RESEARCHERID
THOMSON REUTERS

[Marzouk * *et al.*, 7(3): March, 2018]
IC™ Value: 3.00

ISSN: 2277-9655
Impact Factor: 5.164
CODEN: IJESS7

IJESRT

INTERNATIONAL JOURNAL OF ENGINEERING SCIENCES & RESEARCH TECHNOLOGY

THE IMPACT OF EMOTIONS, AMBIGUITY, AND APATHY ON DECISION-MAKING IN INDIVIDUALS WITH ALZHEIMER'S DISEASE: A PROPOSAL TO FACILITATE DIAGNOSIS OF ALZHEIMER'S DISEASE

Sammer M. Marzouk*
*Pioneer Academics

DOI: 10.5281/zenodo.1199042

ABSTRACT

AD is the fastest-growing cause of dementia and mental illness for elders in the world (Alzheimer's, 2015). Because of this, the rush to diagnosis AD is leading to an increasing amount of false positives. One-fifth of AD diagnosis are false positives. In the U.S, 18.2 billion hours of care and 230 billion dollars are given to the AD diagnosis process (Alzheimer's, 2015). In order to combat this, this five-part proposal (known as the Cumulative Diagnostic Test of the CDT) intends to change the current diagnosis method by creating indexes that only allow the most likely cases of AD to continue with further testing. This proposal tests the emotions, apathy, and ambiguity. These variables were chosen as they have the greatest influence on the decision-making process (Sinz et al., 2008). In this proposal, 1056 data points (n=1056) from 272 healthy elderly people (control, n=272) and 784 elderly people with DAT (experimental, n=784) were analyzed and scored in the CDT, with the average score of the experimental group being 6.10/11, and the average score of the control group was 2.4/11 (Appendix). These scores are positively correlated with risk of developing AD. With this proposal, more than 46 billion dollars of AD funding can be diverted from false positives into more advanced testing. And the U.S as a whole could save about 3.72 billion hours from the diagnosis process.

Keywords: Neuroscience, Neurobiology, Alzheimer's Disease, Brain, Treatment, Diagnosis System, Genetics, Emotions, Mental illness.

I. INTRODUCTION

1. Introduction to Alzheimer's Disease

Alzheimer's Disease is a brain disease that causes the brain to slowly degenerate (Alzheimer's, 2015). It does this by slowly and progressively destroying brain cells. It is not infectious or contagious, but it is the most common cause of dementia in the world. Dementia, a symptom of Alzheimer's Disease, is a term that is used to describe to decline on a person's mental ability. This included cognitive abilities, memory, and language. About 50% of people with dementia suffer from Alzheimer's Disease (Alzheimer's, 2015). Dementia as a whole affects 10% of people aged over 65 and 20% of people aged over 75 in the United States. Over 5.2 million Americans are estimated to have Alzheimer's disease. By 2050 this number is expected to reach 11 to 16 million (Alzheimer's, 2015). AD has many risk factors. These include smoking, high blood pressure, cholesterol, depression, previous brain trauma, age, and familial history with AD. In developed countries, AD is one of the most costly diseases. In 2015, it cost the U.S 259 billion dollars to deal with AD (Alzheimer's, 2015).

2. Diagnosing Alzheimer's Disease

One of the reasons why AD is increasing at such a rapid rate is because of the improvement of how AD is diagnosed (Mohandas, Rajmohan, and Raghunath, 2009). Even though it is easier to diagnosis AD now than it was decades ago, it is still difficult to do so. Diagnosing AD requires a complete medical assessment of a patient. There is no one test that can diagnose AD. In the complete assessment, the patient's medical history, mental status, and emotional stability are all compared with physical tests such as blood tests and brain scans. All of this information is then used in order to diagnose a patient (Mohandas, Rajmohan, and Raghunath, 2009). One of the earliest signs of AD is the appearance of dementia. This includes memory loss, difficulty problem-solving, and poor judgment in making decisions. After these appear, the doctors will interview a family member

ISSN: 2277-9655
Impact Factor: 5.164
CODEN: IJESS7

in order to see whether further testing is required. If it is agreed upon, the doctors use brain-imaging tests like CT scans and MRI`s in order to see any abnormal changes. This culminates with a decision made by the doctor as to whether or not the patient has AD (Mohandas, Rajmohan, and Raghunath, 2009).

3. Treatment of Alzheimer's Disease

After a person has been diagnosed with AD, the treatment begins. Currently, there is no cure for AD (Mohandas, Rajmohan, and Raghunath, 2009). However, both drug and nondrug treatments may help with dealing with the symptoms of AD. To deal with the memory loss, doctors may prescribe drugs such as cholinesterase inhibitors (Aricept, Exelon, Razadyne) and memantine (Namenda). These drugs are used to lessen or stabilize the effect that AD has on neurons (Mohandas, Rajmohan, and Raghunath, 2009). As for behavioral changes caused by AD, those require lifestyle changes to manage symptoms. This means that those around the patient may need to avoid causing emotional distress around the patient. They also have to maintain a calm environment, give them personal comfort, avoid being direct and confrontational, and keep the patient in settings that they are familiar settings (Mohandas, Rajmohan, and Raghunath, 2009). Sudden changes in setting or people may be distressing to the patient. Antidepressants as well and anxiolytics and antipsychotic medications may also be recommended. Even though the treatment options of AD are limited, we understand the ways to prevent or decrease the risk of getting AD very well. The first method is to do regular exercise, as regular exercise can decrease your risk of AD by 50%. Social engagement is also important, as being social and communicated helps to reduce the risk (Mohandas, Rajmohan, and Raghunath, 2009). Eating healthy food, getting enough sleep, and managing your stress are all ways that can help to reduce the risk of getting AD.

4. Neurobiology of Alzheimer`s Disease

From a neurobiological perspective, Alzheimer's Disease is the neurodegeneration of neurons in the human brain. Dementia from AD is related to the irregular production of Amyloid-β and tau, peptides of amino acids commonly found in the brain. Amyloid-β movement in the brain follows a spatial progression pattern, starting at the basal neocortex, spreading throughout the hippocampus, and eventually to the rest of the cortex (Uday, 2015). The irregular amounts of Tau spread throughout neural networks, focusing on the primary areas of the neocortex. This irregular production causes amyloid plaques in the brains of people with AD, specifically in the neocortex, which deals with higher-order reasoning. In normal brains, these irregularities would break down and be eliminated. In AD, they form hard, insoluble plaques called amyloid plaques (Uday, 2015). In AD, the buildup of Tau proteins leads to the destruction of the microtubule structures in neurons. In a neuron, the microtubules help to hold up the neuron and keep a definite shape (Mohandas, Rajmohan, and Raghunath, 2009). As they collapse, the size of the brain itself starts to shrink. This leads to the beginning of the symptoms (Uday, 2015).

5. Proposal

As explained above, AD is an ever-increasing problem in terms of scale and cost. As explained above, there is a possibility that AD can be diagnosed ahead of time if many medical and emotional tests are done. However, many of these tests require a lot of time and money (Fischer et al., 2017). They also require large amounts of human body samples, which might be painful. This is why the production and implementation of a new, written questionnaire exam will help with the diagnosis of AD in a more general population (Alzheimer's, 2015). A written exam will question the emotional and neurological stability of the patients. This will save on cost and time-sensitive evaluations. If a patient earns a score above a certain point, they will then be taken in for further testing. This saves people who do not have AD from continuing with the diagnosis process.

6. Hypothesis

The hypothesis of this paper is that a questionnaire will facilitate the current diagnosis process for AD. Currently, one-fifth of AD diagnoses may be false positives (Fischer et al., 2017). This wastes billions of dollars per year, not to mention the countless hours lost by these patients from testing and hospital visits (Fischer et al., 2017). This proposal aims to reduce that amount by saving the intense testing and stages of the diagnosis process for those who are most likely to have AD, saving those who are not time and money.

Primer On The Brain, Memory, Decision-Making, Neurons, and Neurobiology

In the brain, decision-making is a long and complex process that ends with a choice being made by the person. At the start of the process, the senses of the human body must perceive an external stimuli (Murdock, 1972). When the senses perceive these external stimuli, the nerves of the human body must send this information to the human brain. They do this by allowing the cell body to change its electrical output (Figure 1). They do this by

ISSN: 2277-9655
Impact Factor: 5.164
CODEN: IJESS7

increasing or decreasing their overall electrical charge, creating an electrical impulse (Murdock, 1972). This spreads through the myelin sheath to the axon terminals. This is where it spreads to other nerves in the brain. When it gets to the brain, the neurons start a similar process. When it spreads from neurons, they create an electrical impulse (Figure 1). The neurotransmitter makes the inside of the neuron more positive through depolarization.

