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The Influence of Music on the Autistic Brain

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Abstract:

Scientific and qualitative research studies explain how different activities can affect and impact the brain. Researchers look at brain and wave activity to help determine ways music can be used as a therapeutic and beneficial teaching technique. The information based on these studies shows emotional and physiological changes in human behavior, activity, and development. This thesis discusses how research tools and evidence-based research observes and measures ways music affects autistic and non-autistic brains. Brain research supports how music specifically impacts people with autism and explores diverse ways to incorporate music in educational settings.

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CHAPTER 1: INTRODUCTION

Music has an emotional impact and can shape human characteristics and subjective experiences. A quote by an anonymous person is, “Music is love, in search of a word.” (Unknown). This quote highlights how music connects with people and how music is a form of communication. In “Arts with the Brain in Mind,” Jenson (2001) explains the concept of how the arts and music support the developmental human neurological systems. This thesis will discuss research, observations, and numerous studies by professionals who have obtained scientific and research-based information that methodically supports why music is a practical method as an application for Autistic individuals of all ages.

Music is perceived and identified in many different shapes, forms of communication, and theoretical perceptions. Different forms or styles of music emit emotions such as happiness, sadness, excitement, or love. How we interpret music is based on personal, emotional, and historical experiences such as loss of a loved one, ecstatic instances, or sentimental pastimes. All these events influence our lives and personal perceptions. Music is also a cross-cultural technique which is used directly through an auditory channel to engage emotional and social processing centers of the human brain (Sachs et. Al,. 2014.) Considering these factors helps us investigate and explain why music has such an effect on the Autistic brain.

I chose this topic for my thesis because of my experience working with students with disabilities, including autism, is why I will explain how music is beneficial and can be used for instructional and therapeutic purposes as a therapeutic application in the classroom.

I experienced the application of music in the classroom in several settings and techniques. The first setting I experienced and observed how music impacted special education was through

a program that included music therapy. In this setting, the students are expected to show appropriate social, emotional, and interactive behavior throughout a 20-30-minute class period. This is important because they are not just learning musical concepts, but they are also working on social and interactive skills. The music portion of the class helps with concepts that engage and initiate music interactions within a group of students. The group of students ranged from different disabilities and on multiple developmental levels. A structured schedule was consistent and predictable on the days of music therapy classes. The music therapist is knowledgeable and licensed; therefore, they have the training and background to use the most appropriate and research-based techniques utilized with the classes.

The structure of the class includes an opening/greeting instructed by the music therapist. The greeting is usually a song that the students have heard before. The music therapist then introduces the itinerary for that day. This could be games, activities, or the use of musical instruments. If it is appropriate each student can suggest personal preferences in each activity. This exercise the use of appropriate social and interactive skills. The best part of the class is when the students can get up and dance to a favorite song. It is captivating to watch everyone engaged, relaxed and have fun.

The effects of music are expressed in the following statement: “Music has the potential to provide a space for creativity, expressivity, flow, and flourishing” (Denora, 2000, p. 244). Music can offer a broad perspective of health and knowledge through a creative refuge or asylum from pathogenic factors that foster distress and pain in people with living with a disability (DeNora, 2013).

It is crucial that we explore different ways to apply and support the use of the creative arts, such as music, and to implement and utilize these techniques every day in classroom

settings. Music can be used as a therapeutic technique in mainstream and special education settings to promote and support social, emotional, and teaching methods for all students. Music has been utilized for therapeutic and special education purposes and is supported by research. Jenson (2001) supports the arts in schools and should be taught based on evidence-based practices in science. The values of music as an accepted discipline can impact every student.

Many theories explain how the arts affects brain development. Jenson (2001, p. 2) stated that " Arts enhance the process of learning. And these systems nourish integrated sensory, attentional, cognitive, emotional, and motor capacities. These are driving forces behind all other learning." Ansdell (2014) also supported the influence of the mentality of music, stating, "Music helps by addressing our basic human needs—for recognition as persons, identity, and relationships" (p. 295).

Jenson (2001 describes how music effects the emotional, cognitive, perceptual motor, attention, memory, stress, and immune response biological systems in humans. Music impacts various areas of the brain including the occipital cortex, frontal lobe and temporal lobes which affect emotional, preceptor motor, cognitive and attention and memory.

This literature review includes evidence-base and learning research methods that support my questions regarding how music affects the brain and learning development in individuals with Autism. The evidence-based research derived scholarly and other thesis articles that included studies, theories and practices involving music.

