Music and Memory: Exploring the effects of Active Music Therapy on Alzheimer's Patients

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ABSTRACT

Alzheimer's disease is a type of neurodegenerative disease that progressively impairs memory, cognitive function and behavior. It is very prevalent across the world and there is currently no cure for it. Through a literature review, this paper explores the use of Music Therapy, a form of non-invasive therapy, at various stages of the disease. In particular it analyzes recent findings that Active Music Therapy, in particular, has long term beneficial effects for patients, and that it may even be useful as a tool to reduce risk of developing Alzheimer's.

Introduction

Alzheimer's disease is a type of neurodegenerative disease that is very prevalent with over three million cases per year in the United States alone (CDC, 2020). There is currently no cure for the disease making it fatal. The disease impairs an individual's memory, cognitive function, and behavior. These symptoms are caused by the death of neurons as well as lost connections in the neural pathway. This affects multiple parts of the brain causing damage to different cognitive functions such as memory, language, logical reasoning, and behavior. Because the disease is progressive, over time it deteriorates more and more of the patient's brain.

The first stage of the disease is the early stage. This stage consists of more mild symptoms: early signs of declining memory, weak short-term memory, some linguistic issues, and slight behavioral changes mainly marked by increased irritability. The second stage of the disease is the middle stage also known as moderate Alzheimer's. This stage consists of a worsening of some of the symptoms in the early stage. There is a larger decline in memory, including the person forgetting personal details about themselves. There is increased short term memory loss which can impair their daily function and lead to increased confusion. Other symptoms of this stage include more physical changes, behavioral changes, and issues with sleep. The final stage of the disease is late-stage Alzheimer's. This stage has the most severe symptoms with inability to recognize surroundings, extreme difficulty with language, and susceptibility to developing other conditions, commonly pneumonia (NIA, What Are The Signs of Alzheimer's Disease, 2022).

The preclinical stage of Alzheimer's is referred to as mild cognitive impairment. This is when the patient may start noticing mild symptoms of the disease but clinically does not qualify for having Alzheimer's. Since there is no cure for Alzheimer's there are many studies that look at ways to help manage some of the symptoms of Alzheimer's and slow its progression. The focus in this paper is on the non-invasive technique of music therapy in the hope of improving a patient's memory, language, emotional state and cognitive abilities. Music therapy is a technique that is used in a wide variety of therapies for many different conditions. It works at stimulating many parts of the brain whether through rhythm, sound, or words. There are many studies that explore the efficacy of music therapy on Alzheimer's patients in addressing different symptoms of the disease (ALZA, 2003).

The goal of this paper is to identify how music therapy can affect a patient at each stage of the disease and investigate the possibility of using music therapy in the preclinical period as a form of prevention. The first step will be to create a detailed breakdown of the different stages of Alzheimer's disease and the different symptoms. This paper will look at the different noninvasive techniques that are used, as well as give a detailed overview on how music

therapy works, including detailing the neural mechanisms of music therapy and differentiating active and passive music therapy. Then the paper will provide an overview of each stage of the disease and analyze how active music therapy is effective, if at all, in managing symptoms in each stage and whether passive or another technique is more feasible. The discussion will focus on the possibility of music therapy as prevention. Little is known on whether active music therapy can be used intentionally in order to reduce risk of developing Alzheimer's. Through my research I will formulate a discussion and contribute my own opinions and findings.

This paper is a literature review. The methods will mainly surround presenting different research studies, trials, as well as looking at prior literature reviews on relevant topics. The papers will both help with contextualizing for background research as well as help provide a basis for the discussion. The topics for the research papers include but are not limited to Alzheimer's and Music therapy both together and separately, the specific neural mechanisms of each, the different stages of Alzheimer's and any studies that have been done at each stage of the disease that incorporated music therapy.