Depolarization is a process by which the membrane potential of the neuron is made positive through the movement of electrical charges triggered by neurotransmitters (Murdock, 1972). Enough depolarization can cause an action potential, which is a point in which the neuron has built up so much electricity that it sends out an electric impulse (Figure 1). Electrical signals continue through synapses by releasing neurotransmitters from synaptic vessels. They go across the synapse to receptor sites, which creates the electrical signal. The synapse is a small gap between each individual neuron in the brain (Murdock, 1972). Because electricity cannot jump over the gap, the neuron releases a neurotransmitter in order to transmit the impulse to the next neuron (Figure 1). A neurotransmitter is a chemical that is released by the electrical impulses at the axon terminal of a neuron. Each neurotransmitter has a unique shape that matches with a receptor site.

When the neurotransmitter connects to the axon terminal, it causes an electrical signal and continues the process. In terms of decision-making, the brain works in a similar way as a computer (Murdock, 1972). Neurons are binary cells, meaning that they can make one of two choices. They can either send out an electrical impulse, which is a 1 (Hochreiter and Schmidhuber, 1997), or not send out an electrical impulse, which is a 0. The results of doing this binary task hundreds of times, by thousands of neurons, leads to the decision. Decision-making depends on recognition and the topic of perception. Recognition is being able to put specific objects, based on how you see them, into categories (Hochreiter and Schmidhuber, 1997).

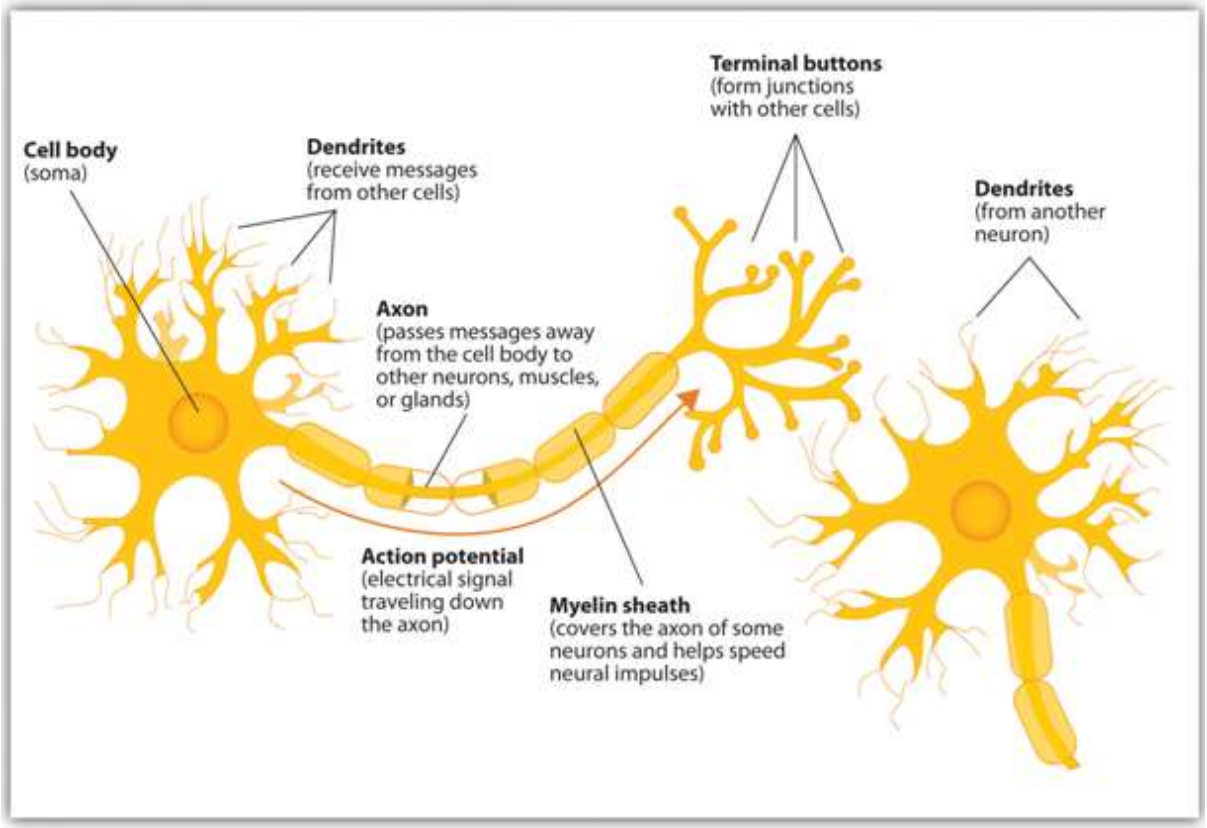

Figure 1. The Anatomy of a Neuron. Adapted from "Introduction to Psychology," by University of Michigan, 2016, University of Michigan Libraries, Copyright (2016).

These categories may be general, such as "safe" or "dangerous," or they might be more specific, focusing on shape, color, and function. Perception is the experience of sensing stimuli. That means when you put your hand

ISSN: 2277-9655
Impact Factor: 5.164
CODEN: IJESS7

on a table and feel how smooth it is, you are sensing stimuli. The other half of perception is remembering the experience, so that even if you are not actually feeling the table, you are able to remember how the table felt (Hochreiter and Schmidhuber, 1997). The memories of these experiences are created through the process of long and short-term memories. In short-term memories, a stimulus activates a pattern of activity across neurons in a specific part of the brain. These neurons fire all of their neurotransmitters, allowing a specific memory a period of about 20 seconds to be the dominant memory.

In long-term memory, the same steps happen in a short-term memory. However, the protein kinase A is activated, which sets off CREB (cyclic AMP-response element binding protein). CREB activates genes, which then begin making specific proteins (Hochreiter and Schmidhuber, 1997). Depending on the specific memory, the proteins and the circuits of the brain that this happens in will be modified. A memory that involves motor skills will be different than a memory that requires visual stimuli. These proteins then bind to the neurons, allowing the memory to remain for that neurons lifetime (Hochreiter and Schmidhuber, 1997).

Two of the proteins that help with the binding of memories to neurons are Amyloid-β and Tau. These two proteins also have the greatest impact on the development of AD (Hernández et al., 2010). Amyloid-β begins its life as a solitary molecule, but over time it starts to form small clusters that travel freely throughout the brain. As the age of the person increases, so does the concentration of Amyloid-β. As the concentration increases, Amyloid-β clusters start to bind to the receptors of neurons (Hernández et al., 2010). These clusters start to form Amyloid-β plaques. This sets off an intracellular process that erodes the synapses between neurons. The destruction of these synapses leads to the loss of memories. The increase of Amyloid-β also leads to the increased concentration of the Tau protein. The Tau protein is normally a protein that helps to stabilize neurons. However, the increase of Amyloid-β in the synapses leads to an increase of Tau proteins. These proteins form tangles within neurons called Tau tangles. Unlike Amyloid-β, which destroys neurons from the outside of the cell, Tau tangles destroy neurons from the inside. Tau tangles disintegrate the system that transports nutrients within the neuron, which leads to its death (Hernández et al., 2010).

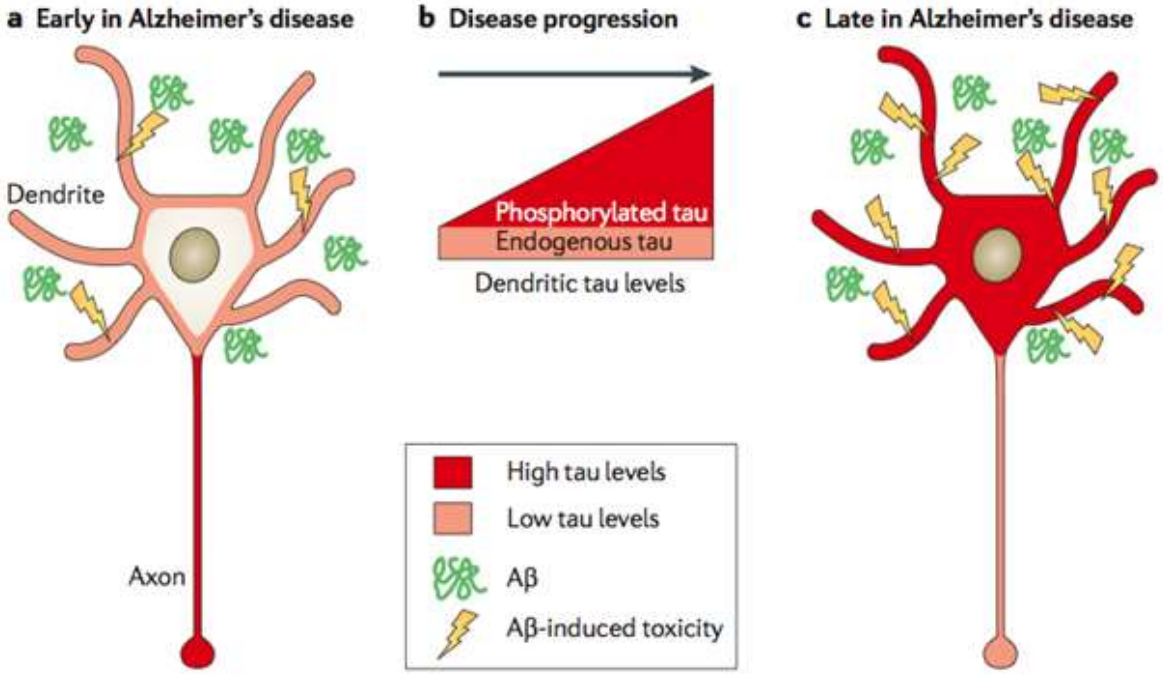

Figure 2. Role of Amyloid-β and Tau in Alzheimer's Progression. Reprinted from "Amyloid-β and tau–a toxic pas de deux in Alzheimer's disease," by J. Goetz, Nature Reviews Neuroscience, Copyright (2011).