We can begin to understand people from distinct cultures and capabilities. With the proper application, knowledge, and educational developments of music in our schools and in society. Research, human development, and devotion is needed to help support music in our public and private school settings. Our children are saturated in social media, gaming, and other

immaterial ways of communicating and could benefit from using music to help develop better social, emotional, and interpersonal relationship building.

The following are terms derived from: *https://www.asha.org/Research/EBP/Evidence-Based-Practice-Glossary:*

*Case study: An uncontrolled observational (descriptive) report of events and outcomes in a single case.

*Evidence-Based Practice: The integration of (a) clinical expertise, (b) current best evidence, and (c) client values to provide high-quality services reflecting the interests, values, needs, and choices of the individuals served.

*Controlled study: A study involving a comparison (control) group.

*fMRI: Functional magnetic resonance imaging or functional MRI (fMRI) measures brain activity by detecting changes associated with blood flow. This technique relies on the fact that cerebral blood flow and neuronal activation are coupled. When an area of the brain is in use, blood flow to that region also increases.

The following terms are derived from: *https://www.medicalnewstoday.com/articles/146309.php*

*MRI: An MRI (Magnetic resonance imaging), scan uses a large magnet, radio waves, and a computer to create a detailed, cross-sectional image of internal organs and structures.

*cerebral cortex: The cerebral cortex (plural cortices), also known as the cerebral mantle, is the outer layer of neural tissue of the cerebrum of the brain in humans and other mammals. It is separated into two cortices, by the longitudinal fissure that divides the cerebrum into the left and right cerebral hemispheres.

This literature review will explore the following questions: How does music impact the brain of an Autistic individual and how does an autistic brain differ from a neurotypical brain? How do we measure and identify the impact of diverse types of music on brain functioning? How do musical interventions improve the emotional and social deficit in individuals on the Autism Spectrum? What theoretical and practical research supports using music as an intervention for students who have developmental and neurological disorders?

Chapter 2: LITERATURE REVIEW

Stages and Development of the Brain

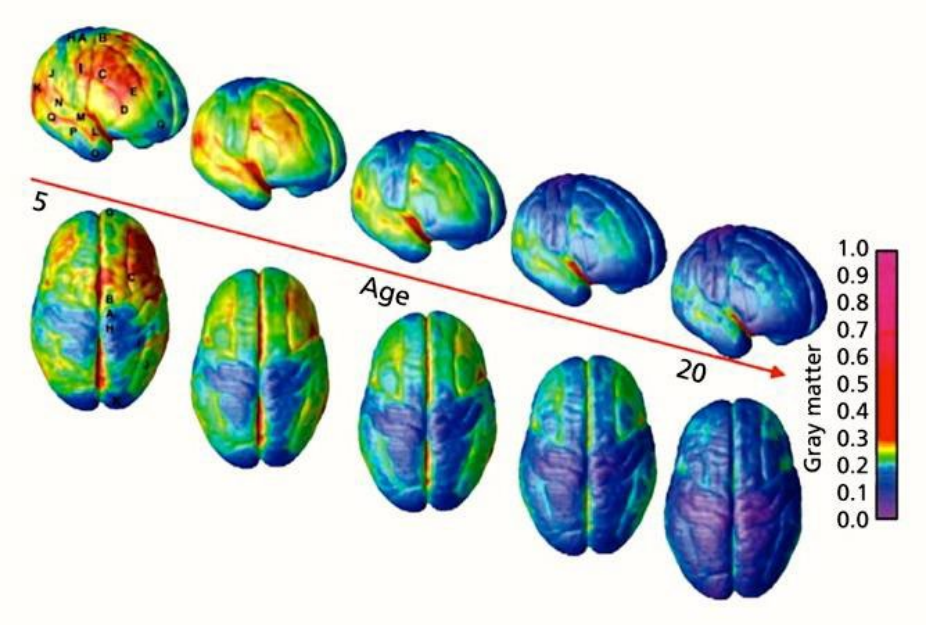
When I started looking for articles regarding my chosen topics, I was able to find articles available through many electronic resources. I also found articles that supported medical, clinical, and neurological evidence regarding brain development and methodical data that supports how different regions of the brain are affected by music.