Alzheimer's Disease and the Different Stages

Alzheimer's disease is a neurodegenerative disease that impacts cells in the brain and causes a variety of symptoms, the most associated being dementia. The disease leads to difficulties in a person's day to day life, impacting their memory, behavior, and ability to communicate. There is ongoing research on Alzheimer's disease as the cause and successful treatment have not been discovered. There are several theories on possible causes for the disease that continue to be researched. Although the cause itself is unknown, there are certain risk factors associated with a higher chance of developing Alzheimer's disease. As Figure 1 shows, several of these factors can be genetic or environmental and continue to be studied. There are currently some invasive and noninvasive treatments being tested to help address some of the symptoms of the disease and slow its progression (Breijyeh, 2020).

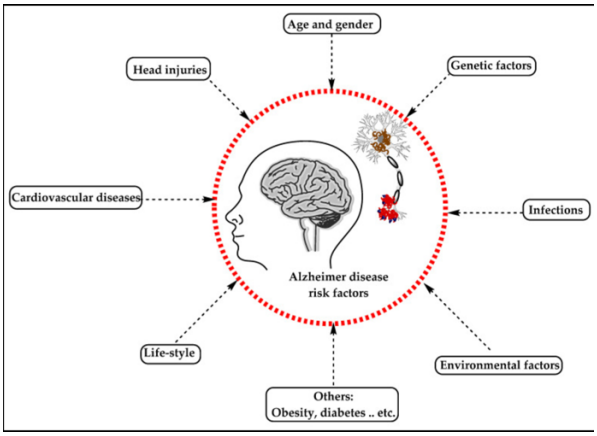

Figure 1. Risk factors for Alzheimer's (Breijyeh, 2020)

Patients are diagnosed with Alzheimer's disease through a series of tests including magnetic resonance imaging (MRI) scans, laboratory tests, and cognitive exams. The disease is associated with findings of neritic plaques and neurofibrillary tangles which heavily impact the neural conduction in the brain and cause neurons to die. These plaques and tangles make it more difficult for nutrients to get to all parts of the brain and cause severe loss of cognitive function over time as well as the eventual shrinking of the cerebral cortex (Breijyeh, 2020). Alzheimer's disease can be broken down into four distinct stages: preclinical stage, mild stage, moderate stage, and late stage.

The preclinical stage is often also referred to as "mild cognitive impairment" (NIA, What Is Mild Cognitive Impairment?, 2021). At this stage there is a buildup of plaques over time but with little to no symptoms of the disease.

These patients do not yet meet all of the criteria for being diagnosed with Alzheimer's and do not feel any significant impacts of their symptoms on their daily lives (Breijyeh, 2020). People with mild cognitive impairment are not guaranteed to develop Alzheimer's (NIA, What Are The Signs of Alzheimer's Disease, 2022). The next stage of Alzheimer's disease is the mild stage. This stage is the most common time of diagnosis as patients start to notice their symptoms slightly impacting their day to day lives. These symptoms include but are not limited to mild memory loss, behavioral changes that surface as decreased initiative and decision-making skills, increased short term memory loss, brain fog, disorientation, and changes in mood (NIA, What Are The Signs of Alzheimer's Disease, 2022).

Once the disease spreads to the cerebral cortex, there is an increase in the number of and intensity of symptoms that is considered the moderate stage of the disease (Breijyeh, 2020). These symptoms include increased memory loss such as forgetting personal details; isolation; difficulty speaking, reading and writing; changes in sleep; hallucinations; inappropriate responses to events; emotional outbursts; difficulty with logic or organization; and muscle twitches (NIA, What Are The Signs of Alzheimer's Disease, 2022). At this stage of the disease patients often need supervision and assistance with everyday activities. The final stage of Alzheimer's disease is the late stage. At this point the disease has spread through the entire cortex and there is a huge buildup of neritic plaques and neurofibrillary tangles (Breijyeh, 2020). This leads to very severe symptoms that completely interfere with the patient's day to day life. These symptoms include being unable to communicate, little to no short-term memory, complete disorientation, changes in appetite, seizures, and other physical and psychological conditions (NIA, What Are The Signs of Alzheimer's Disease, 2022).

