

RUNNING HEAD: Bilingualism, Subjective Cognitive Decline, and Objective Cognitive Performance

**EVALUATING SUBJECTIVE COGNITIVE DECLINE AS A PREDICTOR OF  
OBJECTIVE COGNITIVE PERFORMANCE IN MONOLINGUAL AND BILINGUAL  
OLDER ADULTS: A COMPARISON BETWEEN GROUPS**

**NATHALIE ROBINSON**

Thesis submitted to Saint Paul University in partial fulfillment for the requirements of the Master  
in Arts in Counselling and Spirituality

School of Counselling, Psychotherapy and Spirituality

Saint Paul University

Ottawa, Ontario, Canada

© Nathalie Robinson, Ottawa, Canada, 2021

## Table of Contents

|  |    |
|--|----|
| Abstract   | iv |
| <i>Acknowledgements</i>  | v  |
| Introduction   | 1  |
| Bilinguals and Objective Cognitive Performance   | 2  |
| <i>Executive Function</i>  | 3  |
| <i>Working Memory</i>  | 7  |
| <i>Episodic Memory</i>   | 10 |
| <i>Language</i>  | 12 |
| Bilinguals and Subjective Cognitive Decline  | 15 |
| <i>Executive function</i>  | 17 |
| <i>Language</i>  | 18 |
| Subjective Cognitive Decline as a predictor of Objective Performance in Bilinguals and |    |
| Monolinguals   | 19 |
| Purpose of thesis  | 19 |
| <i>Methods</i>   | 22 |
| Study Population   | 22 |
| Bilingualism   | 23 |
| Predictor  | 23 |
| Subjective Cognitive Decline   | 23 |
| Outcome  | 24 |
| Objective Cognitive Performance  | 24 |
| <i>Statistical analysis</i>  | 30 |
| <i>Results</i>   | 30 |
| Sample characteristics   | 30 |
| Executive Function, Episodic Memory and Language Function Tasks                        | 31 |
| Subjective Cognitive Decline   | 32 |
| Subjective Cognitive Decline as a predictor of Objective Performance in Bilinguals and |    |
| Monolinguals   | 33 |
| <i>Discussion</i>  | 35 |
| Neuropsychological performance in monolinguals and bilinguals                          | 36 |
| SCD in monolinguals and bilinguals   | 37 |
| SCD as a predictor of Objective Performance in Monolinguals and Bilinguals             | 39 |

|                   |    |
|-------------------|----|
| Strengths         | 40 |
| Limitations       | 41 |
| Implications      | 43 |
| Future Direction  | 44 |
| <i>Conclusion</i> | 47 |
| <i>References</i> | 49 |

### Abstract

**Objective.** To evaluate subjective cognitive decline (SCD) as a predictor of objective cognitive performance in monolingual and bilingual older adults and to examine differences in SCD and objective performance between both samples. It is hypothesized that bilinguals will show stronger performance on executive function tasks, episodic memory tasks and weaker performance on language tasks, while also displaying lower levels of SCD, relative to monolinguals. **Methods.** Participants consisted of older adults, aged 65 years and older, fluent in both English and French. Bilingualism was measured using a 5-point Likert scale (1=no ability and 5=native likeability) to measure language proficiency. SCD was measured using 3 yes/no questions assessing concentration, memory problems and word-finding difficulties. Objective performance was assessed in areas of executive function, working memory, episodic memory and language using tasks: The Stroop task, BNT, CVLT II and the LNS task. Two independent sample t-tests were used to examine differences in SCD and objective performance in both samples and several linear regressions analyses were conducted separately for both the monolingual and bilingual sample to evaluate SCD as a predictor of objective performance. **Results.** In the bilingual sample, SCD in language demonstrated to predict objective performance on the CVLT II task. In the monolingual sample, SCD in memory and language demonstrated to predict objective performance on the LNS task. **Conclusion.** These findings suggest there are significant differences in objective performance between both samples and that SCD is a predictor of objective performance in both bilingual and monolingual samples, but further research would need to be conducted.

*Keywords:* bilingualism, subjective cognitive decline, objective performance

### Acknowledgements

Firstly, I would like to thank both of my supervisors, Dr. Yamin and Dr. Taler, for the continuous support and feedback that was provided throughout this process. Thank you for supporting and believing in me even when I thought it was impossible to finish and get everything done. Secondly, I would like to thank the members of my committee, Dr. Jiang and Dr. Bilodeau for also providing feedback throughout this process. I would also like to thank Christine for the continuous support and responses to each of my questions throughout this process and for helping me every step of the way. I would also like to thank Nicolas for his extensive help with the analysis portion of my thesis.

Lastly, I would like to thank my partner, Nickolas, my parents and friends for always supporting me and encouraging me throughout this process. Thank you all from the bottom of my heart because I know that this would have not been possible without all of you.

## Introduction

Bilingualism has been on the rise in Canada since the 1960s (Statistics Canada, 2016). In 2016, the English-French bilingualism rate stood at 17.9%, which has been the highest percentage that the bilingualism rate has been in Canada since 1961, when it was just 12.2% (Statistics Canada, 2016). The population of bilingual individuals in Canada had risen from 5.8 million in 2011, to 6.2 million in 2016, an increase of 420,495 individuals (Statistics Canada, 2016). This growth in the bilingual demographic of the population was the highest increase that the entire population ever saw between 2011 and 2016 (Statistics Canada, 2016).

Over 50% of the world's population is bilingual and research has indicated that bilingualism not only buffers age-related cognitive decline by contributing to an individual's cognitive reserve, but is linked to increased cognitive functioning in the areas of inhibition, executive function, attention and shifting (Bialystok, 2007; Bialystok & Craik, 2010; Kousaie et al., 2014; Perani & Abutalebi, 2015; Quinteros Baumgart & Billick, 2018). A significant amount of research has indicated that proficiency in two languages reduces the impact of cognitive decline that is related to aging (Bialystok & Craik, 2010; Kousaie et al., 2014; Kousaie & Phillips, 2017).

Research in the field of cognitive aging is important because of the current and future population trends estimated for older adults in Canada. The Canadian population has seen the largest increase in older adults ages, 65 and older, in 70 years, since 2011 (Kousaie et al., 2014; Statistics Canada, 2017). It is estimated that by 2031, one in four Canadians will be over the age of 65 and by 2061, the older adult population in Canada will have reached 12 million (Kousaie et al., 2014; Statistics Canada, 2017). Dementia trends have also been on the rise in Canada, where in 2011, it was estimated that 747,000 Canadians were living with

dementia (Vogel, 2014). That number is expected to double to 1.4 million in the next two decades (Vogel, 2014).

Many older adults report expressing negative views towards aging due to experiencing age-related cognitive decline in the areas of memory and other cognitive abilities (Crumley et al., 2014; Perani & Abutalebi, 2015). Approximately 25 to 50% of older adults report experiencing subjective cognitive decline (SCD), which has been linked with future cognitive decline and an increased risk of developing dementia in the near future (Langlois & Belleville, 2014). Research has indicated that 54% of older adults with SCD have shown to exhibit cognitive decline within 7 years of experiencing SCD, while 79% of the older adults developed mild cognitive impairment (MCI) and 21% developed dementia (Langlois & Belleville, 2014).

Older adults with SCD are at increased risk of developing dementia, yet lifelong bilingualism has been observed to possibly delay the onset of dementia and cognitive decline by 4-5 years, which is 3-4 years later than in monolingual older adults (Bialystok et al., 2007, 2010; Bialystok & Craik, 2010; Perani & Abutalebi, 2015). Studies have proven that bilingualism has been associated with delaying postponing the onset of MCI by 4.5 years when compared to monolinguals, thereby further lessening the incidence of any future development of dementia (Quinteros Baumgart & Billick, 2018). Lifelong bilingualism has shown to potentially be linked to delayed development of clinical symptoms that are related to cognitive decline and as well as a delayed onset of dementia (Perani & Abutalebi, 2015).

### **Bilinguals and Objective Cognitive Performance**

Bilingualism can be described as an equal or almost equal mastery of two languages that is used by an individual throughout their life (Quinteros Baumgart & Billick, 2018).

Research conducted on individuals speaking two languages daily since childhood has demonstrated to diminish age-related cognitive decline that is related to control processes (Gold et al., 2013). Previous research has shown that switching routinely between two languages increases an individual's ability to efficiently shift between two different tasks and processes that are related to executive control (Gold et al., 2013; Luo et al., 2013). Bilingual older adults have shown to exhibit strengthened cognitive control and attention, which has been linked to improved mental health among the older adult population (Bialystok et al., 2007; Perani & Abutalebi, 2015). Studies have also proven that lifelong management of two languages for bilinguals has been associated with a possible advantage against age-related cognitive decline concerning inhibitory processes (Adesope et al., 2010; Bialystok et al., 2004). It can be inferred that, as a result, other cognitive domains have also been impacted regarding individuals' attention with respect to tasks that require cognitive control, thus demonstrating better attentional control (Adesope et al., 2010; Bialystok et al., 2004). Bilingualism is a lifelong experience where executive processes are routinely used for attentional control in the management of two language systems, leading to improvements in other cognitive domains and even domains that have very little connection to linguistic performance (Bialystok, 2007).

### ***Executive Function***

Executive function refers to a higher-level set of cognitive skills that help to control and coordinate other cognitive abilities such as inhibition, task switching, working memory (WM) and attention, all of which are important for everyday functioning (Hill et al., 2012; Kousaie et al., 2014). Research has indicated that executive function has a constant role of reviewing and monitoring any cognitive processes that have been initiated to ensure their

success (Schofield & Ashman, 1986). Executive function mechanisms receive information from both coding processes in the sequence that allows for goals, as well as planning and examining strategies, before any action is initiated (Schofield & Ashman, 1986). Even though each cognitive process within executive function seems to be independent of one another, there is an interdependence of cognitive processes amongst each other since planning and decision making processes are reliant on both coding processes, but can facilitate their own synthesis for the demands of a task on their own, apart from one another (Schofield & Ashman, 1986).

Bilingualism has demonstrated that it provides an advantage to older adults, specifically in executive function (Bialystok et al., 2008; Perani & Abutalebi, 2015; Quinteros Baumgart & Billick, 2018). Bilingual individuals have performed at a higher level on executive function tasks than monolingual individuals, displaying executive control that is more flexible, robust and skillful (Kousaie et al., 2014). Researchers have suggested that these advantages in executive function in bilinguals are due to the continual practice of these processes which control attention of the different language systems (Bialystok, 2007). These advantages in executive control have also shown to extend to memory tasks, with regard to those involving recollection (Perani & Abutalebi, 2015). Older adults appeared to be protected against age-related decline in the areas of controlled attention, inhibition and shifting by adding to their cognitive reserve, due to their bilingual capabilities (Perani & Abutalebi, 2015; Quinteros Baumgart & Billick, 2018). Furthermore, older adult bilinguals have proven gains in tasks that are highly demanding such as in the Stroop task where there are many different congruent conditions (Antón et al., 2016). One example is that bilinguals

displayed faster reaction times than monolinguals (Antón et al., 2016; Kousaie & Phillips, 2012).

Research has theorized that continuous control by bilinguals of two language systems leads to smooth usage of executive control processes, via bilinguals continuously shifting between languages, and by suppressing one language system when the other one is in use (Kousaie et al., 2014; Pelham & Abrams, 2014). This allows bilinguals to activate and use both language systems simultaneously, calling on not only executive control processes but also memory processes, which further calls on attentional control processes and the processes related to switching between both language systems (Ljungberg et al., 2013). The combination of these functions is contributing to the advantage which bilingual individuals exhibit (Ljungberg et al., 2013).

Another advantage has emerged for older adults due to being bilingual with respect to switching between different cognitive tasks, where bilingual individuals have shown to display faster response times for switching between tasks than monolingual individuals (Gold et al., 2013). It is theorized that bilingual individuals may be more equipped to switch between different cognitive tasks than monolingual individuals, because they would need less effort to shift from one task to another (López Zunini et al., 2019). Studies have suggested that older adult bilinguals may rely on automatic strategy, while older adult monolinguals may rely on controlled processing strategies to switch between different cognitive tasks (López Zunini et al., 2019).

Bilinguals have shown an advantage in cognitive tasks that require attentional control, leading to proof that bilingualism contributes to improved attention and cognitive control (Bialystok et al., 2007). Evidence has indicated that when individuals use two different

languages, a system is required to suppress any interference from the competing language and control the attention of the language that is in use (Adesope et al., 2010; Bialystok et al., 2007). This processing demand results in bilinguals displaying greater attentional control than monolinguals (Bialystok, 2011; Bialystok et al., 2007). The increase in attentional control is a result of bilinguals having to correctly select all the linguistic criteria that fits both the form and meaning of the information that is being presented in the target language, and not in the competing language (Bialystok, 2009). The system that is necessary to manage the regular use of two languages is executive control, which requires bilinguals to use attentional control mechanisms to sustain attention on the target language and manage interference from the non-target language (Adesope et al., 2010; Kousaie et al., 2014; Kousaie & Phillips, 2012).

Previous research has shown that both languages in bilinguals are simultaneously activated even when only one language is needed (Adesope et al., 2010; Bialystok et al., 2004; Kousaie & Phillips, 2012). This constant activation of both language systems in bilinguals has shown to be the component underlying the advantage (Kousaie et al., 2014; Kousaie & Phillips, 2012). Due to the constant use of these cognitive functions, these mechanisms are said to develop much earlier on in bilinguals and decline much later on in life compared to monolinguals (Kousaie & Phillips, 2012). The nonrelevant language is said to be repressed using similar executive function processes used to manage attention and inhibition (Bialystok et al., 2004). This constant practice of inhibitory control has shown to possibly generalize to other cognitive domains (Bialystok et al., 2004). Older adults who have been bilinguals since early childhood have shown to have better attention when given tasks that require cognitive control (Adesope et al., 2010). This may be due to the individuals being bilingual early on in their lives, which possibly influenced control processes throughout their

life spans (Bialystok et al., 2004). These advantages may also be due to lifelong bilinguals having regular use of processes to control attention of two language systems, leading to declines in these processes that are less severe and more gradual (Bialystok, 2007). Evidence suggests that bilinguals are able to also have better control of their attention in both verbal and non-verbal tasks compared to monolinguals (Adesope et al., 2010; Bialystok, 2009). In Bialystok's (2007) study on the cognitive effects of bilingualism, monolingual participants who were 60 years and older, displayed longer reaction times to different tasks examining executive function, inhibitory control and attention compared to bilinguals. This study demonstrates the protection that bilingualism provides older adults by slowing down the rate of decline of their attentional processes (Bialystok, 2007).

