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Neuro-informed Music Therapy for the Treatment of Anxiety and Depression: A Literature Review

Sarah E. Sullivan
sullivans467@gmail.com

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Neuro-informed Music Therapy for the Treatment of Anxiety and Depression:

A Literature Review

Capstone Thesis

Lesley University

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Name: Sarah Sullivan

Specialization: Music Therapy

Thesis Instructor: Dr. Vivien Marcow-Speiser

Abstract

This capstone thesis project is a literature review of research specifically regarding the neuroscience and neurochemistry of music and how it can inform music therapy treatment of mental health. Mental health is a large, overarching term that includes many disorders that refer to one's psychological and/or emotional condition(s), which further includes an individual's social well-being. This can include, but is not limited to, depression, anxiety, schizophrenia, and obsessive-compulsive disorder (OCD). This paper will focus in on a research-based, neuro-informed music therapy treatment of anxiety and depression. The goal of this paper was to provide research toward a future method in music therapy where therapists can take a research-based and neuro-informed approach to treating anxiety and depression. With the current available research, it can be suggested that a neuro-informed music therapy approach can be used to treat mood disorders, specifically anxiety and depression, however, further research will be needed to support this method.

Keywords: music therapy, neuroscience, neurochemistry, anxiety, depression

Neuro-informed Music Therapy for the

Treatment of Mental Health Issues: Anxiety and Depression:

A Literature Review

Introduction

According to the American Music Therapy Association (2021), music therapy is "the clinical and evidence-based use of music interventions to accomplish individualized goals within a therapeutic relationship by a credentialed professional who has completed an approved music therapy program". Every music therapist defines music therapy differently dependent on their personal, cultural, and systematic views and beliefs. Bruscia (2014) defines music therapy as "a systematic process of intervention wherein the therapist helps the client to promote health, using music experiences and the relationships that develop through them as dynamic forces of change" (p. xxii). The field of music therapy encompasses a wide variety of models, techniques, methods, and theories; however, the growth of the field is endless. As evidenced by many working definitions of music therapy in the literature, as well as unique definitions set by each individual while in their training as a music therapist. While music therapists have accrued many achievements and made significant progress over the years in the development of theories and methods, there is much more to do in the future regarding innovative research, the development of new methods, and inclusion of all emerging perspectives and philosophies.

Though music therapy has been evolving and making its mark in the mental health and psychological fields of practice, music as a healing phenomenon is not a novel idea to these generations of people who have founded music therapy. Music is an age-old entity that has been around since the dawn of time. Plato and Aristotle were the first to write about how music influenced such healing. Ancient artifacts such as pottery, art, and poetry contain references and

remnants of musical instruments. Then later, following World War I, as amateurs and professionals played for veterans suffering from emotional and physical trauma, they would later be described as producing the first instances of music therapy in the civilized world.

When deciding an area to focus on for this thesis capstone project, I knew that mental health would be at the center of my focus within the music therapy field. Additionally, I have done extensive personal work in clinical practice and research regarding the origin of music and cultural humility as part of my music therapy practice. With that being said, as a neuro-informed music therapy treatment for anxiety and mental health is the overall topic of this thesis, and the themes of awareness of culture and origin will be embedded throughout the literature review.

Mental health includes many disorders that refer to one's psychological and/or emotional condition(s) and there are still many gaps in knowledge of some of these disorders and conditions. To ensure proper attention and research, this paper will only look at the treatment of anxiety and depression and how a neuro-informed music therapy approach could be taken and *why* a music therapist would take this approach. It is not an expectation that music therapy will necessarily *cure* anxiety or depression, but music therapy has already been proven to be beneficial in the treatment of these disorders. With the treatment of mental health being the focus, I knew that I wanted to make this neuro based as well. The brain has always fascinated me and there is a significant amount of research on music and the effects it can have on the brain. My goal is to provide a literature review encapsulating the research for a neuro-informed music therapy approach to treat anxiety and depression that can be used to further the development in this area of treatment for the fields of music therapy and mental health in its' entirety. There are many gaps in what is known about anxiety and depression, but I hope that by doing a literature

review on the neuroscience behind these disorders and the neurochemistry of music as a whole, that some gaps can be connected and/or treated through music therapy in a newfound way.

From the start of my music therapy training, I had planned to do my capstone thesis on the benefits of using music therapy in mental health treatment. Little did anyone know that within the next few years, we would all experience, live through, and discover a 'new normal' within a global pandemic, causing many to lose loved ones, to go unemployed, and to be affected in multiple ways, including their physical, mental, and emotional health. Focusing on the treatment of anxiety and depression from a neuro-based perspective is important for the field of music therapy as well as the field of mental health counseling due to the overwhelming amount of need that is in this world today, before, during, and after the COVID-19 pandemic. It is necessary to acknowledge that there is little understanding of how COVID-19 health anxiety (CovH anxiety) impacts critical work, home, and health outcomes. CovH anxiety is defined by Trougakos and Chawla (2020) as, "feelings of fear and apprehension about having or contracting COVID-19" (p. 1234). This article goes into detail on the impact of CovH anxiety on emotion suppression, the impact of emotion suppression on need fulfillment, and the impact of need fulfillment on work, home, and health outcomes. While this capstone focuses on anxiety depression as a whole, CovH anxiety may be a significant factor in how anxiety and depression are to be treated during the pandemic and in the future.