Noninvasive Techniques for Alzheimer's Disease

Possible noninvasive techniques in treating Alzheimer's disease, focusing on slowing progression and managing symptoms, have become an increasingly studied area. These techniques include but are not limited to exercise, brain current stimulation, and the focus of this paper – music therapy. One review conducted in 2021 looked at the effect of different forms of exercise on the cognitive function of patients diagnosed with Alzheimer's (López-Ortiz, 2021). Cognitive tests were repeated in a population that did not exercise, a group that focused on strength training, a group that focused on aerobic exercise, and a group that did a mixture of both. The results revealed that the groups that exercised did experience some statistically significant improvements in cognitive function compared to the group that did not.

There are other forms of noninvasive treatments that are more directly used in treatment, rather than a form of lifestyle change. One example of this is Non-Invasive Brain Stimulation which targets improving cognitive function as well as motor function in patients with different neurodegenerative diseases (Guidetti, 2022). The studies find that there is a correlation between the use of these treatments and specific improvements to the patient's abilities, but it is difficult to monitor the efficacy of these treatments over time to see their overall effect on slowing disease progression. Specifically in Alzheimer's disease these treatments were seen to improve executive performance, memory functions, and global cognition (Guidetti, 2022). The neural mechanisms behind these improvements are not yet fully understood, making it difficult to quantify and replicate these results consistently. The overall aim, however, is to stimulate the creation of proteins that are stifled by the disease in the hopes to slow the deterioration of parts of the brain or even decrease existing impairment.

Music intervention has also become a form of noninvasive technique aimed at improving cognitive function, language abilities, and behavior in Alzheimer's patients. There has been a substantial number of randomized trials as well as literature reviews to help investigate this technique, but there is still a lot unknown. In practice, different forms of music therapy have been seen to have positive impacts on Alzheimer's patients, most noticed in improved cognitive ability and mood (Guess, 2017). There are various methods of music therapy used, the main two categories being active and passive music therapy, with each seen to have their own potential benefits (Leggieri, 2019). However, it is difficult to determine a specific regiment or treatment that works more broadly for Alzheimer's patients as it is difficult to quantify the results of the music therapy (Bleibel, 2023). For this reason, music therapy is often seen as a beneficial

technique at addressing neuropsychiatric symptoms of the disease such as agitation, depression, and anxiety. Improvements in mood are judged more on a case-by-case basis but are still seen to improve the overall well-being of the patient. There is a potential in music therapy to be used in addressing aspects of cognitive and linguistic function due to the unique way in which the brain receives and responds to music neurologically (Leggieri, 2019).

Neural Mechanisms of Music and Music Therapy

Music is able to interact with many different parts of the brain, leading to complex connections which influence the way music can be used as therapy. Through MRI, scientists have observed that music can stimulate different areas that store memory as well as areas that deal with cognition and auditory feedback (Clark, 2015). This is important in cases of Alzheimer's as patients may have different responses to music and different types of music can stimulate different portions of the brain. Music has an emotional and linguistic aspect in addition to memory, so it serves well as a form of therapy able to target multiple different symptoms. Music therapy also lends itself well to an individualized program allowing the type of therapy and type of music to be chosen specifically for the patient (Leggieri, 2019).

There are two overarching forms of music therapy: active and passive music therapy. Active music therapy is when the patient participates in making the music (Schneider, 2022). This includes activities like learning a new instrument and singing in a choir. Active music therapy engages cognitive skills along with audition and memory. There is often a social aspect that goes along with this as well that may work to improve the emotional state of the patient (Leggieri, 2019). Active music therapy does not have to be very involved; simply the process of percussing or humming along would also be considered active music therapy. Passive music therapy is when the patient just listens to and receives the music. This form of music therapy is very common and is much easier to implement as it requires less of the patient. Passive music therapy has also been seen to improve mood, memory, and even have some cognitive benefits. This is partly due to the neural mechanisms of listening to music and how the act of processing and recalling music can benefit different parts of the brain (Schneider, 2022).

One of the most observed benefits of music therapy seen in Alzheimer's patients is improvements in behavior and mood. Music has been seen to activate dopamine production in the brain (Matziorinis, 2022). This is very beneficial for Alzheimer's patients as the disease causes a depletion in dopamine. Music also activates the autonomic nervous system which reduces stress and anxiety (Matziorinis, 2022).

