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Gabrielle Montgomery Gavitt

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Differences in List Learning Performance on the MoCA wordlist and Shepherd Verbal Learning Test in Cognitively Normal, MCI, and AD Individuals

by
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In Clinical Psychology

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We the undersigned committee, having examined the proposed doctoral research project, "Differences in List Learning Performance on the MoCA wordlist and Shepherd Verbal Learning Test in Cognitively Normal, MCI, and AD Individuals" by Gabrielle Montgomery Gavitt, M.S. hereby indicates its unanimous approval.

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Abstract

Title: Differences in List Learning Performance on the MoCA wordlist and Shepherd Verbal Learning Test in Cognitively Normal, MCI, and AD Individuals

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Objective: The present study examines performance on the MoCA wordlist and SVLT wordlist and their association with the outcomes of healthy, MCI, and AD in a memory disorder clinic sample and community sample.

Method: Archival data form 125 Health First Memory Disorder Clinic patients was utilized. Data from a community sample of geriatric individuals was also utilized. Participants were included if they were administered both the MoCA and SVLT and were diagnosed as healthy, MCI, or AD. Additionally, individuals were used from the community sample of their score was 23 and above on the MoCA. Patients' medical and psychosocial information was obtained from their electronic medical records (EMR).

Results: No significant differences were found on MoCA word list performance when comparing community healthy controls and healthy controls from the HFMDC, $t(299) = -.87$, $p = .193$, with the difference to have a 95% CI [-.94, .36]. Additionally, there were no significant differences in performance eon the SVLT when comparing community healthy controls and healthy controls from HFMDC, $t(299) = -.87$, $p = .193$, with the difference to have a 95% CI [-.94, .36]. A significant difference was found between healthy HFMDC controls and MCI patients regarding performance on the MoCA wordlist, $t(198) = -7.73$, $p < .001$,

with the difference to have a 95% CI [-2.24, -1.33]. Additionally, a significant difference was also found between healthy HFMDC controls and MCI patients performance on the SVLT, $t(198) = -7.84$, $p < .001$, with the difference to have a 95% CI [-3.43, -2.05]. A significant difference was found between healthy HFMDC controls and AD patients regarding their performance on the MoCA wordlist, $t(55.83) = -14.78$, $p < .001$, with the differences to have a 95% CI [-3.23, -2.45]. There was also a significant difference found between healthy HFMDC controls and AD patients regarding their performance on the SVLT, $t(63.58) = -20.25$, $p < .001$, with the differences to have a 95% CI [-6.11, -5.01]. Furthermore, a significant difference was found between MCI patients and AD patients with their performance on the MoCA wordlist, $t(180.7) = -8.28$, $p < .001$, with the differences to have a 95% CI [-1.30, -.80]. There was also a significant difference found between MCI patients and AD patients with their performance on the SVLT, $t(214.12) = -13.69$, $p < .001$, with the difference to have a 95% CI [-3.23, -2.41]. An increase in MoCA delayed recall on the wordlist was associated with an increase in the odds of higher cognition based on diagnosis, with an odds ratio of 2.92 (95% CI, 2.41 to 3.52), Wald $\chi^2(1) = 123.110$, $p < .001$. Also, an increase in SVLT delayed recall was associated with an increase in the odds of higher cognition based on diagnosis, with an odds ratio of 2.27 (95% CI, 2.01 to 2.58), Wald $\chi^2(1) = 166.054$, $p < .001$

Conclusion: The results of this present study indicate SVLT and MoCA wordlist performance can indicate an increase in the odds of higher cognition based on

diagnosis. Additionally, there were significant differences between all groups on both the SVLT and MoCA, indicating both appear to have adequate diagnostic capabilities. However, due to the brief nature of the MoCA it is still important to only use as a screener. The SVLT, though, is likely an adequate and brief measure regarding verbal memory, and results on this can likely predict cognitive capabilities regarding verbal memory, thus aiding in providing diagnostic clarity in healthy individuals, MCI patients, and AD patients.

Table of Contents

Chapter 1 Introduction ...……..…….1

Chapter 2 Normal Cognition in Aging …….……..……...…..10

Chapter 3 Mild Cognitive Impairment ……...…….11

Clinical Definition…..……..11

Early History and Overview…….12

Epidemiology ……..……13

Risk Factors …….……13

Chapter 4 Alzheimer's Disease ……...……14

Clinical Definition ……...……14

Overview ……...……..15

Epidemiology ……...……...16

Risk Factors …..…….…..14

Chapter 5 Use of the MoCA to Assess for MCI ……..……...……18

Chapter 6 Factors that Affect Cognition …...……..20

Chapter 7 Research Objective …….……22

Chapter 8 Study Hypotheses …….……..23

Chapter 9 Methods and Procedures ……...……..24

Data Collection …….…….……..24

Measures ……...……...25

Procedures ……...……...…….……27

Research Design and Analysis of Data ……....29

Chapter 10 Results …..……...…..……31

Healthy Community Controls and Healthy HFMDC Controls……31

Descriptive Statistics…….……...…..…...33

MoCA Wordlist Performance for Healthy HFMDC Controls and MCI Patients……...…..…….34

SVLT Wordlist Performance for Healthy HFMDC Controls and MCI Patients ……...…..……35

MoCA and SVLT Performance in AD Patients ……...…..……..36

MoCA Performance and Severity of Cognitive Impairment…….……..41

SVLT Performance and Severity of Cognitive Impairment……..……..41

MoCA and SVLT Performance in Amnestic MCI and Non-amnestic MCI ……..……...…..……...41

MoCA and SVLT Performance in Within Normal Limits and Non-amnestic MCI ……..……...…..…..…. 44

MoCA and SVLT Wordlist Performance for Combined Healthy Controls and MCI Patients ……...…..…….....46

MoCA and SVLT Performance in Combined Healthy Controls and AD Patients …….……...…..…..…. 48

MoCA and SVLT Performance in Combined Within Normal Limits and Non-amnestic MCI……..…49

Chapter 11 Discussion ……...……...…..…….…….50

Chapter 12 Limitations ……...…...…….59

Chapter 13 Conclusions ……...…….……....….……61

List of Figures

Figure 1- Community Healthy Controls and Healthy HFMDC MoCA.....32

Figure 2- Community Healthy Controls and Healthy HFMDC SVLT.....33

Figure 3- Diagnosis.....34

Figure 4- Gender.....34

Figure 5- Ethnicity.....34

Figure 6- Race.....34

Figure 7- Healthy HFMDC Controls and MCI Patients MoCA.....35

Figure 8- Healthy HFMDC Controls and MCI Patients SVLT.....36

Figure 9- Healthy HFMDC Controls and AD Patients MoCA.....37

Figure 10- Healthy HFMDC Controls and AD Patients SVLT.....38

Figure 11- MCI Patients and AD Patients MoCA….....39

Figure 12- MCI Patients and AD Patients SVLT.....40

Figure 13- aMCI Patients and Non-Amnestic MCI Patients MoCA…....42

Figure 14- aMCI Patients and Non-Amnestic MCI Patients SVLT.....43

Figure 15- MoCA Performance with WNL and Non-amnestic MCI……..….....45

Figure 16- SVLT Performance with WNL and Non-amnestic MCI……..…....46

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Chapter 1 Proposal Introduction

The human nervous system is comprised of two mains systems, the central nervous system, which includes the brain and spinal cord, and peripheral nervous system, which contains nerves beyond the brain and spinal cord (Hurtley & Alderton, 2020). Neurodegeneration is a term used to describe when an individual's nervous system undergoes progressive atrophy and a loss of function of the neurons. Because this can occur in the brain, spinal cord, or peripheral nerves, neurodegenerative processes can cause a multitude of symptoms such as physical weakness or immobility, apathy, anxiety, loss of inhibition, mood changes, and cognitive changes such as memory loss (Hurtley & Alderton, 2020). Neurodegenerative diseases can occur for several reasons such as mitochondrial dysfunction, oxidative stress, and/or environmental factors (Sheikh et al., 2013). Aging often plays a dominant role in neurodegenerative processes. Although aging can affect every organ in the human body, the impact of aging on the brain has some of the most distressing symptoms due to our reliance on having intact cognition. Neurodegenerative diseases have become an increasingly prevalent threat to human health due to the fact that humans are living longer (Gitler et al., 2017). As noted above, neurodegenerative diseases can affect vital functions such as cognition and memory as well as the ability to move, speak, and even breathe. Some examples of prominent neurodegenerative diseases are multiple sclerosis, Huntington's disease, amyotrophic lateral sclerosis, frontotemporal dementia, Parkinson's disease and Alzheimer's disease. Early detection of these diseases is

key to initiating therapies promptly, so they have the most beneficial effect (Gitler et al., 2017)

There are several strategies which can be useful in detecting neurodegenerative diseases. Initially individuals begin to experience a clinical presentation of symptoms, which may be more thoroughly examined during a medical evaluation. Neuroimaging can also provide evidence regarding the areas of the brain which are negatively affected, and imaging strategies such as magnetic resonance imaging (MRI), single photon emission computed tomography (SPECT) positron emission tomography (PET), and amyloid imaging are all helpful tools in identifying areas of the central nervous system where atrophy or dysfunction is occurring (Shimizu et al., 2018). Additionally, identification of potential biomarkers is also helpful in identifying neurodegenerative processes, and this can be achieved with a MRI, dopamine transporter (DAT) imaging, and metaiodobenzyl-guanidine (MIBG) myocardial scintigraphy (Schimizu et al., 2018). Finally, identification of biochemical changes that led to misfolding and accumulation of particular proteins is vastly helpful in identifying the neurobiological processes of neurodegeneration (Telling, 2019). Although these techniques allow providers to identify the structural and biological changes occurring in the brain, other strategies are important in identifying the cognitive changes and behavioral impairments demonstrated by the individual (Rascovsky, 2016).

Specifically, neuropsychological testing can be integral in identifying the extent and severity of an individual's cognitive and behavioral dysfunction within the central nervous system, whether that be due to neurodegenerative processes or an injury to the brain (Rascovsky, 2016). Neuropsychological tests are traditionally paper-and-pencil tests where an individual will answer a series of questions to measure cognitive domains (Kessels, 2018). With advances in technology, some of these measures can now be administered electronically (Kessels, 2018). Neuropsychological tests directly communicate individuals' cognitive strengths and weaknesses, providing information regarding the functioning of the individual's brain being tested (Rascovsky, 2016). Neuropsychological testing can allow for detection and understanding of discrete brain functions to aid in the enhancement of diagnostic and treatment outcomes (Casaletto & Heaton, 2017). Overall, the main goals of neuropsychological assessment are to identify the degree of neurocognitive dysfunction and aid in differential diagnosis, identify cognitive strengths and weakness, and aid in providing recommendations on adapting to life and treatment planning (Casaletto & Heaton, 2017).

To achieve the goals of neuropsychological testing, a variety of cognitive domains are measured to determine whether potential strengths or weaknesses exist within those domains. Typical domains measured include sensation, perception, motor skills and construction, attention and concentration, executive functioning, processing speed, language/verbal skills, and memory (Harvey, 2019). Within these domains, there are several subdomains to provide an in-depth analysis of

neurocognitive functioning. Of note, these domains approximate those outlined in the diagnostic criteria of neurocognitive disorders according to the *Diagnostic and Statistical Manual of Mental Disorders, Fifth Addition (DSM-5)* (American Psychiatric Association, 2013).

Neurocognitive disorders (NCD) within the DSM-5 refer to disorders with an identifiable underlying brain pathology and a potential etiology which can be determined (American Psychiatric Association, 2013). There are three categories of neurodegenerative disorders including delirium, mild NCD, and major NCD, and minor NCD and major NCD can be further diagnostically clarified by specifying an etiological subtype (if known or suspected). NCDs are measured and determined based on several cognitive domains including complex attention, executive functioning, learning and memory, language, perceptual-motor abilities, and social cognition. These are evaluated with assessments, presenting symptoms, and impairments in everyday activities (American Psychiatric Association, 2013).