Shahidiani's (2007), research study, " Brain Developmental Autism Spectrum Disorder," studied typical brain development in infants and concurred that infants were born with processing deficits as their neural circuitry was incomplete in many regions of the brain. (Shahidiani, p. 27) stated that the brain's process involved a combination of "constructive and subtractive" brain transformations on a microscopic and macroscopic levels (Shahidiani, 2007). Examining typical brain maturation is the vital first step towards identifying abnormalities that occur in neurodevelopment conditions including ASD (Shahadini, 2007). The identification of white and grey matter helps people understand the different microstructural perspectives in brain development (Shahadini, 2007). The process of brain development begins in the Embryonic stages of the brain and continues to the postnatal stages of development at twenty-four months of age. The cells in the brain mature and develop into the larger brain size. Brain tissue classified with white matter is made of fibers, and interact, and send information to grey matter which processes information (Shahadini, 2007). Myelin is an insulator sheath that increases the speed of information as transferred through a conduction process. Grey matter increases in adolescence and plateaus and starts to decline thereafter. White matter progresses through a linear increase in volume. Aging affects both white and grey matter throughout the lifespan.

Shahadini, 2007, stated that studies of the normal brain maturation into adolescence show grey matter loss and is an essential step in brain development. (See figure 1.0).

White matter identified through several different neuroimaging techniques studies provides insight to the evolution of grey matter. One approach used to assess white matter is DTI or (Diffusion Tensor Imaging). DTI highlights axonal pathways which provides information on the tissue microstructure. DTI also measures the changes of the brain across the lifespan and biomarkers of typical brain development throughout the ageing process. Fractional anisotropy or FA measurements increase throughout childhood and adolescence within the prefrontal cortex white matter region and other pathways (Shahadini, 2007). Changes in white matter can result in impaired neurodevelopmental condition such as ASD. White matter changes affecting cognitive and motor functions. It is important to compare previous brain imaging studies to monitor and identify new changes within the developing brain.

Figure:1.0



The figure above shows the GM maturation over the cortical surface in children ages 5-twenty years. The units on the sidebar represent colors of grey matter. This was taken from Gogtay, N., et al. Proc Natl Acad Sci USA, 2004;101(21): p. 8174-9.

Shahidiani, (2014) stated that ASD could be diagnosed between two and three years of life. Developmental problems related to Autism Spectrum Disorder (ASD) were observed and diagnosed within the first one to three years of life. The procedure for diagnosing ASD is common in Western medicine which may not be available to many countries or regions due to lack of resources, medical advances, and technology. (Shahidiani, 2014), it can be challenging to establish the developmental stages of Autistic individuals under the age of 18. Currently a mental health medical team performs assessments for the diagnosis of Autism Spectrum Disorder. Medical professionals diagnose Autism Spectrum Disorder (ASD) using the *Diagnostic and Statistical Manual of Mental Disorders* (5th ed.; *DSM–5* criterion (Shahidiani, 2014), as well as the *International statistical classification of diseases and related health problems* (11th Revision), A diagnosis is important to individuals and their families to help understand and treat behaviors and to receive proper services. Considered the aesthetics of ways music influenced subjects' responses. The brain is constructed of many different neurons and connectivity tissues. In this study researchers considered the aesthetics of how music influenced subjects' responses. The authors stated that numerous approaches existed on ways to measure music and the affects it has on the brain. (Blood and Zatorre, 2001; Salimpoor et al., 2013). Because it is known that music impacts the brain, it is important to understand the different changes in the brain networks triggered by arts activities compared with how the brain responds to everyday pleasures. The same reward network in the brain responds to basic sensory pleasures

such as food, sex and drugs via the dopaminergic pathways (Blood and Zatorre; Salimpoor et al.,).

It is important to look at different measures to find ways music might encourage people with developmental disabilities who have non-systematic brain functioning. Understanding the similarities and differences across diagnoses provides information about how music is interpreted by persons with various developmental brain processes which includes interpreting, understanding, and connecting on an emotional level.

Sachs and colleagues (2016) stated that having the ability to demonstrate artistic and social rewards ensures that higher order pleasure could be developed by pro-social benefits such as interacting with a small group of people. Others also conceptualize music with higher order pleasures and stimulus-driven activity in the brain's circuitry; these pleasures evoke emotional reactions, responses, and different appraisals (Huron, 2006.) The article in focus examined what types of stimulus and sensory experiences show the neurological effects that music has on various types of brains (Sachs et al.,). Tramo, 2013, stated that stimulus music impacted the brain and could provide humans and other animal pleasures and rewards. Physical reactions have been studied with music and linked with sensational occurrences and behavioral characteristics (Grewe et al., 2005).

