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Comparing Cognition in Women Between the Ages of (18-40) and (40-70)

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Abstract

Currently 5.8 million Americans are living with Alzheimer's disease (AD), which is a degenerative brain disease. It is currently the sixth leading cause of death in the United States (Alzheimer's Association, 2019). AD also possess a financial burned on the United States, estimated to cost $290 billion in 2019. Sufferers of AD insidiously lose their memory, personality, and judgment abilities until there are no longer recognizable by their loved ones. Currently the best chance suffers of AD have is to catch the disease early on to slow its effects. This is due to the fact that treatment can only prevent and slow down the disease not improve on the condition of the patient. One way to effectively do this is determine the target population of individuals that are at risk of developing mild cognitive impairment (MCI). To do that the natural cognitive decline in a person must be separated from the unnatural cognitive decline due to MCI. To do this, a cross-sectional study design was employed comparing two groups of women, one of which was older and one was younger. During each test, their demographics were recorded and they completed four different cognitive tests. All the tests were validated to measure an individual's cognition. The test that provided the results that were analyzed was the Repeatable Battery for the Assessment of Neuro-psychological Status (RBANS), and the Dual-Task test. Ten younger subjects (M = 60.7, SD = 5.2) and 29 older subjects (M = 21.0, SD = 0.6) were tested. After statistical analysis of the RBANS scores of each group it was determined that the older group tested significantly better than the younger group on all aspects of the test. This could have been for potential distractions in the younger group due to COVID complications or the higher education level of the older group compared to the younger group. It could also mean that cognition steadily increases until a tipping point that might be after the age of 70 years.

Introduction

Alzheimer's disease (AD) is a degenerative brain disease, meaning it becomes worse with time. In 2019 5.8 million Americans are living with AD, and this number is expected to grow as the population of age 65 and older continues to increase. Between the years of 2000 and 2017 there was a 145% increase in deaths caused by AD, making it now officially the sixth-leading cause of death in the United States. On average a person with AD survives somewhere between 4 to 8 years after their diagnosis, but some can live as long as 20 years after a diagnosis. However, those 20 years the patient is living with this disease are extremely taxing on not only the patient but also the family (Alzheimer's Association, 2019). These statistics show just how slow, insidious, uncertain, and difficult AD can be. Not only can AD lead to death but it is also the leading cause of disability and poor health, also known as morbidity. Most AD sufferers must deal with years of morbidity as the disease gets worse before they pass. AD is a costly disease, and not only is it costly for the United States economy it is also costly for individuals who are suffering. In 2019, it was estimated that AD would cost over $63 billion out of pocket for those suffering (Alzheimer's Association, 2019). Even though Medicare and Medicaid can help, AD still possess a burden to the families of the affected. AD diminishes a patient's quality of life as they slip so far away until they can no longer care for themselves. This also results in increase caregiver distress and accelerates nursing home placements (Cummings, 2005).

AD is also difficult to diagnose early on. Physicians do not have a difficult time determining if a patent has dementia but they do often have a difficult time determining what the cause is. Although AD is the most common cause of dementia, there are many other causes of dementia in patients aside from AD. To make this more difficult there is no one test for dementia caused by AD (Alzheimer's Association, 2019). Patients often have to undergo many tests and

steps in order to get a positive diagnosis for AD. This might entail considering medical and family history, having a family member provide experience with the patients changes in cognitive skills and behavior, cognition tests, physical and neurological exams, blood tests, and brain imaging (Alzheimer's Association, 2019). Often this testing does not even start until the dementia is noticeable in a patient. By this point cognitive skills have changed or deteriorated so much that the patient will be noticeably different. Since treatment for AD cannot improve the state of the patient, only slowing the progression of the disease, it would be much more beneficial if the disease was caught before these symptoms were noticeable.

Not only is AD difficult to diagnose it is also difficult to treat. Currently there are no treatments in the form of medications that can stop or slow the damage done to neurons by the disease, which in turn cause the symptoms seen in AD patients. The medications that are available can temporarily improve the symptoms but are not a long-term solution as they are limited in duration. Developing pharmacologic treatment for AD is also difficult to do for many reasons. This is due to the difficulty in recruiting patients with AD to participate in studies, lack of knowledge of the molecular changes AD causes, and the time it takes to determine if a treatment is effective or not. Moreover, it is widely believed that the most effective treatment of the disease is done early on in the disease process, meaning it must be identified in a patient early on (Alzheimer's Association, 2019). Which as previously stated is difficult to do.