There is little research regarding the neuropsychology of delirium as delirium is based on a disturbance in attention and awareness that develops over a short period of time representing a change from the individual's baseline, and due to the transient nature of this NCD, diagnosis with neuropsychological assessment is not as stressed (Tieges et al., 2017). However, neuropsychological testing is quite important regarding the diagnosis of mild or major NCD (Lucza et al., 2015). According to the *Diagnostic and Statistical Manual of Mental Disorders*, 5th edition (2013), a mild NCD is diagnosed when there is evidence of a modest

decline in previous level of performance in one or more cognitive domains, no change in carrying out instrumental activities of daily living even if compensatory strategies are used, exclusion of delirium, and exclusion of other mental disorders. The diagnosis of a major NCD occurs when there is a significant cognitive decline from a previous level of performance in one or more cognitive domains as well as interference with independence in everyday activities. Additionally, these deficits must not occur in the context of delirium and the symptoms cannot be better explained by another mental disorder (American Psychiatric Association, 2013). For both mild NCD and major NCD, the specifiers Alzheimer's disease, frontotemporal lobar degeneration, Lewy body disease, vascular disease, traumatic brain injury, substance/medication use, HIV infection, prior disease, Parkinson's disease, Huntington's disease, another medical condition, multiple etiologies, and unspecified can be utilized to further clarify the minor or major NCD (American Psychiatric Association, 2013).

The *DSM-5* diagnoses of mild or major neurocognitive disorder allows for clarifying diagnoses regarding neurodegenerative processes. Although the *DSM-5* includes specifiers such as Alzheimer's disease, a commonly diagnosed condition referred to as mild cognitive impairment (MCI) is not specifically mentioned in the DSM-5. This apparently occurred due to NCD being a diagnosis relating to cognitive impairment at all ages, while MCI is more associated with geriatric disorders (Ganguli, 2013). Over the past two decades, mild cognitive impairment (MCI) has been heavily researched and utilized as an interim diagnostic phase

between normal aging and dementia, with dementia referring to acquired cognitive impairment that interferes with social and occupational functioning (Peterson, 1999). The diagnostic criteria for MCI are used from the Mayo Criteria, which were created at the Key International Symposium in 2003 (Peterson, 2016). Amnestic MCI refers to impairments regarding the memory domain and is the most associated with probable dementia of the Alzheimer's type (AD) (Schmidtke & Hermeneit, 2008).

Although one measure cannot definitively predict whether someone is experiencing MCI, dementia, or a neurodegenerative process from MCI to dementia, several neuropsychological assessments are crucial for determining these diagnoses. Measures regarding verbal learning and recall are key in determining amnestic MCI, AD, and the potential progression of MCI to AD (Galluci et al., 2017). Specifically, story memory and list learning tasks are quite sensitive to the neurodegenerative effects of MCI and AD (Tremont et al., 2009). These assessments allow for details regarding the individuals functioning of their episodic memory, which refers to the individual's ability to learn and recall personal experiences (Gavett et al., 2016). A decline in episodic memory is usually due to medial temporal lobe pathology, and early detection of this decline is an important indicator of the neurodegenerative processes of AD. This early indication can be achieved with cognitive tests involving story memory and list learning activities before the neuropathologies are detectable utilizing neuroimaging (Gavett et al., 2016).

A study researching 55 amnestic MCI patients found that the Rey Auditory Verbal Learning Test (RAVLT), Delayed Recall (p = .031) and Semantic Verbal Fluency tests (p=.031), verbal memory and language tests, respectively, were the most helpful tools in predicting the progression of amnestic MCI to dementia. Individuals with lower scores on these tests were shown to be at risk of developing dementia (Galluci et al., 2017). The RAVLT is comprised of 15 concrete nouns that are read to the participant in a list for 5 trials (Magalhaes & Hamden, 2010). After each trial, the participant is asked to repeat back all the words they remember. After the first 5 trials, a second list is read to the participant with 15 different concrete nouns, and the participant is again asked to repeat back what they remember from the second list. Then, the participants are asked to state words they remember from the first list. After a 20-minute delay, participants are asked to recall what words they remember from the first list. The final task on the RAVLT is the participant being orally presented 50 nouns from both lists, and the participant is required to identify words from the first list (Magalhaes & Hamden, 2010).

Additionally, research involving another verbal list learning test called the California Verbal Learning Test (CVLT) has provided further evidence regarding the importance of list learning tasks in the detection of early Alzheimer's disease in MCI patients (Pozueta et al., 2011). In this study of 109 MCI patients, neuropsychological evaluations were conducted at baseline and at 6-month intervals for 2 years. It was found that 54 of these individuals progressed from MCI to dementia, while 55 maintained the diagnosis of MCI. A strong predictor that

determined the progression of MCI to dementia was episodic memory impairment, and this was determined based on performance on the CVLT with short and long delay recall and both free and cued recall. Individuals who retained the diagnosis of MCI performed better overall on the CVLT. This study concluded that it is possible to determine a pre-AD amnestic MCI at baseline using the CVLT (Pozueta et al., 2011).

The Montreal Cognitive Assessment (MoCA) is a screening measure utilized to determine if an individual is demonstrating cognitive difficulties (Nasreddine et al., 2005). The MoCA includes a 5-word list to measure verbal learning and delayed recall. These 5 words are read twice consecutively to see how many the examinee remembers, and then the examinee is asked to recall these words again after approximately 5 minutes. Thus, up to 5 of the total points on the MoCA are derived from one's ability to remember these 5 words. If most of the points lost on the MoCA are derived from the word list, then the examinee may be assumed to have amnestic MCI (Li et al., 2018).

Word list-learning tasks are fairly common and useful measures of verbal memory and retention and can help in differentiating impairments based on memory difficulties (Lie et al., 2018). However, the 5-item word list on the MoCA is relatively short compared to other word list-learning tests, and therefore it may not be capable of detecting early or milder memory impairments such as those observed in individuals with MCI. A longer word list could potentially be useful in identifying those with milder impairments (Lie et al., 2018). Early detection of mild

cognitive changes in the elderly is imperative, as interventions with those who have MCI can improve brain functioning. For example, cognitive or memory training has shown to enhance activity in the frontal, temporal, and parietal areas of the brain (Chen & Wang, 2013). Additionally, there are memory medications such as cholinesterase inhibitors that help to manage symptoms as well as potentially slow progression of neurocognitive decline (Chen & Wang, 2013).

The Shepherd Verbal Learning Test (SVLT) is a word list-learning task developed for use with older adults with cognitive impairment at the Health First Memory Disorder Clinic (Norheim, N., Kissinger-Knox, A., Cheatham, M., Mulligan, K., & Webbe, F., 2018). It has characteristics that are similar to existing verbal memory tasks that involve word lists, with some differences as well. For example, there are ten words in total on the SVLT, which is more than the number of words in the MoCA (which has 5), but fewer than the number of words on the most recent version of the CVLT (the CVLT-3, which has 16). Additionally, the SVLT words are relatively grammatically simple being that they are only one syllable each. This list is repeated over 5 trials and the examinee is asked to recall as many words as possible after each trial, which provides information regarding the individual's ability to learn repeated verbally presented information. After the 5 trials are completed, there is a 5-minute delay after which the examinee is prompted to recall as many words from the list as possible, as a way to measure delayed verbal recall. Finally, 10 minutes after the delayed recall, the individual is given a sheet of paper with two columns of words, each column containing ten words. Ten

of the words were on the original list, while ten of the words were not on the list, and the individual is asked to circle the words that were on the list. The SVLT is relatively simple to administer in a brief amount of time and the results are easy to interpret. Although it is shorter in comparison to other word lists, it appears to be a valid measure of verbal memory. The current study aims to determine whether the SVLT's longer word list is more accurate than the MoCA's shorter word list in predicting memory disorders, such as amnestic MCI.

Chapter 2 Normal Cognition in Aging

As individuals age, it is normal for subtle neurocognitive changes to occur. Even with a neuropsychological assessment, it can be quite difficult to determine what constitutes normal cognitive changes from pathological cognitive impairments. Additionally, several other factors can influence cognition, including educational background, psychological distress, vascular risk factors, and other health conditions (Harada et al., 2013). However, age-related cognitive changes are often considered normal if the person is still capable of carrying out activities of daily living (Harada et al., 2013). In healthy older adults, it is more likely that they will demonstrate mild relative difficulties in working memory, episodic memory, and tasks of attention in comparison to younger adults. Although there is some degree of measurable decline within these domains, older adults perform better on assessments in which wisdom and general knowledge is tested (Dumas, 2015).

Because of these expected changes in cognition with normal aging, obtaining accurate normative data for individuals experiencing normal cognitive

aging is extremely important. This normative data allows for accurate diagnosis and treatment of neurodegenerative diseases when assessing older adults because their test results can be compared to others who are their own age. Unfortunately, the literature is limited regarding normative data for healthy aging populations and performing normal aging related assessments. Humans are living longer, meaning there needs to be new norms created for these older age groups to aid in diagnostic clarity. The "oldest-old," a label created for individuals 85 and older, is a population with substantially limited normative data regarding neuropsychological assessments. However, Miller et al. (2015) obtained normative ranges for several assessments, as the oldest-old is a growing population. In this study it was found that overall, there are measurable cognitive declines as individuals age, which is congruent with the use of age-appropriate normative data for the oldest-old people (Miller et al., 2015).

Chapter 3 Mild Cognitive Impairment

Clinical Definition. The specific diagnostic criteria and definition of MCI was set forth during the Key International Symposium in 2003 (Petersen, 2016). One of the goals of this symposium was to create distinctions between the different types of MCI, as not all MCI subtypes develop into AD. The initial diagnostic feature that the Key International Symposium identified was that the individual was experiencing a cognitive shortcoming. If these cognitive difficulties were not related to normal aging, but also not related to dementia, the cognitive decline was steady, and the individual exhibited relatively normal functional activities, then the

individual could be diagnosed with MCI. Cognitive screening measures are often used to identify MCI, such as the Mini-Mental State Exam (MMSE) and Montreal Cognitive Assessment (MoCA). However, more comprehensive neuropsychological assessments are beneficial in differentiating MCI subtypes. Specifically, the distinction between having memory impairment, or amnestic MCI, and not having memory impairment, or non-amnestic MCI, has been identified. Additionally, having impairments only within a single cognitive domain, versus having impairments in multiple domains, has been conceptualized as another diagnostic clarification for MCI (Petersen, 2016). It is also of note that MCI can be considered to be a subset of mild NCD, as they can both manifest as an intermediate stage between normal aging and dementia (Geda & Nedelska, 2013).

Early History and Overview. Although a diagnosis of MCI is not considered to be as severe as dementia, it has been known for decades that early detection of cognitive deficits is possible and beneficial for purposes of treatment and future planning. The first indications of an MCI-like diagnosis occurred in 1962, when the term "benign senescent forgetfulness" was utilized (Kral, 1962). Dr. V.A. Kral observed that there was a decline in memory functioning as individuals aged. By 1980, the *Diagnostic and Statistical Manual of Mental Disorders*, 3rd edition (DSM-III) identified a syndrome considered to be a primary degenerative dementia that would likely develop into AD (American Psychiatric Association, 1980). The criteria for this diagnosis reiterated that there needs to be evidence of a progressive deterioration in multiple domains of an individual's life.

Although the criteria detailed for primary degenerative dementia is not as encompassing as the current criteria for MCI, it is considered to be one of the preceding diagnoses to MCI.

