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

Catherine Gosselin, Ph.D. Student in Clinical Neuropsychology

Supervised by : Dr Annick Parent-Lamarche & Dr Benjamin Boller

Université du Québec à Trois-Rivières

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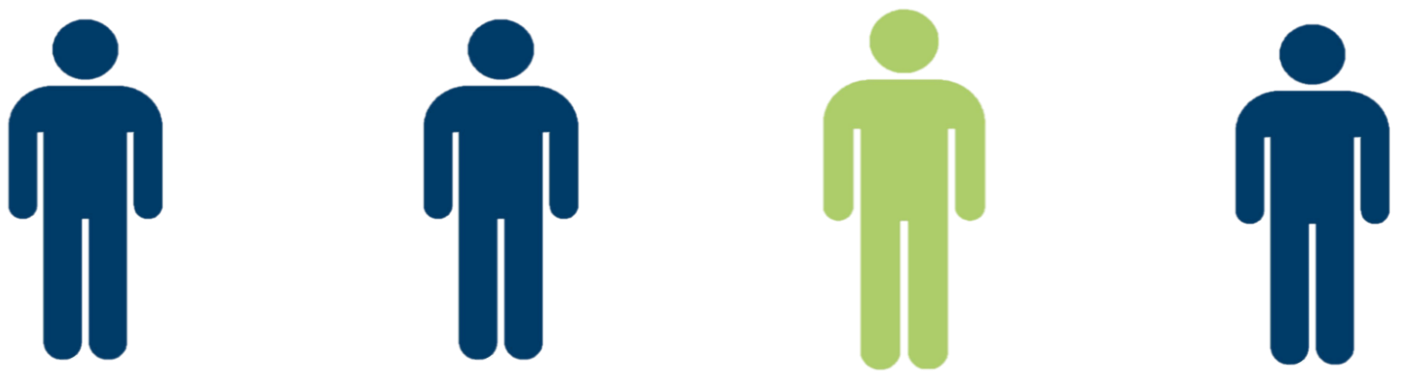
Aging of the Canadian population

The increase in life expectancy + The aging of the population

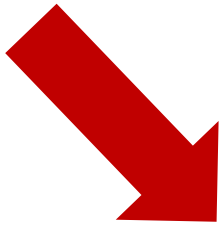
Major demographic change

Almost 1 in 4 Canadians will be 65+ over the next 20 years.



Cognitive Aging

- Cognitive aging is an inherent component of the aging process.
- Age-related changes in brain structure contribute to cognitive decline (Whalley et al., 2004).
- Starting around the age of 30, some cognitive functions begin to decline while others remain stable (Hartshorne & Germine, 2015) :



Processing speed

Working memory

Executive functions

Vocabulary

Semantic knowledge

Theories of Cognitive Aging

Certain cognitive functions exhibit greater sensitivity to age-related brain structural changes :

- Processing speed (Salthouse, 1996; 2009)
- Executive functions (West, 1996)

The Processing Speed Theory of Cognitive Aging (Salthouse, 1996; 2009)

- Age-related cognitive decline is caused by a loss of speed.
- Loss of speed in processing information leads to insufficient time to complete cognitive tasks.

Theories of Cognitive Aging

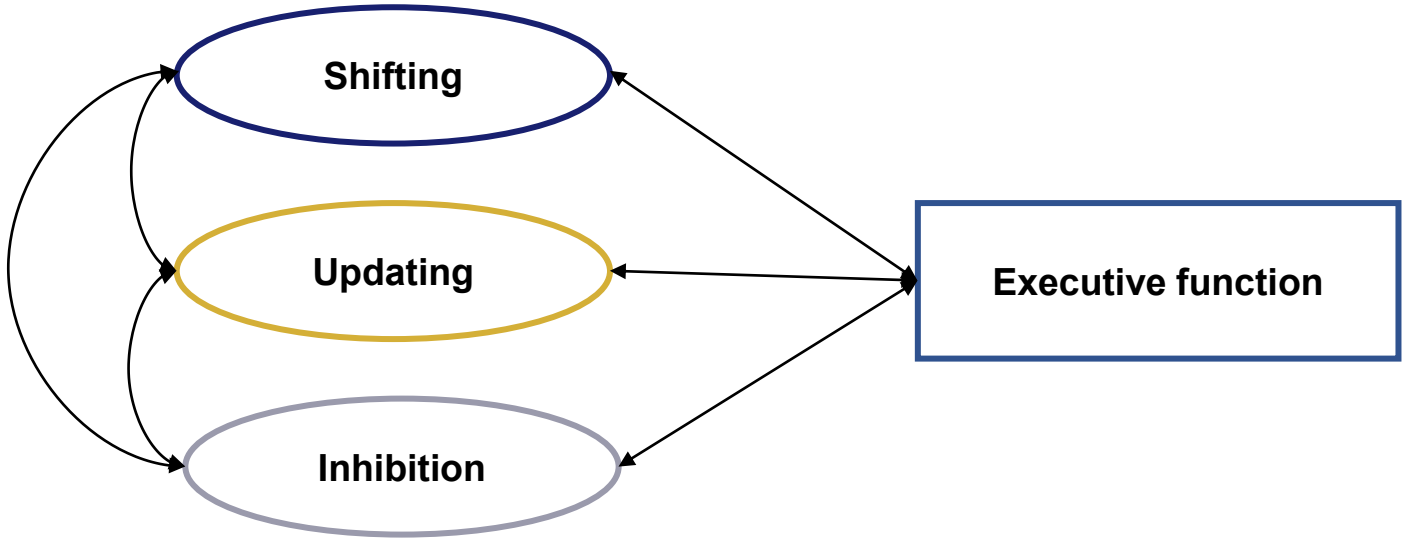
The Prefrontal-Executive Theory of Cognitive Aging (West, 1996)

