USE OF ACOUSTIC STIMULATION TO INCREASE SLOW-WAVE ACTIVITY IN ALZHEIMER'S DISEASE PATIENTS

ANALYZING RACIAL AND SOCIOECONOMIC DIFFERENCES IN THE TREATMENT AND OUTCOMES OF ADULTS WITH ALZHEIMER'S DISEASE

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On my honor as a University student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments.

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Introduction

Alzheimer's disease is a progressive disease that degrades cognitive functions including memory, processing, and behavior over time. It affects over 6.5 million Americans aged 65 and older, a number that is only expected to grow over the years (*Alzheimer's Disease Facts and Figures*, n.d.) Although Alzheimer's disease has a wide effect on the entire population, it has the highest prevalence in African Americans, with a rate of 13.8%, followed by Hispanics at 12.2% and non-Hispanic whites at 10.3 % (*CDC Newsroom*, 2016). Despite having the highest prevalence among African Americans, Alzheimer's disease is 35% less likely to be diagnosed in African Americans than in other races after their initial visits to physicians (*Data Shows Racial Disparities in Alzheimer's Disease Diagnosis between Black and White Research Study Participants*, n.d.). This follows a common trend in which black Americans are not diagnosed with diseases or taken seriously by their doctors until they present with extreme and undeniable symptoms. Considering that Alzheimer's disease is progressive and irreversible, it is essential that the disease is diagnosed as quickly as possible so that the patients can begin treatment as quickly as possible.

In this prospectus, I will describe the technical project, "Enhancing Slow Wave Sleep in Older Adults," followed by the STS project, "Understanding Disparities Around the Treatment and Diagnoses of Alzheimer's Disease." The STS portion of the paper will discuss the socioeconomic and racial differences in the treatment of patients with Alzheimer's Disease, as well as the STS methodologies and frameworks that will be utilized to examine this topic. This section will be followed by a description of the main sources that will be used in my research.

Technical Project: Enhancing Slow Wave Sleep in Older Adults

To compliment the examination of differences in treatments and outcomes of patients with Alzheimer's disease, the technical portion of this project will seek to create an accessible treatment that can be used from home for patients in early stages of the disease who display symptoms of mild cognitive impairment in a project that is being done with Sequoia Neurovitality LLC. This will be done by designing a device that patients can wear as they sleep. This device will monitor patients' brain waves using an electroencephalogram (EEG), respiratory and heart rates and other relevant data to determine what phase of sleep the patients are in. Sleep can be separated into two different components: rapid eye movement (REM) and non-rapid eye movement (NREM) sleep. People in REM sleep exhibit rapid eye movements, as well as mixedfrequency EEG with low amplitude (Roth, 2009). NREM sleep can be characterized by K complexes, which are sharp, high voltage waves that last more than half of a second (Gandhi & Emmady, 2022). NREM sleep also exhibits sleep spindles, which are bursts in the EEG that are thought to demonstrate the strength of certain circuit in the brain (Fernandez & Lüthi, 2020).

Slow wave sleep is a type of NREM sleep that exhibits the slowest brainwaves, which are synchronized on an EEG. Recent studies have found that while people sleep, cerebrospinal fluid (CSF) flows through the brain and clears metabolic waste, and this activity is enhanced during NREM sleep (Fultz et al., 2019). This means that if a patient's time spent in NREM sleep is lengthened, the CSF activity in their brain may be enhanced, and this could help to clear out the amyloid-beta plaques that build up and contribute to the cognitive degeneration seen in

Alzheimer's patients. A study done at Northwestern found that people with mild cognitive impairment who slept with pink noise experienced improved memory and more time spent in slow wave sleep (*Pink Noise Boosts Deep Sleep in Mild Cognitive Impairment Patients*, 2019). Pink noise uses a consistent frequency with a low pitch to create an even, flat sound, which has shown to be effective in inducing relaxation and sleep (*White Noise, Pink Noise, and Brown Noise: What's the Difference?*, n.d.).

By creating a device that can monitor a patient's brain activity and respond with appropriate stimuli, including pink noise, slow wave sleep could be induced and enhanced in patients. If a patient demonstrating mild cognitive impairment resulting from Alzheimer's disease experiences enhanced CSF activity due to more time spent in slow wave sleep, the plaques that build up in their brain may be reduced, and the progress of the disease may be slowed. This device would be accessible to patients, who would only need to access the device and use it at home, without constantly visiting the doctor or getting prescriptions refilled. This may make it easier for patients who are traditionally underserved to access better care for Alzheimer's disease.

Understanding Disparities Around the Treatment and Diagnoses of Alzheimer's Disease

Research Question

When designing new technology, it is essential to analyze and understand the political, social, and economic artifacts that exist around technologies. When examining Alzheimer's disease, the most prominent disparity that arises is a racial disparity surrounding the diagnosis of the disease. Alzheimer's has a higher prevalence in African Americans, and yet African

Americans are 35% less likely to be diagnosed with the disease in their initial visits to doctors (*Data Shows Racial Disparities in Alzheimer's Disease Diagnosis between Black and White Research Study Participants*, n.d.). This study found that although many older adults who are black seek treatment when they encounter hallucinations, delusions and personality or behavioral changes, it is often written off as a normal part of aging, and it takes until the patients begin experience extreme symptoms for them to be diagnosed, resulting in the patients losing valuable time in which they could begin treatment to reduce the progression of the disease. This is part of a common bias seen among doctors, where they are more likely to write off symptoms of black patients. For example, a study found that medical students perceive black patients as feeling less pain, regardless of what the patients reported (*Black Americans Are Systematically UnderTreated for Pain. Why?*, n.d.), which contributes to black patients being under-treated and diagnosed. This means that regardless of what technologies are created to help stall the treatment of Alzheimer's disease, unless the problem of black patients having their symptoms and concerns ignored by doctors is addressed, the technologies will fail to reach those populations.