Epidemiology. The prevalence of MCI has been estimated to range from 12% to 18% in individuals over the age of 60 years, while in individuals over the age of 70, the prevalence of MCI is 16% (Petersen, 2016). It has been found that MCI amnestic single domain has a lower prevalence of only 2% to 4%, while other MCI subtypes make up 18% to 21% of MCI patients (Lopez, 2013). It has been found that 10-15% of patients diagnosed with MCI will progress to AD annually (Varatharajah et al., 2019). Being aware of this distinction regarding types of MCI is quite important, as it can predict the area of cognitive decline and create targeted prevention (Peterson et al., 2014). For example, in a study looking at 1188 individuals diagnosed with MCI, 32% progressed to dementia in an average of 2 years (Glynn et al., 2020). Of the 1188 individuals, 55% were diagnosed with amnestic MCI, and the remaining 45% were diagnosed with non-amnestic MCI (Glynn et al., 2020). It was found amnestic MCI was a significant predictor of the individual's progression in their cognitive deficits when compared to non-amnestic MCI, as individuals were twice as likely to progress to dementia if they were diagnosed with amnestic MCI. (Glynn et al., 2020).

Risk Factors. The risk factors for MCI are fairly similar to that of the risk factors of AD (Chen et al., 2018). For example, increasing age is a risk factor for developing MCI similar to that of AD. Additionally, vascular risk factors such as

hypertension, dyslipidemia, anemia, heart disease, and stroke are also related to an increased risk in developing MCI, and these are also risk factors for AD. Other risk factors include liver disease, renal disease, and gastrointestinal disease. Depression is also a risk factor for developing MCI. The use of more than five medications was also found to be a risk factor (Chen et al., 2018). In a study examining 294 elderly patients, it was found that 54% of patients who were taking 10 or more medications were demonstrating impaired cognition (Jyrkkä et al, 2011). Additionally, 33% of patients taking 6-9 medications, and 22% taking five or fewer medications, exhibited impaired cognition (Jyrkkä et al, 2011).

Chapter 4 Alzheimer's Disease

Clinical Definition. A diagnosis of dementia requires cognitive or behavioral symptoms to be severe enough to interfere with an individual's ability to function at work or other domains of life (McKhann et al., 2011). Additionally, a decline in functioning compared to previous levels must be established. The degree of cognitive impairment must be diagnosed from knowledge of a thorough clinical history of the individual and a comprehensive cognitive assessment. Cognitive or behavioral impairment must be observed in at least two of the following domains: ability to acquire and remember new information, reasoning and handling of complex tasks, visuospatial abilities, language functions, and changes in personality or behavior (McKhann et al., 2011). To more specifically diagnose probable AD dementia, there needs to be presence of an insidious onset, a clear history of cognition worsening by either report or observation, and an amnestic

presentation with language, visuospatial, or executive difficulties (McKhann et al., 2011).

Overview. Alzheimer's disease is the most common cause of dementia and is attributed to 80% of all dementia diagnoses (Weller & Budson, 2018). This disease is named after Dr. Alois Alzheimer, who in 1907 treated a woman who he noticed had died from "unusual mental illness" and had changes in her brain tissue. He discovered she had clumps and fibers in her brain, which were subsequently identified as amyloid plaques and neurofibrillary tangles after further research. He also observed her to have memory loss as well as language problems and odd behavior (Bondi et al., 2018).

Research involving AD was sporadic after the initial identification of this disease. One of the main reasons AD was not researched heavily was due to neuropsychological studies of dementia and AD only focusing on individuals exhibiting symptoms before the age of 65, which is rarer. However, in the mid-1970s, epidemiological data revealed that AD was the fourth leading cause of death in the elderly. This led to greater attention to AD as well as funding research into this disease and refining diagnostic clarity (Bondi et al., 2018).

By the 1980s, research was being conducted on mildly demented patients using methods of cognitive psychology to explore the nature of potential neuropsychological deficits in AD. These studies helped to outline the common neuropsychological presentation of AD, which included impairments in episodic memory and semantic encoding. Additionally, it was observed that although there

will likely be executive functioning impairments and deficits in attention for those with AD, these deficits played a less prominent role. Lastly, some patients did display visuospatial deficits; however, these deficits were less salient than the other cognitive deficits observed.

Several genetic risks for AD were identified during the 1990s and early 2000s, which led to increased diagnostic clarity (Bondi et al., 2018). There has also been advances in neuroimaging regarding the diagnosis of AD. For example, it has been found that in individuals with AD, there is atrophy in structures within the medial temporal lobe. As the disease progresses, there is likely to be atrophy with structures in the medial temporal lobe such as the hippocampus, amygdala, entorhinal cortex, and parahippocampal cortex (Ledig et al, 2018).

Epidemiology. As noted above, Alzheimer's disease cannot be definitively diagnosed until after death. However, if there is no other cause for dementia found, and the symptomatology matches typical AD symptoms, an individual may be diagnosed with possible or probable Alzheimer's dementia while living. This diagnosis may be derived from a detailed assessment performed by a geriatrician, geriatric psychiatrist, neurologist, neuropsychologist, or a combination of these professionals (U.S. Department of Health and Human Services, 2017). By the middle of the 21st century, it is predicted that 13.8 million American individuals will suffer from Alzheimer's dementia, which is a large increase compared to the 5.8 million American individuals who suffer from AD currently. In 2018, 122,019 people died from Alzheimer's disease, making it the 6th leading cause of death in

the United States. Currently, in 2021, 6.2 million Americans over the age of 65 are living with AD, and 72% of these individuals are 75 or older. Additionally, two-thirds of these individuals with AD are women, and black Americans are twice as likely to develop AD in comparison to white Americans. Hispanic Americans are 1.5 times as likely to develop AD when compared to white Americans (Alzheimer's Association, 2020).

Risk Factors. The three most prominent risk factors of Alzheimer's disease are age, genetics, and family history (Alzheimer's Association, 2020). Other risk factors for AD include vascular diseases, type 2 diabetes, traumatic brain injury, epilepsy, and depression (Edwards et al., 2019). The risk of AD increases as people age, with about 3% of diagnoses of Alzheimer's disease occurring between the ages of 65 to 74. Once between the ages of 75 to 84, 17% of people have Alzheimer's disease, and once over the age of 85, 32% of people have Alzheimer's disease (Alzheimer's Association, 2020). Additionally, genetics plays a role in the risk of developing Alzheimer's disease. A gene found to be linked to AD is the apolipoprotein-e4 (APOE-e4) gene allele. The APOE gene controls the protein that takes cholesterol to the bloodstream, and the e4 allele increases risk of developing AD, as 40-65% of individuals with AD have the e4 allele (Van Cauwenberghe et al., 2016). The e2 allele actually has a protective effect regarding the development of AD (Van Cauwenberghe et al., 2016). Finally, family history plays an important role in the development and diagnosis of AD. It has been found that those who

have had a parent with AD increases their risk by 30% (Alzheimer's Association 2020).

Chapter 5 Use of the MoCA to Assess for MCI

The MoCA was created as a screening tool specifically for detecting MCI (Nasreddine et al., 2005). The MoCA is scored out of a possible total of 30 points, and the cut point of 25/26 has a sensitivity of 80 to 100% and specificity of 50 to 76% for detecting MCI (Langa & Levine, 2015). The creators claim the MoCA is capable of screening for a myriad of disorders such as Alzheimer's disease, Parkinson's disease, Lewy body dementia, stroke, fronto-temporal dementia, brain metastasis, brain tumors, amyotrophic lateral sclerosis, multiple sclerosis, and head trauma (mocatest.org). Additionally, diagnoses that would not be considered to have as severe of a cognitive impairment as the previous listed ailments are also claimed by the creators of the MoCA to be detected by this screener, including depression, schizophrenia, heart failure, substance use, and HIV (mocatest.org). Regarding Parkinson's disease, the MoCA demonstrated adequate psychometric properties as a screener for MCI or dementia in Hoops et al.'s 2009 study looking at the MoCA's validity for diagnosing MCI or dementia in Parkinson disease; however, additional assessment was required due to lower than ideal specificity when looking at the MoCA's specific cut point. Furthermore, although the MoCA may be a useful tool in detecting cognitive difficulties or potential dementia, it also detects a high proportion of false positives. In a systematic review looking at the MoCA for the diagnosis of AD and other dementia, the number of individuals that

were incorrectly diagnosed with dementia was upwards of 40% due to using the cut score of less than 26 (Davis et al., 2015). Although the MoCA should not necessarily be used for diagnostic purposes in isolation, it appears to be an adequate tool for utilizing as a screener for cognitive difficulties, such that scoring below the normal range would warrant further diagnostic investigation (Dautzenberg et al., 2020).

The MoCA is a screener capable of detecting some degree of cognitive changes; however, given its brevity, it often does not provide enough data to allow for specific diagnostic clarity. For example, although the MoCA is more sensitive in detecting MCI compared to a clinical interview or ad hoc questions, it may not be comprehensive enough to identify more subtle presentations of MCI (Knopman & Peterson, 2015). It is important to identify cases that may be missed by the MoCA so that action can be taken toward intervention. Additionally, taking further action can help to gauge the likelihood of progression. Therefore, using a screening instrument such as the MoCA by itself could result in some cases of MCI being undetected, also known as “false negatives.” When an individual is diagnosed with MCI, it carries important prognostic implications as individuals diagnosed with MCI are at a higher risk of progressively worsening to Alzheimer’s disease or other types of dementias (Knopman & Peterson, 2015). Therefore, a high level of accuracy in detecting cases of MCI is critical. Furthermore, the ability to accurately classify MCI subtypes has become increasingly relevant as well. In particular, if memory loss is a predominant feature when diagnosing MCI, then the MCI

diagnosis is further specified as “amnestic” in nature. This sub-classification is an important factor in diagnosing MCI, as individuals with amnestic MCI have an even a higher risk of converting to Alzheimer’s disease specifically, while non-amnestic MCI has a higher risk of converting to non-Alzheimer’s dementia (Csukly et al., 2016).

The MoCA can also be utilized to determine if individuals are functioning at a “healthy” cognitive level (Bruijen et al., 2020). In a study of 210 individuals aged 18 to 70 who were administered the three different versions of the MoCA found that the MoCA is a reliable cognitive measure. Additionally, all three MoCA versions were relatively equivalent. However, it was also found that age, education, and intelligence are predictors of MoCA performance in health individuals (Bruijen et al., 2020).

Chapter 6 Factors that Affect Cognition

Age

Throughout human’s lives, there are changes in cognition (Murman, 2015). Whether that be attention, memory, executive functioning, language, or visual spatial abilities, changes in cognition occur. A strong factor that effects cognition is aging. Regarding attention, the most noticeable change that occurs when people age is with complex attentional tasks such as selective or divided attention. Additionally, older adults’ memory changes as there are a decline in new learning abilities as well as retrieval of newly learned material. Aging individuals have stable immediate memory, episodic memory, and procedural memories. However,

new learning that can be measured by delayed free recall declines with age. This can be measured with a list learning task. Working memory and prospective memory also declines with age. Another area of cognition that declines with age is executive functioning. This includes tasks related to decision making, problem solving, planning, sequencing, and multitasking. Speech and language stay relatively intact through aging, Visual-spatial skills also decline with age (Murman, 2015).

Sex

Sex also plays a role in cognition related to aging (Reas et al., 2018). In a study examining 2,225 community-dwelling participants (59% women) were provided neuropsychological testing every four years over a maximum of a 27-year follow up. It was found that cognitive decline occurred between the ages of 65 to 80, with more rapid acceleration occurring after the age of 80. It was found that the rate of decline was similar between sexes; however, males declined more rapidly on a global function test. Women, though, showed a more rapid decline than men on a test of executive functioning (Reas et al., 2018).

Education

Education can also play an important role regarding aging. In a study looking at 659 cognitively normal community dwelling individuals, it was found that the highly educated elderly had better functioning in a variety of areas (Chen et al., 2019). For example, these individuals performed better in several cognitive domains. There were also slower age-related reductions of executive functioning

(Chen et al., 2019). Additionally, in another study of 938 individuals that were 75 and older, six cognitive assessments were provided with a final follow up 15 years after the baseline assessment (Then et al., 2016). It was found that more years of education had a protective effect on dementia risk (Then et al., 2016).

Health Difficulties

There are a variety of risk factors that can affect dementia and its progression (Livingston et al., 2020). Several risk factors that have been identified are hearing impairment, obesity, depression, diabetes, and traumatic brain injury. Additionally, smoking, depression, and physical activity also have been shown to effect dementia (Livingston et al., 2020).

