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INTEGRATING NEUROLOGIC MUSIC THERAPY INTO THE HEIDELBERG MODEL: A STRUCTURED APPROACH TO ENHANCING LONG-TERM COGNITIVE FUNCTION AND EMOTIONAL CAPACITY OF ALZHEIMER'S PATIENTS.

What is the role of Neurologic Music Therapy in the neurorehabilitation of Alzheimer's patients when integrated into more structured treatment pathways such as the Heidelberg Model to improve their cognitive functions and emotional capacity?

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Abstract: Neurodegenerative diseases such as Alzhiemer's Disease (AD) have no prescripted cure to date. Due to this fact the only treatment options that remain are aimed at reducing the severity of the patients' symptoms. These treatment options include Neurologic Music Therapy (NMT), which is often used as a supplemental treatment to conventional treatment pathways. The rehabilitative nature of NMT with regards to the cognitive ability and emotional well-being of AD patients has led me to look futher into more structured NMT treatment options. The Heidelberg Model, originally designed for individuals with chronic tinnitus, has proved to yield long term benefits and has shown improvement in the quality of life of tinnitus patients involved in this experiment. This paper refers to the data from the original experiment to explore how the Heidelberg Model may be restructured and integrated with NMT to accommodate AD patients to help improve memory, attention span, language skills and decision-making abilities to make them self reliant and independent in order to improve their quality of life.

Index Terms **- Neurologic Music Therapy, Alzheimer's Disease, Heidelberg Model, Neuroplasticity, Memory, Rehabilitation.**

1. INTRODUCTION

Music has been known to have theraputic and calming effects on the human mind for centuries. As depicted in the portait "The Power of Music" by Louis Galliat, music is often veiwed as a form of escapism, where one is "oblivious of all grief, mental and physical". Music therapy has been a reilable form of treatment for several neurological disorders such as Dementia, Alzheimer's, and Parkinsons disease. Although music therapy is not an alternative form of conventional therapy, it may supplement standard treatment methods to improve the

rehabilitation process. This type of therapy is extremely beneficial for diseases that attack brain functions like memory, thinking skills, communication and basic language functions. Alzheimer's is a disease in the same category, and is the most common known cause of dementia in older people. As there is currently no cure for Alzheimer's Disease (AD), different forms of therapy to improve the cognitive and emotional state of patients is the best form of treatment.

There are currently about 55 million (World Health Organization, March 2023) people in the world suffering from Alzheimer's Disease. Concerningly, nearly 60% of this number live in low to middle income countires (LMICs), limiting treatment pathways. Given this situation, it becomes increasingly important for low-cost, light-input rehabilitation strategies that require minimal usage of resources and low personnel such as music therapy to come into effect.

2. RESEARCH METHODOLOGY

Retrieving primary data for this paper was not feasible because of the large data set that was required, as well as the equipment and resources that were not within my reach. As a result, I have used secondary data to draw observations and conclusions to address my research question. My paper is supported by the results of the experiment conducted by Professor Eckart Altenmüller in 2013 and his creation of the Heidelberg Model of Music Therapy. This paper refers to the data collected from his orginal experiment on the Heidelberg Model to identify parallels between the neurorehabilitative effects of NMT on chronic tinnitus and Alzheimer's Disease.

3. BACKGROUND

In 1906, a German pathologist named Alois Alzheimer discovered an unusual disease of the cerebral cortex in a 50-year-old woman, Auguste D. The patients symptoms ranged from memory loss, confusion, and aggression to hallucinations until her death 5 years later (Neundörfer). After his discovery, this atrophy of the cerebral cortex was called Alzheimer's Disease from 1910 onwards (Alzheimer's Disease International).

Alzheimer's Disease is a progressive neurodegenerative disease which usually starts showing symptoms around the age of 65 years. The most common symptoms that start showing up in older people are memory loss, reasoning, motor difficulties and general behavioral issues. Such symptoms are often associated with common ageing, and are neglected. This leads to progressive neurodegeneration and the consequent intensification of symptoms over time. The speed of progression of the disease varies from patient to patient, but the average life expectancy post-diagnosis is three to twelve years (Schaffert et al.).