Overall, I had hoped to learn that neuro-informed music therapy has a place in treating anxiety and depression. With the research currently available, it is clear that this method is quite possible, however more research and studies will have to be done in order to confirm this neuro-informed music therapy method to treat anxiety and depression.

Method

The approach taken to conduct this literature review was to research the current literature regarding treatments of anxiety and depression, neuro-informed music therapy, and the neurochemistry of music as it relates to mental illness. Key terms used included but were not limited to music therapy, neuroscience, neurochemistry, anxiety, depression, mental health, and mental illness. Articles were chosen to be used based off of relevance to overall topic and date of publishing. Only peer reviewed articles were used, and each article had to have at least two major contributions to this paper in order to be included in the research.

Literature Review

Mental Health vs. Mental Illness

The terms mental health and mental illness can often create confusion due to lack of understanding of what each phrase entails. However, even then, there are some organizations that use the terms interchangeably. For this reason, both sides of the argument are provided for readers to make a decision on their own for where they stand and which phrase to use in their clinical practice.

According to the Centers for Disease Control and Prevention (CDC), mental illness refers to "conditions that affect a person's thinking, feeling, mood, or behavior" (Centers for Disease Control and Prevention, 2018). These can include but aren't limited to depression, anxiety, bipolar disorder, or schizophrenia. However, mental health reflects our emotional, psychological, and social well-being; affecting how we think, feel, and act, mental health has a strong impact on the way we interact with others, handle problems, and make decisions (McLean, 2021). With this being said, it is important to note that individuals with a diagnosis of anxiety or depression have been diagnosed with a mental illness, but that does not mean that they will have poor mental

health for the rest of their lives. Mental health and mental illness are both states of being, each of which can fluctuate on a spectrum throughout a person's life, diagnosed or not.

The National Alliance on Mental Illness (NAMI) addresses the issue of using 'mental health' or 'mental illness' and clearly states on their website, "NAMI recognizes that other organizations have drawn distinctions between what diagnoses are considered "mental health conditions" as opposed to "mental illnesses." We intentionally use the terms "mental health conditions" and "mental illness/es" interchangeably" (National Alliance on Mental Illness, 2021). NAMI goes on to define mental illness/health as a condition that affects a person's thinking, feeling, behavior, or mood, expanding more to say that this would deeply impact an individual's day-to-day living and relations to others. Additionally, NAMI highlights that many people experience mental illness as proven by the following statistics:

- 1 in 5 U.S. adults experience mental illness each year.

- 1 in 20 U.S. adults experience serious mental illness each year.

- 1 in 6 U.S. youth aged 6-17 experience a mental health disorder each year.

- 50% of all lifetime mental illness begins by age 14, and 75% by age 24.

There are many factors that go into having these experiences, genetics, environment, and lifestyle can all play a part, as well as biochemical processes and circuits and basic brain structure. This is where neuro-informed music therapy will come in. By looking at these biochemical processes and circuits, basic brain structures, and neural substrates of anxiety and depression and joining that with the neuroscience and neurochemistry of music, this paper aims to close gaps in treatment and knowledge of neuro-informed music therapy for patients diagnosed with anxiety and depression.

Anxiety

Anxiety disorders include disorders that "share features of excessive fear and anxiety and related behavioral disturbances" (American Psychiatric Association, 2013, p. 189). Fear is defined as the emotional response to real or perceived imminent threat, whereas anxiety is anticipation of future threat. These responses may overlap, however, are different in that fear is more often associated with the fight/flight automatic reaction, thoughts of immediate danger and escape behaviors, while anxiety is more often associated with bodily responses such as muscle tension and enhanced vigilance in preparation for future danger. Panic attacks are common to see in individuals with anxiety, however, are not limited to this diagnosis alone.

It is common for anxiety disorders to appear comorbid with each other but important to remember that they differ from each other largely in the types of objects or situations that induce the fear, anxiety, or avoidance behavior that an individual experiences as well as the associated cognitive ideation. Anxiety disorders can development during childhood and persist further if untreated. These disorders range from generalized anxiety disorder, separation anxiety, selective mutism, and specific phobias.

According to the *Diagnostic and Statistical Manual of Mental Disorders* (5th ed.; DSM–5; American Psychiatric Association, 2013, p. 222), generalized anxiety disorder (GAD) requires an essential feature of excessive anxiety and worry about a number of events or activities, usually high in intensity and frequency, and long in duration. This anxiety and worry would be out of proportion to the actual likelihood or impact of the anticipated event and is difficult for the individual to control to the point where it interferes with their every day living. It is important to note that a diagnosis of GAD requires that the worries an individual has must be excessive and interfere significantly with their psychosocial functioning, as well as the worries being more

pervasive, pronounced, and distressing, and lasting for a longer duration of time. Lastly, these worries may also have physical symptoms (restlessness, on edge, etc.) attached to them.