Chapter 7 Research Objectives

This research aims to determine whether the 5-word list assessing memory on the MoCA is sensitive enough to determine whether someone is ultimately diagnosed with amnestic MCI. This will be accomplished through an analysis of cognitively intact individuals, patients diagnosed with MCI, and patients diagnosed with AD who have been administered both the MoCA and the SVLT word list. The primary aim of this research is to identify if the SVLT is better at detecting MCI than the word list on the MoCA. Specifically, it is hypothesized that the longer 10-word SVLT list will be more sensitive in detecting amenstic MCI compared to the shorter 5-word list from the MoCA. Performances on the MoCA and SVLT including comparisons to individuals with AD will also be explored to determine their relative usefulness in evaluating increasing levels of cognitive impairment.

Results of this study will be important for aiding in the early detection of amnestic MCI, which will allow for improved diagnostic implications to mitigate the potential progression into AD (Reisberg et al., 2008).

Chapter 8 Study Hypotheses

Hypothesis 1.

Healthy controls and individuals diagnosed with MCI will have similar delayed recall total scores on the MoCA, suggesting that the MoCA word list does not consistently or comprehensively differentiate MCI from normal cognition.

Hypothesis 2.

Healthy controls will have better delayed recall total scores on the SVLT than individuals diagnosed with MCI, suggesting the SVLT is better able to differentiate MCI from normal cognition.

Hypothesis 3.

Individuals diagnosed with AD will have lower delayed recall total scores on both the MoCA and the SVLT compared to healthy controls and individuals diagnosed with MCI suggesting that both tests are useful in detecting dementia.

Hypothesis 4.

Lower delayed recall total scores on both the MoCA and the SVLT are more likely to be associated with more impaired levels of overall cognition based on diagnosis (Healthy, MCI, AD).

Hypothesis 5.

Individuals diagnosed with amnestic MCI will have lower delayed recall total scores on the SVLT compared to individuals diagnosed with non-amnestic MCI, but not the MoCA, suggesting that the SVLT is better able to differentiate amnestic MCI and non-amnestic MCI.

Hypothesis 6.

Individuals who performed within normal limits and were diagnosed with non-amnestic MCI will have similar scores on the MoCA wordlist, but not the SVLT, suggesting the SVLT is better able to differentiate non-amnestic MCI from within normal limits.

Chapter 9 Methods and Procedures

Data Collection

This study utilized test data collected from community-dwelling healthy controls who participated in a research study which obtained normative data for several neuropsychological tests. These individuals were eligible for participation in this research if they were 65 years and older and were not demonstrating cognitive impairments. Specifically, individuals' data was included if they scored 23 or above on the MoCA. Data was also utilized from the HFMDC database. These individuals were administered a MoCA and a brief neuropsychological evaluation. Participants were selected if they performed within normal limits or were diagnosed with MCI or AD.

Measures

Community-dwelling healthy controls were administered several neuropsychological measures to be included in normative data collection. The following tests were administered: MoCA, Test of Memory Malingering (TOMM), Brief Visual Memory Test-Revised (BVMT-R), Boston Naming Test Short Form, Trail Making Test A & B, and SVLT. The TOMM is a measure of assessment validity. The BVMT-R is a measure of visual memory, while the Boston Naming Test Short Form is a measure of language. Finally, the Trail Making Test A & B measures attention, processing speed, and executive functioning.

Patients who performed within normal limits and diagnosed with MCI and AD at the HFMDC were administered a brief neuropsychological evaluation that measured the following cognitive domains: learning and memory, language, attention and processing speed, executive functioning, visuospatial skills, and basic functional living skills. The following tests were administered: (a) SVLT, (b) BVMT-R, (c) Controlled Oral Word Association Test (COWAT), (d) Boston Naming Test Short Form, (e) Western Aphasia Battery (WAB) Comprehension and Repetition, (f) Boston Diagnostic Aphasia Examination (BDAE) Cookie Theft Picture, (g) Trail Making Test A & B, (h) Stroop Color and Word - Golden version, (i) Wechsler Adult Intelligence Scale-Fourth Edition (WAIS-IV) Digit Span subtest, (j) Modified Wisconsin Card Sorting Test (M-WCST), (k) Clock Drawing Test, (l) Geriatric Depression Scale (GDS), (m) Geriatric Anxiety Inventory (GAI), and the (n) Texas Functional Living Scale (TFLS). The COWAT,

WAB, and BDAE Cookie Theft Picture are all measures of language. The Stroop Color and Word – Gold version and WAIS-IV digit span subtest is both measures of attention. Meanwhile, the M-WCST is a measure of executive functioning, and the Clock Drawing Test is a measure of visual-spatial abilities. The GDS and GAI are both mood measures, and finally, the TFLS is a measure of adaptive functioning.

Montreal Cognitive Assessment (MoCA)

The MoCA (Nasreddine et al., 2005) is a standardized memory screener used to assess global cognitive functioning. It looks at several domains including visuospatial, executive functioning, language, attention, memory, orientation, and abstract reasoning. This measure can detect potential cognitive impairment in individuals that are aging. The assessment is scored out of a total of 30 points, and it is interpreted as the higher the score, the more cognitively intact the person is. Education can also be corrected for individuals who have less than 13 years of formal education by adding 1 point (Nasreddine et al., 2005).

Shepherd Verbal Learning Test (SVLT)

The Shepherd Verbal Learning Test (SVLT) is a word list-learning task developed for use with older adults with cognitive impairment at the Health First Memory Disorder Clinic (Norheim, N., Kissinger-Knox, A., Cheatham, M., Mulligan, K., & Webbe, F., 2018). Additionally, the SVLT words are relatively grammatically simple being that they are only one syllable each. This list is repeated over 5 trials and the examinee is asked to recall as many words as possible

after each trial, which provides information regarding the individual's ability to learn repeated verbally presented information. After the 5 trials are completed, there is a 5-minute delay after which the examinee is prompted to recall as many words from the list as possible, as a way to measure delayed verbal recall. Finally, 10 minutes after the delayed recall, the individual is given a sheet of paper with two columns of words, each column containing ten words. Ten of the words were on the original list, while ten of the words were not on the list, and the individual is asked to circle the words that were on the list.

Procedures

Normative test data from community-dwelling healthy seniors was obtained at various senior centers and/or senior living communities within the Brevard County area, which included Greater Palm Bay Senior Center, Wickham Park Senior Center, Martin Anderson Senior Center, and North Brevard Senior Center. Exclusion criteria included individuals who have had some type of brain injury, neurological disorder, or diagnosis of cognitive impairment. It is important to note that these individuals were not seeking an evaluation due to memory concerns; rather, they were recruited solely for the purpose of research participation. Inclusion criteria included age equal to or greater than 65 and a score on the Montreal Cognitive Assessment (MoCA) greater than 23. This cutoff score was used instead of the recommended score of 26 due to a meta-analysis which revealed a score of 23/30 allowed for the best diagnostic accuracy (Carson et al., 2018). The original score of 26/30 has shown to lead to an inflated rate of false positives. A

false positive would be an individual considered to have some type of cognitive impairment because they scored below 26; however, because the cutoff score is considered to be high, the individual would not actually have cognitive impairments (Carson et al., 2018).

Participants who met these inclusion criteria were informed of all study procedures and protocols, and then asked to give consent prior to initiation of testing. Once the informed consent was obtained, participants were asked to fill out demographic information and then complete the MoCA, followed by a short battery of cognitive tests that would assess different areas of cognitive functioning such as language, memory and learning, executive functioning, attention and concentration, motor and processing speed, and visual-spatial skills. The total time of testing was about an hour. In exchange for their participation, participants were compensated with $25.00.

Individuals who were considered cognition within normal limits and diagnosed with MCI or AD were patients from HFMDC who were referred for an evaluation due to memory concerns and subsequently underwent a formal interview with a geriatrician and licensed clinical social worker. During this interview period, the MoCA was administered. If the geriatrician wanted diagnostic clarity, the patient was recommended to undergo neuropsychological testing. A brief neuropsychological examination (BNE) was administered by a clinical psychology doctoral student under the supervision of a board-certified licensed clinical neuropsychologist. A consent form was signed by the patient on the day of their

evaluation, which gave permission for their de-identified test data to be used for future research purposes. After the informed consent was signed, patients underwent a BNE to assess different areas of cognitive functioning including language, memory and learning, executive functioning, attention and concentration, processing speed, visuospatial skills, and basic adaptive functioning skills. Testing was administered in English, and the total time of the BNE took approximately 2 hours.

Once testing was completed, a multi-disciplinary case review developed diagnostic impressions and recommendations based on the data presented for each patient. These case review meetings include a geriatrician, social worker, neuropsychologist, neurologist, pharmacy doctoral students, and clinical psychology doctoral students. Diagnostic impressions were based on the overall presentation of evaluation of data including psychosocial history, onset of memory loss, medical history, review of neuropsychological test data, and brain imaging if available. The multi-disciplinary team would diagnose patients according to the Tenth Revision of the International Classification of Diseases and Related Health Problems (ICD-10; WHO, 1992). The MCI group included both amenstic and non-amnestic types, and this was based on the Peterson (2004) criteria.

Research Design and Analysis of Data

Prior to analyzing data, the researcher obtained approval from the Florida Institute of Technology Review Board (IRB). Additionally, permission was granted to the researcher by the Health First Memory Disorder Clinic to utilize their

research database. Informed consent was also obtained prior to each participant completing their neuropsychological evaluation or before their research study participation.

Means, standard deviations, and frequencies for patient demographics will be obtained utilizing descriptive statistics. An independent samples *t*-test will be conducted to examine performance differences on delayed verbal recall total scores on the MoCA and SVLT. An ordinal logistic regression will be utilized to examined delayed recall total scores for the MoCA and SVLT regarding healthy controls, MCI individuals, and AD individuals. This data will be analyzed using Statistical Package for the Social Sciences (SPSS)-Version 25.

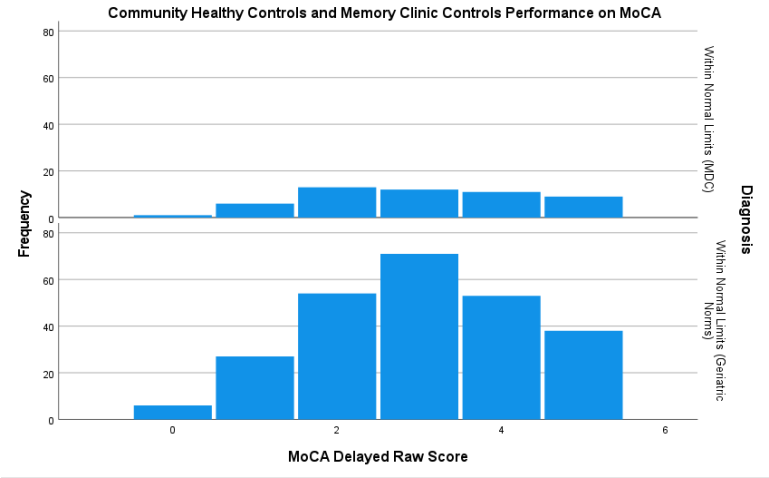
Although the MoCA allows for brevity and insight into an individual's performance within several cognitive domains, it does not allow for an in-depth analysis of an individual's potential cognitive shortcomings. Further diagnostic clarity is almost always warranted when a performance on a MoCA is below average; however, time constraints may cause health professionals to opt for the results from the brief and convenient MoCA. The significance of this study allows for analysis of another brief assessment, the SVLT, which can presumably provide further diagnostic clarity and potentially less false positives in comparison to the MoCA when looking at list learning performance and potential amnestic MCI diagnosis.

Chapter 10 Results

Healthy Community Controls and Healthy HFMDC Controls

Assumption tests suggested that there were no outliers in the mean wordlist delayed recall total scores on the MoCA for healthy controls from the community and healthy controls from HFMDC, and mean wordlist delayed recall total scores on the MoCA was normally distributed. Levene's test suggested that variances in mean wordlist delayed recall total scores on the MoCA for healthy controls from the community and healthy controls from HFMDC were statistically equivalent, $F(299) = .37$, $p = .55$.