In the present thesis, executive function is measured using the Stroop task. This task is able to measure inhibition of irrelevant information by the process of interference suppression, which is known as the Stroop interference effect (Kousaie & Phillips, 2012). It refers to the increase in response time (RT) for incongruent trials compared to the congruent trials (Kousaie et al., 2014).

The Stroop task also allows the bilingual advantage to be assessed by presenting participants with misleading information in the incongruent trial (Bialystok et al., 2004). Participants must make a choice between the conflicting information in order to choose the correct response, which tests participants' selective attention, inhibition to misleading information and their ability to switch between different options (Bialystok et al., 2004). Bilinguals have shown in previous studies to outperform monolinguals on the Stroop task, demonstrating smaller interference effects (Coderre et al., 2013).

### ***Working Memory***

Working memory as a concept has evolved over time, originally being recognized as a peripheral system, using attentional control processes to manage both the input and responses to the information that is being observed (Luo et al., 2013). Lately in the literature, both verbal and spatial WM have been shown to be independent aspects of WM and differences in both abilities have been a result of the WM system's ability to manage the different types of material being observed (Luo et al., 2013). WM contains both attentional and executive function processes that are domain-general and depending on the aspects of the task being performed, WM has also domain-specific abilities (Luo et al., 2013). Therefore, it is demonstrated that any differences in WM and span performance would be a reflection of differences in attentional control and relevant knowledge domains (Luo et al., 2013).

WM has also been shown to have two components (Myerson et al., 2003). The first component is the storage component, which is specified based on the type of information the WM processes are being presented, (e.g., visuospatial or verbal) (Myerson et al., 2003). Within the storage component are two subsystems called the phonological loop and the visuospatial sketchpad (Donolato et al., 2017). The phonological loop provides short-term storage for speech material and is further composed of two subsystems: a passive phonological input store and an active articulatory rehearsal process (Hester et al., 2004). These two subsystems are connected via an executive system that consolidates and manipulates the information that is present (Donolato et al., 2017). The second component of WM is the processing component (Myerson et al., 2003). This component is focused on selecting, manipulating and strategizing the information that is in the storage components (Myerson et al., 2003). Both components of WM are affected by the aging process (Myerson et al., 2003). There is also shown to be a central executive, also known as an attentional

control system, that is a part of WM which is in charge of the selection, control and synchronizing of the processes that are responsible for short-term storage and other processing tasks (Hester et al., 2004).

Information that is held in WM tends to be shaped, reconstructed and revised by active executive functions or controlled attention (Luo et al., 2013). Research has indicated an overlap in executive function and WM processes and bilingualism has shown to provide an advantage in executive function for older adults (Bialystok et al., 2008). The constant management of two language systems has shown increases in the efficiency of WM capacities in bilinguals, as inhibitory processes are an appropriate way to manage WM resources (Adesope et al., 2010). Studies have demonstrated that by bilinguals using two different language systems, it is important to have control of their working memory processes to ensure they are using all of their working memory resources (Bialystok et al., 2008). By using all of their working memory resources more frequently, this could potentially lead to improved resources for other cognitive processes, potentially leading to improved function (Bialystok et al., 2008). In the study, Wodniecka, Craik, Luo & Bialystok (2010), bilinguals showed having an advantage on verbal tasks involving familiarity and recollection of words and it was concluded the advantage was related to retrieval processes placing higher demands on executive control processes (Ljungberg et al., 2013).

In this present thesis, working memory is measured using the Letter/Number sequencing task. An advantage to using the Letter/Number Sequencing task is the ability to assess an individual's maintenance and storage components of their WM (Wilde et al., 2004). Span tests utilizing an individual's memory like the Letter/Number Sequencing task has shown to be a measure that is able to examine both individuals' intellectual and information

processing abilities (Schofield & Ashman, 1986). As indicated in the study by Schofield & Ashman (1986), a forward digit span test, and similar to the Letter/Number Sequencing task, is a test that measures sequential processing.

Due to the fact that the Letter/Number Sequencing test places a higher value on the individual's ability to manipulate information, the Letter/Number Sequencing task allows a more sensitive test to determine the effects of aging on the processing components of WM (Myerson et al., 2003). As the phonological loop, which is a part of WM, is able to keep a line of verbal items in a short-term order, the Letter/Number Sequencing task is a good task to measure working memory processes since the Letter/Number Sequencing task asks participants to repeat letters and numbers in a forward order for a short period of time (Hester et al., 2004). One disadvantage of using the Letter/Number Sequencing task is due to information being presented repeatedly in the forward order with each string length, the individual is getting additional exposure to the information that is being presented, which could possibly impact the score (Wilde et al., 2004). Research has indicated that a disadvantage to using a forward digit span test, similar to the Letter/Number Sequencing task, is poor performance on this task, which could be a result of sequential processing deficit and not be due to deficits in executive functioning (Schofield & Ashman, 1986). Other research has demonstrated that differences that are showcased on digit span tests, similar to the Letter/Number Sequencing task can, likely to be due to processing or planning deficits and once again not be due to the individual's deficits or declines in executive function (Schofield & Ashman, 1986).

### ***Episodic Memory***

Episodic memory is a cognitive process that is characterized by its relation between events and context and composes memories based on the information displayed for specific experiences (Eichenbaum, 2017). Research has indicated that bilinguals have outperformed monolinguals in episodic memory tasks (Rosselli et al., 2019). Other studies report that bilinguals' abilities to recall information on episodic memory tasks can vary depending on the degree of bilingualism of the individual and the language in the list of items is presented (Harris et al., 1995). Nott and Lambert (1965) indicated that French/English bilinguals who reported equal proficiency in both languages recalled 3.4 more words per list than individuals who were proficient in either English or French but not both (Harris et al., 1995).

In the present thesis, episodic memory is assessed using the California Verbal Learning Test (CVLT II) (Harris et al., 1995). An advantage to using the CVLT II task is that it measures both memory and verbal learning by specifically analyzing the learning process (Randolph et al., 1994). It allows researchers to distinguish individuals' problems in encoding verbal information compared to problems in the retrieval of verbal information (Sciaraffa, 1995). Research has indicated that studying the process of how an individual performs on a task demonstrates more valuable information than a task that just generates a score that represents the level of the individual's learning and remembering abilities (Sciaraffa, 1995).

One issue that the studies have uncovered when using CVLT II, is that when the task is not properly standardized and it has a relatively small reference group, the norms of the task are inadequate and inflated (Elwood, 1995). Other research has stated that sensitivity of the CVLT II comes at an increased possibility for creating false positives as the memory problems that are indicated may be due to a temporary difficulty in attention and concentration (Sciaraffa, 1995). Never having words presented to individuals, following

another word from the same semantic category, does present a limitation regarding what information can be gathered about an individual by using the CVLT II (Sciaraffa, 1995).

### *Language*

Studies have shown that bilinguals have displayed possible disadvantages in language function tasks compared to monolinguals (Bialystok & Craik, 2010; Kousaie et al., 2014; Quinteros Baumgart & Billick, 2018). Disadvantages have been documented in verbal recall, which may be attributed to bilinguals having less access to particular words from having two different language vocabularies, creating weaker connections between words and concepts (Bialystok, 2009; Bialystok et al., 2004). Bilinguals have shown to have slower lexical retrieval and rapid lexical access in response to the disadvantages (Bialystok & Craik, 2010; Kousaie et al., 2014; Quinteros Baumgart & Billick, 2018). Deficits in lexical retrieval and language proficiency in bilinguals have been demonstrated in areas of retrieval of specific lexical items and their representational base (Bialystok, 2009). In addition, research has proven that bilinguals display slower lexical retrieval in accessing words in their nondominant language compared to monolinguals (Pelham & Abrams, 2014).

Smaller vocabulary sizes in each language system have also been documented in bilinguals, possibly being linked to the disadvantage for bilinguals along with interference from the non-target language (Bialystok, 2009; Ljungberg et al., 2013; Quinteros Baumgart & Billick, 2018). These smaller vocabulary sizes have led bilinguals to demonstrate slower identification of pictures on picture-naming tasks, score lower on semantic fluency tasks than monolinguals and decrease performance on tasks involving word recall (Bialystok, 2007; Ljungberg et al., 2013; Patra et al., 2020; Quinteros Baumgart & Billick, 2018). Bilinguals

have shown to have more “tip of the tongue” experiences than monolinguals (Quinteros Baumgart & Billick, 2018).

On tasks involving lexical retrieval, verbal fluency or picture naming, bilinguals have performed worse than monolinguals in their first language (Coderre et al., 2013). The study by Coderre et. al., (2013) indicated the disadvantage reported by bilinguals is due to non-selective access to a unified lexicon. Having two or more lexicons activated at the same time increases competition between lexical candidates (Coderre et al., 2013). This hinders lexical access, which results in a disadvantage in performance for bilinguals compared to monolinguals (Coderre et al., 2013).

The Weaker Link Hypothesis associates the disadvantage for bilinguals to be linked between language production and the reoccurring use of the language (Coderre et al., 2013). Bilinguals use both their primary language and secondary language less often, resulting in weaker links between words and concepts (Coderre et al., 2013). Weaker links result in slower lexical access which would demonstrate longer response times in tasks examining lexical access (Coderre et al., 2013). As bilinguals use their primary language less often than monolinguals, bilinguals will display slow lexical processing even for their primary language (Coderre et al., 2013). The Reduced Frequency Hypothesis also predicts slow lexical access in bilinguals’ non-dominant language (Coderre et al., 2013). In previous research, their secondary language as bilinguals demonstrates less frequent use of their secondary language compared to the primary language (Coderre et al., 2013). The Reduced Frequency Hypothesis also projects delayed lexical access in bilinguals’ second language compared to their first language as a result of the second language being used less often (Coderre et al., 2013). Research has shown as bilinguals also do not use their first language as often as

monolinguals, the Bilingual L1 Lexical Disadvantage Hypothesis anticipates bilinguals to demonstrate slow lexical processing in their first language (Coderre et al., 2013).

In the bilingual lexicon, pathways that are responsible for the associative networks between concepts and words would be distributed between two languages which would make the associations between each language less fluid and less practiced in bilinguals (Bialystok, 2009). These disadvantages could also be dependent on the age of acquisition of the bilinguals' second language (Patra et al., 2020). Bilinguals display significant lexical competition as both languages are consistently activated when language processing is occurring (Patra et al., 2020). This lexical competition could be an indicator of bilinguals' poorer performance on language function tasks as compared to monolinguals (Patra et al., 2020). Bilinguals have also shown to have more tip of the tongue experiences, indicating that bilinguals have a difficult time to identify words through noise, causing bilinguals to encounter interference with their lexical decision (Bialystok, 2009).

Bilinguals have shown to display a disadvantage in picture naming tasks, naming pictures more slowly and less accurately in their dominant language than monolinguals (Coderre et al., 2013; Pelham & Abrams, 2014). This disadvantage could be a result of a wide-range access to a combined bilingual lexicon (Coderre et al., 2013). The presence of more than one lexicon being activated at the same time is said to create competition and interactions between possible lexical candidates, slowing down the process of lexical access, proceeding to a performance disadvantage for bilinguals compared to monolinguals (Coderre et al., 2013).

Bilinguals have also shown to take longer on picture naming tests such as the Boston Naming Test (BNT), a task where participants are asked to name the picture in front of them

that increases in difficulty as the task goes on (Bialystok, 2009; Kousaie et al., 2014). Monolinguals have demonstrated to outperform bilinguals in both areas of accuracy and response time in BNT, even when bilinguals are tested in their dominant language (Medvedev et al., 2019). Bilinguals have demonstrated scoring lower than monolinguals and even at lower levels of difficulty on the BNT, bilinguals showed a decline in performance (Medvedev et al., 2019; Quinteros Baumgart & Billick, 2018).

The BNT is the best widely known neuropsychological test that evaluates individuals' language function including word-naming and word retrieval (Ekinci Soylu & Cangöz, 2018). BNT has been known to be an adequate tool that detects cognitive impairment and word-finding difficulties (Harry & Crowe, 2014; Hobson et al., 2011). Despite the advantages, BNT has been criticized for inadequate norms and standardizations and having a non-normal scoring distribution that is negatively skewed due to ceiling effects (Durant et al., 2021; Medvedev et al., 2019). Due to these non-normal scoring distributions, the BNT may be beneficial for detecting impairments in word naming but may be less efficient in determining different levels of word-finding abilities or distinguishing between levels of impairment (Durant et al., 2021). Another limitation of the BNT could be that due to the scores clustering around the mean, the test could be considered a pass or fail test (Hawkins & Bender, 2002). This creates uncertainty as normal individuals with small vocabularies do tend to score significantly lower than individuals who are average or above (Hawkins & Bender, 2002).

### **Bilinguals and Subjective Cognitive Decline**

Subjective Cognitive Decline can be described as repeated expressions of forgetfulness often in areas of cognition that are problematic for individuals (Montejo Carrasco et al., 2017). SCD has shown to be common among older adults, where research has

indicated that one in three older adults aged 75 years and older experience SCD (Riedel-Heller et al., 1999). It has been demonstrated that older adults' beliefs regarding their cognition has shown to impact and potentially intensify any SCD that older adults might already have (Fritsch et al., 2014). SCD in memory has demonstrated to be the most frequent subjective complaint that older adults have regarding their health and functionality (Blazer et al., 1997). The presence of SCD has been shown to be linked with reduced quality of life and mental health among older adults and be the earliest stage of pathologic cognitive decline that is detected in older adults (Mitchell et al., 2014; Smart et al., 2014). SCD has been related to other conditions that affect older adults such as depression, anxiety, problems regarding physical health and chronic diseases (Rabin et al., 2015).

Studies have shown that SCD not only predicts older adults' future cognitive abilities related to their potential for cognitive decline but it has also shown to be an indication of older adults' current well-being (Mitchell et al., 2014). Research has indicated that older adults who worry significantly regarding their cognitive function are more likely to experience dementia over the following four years, compared to older adults who displayed no worries regarding their cognitive function (Snitz et al., 2015). As SCD impacts many different factors in an older adult's overall well-being, it demonstrates the importance of examining SCD levels in older adults and paying close attention to any potential increases (Reid & MacLulich, 2006).