Even if there is a treatment developed that is effective in treating the disease one of the most crucial aspects in managing the disease is detecting it early on. This is still difficult to do. Currently the best chance there is at detecting the disease early on is through cognition testing. There have been many ways of testing cognition developed and currently developing, with most being reliable measures of an individual's cognition levels. For the examiner to determine if the

person being tested is at risk for developing the disease, or even a mild cognitive impairment, many of these tests require the individual to be tested multiple times over a long period of time. The more recent scores are then compared to the later ones and if a significant decrease in the cognition levels is detected the individual is labeled as at risk for developing a mild cognitive impairment. However, if there is naturally a decrease in cognition over time would this attempt at diagnosis be done in vain? Therefore, it is important for the natural decrease in cognition over time to be determined so that the outliers can be separated from those that have a completely normal decrease in cognition as they age.

Literature Review

There is no current cure for Alzheimer's, though it looks hopeful that there are ways to delay its onset by a significant amount. In fact, many studies have focused on this hope. For example, one research group has found that delaying the disease progression is quite feasible even though prevention of the disease is not. They found that the most promising method for treatment to be controlling vascular risks. These vascular risks include hypertension, physical exercise, and even mental exercise (Larson, 2010). The first step in delaying the onset of this disease is being able to detect it early in patients. To do this risk factors should be identified, measured, and tracked over time. Then it could be possible to alter the negative trajectory of the disease or even catch it before it is even a disease. One group has successfully executed this measurement with the Cardiovascular Risk Factors, Aging, and Incidence of Dementia Risk Score (CAIDE). The CAIDE is a tool that is used to predict late in life dementia risk, which is based on midlife vascular risk factors. It is used to identify individuals that are at risk for developing either AD or a mild cognitive impairment (MCI) (Sindi et. al., 2015). CAIDE was also used in the Finnish Geriatric Intervention Study to Prevent Cognitive Impairment and

Disability (FINGER). The FINGER study used CAIDE to determine the at-risk participants invited into the study. Then the lifestyles of the participants were modified to determine the effect of lifestyle intervention on preventing cognitive impairments among individuals at risk for development of AD. The results from FINGER trial found that lifestyle modification effectively delayed the onset of MCI; it showed a 25% increase in the cognition of the at-risk individuals who participated over the 2-year period (Ngandu et. al., 2015). There have been many tests created in the hopes of detecting older individuals with cognitive declines that qualify for a MCI or AD. Many of these tests were promising. However, currently there is no validated test that can determine preclinical changes in cognition over time. There are tests, such as those used in this study, that have shown promise in measuring cognition. With all of this in mind, the purpose of this study was to first measure the cognition in women of two age groups and compare the results. This is done in the hopes that the normal decline in women over time can be determined so that those with an unusual decline in cognition can be identified as early as possible. Because if those women can be identified they can use methods, such as lifestyle modification used in the FINGER study, to hopefully delay the onset of MCI or AD.

One test that has been popular in the testing of MCI was developed by a research team in Montreal. The Montreal Cognitive Assessment (MoCA) was developed so that physicians had a quick, easy, and cheap way to test their patients for MCI. The test was developed to cover eight cognitive domains and was tested on 94 patients that met the criteria for an MCI as well as 90 individuals that did not. They found the test to be a successful screening tool to detect MCI in individuals. The study suggests MoCA to be highly sensitive and specific in detecting. MoCA detected 90% of the patients with MCI while a popular different test only had an 18% success rate (Nasreddine et. al., 2005). Though this test seems to be the perfect solution for testing for

Alzheimer's it has not been without its issues. Davis and his team set out to determine the diagnostic accuracy of the MoCA test for various different thresholds of dementia. They found that the test produced a high proportion of false positives, which can be misleading to individuals. They found that up to 40% of people who did not have dementia tested as a false positive when taking the MoCA test (Davis et. al., 2015).