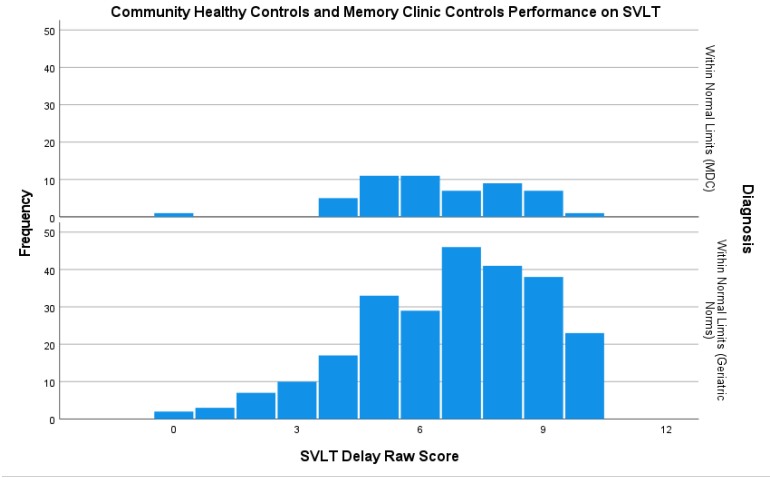
An independent-samples *t*-test was performed to compare mean wordlist delayed recall total scores on the MoCA from healthy controls within the community and healthy controls from HFMDC. Results from 301 individuals (249 healthy community controls, 52 healthy controls from HFMDC) showed that healthy controls within the community ($M = 3.01$, $SD = 1.30$) were not significantly different from healthy controls at HFMDC ($M = 3.02$, $SD = 1.35$) on their wordlist delayed recall total scores on the MoCA, $t(299) = .036$, $p = .486$, with the difference to have a 95% CI [-.39, .40]. The difference presents a small-sized effect, Cohen's $d = 0.0008$. Due to the insignificant difference between these separate groups, healthy community controls were analyzed as well as a combined group of healthy controls from both the community and HFMDC after the hypothesis testing.



Assumption tests suggested that there were no outliers in the mean wordlist delayed recall total scores on the SVLT for healthy controls from the community and healthy controls from HFMDC, and mean wordlist delayed recall total scores on the SVLT was normally distributed. Levene's test suggested that variances in mean wordlist delayed recall total scores on the SVLT for healthy controls from the community and healthy controls from HFMDC were statistically equivalent, $F(299) = 2.41$, $p = .122$.

An independent-samples *t*-test was performed to compare mean wordlist delayed recall total scores on the SVLT from healthy controls within the community and healthy controls from HFMDC. Results from 301 individuals (249 healthy community controls, 52 healthy controls from HFMDC) showed that healthy controls within the community ($M = 6.73$, $SD = 2.23$) were not significantly different from healthy controls at HFMDC ($M = 6.44$, $SD = 1.87$) on their wordlist delayed recall total scores on the SVLT, $t(299) = -.87$, $p = .193$, with the difference to have a 95% CI [-.94, .36]. The difference presents a small-sized effect, Cohen's

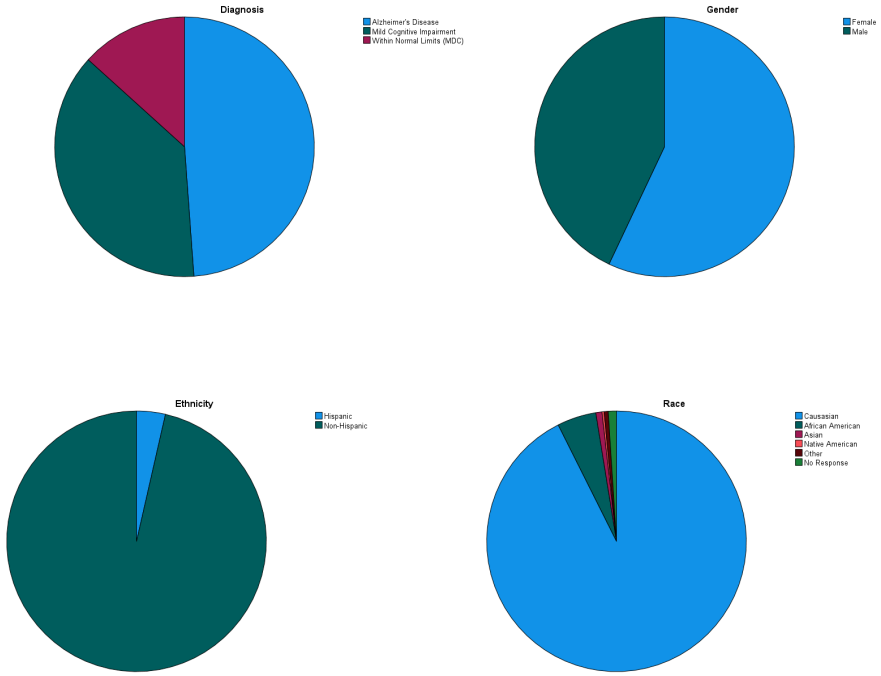
d = 0.14. Due to the insignificant difference between these separate groups, healthy community controls were not used in subsequent analyses regarding the SVLT.



Descriptive Statistics

The final sample consisted of 391 participants, included 48.8% of individuals diagnosed with AD (*n* = 191), 37.9% of individuals diagnosed with MCI (*n* = 148), and 13.3% individuals who were considered cognition within normal limits (*n* = 52). The sample included 57.0% participants who were females (*n* = 223) and 43.0% of whom were males (*n* = 168). Participants' ages ranged from 65 to 97 at the time of their initial evaluation (*M* = 82.33, *SD* = 6.14). Participants' highest level of education ranged from 5 to 20 years (*M* = 13.71, *SD* = 2.63. Most of the sample identified as Caucasian (*n* = 362; 92.6%), followed by African American (*n* = 19; 4.9%), and Asian (*n* = 3; 0.8%). A small number of participants selected "Other" as their race (*n* = 2; 0.5%) or chose not to respond (*n* = 4; 1.0%). In terms of ethnicity, participants were mostly non-Hispanic (*n* = 337; 96.4%), followed by Hispanic ethnicity (*n* = 14; 3.6%). Participants' demographic

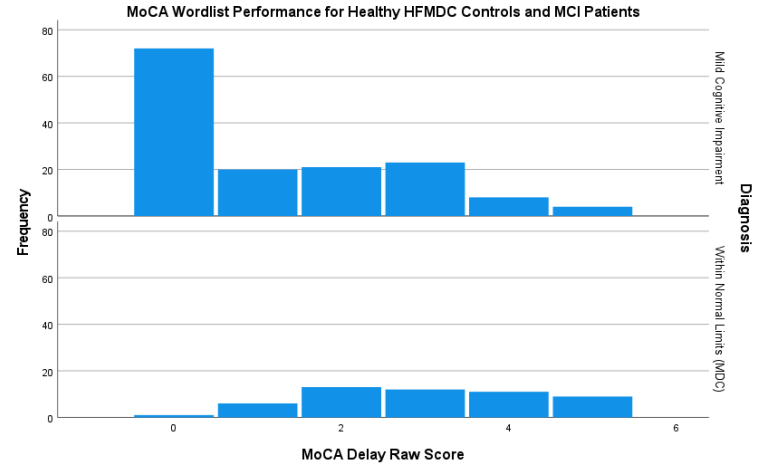
information was collected and documented at the time of their initial evaluation through self-report and/or their electronic medical record (EMR).



MoCA Wordlist Performance for Healthy HFMDC Controls and MCI Patients

Assumption tests suggested that there were no outliers in the mean wordlist delayed recall total scores on the MoCA for healthy controls from HFMDC and individuals diagnosed with MCI from HFMDC, and mean wordlist delayed recall total scores on the MoCA was normally distributed. Levene's test suggested that variances in mean wordlist delayed recall total scores on the MoCA for healthy controls from HFMDC and individuals diagnosed with MCI from HFMDC were statistically equivalent, $F\,(198) = 2.01$, $p = .16$.

An independent-samples *t*-test was performed to compare mean wordlist delayed recall total scores on the MoCA from healthy controls from HFMDC and individuals diagnosed with MCI from HFMDC. Results from 200 patients (52 healthy controls, 148 MCI patients) showed that MCI patients ($M = 1.24$, $SD = 1.50$) were significantly different from healthy controls ($M = 3.02$, $SD = 1.35$) on their wordlist delayed recall total scores on the MoCA, $t(198) = -7.73$, $p < .001$, with the difference to have a 95% CI [-2.24, -1.33]. The difference presents a large-sized effect, Cohen's $d = 1.27$. Hypothesis #1 those healthy controls and individuals diagnosed with MCI will have similar wordlist delayed recall total scores on the MoCA was not supported.



SVLT Wordlist Performance for Healthy HFMDC Controls and MCI Patients

Assumption tests suggested that there were no outliers in the mean delayed recall total scores on the SVLT for healthy controls from HFMDC and individuals diagnosed with MCI from HFMDC and mean delayed recall total scores on the SVLT was normally distributed. Levene's test suggested that variances in mean

delayed recall total scores on the SVLT for healthy controls from HFMDC and individuals diagnosed with MCI from HFMDC were statistically equivalent, $F(198) = 2.61$, $p = .11$.

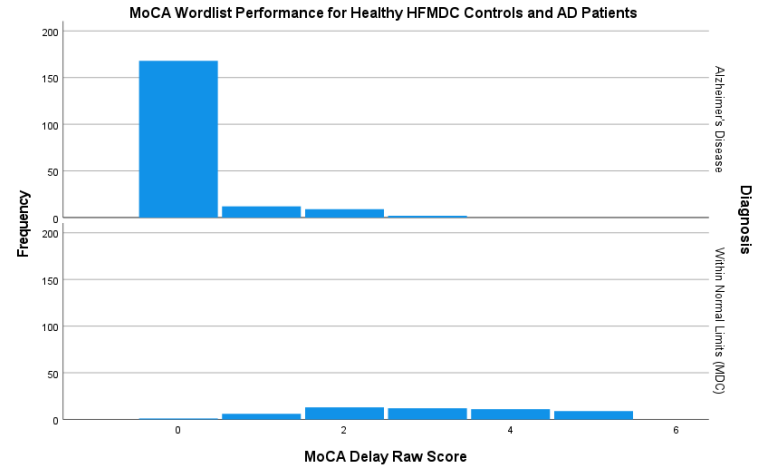
An independent-samples *t*-test was performed to compare mean delayed total scores on the SVLT from healthy controls at HFMDC and patients diagnosed with MCI at HFMDC. Results from 200 patients (52 healthy controls, 148 MCI patients) showed that healthy controls ($M = 6.44$, $SD = 1.87$) were significantly higher than MCI patients ($M = 3.70$, $SD = 2.26$) on their delayed recall total scores on the SVLT, $t(198) = -7.84$, $p < .001$, with the difference to have a 95% CI [-3.43, -2.05]. The difference presents a large-sized effect, Cohen's $d = 1.32$. Hypothesis #2 those healthy controls will have higher delayed recall total scores on the SVLT than individuals diagnosed with MCI was supported.

MoCA and SVLT Performance in AD Patients

Assumption tests suggested that there were outliers in the mean wordlist delayed recall total scores on the MoCA for healthy controls from HFMDC and

individuals diagnosed with AD from HFMDC, and mean wordlist delayed recall total scores on the MoCA was not normally distributed. Levene's test suggested that variances in mean wordlist delayed recall total scores on the MoCA for healthy controls from HFMDC and individuals diagnosed with AD from HFMDC were not statistically equivalent, F (198) = 85.40, $p < .001$.