A study performed by Fritsch and colleagues (2014) assessed SCD in older adults based on their own perception of their cognitive abilities and asked participants to classify their memory problems based on whether the memory problem was serious, somewhat of a problem or not much of a problem. Currently, in the literature, the identification of SCD has been solely reliant on individuals' self-reporting their difficulties relating to cognitive

functioning (Smart et al., 2014). Research has indicated that individuals who self-report their shortcomings in cognitive function increase the possibility of experiencing future cognitive decline (Macoir et al., 2019).

Previous studies have indicated that having a higher level of education can lead the individual to be more resourceful in utilizing memory strategies to counteract deficits in their cognition, giving the individual an overall better understanding of their memory abilities (Crumley et al., 2014). Research has indicated that lifelong bilinguals have an advantage due to bilingualism providing an advantage in helping bilinguals maintain their cognitive performance, reducing age-related declines in their cognitive processes (Gold et al., 2013). Bilingual individuals have shown to have the ability to suppress the non-target language, which has demonstrated to possibly lead to improved executive function (Antón et al., 2016; Gold et al., 2013).

### ***Executive Function***

Many different studies have indicated that an overall decline in cognitive functioning, specifically in the area of attentional control, could possibly result in an increase in subjective cognitive decline due to the sensitivity of declines in attention capacity in the early stages of individuals' cognitive decline (Fritsch et al., 2014; Langlois & Belleville, 2014; Smart et al., 2014). Attentional control has also shown to provide support to other cognitive domains such as memory, however, bilingualism seems to provide a potential advantage for tasks specific to controlled attention due to the usage of two language systems (Adesope et al., 2010; Bialystok, 2007, 2011). Also, the individual requires greater attentional control to suppress the interference from the language that is not in use and focus on the language that is being used (Adesope et al., 2010; Bialystok, 2007, 2011). If older adults are having difficulty with

their basic attention capacity, this could potentially lead to affecting their ability to encode new information, as well as their ability to merge and recall that information, possibly leading to memory declines (Smart et al., 2014). However, advantages have been demonstrated in bilinguals (Perani & Abutalebi, 2015; Smart et al., 2014). For example, as their executive function system is constantly being used, it increases its effectiveness, leading to both advantages in attentional control, which could potentially lead to advantages in memory, as the executive function system is possibly preventing declines in attention, since memory problems have been shown to be a result of impaired attention (Perani & Abutalebi, 2015; Smart et al., 2014).

Older adults who engage in executive function tasks more frequently have shown to potentially demonstrate an increase in SCD in areas of executive function (Fritsch et al., 2014; Langlois & Belleville, 2014). On the other hand, bilingualism has shown to provide a possible advantage in areas of executive function due to bilinguals having two different language systems (Bialystok, 2009; Kousaie et al., 2014). As a result, more efficient use of executive function control processes arises to enhance attentional control of the one language system, while suppressing interference from the other language system, leading to enhancements of other cognitive function processes (Bialystok, 2009; Kousaie et al., 2014).

### ***Language***

Bilinguals have demonstrated in many different studies' possible disadvantages in language function tasks compared to monolinguals, indicating that bilinguals show a slower rate of identifying pictures on picture naming tasks, similarly to the BNT and objective performance tasks that include word recall, similarly to CVLT II (Bialystok, 2007; Bialystok et al., 2010; Kousaie et al., 2014; Ljungberg et al., 2013; Patra et al., 2020; Quinteros

Baumgart & Billick, 2018). On the other hand, this could possibly indicate that monolinguals would show faster rates on picture naming tasks and showcase an increase in performance on objective performance tasks involving word recall, leading to potentially monolinguals displaying less SCD in language function tasks compared to bilinguals, thus pointing to a significant difference.

### **Subjective Cognitive Decline as a predictor of Objective Performance in Bilinguals and Monolinguals**

The purpose of the following study was to evaluate SCD as a predictor of objective cognitive performance in monolingual and bilingual older adults and compare differences in subjective cognitive decline and objective performance in both samples. The current literature presents significant gaps regarding evaluating *SCD being a predictor of objective performance in bilingual and monolingual older adults and comparing differences in SCD and objective cognitive performance between the two samples.* There is a limited number of research studies that have looked at SCD being a predictor of objective performance in bilingual and monolingual samples and comparing differences in SCD and objective performance between both samples, using a range of psychometric measures. Comparing differences and evaluating SCD as a predictor of objective cognitive performance in bilingual and monolingual older adults will demonstrate the possible significant advantages that bilingualism could have on older adults and provide new information on their cognitive functioning. Such new insight could help older adults maintain their cognitive functioning for a long period of their lifespan, which would have both social and economic benefits (Perani & Abutalebi, 2015; Quinteros Baumgart & Billick, 2018). As the older adult population is the

fastest-growing demographic in Canada and the bilingualism rate in Canada has reached an all-time high, this is an immensely important area of research (Statistics Canada, 2017).

Previous research has indicated that bilinguals have demonstrated an advantage in executive function and since there is an overlap between executive function and WM processes, bilinguals have also shown a possible advantage in working memory relative to monolinguals (Bialystok et al., 2008; Perani & Abutalebi, 2015; Quinteros Baumgart & Billick, 2018). The evidence suggested that bilinguals performed better on episodic memory tasks than monolinguals (Rosselli et al., 2019). Bilinguals have also shown to have possible disadvantages in language function tasks compared to monolinguals (Bialystok & Craik, 2010; Kousaie et al., 2014; Quinteros Baumgart & Billick, 2018). Therefore, it is hypothesized that:

**Hypothesis 1: Bilinguals will show a stronger performance on executive function tasks, episodic memory tasks and weaker performance on language tasks, relative to monolinguals.**

Previous research has indicated that declines in the area of attention and engaging in executive function tasks more frequently for bilinguals has led to possibly an increase in subjective cognitive decline (Fritsch et al., 2014; Langlois & Belleville, 2014). On the other hand, bilinguals have demonstrated an advantage in executive function due to having two different language systems enhancing attentional control due to having to suppress one language system, while the other language system is in use (Bialystok et al., 2008; Perani & Abutalebi, 2015; Quinteros Baumgart & Billick, 2018). Therefore, it is hypothesized that:

**Hypothesis 2: Bilinguals will show lower levels of SCD than monolinguals.**

SCD has been shown in previous research to be a predictor of objective cognitive performance (Jorm et al., 2001). Studies that have examined cognitive performance in different areas of cognitive functioning and have demonstrated an individual's self-reported SCD could be a significant predictor of objective performance in some areas of cognitive function such as on memory tests (Jonker et al., 1996; Riedel-Heller et al., 1999). Moreover, a subjective cognitive decline has shown to be a predictor of objective deficits in attention and memory, relative to other cognitive domains (Amariglio et al., 2011; Bialystok, 2007; Bialystok et al., 2008; Bialystok & Craik, 2010; Cargin et al., 2008; Jessen et al., 2007; Jonker et al., 1996; Perani & Abutalebi, 2015; Quinteros Baumgart & Billick, 2018; Riedel-Heller et al., 1999). It is therefore hypothesized that:

**Hypothesis 3: In the monolingual sample, SCD will be a predictor of objective performance.**

Riedel-Heller et al., (1999) examined SCD and performance in both visual and verbal memory tasks and found that individuals who reported more memory problems in the different tasks scored significantly lower on those tasks, demonstrating that SCD could potentially be a predictor of their objective performance. Other research such as the study done by Jonker et al., (1996) examined SCD as a predictor of objective performance in older adults without depression or dementia and found that older adults who reported SCD, performed more poorly on cognitive tasks than older adults who did not report any SCD. Bilinguals have shown possible disadvantages in language function tasks, these disadvantages could possibly lead to an increase in SCD for bilinguals in language, potentially leading to SCD being a predictor for objective cognitive performance in language function tasks

(Bialystok & Craik, 2010; Kousaie et al., 2014; Quinteros Baumgart & Billick, 2018).

Therefore, it is hypothesized that:

**Hypothesis 4: In the bilingual sample, SCD will be a predictor of objective performance on language tasks.**

## Methods

### Study Population

The data for this study was drawn from the Bruyère Research Institute and an addendum request was approved for use of the data by the Chair of the Research Ethics Board from Bruyère Research Institute. This study was approved for secondary use of data by the Saint Paul University Research Ethics board (REB). The study had participants complete a series of tasks evaluating semantic function. The participants were tested in two waves: the first wave consisted of the initial data collection of the full set of stimuli and the second wave collected data from more sensitive stimuli that could differ between the participants. The study was a cross-sectional design, with a convenience sample consisting of healthy older adults ages 65 and older who have been fluent in both English and French languages since the age of 13 or younger. Participants were of either female or male gender and their average years of birth was 1943. Participants also had an average of 16 years of education.

Participants were included in the study if their primary spoken language was English, reported good health and normal vision and hearing. Participants were also included in the study if their cognitive functioning was clinically appropriate based on results from the Montreal Cognitive Assessment, which detects mild cognitive impairment (MCI) in older adults with high sensitivity and specificity (Nasreddine et al., 2005). Based on Montreal Cognitive

Assessment individuals with MCI or AD would score below normal cognitive function ( $<26/30$ ) and normal range would be ( $\geq 26/30$ ) (Nasreddine et al., 2005).

The sample was recruited from exercise classes, community centres, and advertisements from local newspapers, supermarkets and nursing homes. Participants were excluded from the study if they had any history of neurological or psychiatric disease, if they met criteria for major depression, measured using the Geriatric Depression Scale or had any significant cardiovascular diseases (Muller et al., 2007; Yesavage et al., 1982).

The data for this study was analyzed using Statistical Package for Social Science (SPSS, Version 28), a publicly available statistical software used for many different types of research analysis in social science. The sample of this study consisted of participants aged 65 years and older ( $n=183$ ). Excluding the missing data, the final analysis of the study consisted of 183 participants, 101 monolingual participants and 82 bilingual participants.

### ***Bilingualism***

To measure bilingualism participants gave self-reports of age of acquisition and proficiency. Bilingualism was assessed based on self-reported language proficiency in both English and French. Participants were asked at what age they first learned to speak English and French and at what age they became fluent in English and French. Participants were assessed using a 5-point Likert scale, examining an individual's proficiency in both English and French in four areas: reading, writing, speaking and listening. On the 5-point Likert scale, 1=no ability and 5= native likeability. Participants who indicate 5 on the Likert scale will demonstrate a higher proficiency than participants who indicate 1.

### **Predictor**

#### ***Subjective Cognitive Decline***

To assess subjective cognitive decline, participants were asked 3 yes/no questions measuring older adult's memory problems, which assesses their memory, word-finding difficulties, which looks at their language function and problems with concentration, which assesses their attentional abilities. The questions were: "Do you have memory problems?", "Do you have word-finding difficulties?", and "Do you have problems concentrating?". Questions were divided into categories based on previous literature indicating that working memory, attention and word-finding difficulties are areas of concern for older adults (Langlois & Belleville, 2014). Participants indicating yes on any of the three questions would indicate that the participant has difficulties or problems in that area of SCD. Participants indicating no on any of the three questions would indicate that the participant has no difficulties or problems in that area of SCD. Previous research has shown that asking one to three general questions to assess subjective cognitive decline has been a frequently used method (Montejo et al., 2014). Other research has demonstrated the use of self-reported questionnaires using yes and no questions to assess different areas of individuals subjective cognitive decline has been effective and other studies have indicated that asking one question was no more effective than using a structured question (Cargin et al., 2008; Spano et al., 2020).

## **Outcome**

### ***Objective Cognitive Performance***

Objective performance was assessed specifically looking at 3 areas of cognition: language, memory and attention. Data from four neuropsychological tasks was used to analyze older adults' objective cognitive performance:

1. The Stroop task was published by Stroop, (1935). This task specifically measures individual's executive function (Kousaie et al., 2014). The Stroop task consists of three conditions, two congruent conditions; word reading and color naming and one incongruent condition; color naming (Kousaie et al., 2014). Participants were presented in each of the three conditions a sheet with 4 columns containing 30 stimuli appearing in random order and asked to complete as many trials in 45s as possible, moving from the first column and going downwards (Kousaie et al., 2014). In the first congruent condition, the word naming, participants were asked to read the colored words GREEN, RED, BLUE AND YELLOW which were presented in black writing as many times as possible (Kousaie et al., 2014). In the second congruent condition, the colour naming, participants were presented a line of six X's which were either green, blue, yellow or red and asked to name as many of the colours of the stimuli as possible (Kousaie et al., 2014). In the third condition, the incongruent condition of the Stroop task, the colour words red, blue, yellow and green were printed in an incongruent colour (Kousaie et al., 2014). Each colour word appeared 10 times and participants had to identify the font colour of as many words as possible without reading the word (Kousaie et al., 2014). A score was generated for how many correct answers the participants got in 45 seconds in each trial (Kousaie et al., 2014). A higher score would indicate that participants answered more correct answers in each trial and a lower score meant that participants gave fewer correct answers in each trial within 45 seconds. Afterwards, a Stroop interference score was calculated by adding together the two congruent trials and subtracting the two congruent trials from the incongruent trial of the Stroop task to eliminate any irrelevant information in the environment that would impact the participants ability to name

correctly the colour of the word in the incongruent trial (Kousaie & Phillips, 2012). A lower Stroop interference score would demonstrate that participants got less correct answers in both the congruent trials and the incongruent trial, resulting in worse performance. A higher Stroop interference score would demonstrate that participants got more correct answers in both the congruent trials and the incongruent trial, resulting in better performance. Prior studies have presented the Stroop task's reliability as a psychometric measuring tool and effectiveness as a performance validity test (Erdodi et al., 2018; Faulkner et al., 2020). Other studies have determined that the Stroop task has high test-retest reliability with each condition and the color-naming times are also reliable (Strauss et al., 2005). Furthermore, there is evidence that the responses that were observed in the color-word format were also highly reliable (Strauss et al., 2005). Previous studies have indicated Stroop reliability coefficients to be .86 for the word score, .82 for the colour score and .73 for the colour-word score, which has proven by other research studies to be within the range for high reliability scores, the reliability coefficients ranged from (.72-.88) (Franzen et al., 1987; Jensen, 1965).