A more resent way researchers have tried detecting cognitive impairments is through the Visual Paired Comparison (VPC) task. This test uses a web camera and eye tracker software to detect MCI in subjects. The software can estimate cognition levels by using a web-cam to measure the time spent looking at novel versus previously seen images. First to determine if the software worked in tracking eye movement, Bott et al. 2017 tested the software on 54 deemed cognitively normal older adults, each being tested three times using the VPC test. Using Pearson correlations, the researchers found the software was successful in tracking eye movements on decisional tasks. They also found the software to have high accuracy while still being low cost (Bott et. al, 2017). A team of researchers here at the University of Arkansas had an idea that this software could be used to detect early signs of MCI so they decided to test this theory. Gray and colleagues (2019) tested 51 individuals using MoCA and the VPC assessment. They used a web camera to track the eye movements of the participants. This was done to measure the time spent locating a novel image in comparison to a preciously viewed image. They found the software to be a viable way to screen for cognitive impairments. It correctly identified 90% of adults as either cognitively impaired or cognitively intact. Specifically, 95% of those with cognitive impairments were correctly identified as having a cognitive impairment through the test. They found it to be a good alternative to in-person assessments done in the physician's office as well as an easily assessable test. (Gray et. al., 2019)

A test for MCI is not required to be completed sitting down, a research team in Edinburgh found a way to detect MCI using physical tasks. Previous studies have shown that MCI's can impair the dual task abilities, which involves walking while doing a secondary task, of patients. One of these studies was conducted by Montero-Odasso et. al. (2009) and his team with BioMed Central. Eleven elderly participants with MCI were tested in two sessions using six gait parameters. They were tested for a single task walk and a dual task walk, the dual task consisted of having the participants count backwards from 100 until the end of the walk, which was 600 cm in length. The team found that under the dual task condition the participant's gait speed decreased significantly. This meant that they walked significantly slower during the dual task compared to the walk without the dual task. This suggested firstly, a cognitive connection to gait performance and secondly, an impairment of dual task abilities with MCI (Montero-Odasso et. al., 2009). With this information, Dr. Foley and her team decided to create a dual task test that could detect AD. They tested this assessment on 50 people with AD, 50 heathy controls, and 49 people with MCI. They found that the group with AD performed significantly worse on the dual task assessment than the group with MCI. Interestingly they also found that the group with MCI performed relatively similar at the dual task assessment to the healthy group. Of the three groups the AD group scored lowest on digit recall, tracking, dual task performance, and overall. The digit recall required the participants to cross out boxes arranged in a path around a sheet of paper. For the tracking task the participants followed a moving square using a light sensitive pen on a computer screen. They also found that typical ageing had no impairment on the performance of subjects (Foley et. at., 2011).

Someone that has a MCI has a cognition level that is below the average level of cognition. However, many studies have suggested that the average cognition level of an older

age group is expected to be lower than that of the younger age group. This is due to the natural decrease in cognition over time. These declines typically do not arise until the age of 65 and up (Cornelis et. al., 2019). So, it would be unwise to compare the cognition level of someone 65 and over to the overall average cognition level in individuals significantly younger. To better find those that are below the typical level of cognition that are at risk for MCI the natural decline in cognition needs to be determined.

Freeman et. al. (2009) considered the physiology behind the natural decline in cognition. They found this age-related decline to be associated with many different factors. Those factors included changes in the glucose utilization of the brain, neurotransmitter levels, the expression of proteins in the body, and trophic factors. The neurotransmitters they were interested in specifically were dopamine, norepinephrine, 5-HT, GABA, and acetylcholine. The trophic factors they were looking at were brain-derived neurotropic factors, nerve growth factors, and insulin-like growth factors. The proteins they were interested in calcium regulatory proteins, synaptophysin, excitatory and inhibitory neurotransmitter receptors. They found that both glucose utilization and ATP generation decreased in the hippocampus of rats with aging. The changes in these levels leads to a decrease in neural processing with aging. They however were not able to distinguish whether these changes in the body due to age were the cause or the effect of the natural decline in cognition. Though they could identify what exactly the natural decline in cognition is, and they found it to be alterations due to age in dendritic and synaptic morphology in the neurons. (Freeman et. al., 2009). They found all of this through studying the changes in the hippocampal proteome, which is the entire set of proteins, in aging mice. Specific changes they found in the mice include a decrease in phosphatidylethanolamine binding proteins in the hippocampus, as well as increased heat shock proteins in the hippocampus in both humans and

mice with age. So, it must be kept in mind that the physiological changes in the human brain could be different than found in this study. However, this study was still a good start for the physiological background to the natural decline in cognition over time.