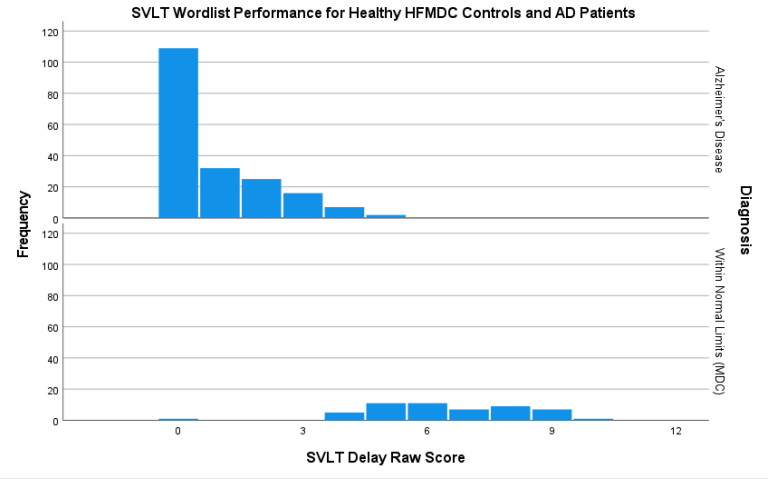
An independent-samples t-test was performed to compare the mean wordlist delayed recall total scores on the MoCA in healthy controls and patients diagnosed with AD. Results from 243 patients (52 healthy controls, 191 AD) showed that healthy controls (M = 3.02, SD = 1.35) were significantly higher than AD patients (M = .19, SD = .56) on their wordlist delayed recall total scores on the MoCA, t(55.83) = -14.78, $p < .001$, with the differences to have a 95% CI [-3.23, -2.45]. The difference presents a large-sized effect, Cohen's d = 2.74.



Assumption tests suggested that there were outliers in the mean wordlist delayed recall total scores on the SVLT for healthy controls from HFMDC and individuals diagnosed with AD from HFMDC, and mean wordlist delayed recall

total scores on the SVLT were not normally distributed. Levene's test suggested that variances in mean wordlist delayed recall total scores on the SVLT for healthy controls from HFMDC and individuals diagnosed with AD from HFMDC were not statistically equivalent, F (241) = 16.35, $p < .001$.

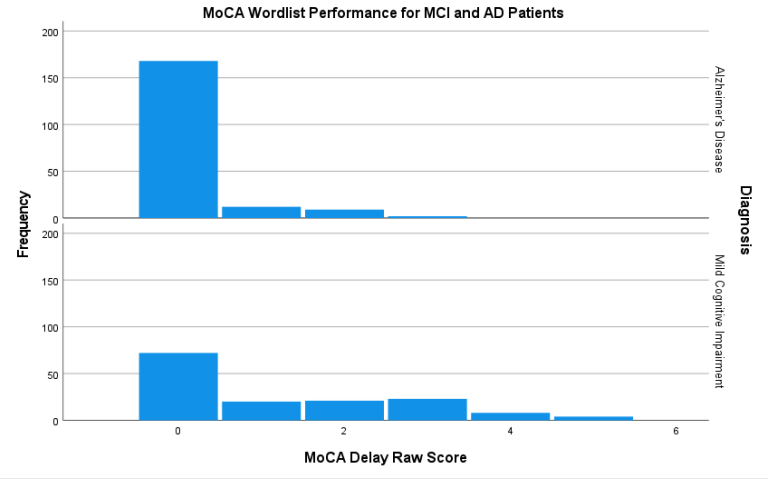
An independent-samples t-test was performed to compare the mean delayed recall total scores on the SVLT in healthy controls and patients diagnosed with AD. Results from 243 patients (52 healthy controls, 191 AD) showed that healthy controls (M = 6.44, SD = 1.87) were significantly higher than AD patients (M = .88, SD = 1.24) on their delayed recall total scores on the SVLT, t(63.58) = -20.25, $p <$ .001, with the differences to have a 95% CI [-6.11, -5.01]. The difference presents a large-sized effect, Cohen's d = 3.5.



Assumption tests suggested that there were outliers in the mean wordlist delayed recall total scores on the MoCA for individuals diagnosed with MCI from HFMDC and individuals diagnosed with AD from HFMDC, and mean wordlist delayed recall total scores on the MoCA were not normally distributed. Levene's

test suggested that variances in mean wordlist delayed recall total scores on the MoCA for individuals diagnosed with MCI from HFMDC and individuals diagnosed with AD from HFMDC were not statistically equivalent, F (337) = 216.90, $p < .001$.

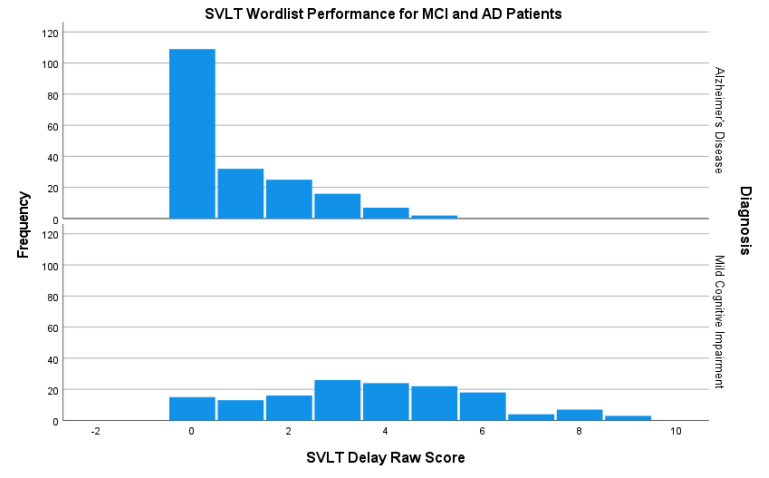
An independent-samples t-test was performed to compare the mean wordlist delayed recall total scores on the MoCA in MCI patients and patients diagnosed with AD. Results from 339 patients (148 MCI, 191 AD) showed that MCI patients ($M = 1.24$, $SD = 1.46$) were significantly higher than AD patients ($M = .19$, $SD = .56$) on their wordlist delayed recall total scores on the MoCA, $t(180.7) = -8.28$, $p < .001$, with the differences to have a 95% CI [-1.30, -.80]. The difference presents a large-sized effect, Cohen's $d = .95$.



Assumption tests suggested that there were outliers in the mean wordlist delayed recall total scores on the SVLT for individuals diagnosed with MCI from HFMDC and individuals diagnosed with AD from HFMDC, and mean wordlist delayed recall total scores on the SVLT were not normally distributed. Levene's

test suggested that variances in mean wordlist delayed recall total scores on the SVLT for individuals diagnosed with MCI from HFMDC and individuals diagnosed with AD from HFMDC were not statistically equivalent, F (337) = -14.67, $p < .001$.

An independent-samples t-test was performed to compare the mean wordlist delayed recall total scores on the SVLT in MCI patients and patients diagnosed with AD. Results from 339 patients (148 MCI, 191 AD) showed that MCI patients ($M = 3.70$, $SD = 2.26$) were significantly higher than AD patients ($M = .88$, $SD = 1.24$) on their wordlist delayed recall total scores on the SVLT, $t(214.12) = -13.69$, $p < .001$, with the difference to have a 95% CI [-3.23, -2.41]. The difference presents a large-sized effect, Cohen's $d = 1.55$. Combined, these analyses support hypothesis #3 those individuals diagnosed with AD will have lower delayed recall total scores on both the MoCA and the SVLT compared to healthy controls and individuals diagnosed with MCI.



MoCA Performance and Severity of Cognitive Impairment

An ordinal logistic regression was conducted to predict more severe cognitive impairment based on diagnosis (HFMDC healthy, MCI, AD), based on participant's performance on the wordlist recall scores on the MoCA. A decrease in MoCA delayed recall on the wordlist was associated with an increase in the odds of poorer cognition based on diagnosis, with an odds ratio of 2.92 (95% CI, 2.41 to 3.52), Wald $\chi^2(1) = 123.110$, $p < .001$.

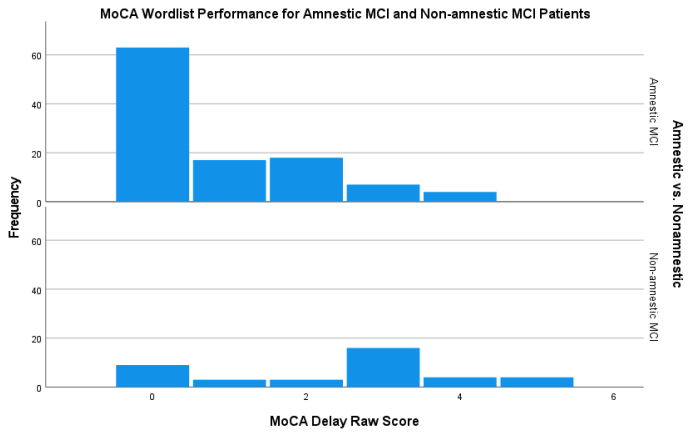
SVLT Performance and Severity of Cognitive Impairment

An ordinal logistic regression was conducted to predict more severe cognitive impairment based on diagnosis (HFMDC healthy, MCI, AD), based on participant's performance on the SVLT delayed recall. A decrease in SVLT delayed recall was associated with an increase in the odds of poorer cognition based on diagnosis, with an odds ratio of 2.27 (95% CI, 2.01 to 2.58), Wald $\chi^2(1) = 166.054$, $p < .001$

MoCA and SVLT Performance in Amnestic MCI and Non-amnestic MCI

Assumption tests suggested that there were outliers in the mean wordlist delayed recall total scores on the MoCA for individuals diagnosed with amnestic MCI and non-amnestic MCI, and mean wordlist delayed recall total scores on the MoCA were not normally distributed. Levene's test suggested that variances in mean wordlist delayed recall total scores on the MoCA for individuals diagnosed with amnestic MCI and individuals diagnosed with non-amnestic MCI were not statistically equivalent, $F(146) = -6.48$, $p < .001$.

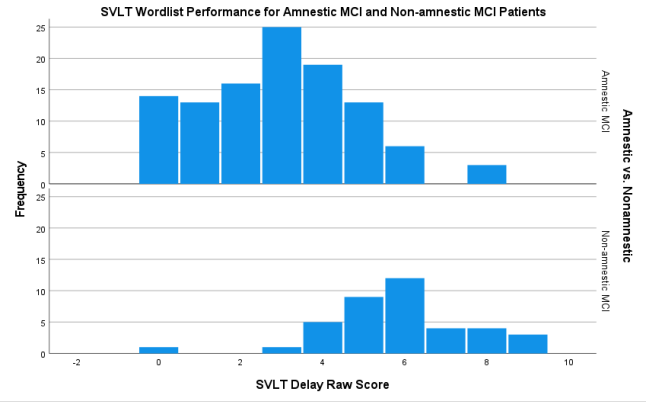
An independent-samples *t*-test was performed to compare the mean wordlist delayed recall total scores on the MoCA in amnestic MCI patients and non-amnestic MCI patients. Results from 148 patients (109 amnestic MCI, 39 non-amnestic MCI) showed that non-amnestic MCI patients ($M = 2.38$, $SD = 1.63$) were significantly higher than amnestic MCI patients ($M = .83$, $SD = 1.15$) on their wordlist delayed recall total scores on the MoCA, $t(52) = -5.50$, $p < .001$, with the difference to have a 95% CI [-2.13, -.99]. The difference presents a large-sized effect, Cohen's $d = 1.10$. The hypothesis that there would be no difference in MoCA wordlist performance in amnestic MCI and non-amnestic MCI was not supported. This finding, though, does explain and provide evidence for why the first hypothesis was not supported, as there were significantly more amnestic MCI patients in the total sample. this may have contributed to why the MoCA delayed recall scores in the total MCI group were so poor in comparison to individuals with normal cognition.



Assumption tests suggested that there were no outliers in the mean wordlist delayed recall total scores on the SVLT for individuals diagnosed with amnestic

MCI and non-amnestic MCI, and mean wordlist delayed recall total scores on the SVLT were normally distributed. Levene's test suggested that variances in mean wordlist delayed recall total scores on the SVLT for individuals diagnosed with amnestic MCI and individuals diagnosed with non-amnestic MCI were statistically equivalent, F (146) = .90, p = .34.