2. Boston Naming Test (BNT) published by Kaplan et al., (1983). BNT assesses individual's language function, by using a picture naming method, where individuals are presented an image one by one and asked to name the item (Kousaie et al., 2014). The task consists of a total of 60 line drawn images that are presented to participants in order of difficulty from "easiest" to "most difficult" (Harry & Crowe, 2014; Kousaie et al., 2014). One point was given for each image that was identified correctly (Kousaie et al., 2014). Higher scores reflected that participants identified more images correctly, resulting in better performance and lower scores meant that participants identified less

images correctly, resulting in worse performance. Research has demonstrated that BNT has both well-established validity and reliability (Harry & Crowe, 2014). Multiple studies have reported BNT to be the most frequently used method to measure neuropsychological function and to have an external reliability rate of 93% (Messerly & Marceaux, 2020; Namdar Khatibani et al., 2020). BNT has demonstrated reliability that is satisfactory and converging validity (Medvedev et al., 2019). The internal consistency of BNT ranges from .78 to .96 and test-retest reliability scores range from .59 to .92 represented by Cronbach's alpha values which corresponds with other picture naming tasks ( $r=.59-.92$ ) (Medvedev et al., 2019; Strauss et al., 2006).

3. California Verbal Learning Test (CVLT II) was published by Delis et al., (2000). This task will measure individuals' episodic memory (Harris et al., 1995). Participants are presented orally two 16 word lists (Hill et al., 2012). List A consists of 4 separate semantic categories, presented with 4 words in each category, this list is presented 5 consecutive times to participants and participants are asked to recall the list after each time presented (Delis et al., 2005; Hill et al., 2012). List B is presented a single time and List B is used as an interference trial (Delis et al., 2005; Hill et al., 2012). An interference list (List B) is subsequently presented to participants who are then asked to recall the list of words presented (Hill et al., 2012). Once list B is presented, participants are asked to recall List A (Hill et al., 2012). This is known as the free recall trial (Hill et al., 2012). Afterwards, a semantic cue is given for each of the four semantic categories and participants' cued recall is analyzed (Hill et al., 2012). Participants' free and cued recall abilities are tested again in 20 minutes, followed by a recognition trial using a combination of words that appear on List A (Hill et al., 2012). The participants then must

answer either yes or no to the words appearing on the list (Hill et al., 2012). Participants are scored on CVLT II by the traditional correct recall score known as the (T score) (Delis et al., 2005). The T-score represents the total amount of words the participants were able to recall within trials 1-5 (Delis et al., 2005). A high T-score would indicate that participants recalled more words within 1-5 trials, demonstrating better performance and a lower T-score would indicate participants recalled less words, demonstrating worse performance on the CVLT II. CVLT II has proven to have high internal consistency based on previous studies measuring split-half reliability ( $r=.94$ ) in a sample of 1,087 adults aged 16-89 years old (Yochim et al., 2015). CVLT II has also proven to have reliable internal consistency scores for both total recall and test-retest reliability based on a subsample of 21 participants (Elwood, 1995). Previous research has indicated CVLT II to have long-term reliability and proven to be a widely used psychometric tool in measuring healthy older adults' verbal learning and memory (Alioto et al., 2017). Reliability coefficients for the CVLT II ranged from .50 to .72, which previous research has indicated that reliability coefficients of at least .7 are acceptable, but coefficients lower than .4 to .6 are not acceptable (Alioto et al., 2017). Other studies have concluded that CVLT II has good discriminative validity (Elwood, 1995). CVLT II has shown to have higher and more robust reliability coefficients than other commonly used memory tests (Delis et al., 2007).

4. Letter/Number Sequencing task was published by Wechsler (1997). The Letter/Number Sequencing task measures individuals' executive function by having participants recall a list of letters and numbers (Chen et al., 2018; Mielicki et al., 2018). The list of letters and numbers is presented to the participant and the participant is asked to recall the list of

numbers first, in ascending order, and then is asked to recall the list of letters in alphabetical order (Coalson et al., 2010). There is no time limit placed on the participants to respond (Coalson et al., 2010). The list of letters and numbers is presented to the participant at the rate of one number and letter per second (Coalson et al., 2010). The list of numbers is presented first to participants with 2 digits and then the string length increases by 1 digit each time until a maximum of 9 digits has been presented in one string length in numerical order (Kousaie et al., 2014). The list of letters is presented the same way, where the participant is presented two letters at the beginning and the string length increases by 1 letter each time until a maximum of 9 letters has been presented in one string length (Kousaie et al., 2014). For each string length presented for both letters and numbers, there are two trials where a point is given each time the string length is done correctly (Kousaie et al., 2014). Higher scores indicate that participants identified more string lengths correctly for both letter and number trials, resulting in better performance. Lower scores indicate that participants identified less correct string lengths for both letter and number trials, resulting in worse performance. The task was discontinued as soon as a participant made an error within a trial at any string length (Kousaie et al., 2014). The letter/number sequencing task is a part of the WM subtests of the Wechsler Adult Intelligence Scale III (Wechsler, 1997). Previous studies have indicated that the Letter/Number Sequencing task has a high validity rate as a psychometric measure assessing an individual's WM (Chen et al., 2018). As the Letter/Number Sequencing task is very similar to the Digit Span test, the Letter/Number Sequencing task is shown to have high internal consistency (Iverson, 2001). The Letter/Number Sequencing task is also part of the WM index of the WMS-III subtests

(Iverson, 2001). The WM index demonstrates a test-retest reliability score of 0.80 among older adults (Iverson, 2001). Adequate test-retest reliability scores range between (0.75-0.99) and low test-retest reliability is (<0.70) (Iverson, 2001).

### **Statistical analysis**

Separate comparisons were conducted for both the bilingual and monolingual sample to assess differences in subjective cognitive decline and objective performance individually, using independent sample t-tests. The separate comparisons tested for both the first hypothesis that stated bilinguals would show a stronger performance on executive function tasks, episodic memory tasks and weaker performance on language tasks, relative to monolinguals. In contrast, the second hypothesis stated that bilinguals would show lower levels of SCD than monolinguals. To test the third hypothesis that stated, in the monolingual sample, SCD would be a predictor of objective performance and the fourth hypothesis that stated in the bilingual sample, SCD would be a predictor of objective performance on language function tasks. Four linear regressions were conducted for the monolingual sample and four other separate linear regressions were conducted for the bilingual sample. All eight linear regressions aided to identify how each of the different domains of SCD (attention, memory and language) could be predictors of objective cognitive performance in the monolingual and in the bilingual sample. The variance was accounted for with each linear regression analysis that was approximated using Nagelkerke  $R^2$ . The data was analyzed using SPSS, Version 28 (SPSS, Inc., Armonk, NY) for Microsoft Windows.

## **Results**

### **Sample characteristics**

Table 1 reported the overall sample consisting of 101 (55.2%) monolinguals and 82 (44.8%) bilinguals ( $N=183$ ).

In the bilingual sample, the range of years of birth of the participants was between 1954-1931 and the average year of birth for the bilingual sample was 1945. The education level ranged from 11 years of education up to 23 years of education and the average years of education was 17. The gender of the bilingual sample varied between 29 male and 53 female participants and the average gender in the bilingual sample was female.

In the monolingual sample, the range of years of birth of the participants was between 1925-1953 and the average year of birth for the monolingual sample was 1942. The education level ranged from 11 years of education up to 22 years of education and the average years of education of the monolingual sample was 16. The gender of the monolingual sample varied between 36 male and 65 female participants and the average gender was female.

Table 2 displays the different frequency distributions and percentages of subjective cognitive decline in areas of attention, memory and language in the monolingual sample. Table 3 showcases the frequency distribution and percentages of overall subjective cognitive decline in the areas of attention, memory and language in the bilingual sample.

### **Executive Function, Episodic Memory and Language Function Tasks**

In Table 4, an independent sample t-test was conducted to determine if there was a difference in performance for bilinguals on executive function tasks, episodic memory tasks and on language function tasks, relative to monolinguals. **Hypothesis 1: Bilinguals will show stronger performance on executive function tasks, episodic memory tasks and weaker performance on language tasks, relative to monolinguals.** The missing data from the executive function, episodic memory and language function tasks were excluded from the results of the

independent sample t-test. The results in Table 4 showed that in the Stroop task, which tests an individual's executive function, monolinguals (M=126.7, SD=21.02) and bilinguals (M=119.1, SD=20.30) demonstrated significant differences in scores on the Stroop task,  $t(173) = 2.41$ ,  $p < 0.05$ . In the BNT test, which examined language function, monolinguals (M=53.3, SD=4) were compared to bilinguals (M=49.2, SD=6.15) which showed a significant difference between scores,  $t(132) = 5.05$ ,  $p < 0.05$ . In CVLT II test, which examined episodic memory, there was no significant difference in scores  $t(172) = 0.94$ ,  $p = 0.70$  between monolinguals (M=56.7, SD=9.14) and bilinguals (M=55.4, SD=9.72). In the LNS task, which tested working memory, monolinguals (M=10.4, SD=2.36) and bilinguals (M=9.4, SD=1.80), displayed a significant difference in scores,  $t(140) = 2.93$ ,  $p < 0.05$ . These results conclude based on the 2 tailed p-value that there was a significant difference between monolinguals and bilinguals in their performance on the Stroop, LNS task and BNT. The results conclude based on the means that monolinguals showed stronger performance on the Stroop and LNS relative to bilinguals. The results also conclude that bilinguals showed weaker performance on the BNT than monolinguals.

### **Subjective Cognitive Decline**

An independent sample t-test was conducted to examine differences between subjective cognitive decline in both the monolingual and bilingual sample. **Hypothesis 2: Bilinguals will show lower levels of SCD than monolinguals.** The missing data in both the categories of memory and language was excluded from the independent sample t-test results. As displayed in Table 5, in the category of attention, there was no significant difference in SCD between monolinguals (M=0.12, SD=0.33) and bilinguals (M=0.10, SD=0.30),  $t(181) = 0.46$ ,  $p = 0.36$ . In the category of memory, there was no significant difference in SCD between monolinguals (M=0.16, SD=0.37) and bilinguals (M=0.24, SD=0.43),  $t(156) = -1.31$ ,  $p = 0.19$ . In the category

of language, there was no significant difference in SCD between monolinguals ( $M=0.37$ ,  $SD=0.48$ ) and bilinguals ( $M=0.29$ ,  $SD=0.46$ ),  $t(174)=1.13$ ,  $p=0.26$ . These results conclude based on the 2 tailed p-value that in the categories of attention, memory and language, there is no significant difference in subjective cognitive decline between bilinguals and monolinguals.

### **Subjective Cognitive Decline as a predictor of Objective Performance in Bilinguals and Monolinguals**

Table 6 shows the results of linear regression analyses that were conducted to assess whether SCD in attention, memory or language were predictors of objective cognitive performance in the sample of monolingual older adults. **Hypothesis 3: In the monolingual sample, SCD will be a predictor of objective performance.** The linear regressions were also performed to determine if SCD in attention, memory or language were predictors of objective cognitive performance in the sample of bilingual older adults. **Hypothesis 4: In the bilingual sample, SCD will be a predictor of objective performance on language tasks.** By examining the p-value in the linear regression analysis, it can be determined what area of SCD (attention, memory and language) is a significant predictor of objective cognitive performance in the Stroop, BNT, CVLT II and LNS. The missing data for both SCD and objective performance was excluded from the results of the linear regression analysis for both the bilingual and monolingual samples.

The results of the regression for the monolingual sample are displayed in Table 6. These results suggest that in the Stroop task, SCD explained 4% of the variance in objective performance,  $R^2=0.04$ ,  $F(3,91)=1.23$ ,  $p>0.05$ . In the Stroop task, SCD was not a significant predictor of objective performance in the category of attention  $B=-5.01$ ,  $t=-.69$ ,  $p>0.05$ , in the

category of memory  $B=10.38$ ,  $t=1.64$ ,  $p>0.05$  and in the category of language  $B=-5.47$ ,  $t=-1.15$ ,  $p>0.05$ .

In the BNT, SCD explained 2% of the variance in objective performance  $R^2=0.02$ ,  $F(3,84)=0.61$ ,  $p>0.05$ . SCD was also not a significant predictor of objective performance in the category of attention  $B=1.17$ ,  $t=0.78$ ,  $p>0.05$ , in the category of memory  $B=0.31$ ,  $t=0.24$ ,  $p>0.05$  and in the category of language  $B=-1.22$ ,  $t=-1.28$ ,  $p>0.05$ .

In the CVLT II, SCD explained 4% of the variance in objective performance,  $R^2=0.04$ ,  $F(3,91)=1.31$ ,  $p>0.05$ . SCD was also not a significant predictor of objective performance in the category of attention  $B=4.41$ ,  $t=1.40$ ,  $p>0.05$ , in the category of memory  $B=2.78$ ,  $t=1.01$ ,  $p>0.05$  and in the category of language  $B=-0.80$ ,  $t=-0.38$ ,  $p>0.05$ .

In the LNS task, SCD explained 11% of the variance in objective performance,  $R^2=0.11$ ,  $F(3, 72)=3.02$ ,  $p\leq 0.05$ . SCD was also not a significant predictor of objective performance in the category of attention  $B=1.17$ ,  $t=1.44$ ,  $p>0.05$ . SCD was a significant predictor of objective performance in the category of memory  $B=1.52$ ,  $t=2.05$ ,  $p<0.05$  and in the category of language  $B=-1.15$ ,  $t=-1.99$ ,  $p=0.05$ .

These results indicate that in the monolingual sample, SCD was not a significant predictor of objective performance in the Stroop, BNT, or CVLT II, in any of the three categories of attention, memory or language. But in the LNS task, SCD in memory and language was a significant predictor of objective performance in the category of both memory and language.

The results of the regression for the bilingual sample are displayed in Table 7. These results show that in the Stroop task, SCD explained 4% of the variance in objective performance,  $R^2=0.04$ ,  $F(3, 73)=1.10$ ,  $p>0.05$ . SCD was not a significant predictor of

objective performance in the Stroop task in the category of attention  $B=-8.54$ ,  $t=-1.08$ ,  $p>0.05$ , in the category of memory  $B=-2.86$ ,  $t=-0.50$ ,  $p>0.05$  and in the category of language  $B=-4.35$ ,  $t=-0.79$ ,  $p>0.05$ .