- Executive functioning skills : planning, reasoning, attention, inhibition, self-monitoring, self-regulation, mental flexibility, updating, and initiating actions.
- Local structural and functional changes in frontal cortex areas lead to a decline in executive abilities.
- This decline in executive abilities leads to more general cognitive deficits (West, 1996).

Executive Functions

- **Mental set shifting** : to switch between multiple tasks, operations, or mental sets.
- **Inhibition :** to deliberately inhibit a dominant, automatic, or prepotent response when necessary.
- **Monitoring and updating :** to invest and disinvest in a task and clear old information in working memory for processing new stimuli.

Miyake's theory refines the understanding of executive function and cognitive decline.



(Adapted from Miyake et al., 2000)

Impacts of Social Factors on Cognitive Aging

- Aging is the most important predictor of cognitive decline (World Health Organization, 2012).
- Major life events, such as bereavement (Atalay & Staneva, 2020) and the diagnosis of a chronic illness (Hung et al., 2009) may have a significant impact on cognitive aging.
- Retirement is a significant life event that frequently involves various adjustments (Zantinge et al., 2014).

Retirement and Cognitive Aging

Retirement

- Defined as complete withdrawal from the working force (Bowlby, 2007).

Retirement is associated with a decline in processing speed :

Retirement may impair cognitive processing speed, especially for those with lower education according to a study conducted in the Netherlands (De Grip et al., 2015).

Retirement and Cognitive Aging

Retirement

- Defined as complete withdrawal from the working force (Bowlby, 2007)

Retirement is associated with a decline in executive functions :

In task involving **inductive reasoning** in Whitehall II study of London-based Civil Servants (Roberts et al., 2011).

In tasks involving **inhibition** and **updating abilities** in Survey on Health, Aging, and Retirement in Europe (SHARE) (Mazzonna & Peracchi, 2012).

Canadian Longitudinal Study on Aging

CLSA data (Raina et al., 2009)

- Includes sociodemographic data, lifestyle habits, cognition, social and psychological factors
- Based on a sample of **50,000 participants**
- Participants were aged **45-85 years at the baseline** of the study
- **Three-year follow-ups** were conducted
- **The Comprehensive cohort** participants (n = 30 000) completed both cognitive and neuropsychological test batteries.

Objective and hypotheses

Investigate the impact of retirement on age-related decline in executive functions and processing speed

Hypotheses :

1. Retirees experience greater decline in **processing speed** than individuals who remain active in the workplace.
2. Retirees experience greater decline in **mental flexibility** than individuals who remain active in the workplace.
3. Retirees experience greater decline in **inhibition** than individuals who remain active in the workplace.