Music affects individuals differently due to factors such as familiarity, engagement and measures that include the Big Five personality traits that respond to different experiences. These traits helped decipher whether reactions to aesthetic stimuli could be found within all people (Nusbaum and Silvia, 2010). A person's ability to feel or experience pleasure while listening to music could be demised or even nonexistent. This was even the case when individuals had normal responses to rewards other than music as noticed by Mas-Herrero et al., 2014. It might be

the case where some people do not experience the ability to connect this functional connectivity where the brain connects with auditory cortices or mesolimbic reward circuitry as considered by Blood and Zatorre, 2001; Salimpoor et al., 2013. Sachs, et al. noted that if we could find the neural basis for individuals who have different emotions who are non-emotional responders, it could help define the neural pathways so sensory stimuli could attain some type of reward or pleasure for certain individuals. (Sachs, et. al, 2016).

Measurement tools/ techniques used on brain

Diffusion Tensor imaging (DTI), is a method that detects differences in structural connectivity with individuals who have diagnosed psychiatric and neurological disorders. (Barnea-Goraly et al., 2004; Park et al., 2004; Johnstone and Reekum, 2007). The use of DTI promoted the search to find a neurobiological basis for the different ways people respond to music (Sachs, et. Al, 2016).

Ecker et al., (2015) stated that DTI studies have been a prevalent way to study and observe neural substrates in individuals with Autism Spectrum Disorder (ASD). This type of neuroimaging technique looks at brain anatomy, functioning and connectivity areas in the brain. The pathology in younger children with ASD differs from other stages and ages of brain development throughout a lifespan (Ecker, Bookheimer Y, & Declan G M, 2015).

Children can develop autism at an early age, and diagnosis is combination of observations and clinical interventions which assess deficits in social communication and repetitive behaviors or interests (Ecker, Bookheimer Y, & Declan G M, 2015). Autism can be reliably diagnosed as young as two years of age. Autistic behavior can trigger differences in brain anatomy, functioning and connectivity. Genetic and environmental factors are known to be contributors or causes for the diagnosis of autism. (Hallmayer, Cleveland and Torres, 2011). In

the series paper, (Ecker, Bookheimer Y, & Declan G M, 2015) observed different autistic traits and symptoms that can occurred during the lifespan of autistic individuals. The researchers looked at brain anatomy, functioning and brain connectivity that were specific to autistic symptoms. Other types of neuroimaging techniques included EG's, PET's and magnetoencephalography but MRI's were noted as the most common ways to study a brain with ASD (Ecker, Bookheimer Y, & Declan G M, 2015).

In earlier brain development MRI studies have shown that toddlers, ages two to four years, with autism, had a larger brain volume than typically developing toddlers (Ecker, Bookheimer Y, & Declan G M, 2015). The differences of the volume of the autistic brain disappeared around ages six to eight after the intersection of the growth curve. Courchesne et. al., (2001) suggested that the neurodevelopmental curve of the brain was atypical in ASD and decreased in brain volume at a later stage. The affected areas of the brain included the frontal and temporal lobes. The study suggested that the temporal lobes were more affected then the parietal and occipital lobes. Abnormalities in ASD were noted at an early onset age and they differed from disorders that usually presented later in life such as schizophrenia (Ecker, Bookheimer Y, & Declan G M, 2015).

MRI findings can identify infants who have ASD who have elevated risk of developing the disorder as early 24 months. Brain enlargement was noted in the cortical of children two and a half years old. Hazlett et. al., (2011) also found brain enlargements at the same age but enlargements were not associated with increased growth rates. These studies supported previous research that highlighted abnormal brain growth at about two years of age.

Early enlargement of the brain in ASD, caused by an accelerated expansion of cortical surface area but not cortical thickness, is of importance because it points towards specific genetic

and impaired neurobiological mechanisms in ASD and highlights the need for the development of novel neuroimaging measurements that offer a higher degree of specificity regarding underlying mechanisms. (Ecker et al,. p.2). Evidence of early white matter differences was also noted. Atypical development of cortical grey matter linked to white matter may cause a curve in early brain development (Ecker et al., p. 2).

The frontotemporal and frontoparietal regions along with amygdala-hippocampal and cerebellum and anterior and posterior regions compose the neural system areas for ASD. These areas were highlighted when looking at clinical symptoms in the brain. Rojas et al., 2006; and Boddaertet al., 2004 stated frontotemporal regions could relate to differences in socio-emotional processing. Studies found that the orbitofrontal cortex controlled repetitive or stereotype ASD behaviors (McAlonan et al., 2002). Other areas such as the amygdala were shown to be enlarged in children with ASD and other anxiety disorders (De Bellis et al., 2000).

Neurodevelopment is also important to study in people with ASD because brain anatomy can change throughout the human lifespan. Limited research has been conducted on neurodevelopment in adolescents and adults with ASD. Adolescent brain development in people with ASD indicated accelerated age-related declines in the total brain volume based on cortical thinness and surface areas (Beatty et al., 1993).