In the BNT, SCD explained 8% of the variance in objective performance,  $R^2=0.08$ ,  $F(3,72)=0.41$ ,  $p>0.05$ . SCD was also not a significant predictor of objective performance in the BNT in the category of attention  $B=-1.73$ ,  $t=-0.66$ ,  $p>0.05$ , in the category of memory  $B=-1.16$ ,  $t=-0.64$ ,  $p>0.05$  and in the category of language  $B=-0.15$ ,  $t=-0.09$ ,  $p>0.05$ .

In the CVLT II, SCD explained 10% of the variance in objective performance,  $R^2=0.10$ ,  $F(3, 72)=2.57$ ,  $p<0.05$ . SCD was also not a significant predictor of objective performance in the CVLT II in the category of attention  $B=2.20$ ,  $t=0.60$ ,  $p>0.05$  and in the category of memory  $B=-1.79$ ,  $t=-0.67$ ,  $p>0.05$ . In the category of language SCD was a significant predictor of objective performance  $B=-6.20$ ,  $t=-2.41$ ,  $p<0.05$ .

In the LNS task, SCD explained 1% of the variance in objective performance,  $R^2=0.01$ ,  $F(3, 59)=0.17$ ,  $p>0.05$ . SCD was also not a significant predictor of objective performance in the LNS task, in the category of attention  $B=0.36$ ,  $t=0.46$ ,  $p>0.05$ , in the category of memory  $B=-0.30$ ,  $t=-0.52$ ,  $p>0.05$  and in the category of language  $B=-0.18$ ,  $t=-0.19$ ,  $p>0.05$ .

These results indicate that in the bilingual sample SCD is not a significant predictor of objective performance in Stroop task, BNT or LNS in any of the three categories of attention, memory and language but that in the CVLT II task, SCD in language is a significant predictor of objective cognitive performance.

## Discussion

The purpose of this thesis was to evaluate SCD as a predictor of objective cognitive performance in monolingual and bilingual older adults and compare differences in subjective cognitive decline and objective performance in both samples. The thesis also examined if bilinguals showed stronger performance on objective performance on executive function tasks, episodic memory tasks and weaker performance on language tasks, relative to monolinguals, and whether or not bilinguals will show lower levels of SCD than monolinguals. The thesis further examined if SCD in the categories of attention, memory and language were stronger predictors of objective performance on executive function tasks (Stroop, LNS), episodic memory tasks (CVLT II) and a weaker predictor of objective performance on language tasks (BNT) in the monolingual sample. It also explored if SCD in the categories of attention, memory and language were weaker predictors of objective performance on executive function tasks (Stroop, LNS), episodic memory tasks (CVLT II) and a stronger predictor of objective performance on language tasks (BNT) in the bilingual sample.

### **Neuropsychological performance in monolinguals and bilinguals**

Significant differences in objective performance between monolinguals and bilinguals were reported in both the Stroop task and LNS task, which are executive function tasks. Significant differences in performance were also found between monolinguals and bilinguals on the BNT, which is a language function task. The results of the independent sample t-test did not fully support the first hypothesis, that bilinguals would show stronger performance on executive function tasks, episodic memory tasks and weaker performance on language tasks. The results also did not support previous research which indicated that bilinguals perform at a higher level than monolinguals on executive function tasks and have shown advantages, as

well as faster reaction times on tasks such as the Stroop task that are highly demanding with many different congruent conditions, than monolinguals (Bialystok et al., 2008; Kousaie et al., 2014; Perani & Abutalebi, 2015; Quinteros Baumgart & Billick, 2018). Research has theorized that continuous control of two language systems by bilinguals leads to smoother usage of executive function processes due to bilinguals continuously shifting between languages, and also by suppressing one language system while the other one is in use (Kousaie et al., 2014; Pelham & Abrams, 2014). These results not supporting the hypothesis may be due to demographic factors that were distributed differently between the monolingual and bilingual samples (e.g., education level) (Antón et al., 2016). It also questions the reliability, robustness and specificity of the bilingual advantage, suggesting that it is possible that the bilingual advantage is more specific and less vigorous than previously stated (Kousaie et al., 2014). The results did support previous research, which concluded that bilinguals showed possible disadvantages in language tasks, relative to monolinguals (Bialystok & Craik, 2010; Kousaie et al., 2014; Quinteros Baumgart & Billick, 2018). Bilinguals have demonstrated to score lower, even on lower levels of difficulty on the BNT than monolinguals (Medvedev et al., 2019; Quinteros Baumgart & Billick, 2018). Further research would need to be conducted using a variety of language tasks to confirm the validity of the results. More analysis using a variety of episodic memory tasks comparing differences in monolingual and bilingual older adults would also need to be done as research has indicated a difference in performance in bilinguals, relative to monolinguals on episodic memory tasks (Rosselli et al., 2019).

### **SCD in monolinguals and bilinguals**

We found no significant difference in SCD scores between the monolingual and bilingual samples. These results do not support the second hypothesis that bilinguals would show lower levels of SCD than monolinguals. Based on these results, this study did not support previous research that concluded that deficits in executive function have indicated a higher presence of SCD and bilingualism have shown to buffer age-related cognitive decline in areas of executive function (Antón et al., 2016; Bialystok et al., 2007, 2008, 2010; Kousaie et al., 2014; Langlois & Belleville, 2014; Perani & Abutalebi, 2015; Quinteros Baumgart & Billick, 2018). Regarding attention and memory, it was hypothesized that bilinguals would show lower levels of SCD than monolinguals, confirming that bilinguals showed advantages in executive function. In addition, the study did not support previous literature which demonstrated that declines in the area of attention has possibly led to an increase in subjective cognitive decline, but that bilinguals have demonstrated advantages in attention and memory, due to the constant usage of their executive function system, possibly preventing declines (Fritsch et al., 2014; Langlois & Belleville, 2014; Perani & Abutalebi, 2015; Smart et al., 2014). The study also did not support earlier research that proved bilinguals possibly having disadvantages in language function tasks when compared to monolinguals, possibly indicating that monolinguals could potentially show an increase in performance on language function tasks, thus displaying lower levels of SCD than bilinguals (Bialystok, 2007; Bialystok & Craik, 2010; Kousaie et al., 2014; Ljungberg et al., 2013; Patra et al., 2020; Quinteros Baumgart & Billick, 2018). These insignificant findings could be due to bilinguals not having a possible advantage in attention and memory, which means that bilinguals are not able slow down the impact of cognitive deficits in these cognitive domains which might lead to lower levels of SCD. Three yes/no questions that were used to measure SCD could have limited the

variability of participants responses to the questions, thereby limiting the generalizability of the results. The study could have also been limited due to the use of a population-based sampling strategy, which may have been biased due to the individuals who participated in the study being generally healthier and having a lower prevalence of SCD (Fritsch et al., 2014).

### **SCD as a predictor of Objective Performance in Monolinguals and Bilinguals**

SCD in both memory and language was a significant predictor of objective cognitive performance, in the monolingual sample. These results confirm with the third hypothesis that stated in the monolingual sample, SCD would be a predictor of objective performance. These results are also supported by previous research that indicated that SCD has been shown to be a predictor of objective performance and that SCD in memory has also shown to be a predictor of objective performance (Amariglio et al., 2011; Bialystok, 2007; Bialystok et al., 2008; Bialystok & Craik, 2010; Cargin et al., 2008; Jessen et al., 2007; Jonker et al., 1996; Jorm et al., 2001; Perani & Abutalebi, 2015; Quinteros Baumgart & Billick, 2018; Riedel-Heller et al., 1999). These results indicated that as people reported complaints regarding their memory and word-finding difficulties, these complaints were a significant predictor of their objective performance on the LNS task. Future research could be conducted by using a larger sample size to increase the power of the sample, increasing effect of the sample.

In the bilingual sample, SCD in language was a significant predictor of their objective performance on the CVLT II. As people reported more word-finding difficulties, their complaints were a significant predictor of their objective performance on the CVLT II. SCD was not found to be a significant predictor of objective performance on the Stroop, BNT and LNS in the domains of memory, attention or language. These results did not support previous research that indicated that bilinguals have demonstrated possible disadvantages in language

function tasks, possibly leading to increased levels of SCD in language, potentially leading to SCD being a predictor of objective performance on language function tasks for bilinguals (Bialystok & Craik, 2010; Kousaie et al., 2014; Quinteros Baumgart & Billick, 2018). These results could have been due to using CVLT II to measure episodic memory. CVLT II utilizes the participants word-recall ability to test their episodic memory which is similar to how individuals are tested on the BNT, where bilinguals have shown slower rates since it is a picture-naming task (Bialystok, 2007; Bialystok & Craik, 2010; Kousaie et al., 2014; Ljungberg et al., 2013; Patra et al., 2020; Quinteros Baumgart & Billick, 2018). These results are also supported by previous studies that have shown individuals who report SCD on visual and verbal memory tasks, have scored significantly lower on those tasks, demonstrating that SCD could possibly be a predictor of their objective performance (Riedel-Heller et al., 1999). Future research would need to be conducted using a different standardized neuropsychological test to measure episodic memory that tests individuals' episodic memory using their working memory instead of word-recall ability, as bilinguals have shown slower rates on cognitive tasks using word-recall (Bialystok, 2007; Bialystok & Craik, 2010; Kousaie et al., 2014; Ljungberg et al., 2013; Patra et al., 2020; Quinteros Baumgart & Billick, 2018)

### **Strengths**

This thesis adds to the body of literature surrounding the impact of SCD being a predictor of objective performance and the importance of studying differences in subjective cognitive decline and objective performance between bilingual and monolingual older adults as differences are found between both groups. The study demonstrated that there is a significant difference in performance on executive function tasks and language function tasks between monolinguals and bilinguals, which is consistent with previous research (Antón et

al., 2016; Bialystok et al., 2007, 2008, 2010; Kousaie et al., 2014; Langlois & Belleville, 2014; Perani & Abutalebi, 2015; Quinteros Baumgart & Billick, 2018). The study also concluded that bilinguals demonstrated worse performance on language function tasks than monolinguals, which was also consistent with previous research that bilinguals have shown disadvantages on language tasks (Bialystok & Craik, 2010; Kousaie et al., 2014; Quinteros Baumgart & Billick, 2018). The study was also consistent with previous studies that indicated SCD was a significant predictor of objective performance (Jonker et al., 1996; Jorm et al., 2001; Riedel-Heller et al., 1999).

In addition, the neuropsychological tests that were used to measure objective cognitive performance have been demonstrated in earlier research to have extensive validity and reliability as cognitive performance measures. The sample of both monolingual and bilingual older adults was not influenced by gender being a covariate. The missing data that was excluded from the study did not impact the results, as the results were analyzed again using a mean substitution method to code for the missing data.

### **Limitations**

There were several limitations of this study. Due to the COVID-19 pandemic, there was limited access to all the data sets that were collected by research assistants at the Bruyère Research Institute. The result of not being able to go into the office to access more data sets for the study, led to a smaller sample size of only 183 participants, creating a low effect and lowering the power of the sample. The bilingual sample was also larger by 19 participants than the monolingual sample. Due to unequal sample sizes, it could have led to unequal variances between both samples, affecting the assumption of equal variances, the statistical power of the sample and creating a type II error. In addition, another limitation of the study

could be the significance difference in the covariates of age and education that were not controlled for in the study, which could have impacted the results. By separating the bilingual and monolingual sample to perform separate linear regression analyses, the power of the sample was decreased, creating low effect from the sample. As well, given the small amount of data available for the comparison of SCD in (memory, attention and language) between both samples, restriction of range of the responses for SCD is another limitation.

In the first independent sample t-test analysis comparing monolingual and bilingual older adults' performance on executive function and language function tasks, there were some false positives that showed up in the results that monolingual older adults demonstrated a stronger performance on executive function tasks than bilinguals based on the means, which were not consistent with previous research. This created a Type I error, where the researcher rejected a true null hypothesis based on personal biases that impacted the researcher's ability to interpret the significance of the literature.

Furthermore, due to the fact the study is relying on self-reported measures for both bilingualism and SCD, the data is subjected to sources of bias as a result of the participants' self-reporting their own level of bilingualism and their SCD, altering the generalizability of the results. The use of only one yes/no question for each area of attention, memory and language is also subjected to sources of bias, as one yes/no question does not take into consideration the participants' previous experience, events in their lives that could have impacted their responses, and their possible reaction to being asked the 3 yes/no questions.

Another limitation of the study was the use of an independent sample t-test to determine if bilinguals would show better performance on executive function tasks and lower performance on language function tasks. A one-way ANOVA test would have been a more

accurate test to compare cognitive performance between bilinguals and monolinguals, providing mean scores that could be differentiated more precisely based on cognitive performance in areas of attention, memory and language between the two samples, instead of comparing generally significant differences in performance between the two samples.

Other factors to mention are not taking into consideration participants level of physical activity and anxiety level as possible confounds, which could have possibly impacted the results, is another limitation of the study. Research has concluded that higher levels of physical activity in older adults have shown to reduce future cognitive decline and higher levels of anxiety sensitivity have shown to be related with increased SCD (Dux et al., 2008; Miyawaki et al., 2017).

## **Implications**

As English-French bilingualism rate has risen significantly in the Canadian population since the 1960s, it is estimated that 50% of the population is bilingual and the Canadian population is projected to have 12 million older adults by 2061 (Kousaie et al., 2014; Statistics Canada, 2016, 2017). Therefore, the results of this thesis have great implications for the aging Canadian population, as the results of this thesis yielded that there are significant differences in performance on executive function tasks and language function tasks between bilingual and monolingual older adults. As the results of this thesis also indicated that in the bilingual sample, SCD in language was a predictor of objective performance on the CVLT II and in the monolingual sample, SCD in both memory and language were significant predictors of objective performance. These findings are important as 25 to 50% of older adults display some sort of SCD and SCD has demonstrated in previous research to be an indication of future cognitive decline within 8 years of having SCD (Langlois & Belleville, 2014). SCD

has also been a risk factor for the development of dementia, where bilinguals have shown symptoms within 4 years of having SCD as compared to monolinguals (Bialystok et al., 2007; Bialystok & Craik, 2010; Crumley et al., 2014; Perani & Abutalebi, 2015). These results conclude that in older adults who displayed SCD in language on the CVLT II, their SCD was an indication of their objective performance on the CVLT II. This opens up an opportunity for future research to determine if SCD in the bilingual sample is a significant predictor of objective performance in other episodic memory tasks besides CVLT II, and to examine if SCD was a predictor of objective performance for the monolingual sample in other cognition tasks besides LNS that measures more working memory.