Method

Participants

Inclusion criteria

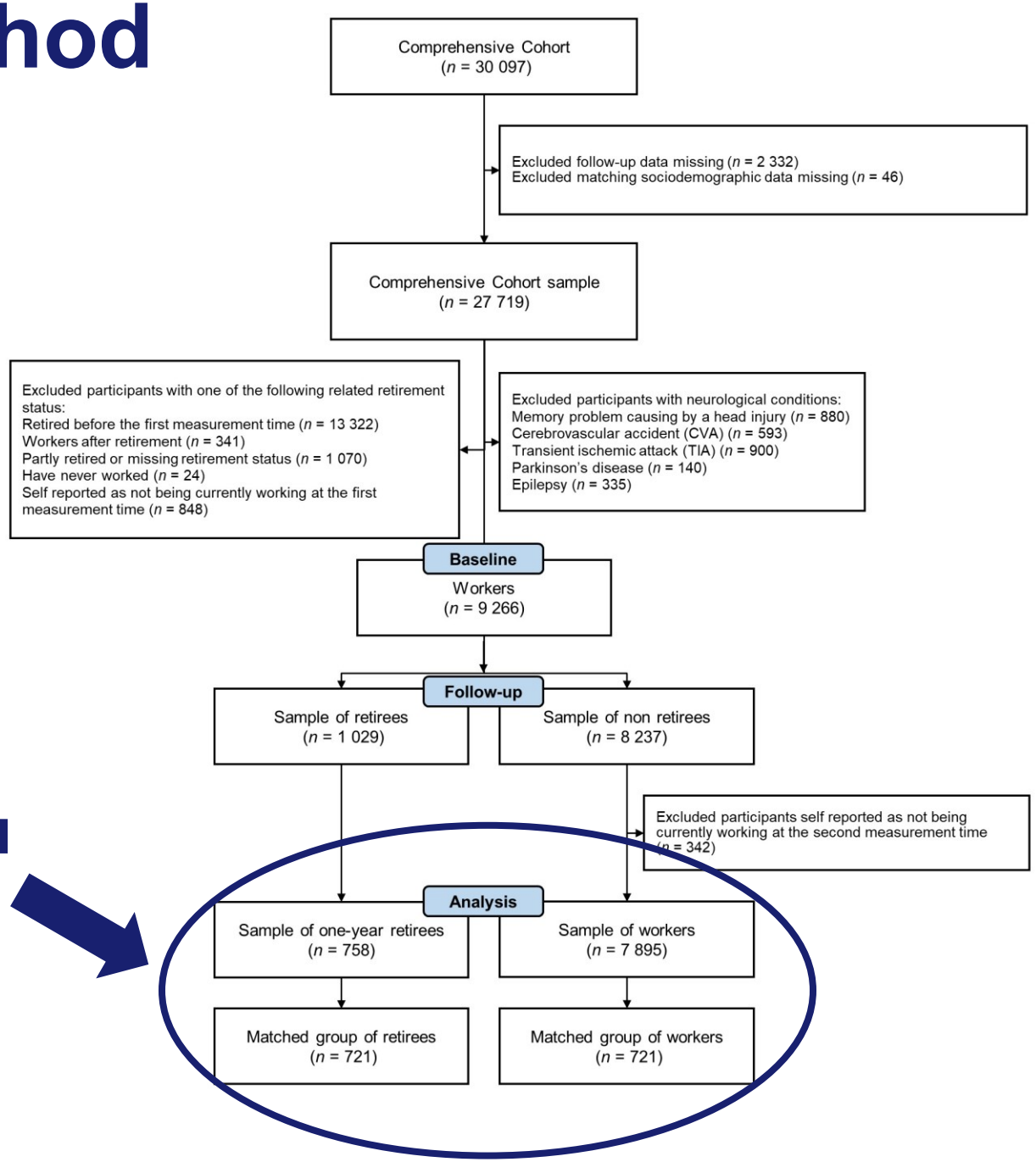
- Actively working at baseline
- Actively working or completely retired for at least 1 year at Follow-up 1

Exclusion criteria

- Neurological condition
- Have never work
- Retired before the baseline

Retirees and workers matching method

- 1:1 Nearest Neighbor Method
- Use to balance confounding variables



Method

Materials : Questionairies

Sociodemographic characteristics

- Were collected from CLSA participants during in-home interview
- The questionnaire contains :
  - Conversational speaking variables in English and French (1 = yes, 0 = no)
  - Baseline and Follow-up 1 ages (years)
  - Sex variables (1 = male, 2 = female)
  - Level of education (11-level scale)

Retirement status

- Retirement status was determined using :
  - Subjective retirement status (1 = Retired, 2 = Partially retired or 3 = Not retired)
  - Currently working status (yes = 1, no = 2)

Method

Material

Cognitive and neuropsychological tests

- The Mental Alternation Test (MAT; Teng, 1995) was used to measure cognitive flexibility.
- The MAT test consists of two parts :
  - Part A involves counting from 1 to 26 and then reciting the alphabet.
  - Part B involves alternating between alphabet letters (A-Z) and numbers (1–26).
- Scores range from 0 to 51 and are based on the number of correct alternations minus errors during a 30-second period.