Cortical thinning in different brain regions showed accelerated development in people with ASD. MRI studies have supported this claim (Wallace et al., 2010). Observations of the process of cortical folding allowed researchers to look at microstructural processes and differences in brain development in ASD. MRI studies have concluded that atypical cortical gyrification occurs in brains of individuals with ASD. Piven et. al (1990) stated that ASD people have higher cortical malformations compared to healthy controls. There is also a significant

increase of gyrification of frontal lobes in children and adolescents with ASD (Hardan et al., 2004).

A modern neuroimaging technique called the local gyrification index compared the amount of cortex between what is the local variant of classic two-dimension gyrification index.. It represents the amount of cortex between the smooth circular surface of the brain and grey matter (Zilles et al., 1988). The brain development in males with ASD ranging from age 12-23 years showed increased local gyrification in bilateral posterior brain regions compared with brains of typically developing males (Wallace et al., 2013). The gyrification was also reduced in males ages eight to 40 years and the inferior frontal and medical parieto-occipital cortices in children with ASD (Libero et al., 2014). Genetic and non-genetic factors could affect the development of cortical folding. (Bartley et al., 1997).

Devries et al., (2015) stated that future studies regarding genetic and environmental factors will need to take measurements of the cortical geometry in addition to volume with those with ASD. The study also stressed the importance of looking at brain development in ASD and looking at shape characteristic of the brain. Early MRI studies found that different regions of the brain had different magnitudes of activation. Face processing studies depicted different emotional faces resulted in reduced activation in perceptual regions (Critchley et. al., 2000; Pierce et. al 2001; Schultz et al,.2000). The difference between brain activity in ASD individuals was strong when measuring gaze direction and face familiarity (Dalton et al., 2007; Pierce & Recay, 2008).

Decreased activity was observed in regions of the social brain network during a task that related to emotional processing and social cognition. Ashwin et. al, (2007) stated there were also differences observed with activation including language circuitry and communication tasks (Just

et. al., 2013; Scott et. al., 2010; Delmonte et. al., 2012). The differences in the severity of ASD based on fMRI studies of people with autism noted decreased of functional connectivity during different task performances (Abrhams et. al., 2013).

Effects of music on autistic brain and non-autistic brain (research)

Mas et. al., (2014) studied the effects that music had on brain connectivity and the human aesthetic responses to music. Sachs et al., (2016) suggested that people with difficult experiences or Autism had strong emotional responses to stimuli and may be susceptible to other sensitivities and impairments with emotional and social functioning. This research supported the hypothesis that the autistic brain differs from a non-autistic brain based on brain's connectivity and ability to respond to aesthetic stimuli through music. This study began with the question of how humans experienced pleasure in response to higher order stimuli (Sachs, et. al.). Blood and Zattore, 2001; Salimpoor et. al., 2013, knew that different responses through engaging with the arts helped activated the same reward network in the brain that responded to the basic sensory pleasure systems associated with sex, food and drugs. The reward system also must be active in prosocial functions including cooperation with something (Declerck et al., 2013) and self-disclosure (Tamir and Mitchell, 2012). This suggested that individuals who engaged in music activities could emote different feelings and emotions depending on how connected they were when listening to music. Music provided the ideal stimuli to the study of pleasure and rewards because music has understood to be one of the most enjoyable experiences in human civilization throughout history (Tramo 2013).

Greet al., 2005 stated that emotion and reward systems were found in all humans, yet not everyone experienced the same emotional responses to music. Previous studies showed varied rates of reactions (Sachs et. Al.,) wanted to find out if people who consistently responded

emotionally to aesthetic musical stimuli possessed strong white matter connectivity between auditory regions in the posterior superior temporal gyrus (pSTG), and the emotion and reward processing regions of the brain. The study used a questionnaire called the Short Test of Musical Preferences (STOMP) (Rentfrow and Gosling, 2003). The study selected 20 participants for the behavioral and scanning portion. The groups also matched those who were similar in age of onset of musical training, IQ, and personality traits. Subjects were healthy with no documented hearing impairments. There were no diagnosed neurological or psychiatric disorders. The participants were able to submit three to five pieces of music to listen to during the study. This study concluded that people who were open to the experience and had more musical training been more likely to report strong emotional responses to the music stimuli (Such et al.,).