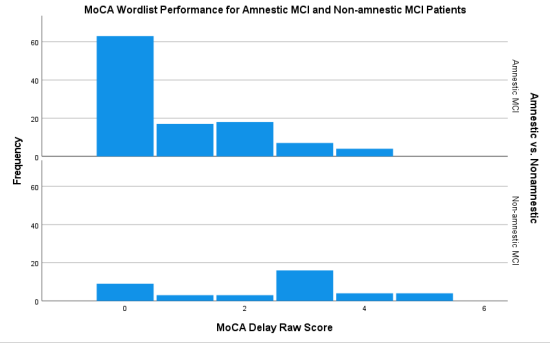
An independent-samples t-test was performed to compare the mean wordlist delayed recall total scores on the SVLT in amnestic MCI patients and non-amnestic MCI. Results from 148 patients (109 amnestic MCI, 39 non-amnestic MCI) showed that non-amnestic MCI patients (M = 5.82, SD = 1.78) were significantly higher than amnestic MCI patients (M = 2.94, SD = 1.91) on their wordlist delayed recall total scores on the SVLT, t(146) = -8.22, p < .001, with the difference to have a 95% CI [-3.57, -2.18]. The difference presents a large-sized effect, Cohen's d = 1.56. The hypothesis that there would be a difference on the SVLT in patients diagnosed with amnestic MCI and non-amnestic MCI was supported.



MoCA and SVLT Performance in Within Normal Limits and Non-amnestic MCI

Assumption tests suggested that there were no outliers in the mean wordlist delayed recall total scores on the MoCA for individuals who were within normal limits and non-amnestic MCI, and mean wordlist delayed recall total scores on the MoCA was normally distributed. Levene's test suggested that variances in mean wordlist delayed recall total scores on the MoCA for individuals within normal limits and patients diagnosed with non-amnestic MCI were statistically equivalent, F (89) = 2.55, p = .11.

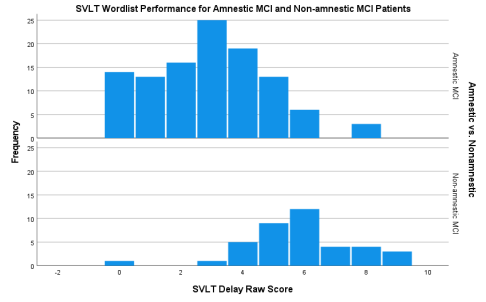
An independent-samples t-test was performed to compare the mean wordlist delayed recall total scores on the MoCA in individuals who performed within normal limits and non-amnestic MCI patients. Results from 91 patients (52 within normal limits, 39 non-amnestic MCI) showed that individuals who performed within normal limits (M = 3.02, SD = 1.35) were significantly higher than non-amnestic MCI patients (M = 2.38, SD = 1.63) on their wordlist delayed recall total scores on the MoCA, t(89) = 2.03, p = .046, with the difference to have a 95% CI [.01, 1.25]. The difference presents a small to medium-sized effect, Cohen's d = 0.43.



Assumption tests suggested that there were no outliers in the mean wordlist delayed recall total scores on the SVLT for individuals who performed within normal limits and non-amnestic MCI, and mean wordlist delayed recall total scores on the SVLT was normally distributed. Levene's test suggested that variances in mean wordlist delayed recall total scores on the SVLT for individuals who performed within normal limits and individuals diagnosed with non-amnestic MCI were statistically equivalent, F (89) = .89, p = .35.

An independent-samples t-test was performed to compare the mean wordlist delayed recall total scores on the SVLT in individuals who performed within normal limits and non-amnestic MCI patients. Results from 91 patients (52 within normal limits, 39 non-amnestic MCI) showed that there was no a significant difference between individuals who performed within normal limits (M = 6.44, SD = 1.87) and non-amnestic MCI patients (M = 5.82, SD = 1.78) on their wordlist delayed recall total scores on the SVLT, t(89) = 1.60, p = .11, with the difference to have a 95% CI [-.15, 1.39]. The difference presents a small to medium-sized effect, Cohen's d = 0.33. The hypothesis that individuals who performed within normal

limits and patients who were diagnosed with non-amnestic MCI will have similar scores on the MoCA wordlist, but not the SVLT, was not supported.



MoCA and SVLT Wordlist Performance for Combined Healthy Controls and MCI Patients

Assumption tests suggested that there were outliers in the mean wordlist delayed recall total scores on the MoCA for combined healthy controls and individuals diagnosed with MCI from HFMDC, and mean wordlist delayed recall total scores on the MoCA were not normally distributed. Levene's test suggested that variances in mean wordlist delayed recall total scores on the MoCA for combined healthy controls and individuals diagnosed with MCI from HFMDC were not statistically equivalent, F (447) = 8.67, p = .003.

An independent-samples t-test was performed to compare mean wordlist delayed recall total scores on the MoCA from combined healthy controls and individuals diagnosed with MCI from HFMDC. Results from 449 patients (301 combined healthy controls, 148 MCI patients) showed that MCI patients (M = 1.24, SD = 1.50) were significantly different from combined healthy controls (M = 3.01, SD = 1.31) on their wordlist delayed recall total scores on the MoCA, t(266) = -

12.54, p <.001, with the difference to have a 95% CI [-2.06, -1.50]. The difference presents a large-sized effect, Cohen's d = 1.26.

Assumption tests suggested that there were no outliers in the mean delayed recall total scores on the SVLT for combined healthy controls and individuals diagnosed with MCI from HFMDC and mean delayed recall total scores on the SVLT was normally distributed. Levene's test suggested that variances in mean delayed recall total scores on the SVLT for combined healthy controls and individuals diagnosed with MCI from HFMDC were statistically equivalent, F (447) = .28, p = .60.

An independent-samples t-test was performed to compare mean delayed recall total scores on the SVLT from combined healthy controls and patients diagnosed with MCI at HFMDC. Results from 449 patients (301 combined healthy controls, 148 MCI patients) showed that combined healthy controls (M = 6.68, SD = 2.18) were significantly higher than MCI patients (M = 3.70, SD = 2.26) on their delayed recall total scores on the SVLT, t(447) = -13.46, p <.001, with the difference to have a 95% CI [-3.41, -2.54]. The difference presents a large-sized effect, Cohen's d = 1.34.

MoCA and SVLT Performance in Combined Healthy Controls and AD Patients

Assumption tests suggested that there were outliers in the mean wordlist delayed recall total scores on the MoCA for combined healthy controls and

individuals diagnosed with AD from HFMDC, and mean wordlist delayed recall total scores on the MoCA was not normally distributed. Levene's test suggested that variances in mean wordlist delayed recall total scores on the MoCA for combined healthy controls and individuals diagnosed with AD from HFMDC were not statistically equivalent, F (490) = -28.23, $p < .001$.

An independent-samples t-test was performed to compare the mean wordlist delayed recall total scores on the MoCA in combined healthy controls and patients diagnosed with AD. Results from 492 patients (301 combined healthy controls, 191 AD) showed that combined healthy controls (M = 3.01, SD = 1.31) were significantly higher than AD patients (M = .19, SD = .56) on their wordlist delayed recall total scores on the MoCA, t(439.62) = -33.01, $p < .001$, with the differences to have a 95% CI [-2.99, -2.66]. The difference presents a large-sized effect, Cohen's d = 2.80.

Assumption tests suggested that there were outliers in the mean wordlist delayed recall total scores on the SVLT for combined healthy controls and individuals diagnosed with AD from HFMDC, and mean wordlist delayed recall total scores on the SVLT were not normally distributed. Levene's test suggested that variances in mean wordlist delayed recall total scores on the SVLT for combined healthy controls and individuals diagnosed with AD from HFMDC were not statistically equivalent, F (490) = -33.57, $p < .001$.

An independent-samples t-test was performed to compare the mean delayed recall total scores on the SVLT in combined healthy controls and patients

diagnosed with AD. Results from 492 patients (301 combined healthy controls, 191 AD) showed that combined healthy controls (M = 6.68, SD = 2.18) were significantly higher than AD patients (M = .88, SD = 1.24) on their delayed recall total scores on the SVLT, $t(484.79) = -37.67$, $p < .001$, with the differences to have a 95% CI [-6.10, -5.50]. The difference presents a large-sized effect, Cohen's d = 3.27.

MoCA and SVLT Performance in Combined Within Normal Limits and Non-amnestic MCI

Assumption tests suggested that there were outliers in the mean wordlist delayed recall total scores on the MoCA for the combined group of individuals who were within normal limits and non-amnestic MCI, and mean wordlist delayed recall total scores on the MoCA was normally distributed. Levene's test suggested that variances in mean wordlist delayed recall total scores on the MoCA for individuals within normal limits and patients diagnosed with non-amnestic MCI were not statistically equivalent, $F(338) = 5.98$, $p = .01$.

An independent-samples t-test was performed to compare the mean wordlist delayed recall total scores on the MoCA in the combined group of individuals who performed within normal limits and non-amnestic MCI patients. Results from 340 patients (301 combined within normal limits, 39 non-amnestic MCI) showed that combined group of individuals who performed within normal limits (M = 3.01, SD = 1.31) were significantly higher than non-amnestic MCI patients (M = 2.38, SD =

1.63) on their wordlist delayed recall total scores on the MoCA, $t(44.56) = -2.31$, $p = .026$, with the difference to have a 95% CI [-1.18, -.08]. The difference presents a small to medium-sized effect, Cohen's $d = 0.42$.

Assumption tests suggested that there were outliers in the mean wordlist delayed recall total scores on the SVLT for the combined group of individuals who performed within normal limits and non-amnestic MCI, and mean wordlist delayed recall total scores on the SVLT was normally distributed. Levene's test suggested that variances in mean wordlist delayed recall total scores on the SVLT for individuals who performed within normal limits and individuals diagnosed with non-amnestic MCI were not statistically equivalent, $F(338) = 5.19$, $p = .02$.

An independent-samples *t*-test was performed to compare the mean wordlist delayed recall total scores on the SVLT in the combined group of individuals who performed within normal limits and non-amnestic MCI patients. Results from 340 patients (301 combined healthy controls, 39 non-amnestic MCI) showed that combined healthy controls ($M = 6.68$, $SD = 2.18$) were significantly higher than non-amnestic MCI patients ($M = 5.82$, $SD = 1.78$) on their delayed recall total scores on the SVLT, $t(53.96) = -2.77$, $p = .01$, with the differences to have a 95% CI [-1.48, -.24]. The difference presents a small to medium-sized effect, Cohen's $d = 0.43$.

Chapter 11 Discussion

Gaining insight into the diagnostic capabilities of well-known cognitive measures is integral to the field of clinical neuropsychology. Additionally, it is also

imperative to identify the diagnostic capabilities of new assessments being developed and utilized for diagnostic purposes. Determining a diagnosis correctly allows patients to be presented with the correct resources and treatment plan while following up with the potential progression of their disorder. Also, with advances in medicine, there can be specific treatments for certain diagnoses, which again illustrates why making the correct diagnosis in the first place is extremely important.

Normative data is typically acquired by administering assessments to individuals who are not showing signs of cognitive impairment. One of the most effective ways to gather normative data is from healthy volunteers within community settings. Although data can also be obtained from individuals undergoing cognitive testing in a medical setting who are ultimately diagnosed with normal cognition, most of these individuals or their families have expressed concerns regarding cognitive issues, suggesting that they might be "different" in some way compared to individuals from community settings. In the current study, it was predicted that the memory performance of individuals collected within the community would be significantly different when compared to the individuals diagnosed with normal cognition at the HFMDC. However, the results showed there was not a significant difference between these two groups. This suggests that it might be reasonable to consider data collected from individuals who were evaluated for a possible memory disorder but diagnosed as having normal cognition

as normative data. Having a greater sample of normative data might in turn allow for even greater diagnostic precision.