ISSN: 2277-9655
Impact Factor: 5.164
CODEN: IJESS7

Literature Review

The Effect of Ambiguity on Decision-Making

Zamarian, Weiss, and Delazer aimed to investigate whether individuals with mild cognitive impairment (MCI) experience difficulties in decision-making under risky and ambiguous situations in the Iowa Gambling Task and the Probability-Associated Gambling Test (Zamarian, Weiss, Delazer, 2010). They found that people without MCI at first made disadvantageous choices, but over time they began to make more advantageous choices. People with MCI did not prefer advantageous or disadvantageous choices. They did not improve over time. In the Probability-Associated Gambling Test, people with MCI made less advantageous decisions than those without MCI in low winning probability tests. It was also found that those with MCI have difficulties in making advantageous choices similar to those with mild dementia from Alzheimer's (Zamarian, Weiss, Delazer, 2010).

Delazer, Sinz, Zamarian, Wenning, and Benke conducted a study in order to see how ambiguity impacted decision-making in patients with AD (Sinz et al., 2008). The study tested the decision-making abilities by using the Iowa Gambling Task (IGT) and Probability-Associated Gambling (PAG). From these tests, it was demonstrated that people with AD made more disadvantageous decisions than those who do not have AD. Patients that were under ambiguous conditions also made random decisions and did not develop a clear strategy. In the PAG, patients with AD also demonstrated less advantageous decision-making. They would often bet and risky and likely deck with at random rates (Sinz et al., 2008). The patient's performance on the tasks also correlates with early pathological cerebral changes and cognitive and emotional deficits. This indicates that as the number of deficits from AD increase from pathological cerebral changes, the performance in both the IGT and PAG decreases and causes the patients to make less advantageous choices. From the study, ambiguity is shown to amplify the number of disadvantageous choices made (Sinz et al., 2008).

Hot, Ramdeen, Borg, Balon, and Couturier conducted a study to see whether the decline of decision-making abilities in people with AD is correlated by the use of incorrect or no strategy (Hot et al., 2013). Using the IGT, patients with AD had impaired and decreased performance in the IGT, the patients that were overall happier performed better on the IGT than those who were not. Additional analysis demonstrated that decreased performances on the IGT was not due to memory functions. This allows the proposition of the idea that higher uncertainty level in patients with AD can be reduced through emotional responses (Hot et al., 2013).

The Effect of Apathy on Decision-Making

Bayard, Jacus, Raffard, and Nargeot conducted tests of patients with mild dementia from Alzheimer's Disease (AD) and with MCI (Bayard et al., 2014). They were tested using the Iowa Gambling Task and the Lars Apathy Scale. The aim of the study was to investigate decision-making based on emotional feedback processes. From the study, both people with AD and MCI had reduced performances if they had higher scores on the Lars Apathy Scale. Those with lower scores did better on the IGT. This related disadvantageous choices on the IGT to apathy levels. This correlation might lead to further studies being done to use the IGT as a risk factor for increasing apathy, especially among older populations (Bayard et al., 2014).

The Effect of Reaction Time on Decision-Making

Delazer, Sinz, Zamarian, and Benke conduct a study in order to try and understand the strategy that people with mild Alzheimer's follow in decision-making (Delazer et al., 2008). This was tested by using a gambling test. The patients with AD shifted more frequency between safe and risky choices. They also demonstrated less consistent strategies and choices. Due to the frequent changes, this indicates that the choices were random and that there was no consideration of strategy. This is in comparison to those without AD, who favored safe choices and demonstrated a consistent strategy (Delazer et al., 2008). Those with AD also did not adapt their strategies as the problems changed. Those without AD demonstrated a clear change in strategy. These differences are not attributed to impulsive reactions as those with AD and those without AD have similar reaction times. This also proposes the gambling test could be used as an indicator for AD, as the frequency of changes between safe and risky choices could be used as a fair indicator (Delazer et al., 2008).

The Ability to Comprehend and Use Information for Decision-Making

Karlawish conducts a literature review on developing a model that covers four decision-making concepts: understanding, appreciating, reasoning and choice (Karlawish, 2008). Karlawish tested the amount of information that those with AD could retain from reading. After being given a text to read, they would be asked a question referencing said text. Less than 40% of those with AD received a passing grade on the test. Another test conducted was that people with AD would have an interview on the text with a supervisor (Karlawish,

ISSN: 2277-9655
Impact Factor: 5.164
CODEN: IJESS7

2008). This time, 60% of the patients received passing grades. This indicated that the decision-making process is impacted by what senses are used to perceive the information. In general, the study found that even when information is explained or written to a person with AD, they will often be unable comprehend substantial parts. Also, those with mild dementia are more likely to retain more important information than those with mild AD (Karlawish, 2008).

The Effect of Alzheimer's Disease on Decision-Making in Giving Consent

High examined the effect that AD has on people's ability to give consent (High, 1992). Though there are already laws in place for this, there is a lack of uniformity in how well the laws are able to apply to people with AD. People with AD who have to give consent face emotional problems, problems of not having enough information, and fluctuating orientations of the mind. People under these circumstances are facing similar emotional and environmental stimuli as those taking the IGT or PAG (High, 1992). From these people, we see that those who are more uninformed or ignorant of the situation make the same amount of disadvantageous choices as those who would be considered informed of the situation. Also, those who are more emotional, specifically those who are more apathetic end up making more disadvantageous and more random choices than those who are not (High, 1992).

Significance

The proposed exam would be significant for that fact that it would reduce the time, cost, and investments needed to be diagnosed with or without AD (Alzheimer's, 2015). This proposal would make it so that the cheapest and quickest part of the diagnosis process, the questionnaire, would separate participants who need further testing from those who do not. Instead of making all participants conduct the costly and time-intensive testing, the testing could be reserved for those who got above a specific score on the exam. This makes it so those who score below do not have to be bothered with additional testing. More than ⅕ AD diagnosis may be false positives (Fischer et al., 1992). This means ⅕ people who have been diagnosed with AD may be spending money, time and recourses on medicine and testing that they do not need. These resources could be focused on the people that actually do have AD (Fischer et al., 1992).

II. ESTABLISHED METHODOLOGY

1. Iowa Gambling Task (IGT)

The Iowa Gambling Task (IGT) is a psychological test that is designed to stimulate real-life decision-making (Li et al., 2010). In it, the participants are given four virtual decks of cards on a monitor (Brevers et al., 2013). They are told that every deck has cards that either reward or penalize them. They are given game money, and if they are rewarded, they gain money. If they are penalized, they lose money (Brevers et al., 2013). In the study, there were 20 patients with AD, 20 participants with aMCI, and 20 healthy people who were the controls (Figure 2). All participants completed the Iowa gambling task (IGT). The goal of the task is to earn as much money as possible. The decks are different as each deck has a different ratio of reward to penalty decks. Therefore, there are "bad" and "good" decks (Li et al., 2010).

ISSN: 2277-9655
Impact Factor: 5.164
CODEN: IJESS7

Figure 2. The Home Screen of the Iowa Gambling Task. Reprinted from the Iowa Gambling Task Homescreen.

2. Probability-Associated Gambling Task—Revised (PAQ)-R

The PAG-R is a psychological test that is designed to test the ability of the participant to adapt to changing probabilities overtime (Sinz et al., 2008). In the task, the participants are given four decks. Each deck is designated a rating. Either it has a high-winning probability, or it has a low-winning probability (Sinz et al., 2007). If you win, you gain game money. If you lose, you lose game money. However, a high-winning deck it not guaranteed to win, and vice verse. The goal of the task is to earn as much money as possible (Sinz et al., 2008).

3. Lars Apathy Scale (LAS)

The LAS is a written questionnaire that examines the amount of apathy a participant has (Sockeel, 2006). The examination itself has 18 statements, each of them being answered on a four-point scale (Sockeel et al., 2006). For example, the statement of "Meeting my family is important for me" might be displayed. The participant will then circle a number. The higher the number, the more they disagree with the statement. The smaller the number, the more they agree. A higher score means they are less apathetic, and vice-versa (Sockeel, 2006).

4. Lille Apathy Rating Scale (LARS)

The LARS task is an interview given to participants in order to see the amount of apathy they have (Ross, 2017). It is based on a structured interview. It includes 33 items, divided into nine domains. In the interview, the questions are based on day-to-day tasks. Each section is designed to test a certain part of the emotional intelligence, including emotion and curiosity. Responses are scored on a dichotomous scale (Ross, 2017).