Music Therapy in Early Alzheimer's Disease

Early Alzheimer's disease, also known as mild stage Alzheimer's, is when the patient first begins to notice their symptoms affecting their day-to-day life. The symptoms are not yet debilitating, and patients may still try to sustain their normal lifestyle (NIA, What Are The Signs of Alzheimer's Disease, 2022). The intention of active music therapy is to help delay the onset of more or worsening symptoms. At this stage, patients are still able to participate in active music therapy.

One study implemented active music therapy under the supervision of a music therapist. The patients were able to choose any instrument and play freely under the supervision of a music therapist. The patients showed some improvement in cognitive testing, significant improvement in memory, and a decrease in anxiety and depression (Gallego, 2017). In comparison, another study utilized passive music therapy as a supplemental treatment for patients with mild Alzheimer's disease. The patients incorporated listening to 30 minutes of classical music twice a day. These patients experienced no significant improvement in cognitive ability or mood (Li).

Music Therapy in Moderate Alzheimer's Disease

Moderate stage Alzheimer's disease is characterized by both an increase in the intensity and number of symptoms. At this stage patients find that they have a lot more difficulty performing their everyday activities and start forgetting personal details. At this stage of the disease patients are still able to participate in active music therapy but may find that passive music therapy is easier to incorporate into their treatment plan.

One study used active music therapy on patients with mild-moderate Alzheimer's disease. The study found slight improvements in memory. However, the study shows that other methods, such as cognitive training, were a lot more successful in improving patient's memory. The active music therapy was very successful in improving social interactions and mood. (Giovagnoli, 2017). These results may suggest a benefit in pairing active music therapy with techniques like cognitive training to maximize improvements to all symptoms.

Another study looked at the impact of using passive music therapy with patients with mild-moderate Alzheimer's disease. The study specifically had some patients listen to a variety of unfamiliar music over the course of three months and some listen to familiar music. The results found a significant improvement in self-consciousness and mood for the patients who had listened to familiar music. Self-consciousness measured the patients' ability to recognize personal details, elements of memory, and moral judgment (Arroyo-Anlló, 2013).

Music Therapy in Late-Stage Alzheimer's Disease

Late-stage Alzheimer's disease is when the disease has progressed to the point where the patient can no longer perform their daily functions and often need care and supervision. Patients experience severe memory loss, resulting in forgetting personal details, difficulty communicating, and disorientation. Patients, depending on their symptoms, may or may not be able to participate in active music therapy. For patients who are able, active music therapy may be beneficial in improving some cognitive symptoms and mood. For patients who are unable, passive music therapy still offers an opportunity in helping the patient with memory and mood.

One study used both active and passive music therapy aimed at improving the psychological state of patients with severe Alzheimer's disease. The study compared three groups: one using active music therapy, one using passive music therapy, and one with no music therapy. The active music therapy saw the greatest improvement in behavioral and psychological symptoms, with these improvements lasting long term. The passive music therapy group only saw short term improvements which went away soon after the experiment. Although the improvements were only temporary, passive music therapy was still shown to be more beneficial than the group that had no form of music therapy (Sakamoto, 2013).

Another study conducted showed similar results. Patients were assigned to either a group that had music therapy or a control group. The group with music therapy showed significant improvements in behavior and mood. Specifically, patients experienced decreased anxiety and decreased agitation. The patients with music therapy also had fewer disturbances to their daily life (Svansdottir, 2006). Although there are some limitations of music therapy at late-stage Alzheimer's disease, the improvements to mood and behavior are beneficial as they increase the patients' overall quality of life.

Possibility of Music Therapy as Prevention

Music therapy in Alzheimer's disease at each stage aims at reducing some of the symptoms of the disease, either cognitive or psychological. However, these improvements are unable to halt or reverse the progression of the disease. There is a period before the formal diagnosis of Alzheimer's disease known as the preclinical stage, or mild cognitive impairment. Patients may start noticing symptoms of the disease but do not yet meet the threshold for a formal diag-

nosis. Not all patients with mild cognitive impairment develop Alzheimer's disease. Is there a possibility of incorporating active music therapy at this preclinical stage as a preventative measure to reduce the risk of developing Alzheimer's disease?