Counting

- 1,2,3…20

Reciting the alphabet

- A,B,C…Z

Alternating

- 1-A,2-B,3-C…Z-26

Method

Material

Cognitive and neuropsychological tests

- The Stroop Test (Victoria version; Troyer et al., 2006) was used to measure processing speed and inhibition.
- A French language modification of the Stroop was used for participants Bayard et al., 2009.
- The test includes three parts:
  1. Naming color of printed dots.
  2. Reading non-color words written in different colors.
  3. Identifying color of ink without reading color word.
- Scores based on response time for each parts
  - ⬆ Score (response time) = ⬇ Processing speed and inhibition.

Card 1. Color-naming

Card 2. Word-reading

green blue green red blue

green red green blue red

Card 3. Interference

green blue green red blue

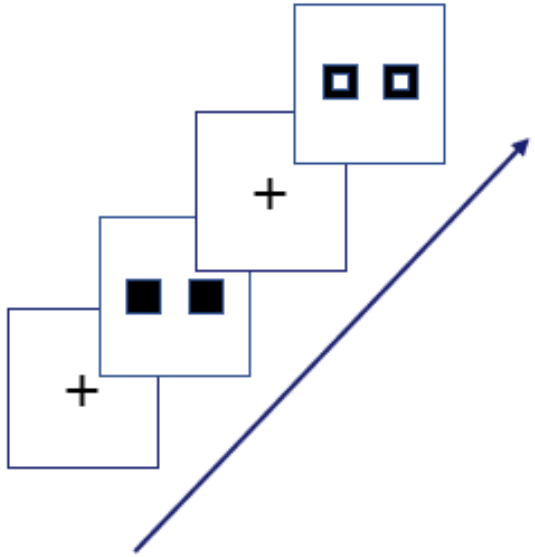
green red green blue red

Method

Material

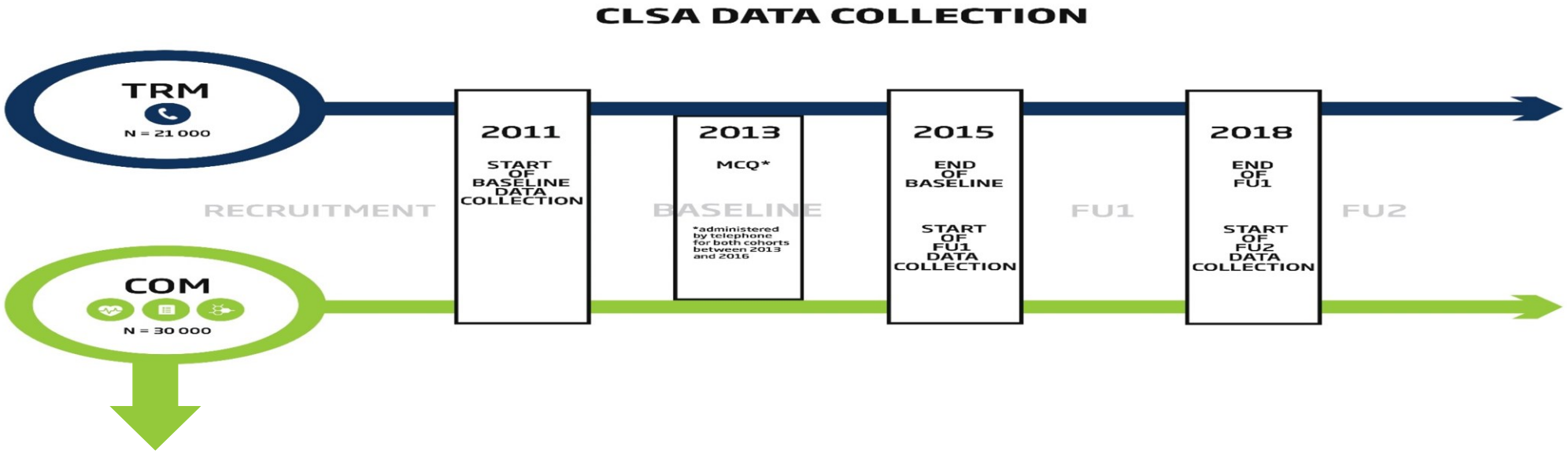
Cognitive and neuropsychological tests

- Choice Reaction Time (CRT) is a computer-based measure of psychomotor speed.
- CRT requires multiple stimuli (2) and answers (2).
- Measures used are the latencies of correct answers for presentations.