5. Mild Cognitive Impairment (MCI)

A mild cognitive impairment is a middle stage between the cognitive decline of normal aging and the more-serious decline that comes with dementia (Boyle et al., 2012). It can involve problems with memory, language, thinking, and judgment that are greater than normal age-related changes. People with MCI are at a greater risk of getting more advanced stages of dementia. MCI itself is not severe, as people affected by it can still function in a normal setting (Boyle et al., 2012).

ISSN: 2277-9655
Impact Factor: 5.164
CODEN: IJESS7

6. Alzheimer Smell Test

In the development of Alzheimer's, the sense of smell is the only sense that is not affected by the deterioration of the brain (Duff, McCaffery, and Salomon, 2002). Due to the frontal lobe being the center for the senses of small, it is not affected by the effects of AD. The other senses are in the cerebellum, which is heavily affected by the effects of AD. In the AD smell test, the participants are given scent cards that smell of peanut butter, soap, and mouthwash. They are then asked to describe it. If a person passes this exam, it is likely that they will not have to worry about AD developing in them for four years (Duff, McCaffery, and Salomon, 2002).

III. DEMOGRAPHIC AND CLINICAL DATA

1. Demographic Data

Demographic and clinical data are reported on, in detail, in Table 1(Bayard et al., 2014). The table refers to the IGT, PAG-R, and the LAS participants. AD and aMCI participants were, on average, older (resp., $P < 0.001$ and $P = 0.043$) and less educated (resp., $P = 0.09$ and $P = 0.027$) than the controls. In terms of education and age, there were not many differences between AD and MCI participants (all P values = 1). All groups were matched for gender. As expected, AD participants performed worse than MCI participants ($P = 0.006$) and controls ($P < 0.001$) on the MMSE (Mini-Mental State Examination), as a significant difference was also observed between MCI participants and controls ($P = 0.018$). Finally, there was no significant difference between groups in reported depression symptom severity using the BDI total score.

Table 1. Demographic and Clinical Data for the CDT. Data from "Apathy and Emotion-Based Decision-Making in Amnestic Mild Cognitive Impairment and Alzheimer's Disease" by S. Bayard, 2014, Behavioral Neurology.

	Healthy controls (n = 20)	MCI participants (n = 20)	DTA participants (n = 20)	Statistics	P value
Demographic and clinical data					
Age, mean (SD)	73.5 (6.7)	78.25 (6.9)	80.9 (5.4)	$F = 8.7$	<0.001[a]
Sex, n (women)	11	11	12	$\chi^2 = 0.13$	0.93
Years of education, mean (SD)	11.1 (2.7)	7.9 (2.4)	8.3 (3.1)	$F = 7.7$	0.001[a]
Minimental State Examination[c], mean (SD)	28.5 (0.9)	27.15 (2)	24.8 (2.3)	$F = 11.6$	<0.001[b]
Beck depression inventory					
Total score, mean (SD)	10.6 (6.5)	12.2 (7.8)	13 (7.44)	$F = 0.57$	0.57
Moderate (>18), n (%)	2 (10)	4 (20)	5 (25)	$\chi^2 = 1.55$	0.45
Severe (>19), n (%)	1 (5)	0	0	$\chi^2 = 2.03$	0.36
Lille apathy rating scale[c], mean (SD)					
Intellectual curiosity	−2.6 (0.76)	−1.4 (0.96)	−1.5 (1.01)	$F = 5.6$	0.006[a]
Emotion	−3.6 (0.59)	−2.5 (1.29)	−2.7 (1.50)	$F = 1.9$	0.15
Action initiation	−3.5 (0.64)	−2.2 (1.15)	−2.0 (1.74)	$F = 5.1$	0.009[a]
Self-awareness	−2.9 (1.14)	−2.4 (1.27)	−2.5 (1.31)	$F = 0.1$	0.86
Total score, mean (SD)	−28 (4.18)	−17.8 (6.80)	−19.1 (6.40)	$F = 9.6$	<0.001[a]
Lille apathy rating scale-cutoff					
Lightly apathetic to severely apathetic, n (%)	1 (5)	12 (60)	12 (60)	OR = 3.62 95% CI 1.6 to 7.7	<0.001
IGT disadvantageous profile (net score <0)					
Total net score, n (%)	6 (20)	13 (45)	10 (35)	$\chi^2 = 5.64$	0.05[a]
Blocks 3 to 5 (trials 41–100), n (%)	5 (18)	12 (42)	11 (39)	$\chi^2 = 6.66$	0.03[a]
Executive function assessment[c], mean (SD)					
Hayling Test (time)	4 (2.34)	7.5 (4.51)	6.8 (3.67)	$F = 1.66$	0.19
Hayling Test (error)	2.7 (1.92)	8.5 (7.34)	9.8 (5.90)	$F = 3.27$	0.04[a]
Trail Making Test (time)	112 (50)	191 (60)	198 (46)	$F = 5.98$	0.004[a]
Trail Making Test (error)	0.5 (1.05)	3.1 (4.58)	5.3 (7.14)	$F = 1.96$	0.14
Updating memory task	3.3 (0.83)	2.6 (0.64)	2.4 (0.64)	$F = 1.56$	0.21

AD: Alzheimer's disease; CI: confidence internal; IGT: Iowa gambling task; MCI: mild cognitive impairment.
[a]Controls ≠ (MCI = DTA); [b](Controls = MCI) ≠ DTA; [c]adjustment for age and education.

ISSN: 2277-9655
Impact Factor: 5.164
CODEN: IJESS7

2. Results of Impact of Emotion on Decision-Making in Patients with Alzheimer's Disease

In the IGT, both the MCI and the AD patients had significantly reduced results. Both MCI's and the AD patients were more emotional compared to the controls, but there was not a difference between the MCI's and the AD patients in terms of emotion (Bayard et al., 2014). A group effect was demonstrated for the IGT net win (F = 6.83, P = 0.002), with a lower final outcome in MCI's (mean = 492, SD = 255) and AD participants (mean = 630, SD = 199) than compared to controls (mean = 1416, SD = 280; resp., P = 0.003, Cohen d` = 3.63 and $P$ = 0.014, Cohen d` = 3.27) (Figure 3). There was no difference found between MCI and AD Patients (P = 0.1) (Bayard et al., 2014). It was also discovered that MCI and AD participants and controls displayed different decision-making patterns during the task (Figure 3) (F = 2.42, P = 0.025, η2 = 0.07). In trials 41 to 100, a group effect was noted (F = 3.43, P = 0.042, η2 = 0.10). Controls performed better than MCI and AD patients did (resp., P = 0.048, Cohen d` = 1.18 and $P$ = 0.043, Cohen d` = 1.21). There was no difference observed between MCI and AD patients (P = 0.8). Overall, the percent of participants with a more disadvantageous record was higher in aMCI and AD groups compared to controls (Table 1, all P values < 0.05). There was no significant difference observed between AD and aMCI participants (all P values > 0.8) (Bayard et al., 2014). In summary, patients with AD and MCI made less advantageous choices than those in the control group. Also, there is a negative correlation between the level of emotions that the patient's exhibit and the score they get on the IGT (Bayard et al., 2014). This makes emotion an influential part of the decision-making process.