One study investigated whether playing an instrument, a form of active music therapy, reduced the risk of developing mild cognitive impairment or dementia. The results showed a 59% reduction in the risk of developing these conditions if the person played a musical instrument. The study specifically looked at people who played musical instruments in mid-life and their outcomes in late life (Walsh, 2021). Another study looked at the benefits of learning an instrument at a young age and its effects on the risk of developing dementia later in life. The results showed a significant reduction in the risk of developing dementia or cognitive impairment if the person learned an instrument at a young age (Balbag, 2014). A meta-analysis of 21 studies was conducted using patients who had been diagnosed with mild cognitive impairment or dementia. The study used music making, also known as composition, another form of active music therapy, to see the impacts on cognitive function. As illustrated in Figure 2, the results showed a significant improvement in cognitive function for the patients who participated in music making (Dorris, 2022).

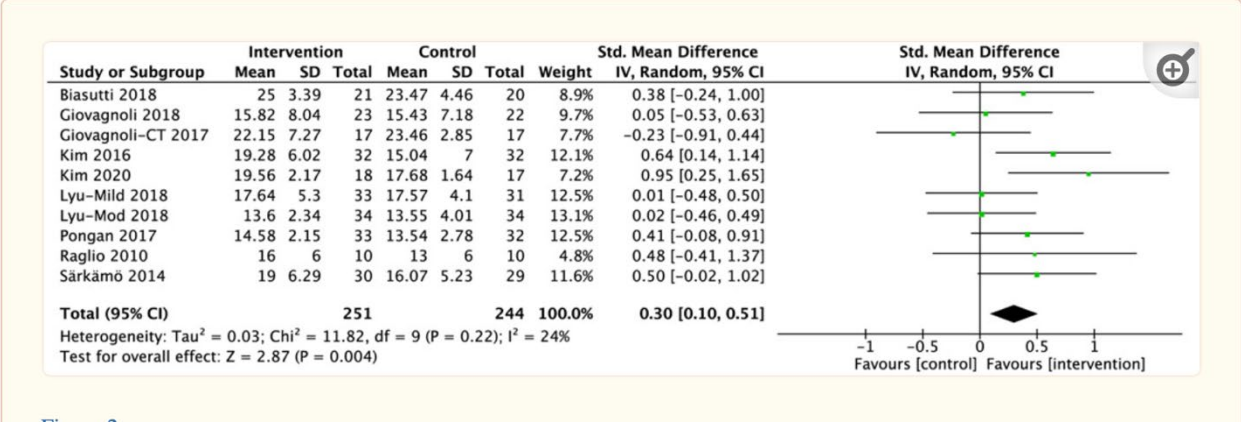

Figure 2. Forest plot to illustrate the standardized mean difference (SMD) of active music intervention compared to control groups on changes in global cognitive functioning (Dorris, 2022)

Active music therapy has been shown to reduce the risk of developing dementia or cognitive impairment even when incorporated at different times in life. Whether at early life, mid-life, or even when diagnosed with mild cognitive impairment, patients have seen benefits of active music therapy. More research must be done to determine the extent of these improvements as well as the best method of active music therapy to use. There is potential for active music therapy, in whatever capacity, to reduce the risk of Alzheimer's disease.

Conclusion

Alzheimer's disease is an incurable neurodegenerative disease that affects millions of people. One sector of research is focusing on how noninvasive techniques can help slow the onset of symptoms of the disease. Music therapy, both active and passive, has been used with Alzheimer's patients at all stages of the disease and has shown to help with a wide variety of symptoms. Active music therapy in particular has shown to have more widespread and long-term effects for patients. There is evidence supporting the possibility of using active music therapy as a preventative measure. Active music therapy has been shown to reduce the risk of cognitive impairment and dementia when incorporated at any stage of a person's life.

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