### **Future Direction**

The results of this study determined that on the Stroop and LNS there was a significant difference in performance scores between monolinguals and bilinguals, but that monolinguals demonstrated a stronger performance on Stroop and LNS, which was not consistent with previous research. Additional studies could use a larger sample size of both bilinguals and monolinguals and control for covariates such as age, education and gender that may be distributed differently between the two samples and impact the results (Antón et al., 2016). As significant differences in performance on the BNT were also determined between the bilingual and monolingual sample, more research could be conducted using a larger range of neuropsychological tests measuring language function to determine the reliability of the results found in this study.

The independent sample t-test in this study examined the difference in SCD between monolinguals and bilinguals, and it did not yield any significant findings. It would be more beneficial to use a larger sample size for both bilinguals and monolinguals in order to increase

the power of the sample, thereby increasing the effect of the sample. Another recommendation would be to control for demographic factors such as age and education that could impact the results or differentiate between both samples (Antón et al., 2016). Future research should also use an Informant Questionnaire to measure SCD since the questionnaire is administered to both the participant and the caregiver to reduce any possibility of bias due to using a self-report measure for SCD (Youn et al., 2009).

Using a larger sample size and equal sample sizes for both the monolinguals and bilinguals would increase the power of the sample and the effect of the sample on the results. This method would also prevent issues with the statistical power of the sample and any issues with unequal variances between samples, affecting the assumption of equal variances. Future studies could combine both the monolingual and bilingual sample together to increase the power of the sample and use a multiple regression analysis to evaluate SCD as a predictor of objective performance, allowing the study to compare both samples simultaneously. This is because SCD in memory and language were significant predictors of objective performance on the LNS in the monolingual sample. Using a larger variety of standardized neuropsychological tests would increase the generalizability of the results found in the monolingual sample and increase the effect of the sample on the results as the sample had a small effect in this study. Another recommendation is to use an ANCOVA test to control for covariates such as age and education, since previous research has shown SCD to increase with age and be more common in individuals who have lower levels of education (Cargin et al., 2008).

The four linear regression analyses examining SCD as a predictor of objective performance in the bilingual sample concluded that SCD in language was a significant

predictor of objective performance on the CVLT II, but these results were inconsistent with previous research. Future research should be conducted measuring episodic memory in bilingual older adults, using a neuropsychological test that measures episodic memory via the individuals' memory ability and not word-recall, as bilinguals have shown slower rates on tasks that involve word-recall (Bialystok, 2007; Bialystok & Craik, 2010; Kousaie et al., 2014; Ljungberg et al., 2013; Patra et al., 2020; Quinteros Baumgart & Billick, 2018). Additional examination could be conducted using a larger variety of standardized neuropsychological tests to determine if SCD is a significant predictor in other executive function tasks, and/or language function tasks for the bilingual sample other than just on cognitive tasks, measuring episodic memory. Using a larger variety of neuropsychological tests would also increase the generalizability of the results found in the bilingual sample. It would also be important use an ANCOVA test to control for covariates such as age and education, as previous research has concluded that age and education have impacted SCD (Cargin et al., 2008).

Since both the level of physical activity and anxiety sensitivity have shown to impact SCD and future cognitive decline, and these confounds were not part of the exclusion criteria of the study, future research should control for physical activity, anxiety sensitivity and for participants who meet the criteria for the Major Depression based on the Geriatric Depression Scale, or demonstrate significant cardiovascular disease and Atherosclerosis (Muller et al., 2007; Yesavage et al., 1982). Physical activity should be controlled for, by asking participants a series of questions pertaining to their levels of physical activity or exercise. Participants who indicate that they do not engage in physical activity or exercise would be considered as inactive and should be included in the study sample (Miyawaki et al., 2017). Those

participants who demonstrate anxiety sensitivity using the Anxiety Sensitivity Index, or those who report having major depression based on the Geriatric Depression Scale, should be excluded from the study (Dux et al., 2008).

### **Conclusion**

It has been documented that the English-French bilingualism rate in Canada has been steadily increasing since the early 1960s and the older adult population in Canada will be changing dramatically, (where it is estimated that the older adult population will reach 12 million by 2061) (Statistics Canada, 2016, 2017). Therefore, it is clear that the results of this study contribute to the understanding of SCD as a predictor of objective performance and the differences between SCD and objective performance in bilinguals and monolinguals (Statistics Canada, 2016, 2017). A large portion of the older adult population reports having SCD, that has shown to possibly contribute to early signs of cognitive decline, while bilingualism has shown to potentially lessen the impact of age-related cognitive decline, thus delaying the onset of dementia for bilinguals as compared to monolinguals (Bialystok et al., 2007, 2010; Crumley et al., 2014; Langlois & Belleville, 2014; Perani & Abutalebi, 2015; Quinteros Baumgart & Billick, 2018). This thesis concluded both significant and unexpected results demonstrating differences between bilinguals and monolinguals in objective performance. Monolingual older adults demonstrated stronger performance on executive function tasks and bilingual older adult showed weaker performance on language tasks. In the monolingual sample, SCD in both memory and language was found to be a significant predictor of objective performance on the LNS task. In the bilingual sample, SCD in language was found to be a significant predictor of objective performance on the CVLT II. This study gives a starting point to showcase the importance of the evaluating SCD as a predictor of

objective performance in both bilinguals and monolinguals, but further research is needed since the older adult population is increasing rapidly in Canada and the majority of them report some sort of SCD. This study demonstrated the importance of SCD in being a predictor of objective performance in both bilingual and monolingual older adults.

### References

- Adesope, O. O., Lavin, T., Thompson, T., & Ungerleider, C. (2010). A systematic review and meta-analysis of the cognitive correlates of bilingualism. *Review of Educational Research, 80*(2), 207–245. <https://doi.org/10.3102/0034654310368803>
- Alioto, A. G., Kramer, J. H., Borish, S., Neuhaus, J., Saloner, R., Wynn, M., & Foley, J. M. (2017). Long-term test-retest reliability of the California Verbal Learning Test—second edition. *Clinical Neuropsychologist, 31*(8), 1449–1458. <https://doi.org/10.1080/13854046.2017.1310300>
- Amariglio, R. E., Townsend, M. K., Grodstein, F., Sperling, R. A., & Rentz, D. M. (2011). Specific Subjective Memory Complaints in Older Persons May Indicate Poor Cognitive Function. *The American Geriatrics Society, 59*(9), 1612–1617. <https://doi.org/10.1111/j.1532-5415.2011.03543.x>
- Antón, E., Fernández García, Y., Carreiras, M., & Duñabeitia, J. A. (2016). Does bilingualism shape inhibitory control in the elderly? *Journal of Memory and Language, 90*, 147–160. <https://doi.org/10.1016/j.jml.2016.04.007>
- Bialystok, E. (2007). Cognitive effects of bilingualism: How linguistic experience leads to cognitive change. *International Journal of Bilingual Education and Bilingualism, 10*(3), 210–223. <https://doi.org/10.2167/beb441.0>
- Bialystok, E. (2009). Bilingualism: The good, the bad, and the indifferent. *Bilingualism, 12*(1), 3–11. <https://doi.org/10.1017/S1366728908003477>
- Bialystok, E. (2011). Reshaping the mind: The benefits of bilingualism. *Canadian Journal of Experimental Psychology, 65*(4), 229–235. <https://doi.org/10.1037/a0025406>
- Bialystok, E., & Craik, F. I. M. (2010). Cognitive and linguistic processing in the bilingual mind.

*Current Directions in Psychological Science*, 19(1), 19–23.

<https://doi.org/10.1177/0963721409358571>

Bialystok, E., Craik, F. I. M., & Freedman, M. (2007). Bilingualism as a protection against the onset of symptoms of dementia. *Neuropsychologia*, 45(2), 459–464.

<https://doi.org/10.1016/j.neuropsychologia.2006.10.009>

Bialystok, E., Craik, F. I. M., & Freedman, M. (2010). Delaying the onset of Alzheimer disease. *Neurology*, 75, 1726–1729. <http://www.neurology.org/content/75/19/1726.abstract>

Bialystok, E., Craik, F., & Luk, G. (2008). Cognitive Control and Lexical Access in Younger and Older Bilinguals. *Journal of Experimental Psychology: Learning Memory and Cognition*, 34(4), 859–873. <https://doi.org/10.1037/0278-7393.34.4.859>

Bialystok, E., Klein, R., Craik, F. I. M., & Viswanathan, M. (2004). Bilingualism, aging, and cognitive control: Evidence from the Simon task. *Psychology and Aging*, 19(2), 290–303.

<https://doi.org/10.1037/0882-7974.19.2.290>

Blazer, D., Hays, J. C., Fillenbaum, G. G., & Gold, D. T. (1997). Memory Complaint as a Predictor of Cognitive Decline. *Journal of Aging and Health*, 9(2), 171–184.

Cargin, J. W., Collie, A., Masters, C., & Maruff, P. (2008). The nature of cognitive complaints in healthy older adults with and without objective memory decline. *Journal of Clinical and Experimental Neuropsychology*, 30(2), 245–257.

<https://doi.org/10.1080/13803390701377829>

Chen, Y. T., Peng, C. Y., Hua, M. S., Liu, C. C., Chen, H. Y., & Hwu, H. G. (2018).

Development and Psychometric Properties of the Taiwan Odd–Even Number Sequencing Test: A Nonalphabetic Measure of Working Memory. *Assessment*, 25(2), 183–192.

<https://doi.org/10.1177/1073191116648769>

Coalson, D. L., Raiford, S. E., Saklofske, D. H., & Weiss, L. G. (2010). WAIS-IV. Advances in the Assessment of Intelligence. *WAIS-IV Clinical Use and Interpretation*, 3–23.

<https://doi.org/10.1016/B978-0-12-375035-8.10001-1>

Coderre, E. L., Van Heuven, W. J. B., & Conklin, K. (2013). The timing and magnitude of Stroop interference and facilitation in monolinguals and bilinguals. *Bilingualism*, 16(2), 420–441. <https://doi.org/10.1017/S1366728912000405>

Crumley, J. J., Stetler, C. A., & Horhota, M. (2014). Examining the relationship between subjective and objective memory performance in older adults: A meta-analysis. *Psychology and Aging*, 29(2), 250–263. <https://doi.org/10.1037/a0035908>

Delis, D., Kramer, E.J., Kaplan, B., Ober. (2000). *California Verbal Learning Test-Second Edition*. San Antonio, TX. The Psychological Corporation. 2000.

Delis, D. C., Massman, P. J., Kaplan, E., Mckee, R., Joel, H., Gettman, D., Delis, D. C., Massman, P. J., Kaplan, E., Mckee, R., Joel, H., & Kaplan, E. (2007). *Alternate form of the california verbal learning test : Development and reliability Alternate Form of the California Verbal Learning Test : Development and Reliability*. 1637.

<https://doi.org/10.1080/13854049108403299>

Delis, D. C., Wetter, S. R., Jacobson, M. W., Peavy, G., Hamilton, J., Gongvatana, A., Kramer, J. H., Bondi, M. W., Corey-Bloom, J., & Salmon, D. P. (2005). Recall discriminability: Utility of a new CVLT-II measure in the differential diagnosis of dementia. *Journal of the International Neuropsychological Society*, 11(6), 708–715.

<https://doi.org/10.1017/S1355617705050812>

Donolato, E., Giofrè, D., & Mammarella, I. C. (2017). Differences in verbal and visuospatial forward and backward order recall: A review of the literature. *Frontiers in Psychology*,

8(May). <https://doi.org/10.3389/fpsyg.2017.00663>

Durant, J., Berg, J.-L., Banks, S. J., Kaylegian, J., & Miller, J. B. (2021). Comparing the Boston Naming Test With the Neuropsychological Assessment Battery-Naming Subtest in a Neurodegenerative Disease Clinic Population. *Cleveland Clinic, Lou Ruvo Center for Brain Health, 28*(5), 1256–1266. <https://doi.org/10.1177/1073191119872253>

Dux, M. C., Woodard, J. L., Calamari, J. E., Messina, M., Arora, S., Chik, H., & Pontarelli, N. (2008). The moderating role of negative affect on objective verbal memory performance and subjective memory complaints in healthy older adults. *Journal of the International Neuropsychological Society, 14*(2), 327–336. <https://doi.org/10.1017/S1355617708080363>

Eichenbaum, H. (2017). Prefrontal-hippocampal interactions in episodic memory. *Nature Reviews Neuroscience, 18*(9), 547–558. <https://doi.org/10.1038/nrn.2017.74>

Ekinci Soylu, A., & Cangöz, B. (2018). Adaptation and norm determination study of the boston naming test for healthy turkish elderly. *Noropsikiyatri Arsivi, 55*(4), 341–348. <https://doi.org/10.5152/npa.2017.19331>

Elwood, R. W. (1995). *The California Verbal Learning Test : Psychometric Characteristics and Clinical Application. 5*(3), 173–201.

Erdodi, L. A., Sagar, S., Seke, K., Zuccato, B. G., Schwartz, E. S., & Roth, R. M. (2018). The stroop test as a measure of performance validity in adults clinically referred for neuropsychological assessment. *Psychological Assessment, 30*(6), 755–766. <https://doi.org/10.1037/pas0000525>

Faulkner, L. M. D., Tolle, K. A., Wendell, C. R., Waldstein, S. R., Katzel, L. I., & Spencer, R. J. (2020). Incremental utility of an extended stroop task for identifying subtle differences in cognitive performance among healthy older adults. *Applied Neuropsychology:Adult, 27*(5),

440–449. <https://doi.org/10.1080/23279095.2019.1565763>

Franzen, M. D., Tishelman, A. C., Sharp, B. H., & Friedman, A. G. (1987). An investigation of the test-retest reliability of the stroop colorword test across two intervals. *Archives of Clinical Neuropsychology*, 2(3), 265–272. [https://doi.org/10.1016/0887-6177\(87\)90014-X](https://doi.org/10.1016/0887-6177(87)90014-X)

Fritsch, T., McClendon, M. J., Wallendal, M. S., Hyde, T. F., & Larsen, J. D. (2014). Prevalence and Cognitive Bases of Subjective Memory Complaints in Older Adults: Evidence from a Community Sample. *Journal of Neurodegenerative Diseases*, 2014, 1–9.