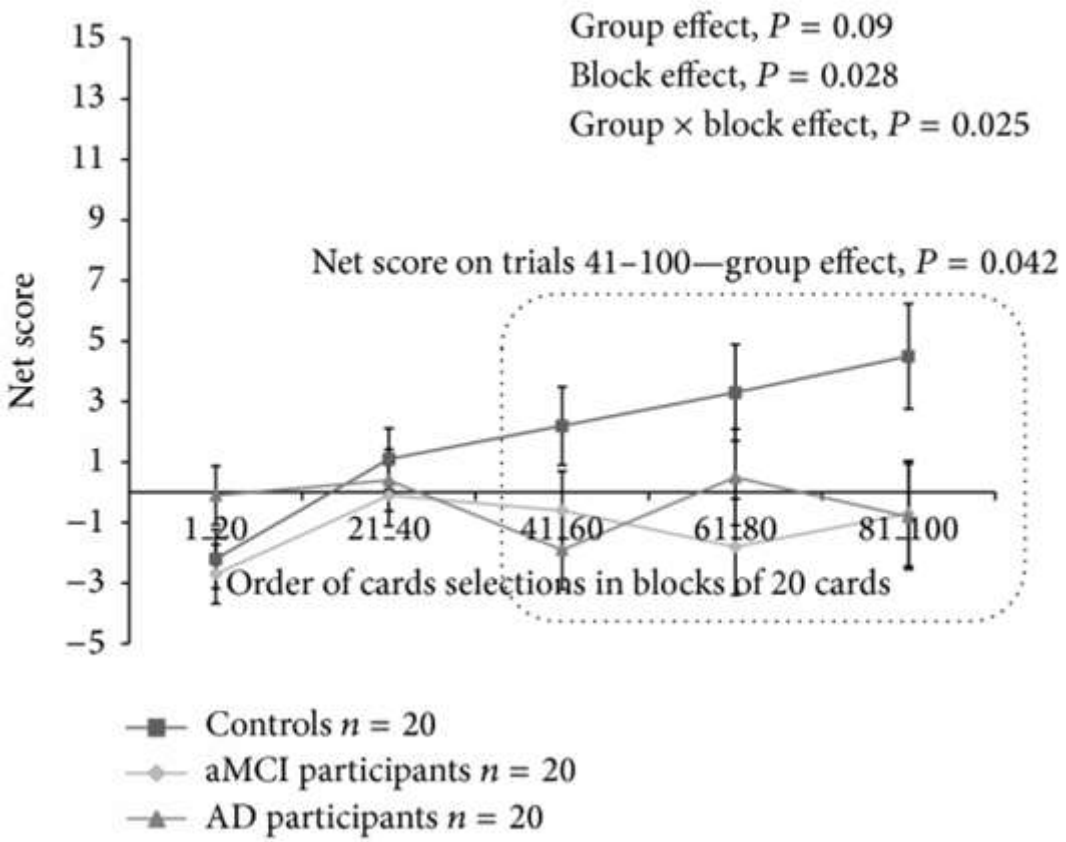

Figure 3. Demographic and Clinical Data for the CDT. Data from "Apathy and Emotion-Based Decision-Making in Amnesic Mild Cognitive Impairment and Alzheimer's Disease" by S. Bayard, 2014, Behavioral Neurology.

3. Results of Impact of Ambiguity on Decision-Making in Patients with Alzheimer's Disease

Overall, Mild Alzheimer's and Dementia (DAT) and MCI patients in the IGT selected the advantageous decks less frequently than healthy controls (Bayard et al., 2014). DAT patients chose the more advantageous decks more frequently than healthy controls in the first deck (p < 0.01), whereas the opposite pattern was found for decks 3, 4 and 5 (t-tests, all p < 0.05)(Bayard et al., 2014). In general, the frequency of advantageous choices significantly increased over the task for healthy participants (block 1 p < 0.001), while no relevant difference

ISSN: 2277-9655
Impact Factor: 5.164
CODEN: IJESS7

between decks was detected for DAT patients (Table 3). In the PAG-R, the low probability decks had chances between p = 0.125 and p = 0.375 to win money. The high probability decks chances are p = 0.625 and p = 0.875 in order to win (Bayard et al., 2014). DAT patients chose to gamble more often than the controls in the low probability decks, whereas the opposite pattern was found for the high probability condition (Table 3). In the low probability conditions, AD patients gambled more often than healthy participants, and for the patients with AD, the ambiguity of the decks led them to make significantly worse choices than the control group (p = 0.125, p < 0.01; condition p = 0.375, p < 0.01). In contrast, they gambled less frequently in the highest winning probability condition (condition p = 0.875, p < 0.01; in the condition p = 0.625, differences were not significant; Table 3) (Bayard et al., 2014). In general, AD and MCI patients gambled more than healthy patients. Also, there was a correlation between the ambiguity of the decks and the amount by which patients gambled by et al., 2014).
(Table 3). This leads to the conclusion that ambiguity is a major factor in the decision-making process (Bayard

	M (S.D.)		*t*-Test (*p*-value)
	DAT patients	Controls	
IGT			
Advantageous choices (C + D) (frequency)			
Total sum	49.4 (4.4)	58.5 (8.6)	0.0001
Block 1	9.5 (1.7)	7.5 (2.4)	0.005
Block 2	9.6 (1.6)	10.8 (2.3)	n.s.
Block 3	10.8 (1.9)	13.0 (3.0)	0.01
Block 4	10.0 (1.9)	13.7 (3.6)	0.0001
Block 5	9.2 (1.6)	13.5 (4.3)	0.0001
Shifts between single decks (frequency)			
Total sum	92.0 (10.6)	59.0 (24.6)	0.0001
Block 1	19.6 (0.5)	13.9 (5.0)	0.0001
Block 2	19.3 (1.2)	12.9 (5.3)	0.0001
Block 3	17.8 (4.2)	11.4 (6.0)	0.001
Block 4	18.5 (2.0)	11.0 (5.6)	0.0001
Block 5	16.7 (4.0)	9.8 (5.5)	0.0001
Shifts between good (C + D) and bad (A + B) decks (frequency)			
Total sum	61.2 (9.4)	35.7 (19.1)	0.0001
Block 1	13.4 (2.6)	8.0 (4.4)	0.0001
Block 2	13.1 (1.9)	8.6 (4.1)	0.0001
Block 3	11.5 (3.4)	7.0 (5.0)	0.003
Block 4	12.4 (2.6)	6.8 (4.8)	0.0001
Block 5	10.9 (3.8)	5.3 (3.9)	0.0001
Net win (€)	1834 (731)	1967 (902)	n.s.
Final borrow (€)	3059 (1029)	2455 (858)	0.053
PAG			
Gambles (frequency)[a]			
p = 0.125	1.2 (1.0)	0.3 (0.6)	0.0001
p = 0.375	1.6 (1.4)	0.5 (0.8)	0.004
p = 0.625	3.2 (1.1)	3.8 (1.1)	n.s.
p = 0.875	3.7 (1.3)	4.7 (0.6)	0.002

Legend: *M*, mean; S.D., standard deviation; n.s., not significant.
[a] Trials corresponding to different fix sums (+20, −20) are collapsed.

Table 3. Demographic and Clinical Data for the CDT. Data from " Impact of ambiguity and risk on decision-making in mild Alzheimer's disease " by H. Sinz, 2008, Neuropsychologia.

ISSN: 2277-9655
Impact Factor: 5.164
CODEN: IJESS7

4. Results of Impact of Apathy on Decision-Making in Patients with Alzheimer's Disease

Of the 40 participants with AD or MCI, 29 participants were identified to have a disadvantageous profile (IGT < 0); 28 demonstrated a preference for disadvantageous choices for decks 3 to 5 net score (trials 41–100; IGT < 0) (Sinz et al., 2008). Table 1 indicates that participants with an advantageous profile at the IGT (net score > 0) were less apathetic than participants who demonstrated a preference for disadvantageous choices (net score < 0). Overall, this represents a negative correlation between apathy, and decision-making. In the survey, 29/30 participants with AD or MCI reported having an increase in making disadvantageous choices. This means that the view that the participants bring to the task impacts the way they perform the task (Sinz et al., 2008). Those who are more apathetic towards a particular task or goal are more likely to make less advantageous choices that relate to that task. Those who are less apathetic are more likely to make more advantageous choices. And this difference is significantly increased in people with AD and MCI. This means that apathy is an important part of the decision-making process (Sinz et al., 2008).

IV. PROPOSAL

Discussion of Presented Paper Results

From the data presented in the previous proposals, it is shown that the impact of emotions is a significant variable when it comes to decision-making. When making a choice, your emotions will impact the way your brain will think before a final decision is reached. Because emotions are linked to memories, the increase of proteins is linked with emotions that blocking experiences that you have had (Sinz et al., 2008). The blockages of these neurons in the frontal lobe leads to a decrease in logical and level-headed thinking (Tabert et al., 2005). In people with AD, this effect is increased dramatically as these people already have a limited amount of neurons left, due to the accumulation of Amyloid-β. It is shown that the ambiguity of the question presented also affects the decision-making process. As shown from the IGT, the ambiguity of the task leads to confusion and anger. This ambiguity leads to emotions and apathy, two other influential factors in the decision-making process (Sinz et al., 2008). This impact is due to the confusion of the unknown details, as well as the required skill of needing to use the frontal lobe. Since patients with AD have limited control of their frontal lobe, this prevents them from using logic in order to solve ambiguous problems. For the impact of apathy, this is the process in which the patients become apathetic and lose interest in doing well (Tabert et al., 2005). This is caused by a multitude of factors. One reason is that due to natural human emotions when confronted with a difficult task with seemingly no solutions, humans tend to abandon the task. Since the patients were not confronted with this option, they choose to finish the task but did so apathetically. This led to the same reaction times, but less thought devoted to each problem (Tabert et al., 2005). Also, as apathy is an emotion, the rise of apathy also leads to the influence of general emotions in the decision-making process. This increases the severity of the impact on decision-making, as demonstrated by the increased difference between the control and the experimental groups.