No significant differences were found on the wordlist delayed recall scores from the MoCA between healthy controls and individuals diagnosed with MCI. Due to the MoCA having a relatively short word list containing only 5 words, it was hypothesized that it did not have the breadth to clearly differentiate healthy controls and individuals diagnosed with MCI. This hypothesis was not supported, indicating that the MoCA is an adequate tool to potentially detect MCI. However, it should be noted that the majority of patients in the MCI group were amnestic (around 74%), and individuals with amnestic MCI typically exhibit prominent memory issues. Indeed, individuals with amnestic MCI performed worse on the MoCA word list than individuals with non-amnestic MCI. This may have potentially skewed average scores on both measures in the overall MCI group toward suggesting more prominent memory deficits, which may not have been observed if the relative proportions of individuals with amnestic MCI and non-amnestic MCI were more evenly distributed.

Prior research has suggested this as well. For example, Kaur et al. (2018) compared two measures of delayed recall including both the MoCA and the Craft Story 21 and found the MoCA's memory index score was better at discriminating normal cognition from amnestic MCI than the Craft Story. Further research would be beneficial to find what score on the MoCA wordlist is likely indicative of MCI specifically amnestic MCI. This is an important finding because it also supports

previous literature about the MoCA being an adequate tool to detect cognitive changes. Furthermore, it could aid in follow up if the person were to engage in a neuropsychological evaluation. In many instances patients are only interacting with doctors briefly, and especially with how integrated clinical psychology is becoming with overall healthcare, a brief measure to identify cognitive changes would be ideal, such as the MoCA. Additionally, if the MoCA provides an adequate prediction of the neuropsychological difficulties an individual may possess, the neuropsychologist can tailor their battery to the deficits indicated on the MoCA.

Differences in delayed recall total scores on the SVLT were observed between healthy controls at HFMDC and patients diagnosed with MCI at HFMDC. This finding is important, because it indicates the SVLT is an adequate tool for differentiating cognitive changes in verbal memory between those who do not present with a cognitive decline and those who are having a cognitive decline. As mentioned previously, the SVLT is a measure that was created at the HFMDC. It is brief but provides a detailed amount of information regarding learning, encoding, and recall with respect to verbal memory. Although not as brief as the MoCA, it is still a brief tool that also provides more detailed information than the MoCA. It is a useful assessment, only taking about 10 minutes in total to administer. It appears to be a useful tool to include in neuropsychological batteries, especially in evaluating individuals where concerns regarding memory functioning are present.

A significant difference was also found between healthy controls and individuals diagnosed with AD in relation to their performance on the MoCA

wordlist. This finding was not surprising; usually individuals with AD are already showing prominent cognitive deficits. It would be expected for there to be a significant difference on the wordlist on the MoCA in individuals who are healthy, and those individuals diagnosed with AD, primarily based on the severity of impairment in those with AD. Additionally, there was also a significant difference on delayed recall total scores on the SVLT in healthy controls and patients diagnosed with AD. As described previously, the SVLT is a somewhat expanded verbal memory test compared to the wordlist on the MoCA.

Additionally, there was also a significant difference found when comparing the mean wordlist delayed recall total scores on the MoCA in MCI patients and patients diagnosed with AD. This finding is important due to the diagnostic implications regarding these diagnoses. When an individual has MCI, they are better able to maintain the ability to independently perform most activities of daily living, while those diagnosed with AD are unable to perform many of these tasks (Jongsiriyanyong & Limpawattana, 2018). This distinction is critical in determining follow up care and coordination of services. There was also a significant difference found when comparing the mean wordlist delayed recall total scores on the SVLT in MCI patients and patients diagnosed with AD. This is an important finding for many of the reasons previously detailed as well as the SVLT being utilized for diagnostic purposes. Differences on the performances of the SVLT wordlist can differentiate MCI from AD, and due to the different prognoses MCI and AD have,

this finding is helpful in knowing that performance on the SVLT is significantly different in these separate populations.

It was also found that MoCA wordlist performance can predict more severe cognitive impairment in regard to diagnosing healthy, MCI, and AD. This finding means that the lower the MoCA delayed recall on the wordlist was, there was an increase in the odds of poorer cognition based on diagnosis. This finding was similar to what was found regarding the SVLT. Regarding the MoCA, this finding is important because although it is a screener, performance on delayed recall can differentiate potential MCI and AD. However, this finding carries more weight regarding the SVLT because the SVLT is used for actual diagnostic purposes.

Analyses also showed that performance on the MoCA wordlist and the SVLT wordlist were significantly higher in individuals with non-amnestic MCI patients when compared to amnestic MCI patients. This did not support the fifth hypothesis, as it was predicted there would be a significant difference on the SVLT and not the MoCA. What this suggests is that both the MoCA and SVLT are adequate measures for determining memory difficulties, even in the potentially more subtle memory presentations often observed with amnestic MCI.

Furthermore, it was found that there was a significant difference between individuals who performed within normal limits and non-amnestic MCI patients on the MoCA wordlist. However, there was a difference, but not a significant difference, between individuals who performed within normal limits and non-amnestic MCI patients on the SVLT wordlist. This suggests that although there was

a significant difference regarding the MoCA, the non-significance difference on the SVLT may suggest that individuals who perform within normal limits and non-amnestic MCI patients may have similar performances on verbal memory tasks. This would likely be due to individuals who performed within normal limits and non-amnestic MCI patients still having intact verbal memory with potential deficits in other areas for non-amnestic MCI patients. The significant difference regarding the MoCA is likely due to the potential limited capacity it has in differentiating memory changes.

It can be difficult for aging individuals to know when they are experiencing normal aging, or if they are exhibiting signs of a meaningful cognitive decline. Collecting normative data in geriatric individuals is important because there are known age-related cognitive changes that do not constitute a clinically meaningful decline or impairment. Earlier detection of potential dementia processes better aids in positive outcomes and continuity of care. In a 2019 study conducted by Nakahori et al., it was found that both older adults and family members were aware of the individual's forgetfulness, which can often be a sign of normal aging. However, this may also be a symptom of potential cognitive decline. In this study, family members appeared more aware of forgetfulness as a potential symptom in comparison to the older adults themselves. Overall, it appeared there was a discrepancy in cognitive decline between older adults and their family members (Nakahori et al., 2019). This is telling in that older adults may not be aware of their potential cognitive decline or are avoiding addressing it. This encourages the idea

of early education about neuropsychology in older adults and pushing for early cognitive testing before cognitive decline. Cognitive testing would be beneficial in being implemented as a yearly checkup, much like when individuals have yearly checkups regarding other aspects of their health.

Overall, it appears the MoCA and SVLT are both adequate measures for differentiating memory impairments among healthy controls, MCI patients, and AD patients. Specifically, it appears the MoCA is adequate in detecting memory declines even among those experiencing milder memory impairments that are clinically meaningful but do not constitute AD. In the future, it would be beneficial to see if the MoCA is also successful at identifying cognitive changes in those without memory issues but maybe executive or language difficulties. Although the MoCA could potentially be adequate and sufficient for determining potential memory issues, a more comprehensive battery of assessments would be important to administer to determine what other cognitive changes are present toward providing greater overall diagnostic accuracy.

Additionally, it may be that the MoCA is over pathologizing individuals. Although it is essentially a triage measure, the MoCA cut score may be too high to indicate cognitive impairment. In a study conducted by Dautzenberg & Beekman in 2020, it was found that a cut score of 21 or above would be the “best” cutoff score, as those with scores above this are likely not indicative of dementia. Thus, if this cutoff score would be used, it could reduce referrals to memory clinics or other neuropsychological testing centers by 50% (Dautzenber & Beekman, 2020).

However, one could argue that it may be beneficial to use a higher cut-off score even if that results in having more false positives, as it would be better to over-inclusive in identifying a possible memory concern. Furthermore, a screening measure that identifies an individual as having possible cognitive impairment that is ultimately diagnosed within normal limits might be better than one that fails to identify clinically meaningful cognitive impairment by having too low of a cut-off score that overlooks mild cognitive changes. Given that these mild cognitive changes could potentially be indicative of an underlying progressive neurodegenerative process, the risk of failing to identify them early in the course of the disease appears to be too great.

With that, the SVLT could be utilized when examining the learning and memory domain compared to other domains. Different neurodegenerative disorders, including those disorders associated with aging, have different presentations, and although the MoCA seems to be capable of showing cognitive changes regarding verbal memory, there are many other nuances in diagnosis with neurodegenerative disorders. For example, individuals with vascular dementia tend to exhibit more of a disturbance to frontal lobe functions with less of a deficit in verbal memory impairment (Sachdev et al., 2004). Specifically, individuals with vascular dementia are more likely to have difficulties with abstraction, mental flexibility, information processing speed, and working memory (Sachdev et al., 2004). If an individual with vascular dementia were administered the MoCA, some impairments may be noticeable; however, performance on the MoCA alone may be

insufficient to justify a diagnosis. A comprehensive battery of cognitive assessments would provide more information to assist with differential diagnosis, while looking for an overall pattern which may be suggestive of vascular dementia. Additionally, individuals with frontotemporal lobar degeneration, or frontotemporal dementia, typically present with deficits in the language and attention or executive functioning domains, with memory impairments being less severe when compared to AD (Yoshizama et al., 2013). Similarly, the MoCA would likely be insufficient to differentiate these conditions in many cases due to its brevity, whereas a pattern of relative strengths and weaknesses across cognitive domains is often better observed when conducting a more comprehensive assessment.

Nevertheless, the MoCA appears to be capable of identifying memory impairments in those with amnestic MCI and AD. In the future, though, it would be important to explore whether other sections of the MoCA correspond with other cognitive domains (e.g., attention, language), and subsequently how well the MoCA is able to screen for other neurodegenerative diseases with less of a memory impairment. As mentioned previously, other neurodegenerative disorders have more prominent deficits in different domains other than memory.

Chapter 12 Limitations

There are several limitations within this current study. One of these limitations is the lack of diversity. However, this issue appears present in many settings related to neuropsychology. For example, a survey was sent out by Elbulok-Charcape et al., in 2014 to 2,178 neuropsychologists in the United States

and Canada with 512 surveys being returned for analysis. It was reported that 66% of their patients were white, 15.7% of their patients were black, 11.7% of their patients were Hispanic/Latino, and 4.2% of their patients were Asian. There were several suggestions in this study to work towards fixing the lack of representation in the field of neuropsychology. This included educating people at a younger age about neuropsychology at a younger age as well as increasing diversity in neuropsychology research (Elbulok-Charcape et al., 2014).

Another limitation in this current study is the lack of research on sensitivity and specificity of the SVLT. Although the SVLT is used as a diagnostic tool for determining whether someone is healthy, has MCI, or had AD, research into its sensitivity and specificity has not yet been determined. This study was created to widen the knowledge on this measure and appeared to align with the results that are determined by the MoCA, more knowledge on the SVLT would have been beneficial for comparison.

Another limitation in this current study is regarding the individual's data from HFMDC. The obtainment of the MoCA data and SVLT data would have been beneficial if administered by the same individual, and the MoCA and SVLT were administered by different people and on different days. There are a variety of factors as to how different examiners and being examined on different days can affect performance.

Chapter 13 Conclusions

Screening measures and diagnostic tools are extremely important when evaluating cognitive difficulties or changes. It appears the MoCA is a capable screening measure in differentiating within normal limits, MCI, and AD when looking at the memory/word list section in particular. Additionally, the SVLT appears to be a strong measure to aid in diagnosing within normal limits, MCI, and AD. Regarding the MoCA, it would be important to further explore its utility as an independent tool to assistant with differential diagnosis of dementias and neurodegenerative diseases. Additionally, more research regarding the SVLT would be beneficial to determine specific cut scores regarding MCI and AD diagnosis, as it appears to be an adequate tool for measuring verbal memory in these populations. Furthermore, overall, more research with the SVLT would be beneficial to see the utility it provides regarding its diagnostic capabilities with the broader spectrum of neurodegenerative diseases.

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