Emotional reactions to aesthetic stimuli are intriguing to humans and are found to be pleasurable and rewarding yet are highly individualized (Sachs et al.,). It is apparent from the study that finding the behavioral and neural differences between individuals who experienced different reactions helped gain better understanding of brain circuitry and the evolutionary significance of aesthetics for humans (Sachs et al.,). The increase of white matter pathways overlapped with fiber bundles in the brain and included the arcuate fasciculus and uncinate fasciculus. The white matter bundle changes had implications for individual differences in behavior (Johansen-Berg, 2010). This finding is important for people with Autism because higher white matter connectivity was observed in people with high emotional empathy, whereas lower white matter connectivity was observed in people with social-emotional impairments (Barnea-Goraly et al., 2004). The present findings suggested that people who have difficulty experiencing emotional responses to aesthetic stimuli may also be susceptible to other sensitivities or impairments in emotional and social functioning (Mas-Herrero et al., 2014 &

Heaton, 2009). Heaton (2009) stated that little was known about individuals who were not savants but possessed musical talents. Music perception, cognition and learning in untrained children with autism revealed patterns of abilities that were either enhanced or spared. One example was how music affected the child's ability to distinguish music pitch and timbre and the ability to understand musical structure. Children can possess musical potential and many studies have been created to compare their abilities with savants.

This literature review considers the types of characteristics and patterns typical of non-savant autistic people (Heaton, 2009). Kanner was the first person to discuss the theory of savants and their ability to have exceptional musical memory and talent. He observed this in clinical groups and included six out of eleven individuals who showed music-related behaviors and possessed this type of musicality (Heaton, 2009). One student was able to identify 18 symphonies and named the composer of each. The student's background were not clearly identified so Kanner made assumptions that were not fully justifiable. "Rote memory," was a term used to describe an individual's deficits with affective and functional significances (Heaton, 2009). Another issue with Kanner's study was that the autistic children he utilized learned similarly to children who were non-autistic. The type of learning could not be distinguished between the two groups. A technique used to learn music is statistical learning which is a mechanism that enables individuals to extract and represent higher order structures from stimuli to which they are exposed. This technique has been widely used in music (Krumhansl et al., 2000). Children with autism have a different perception of musical abilities. This is measured by focused attention and perceptions of music that use "typical," learning practices (Heaton, 2009).

Enhanced perceptual functioning, used diverse ways to portray perceptual and cognitive processing for individuals with autism (Mottron & Burack 2001; Mottron et al. 2006). The

predictions from the models, were tested in several studies that compared music perception ad cognition with autistic and typical development subjects (Mottron & Burack 2001; Mottron et al. 2006). This study provided evidence that Autistic individuals can have exceptional talents and advanced musical abilities (Heaton, 2009).

Applebaum et al. (1979), was the first group that observed and documented that individuals with autism demonstrated exceptional performance of a musical task. They also were able to reproduce melodies that required a higher level of musical talent. Another study measured autism and the subjects' ability to distinguish musical and absolute pitch (Heaton et al., 1998). The study conducted by Heaton et al., 1998, tested the hypothesis that proved that absolute pitch and the musical ability between savants might be relevant to autism. This study included children with autism and ways they demonstrated the ability to associate pitch and verbal labels using tones and animal pictures. The autistic individuals listened to the tones and pictures and were able to recall the correct pairings of both materials.

Absolute pitch ability (AP) is the ability to associate a pitch with a verbal label. It is one of the earliest musical abilities one can learn. During a child's early years, they can match tones and note names stored in long term memory banks. This is a method that is used to remember or recall different sounds to figures (Heaton, 2009). The ability to have exceptional awareness in music, which was previously studied in Kanner's report, helped autistic children recall sounds with unlabeled pitches in their long-term memory (Heaton, 2009). Suggestions show that AP can affect the functional anatomy and that could be associated with neuro-typical groups (Zatorre et al. 1998).

Heaton, 2009, conducted an experiment to test children with autism and neurotypical children who were not musically trained to compare patterns of performances when the

paradigms were tested with musically untrained adults. Target chords were played with increments of 1-6 chords progressing in sequence. The study proved that children with ASD had better interpretations of musical harmony, the ability to match tones in musical chords that were played. Some of the children with autism, however, were unable to process the music. The slower the musical stimuli played for the autistic individuals the harder it was for them to form a correct response to the music (Heaton, 2009).

"Music as a Therapeutic Intervention with Autism: A Systematic Review of the Literature," (2015) focused on effective outcomes of music used as a therapeutic tool by studying program needs and assorted designs. This type of therapeutic intervention improved interpersonal skills, social skills, and cognitive skills. There were reported benefits to increased appropriate social behaviors and attention to tasks. Increased vocalization and verbalization were noted including vocabulary comprehension and communication and social skills progression which helped with body awareness and coordination. These skills led to improved self-care skills and reduction in anxiety levels for children.

