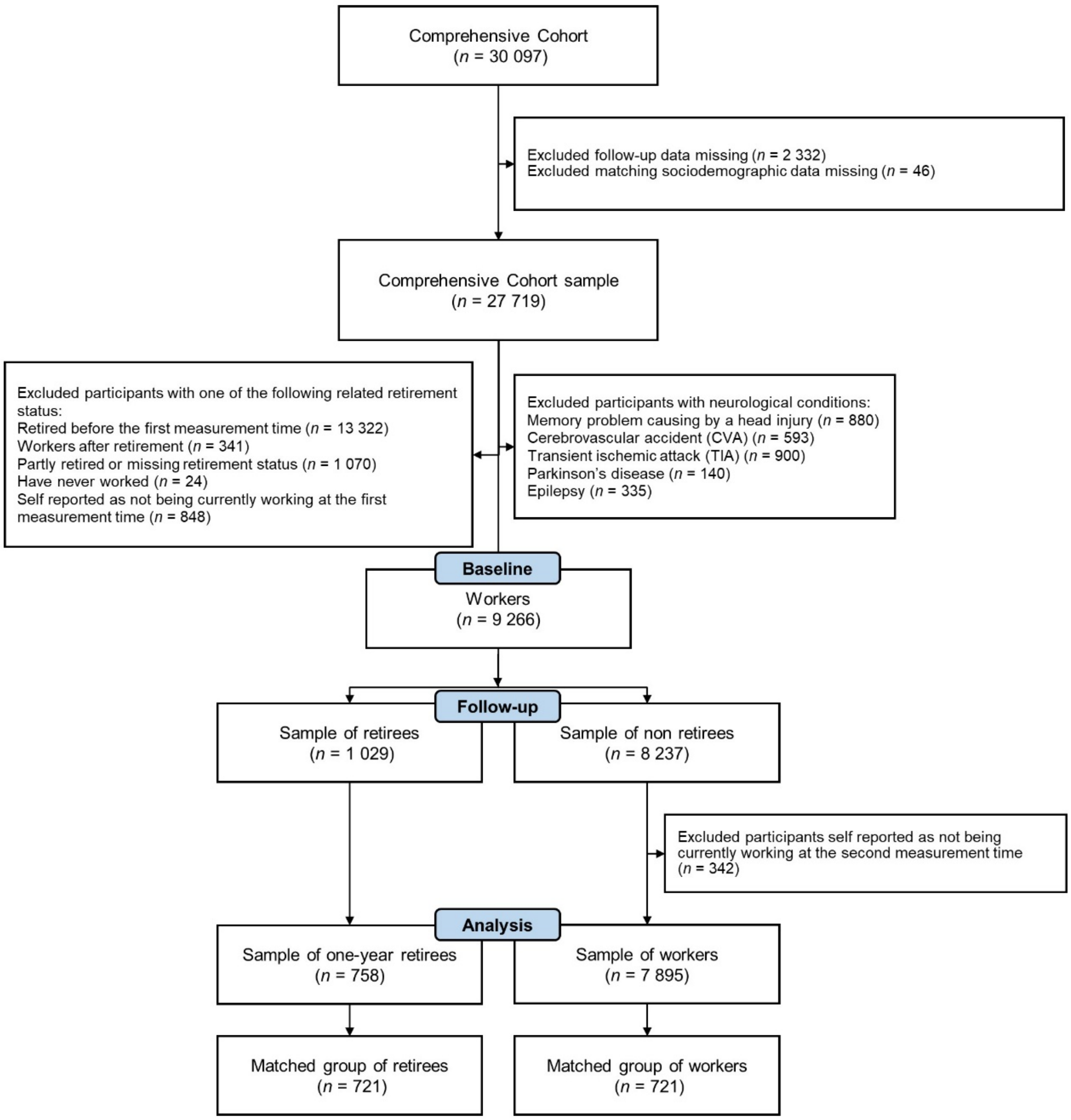

Figure 2

Performance trajectory of English-speaking sample on the MAT at baseline and at follow-up