Proposed Methodology

The current diagnosis process for people for AD in America and the world at large is inefficient, costly, time-wasting, and inaccurate. More than ⅕ patients diagnosed with AD may not have AD, or may not have a severe case of AD that requires massive testing and medicine. These cases result in billions of dollars and countless hours being wasted (Alzheimer's, 2015). These resources could be redistributed to patients with likely or current cases of AD. To combat this, this proposal intends to diagnosis suspected patients of AD through cheap, accurate and general tests and screenings. These tests will decrease the number of false positives for the diagnosis process, as only those deemed "likely" to possess AD will go on and get further, expensive testing. Those that score below a certain percentile do not have to worry about developing AD for the next four years. Those within a warning range should be monitored and should come to retake the test in six months to a year. The proposal is the Cumulative Diagnostic Test (CDT). The CDT is a 5-stage questionnaire and interview test. The 5-stages covered are emotions, interview signs, apathy, sniff test, and the IGT (ambiguity task). The reason why these specific variables are covered is that from the previous studies, it has been shown that emotions, apathy, and ambiguity are the largest influencers in the decision-making process. In the emotions test, the patients are questions in the form of a questionnaire. The range for this exam is -8 to 8, where an eight is the maximum and negative eight is the minimum. The higher you score, the lower your emotional intelligence. The average range for healthy people is from -2 to 2 (Appendix). In the apathy exam, the test is given in an interview-like setting. In the interview, the patients are statements in which they are asked to rank how much they agree with them or disagree with them. This ranking is on a scale from 1-4, where 4 is strongly disagrees, and 1 is strongly agrees. The range is from 18 to 72, where the normal range for healthy adults is from 18 to 28

ISSN: 2277-9655
Impact Factor: 5.164
CODEN: IJESS7

(Appendix). In the smell test, the patients would be blindfolded. They would then be presented with three strips. One strip would smell like smell beans, one like mouthwash, and the last one would smell like soap (Duff et al., 2002). After the patient smelled the strip, they would then be asked to describe a memory associated with that smell. They would be asked about who, what, where, when, and why. For each one they fail to describe, they gain a point. There are 15 points in total, with the average for health elders being from zero to two. The next test would be the interview signs test (Appendix). This would be in conjunction with the apathy test and the smell test. During the interview during these two exams, the interviewee would notice and check off if the patient exhibited any asocial or awkward motions. The scale is from zero to five, where five means that you exhibit most of the aforementioned signs. The final test is the IGT. The IGT tests the patient's ability to deal with ambiguity and ambiguous situations (Sinz et al., 2008). As described in the methods, the IGT's main goal is to gain as much money as possible from choosing the more beneficial decks. In the IGT, the range of scores that a patient can get is from 0 dollars to 4500 dollars. The normal range for a healthy elder is from 2250 dollars to 4500 dollars. From these five tests, all the results are compiled and put into a singular, comprehensive formula that reduces and approximates all of the results into one number. This number ranges from zero to 11, which the normal range being zero to four. This means that the patient does not have to worry about developing AD for the next four years. From four to six, there is a warning range, which means that that the patient should come to retake the test in six months to a year (Seeber et al., 2008). From six to eight, this is a range for a likely case of DAT. This will require further, more physical testing to prove (Alzheimer's, 2015). And from eight to eleven, this indicates a severe case of AD, in which case more physical testing is required, as well as some medication. From this proposal, the percentage of false positives will decrease from ⅕. In the U.S, 18.2 billion hours of care and 230 billion dollars are given to the AD diagnosis process (Alzheimer's, 2015). With this proposal, more than 46 billion dollars of AD funding can be diverted from false positives into more advanced testing. And the U.S as a whole could save about 3.72 billion more hours from the diagnosis process to help patients with known cases of AD.

Analysis of Data

Since the CDT is an accumulation of established and new AD tests, the data from individual studies of these exams can be averaged out and can be cultured into an average for the CDT. For the Iowa Gambling Task, 100 people were divided into two groups: the control and the experimental group. There were 60 controls of people with healthy mental health. There were 40 people in the experimental group, with MCI`s or AD. After taking the IGT, it was shown that the average score for the control group was 1415, while the average score for the experimental group was 473 (Sinz et al., 2008). For the interview signs, in a group of 159 patients with AD and 58 healthy subjects, AD and MCI patients demonstrate 2.7 out of the 5 asocial signs during an interview, on average (Sockell et al., 2006). The control group of healthy, elderly people scored 0.5 out of 5, on average. For the emotion test, in a group of 159 patients with AD and 58 healthy subjects, the average patient with AD scored between 4-6. For the Apathy Scale, in a group of 159 patients with AD and 58 healthy subjects, the average score of AD patients is 44 out of 72 points (Sockell et al., 2006). For the AD smell test, 147 patients with MCI and 100 AD were tested with the sniff test, and they got a 6.78 out of 15 on average (Table 4). For the Table below, the scores for the MCI, AD and healthy elders were converted to the scale of the LARS scale of the CDT. This was done in a traditional proportion table. The control group, with 58 people, on average, scored 1.53 out of 15. In the CDT, a higher score in the AD is correlated with a higher risk of AD. From this distribution of data, this is submitted into the CDT, which gives the average score of both the control group and the experimental group (Tabert et al., 2005). In the normalized set of 1056 total data points, 784 being the experimental group with AD, and 272 being the control group of healthy elderly people, the average CDT score for the experimental group is 2.44 out of 11, which puts in the range of being safe from the risk of AD for four years (Sinz et al., 2008). The average CDT score for the experimental group with DAT is 6.10/11. This puts it in the range of DAT, which all of the members of the experimental group had.

ISSN: 2277-9655
Impact Factor: 5.164
CODEN: IJESS7

Demographic Variable	Healthy Elderly (n = 63), Mean (SD)	MCI Patients (n = 147), Mean (SD)	AD Patients (n = 100), Mean (SD)	p^a	MCI Nonconverters (n = 109), Mean (SD)	MCI Converters (n = 38), Mean (SD)	p^b
Age (yr)	65.71 (9.38)	67.43 (9.85)	71.72 (9.54)	<0.001	65.59 (9.99)	72.71 (7.28)	<0.001
Education (yr)	16.68 (2.60)	14.96 (4.29)	13.09 (4.35)	<0.001	15.27 (4.19)	14.08 (4.49)	0.142
Sex (% female)	54.0	55.1	63.8	0.33	54.1	57.9	.417
Folstein MMSE score	29.37 (0.768)	27.28 (3.23)	19.96 (5.96)	<0.001	27.68 (3.43)	26.13 (2.21)	0.01
UPSIT score	34.86 (4.18)	31.22 (6.45)	23.72 (6.48)	<0.001	33.02 (4.68)	26.05 (7.96)	<0.001
B-SIT score	10.60 (1.53)	9.56 (2.21)	7.04 (2.62)	<0.001	10.12 (1.70)	7.95 (2.67)	<0.001
10-item Scale score	8.98 (1.24)	8.26 (1.66)	5.48 (1.71)	<0.001	8.75 (1.23)	6.84 (1.90)	<0.001

[a]One-way analysis of variance or Fisher's exact test (sex) were conducted to compare healthy elderly, MCI patients, and AD patients.
[b]*t* tests or Fisher's exact test (sex) were conducted to compare nonconverters vs converters to AD on follow-up evaluation.

MCI = mild cognitive impairment; SD = standard deviation; AD = Alzheimer's disease; MMSE = 30-item Mini-Mental State Examination; UPSIT = University of Pennsylvania Smell Identification Test; B-SIT = Brief Smell Identification Test.

Table 4. Demographic and Clinical Data for the CDT. Data from "A 10-item smell identification scale related to risk for Alzheimer's disease." by M. Tabert, 2005, Annals of Neurology.

Limitations of Method

From the presented proposal, there are some minor problems that arise in its methodology, execution, and necessity. For the methodology, all of the data was derived from human studies. This allows for there to be human error or a misinterpretation of the presented results. Also, the statistical analysis done on the data may dilute the data or all for unintentional changes. For the data points, there are almost three times the number of experimental as there are for the control group. For the test, AD develops differently in different people. This makes it so that it is near-impossible for there to be a single, universal test to diagnosis AD. This proposal was designed to be able to diagnose the vast majority of AD cases through the traditional and developmental patterns (Alzheimer's, 2015). However, not every case follows these patterns. For the execution, the time and cost saving analysis may change to new discoveries, poor implementation of the program and by individual doctors. This proposal requires there to be an interview setting, with a qualified interviewer in the medical or psychological sciences. This requirement may be a burden on some hospitals, which may decrease its implementation. Also, the importance of this proposal may vary from doctor to doctor. Some doctors may feel that the proposal is too lenient and may not follow all of the suggested proposals. For the necessity of the proposal, this proposal was designed to be a conglomeration of the most accurate and most detailed AD tests in current use. This proposal does not take into consideration upcoming or theoretical AD prediction models. These models may yield future results, but are not considered substantive enough to base a proposal on (DeFina et al., 2013).

Statistical Analysis

The data were examined for normal distribution (tested with the Kolmogorov-Smirnov test) and for a homogeneity of variance (tested with the Levene test) (Bayard et al., 2014). For the normally distributed data, parametric tests were used (Student's t-test for independent samples, univariate analysis of covariance (ANCOVA), analysis of covariance with repeated measures, and Greenhouse-Geisser adjusted degrees of freedom (MANCOVA)). If there were significant deviations from the normal distribution, we used corresponding nonparametric methods (Mann Whitney, U test, chi-square test, and logistic regression) (Bayard et al., 2014). We calculated partial eta squared ($\eta 2$) and Cohen's d` as a measure of the effect size and designated the effect size as small ($\eta 2 = 0.01$; d` = 0.2), medium ($\eta 2 = 0.06$; d` = 0.5), or large ($\eta 2 = 0.14$; d` = 0.8). The level of significance was set at $P < 0.05$. All statistical analyses were carried out using the Statistical Package for the Social Sciences (SPSS) version 19 for Windows, and all of the analysis was carried out by the Bayard Laboratory (Bayard et al., 2014).