Generalized anxiety disorder has a prevalence of 0.9% among adolescents and 2.9% among adults in general community of the United States, whereas in other countries it can range from 0.4% to 3.6% (American Psychiatric Association, 2013, p. 223). Many individuals can experience anxiety over the course of their entire lives; however, onset of GAD is spread over an extremely broad range.

Diagnostic Criteria

Listed below are the criteria that is needed to be met in order to meet a proper diagnosis of generalized anxiety disorder provided by the DSM-5:

- Excessive anxiety and worry about a number of events or activities

- Worry is difficult for individual to control

- Anxiety and worry are associated with three or more of the following six symptoms:

    o Restlessness or feeling keyed up or on edge

    o Being easily fatigued

    o Difficulty concentrating or mind going blank

    o Irritability

    o Muscle tension

    o Sleep disturbance

- Anxiety, worry, or physical symptoms causing clinically significant distress or impairment in social, occupational, or other important areas of functioning

- Disturbance in not attributable to the physiological effects of a substance or another medical condition

- Disturbance is not better explained by another mental disorder

(American Psychiatric Association, 2013, p. 222).

The author would be remiss to not acknowledge the fact that every individual may experience some level of anxiety or worry in their everyday lives. The difference between this and a diagnosis of generalized anxiety disorder has to do with the criteria that needs to be met in order to be properly diagnosed. The criteria listed in the DSM-5 sets everyday anxiety and worries apart from a physical diagnosis.

Factors, Issues, and Risk

Many risk and prognostic factors as well as culture-related and gender-related diagnostic issues exist in the consideration of assigning a diagnosis of generalized anxiety disorder to an individual. From a temperamental perspective, behavioral inhibition, negative affectivity (neuroticism), and harm avoidance have been associated with GAD, however, environmentally, no factors have been identified as specific to GAD or necessary and sufficient enough to properly make a diagnosis. Going further, genetics does play a role in whether or not an individual may experience generalized anxiety disorder, in fact, 1 in 3 individuals with GAD in their family history are likely to experience it themselves.

The expression of generalized anxiety disorder varies greatly from culture to culture, where somatic symptoms or cognitive symptoms may take the dominate role within the diagnosis in some cultures more than others (American Psychiatric Association, 2013, p. 224). For good measure and practice, it is always vital to be cognizant of cultural factors when diagnosing, but this is especially true for this particular disorder.

Lastly, generalized anxiety disorder is found more commonly in females than in males and of note, females tend to have a comorbidity with unipolar depression, whereas in males, their comorbidity may lie more in substance use disorders.

Depression

Depressive disorders are categorized in the DSM-5 as having the presence of sad, empty, or irritable mood, accompanied by somatic and cognitive changes that significantly affect the individual's capacity to function (American Psychiatric Association, 2013, p. 155). Some disorders included in this section are disruptive mood dysregulation disorder, major depressive disorder, persistent depressive disorder, premenstrual dysphoric disorder, substance/medication-induced depressive disorder, and unspecified depressive disorder. Each diagnosis has similar characteristics, however, what sets them apart from each other are issues of duration, timing, or presumed etiology. The prevalence of major depressive disorder in the United Sates sits at 7%, with a striking difference in the 18- to 29-year-old age group, which is threefold higher than the frequency seen in individuals age 60 or older (American Psychiatric Association, 2013, p. 165).

The DSM-5 characterizes major depressive disorder (MDD) by discrete episodes of at least 2 weeks' duration involving clear-cut changes in affect, cognition, and neurovegetative functions and inter-episode remissions (American Psychiatric Association, 2013, p. 160-162). Typically, these episodes last much longer than just the two-week minimum. A diagnosis on a single episode is possible, however, this disorder is a recurrent in the majority of known cases. There are several specifiers for MDD that each have their own criteria and coding. These specifiers are mild, moderate, severe, with psychotic features, in partial or full remission, and unspecified. Additionally, there are other specifiers without codes that can apply to an episode in question:

- With anxious distress

- With mixed features

- With melancholic features

- With atypical features

- With mood-congruent psychotic features

- With mood-incongruent psychotic features

- With catatonia

- With peripartum onset

- With seasonal pattern

As these specifiers do not have their own coding, typically they will be found at the end of the diagnosis when recording them in documentation.

Diagnostic Criteria

For MDD to be diagnosed properly, five or more of the symptoms listed in the DSM-5 have to be present during the same 2-week period and represent a change from previous functioning; at least one of the symptoms being depressed mood or loss of interest or pleasure (American Psychiatric Association, 2013, p. 160-161). Other symptoms that could be present are the following:

- Depressed mood most of the day

- Markedly diminished interest or pleasure in all, or almost all, activities most of the day

- Significant weight loss or weight gain

- Insomnia or hypersomnia

- Psychomotor agitation or retardation

- Fatigue or loss of energy

- Feelings of worthlessness or excessive or inappropriate guilt

- Diminished ability to think or concentrate, or indecisiveness,

- Recurrent thoughts of death, suicidal ideation without a specific plan, or a suicide attempt or specific plan for committing suicide

To consider making this diagnosis, all symptoms listed above that are present in an individual have to have occurred nearly every day, with the exception of weight change and suicidal ideation. Other criteria that need to be met are that the symptoms specified above cause clinically significant distress or impairment in social, occupational, or other important areas of functioning and that the episode is not attributable to the physiological effects of a substance or another medical condition. To properly record the name of a diagnosis for an individual with MDD, terms should be listed in the following order: major depressive disorder, single or recurrent episode, severity/psychotic/remission specifiers, then followed by as many specifiers without codes that apply to the current episode in question.