<https://doi.org/10.1155/2014/176843>

Gold, B. T., Kim, C., Johnson, N. F., Kryscio, R. J., & Smith, C. D. (2013). Lifelong bilingualism maintains neural efficiency for cognitive control in aging. *Journal of Neuroscience*, 33(2), 387–396. <https://doi.org/10.1523/JNEUROSCI.3837-12.2013>

Harris, J. G., Cullum, C. M., & Puente, A. E. (1995). Effects of bilingualism on verbal learning and memory in Hispanic adults. *Journal of the International Neuropsychological Society*, 1(1), 10–16. <https://doi.org/10.1017/S1355617700000059>

Harry, A., & Crowe, S. F. (2014). Is the Boston naming test still fit for purpose. *Clinical Neuropsychologist*, 28(3), 486–504. <https://doi.org/10.1080/13854046.2014.892155>

Hawkins, K. A., & Bender, S. (2002). Norms and the relationship of Boston Naming Test performance to vocabulary and education: A review. *Aphasiology*, 16(12), 1143–1153. <https://doi.org/10.1080/02687030244000031>

Hester, R. L., Kinsella, G. J., & Ong, B. (2004). Effect of age on forward and backward span tasks. *Journal of the International Neuropsychological Society*, 10(4), 475–481.

<https://doi.org/10.1017/S1355617704104037>

Hill, B. D., Alosco, M., Bauer, L., & Tremont, G. (2012). The relation of executive functioning

to CVLT-II learning, memory, and process indexes. *Applied Neuropsychology*, *19*(3), 198–206. <https://doi.org/10.1080/09084282.2011.643960>

Hobson, V. L., Hall, J. R., Harvey, M., Cullum, C. M., Lacritz, L., Massman, P. J., Waring, S. C., & O'Bryant, S. E. (2011). An examination of the Boston Naming Test: calculation of “estimated” 60-item score from 30- and 15 item scores in cognitively impaired population. *International Journal of Geriatric Psychiatry*, *26*, 351–355. <https://doi.org/10.1002/gps.2533>

Iverson, G. L. (2001). Interpreting change on the WAIS-III/WMS-III in clinical samples. *Archives of Clinical Neuropsychology*, *16*(2), 183–191. [https://doi.org/10.1016/S0887-6177\(00\)00060-3](https://doi.org/10.1016/S0887-6177(00)00060-3)

Jensen, A. R. (1965). Scoring The Stroop Test. *Acta Psychologica*, *24*, 398–408.

Jessen, F., Wiese, B., Cvetanovska, G., Fuchs, A., Kaduszkiewicz, H., Kölsch, H., Luck, T., Mösch, E., Pentzek, M., Riedel-Heller, S. G., Werle, J., Weyerer, S., Zimmermann, T., Maier, W., & Bickel, H. (2007). Patterns of subjective memory impairment in the elderly: Association with memory performance. *Psychological Medicine*, *37*(12), 1753–1762. <https://doi.org/10.1017/S0033291707001122>

Jonker, C., Launer, L. J., Hooijer, C., & Lindeboom, J. (1996). Memory Complaints and Memory Impairment in Older Adults. *American Geriatrics Society*, *44*(1), 44–49.

Jorm, A. F., Christensen, H., Korten, A. E., Jacomb, P. A., & Henderson, A. S. (2001). Memory complaints as a precursor of memory impairment in older people: A longitudinal analysis over 7-8 years. *Psychological Medicine*, *31*(3), 441–449. <https://doi.org/10.1017/s0033291701003245>

Kaplan, E.F., Goodglass, H., & Weintraub, S. (1983). *Boston Naming Test 1983*, Philadelphia, PA: Lea & Febiger.

- Kousaie, S., & Phillips, N. A. (2012). Ageing and bilingualism: Absence of a “bilingual advantage” in Stroop interference in a nonimmigrant sample. *Quarterly Journal of Experimental Psychology*, *65*(2), 356–369. <https://doi.org/10.1080/17470218.2011.604788>
- Kousaie, S., & Phillips, N. A. (2017). A behavioural and electrophysiological investigation of the effect of bilingualism on aging and cognitive control. *Neuropsychologia*, *94*(July 2016), 23–35. <https://doi.org/10.1016/j.neuropsychologia.2016.11.013>
- Kousaie, S., Sheppard, C., Lemieux, M., Monetta, L., & Taler, V. (2014). Executive function and bilingualism in young and older adults. *Frontiers in Behavioral Neuroscience*, *8*(JULY), 1–12. <https://doi.org/10.3389/fnbeh.2014.00250>
- Langlois, A. S., & Belleville, S. (2014). Subjective cognitive complaint in healthy older adults: Identification of major domains and relation to objective performance. *Aging, Neuropsychology, and Cognition*, *21*(3), 257–282. <https://doi.org/10.1080/13825585.2013.795928>
- Ljungberg, J. K., Hansson, P., Andrés, P., Josefsson, M., & Nilsson, L. G. (2013). A Longitudinal Study of Memory Advantages in Bilinguals. *PLoS ONE*, *8*(9). <https://doi.org/10.1371/journal.pone.0073029>
- López Zunini, R. A., Morrison, C., Kousaie, S., & Taler, V. (2019). Task switching and bilingualism in young and older adults: A behavioral and electrophysiological investigation. *Neuropsychologia*, *133*(August), 107186. <https://doi.org/10.1016/j.neuropsychologia.2019.107186>
- Luo, L., Craik, F. I. M., Moreno, S., & Bialystok, E. (2013). Bilingualism interacts with domain in a working memory task: Evidence from aging. *Psychology and Aging*, *28*(1), 28–34. <https://doi.org/10.1037/a0030875>

- Macoir, J., Lafay, A., & Hudson, C. (2019). Reduced Lexical Access to Verbs in Individuals With Subjective Cognitive Decline. *American Journal of Alzheimer's Disease & Other Dementias*, 34(1), 5–15. <https://doi.org/DOI: 10.1177/1533317518790541>
- Medvedev, O. N., Sheppard, C., Monetta, L., & Taler, V. (2019). The\_BNT38\_Applying\_Rasch\_Analy.pdf. *Journal of Speech, Language, and Hearing Research*, 62(4), 909–917. [https://doi.org/10.1044/2018\\_JSLHR-L18-0084](https://doi.org/10.1044/2018_JSLHR-L18-0084)
- Messerly, J., & Marceaux, J. C. (2020). Examination of the reliability and validity of the NAB Naming Test in a diverse clinical sample. *Clinical Neuropsychologist*, 34(2), 406–422. <https://doi.org/10.1080/13854046.2019.1635647>
- Mielicki, M. K., Koppel, R. H., Valencia, G., & Wiley, J. (2018). Measuring working memory capacity with the letter–number sequencing task: Advantages of visual administration. *Applied Cognitive Psychology*, 32(6), 805–814. <https://doi.org/10.1002/acp.3468>
- Mitchell, A. J., Beaumont, H., Ferguson, D., Yadegarfar, M., & Stubbs, B. (2014). Risk of dementia and mild cognitive impairment in older people with subjective memory complaints: Meta-analysis. *Acta Psychiatrica Scandinavica*, 130(6), 439–451. <https://doi.org/10.1111/acps.12336>
- Miyawaki, C. E., Bouldin, E. D., Kumar, G. S., & Mcguire, L. C. (2017). *Associations Between Physical Activity and Cognitive Functioning*. 21(6), 637–647.
- Montejo Carrasco, P., Montenegro-Peña, M., López-Higes, R., Estrada, E., Prada Crespo, D., Montejo Rubio, C., & García Azorín, D. (2017). Subjective Memory Complaints in healthy older adults: Fewer complaints associated with depression and perceived health, more complaints also associated with lower memory performance. *Archives of Gerontology and Geriatrics*, 70, 28–37. <https://doi.org/10.1016/j.archger.2016.12.007>

- Montejo, P., Montenegro, M., Fernández-Blázquez, M. A., Turrero-Nogués, A., Yubero, R., Huertas, E., & Maestú, F. (2014). Association of perceived health and depression with older adults' subjective memory complaints: contrasting a specific questionnaire with general complaints questions. *European Journal of Ageing, 11*(1), 77–87.  
<https://doi.org/10.1007/s10433-013-0286-4>
- Muller, M., Grobbee, D. E., Aleman, A., Bots, M., & van der Schouw, Y. T. (2007). Cardiovascular disease and cognitive performance in middle-aged and elderly men. *Atherosclerosis, 190*(1), 143–149. <https://doi.org/10.1016/j.atherosclerosis.2006.01.005>
- Myerson, J., Emery, L., White, D. A., & Hale, S. (2003). Effects of age, domain, and processing demands on memory span: Evidence for differential decline. *Aging, Neuropsychology, and Cognition, 10*(1), 20–27. <https://doi.org/10.1076/anec.10.1.20.13454>
- Namdar Khatibani, M., Mehri, A., Jalaie, S., & Dastjerdi Kazemi, M. (2020). Developing Verb Picture Naming Test for Persian adults and determining its psychometric properties. *Applied Neuropsychology: Adult, 0*(0), 1–10. <https://doi.org/10.1080/23279095.2020.1762085>
- Nasreddine, Z. S., Phillips, N. A., Bédirian, V., Charbonneau, S., Whitehead, V., Collin, I., Cummings, J. L., & Chertkow, H. (2005). The Montreal Cognitive Assessment, MoCA: A brief screening tool for mild cognitive impairment. *Journal of the American Geriatrics Society, 53*(4), 695–699. <https://doi.org/10.1111/j.1532-5415.2005.53221.x>
- Patra, A., Bose, A., & Marinis, T. (2020). Performance difference in verbal fluency in bilingual and monolingual speakers. *Bilingualism, 23*(1), 204–218.  
<https://doi.org/10.1017/S1366728918001098>
- Pelham, S. D., & Abrams, L. (2014). Cognitive advantages and disadvantages in early and late bilinguals. *Journal of Experimental Psychology: Learning Memory and Cognition, 40*(2),

313–325. <https://doi.org/10.1037/a0035224>

Perani, D., & Abutalebi, J. (2015). Bilingualism, dementia, cognitive and neural reserve. *Current*

*Opinion in Neurology*, 28(6), 618–625. <https://doi.org/10.1097/WCO.0000000000000267>

Quinteros Baumgart, C., & Billick, S. B. (2018). Positive Cognitive Effects of Bilingualism and

Multilingualism on Cerebral Function: a Review. *Psychiatric Quarterly*, 89(2), 273–283.

<https://doi.org/10.1007/s11126-017-9532-9>

Rabin, L. A., Smart, C. M., Crane, P. K., Amariglio, R. E., Berman, L. M., Boada, M., Buckley,

R. F., Chetelat, G., Dubois, B., Ellis, K. A., Gifford, K. A., Jefferson, A. L., Jessen, F.,

Katz, M. J., Lipton, R. B., Luck, T., Maruff, P., Mielke, M. M., Molineuvo, J. L., ... Group,

the S. C. D. I. (SCD-I. W. (2015). Subjective Cognitive Decline in Older Adults: An

Overview of Self-Report Measures Used Across 19 International Research Studies. *J*

*Alzheimers Dis.*, 24(48), 63–86. <https://doi.org/10.3233/JAD-150154>.

Randolph, C., Gold, J. M., Kozora, E., Cullum, C. M., Hermann, B. P., & Wyler, A. R. (1994).

Estimating memory function: Disparity of Wechsler Memory Scale-Revised and California

Verbal Learning Test indices in clinical and normal samples. *Clinical Neuropsychologist*,

8(1), 99–108. <https://doi.org/10.1080/13854049408401547>

Reid, L. M., & MacLulich, M. J. (2006). Subjective Memory Complaints and Cognitive

Impairment in Older People. *Dementia and Geriatric Cognitive Disorders*, 22, 471–485.

<https://doi.org/10.1159/000096295>

Riedel-Heller, S. G., Matschinger, H., Schork, A., & Angermeyer, M. C. (1999). Do memory

complaints indicate the presence of cognitive impairment? Results of a field study.

*European Archives of Psychiatry and Clinical Neuroscience*, 249(4), 197–204.