V. CONCLUSION

AD is the fastest-growing cause of dementia and mental illness for elders in the world (Alzheimer's, 2015). Because of this increase, the rush to diagnosis AD in elders is leading to an increasing amount of false positives. More than ⅕ AD diagnosis are false positives. In the U.S, 18.2 billion hours of care and 230 billion dollars are given to the AD diagnosis process (Alzheimer's, 2015). This means that 3.6 billion hours and 46 billion dollars are spent on false positives. These resources could be better spent on more research. In the current AD diagnosis

ISSN: 2277-9655
Impact Factor: 5.164
CODEN: IJESS7

process, patients must go through physical and mental tests that are costly in terms of time and money. Patients have to pay around 5000 dollars per hour for an AD consolation (Sockell et al., 2006). This is a large amount of money for someone who is yet to be diagnosed. This current proposal is designed to save time and money for both the patients and the doctors. By holding off the more expensive parts of the AD diagnosis process until patients have reached a certain level of risk, this proposal can save billions of dollars and hours. From the discussed methods, the discussed AD diagnosis methods will be used as a groundwork. Using their publicly available samples sizes sample variable, this proposal intended to use this as a base for future studies of the CDT. In the proposal, 1056 data points from 272 healthy elderly people (control) and 784 elderly people with DAT are used in order to develop a new way of diagnosing AD (BRF, 2017). In the CDT, those that score below a certain percentile do not have to worry about developing AD for the next four years. Those within a warning range should be monitored and should come to retake the test in six months to a year (Appendix). The CDT is a 5-stage questionnaire and interview test. The 5-stages covered are emotions, interview signs, apathy, sniff test, and the IGT (ambiguity task). The reason why these specific variables are covered is that from the previous studies, it has been shown that emotions, apathy, and ambiguity are the largest influencers in the decision-making process. In the study with the CDT, the average score of the experimental group was 6.10/11, which is the range of DATA or mild AD. The average score of the control group was 2.4/11, which means that it is unlikely that they will develop AD for the next four years (Appendix). With this proposal, more than 46 billion dollars of AD funding can be diverted from false positives into more advanced testing. And the U.S as a whole could save about 3.72 billion more hours from the diagnosis process to help patients with known cases of AD (Alzheimer's, 2015). For future directions of research, the proposal suggests developing less behavior-focused methods of diagnosis. More affordable and time-effective physical diagnosis methods are needed. The correlation between hippocampal volume and cognitive abilities is applicable to this research proposal, as well as the development of Tau Tangles (Nathan et al., 2017). These physical diagnosis methods could lead to more affordable and reliable diagnosis methods in the future with a combination of behavioral and physical analysis

VI. REFERENCES

[1] Alzheimer's, A. (2015). 2015 Alzheimer's disease facts and figures. *Alzheimer's & dementia: the journal of the Alzheimer's Association*, *11*(3), 332.
[2] Bayard, S., Jakus, J., Raffard, S. and Gely-Nargeot, M. (2014). Apathy and Emotion-Based Decision-Making in Amnesic Mild Cognitive Impairment and Alzheimer's Disease. *Behavioural Neurology*, 2014, 1-7. http://dx.doi.org/10.1155/2014/231469
[3] Biomedical Research Forum. (n.d.). Retrieved November 09, 2017, from http://www.alzforum.org/databases
[4] Boyle, P., Yu, L., Wilson, R., Gamble, K., Buchmann, A. and Bennett, D. (2012). Poor Decision Making Is a Consequence of Cognitive Decline among Older Persons without Alzheimer's Disease or Mild Cognitive Impairment. *PLoS ONE*, 7(8), 436-443. https://doi.org/10.1371/journal.pone.0043647
[5] Brevers, D., Bechara, A., Cleeremans, A., & Noël, X. (2013). Iowa Gambling Task (IGT): twenty years after – gambling disorder and IGT. *Frontiers in Psychology*, 4, 665. http://doi.org/10.3389/fpsyg.2013.00665
[6] Cosentino, S., Metcalfe, J., Cary, M. and Karlawish, J. (2017). Memory awareness influences everyday decision making capacity in Alzheimer's disease. *Alzheimer's and Dementia*. http://dx.doi.org/10.1016/j.jalz.2011.05.683
[7] DeFina, P., Moser, R., Glenn, M., Lichtenstein, J. and Fellus, J. (2013). Alzheimer's Disease Clinical and Research Update for Health Care Practitioners. *The Journal of Neuroscience.* http://dx.doi.org/10.1155/2013/207178
[8] Delazer, M., Sinz, H., Zamarian, L. and Benke, T. (2007). Decision-making with explicit and stable rules in mild Alzheimer's disease. *Neuropsychologia*, 45(8), 1632-1641. https://doi.org/10.1016/j.neuropsychologia.2007.01.006
[9] Duff, K., McCaffrey, R. and Salomon, G. (2002). The Pocket Smell Test. *The Journal of Neuropsychiatry and Clinical Neurosciences*, 14(2), 197-201. https://doi.org/10.1176/jnp.14.2.197
[10] Fischer, C., Qian, W., Schweizer, T., Ismail, Z., Smith, E., Millikin, C. and Munoz, D. (2017). Determining the impact of psychosis on rates of false-positive and false-negative diagnosis in Alzheimer's disease. *Alzheimer's & Dementia: Translational Research & Clinical Interventions*, 3(3), 385-392. https://doi.org/10.1016/j.trci.2017.06.001
[11] Gleichgerrcht, E., Ibáñez, A., Roca, M., Torralva, T. and Manes, F. (2010). Decision-making cognition in neurodegenerative diseases. *Nature Reviews Neurology*, 6(11), 611-623. https://dx.doi.org/doi:10.1038/nrneurol.2010.148

[12] Hernández, F., de Barreda, E. G., Fuster-Matanzo, A., Lucas, J. J., & Avila, J. (2010). GSK3: a possible link between beta amyloid peptide and tau protein. *Experimental neurology*, *223*(2), 322-325.
[13] High, D. M. (1992), Research with Alzheimer's Disease Subjects: Informed Consent and Proxy Decision Making. *Journal of the American Geriatrics Society*, 40: 950–957. http://dx.doi.org/10.1111/j.1532-5415.1992.tb01995.x
[14] Hochreiter, S., & Schmidhuber, J. (1997). Long short-term memory. *Neural computation*, *9*(8), 1735-1780.
[15] Hot, P., Ramdeen, K., Borg, C., Bellon, T. and Couturier, P. (2013). Impaired Decision Making in Alzheimer's Disease. *Clinical Psychological Science*, 2(3), 328-335. http://dx.doi.org/10.1177/2167702613504094
[16] Karlawish J. (2008), Measuring Decision-Making Capacity in Cognitively Impaired Individuals. *Neuro-Signals*, 16(1): 91-98. http://doi.org/10.1159/000109763
[17] Kim, S., Cox, C. and Caine, E. (2002). Impaired Decision-Making Ability in Subjects With Alzheimer's Disease and Willingness to Participate in Research. *American Journal of Psychiatry*, 159(5), 797-802. https://doi.org/10.1176/appi.ajp.159.5.797
[18] Lane-Brown, A. and Tate, R. (2017). Measuring apathy after traumatic brain injury: Psychometric properties of the Apathy Evaluation Scale and the Frontal Systems Behavior Scale. *Taylor & Francis Online*, 13(4), 999-1007. http://dx.doi.org/10.3109/02699050903379347
[19] Li, X., Lu, Z.-L., D'Argembeau, A., Ng, M., & Bechara, A. (2010). The Iowa Gambling Task in fMRI Images. *Human Brain Mapping*, *31*(3), 410–423. http://doi.org/10.1002/hbm.20875
[20] Mohandas, E., Rajmohan, V., & Raghunath, B. (2009). Neurobiology of Alzheimer's disease. *Indian Journal of Psychiatry*, 51(1), 55–61. http://doi.org/10.4103/0019-5545.44908
[21] Murdock, B. B. (1972). Short-term memory. *Psychology of learning and motivation*, *5*, 67-127.
[22] Nathan, P., Lim, Y., Abbott, R., Galluzzi, S., Mazzoni, M., Babiloni, C., Albani, D., Bartres-Faz, D., Didic, M., Feretti, L., Parnetti, L., Salvadori, N., Müller, B., Forlani, G., Girtler, N., Hensch, T., Jovicich, J., Leeuwis, A., Marra, C., Molinuevo, J., Nobili, F., Pariente, J., Payoux, P., Ranjeva, J., Rolandi, E., Rossini, P., Schönknecht, P., Soricelli, A., Tsolaki, M., Visser, P., Wiltfang, J., Richardson, J., Bordet, R., Blin, O. and Frisoni, G. (2017). Association between CSF biomarkers, hippocampal volume and cognitive function in patients with amnestic mild cognitive impairment (MCI). *Neurobiology of Aging*, 53, 1-10. http://doi.org/10.1016/j.neuroimage.
[23] Paula, V., Guimarães, F., Diniz, B. and Forlenza, O. (2009). Neurobiological pathways to Alzheimer's disease: Amyloid-beta, TAU protein or both?. *Dementia & Neuropsychologia*, 3(3),188-194. http://dx.doi.org/10.1590/S1980-57642009DN30300003
[24] Raskin, J., Cummings, J., Hardy, J., Schuh, K., & Dean, R. A. (2015). Neurobiology of Alzheimer's Disease: Integrated Molecular, Physiological, Anatomical, Biomarker, and Cognitive Dimensions. *Current Alzheimer Research*, 12(8), 712–722. http://doi.org/10.2174/1567205012666150701103107
[25] Rocca, W. A., Petersen, R. C., Knopman, D. S., Hebert, L. E., Evans, D. A., Hall, K. S., White, L. R. (2011). Trends in the incidence and prevalence of Alzheimer's disease, dementia, and cognitive impairment in the United States. Alzheimer's & Dementia : *The Journal of the Alzheimer's Association*, 7(1), 80–93. http://doi.org/10.1016/j.jalz.2010.11.002
[26] Ross, M. (2017). Apathy: Concept, Syndrome, Neural Mechanisms, and Treatment. *Clinical Neuropsychiatry*, 1(4), 304-314. https://doi.org/10.1053/SCNP00100304
[27] Sinz, H., Zamarian, L., Benke, T., Wenning, G. and Delazer, M. (2008). Impact of ambiguity and risk on decision making in mild Alzheimer's disease. *Neuropsychologia*, 46(7), 2043-2055. https://doi.org/10.1016/j.neuropsychologia.2008.02.002
[28] Smebye, K., Kirkevold, M. and Engedal, K. (2012). How do persons with dementia participate in decision making related to health and daily care? A multi-case study. *BMC Health Services Research*, 12(1), 241. https://doi.org/10.1186/1472-6963-12-241
[29] Sockeel, P., Dujardin, K., Devos, D., Denève, C., Destée, A., & Defebvre, L. (2006). The Lille apathy rating scale (LARS), a new instrument for detecting and quantifying apathy: validation in Parkinson's disease. *Journal of Neurology, Neurosurgery, and Psychiatry*, 77(5), 579–584. http://doi.org/10.1136/jnnp.2005.075929
[30] Tabert, M., Liu, X., Doty, R., Serby, M., Zamora, D., Pelton, G., Marder, K., Albers, M., Stern, Y. and Devanand, D. (2005). A 10-item smell identification scale related to risk for Alzheimer's disease. *Annals of Neurology*, 58(1), 155-160. http://doi.org/10.1002/ana.20533