Method

Procedure



Trained staff members administered the tests using standardized operating procedures to evaluate participants on memory, processing speed, and executive function

In-home interview : 27-minute battery tests including the Mental Alternation Test

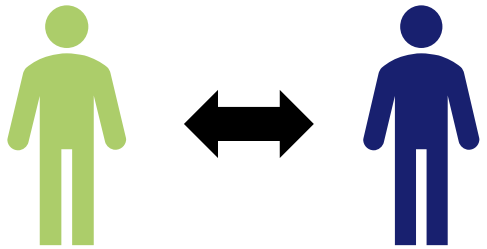
Data Collection Site (DCS) : additional neuropsychological tests including the Stroop Test and the Choice Reaction Time.

Method

Data analyses

- **Matching method :**
  - Nearest neighbor matching used with a caliper of ≤ 0.02.
  - Used to create a comparable sample of workers and retirees based on sociodemographic characteristics.
  - Propensity score estimated with logistic regression with multiple variables : language spoken, sex, age, and educational level.

Retiree **Worker**



Matched by sociodemographic characteristics:

- Conversational language
- Age at baseline
- Sex
- Level of education

Method

Data analyses

- **Mixed design analyses of variance model**
  - English and French speakers' data were analyzed separately (Tuokko et al., 2017).
  - Within-group factor : Time (Baseline and Follow-up 1).
  - Between-group factor : Retirement status (Retirees and Workers).
  - Bonferroni correction method was applied to ANOVA analyses due to multiple comparisons.

Results

Comparison of 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.

Results

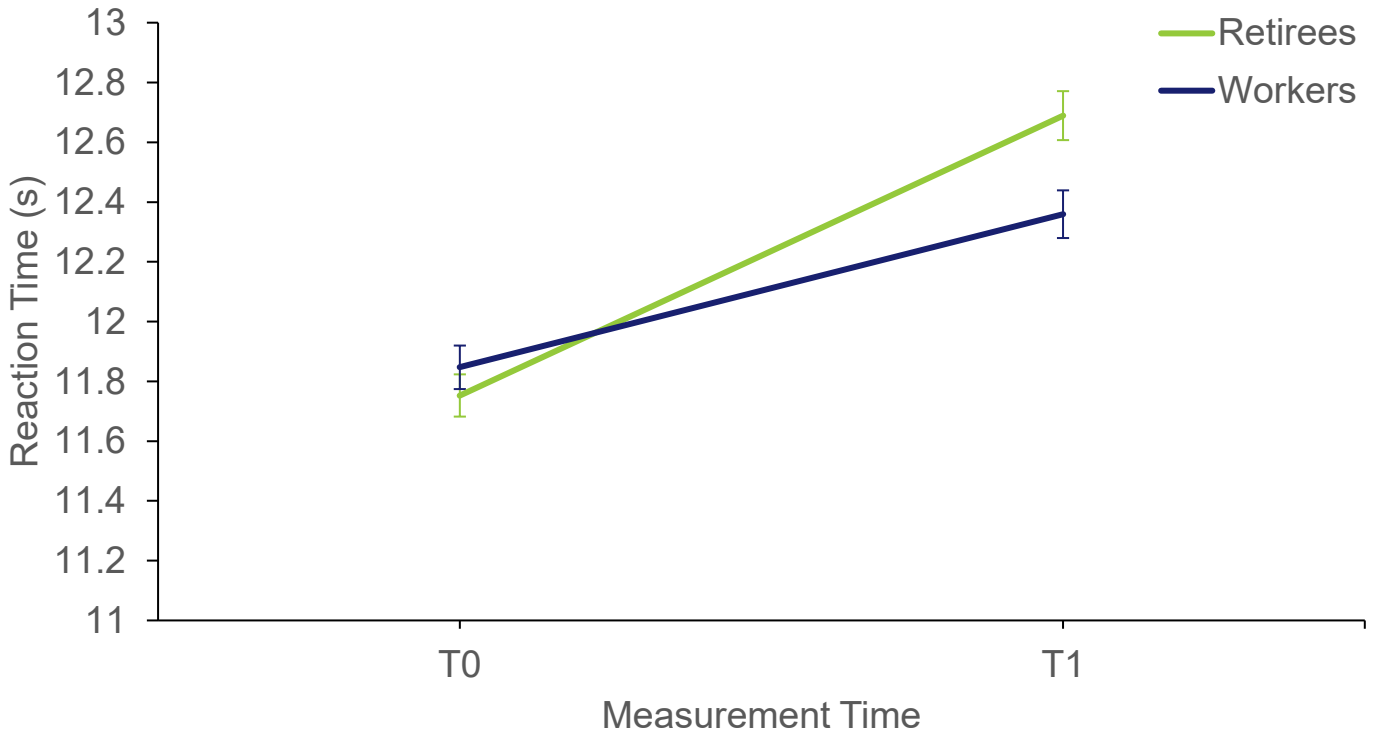
Baseline and follow-up comparison between groups (workers and retirees) of English-speaking participants

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. *$p < .05$; **$p < .01$; ***$p < .001$.