4. NEUROLOGIC MUSIC THERAPY (NMT)

Music often arouses a range of feelings, and provides an emotional, sensory motor and cognitive experience. Music stimulates many parts of the brain. For instance, rythymic music gets the cerebellum and motor cortex involved, the recognition of pitch and tone of a piece is handled by the auditory cortex and the hippocampus is responsible for musical memory.

Neurologic Music Therapy is a rehabilitative form of treatment that uses music to improve cognitive, motor and speech centers in the brain that have degraded due to a neurological diseases such as Dementia, Alzheimer's, Cerebral Palsy and Parkinson's. NMT focuses on treating aphasia, motor skills, coordination, dexterity and memory. Recent advances in neruroimaging like Magnetic Resonance Imaging (MRI scans) have revealed that listening to music activates many areas of the brain. Music also activates the release of neurotransmitters like dopamine and serotonin. In a research done on rats (Moraes et al.), it was found that on listening to classical music, the auditory stimulus of the rats resulted in major activity of the brain in monoaminergic systems, relating to the working of neurotransmitters like dopamine and sertonnin.

4.1 Neuroplasticity and the Long Term Effects of NMT

Neuroplasticity is the ability of the nervous system to make adaptive changes in response to any internal or external stimuli. The brain can adapt to trauma by reorganizing its neural pathways. This includes making neuron connections to compensate for lost or broken connections due to traumatic brain injuries, or neurodegenrative diseases like Alzheimer's. Neuroplasticity was once believed to be manifested only during infancy and adolescence, when a child's brain is still developing. Discoveries in the later half of the 20th century proved otherwise. During this time, activity dependent plasticity during adulthood was discovered to have significant benefits toward improving memory, learning and recovery from brain damage.

NMT has shown to promote neuroplasticity in the brain. The brain can make adaptive changes in response to the external auditory stimulus of music. The ability of music to induce neuroplastic chnages in the brain helps address several symptoms in AD patients. For instance, their motor ability and communication skills slowly start improving through developing neural connections. In the long run, these small changes in the brain over years of music therapy helps the growth of neural pathways that allow AD patients to improve motor and cognitive ability, highly improving their quality of life as they become more independent.

5. HEIDELBERG MODEL OF MUSIC THERAPY

The Heidelberg Model was an experiment conducted by Professor Eckart Altenmüller in Germany in 2013, originally meant as a treatment structured for patients with chronic tinnitus. Tinnitus is a neurological condition that causes a ringing in the ears and overall disorientation even though no external sound is present. The Heidelberg Model proved to be effective in reducing the symptoms of this condition by offering a treatment of nine consecutive 50 minute sessions of individualized music therapy for five consecutive days. After this treatment, the patients were made to answer a carefully designed questionnare to gather data to assess their cognitive ability and emotional well-being post-treatment. The questionnare contained 12 main sections, seven of which concerned the emotional distress and level of intrusivness felt by the patient. Three sections regarded cognitive distress, and the last section asked questions about the negative effects on social relationships and sleep cycle of the patient. The final score of the questionnare was out of 24 points. The results were divided into four clinical categories. The first (0-7 points) was 'light distress', the second (8-12 points) was 'moderately distressed', the third (13-18 points) was 'severely distressed'. Lastly, the patients with 19-24 points were categorized as 'most severely distressed' (Argstatter et al.).

The final results of this questionnare indicated that 87% of the patients were satisfied with the treatment and 48% were happy with the therapy outcome in the long run (Argstatter et al.). The application of NMT in rehabilitation did not halt the decline of the disease entirely, and nor did it aim to. The Heidelberg Model was successful only in decreasing the intensity of the symptoms in tinnitus patients and improving their life marginally, offering them more control and independence over menial daily tasks.