The research has historically said that depression results from a chemical imbalance, however, Harvard Health Publishing (2019) suggests that depression is much more complex than this. There are many possible causes of depression, which Harvard Medical School outlines as including faulty mood regulation by the brain, genetic vulnerability, stressful life events, medications, and medical problems. In essence, taking a larger look at the neuroscience of these chemicals and how they respond to music is exceptionally vital to the mental health field in terms of treatment and the music therapy field in terms of advancement.

Factors, Issues, and Risk

The DSM-5 lists risk and prognostic factors, culture-related and gender-related diagnostic issues, and suicide risk to be aware of when making a MDD diagnosis (American Psychiatric

Association, 2013, p. 166-167). Each of these areas are important to be aware of when treating or diagnosing major depressive disorder because there can be substantial cultural differences in an individual's expression of their symptoms. Clinicians must be cognizant of the fact that in most countries, the majority of cases of depression go unrecognized for a multitude of reasons. Regarding gender, the most reproducible finding has been that MDD is more prevalent in women than men, however, while the risk for suicide attempts is higher in women, the risk for suicide completion is higher in men.

Mental Health Stigma

There is stigma around having a mental illness or an individual deciding to work on their mental health. Corrigan and Watson (2002) explore the mental illness stigma in regard to stereotypes and prejudices attached to it as well to uncover specific issues in this realm. It is important to understand concepts such as these not only in therapy, but as a worldview because in today's age, there are so many more stereotypes and prejudices that are being assigned to certain people by a variety of characteristics assumed about them. The authors immediately address that individuals with mental illnesses are challenged in two ways: first with the struggles and disabilities that may result from their specific disease, and second with the stereotypes and prejudices that accumulate from the misconceptions about mental illness. The authors provide an historical context of stereotyping mental illness as negative, but researchers, therapists, and psychologists alike seem to be trying to erase that by providing resources to clients through the therapists in ways of research, conferences, and seminars. Being stigmatized, by itself, depletes instrumental, social, and economic resources, resulting in many negative outcomes, including disparities in the quality and quantity of education (Hatzenbuehler et al., 2013). Shown in Table

1 below, the impact of public stigma and self-stigma, also known as personal stigma, can be seen in all aspects, stereotypes, prejudices, and discrimination.

Table 1

Comparing and Contrasting the Definitions of Public Stigma and Self-Stigma

Public Stigma	
Stereotype	Negative belief about a group (e.g., dangerousness, incompetence, character weakness)
Prejudice	Agreement with belief and/or negative emotional reaction (e.g., anger, fear)
Discrimination	Behavior response to prejudice (e.g., avoidance, withhold employment and housing opportunities, withhold help)
Self-Stigma	
Stereotype	Negative belief about the self (e.g., character weakness, incompetence)
Prejudice	Agreement with belief, negative emotional reaction (e.g., low self-esteem, low self-efficacy)
Discrimination	Behavior response to prejudice (e.g., fails to pursue work and housing opportunities)

Note. Adapted from Corrigan, P. W., & Watson, A. C. (2002). Understanding the impact of stigma on people with mental illness. *World Psychiatry, 1*(1), 16–20.

These stereotypes, prejudices, and discriminations outlined above show clear reasons as to why ending the stigma around mental health and mental illness is vital to the overall wellness and safety for many individuals. Understanding mental health and the stigmas that surround it is just the beginning to being able to treat patients with these issues.

Eisenberg et al. (2009) states that the "mental illness stigma has been identified by national policy makers as an important barrier to help seeking for mental health", highlighting that many individuals are hesitant for an appropriate reason. In this empirical study, an association of help-seeking behavior with both perceived public stigma and personal stigma was looked at using a random sample of 5,555 students from a pool of thirteen diverse universities. The study's focus was explicitly on the mental health stigma and the barrier that it creates for individuals seeking help with a goal of trying to find ways to reduce the hesitation in those who do need help. The aim in studying music therapy in relation to the brain is to aid in the struggle that many individuals with mental illness experience regarding the stigma attached to their diagnosis and presentation.

Music and the Brain

It has been shown numerous times that music activates both the right and left sides of the brain (Peretz & Zotarre, 2005) and furthermore, Tramo (2001) goes on to say that this fact should not come as a surprise since musical activities are numerous, complex, and diverse. This is significant due to the goals set in place, physical and emotional, during music therapy that would require one part of the brain, yet music lights up all of the brain. Research has shown that music can reduce anxiety, blood pressure, and pain as well as improve sleep quality, mood, mental alertness, and memory (Johns Hopkins Medicine, 2021) especially important in the treatment of anxiety and depression as all of these non-music behaviors are goals to be achieved by an individual.