Results

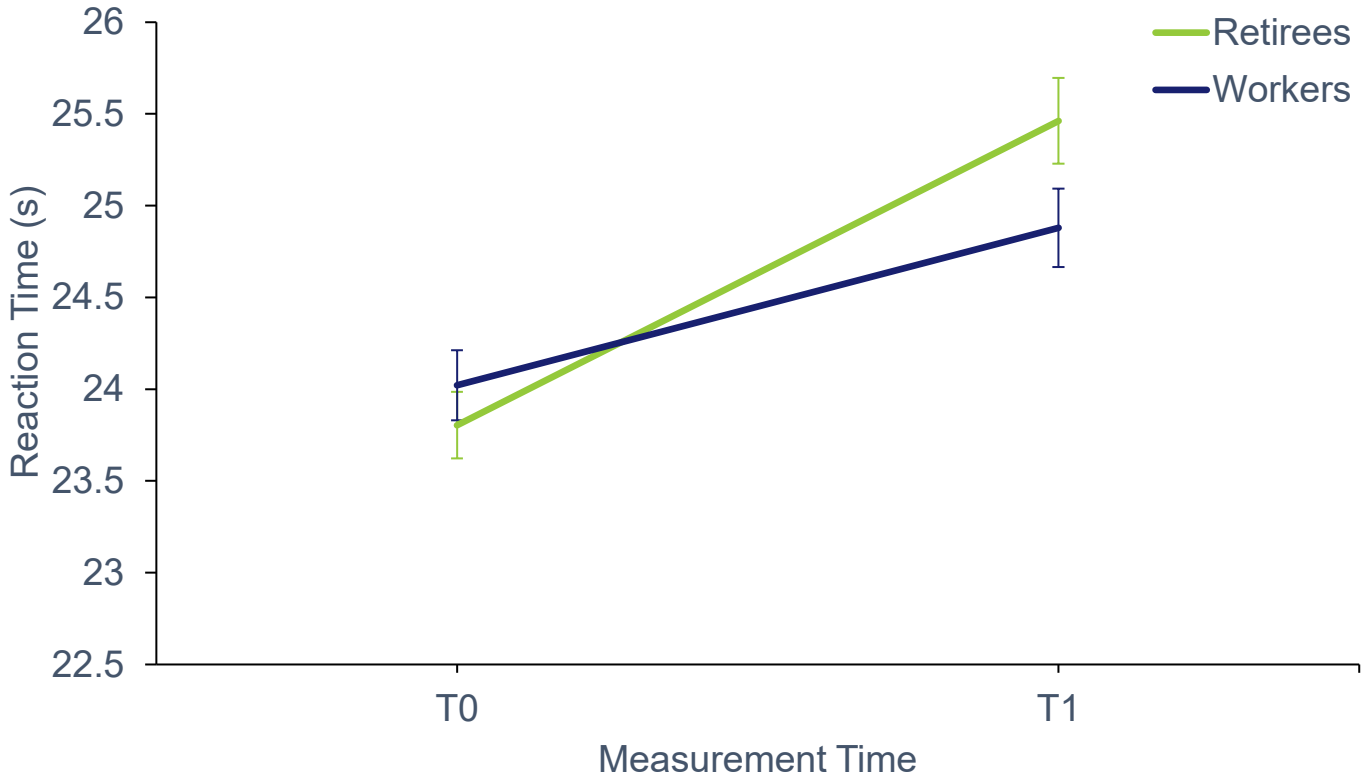
Performance trajectory of English-speaking sample on the **color-naming card (Dot) of Stroop task** (Victoria version) at baseline and at follow-up.