5.1 Exploring the Similaries Between Chronic Tinnitus and Alzheimer's Disease

Upon analysing the causes and symptoms of chronic tinnitus alongside those of Alzheimer's, I found major similarities between the two diseases. Both Tinnitus and AD are characterized by progressive loss of neuronal function, and neither disease currently has a prescripted cure. The only treatment for chronic tinnitus and AD is rehabilitation to lessen its symptoms in the patient. Another similarity is that both are neurodegenerative chronic diseases that persist for a long period of time and progressively get worse over the years if not treated in its early developmental stages. Tinnitus and AD majorly affect the patient's lifestyle, causing disorientation, and functional decline.

Moreover, emerging research studies have been conducted in 2021 using data from the National Health Insurance (NHI) to determine whether or not chronic tinnitus increases the risk of developing AD and Parkinsons disease (Chu et al.). These studies have established the possibility of a strong link between tinnitus and the early development of Alzheimer's.

As of now, aging is the most common known factor that leads to neurodegenerative diseases, at the same time the most common sensory disorder in older people is hearing related issues. Research studies conducted as recently as 2023 (Elmer et al.) have established that chronic tinnitus is related to abnormalities in the anatomical structure of the brain. This includes the shrinkage of grey matter and reduced white matter integrity (responsible for overall information processing speed). These changes are also prevalent in the atrophic brains of AD patients. The cognitive and functional decline that sprouts from these changes, especially those in the cerebral grey matter, are seen in both patients with chronic tinnitus and patients with Alzhiemer's.

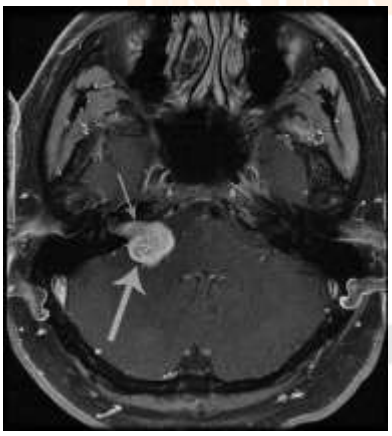

Fig 1. Chronic Tinnitus MRI [1]

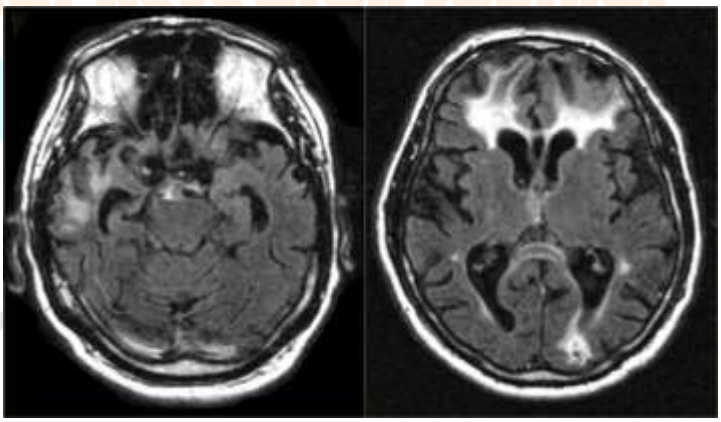

Fig 2. Development of Alzheimer's MRI [2]

The Heidelberg Model created by Professor Altenmüller experimented on the applicability of Neruologic Music Therapy in the rehabilitation of patients with chronic tinnitus. The results of the experiment positively contributed to the hypothesis that NMT has potential benefits for most neurodegenerative diseases. Although NMT benefits both chronic tinnitus and Alzheimer's Disease, the application and goals of NMT through such models differs slightly. The treatment aims to reduce the ringing in a tinnitus patients ears, but for AD patients it aims to improve memory and reasoning. Consequently, the treatment must be modified depending on its target group.

Due to the evidence showing strong similarities as well as a possible correlation between chronic tinnitus and Alzheimer's Disease, I conclude that the Heidelberg Model of Music Therapy can be used for the cognitive rehabilitation of AD patients. Through my research, I believe that although the Heidelberg Model was not specificallly tailored for patients with Alzheimer's Disease, this type of treatment can easily be restructured to accommodate them.