In 2009, a conceptual model of cognitive aging was proposed called the Scaffolding Theory of Aging and Cognition (STAC). This theory used neuroimaging of the structural and functional aspects of the brain to explain the neurophysiological factors that are typically associated with aging. This model was a cross-sectional study that compared groups of younger and older adults and incorporated principles that would play across the lifespan. They found that healthy older adults were subject to varying degrees of neural degradation. The model states that aging causes two changes in the brain, that being neural challenges and functional deterioration. The neural challenges are structural changes in the brain that come with age. That includes things like shrinkage, changes in white matter, dopamine depletion, and more. The functional deterioration represents things such as decreased specificity of ventral-visual and motor areas, increased default activity, and decreased recruitment of medial temporal lobe regions. The combination of neural challenges and functional deterioration combined then have a direct effect on the level of cognitive function in an individual as they age (Reuter-Lorenz et. al., 2014).

Now that the natural decline in cognition has been discovered it still begs the question of when exactly does cognition begin to decline in an individual. This information is important so that relevant interventions can implement at the earliest possible time. The earlier a decrease in cognition is found the earlier treatment can be implemented. The earlier treatment is implemented the more effective it can be. Salthouse (2009) has tried to answer this question when he tested 2,350 participants between the ages of 18 and 60. The participants completed a battery which consisted of 12 different cognitive tests two different times. It tested aspects of

cognition like memory, reasoning, spatial visualization, speed, matrix reasoning, form boards, and pattern comparison. His data suggested that the age-related decline in cognition starts relatively early in adulthood when they are in their 20s or 30s. However, he could not detect the exact time in which it began. He also surprisingly found that not all cognitive functioning aspects exhibit a decline due to age. It turned out that performance on vocabulary tests or general information increased until at least the age of 60 unlike other aspects of cognition (Salthouse, 2009).

One way to study the natural decrease in cognition over time is to test the cognition levels of individuals' multiple times throughout their life time. This type of study is difficult to conduct though yields more accurate results than testing different individuals of different ages and comparing their cognition levels to each other. Schönknecht et. al. (2005) tried this method. They studied upwards of 500 people over the course of four years. At the start of the study 13.4% of the subjects tested for an age associated cognitive decline. At the end of the four years that number increased to 23.6%. Those who showed signs for an age-related cognitive decline had reduced performance on all the cognitive aspects tested on their last trial compared to their first. Interestingly, a significant decline in performance was in the verbal memory portion of the test. They also found that this decrease in cognition was not a predictive of future cognitive impairments showing that it was natural and in no way abnormal (Schönknecht et. al., 2005). This leaves the question of when does this decrease become abnormal and is there a threshold when the decline becomes an indicator for MCI or even AD?

One question that these tests have overlooked is what causes this natural decline in cognition? One research team at the University of Virginia have tried to answer this question through neuroanatomical substrates in the brain. Neuroanatomical can be defined as the neural

tissue of the nervous system. In basic terms, they believe that age related changes in the brain structure cause the cognitive changes associated with the natural decline in cognition. They reviewed various literature and studies done on the relationship between the neuroanatomical substrates and age related cognitive decline. After reviewing they found that this relationship was weak in current research (Salthouse, 2011).

Even though the decline in cognition due to age is natural not everyone experiences it and some have even looked into how it can be prevented. Orbi, Khrimian, Karsenty, and Oury found that a bone derived hormone called osteocalcin can be important in preventing this decline. Though osteocalcin is typically associated with the skeletal regulation of energy it also has an important role in regulating other physiological functions and developmental aspects. Specifically, it helps regulate the development and function of the brain. The researchers studied these levels of osteocalcin as well in comparison to the cognitive levels of mice. They found that increased levels of osteocalcin lead to a decrease in the decline in cognition over time. This lead them to believe that it was a hormone that could prevent the decline in cognition due to age (Obri et. al., 2018). Just as stated with a previous study since mice were used there is a chance that the physiology could be different in humans.