There was a significant interaction between retirement status and time that indicates **a more pronounced reaction time for retirees,** F (1, 1118) = 8.80, $p < .01$, $p\eta^2 = 0.01$

Results

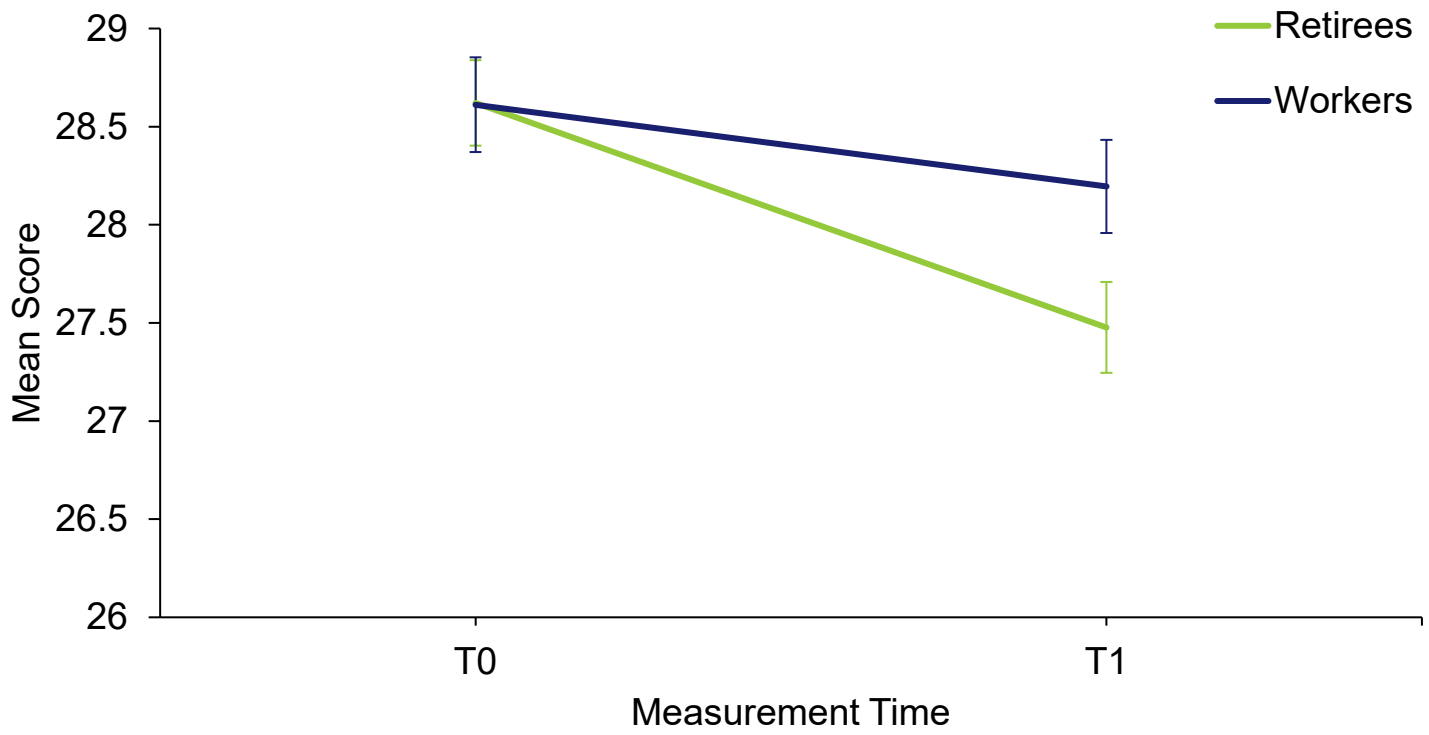
Performance trajectory of English-speaking sample on **the interference card (Color) of Stroop task** (Victoria version) at baseline and at follow-up.



There was a significant interaction between retirement status and time that indicates **a more pronounced reaction time for retirees,** $F(1, 1118) = 5.04$, $p < .05$, $p\eta^2 = 0.004$

Results

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



There was a significant interaction between retirement status and time that indicates **a decline in performance only among retirees**, $F(1, 922) = 4.27$, $p < .05$, $p\eta^2 = 0.01$

Results

Choice Reaction Time

- There was no significant interaction effect between retirement status and time for English-speaking and French-speaking groups.

No interaction effects were observed between retirement status and time for the Mental Alternation or Stroop tasks in the **French-speaking group**.

Discussion

This study aimed to investigate the impact of retirement on cognitive decline on different areas of cognition including, processing speed, mental flexibility, and inhibition among older adults from the CLSA sample:

- Retired participants were expected to show more decline than workers.

Findings

- Retirement ✗ performance on the Choice Reaction Time, which measures processing speed.
- Retirement ↓ performance on the Stroop task, which measures processing speed.
- Retirement ↓ performance on the Mental Alternation Task, which measures mental flexibility.
- Retirement ✗ performance on the Stroop task component, which measures inhibition.