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[1] *https://www.cambridge.org/core/books/abs/imaging-acute-neurologic*

[2] *https://radiologyassistant.nl/neuroradiology/dementia/role-of-mri-disease/hearing-loss-and-tinnitus/A120A2133BC364577BCD1F9C2A241CBD*

6. ALZHEIMER'S DISEASE

6.1. Effects on Neural Pathways

Alzheimer's Disease (AD) has degenerative effects on the nervous system. The previously healthy system of nerve cells becomes weak, and dies off due to the accumulation of amyloid plaques and tau tangles (mishapen protiens that form clumps) in the brain. This prevents neurons from communicating with each other and sending signals through neurotransmitters. Due to this atrophy, the cerebral cortex which contains grey matter shrinks, resulting in memory loss, communication and language issues and decision making abilities. In short, AD causes the degeneration of neural pathways in the brain.

Neurologic Music Therapy is shown to have a positive effect on brain plasticity. This is beneficial while treating Alzheimer's patients as music induced neuroplasticity helps the brain adapt and accommodate its neural pathways to compensate for the degenerated neuron connections. AD usually targets the hippocampus, which is the center of learning and memory. NMT promotes neruroplasticity and provokes neural pathways to form new connections. Thus, slowly improving memory.

6.2. Benefits of Music Therapy on Cogntivie Function and Emotional Wellbeing

Music therapy treatment structures like Rhythmic Auditory Simulation and Melodic Intonation Therapy target specific cognitive functions to activate neuroplasticity. Moreover, musical stimulation is closely linked to memory. Certain music pieces may evoke strong emotional associations with a persons past experiences. NMT techniques such as music making, singing, instrument playing leverage the pre-existing muscial memory to facilitate memory retrieval for Alzheimer's patients. It improves the ability of AD patients to consolidate and store new information and improves their overall recall performance. An example of this is the way a case study (Belfi et al.) proved that background music improved autobiographical recall, similar to involuntary memories - those that can be retrieved on cue automatically.

Another study in 2018 (de la Rubia Ortí et al.) measured cortisol levels in saliva to give evidence that music can improve AD patients' emotional state. As mentioned in a previous section, NMT impacts the monoaminergic system resluting in the release of dopamine and serotonnin, both of which are known as 'happiness hormones'. They are named so as they provide a feeling of pleasure and satisfaction. This has proved to be exceptionally beneficial for AD patients who tend to experience mood swings and behavorial issues. Memory loss and communication issues are often frustrating for both patients and their caregivers to deal with. Music therapy is great way to relieve stress in these situations.

7. CONCLUSION

This paper has established the positive impacts of the intergration of music therapy into standard rehabilitative programs for patients diagnosed with neurological diseases like Alzheimer's Disease. The progressive nature of AD makes it difficult to for any form of treatment to halt neruological decline, hence it must be made clear that integrating NMT into therapy structures such as the Heidelberg Model will only delay symptom intensity and slow its progression to a certain degree. As an emerging treatment pathway, I believe that Neurologic Music Therapy is a step forward in providing low-cost and accessible treatment to AD patients to improve their overall quality of life.

7.1 Clinical Applications and Challenges

The clinical applications of Neurologic Music Therapy have proven to be successful. There have been many clinical tests working on producing the most efficient form of NMT treatment. The Heidelberg Model is a testimony to the success of NMT as a proper treatment structure. However, challeneges such as meeting standard protocols and individualizing treatment plans from patient to patient need to be addressed. The future of NMT and its clinical application should be focused on structuring the treatment around dosage, intensity and time intervals so that it is a more sustainable form of rehabilitation with long term impacts. NMT should be made a more accessible form of therapy for all types of neurodegenerative diseases like Alzheimer's which still do not have a cure, for example, Parkinson's Disease, Multiple Sclerosis, Stroke, etc.

The steps to improving NMT, in my opinion, would include combining music therapy techniques like Rhythmic Auditory Simulation and Melodic Intonation Therapy with structured treatments such as the Heidelberg Model of Music Therapy to maximze the long term impacts in terms of the patients well-being.

Another aspect of improving the clinical applications of NMT could be integrating artificial intelligence into music therapy treatment plans to create more personalized treatment options and to explore the synergistic effects of combining medication with non-pharmacological intervention techniques.

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