Studying the neuroscience of music could be valuable to many fields of study, in particular, music therapy (Zatorre, 2003). This perspective may be a valuable way to analyze a variety of complex cognitive functions and their neural substrate, or the part of the nervous

and/or brain system that underlies a specific behavior or psychological state. Zatorre looks at

three different topics including brain correlates of musical imagery, absolute pitch, and music

and emotion. All of these essential to understanding how the brain responds to music and what

the relationship is there, through a neurological lens. Although neurologically based, this

information can be useful to multiple fields including but not limited to neurology, psychology,

music therapy, and music as a whole. He also addresses how this particular field of study, music

and neuroscience, is maturing and leaving more room for research and acceptance. It is essential

to be clear and cognizant of the connections as well as the roadblocks and struggles that come

along with this area of interest.

Emotion

Emotion regulation is a critical skill for emotional health and well-being (Gross &

Munoz, 1995) and therefore would be a key target in treating clients with mental health issues.

Lepping et al. (2016) conducted a study consisting of 19 individuals with Major Depressive

Disorder (MDD) and 20 never depressed (ND) control individuals that listened to standardized

positive and negative emotional musical and nonmusical stimuli during fMRI scanning and gave

subjective ratings of valence and arousal following scanning. Results showed that MDD

individuals showed a different pattern of activation in their anterior cingulate cortex (ACC),

which is part of the emotional neural circuitry implicated in MDD. Furthermore, in the front part

of the ACC, ND individuals showed greater activation for positive information, while MDD

individuals showed greater activation to negative information.

The limbic system is a group of structures located in the brain that are responsible for

behavioral and emotional responses. The two major parts are the hippocampus and the amygdala,

however there are other structures involved in the processes of the limbic system. These

structures include the thalamus, hypothalamus (production of important hormones and regulation of thirst, hunger, mood etc.) and the basal ganglia (reward processing, habit formation, movement and learning). Many may recall that the amygdala is responsible for a person's fight or flight response in regard to an anxiety-provoking or fearful situation. When considering emotion, the limbic system is the center of control, however, the frontal lobes play an important part to emotion in the brain as well as the frontal lobes are "the brain's disciplinarian" (Jourdain, 1997, p. 309), meaning that they function as the reins for other parts of the brain. Connecting the brain to music in this sense is logical due to the inherent fact that music generates emotion, positive and negative. How is this known? Music sets up expectations and gives anticipation to listeners and then satisfies those needs in our brains by resolving. There are various ways in which the musical structure of a song manipulates how a listener feels, and the same can be said for using music therapy with a patient, specifically targeting their emotions.

To understand better the emotional responses to music at a neural level, fMRI methods are used in order to identify activity in the structures associated with emotion, i.e., the primary limbic and paralimbic structures of the brain. Koelsch (2009) believes this understanding of how music affects these areas should eventually translate into music therapy treatments addressing dysfunction in these areas, as found in anxiety and depression, as well as post-traumatic stress disorder (PTSD) (p. 374). There have been studies in mental health that use distinctive electroencephalogram (EEG) responses to correspond to depression and anxiety, specifically looking at frontal alpha asymmetry (FAA), where higher left sided activity in alpha is associated with active inhibition relating to depressive behaviors, and frontal midline theta (FMT), correlated in a range of studies with anxiety (O'Kelly, 2016). Fachner et al. (2013) studied music listening and its effects on FAA and FMT in depression and anxiety by using improvisational

psychodynamic music therapy and how it could utilize verbal and musical reflection on emotions.

Although these findings may seem to support this method to be used in music therapy practice, the validity of them has been variable and more research studies will need to be done to further investigate.

Neurochemistry of Music

Neurochemistry is the branch of biochemistry concerned with the processes occurring in nerve tissue and the nervous system, additionally, the neurochemistry of music encompasses a bridge between the fields of music cognition and social neuroscience to explore the effectiveness of music on the brain in relation to physical and psychological health and well-being in clinical settings. Chanda & Levitin (2013) evaluated how music improves health and well-being through the engagement of neurochemical systems in multiple capacities: (i) reward, motivation, and pleasure; (ii) stress and arousal; (iii) immunity; and (iv) social affiliation. They go on to say that

> These domains parallel, respectively, the known neurochemical systems of: (i) dopamine
> and opioids; (ii) cortisol, corticotrophin-releasing hormone (CRH), adrenocorticotropic
> hormone (ACTH); (iii) serotonin and the peptide derivatives of proopiomelanocortin
> (POMC), including alpha-melanocyte stimulating hormone and beta-endorphin; and (iv)
> oxytocin. (Chanda & Levitin, 2013).

As referenced earlier, music is known to stimulate the entirety of the brain, whereas other various functions, cognitions, and emotions are assigned to specific parts of the brain. With this being true, it is important and relevant to the development of a neuro-informed music therapy method due to the range of possibilities in affecting moods in individuals who have anxiety or depression. In Figure 1 below, Särkämö et al. (2013) compile over twenty years of music

neuroscience studies to show the multiple brain regions that are used in general musical activities.