[31] Uday, U. (2015). Neurobiology of Alzheimer's Disease. *European Psychiatry*, 30(7), 1438. https://doi.org/10.1016/S0924-9338(15)31112-3
[32] Zamarian, L., Weiss, E. and Delazer, M. (2010). The Impact of Mild Cognitive Impairment on Decision Making in Two Gambling Tasks. *The Journals of Gerontology Series B: Psychological Sciences and Social Sciences*, 66(1), 23-31. https://doi.org/10.1093/geronb/gbq067

APPENDIX

Emotions Test

The interview is structured and the questions should to be posed exactly as stated. To obtain the best validity, it is not advisable to change the vocabulary or to add additional comments to the questions. Before beginning the interview, the patient has to be instructed as follows: "I am going to ask you some questions about your daily life. It is important that you base your answers on your life over the last four weeks" If the patient evokes general events or any that predate the last month, he or she must be reminded that only the current situation must be referred to: "Please try to answer according to your current way of life, by referring to the last four weeks" A precise scoring mode is proposed for each reply and should be followed as closely as possible. When an item does not apply to the patient, it is scored "0", for non-applicable (NA). When the reply is not clear at all and cannot be classified, it is also scored "0" for a non-classifiable reply.
It is on a scale from -8 to 8. Anywhere from a -2 to a +2 is a normal score.

When you watch a movie, do you become emotional?
- No, I do not experience any specific emotion. (+1)
- No response, N/A, unable to understand (0)
- Yes (-1)

When someone tells you a joke, or you see something funny on television, do you easily laugh?
- No, I do not experience any specific emotion. (+1)
- No response, N/A, unable to understand (0)
- Yes (-1)

Do you feel happy when somebody tells you good news?
- No, I do not experience any specific emotion. (+1)
- No response, N/A, unable to understand (0)
- Yes (-1)

Do you feel sad when you hear any bad news?
- No, I do not experience any specific emotion. (+1)
- No response, N/A, unable to understand (0)
- Yes (-1)

When you have a problem (you lost your keys), does it worry you?
- No (+1)
- No response, N/A, unable to understand (0)
- Yes (-1)

When something is not working, do you give up, or do you look for a solution?
- No, I give up (+1)
- N/A (0)
- Yes, I look for a solution (-1)

When you and your family has a minor problem (lost the car keys), does it worry you?
- No (+1)
- N/A (0)
- Yes (-1)

Do you like to ask your friends or family how they feel on a regular basis?
- No (+1)
- N/A (0)

ISSN: 2277-9655
Impact Factor: 5.164
CODEN: IJESS7

- Yes (-1)

Interview Signs
During the Interview, if you notice any of these signs, make sure to make them off

- Poor Orientation (+1)
- Increased Forgetfulness (+1)
- Language Perseverations (+1)
- Change in Personality and Emotional Status (+1)
- Social Isolation (+1)

Sniff Test
Blindfold the participant. Then present them three strips. One strip will smell like coffee beans, one like mouthwash, and the last one like soap. For each of these, ask the participant to describe any memories associated with the smell. For each strip, you will look for the participant to describe the

- Who
- What
- Where
- When
- Why

of the memory associated with that strip. If they are successful in describing these, they gain 0 points. If they describe all but one, then they have 1 point. Each point is added for every description they are unable to give. This is on a scale from 0-15. 0-3 is the range of people without MCI. 15 is the maximum, in which they cannot associate any detail with their memories.

Apathy Test
For this test, you will ask these questions to the participant in an interview-like setting. For each question, you will record on a scale from 1-4 how strongly they say they exhibit this characteristic. 1 means that they strongly agree/exhibit these characteristics. 4 means they strongly disagree/do not exhibit these characteristics. The scale should be from 18-72. 72 means that they are extremely apathetic, while 18 means that they are extremely sympathetic.

1. You are interested in things
2. You get things done during the day.
3. Getting things started on your own is important to you
4. You are interested in having new experiences
5. You are interested in learning new things
6. You put little effort into anything.
7. You approach life with intensity
8. Seeing a job through to the end is important to you
9. You spend time doing things that interest her/him
10. Someone has to tell you what to do each day
11. You are less concerned about your problems than you should be
12. You have friends
13. Getting together with friends is important to you
14. When something good happens, you get excited
15. You have an accurate understanding of her/him problems
16. Getting things done during the day is important to you
17. You have initiative
18. You have motivation

Ambiguity Test Through the Iowa Gambling Task (IGT)
In this part of the exam, you will take the Iowa Gambling Task. The rules are explained on the screen. After you have finished your exam, take your score, x, and plug it into the formula:
(2000-x)/(1000)

Cumulative Formula for Overall Score
(E + I + A/12 + S/5 + (2000-IGT)/(1000))/(2)*

ISSN: 2277-9655
Impact Factor: 5.164
CODEN: IJESS7

E = Emotion Test
I = Interview Signs
A = Apathy Test
S = Smell Test
IGT = Iowa Gambling Task

*Note: If the score you get is a decimal, round to the hundredth number.

Index for Results
Emotion Test:
Range: -8 to +8
Normal Range: -2 to +2

Interview Signs:
Range: 0 to +5
Normal Range: 0 to +1

Apathy Test:
Range: +18 to +72
Normal Range: +18 to +28

Smell Test:
Range: 0 to +15
Normal Range: 0 to +2

IGT:
Range: 0 to +4500
Normal Range: +2250 to +4500

Range: 0 to +11
Normal Range: 0 to +4
Warning Range for Testing: +4 to +6
Range for A Likely Case of Mild Dementia: +6 to +8
Requires More Physical Testing as it is likely a Severe Case: +8 to +11

CITE AN ARTICLE

Marzouk, S. M. (n.d.). THE IMPACT OF EMOTIONS, AMBIGUITY, AND APATHY ON DECISION-MAKING IN INDIVIDUALS WITH ALZHEIMER'S DISEASE: A PROPOSAL TO FACILITATE DIAGNOSIS OF ALZHEIMER'S DISEASE. *INTERNATIONAL JOURNAL OF ENGINEERING SCIENCES & RESEARCH TECHNOLOGY*, *7*(3), 272-289.