When thinking of the variables that can affect cognition and in return effect the study of cognition one of the greatest factors that can affect it is sex. Its widely known that there are differences in cognition between sexes. It has been found that males tend to perform better than females in motor cognitive tasks as well as spatial cognitive tasks. On the other hand, women perform better on emotional identification as well as nonverbal reasoning (Satterthwaite et. al., 2014). Keeping this in mind it makes sense to question whether gender also effects how cognition declines over time. Gur and Gur conducted a study comparing differences many

differences between the genders when going through the process of aging. One of these differences was in cognition. They used magnetic resonance imaging (MRI) during neuroimaging studies to compare the effects of aging on men and women in the areas of cognition and emotion. One thing they found was that the progressive decrease in brain volume due to aging affects the frontotemporal brain regions, which are associated with memory, attention, and inhibition, in men more than it does in women. They also found that age-related decline in cognition begins earlier in men than it does in women, by around 10 years(Gur et. al., 2002).

Methods

Two groups of women were recruited to participate in this study. The first group recruited were women between the ages of 18 and 40, and the second group recruited were women over the age of 40. The participants were asked to complete a questionnaire assessing both their mental and physical well-being to further identify any outside factors that could influence the tests. The first part of the questionnaire was an informed consent agreement that they were asked to fill out. The questionnaire as well as the informed consent was completed before each participant's study. For demographics the age, weight, height, sex, and body composition of the participants were recorded. To test the body composition of the participants a DXA scan was completed at the end of the sessions.

Each session was completed in the Health, Physical Education, and Recreation building with a researcher. Because some of the participants could have had a potential cognitive impairment it was important that the researchers knew whether they had the capacity to consent to the test. That is why at the beginning of the session they were evaluated using the Montreal Cognitive Assessment. Which is a 10-minute assessment testing short term memory recall,

visuospatial abilities, executive functions, phonemic fluency, attention, concentration, working memory, and language. MoCA has been found successful in deciphering those that have a true developing MCI against those that simply have a natural cognitive decline due to age (Nasreddine, et at., 2005). If the participant had failed the MoCA assessment they would have required a guardian to sign their consent agreement.

Over the course of their session the participants took two stationary cognition tests, a demographic data analysis, and a mobile cognition test. The first stationary cognition test was the Visual Paired Comparison Test. This test uses the web camera in a laptop as a tool to measure an individual's cognition. VPC focuses on the recognition memory of the participant and measures it by comparing the time the participant views a new picture to the time they spend on a previous picture. Before the test was conducted the participants are familiarized with a group of pictures, these are the previous pictures. After they are familiar with those pictures they were asked to focus their sight on the new picture when compared to the previous pictures. The software used by VPC tracks the participants eye movements while they are looking at the pictures on the screen, and can determine which image they are looking at and how long it took them to focus on the new image. The participants that take a longer time to focus on the new image have lower cognition and can be at risk for MCI or AD (Bott et al., 2017).

The next stationary test the participants completed was the Repeatable Battery for the Assessment of Neuro-psychological Status (RBANS). This test was created specifically with the purpose of identifying dementia in older individuals, as well as characterizing it. It tests many different aspects of the participant's cognition. RBANS was validated to detect dementia and identify distinct profiles of impairment that distinguished the patients with dementia from individuals that did not have dementia (Randolph, et al. 1998). The test specifically focuses on

five different aspects of cognition: immediate memory, visuospatial/constructional, language, attention, and delayed memory. To test these aspects of cognition there are ten different trials during the test, with two different trials for each aspect of cognition. The immediate memory portion includes a list learning test and a story memory test. The visuospatial/constructional portion includes a figure copy and a line orientation test. The language portion includes a picture naming activity and a test of semantic fluency. The attention portion includes a test of digit span and a test including coding. Finally, the delayed memory portion calls back to the list and story told at the beginning of the test.