Figure 1

Schematic Illustration of Key Brain Areas Associated with Music Processing-Based Neuroimaging Studies of Healthy Subjects.
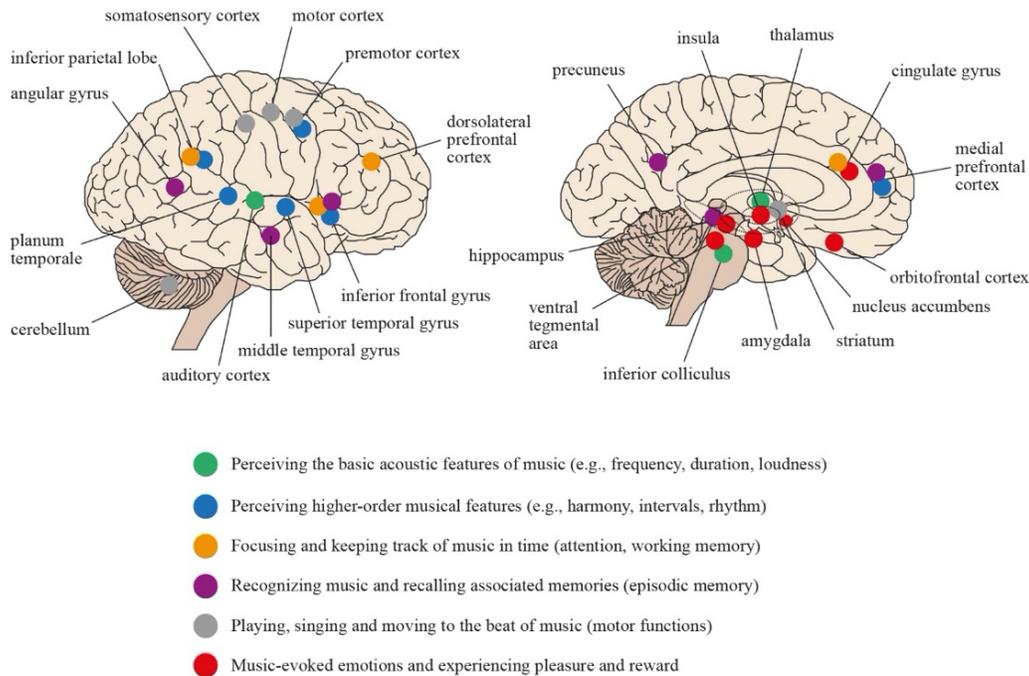
Note. Although the image displays parts of the right hemisphere of the brain, many musical subfunctions are actually largely bilateral, with the exception of pitch and melody processing, which is more lateralized to the right hemisphere (O'Kelly, 2016).

Music may have multiple underlying mechanisms, in fact, one proposed mechanism for the ability of music to regulate stress, arousal, and emotions is that it initiates reflexive brainstem responses (Chanda & Levitin, 2013). As the research focuses more on the neuroscience within music therapy, discoveries such as this one could prove to be useful in music therapy treatment in patients with anxiety and depression.

Neuroplasticity

For years, researchers and neuroscientists have been studying the brain and in recent years they have made quite a few major advances in the current understanding of how the brain works. In the public eye, one concept has drawn a significant amount of attention due to the potential it may offer, and that is the concept of neuroplasticity.

Neuroplasticity is simply a change in the nervous system (Costandi, 2016, p. 147). It also encompasses all processes that change the structure and function of the brain. In essence, all brains go through this process in the duration of an individual's life as brains evolve and adapt to the environment it is in at that moment. This meaning, that neuroplasticity is a fundamental property of nervous tissue in the brain, which can occur at all levels of organization, be it genetic or behavioral. As this concept is becoming more present in conversations, academic and otherwise, it is important to note that the phrase "rewiring the brain" is connected to the concept of neuroplasticity.

History of Neuroplasticity

Although the concept of neuroplasticity may seem novel to the general public, it has been around for centuries. In the 1780's, Swiss naturalist Charles Bonnet and Italian anatomist Michele Vincenzo Malacarne discussed the possibility of mental exercises leading to brain growth and how to experiment this. Malacarne tested this idea with a pair of dogs and a pair of birds, noting that the cerebellum in the extensively trained animal from each pair was significantly larger than in the untrained ones (Costandi, 2016, p. 5). Following this, other physicians around the world started having discussions regarding the development of mental capabilities and if the brain structures associated with them could be stimulated by exercise and education.

The term, plasticity, was first defined by William James in his 1890 textbook called *The Principles of Psychology*, as "the possession of a structure weak enough to yield to an influence, but strong enough not to yield all at once", as quoted in the book *Neuroplasticity*, by Moheb Costandi. James had further explained the formation of habits due to the strengthening of synapses at the cellular level in neurons. Then, in 1894, Spanish neuroanatomist Santiago Ramón y Cajal suggested that the plasticity that William James had discussed occurs at the junctions of nerve cells and that the mental exercise that Bonnet and Malacarne tested resulted in the growth of new nerve fiber branches (Costandi, 2016, p. 8). Many years later, into the early 1970's, Tim Bliss and Terje Lømo reported the discovery of long-term potentiation (LTP), which is a physiological mechanism by which synapses could be strengthened for prolonged periods of time. This modification system is widely regarded as the cellular basis of learning and memory and is by far, the best understood mode of neuroplasticity (Costandi, 2016, p. 11). Contrary to early conversations regarding neuroplasticity and the fact that it wouldn't be possible to happen within the brains of grown adults, it is now well accepted that neuroplasticity encompasses changes on multiple levels, from individual synapses to entire cortical networks and can happen throughout the lifespan of a person (Stegemöller, 2014, Costandi, 2016, p. 3). The concept of neuroplasticity is a large base component of NMT and arguably for neuro-informed music therapy as well.