The relevant social groups in this research question are patients who have been diagnosed with Alzheimer's disease, with those patients being separated by their race and socioeconomic class, to better understand the differences between the treatments and outcomes of these patients.

Another relevant social group is the doctors that treat these patients, as the doctors' biases greatly affect the diagnosis and subsequent treatment of the patients.

Another realm in which racial minorities and people from lower socioeconomic classes are ignored when it comes to Alzheimer's disease is with the cognitive impairment test that is typically used to diagnose the disease. People who may have Alzheimer's are typically given the

Mini-Mental State Examination (MMSE), which measures cognitive abilities including orientation, the ability to recall words, attention, calculation, language abilities and visual construction (*Screening Tests Used for Alzheimer's and Other Dementias*, n.d.). This test scores the test-taker on how they complete these different tasks, but because different races and education levels may be expected to perform differently on the test, it has been altered over time to adjust the score to account for the person's age, educational level and their ethnicity/race. A study that explored the differences in MMSE scores between older Mexican Americans and European Americans based on where they lived found that the MMSE indicated cognitive impairments in those from lower class neighborhoods, regardless of if the patients were actually cognitively impaired (Espino et al., 2001). Considering that the test scored people from lower class neighborhoods poorly, it is possible that biases such as these exist in other scoring methods the test uses. This may cause doctors to either disregard the test results for certain groups of patients, regardless of if the test indicates cognitive impairment or not because the test has a bias, or it may cause the test to give untrue results that lead to misdiagnoses.

Overall, there are biases that exist when it comes to doctors diagnosing Alzheimer's disease, and these biases lead to black patients being underdiagnosed, as well as patients with certain education levels who live in neighborhoods that are classically poor or underserved receiving misdiagnoses due to untrue test results. This is very dangerous, as a delay in the treatment for this disease can cause the disease to progress faster and for the patients to experience greater cognitive decline.

Methods, Frameworks, and Timeline

To examine this, I will be focusing on the black/race critique and examining the racial differences in the treatment of the patients. I will also be using the Actor-Network Theory (ANT) to examine how the different components of the medical system contribute to the treatments of patients. For example, doctors are important actors in the system, but they are also influenced by administrators, what kind of technology they have available to them for treatments, and the engineers that develop new technologies and the biases that those engineers may have that will influence the technologies. The treatment of patients with Alzheimer's disease is largely influenced by multiple sources, including outside sources that can affect how patients interact with the medical system, as well as how much access they have to it, and it is important to understand and analyze it all to understand why disparities in the medical system exist. Another important group of actors are the families and caregivers of patients, as if they perpetuate a stigma against seeking medical help or for some reason are unable to transport the patients to doctors appointments and hospitals, then the medical care that patients will receive will be affected. To explore this, I will look at primary research articles and studies, such as the ones I have mentioned prior to this, which demonstrate and investigate disparities that exist with Alzheimer's patients. I will also interview medical professionals and understand their perspectives on how they treat and diagnose patients. In terms of the timeline, I have already done research investigating the issue, and in the next few weeks I will likely try and reach out to professionals to better understand their perspectives. Before meeting with medical professionals, I will research the history of disparities in the medical system, as well as how medical professionals are trained in medical school, which will allow me to better understand how they have been taught and will allow me to ask more targeted questions.

Foundational Texts and Primary Resources

One of the most prominent texts I have encountered when doing my research is a study done by tracking 15 years of data on 5,700 black Americans and 31,225 white Americans and analyzing when and how the patients were diagnosed with Alzheimer's or related dementias (*Data Shows Racial Disparities in Alzheimer's Disease Diagnosis between Black and White Research Study Participants*, n.d.). This study found that black patients were 35% less likely to be diagnosed with Alzheimer's or dementia after their initial visit. This is an extremely important study, as it highlights the racial disparities that exist when examining diagnoses of patients. On a related note, another study that I found very helpful was a study done on UVA medical students that found that students who do not demonstrate racial preferences or that show a positive racial preference to black patients were still more likely to minimize the black patient's perceived pain (*Black Americans Are Systematically Under-Treated for Pain. Why?*, n.d.). This study is extremely important, as it demonstrates that black patients are historically underserved by the medical system and their symptoms are ignored, which feeds into the previous study, in which black patients were not properly diagnosed.

Another essential source that I found was the study examining the MMSE and how it was biased based on ethnicity and what neighborhoods the patients resided in. The study found that the MMSE was more likely to assign cognitive impairment to people who lived in historically lower class neighborhoods (Espino et al., 2001), even if the patients did not have cognitive impairment. This furthers the idea that patients may be misdiagnosed and thus mistreated based on their ethnicity and socioeconomic status. Finally, the last source that will be used in this paper is Medical Apartheid: The Dark History of Medical Experimentation on Black Americans from Colonial Times to the Present, a book written by Harriet Washington that outlines the dark history of the medical field and how black patients have been historically mistreated by doctors including by being exposed to untried drugs, forced anatomical investigations, and abuse at the hands of doctors (Washington, 2006, p. 501). I will use this source to create and expand upon my argument that black patients have historically been overlooked by the medical system, and that reform within it is necessary to put an end to this. This source provides important historical context that will explain the foundations of the medical system.

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