Devries et al, 2015, stated that music has medical and healthcare benefits that have been used for centuries. (Lindbaek, 2000). There has been evidence that music produces certain outcomes in a multiple diagnostic group. Some of the benefits included stimulating the brain in multiple areas and enhancing social, physical, and emotional deficits in autistic children (Devries, 2015). ASD individuals may have normal to superior abilities with certain elements and components in music. This allowed music to be a positive and reputable intervention (Molnar-Szakacs et al., 2009).

Individuals with Autism have deficits in social, interpersonal communication, and abnormal developmental progress. The ability to demonstrate flexible thinking and appropriate

emotional responses are challenging based on the severity of autism. Speech, eye contact and social skills may be significantly impaired. ASD diagnostic criteria includes impairments in social communication and repetitive behaviors. These challenges may include difficulty making friends or preservation with special interests. The Centers for Disease Control & Prevention (2014a), provided that one in every 59 children have autism. Males are diagnosed four time more than females. Environmental, biological, and genetic issues have been noted as linked to autism, although a scientific cause has not been determined (Devrie et al., 2015).

Therapeutic recreation, or TC, was noted as one intervention used to treat individuals with autism. Devrie (2015) thought of music as an integrated approach did not prove to treat illness but rather as a wellness component which incorporated physical, cognitive, emotional, and social benefits. The activities used by recreational therapists addressed knowledge, skills, and behaviors of people with autism. Specific interests of the patients were the focus of therapy. The therapist helped the families and clients generate the knowledge, skills and abilities to real-life situations (ATRA, 2014). There was also evidence-based research to help support the selection of specific interventions. Evidence demonstrates that music improved physical function in the range of motion and various fine motor skills. Improvements were also noted in attention span and memory. The ability to express and share feelings was targeted through this type of music therapy.

This literature review is systematically explored research related to autism and music to discover evidence and outcomes proven to support the need for therapeutic uses of music as a tool for children on the autism spectrum. This study considered severity of autism and which

music worked best. What was the most successful environment to conduct music therapy? Which genre of music worked the best with children on the autism spectrum?

Devrie's literature review wanted to look at ways to improve and obtain information to help children on the Autism Spectrum. They wanted to show that one who participated in diverse types of music interventions, such as music therapy, could be adapted to fit the needs of each individual child. The study considered issues such as session length and other specific activities to help determine what best helped a child with autism. There have been evidence-based practices that support the literature and research to support the importance music has as a therapeutic service.

In this study, Devries et al., (2015) included children with Autism who ranged from ages zero-18. The evidence-based research included 17 databases from Grand Valley State University. The study focused on the outcomes related to therapeutic uses of music and not music therapy. Articles that affected adult populations were also included. Five different outcomes were identified as supportive evidence for music as a beneficial therapeutic intervention. The outcomes included increased social and responsive behaviors and verbal communication. Additional positive outcomes such as increased recognition and understanding of emotions and decreased anxiety were noted (Devries et al., 2015) .

Dieringer & Porretta (2013); Finnigan & Starr(2010), stated that individuals with autism tended to have difficulties in social and behavioral aspects including following directions, or regulating voice levels or appropriately controlling self-stimulating/ repetitive behaviors. Self-stimulating behaviors were identified when an autistic individual had oversensitive reactions and used behaviors to compensate, such as, rocking, chewing on objects, etc. (Finnigan & Starr,

2010). Auditory stimuli such as music, helped the individual engage in music for longer periods of time (Simpson & Keen, 2011).

The types of music and sounds used helped individuals with autism reduce stimulation as shown in the O'Connor and Dieringer (2014) study. The behaviors differed depending on the type of music played for the individuals. The specific behaviors improved or decreased when listening to a whale song and the behaviors increased with classic rock music. Therefore, listening to more relaxing music improved behaviors such as chewing and pulling clothes. "The Listening Program," a type of classical music demonstrated a decrease in negative behaviors by autistic individuals (Gee, Thompson and St. John, 2014).

Music helped maintain and improve attention and direction following tasks. Dieringer and Porretta, (2013), found that music improved gross motor skills. Two male subjects in the study were able to remain on task using age-appropriate music for four-year olds. Another behavior measure included social behaviors and responses with individuals with autism. Deficits and difficulties in individual subjects included characteristics such as eye contact and imitating repeated words or phrases. Also, demonstrating an interest in other people was shown (CDC, 2014b). Music improvisation was used as a technique to help teach autistic individuals to freely perform and create their own dialogue or conversation as a recreational therapeutic technique (Ragio & Traficate, 2011). The individuals were able to bond with their therapist and created and produced interactive responses through music play while creating sounds and melodies. (Raglio & Traficante, 2011).