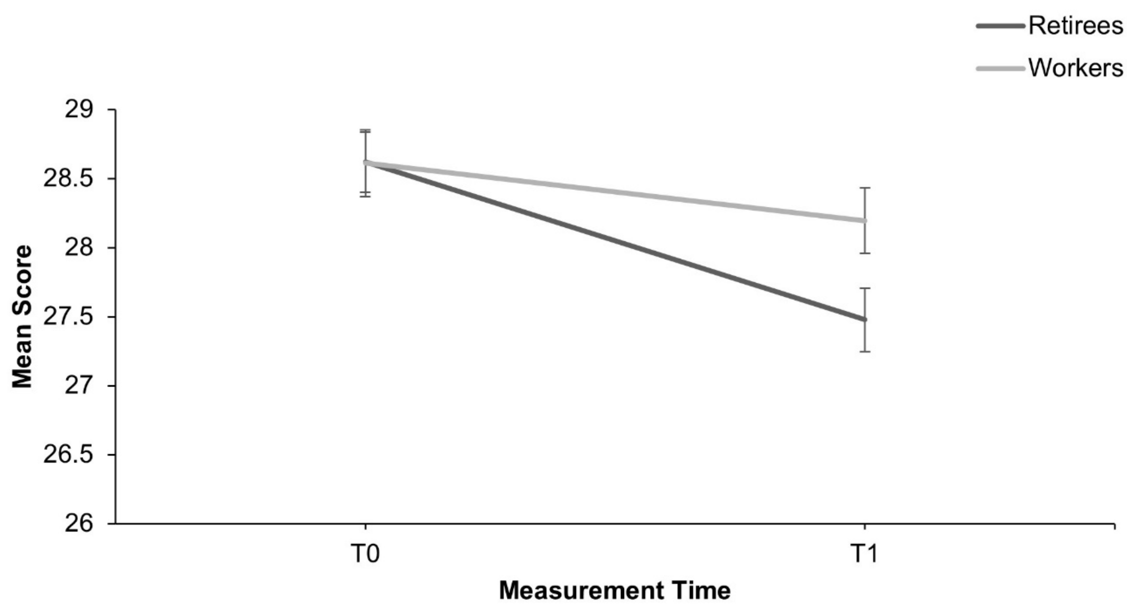

Figure 3

Performance trajectory of English-speaking sample on the color-naming card (Dot) of Stroop task (Victoria version) at baseline and at follow-up

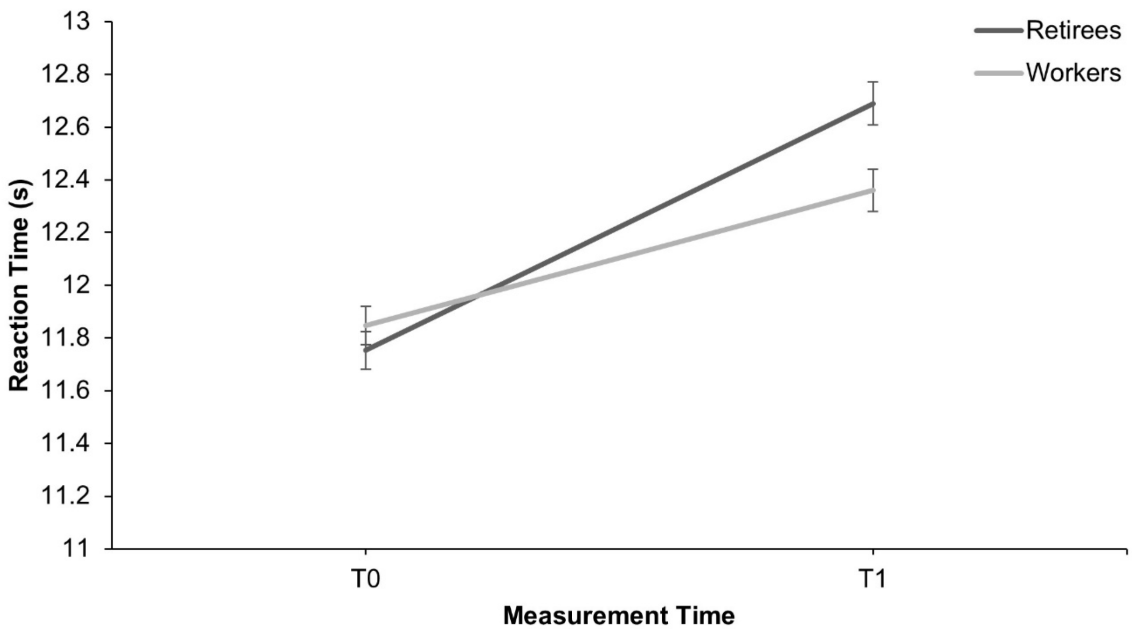

Figure 4

Performance trajectory of English-speaking sample on the interference card (Color) of Stroop task (Victoria version) at baseline and at follow-up