Discussion

Effect of retirement on cognitive decline in processing speed

- Retirement has a small negative effect on processing speed for both the first and third Stroop cards.
  - However, the effect of retirement on cognitive decline was not found in the inhibition measure.
- This finding agree with a prior study :
  - De Grip et al. (2015) found that retirement was associated with a decline in processing speed.

Discussion

Effect of retirement on cognitive decline in processing speed

- No effect of retirement on cognitive aging in processing speed was observed in the Choice Reaction Time (CRT) task performances.
- Average reaction times may not accurately assess cognitive aging (Dykiert et al., 2012) ➡ Intra-individual variability in this task may provide a more accurate measure.

Discussion

Effect of retirement on cognitive decline in mental flexibility

- Retirement has a small effect on decline of mental flexibility performance in the English-speaking retiree group only.
- This finding is consistent with previous studies :
  - Roberts et al. (2011) which found a negative association between retirement and mental flexibility.
  - Ryan (2008) found a decline in mental flexibility for retired participants compared to those who remained employed in a three-phase longitudinal study.

Discussion

Strengths

- Longitudinal design
- Validated measures of multiple cognitive domains
- Propensity score matching method

Limitations

- Only one test used to measure mental flexibility
- Interaction effects not found in Francophones

Discussion

Conclusion

- Retirement may affect cognitive performance in executive functioning and processing speed.
- The lack of significant results in French-speaking individuals may be interpretated in terms of sample size as well as the proportion of bilingual speakers.

Future Research

- Investigate the role of work history on the effect of retirement on cognitive abilities.

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Canadian Longitudinal Study on Aging
Étude longitudinale canadienne sur le vieillissement

CLSA Approved Project

Applicant
Dr. Benjamin Boller, Université du Québec à Trois-Rivières

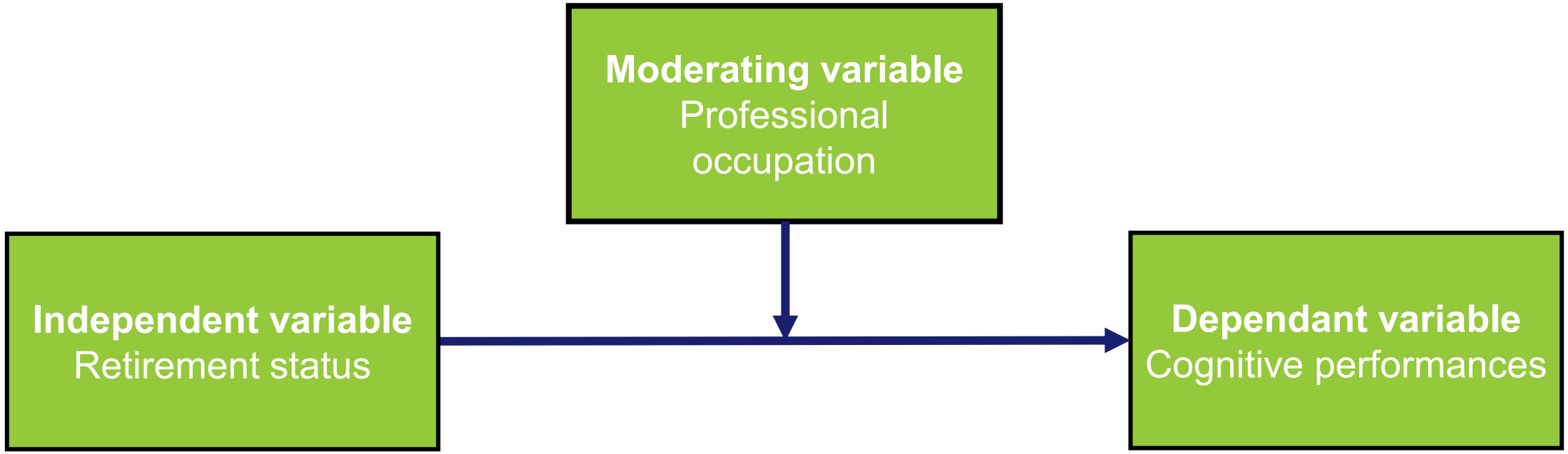
E-mail Address
Benjamin.Boller@uqtr.ca

Project Title
Le rôle de la réserve cognitive dans le déclin cognitif associé à la prise de retraite

Discussion

Future Research

- To investigate the role of professional occupation on the effect of retirement on cognitive abilities.



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Canadian Longitudinal Study on Aging
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Thank You !

Questions ?

Email : Catherine.Gosselin2@uqtr.ca

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