<https://doi.org/10.1007/s004060050087>

- Rosselli, M., Loewenstein, D. A., Curiel, R. E., Penate, A., Torres, V. L., Lang, M., Greig, M. T., Barker, W. W., & Duara, R. (2019). Effects of bilingualism on verbal and nonverbal memory measures in mild cognitive impairment. *Journal of the International Neuropsychological Society*, 25(1), 15–28. <https://doi.org/10.1017/S135561771800070X>
- Schofield, N. J., & Ashman, A. F. (1986). The relationship between digit span and cognitive processing across ability groups. *Intelligence*, 10(1), 59–73. [https://doi.org/10.1016/0160-2896\(86\)90027-9](https://doi.org/10.1016/0160-2896(86)90027-9)
- Sciaraffa, K. A. (1995). The Validity of the California Verbal Learning Test as a Neuropsychological Screening Instrument. In *A Bell & Howell Information Company*.
- Smart, C. M., Segalowitz, S. J., Mulligan, B. P., & MacDonald, S. W. S. (2014). Attention capacity and self-report of subjective cognitive decline: A P3 ERP study. *Biological Psychology*, 103, 144–151. <https://doi.org/10.1016/j.biopsycho.2014.08.016>
- Snitz, B. E., Lopez, O. L., McDade, E., Becker, J. T., Cohen, A. D., Price, J. C., Mathis, C. A., & Klunk, W. E. (2015). Amyloid-beta imaging in older adults presenting to a memory clinic with subjective cognitive decline. *Physiology & Behavior*, 48(1), 151–159. <https://doi.org/10.3233/JAD-150113>
- Spano, G., Caffò, A. O., Lanciano, T., Curci, A., & Bosco, A. (2020). Visuospatial/executive abilities and mood affect the reliability of a subjective memory complaints measure. *Aging Clinical and Experimental Research*, 32(7), 1317–1326. <https://doi.org/10.1007/s40520-019-01307-2>
- Statistics Canada. (2016). English–French bilingualism reaches new heights Census in Brief. *Census of Population, 2016*, 98, 10. <http://www12.statcan.gc.ca/census-recensement/2016/as-sa/98-200-x/2016009/98-200-x2016009-eng.pdf>

- Statistics Canada. (2017). Age and sex, and type of dwelling data: key results from the 2016 Census. *The Daily*, 1–17. <http://www.statcan.gc.ca/daily-quotidien/170503/dq170503a-eng.pdf>
- Strauss E., Sherman, E.M.S., & Spreen, O. (2006). A compendium of neuropsychological tests: Administration, norms, and commentary (3<sup>rd</sup> ed.). New York, NY: Oxford University Press
- Strauss, G. P., Allen, D. N., Jorgensen, M. L., & Cramer, S. L. (2005). Test-Retest Reliability of Standard and Emotional Stroop Tasks. An Investigation of Color-Word and Picture-Word Versions. *Department of Psychology; University of Nevada, Las Vegas*, 12(3), 330–337. <https://doi.org/10.1177/1073191105276375>
- Stroop, J.R. (1935). *Studies of interference in serial verbal reactions*. *J. Exp. Psychol.* 18, 643–662. <https://doi.org/10.1037/h0054651>
- Vogel, L. (2014). Canada releases national dementia plan. *Canadian Medical Association*, 186(15), 562. <https://doi.org/10.1503/emaj.109-4902>
- Wechsler, D. (1997). *WAIS-III Wechsler adult intelligence scale*. (3<sup>rd</sup> ed). Psychology Corporation.
- Wilde, N. J., Strauss, E., & Tulskey, D. S. (2004). Memory span on the wechsler scales. *Journal of Clinical and Experimental Neuropsychology*, 26(4), 539–549. <https://doi.org/10.1080/13803390490496605>
- Yesavage, J. A., Brink, T. L., Rose, T. L., Lum, O., Huang, V., Adey, M., & Leirer, V. O. (1982). Development and validation of a geriatric depression screening scale: A preliminary report. *Journal of Psychiatric Research*, 17(1), 37–49. [https://doi.org/10.1016/0022-3956\(82\)90033-4](https://doi.org/10.1016/0022-3956(82)90033-4)
- Yochim, B. P., Beaudreau, S. A., Kaci Fairchild, J., Yutsis, M. V., Raymond, N., Friedman, L.,

& Yesavage, J. (2015). Verbal naming test for use with older adults: Development and initial validation. *Journal of the International Neuropsychological Society*, *21*(3), 239–248.

<https://doi.org/10.1017/S1355617715000120>

Youn, J. C., Kim, K. W., Lee, D. Y., Jhoo, J. H., Lee, S. B., Park, J. H., Choi, E. A., Choe, J. Y.,

Jeong, J. W., Choo, I. H., & Woo, J. I. (2009). Development of the subjective memory complaints questionnaire. *Dementia and Geriatric Cognitive Disorders*, *27*(4), 310–317.

<https://doi.org/10.1159/000205512>

**Table 1***Overall Frequency Distributions of the Sample | N=183*

| Sample      | F   | Sample % |
|-------------|-----|----------|
| Monolingual | 101 | 55.2     |
| Bilingual   | 82  | 44.8     |

**Table 2**

*Frequency Distributions of the Overall Subjective Cognitive Decline in areas of Attention, Memory and Language in the Monolingual sample | N=101*

| Memory Complaints | F  | Sample % |
|-------------------|----|----------|
| <b>Attention</b>  |    |          |
| No                | 89 | 88.1     |
| Yes               | 12 | 11.9     |
| <b>Memory</b>     |    |          |
| No                | 85 | 84.2     |
| Yes               | 16 | 15.8     |
| <b>Language</b>   |    |          |
| No                | 64 | 63.4     |
| Yes               | 37 | 36.6     |

*Note. In each category of attention, memory and language, subjective cognitive decline has divided into two categories, older adults indicating no to having any memory complaints and older adults indicating yes to having memory complaints. F=Frequency.*

**Table 3**

Frequency Distributions of the Overall Subjective Cognitive in the areas of Attention, Memory and Language in the Bilingual sample |  $N=82$

| Memory Complaints | F  | Sample % |
|-------------------|----|----------|
| <b>Attention</b>  |    |          |
| No                | 74 | 90.2     |
| Yes               | 8  | 9.8      |
| <b>Memory</b>     |    |          |
| No                | 61 | 74.4     |
| Yes               | 19 | 23.2     |
| Missing           | 2  | 2.4      |
| <b>Language</b>   |    |          |
| No                | 57 | 69.5     |
| Yes               | 23 | 28.0     |
| Missing           | 2  | 2.4      |

*Note. In each category of attention, memory and language, subjective cognitive decline has been divided into two categories, older adults indicating no to having any memory complaints and older adults indicating yes to having memory complaints. F=Frequency. Missing=the missing data in each category.*

**Table 4**

*Independent sample t-test results comparing differences in performances in executive function tasks, episodic memory tasks and language tasks in monolinguals and bilinguals | N=183*

| Objective Performance       | M     | SD    | Levene's Test for Equality of Variances |       | t-test for Equality of Means |     |                 |                 |                       |             |
|-----------------------------|-------|-------|---|-------|------------------------------|-----|-----------------|-----------------|-----------------------|-------------|
|                             |       |       | F                                       | p     | t                            | df  | p (2-tailed)    | Mean Difference | Std. Error Difference | 95% CI      |
| <b>Stroop</b>               |       |       |   |       |                              |     |                 |                 |                       |             |
| Monolingual                 | 126.7 | 21.02 |   |       |                              |     |                 |                 |                       |             |
| Bilingual                   | 119.1 | 20.30 |   |       |                              |     |                 |                 |                       |             |
| Equal variances assumed     |       |       | 0.20                                    | 0.66  | 2.41                         | 173 | <b>&lt;0.05</b> | 7.58            | 3.14                  | 1.38- 13.78 |
| <b>BNT</b>                  |       |       |   |       |                              |     |                 |                 |                       |             |
| Monolingual                 | 53.3  | 4.00  |   |       |                              |     |                 |                 |                       |             |
| Bilingual                   | 49.2  | 6.15  |   |       |                              |     |                 |                 |                       |             |
| Equal variances not assumed |       |       | 7.23                                    | <0.05 | 5.05                         | 132 | <b>&lt;0.05</b> | 4.11            | 0.81                  | 2.50 - 5.72 |
| <b>CVLT</b>                 |       |       |   |       |                              |     |                 |                 |                       |             |
| Monolingual                 | 56.7  | 9.14  |   |       |                              |     |                 |                 |                       |             |
| Bilingual                   | 55.4  | 9.72  |   |       |                              |     |                 |                 |                       |             |
| Equal variances assumed     |       |       | 0.15                                    | 0.70  | 0.94                         | 172 | 0.35            | 1.35            | 1.43                  | -1.48-4.18  |
| <b>LNS</b>                  |       |       |   |       |                              |     |                 |                 |                       |             |

|                            |      |      |      |      |      |     |       |      |      |            |
|----------------------------|------|------|------|------|------|-----|-------|------|------|------------|
| Monolingual                | 10.4 | 2.36 |      |      |      |     |       |      |      |            |
| Bilingual                  | 9.4  | 1.80 |      |      |      |     |       |      |      |            |
| Equal variances<br>assumed |      |      | 1.76 | 0.19 | 2.93 | 140 | <0.05 | 1.04 | 0.36 | 0.34- 1.75 |

*Note. M=mean, SD=standard deviation, F=frequency, p=significance value, t=t-statistic value, df=degree of freedom, CI=confidence interval. Significance at the  $p<0.05$  level.*

**Table 5**

*Independent sample t-test results for subjective cognitive decline in both the monolingual and bilingual sample*

| Subjective Cognitive Decline | M    | SD   | Levene's Test for Equality of Variances |       | t-test for Equality of Means |        |              |                 |                       |              |
|------------------------------|------|------|---|-------|------------------------------|--------|--------------|-----------------|-----------------------|--------------|
|                              |      |      | F                                       | p     | t                            | df     | p (2-tailed) | Mean Difference | Std. Error Difference | 95% CI       |
| <b>Attention</b>             |      |      |   |       |                              |        |              |                 |                       |              |
| Monolingual                  | 0.12 | 0.33 |   |       |                              |        |              |                 |                       |              |
| Bilingual                    | 0.10 | 0.30 |   |       |                              |        |              |                 |                       |              |
| Equal variances Assumed      |      |      | 0.84                                    | 0.36  | 0.46                         | 181    | 0.65         | 0.02            | 0.05                  | - 0.07- 0.11 |
| <b>Memory</b>                |      |      |   |       |                              |        |              |                 |                       |              |
| Monolingual                  | 0.16 | 0.37 |   |       |                              |        |              |                 |                       |              |
| Bilingual                    | 0.24 | 0.43 |   |       |                              |        |              |                 |                       |              |
| Equal variances not assumed  |      |      | 7.10                                    | <0.05 | -1.31                        | 155.94 | 0.19         | -0.08           | 0.06                  | -0.20-0.04   |
| <b>Language</b>              |      |      |   |       |                              |        |              |                 |                       |              |
| Monolingual                  | 0.37 | 0.48 |   |       |                              |        |              |                 |                       |              |
| Bilingual                    | 0.29 | 0.46 |   |       |                              |        |              |                 |                       |              |
| Equal variances not assumed  |      |      | 5.14                                    | <0.05 | 1.13                         | 173.75 | 0.26         | 0.08            | 0.07                  | -0.06-0.22   |

*Note. M=mean, SD=standard deviation, F=frequency, p=significance value, t=t-statistic value, df=degree of freedom, CI=confidence interval. Significance at the p<0.05 level.*

**Table 6**

*Linear regression results examining SCD as a predictor of objective cognitive performance in the monolingual sample | N=183*

| Variables             | Stroop                      |      |      |              | BNT                          |      |      |            | CVLT                        |      |      |             | LNS                           |      |                 |            |
|-----------------------|-----------------------------|------|------|--------------|------------------------------|------|------|------------|-----------------------------|------|------|-------------|-------------------------------|------|-----------------|------------|
|                       | B                           | SE   | p    | 95% CI       | B                            | SE   | p    | 95% CI     | B                           | SE   | p    | 95% CI      | B                             | SE   | p               | 95% CI     |
| Attention             | -5.01                       | 7.26 | 0.49 | -19.43- 9.41 | 1.17                         | 1.51 | 0.44 | -1.83-4.17 | 4.41                        | 3.16 | 0.17 | -1.86-10.68 | 1.17                          | 0.82 | 0.16            | -0.46-2.80 |
| Memory                | 10.38                       | 6.34 | 0.11 | -2.22 -22.98 | 0.31                         | 1.27 | 0.81 | -2.21-2.83 | 2.78                        | 2.76 | 0.32 | -2.70-8.26  | 1.52                          | 0.74 | <b>&lt;0.05</b> | 0.04-2.99  |
| Language              | -5.47                       | 4.78 | 0.26 | -14.97- 4.02 | -1.22                        | 0.96 | 0.21 | -3.13-0.69 | -0.80                       | 2.10 | 0.70 | 4.97-3.37   | -1.15                         | 0.58 | <b>0.05</b>     | -2.31-0.00 |
| R <sup>2</sup>        | R <sup>2</sup> =0.04 p>0.05 |      |      |              | R <sup>2</sup> =0.03 p>0.05  |      |      |            | R <sup>2</sup> =0.04 p>0.05 |      |      |             | R <sup>2</sup> =0.11 p</=0.05 |      |                 |            |
| R <sup>2</sup> Change |                             |      |      |              | R <sup>2</sup> =-0.02 p>0.05 |      |      |            | R <sup>2</sup> =0.02 p>0.05 |      |      |             | R <sup>2</sup> =0.07 p</=0.05 |      |                 |            |

*Note. B=beta value, SE= standard error, p=significance value, CI=confidence interval. Significance at the p< 0.05 level.*

**Table 7**

*Linear regression results examining SCD as a predictor of objective cognitive performance in the bilingual sample | N=183*

| Variables             | Stroop                      |      |      |              | BNT                         |      |      |            | CVLT                         |      |                 |                | LNS                         |      |      |            |
|-----------------------|-----------------------------|------|------|--------------|-----------------------------|------|------|------------|------------------------------|------|-----------------|----------------|-----------------------------|------|------|------------|
|                       | B                           | SE   | p    | 95% CI       | B                           | SE   | p    | 95% CI     | B                            | SE   | p               | 95% CI         | B                           | SE   | p    | 95% CI     |
| Attention             | -8.54                       | 7.92 | 0.28 | -24.32- 7.24 | -1.73                       | 2.62 | 0.51 | -6.95-3.49 | 2.20                         | 3.69 | 0.55            | -5.17-9.56     | 0.36                        | 0.79 | 0.65 | -1.22-1.94 |
| Memory                | -2.86                       | 5.69 | 0.62 | -14.20- 8.48 | -1.16                       | 1.82 | 0.53 | -4.79-2.47 | -1.79                        | 2.66 | 0.50            | -7.09-3.51     | -0.30                       | 0.57 | 0.60 | -1.44-0.84 |
| Language              | -4.35                       | 5.50 | 0.43 | -15.31- 6.62 | -0.15                       | 1.75 | 0.93 | -3.63-3.33 | -6.20                        | 2.57 | <b>&lt;0.05</b> | -11.32-(-1.08) | -0.11                       | 0.57 | 0.85 | -1.24-1.03 |
| R <sup>2</sup>        | R <sup>2</sup> =0.04 p>0.05 |      |      |              | R <sup>2</sup> =0.08 p>0.05 |      |      |            | R <sup>2</sup> =0.10 p<0.05  |      |                 |                | R <sup>2</sup> =0.01 p>0.05 |      |      |            |
| R <sup>2</sup> Change |                             |      |      |              | R <sup>2</sup> =0.04 p>0.05 |      |      |            | R <sup>2</sup> =0.02, p<0.05 |      |                 |                | R <sup>2</sup> =-0.01p>0.05 |      |      |            |

*Note. B=beta value, SE= standard error, p=significance value, CI=confidence interval. Significance at the p< 0.05 level.*