Relevance in Music Therapy

While still focusing on the treatment of anxiety and depression with a neuro-informed music therapy approach, it is important to understand the neurotransmitters involved in both neuroplasticity and music therapy. Dopamine is the neurotransmitter found in the midbrain that is involved in movement, reward and motivation, and other functions. Music therapists can tap

into the brain reward system by pairing music to non-music related functions and goals that are

set in treatment, similar to how food and drugs tap into the brains' reward system (Zatorre,

2015). According to Koelsch (2014),

> Research has consistently shown that dopamine is a primary neurotransmitter involved in
>
> neuroplasticity, and dopaminergic neurons in the reward network of the brain, including
>
> the ventral tegmental area (VTA) and nucleus accumbens (NA), have been implicated in
>
> cortical remodeling, reward-related learning, and hippocampal long-term potentiation
>
> (the strengthening of synapses due to a long-lasting increase in signal transmission
>
> between two neurons).

Activities that one may be challenged to work towards in music therapy may include, but are not

limited to, movement, vocalization, breathing, and maintaining heart rate. Non-music behaviors

that are specific to anxiety and depression treatment would include awareness of self and

environment, expression, social skills, cognition, coping skills and more. As music therapists

work with their patients, targeting these types of goals, they would be eliciting simultaneous

firing of neurons in the specific brain areas involved in the control of those behaviors,

strengthening neuronal connectivity and leading to faster and more-permanent changes in their

patients (Stegemöller, 2017). Furthermore, Levitin (2006) discusses how increased dopamine

levels are not only seen in the nucleus accumbens, but also the cerebellum is regulating that

emotion through its connections to the frontal lobe and limbic system (p. 191). Since current

neuropsychological theories associate positive mood and affect with increased dopamine levels,

and psychiatrists prescribe antidepressants that act on the dopaminergic system, it is clear how

music can also be a treatment in order to improve an individual's mood while treating their

anxiety or depression.

Research has assessed musicians and nonmusicians in studies regarding neuroplasticity, which is the brain's ability to form new neural connections throughout life in order to reorganize itself. This usually happens when an injury or disease is present, so the brain has to adjust to new situations and changes in its environment in order to still function. There is a difference in this process of neuroplasticity in the brain of a musician versus the brain of a nonmusician (Merrett et al., 2013). Researchers have also addressed how there is an assumed existence of music-specific neural networks but do not go further into it because there is a scarce amount of research in this area and due to cultural differences, it is difficult to generalize (Peretz and Zatorre, 2005). This relates not only to the music therapy perspective, but also to the neurological perspective as well, which is important in understanding possible relationships between mental health, music therapy, and neurology. In connecting music and the brain, specifically looking at how music offers a unique way to better understand the organization of the human brain, one can attempt to go further in understanding how mental illness fits into that equation and then can finally make the broad connection of neurologic music therapy and mental health.

The emergence of neuroscience in the music and music therapy fields is becoming more relevant within the past decade. As mentioned above, neuroplasticity refers to a change in the brain where new neural pathways can be created. According to Julian O'Kelly (2016), "musical activity may provide an ideal stimulus in this context, with the potential to literally change the shape and connectivity of brain structures", so that in clinical settings, music therapists would be able to guide patients in treatment toward their goals and overall improvement. NMT is a rehabilitation model that is the most widely researched in this field at the moment, however, the research in mood disorders, as well as speech, cognition, and disorders of consciousness, is now becoming more prevalent and known.

Neuro-informed Music Therapy

Connelly (2020) defines neuro-informed music therapy as, "a method of music therapy that uses knowledge and research in the field of neuroscience to design interventions that meet the unique and complex needs of each patient. This includes three separate domains or areas of focus when designing interventions: rehabilitative, compensatory, and psycho-social-emotional" (p. 5). This should not be confused with Neurologic Music Therapy (NMT), which is an already established technique in the field and requires specific training, resulting in a certification. Michael Thaut, founder of NMT states that, "NMT is defined as the therapeutic application of music to cognitive, affective, sensory, language, and motor dysfunctions due to disease or injury to the human nervous system (Thaut, 2014, p. 2). NMT is purely a rehabilitation model in music therapy, which is proven to work toward physical rehabilitation, development, and the maintenance of functional behaviors of a patient. Practitioners go through trainings periodically to be educated in many areas of importance within this model, consisting of education in the areas of neuroanatomy and physiology, neuropathology medical terminology, and (re)habilitation of cognitive, motor, speech, and language functions (Thaut, 2014, p. 2). The interventions used in NMT cannot be altered, which makes neuro-informed music therapy distinct from NMT. At its core, neuro-informed music therapy emphasizes the need for patient-led and patient-centered care. This model has a tri-pronged approach for treatment which includes a rehabilitative, a compensatory, and a psycho-social-emotional approach. The area of focus in neuro-informed music therapy that is most relevant to the treatment of anxiety and depression is the psycho-social-emotional domain.

