

Senior Project Proposal
Anila Tynan
Faculty Advisor: Mrs. Kate Taylor
Onsite Advisor: Dr. Elliott Mufson
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I. Title of Project:

Music and the Brain: How music affects our memories

II. Statement of Purpose:

The goal of this research project is to explore the mechanisms by which Alzheimer's Disease and Dementia deteriorate brain function, and how music, through music therapy, affects the progression of the disease. Does music strengthen brain connections and relieve the symptoms of Alzheimer's and Dementia? Additional questions to be answered are: how is music encoded in the brain, and how can understanding this mechanism lead to possible breakthroughs in Alzheimer's and Dementia research and treatment?

III. Background:

I am very interested in not just the research aspect of neuroscience, but also the practical applications of the discoveries made in the lab that may help heal, and one day cure patients with brain deterioration diseases. Long-term memory is often lost in these patients, yet prior research has revealed that Alzheimer's patients with severe memory loss can remember songs from their teenage years, even when they cannot remember family members. When set in front of a piano, some patients with past musical experience have no decrease in musical performance despite massive declines in many other neurological domains such as memory, language, visuospatial functioning, and attention. Also very interestingly, normally functioning individuals can very quickly learn the lyrics to songs, and many years later recall the lyrics to hundreds, yet it takes much longer and is much more difficult to memorize and recite a speech without a tune. It is clear that the way the brain processes music is as unique and potentially useful as it is mysterious.

Both music and neuroscience are passions of mine. I have played violin for multiple years and am curious as to how the brain forms and strengthens neural connections, and cues chemical and electrical responses in reaction to listening to and playing music. I am decently prepared to take on this senior project. I have excelled in AP Biology, AP Chemistry, AP Psychology, and Anatomy and Physiology classes that have given me a solid foundation in basic brain and neuroscience knowledge. This and my past musical

experience combined aligns perfectly the subject of music and the brain with my interests.

IV. **Prior Research:**

The adolescent years are some of the most influential in a person's life, and are a time of heightened emotional experience. Music from this point in people's lives is often remembered well into old age, and patients with Alzheimer's and Dementia are known to recall lyrics, melody, and experience a sense of nostalgia when listening to the tunes of their past. Daniel Levitin's novel *This Is Your Brain on Music* theorizes music is so memorable because its mechanisms span many brain pathways, from the cerebellum, which notes rhythm and beat, to the nucleus accumbens, aka the reward pathway, to the limbic circuit, which mediates emotions and higher-order thinking. It is also noted that music releases "feel-good" chemicals in the brain such as Dopamine and Serotonin, according to Paolo Pietropaolo's podcast *Music and Mental Illness*. In addition, studies have shown that music has the ability to change the electrical soundwaves of the brain. The mechanisms by which music affects the brain in all these ways is still unknown.

Oliver Sacks' documentary based on his book *Musicophilia: Tales of Music and the Brain* demonstrates how the brain is activated in response to different types of music, as well as how music prodigies with disadvantages such as blindness or autism, have extensive and unexplained musical ability. A man with Tourette's syndrome is able to quell his uncontrollable tics by drumming, and a man with no previous musical ability, after being struck by lightning, develops an unquenchable passion for composition and the piano.

Research at Northwestern University shows that those who play an instrument have a greater aptitude for neural speech processing that is crucial for reading, which increases over time. Well into old age, musicians, even those with hearing loss, have superior hearing in a noisy environment, and enhanced auditory cognitive skills. Practicing music over one's lifetime has also correlated to decreased reaction time (increased attention) and working memory. Similarly, past studies at Stanford University have revealed that musical training enhances speech processing in the brain, in children and adults alike. The brain of a musician is more adept at processing changes in pitch, tone, and timing that are essential for speaking and perceiving language. At the University of Helsinki in Finland, the Cognitive Brain Research Unit conducted a study to see if listening to enjoyable music would aid in the strengthening of cognitive functioning, and lead to an improved mood after a stroke. Their single-blind, randomly controlled study revealed that patients who listened daily to music they liked had greater improvement over the control group without access to music, in areas of spoken memory and focused attention, as well as mood improvement.

V. Significance:

Neuroscience is a broad subject with much to be explored and discovered, and has research implications that could serve to expand base knowledge of the subject, as well as potentially help people with mental or psychological disorders/diseases/problems. I hope to contribute to the neuroscience community with new insights, and grow my passion and knowledge of the subject so that I may become even more influential at the university and professional levels. I also hope to inspire my peers who may be interested in neuroscience, and shed light on this interdisciplinary natural science that is the core part of every animal alive.

Music in regards to neuroscience specifically is an especially mysterious and unexplored science that I feel might one day be critical to understanding the brain's functioning. Its undiscovered implications are numerous and involve memory, language, visuospatial ability, and executive functioning.

VI. Description:

I would like to conduct scientific research with a professional in the neuroscience field, especially one studying degenerative brain diseases, as well as volunteer with the Neurologic Music Therapy Association of Arizona, assisting the therapists with group therapy and observing how the patients respond to treatment. This way, I could better understand the mechanisms of degenerative brain disorders, as well as how music seeks to heal those who suffer from them. I also plan to interview both the researcher/physician I shadow and the therapists I work with to gain their knowledge and experiences from having been in the field of neuroscience for an extended period of time. Alongside this research, I plan to read books, journals, and papers describing music and its impact on the brain, as well as do internet research, listen to podcasts, and watch documentaries. My final project would be a senior project blog, a scientific journal documenting my experiences and findings, and a presentation at the end of the project.

VII. Methodology:

I will shadow the physician or researcher I am working with, asking questions and taking notes throughout the day to gather as much information and to understand as much as possible about degenerative brain diseases. I will also volunteer with the therapists at the Neurologic Music Therapy Services of Arizona, interacting with and observing the patients, while tracking their progress and response to the music therapy. I plan to conduct interviews with the staff to gain their insights and experiences on music therapy. I also hope to be able to conduct "Mini-Mental State Examinations" (MMSE), thirty

point tests designed to measure memory, problem solving skills, and thinking skills, to essentially screen for levels of Alzheimer's and Dementia. I would like to use this longitudinally on patients undergoing music therapy, to determine if, overtime, their symptoms are impacted by the therapy. Through these methods I hope to be able to at least partially answer my research question.

VIII. Problems:

A prominent problem in answering my research question will likely be my lack of knowledge on the subject of neuroscience. I hope to solve this by asking many questions and reading the literature in hopes to gain a better understanding of what I am studying. I also might face issues with HIPAA that would prevent me from observing or working with the patients of both the physician and the Neurological Music Therapy Services of Arizona, especially with possible application of the MMSE. In this case I would have to rely solely on the experiences of the professionals who advise me, and would not be able to observe patients first-hand.

IX. Bibliography:

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