As previously stated for every session a mobile cognitive test was conducted in between the second and third stationary cognitive tests. During this time hand grip strength was also recorded using a Takei Handgrip Dynamometer. The grip strength of each hand was taken three times on each hand, alternating between hands after each time to decrease fatigue. The mobile test done in this study was a dual-task assessment. Several studies have found that some of the early symptoms of memory impairment has been linked with dual-tasking ability (Foley, et al., 2011). During this test, the participants completed four 20 meter walks, each of which being different. The sensors were set up to be at the 5 meter and the 10-meter mark of the walk in order to measure the time the participants took to walk from the 5 meter mark to the 10 meter mark. In a test of 50 people with AD, 49 people with a MCI, and 50 people without cognitive impairments the dual task test was proved to be valid and reliable in testing for AD. However, in this test it was not proven to be valid or reliable in testing for MCI amongst healthy individuals (Foley et. al., 2011). Montero-Odasso found the dual-task test to be a reliable study in determining older individuals with MCI. They found the variability in the time taken during the dual task assessment in comparison to the control test were increased in older people with MCI (Montero-

Odasso et. al., 2009). The first two walks were done at a typical walking pace. The second of which was done with an additional math task, which composed of counting backwards from a randomly generated number by threes. The second two tasks were conducted the same way but at a faster walking pace.

For statistical analysis, the differences in the cognitive assessments were assessed. The results of the two age groups were compared against each other during the analyses.

Results

Table 1. Demographics of study sample. Includes Gender, Mean age, Highest level of education, and room study was completed in.

	Older	**Younger**
Variable	n=29	n=10
Gender		
Female	29	10
Age (Mean)	60.7	21.0
Schooling		
Bachelor's Degree (including currently working towards one)	20	10
Past Bachelor's Degree	9	0
Room Assignment		
Pre COVID Room	29	0
Post COVID Room	0	10

A total of 39 participants completed the study. Of which 29 were older participants

between the ages of 50 and 69 (M = 60.7, SD = 5.2). The remaining 10 participants were younger between the ages of 20 and 21 (M = 21.0, SD = 0.6). All participants completed the full study completing a MOCA test, a RBANS test, a VPC test, a Dual task test, a hand grip test, demographics, and a DXA scan. The study began just months before the COVID pandemic started, which effected how the study was conducted specifically in the room it was taken in. After the quarantine ended and testing resumed the original room that was designated for this study was deemed too small for two individuals to occupy at the same time. Because the study required that the participant and the researcher to occupy the same room at the same time, the test had to be moved into a larger room. The room that the study was then moved to happened to also act as a breakroom for some professors and graduate students in the laboratory. Because of this there would sometimes be interruptions during a participant's test, most likely disrupting their concentration and potentially effecting their results. All the younger subjects and half of the older subjects were tested after the pandemic began and subsequently were tested in this breakroom. The remaining older participants were tested before the pandemic began in the smaller room which posed no interruptions during testing.

The average weight of the older participants was 72.03 kg. The average weight of the younger participants was 65.41 kg. The average height for the older participants was 163.37 cm. The average height for the younger participants was 165.75 cm. The RBANS test was divided into five different sections testing five different aspects of cognition. The test provided a score for four of the five sections as well as a total score. Those sections were memory, visuospatial/constructional, attention, and delayed memory. The scores were reported in the form of percentiles. With the percentiles, a score of 60 for example means the individual performed better than 60 percent of the population. The scores for the younger group and the older group

were separately analyzed. For each section where a percentile was provided the mean and standard deviation for each group was calculated. Table 2 lists all the means and standard deviations from the RBANS test.

Table 2. Means and Standard Deviations of RBANS Scores for both groups. Scores are listed as percentiles and separated by section. In addition to Significance or P value found by comparing the percentiles of both subject groups.

Item	**Younger**		**Older**		**Significance**
	M	***SD***	***M***	***SD***	***P Value***
RBANS Score:					
Memory percentile	28.40	24.45	65.97	22.02	0.000
Visuospatial/constructional percentile	44.70	25.15	70.14	27.93	0.015
Attention percentile	47.10	27.04	68.69	22.30	0.017
Delayed memory percentile	44.51	20.31	65.62	22.90	0.014
Total percentile	35.70	21.93	73.47	17.34	0.000

The mean percentiles from each group were then compared to each other. This was done to find if there was a statistically significant difference between the two values. This was done for each section of the RBANS test as well as the total. These results are listed in Table 2. It was found that there was a statistically significant difference between the scores of the two groups for every section and the total score. The older women scored 43% higher on the Memory section, 63% higher on the Visuospatial/Constructional section, 68% higher on the attention section, 67% higher on the delayed memory section, and 48% higher total compared to the younger women. A

difference is found to be statistically significant if its p value is found to be less than 0.05 and all the differences tested provided a p value lower than that of 0.05.