Psycho-social-emotional approach

      This particular approach within neuro-informed music therapy is useful for patients who are unable or unwilling to participate in therapy services due to social or emotional barriers. The use of music gives patients the ability to convey emotions, alter emotions, enable socialization and social skill development, and shape psychological functioning (Connelly, 2020, p. 16). When treating anxiety and depression, many theories influence the way clinicians conceptualize these cases such as psychotherapy, cognitive behavioral therapy (CBT), dialectical behavioral therapy (DBT), and acceptance and commitment therapy (ACT) (Berzoff & Méndez, 2016, p. 412-454, Berzoff, 2016, p. 455-480). These theoretical frameworks, as well as others not listed, are clinically significant for patients diagnosed with anxiety or depression due to the way that these diagnoses can alter their psycho-social-emotional well-being.

Music Therapy in Mental Health

      Windle et al. (2020) focuses on how different forms of music therapy can benefit treatment for those with long-term depression in various ways, including but not limited to, songwriting, improvisation, and music listening. Songwriting proved to be an effective intervention in each of the groups that participated which offers a new perspective on how music therapy can address the many challenges of long-term depression. The intensity of the treatment in the research study was more than a typical treatment may be in general, but the treatment in this trial happened three times a week. Gold et al. (2009, as cited in Windle et al., 2020) found that the number of music therapy sessions is linked to increased benefits although they also stated that it is unclear to what extent frequency and overall duration contribute to this. Furthermore, within improvisation and music listening, as well as other active music therapy interventions, patients experience a sense of achievement as they explore how to be expressive

through the music modality. In turn, this behavioral activation that occurs during music therapy can treat a patient's depression.

In another study, the effectiveness of CBT (cognitive behavior therapy) group counseling with passive versus active music therapy was explored to see a hopeful reduction in academic anxiety in millennials. Passive music therapy involves patients or subjects being minimally involved, and sometimes not involved at all, in music-making and interactions with the therapist, whereas active music therapy has patients or subjects involved in the music by helping to create a song or actively playing a musical instrument. Situmorang, Mulawarman, & Wibowo (2018) found that CBT with the addition of active music therapy was more effective in reducing academic anxiety compared to CBT groups with passive music therapy.

Music therapy treatments have also been studied in an inpatient setting looking at changes in mood and anxiety after music therapy treatments. Tan, Lester, & Lin (2020) saw a statistically significant difference in mood and anxiety using multivariate regression models for examination. When a music therapy intervention is introduced to improve moods, the neural gates will be partially closed causing a decrease in the transmission of sensory signals to the brain (Sperry & Binensztok, 2019), resulting in further confirmation that receptive music therapy in the previous study is effective in treating mood disorders.

Discussion

The development of a neuro-informed music therapy approach to treat mood disorders is inevitable to happen within the coming years. Anxiety and depression are proving to be more prevalent, and already, psychologists and psychiatrists are speculating that the general public will see a rise in these areas, as well as others, due to the COVID-19 pandemic. Music therapy has proven to be a significant motivator for patients who are unwilling to engage due to the

opportunity to engage passively or actively within session. As we move toward a neuro-informed lens on music therapy in treating those with anxiety and depression, it is important to look at the specific brain regions at play and even more so, if there are deficits in patients that are seen in those brain structures. With the continuous emergence of neuroimaging and research, more can be discovered concerning the effects of music therapy on the brain and individual's mental health, as well as understanding better the neural mechanisms of music therapy so that every patient's need can be met in treatment.

Further research is highly recommended to be done in the future in order to advance the mental health and music therapy fields. Moreover, this impending research will inevitably benefit those who are selected to participate in it. As stated at the beginning of this review, a neuro-informed music therapy approach is not expected to cure anxiety and depression, nevertheless, there is evidence that it is a valuable treatment modality to rely on.

Music has been around for longer than anyone has been on this earth and has been used by people all over the world for various different purposes. Claims about the healing power of music are found in many pre-industrial societies and in ancient Greece (Chanda & Levitin, 2013). As a field, we must acknowledge that no one piece, style, or genre of music belongs to us, rather, it belongs to every person, otherwise it wouldn't be so effective on us as human beings. There are many theories and interventions within music therapy that are research-based with sound explanations and references, but I do not believe that our work is done yet. By reviewing the literature from a neuroscientific perspective, my hope is to inspire others to do the same so that our future patients can benefit from the research that is out there but isn't always looked at. Neuro-informed music therapy is a method that is still in its infancy, however, there is much

promise and possibility on the horizon for the various benefits and enhancements that it can

bring to the mental health, music therapy, and neuroscience fields.

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THESIS APPROVAL FORM

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