The younger group of participants mean score was in a lower percentile than the older group of participants for every section of the RBANS test as well as in the total score. In three of the four aspects of cognition that were tested the older groups minimum and maximum score were both higher than the minimum and maximum scores of the younger group respectively. The only section that the older group did not out score the younger group in the minimum and maximum scores was the Visuospatial/ Constructional section. The only reason for this was that the older groups minimum score was the same as the minimum score for the younger group. However, for this section their maximum score was still higher for the older group than the younger groups.

Discussion

There was an obvious difference in cognition found between the groups. While a significant decrease in cognition was not found between the two groups of subjects a significant increase in cognition was found. None of the confounding variables tested for were found to have any significant effects on the results. Those confounding variables tested for included body mass, height, and hand grip strength. These results give room to the idea that instead of steadily decreasing overtime, cognition levels may instead steadily increase. That is until at least the age of 70. When considering what was found in this study all that is known at this point is that cognition increases until at least the age of 70. If cognition does decline, when considering the results from this study, it would have to happen past the age of 70. This would be because no participants over the age of seventy were tested during this study. However, there is some room

for bias in the test. It is impossible to run a test without some potential for bias. The fact that half of the older individuals were tested in a room without the same distractions that the other participants had to face could have potentially skewed results. It has been found that auditory distractions during memory tasks can minimize a participant's control over their own memory processes. Auditory distractions have also reduced a participant's confidence in their responses during cognitive tests. Which in turn increases their chances of withholding responses in free-report recognition (Beaman et. al., 2014). The distractions that happened in the room used after the COVID pandemic began were not only auditory distractions but visual ones as well. This very well could be a potential explanation for the significant increase in scores amongst the older participants.

Another potential biased in the test related to the education levels of the participants. Since the recruitment process for participants happened mainly on or around the campus of the University of Arkansas most subjects were in some way related to the University. For the younger participants, this meant undergraduate students completing their bachelor's degree. However, for the older participants this meant University professors who had already completed their doctoral degrees. In fact, 9 out of the 29 older participants tested had completed some education that was higher than a Bachelor's degree. The fact that most of the older participants had approximately more than 8 and a half years of higher level education more than the younger students could be another explanation for the significant difference in cognitive levels between the groups. In one study, it was found that elderly participants who completed primary school scored 18.2% higher than individuals who did not complete primary school on cognitive tests (Huang et. al., 2013). If the presence or absence of primary school has that large of an impact on cognitive levels later in life the presence or absence of higher education could also have some

impact on cognition levels. However, a different study that used the MoCA test used in this study tested individuals with three different education levels; less than primary, primary, and more than primary. They found no differences in the total scores or most of the sub scores. The only difference they found between the groups was in the language sub score (Yancar Demir et. al., 2015).

There are limited studies focused on the gradual increase in cognition overtime, but there have been some that have found evidence for it. Most of these studies start out with similar goals to this one in proving the natural decrease in cognition over time. One potential explanation for the increase in cognition levels over time is that the stability of cognition increases with age. This was found in a study that focused on the stability of cognition and personality with age. They also found that the increase in stability of cognition with age is mainly mediated by genetic factors (Briley et. al., 2015). Reuter-Lorenz revisited the Scaffolding Theory of Aging and Cognition (STAC) found that aging was associated with reduction in things like white matter integrity, cortical thickness, functional engagement in the posterior brain regions, and dopaminergic activity. However, they also found that there are increases in the engagement of the frontal area of the brain that can be correlated with increased behavioral performance with age (Reuter-Lorenz et. al., 2014).

Conclusion

The purpose of this study was to compare the cognition levels between two different groups of women varying in age. It was originally conducted to determine the natural decrease in cognition over time. However, the results of this study suggest that prior to former ideas that cognition levels increase with age. That is until at least the age of 70. The group of older

participants scored significantly higher than the group of younger participants on the RBANS test conducted. The older groups mean score and range was higher than the younger groups scores in every section of the test as well as in the total score. There were some potential bias in the results. Due to the COVID pandemic all the younger participants had to be tested in a larger room with more distractions than most of the older participants. These distractions could account for the lower scores in the younger group. Most of the older group had higher levels of education than the younger group. That of which could have accounted for the difference in scores. Or cognition could simply increase steadily over time, at least until the age of 70.

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