The literature articles reviewed by several authors explained how music was used a therapeutic technique. The articles shared comparable results noting improvement in social

and emotional functional areas that helped the individuals with better emotional understanding and behavior regulation.

Finnigin and Starr (2006) provided a case study that observed how music affected social responsiveness by using three instruments including toys, signing and a guitar. The 15-minutes sessions included a therapist playing an instrument and prompting students to engage in activities they provided. This activity lasted for 29 sessions, four times a week. The first eight weeks were recorded using the child's social baseline and were not altered until week nine when the sessions used music and non-music for 12 more sessions. The outcomes showed that during the first seven sessions that music was implemented, there were observations that more eye contact was used and in following weeks using non-music interventions autistic individuals had little to no eye contact with the therapist and others. The researcher discovered that eye contact was not based on the therapist and client bond but was the lack of interaction through imitation.

Stephens (2008) described that music during therapy sessions showed benefits in the area of imitation. Music interaction demonstrated through the music of play routines which allowed children to participate or join without participating with the group. Musical interactions included dance, playing and verbalizing. Three of the four participating children showed increased action and word imitation using the interactions provided during the sessions. Studies to help increase verbal communication supported the finding that 30-50% of individuals with autism do not develop functional verbal speech skills (CDC, 2014b). Speech therapy efforts aid in an autistic individual ability to develop functional speech skills using words, phrases, and repetition.

A music-based technique called Melodic-Based Communication therapy (MBCT), helped individuals by increasing their verbal skills in the span of five years during language development (Sandi-ford et al., 2013). The technique used rhythm, and preprogrammed melodies that involved clapping or stomping. A specific pilot study from Saniford et al., (2013) included 12 children, ages five to seven. Autism Diagnostic Observation Schedule or (ADOS). ADOS was used as a way to observe and assess ASD through communication and social interactions. The evaluation measured the accuracy of verbal attempts using a language application. The goal of the study by Saniford et al., (2013) was to have children learn a set of 25 target words along with a melody during a 45-minute session during a five-week period. The control group using MBCT, found children had stronger gains using verbal skills in a shorter amount of time. The study also found that using music at home or school helped develop social and developmental language skills (Koning, 2011). The study also supported using favorable or varietal musical instruments and songs at home and in the classroom as a tool for children with autism for developmental language acquisition.

The literature review used evidence-based study to help show interventions for children with autism and to prove that music improved social and socially acceptable behavior/ skills. It also observed the affects music had on verbal and communicative skills. Music has used as a therapeutic technique and helped individuals with autism overcome isolation and increased interpersonal relationships. Devrie et al,. 2015 provided proof that music could also teach parents and teachers ways to cope with autistic individuals' behaviors.

The implications of using music as an intervention practice included concerns with figuring out the best evidence-based outcomes and how to use music as a proper intervention

for children with autism. Throughout the research in this study, using music increased verbal communication and attention span. Other benefits were found such as decrease in anxiety and improvement in coping with stress (Gee, Thompson & St. John, 2014).

Music is one technique that can be used with individuals at various levels of autism ranging from lower functioning with minimal verbal skills to higher functioning individuals with increased social and daily functioning skills (Saniford et al., 2013). The studies also supported the use of 30 to 60-minute intervals up to four or five times a week to best benefit individuals with autism. Structured environments were shown to help autistic individuals by providing predictable and safe areas to enjoy music (Wigram & Gold, 2006).

Biology of the ASD brain

Studying biology of the ASD brain has helped educators, doctors, and scientists gain information on the developmental factors related to anatomy and structural connectivity in autism. The different methods of measuring an ASD brain have been an integral part in helping individuals understand the brain's relation to behavioral, psychological, and biological development. Autism has been widely studied as demonstrated by a variety of available research and evidence-based practices. The techniques and tools used to determine how the ASD brain works include neuroimaging, using FMRI's, magnetic resonance techniques, and various diagnostic screenings that gather information. This mass of information helps us to better understand how the autistic brain works.

Shahidiani, from the Institute of Psychiatry at King's College London, provided an evidence-based research, focusing on brain development, genetics that contribute to ASD and insights from "typical brain development and connectivity and brain chemistry", with individuals with ASD. Several techniques were used to measure the cerebral cortex and brain imaging that

included nuclear magnetic resonance and quantitative magnetic resonance imaging. The article reviewed the methodology for diagnostic screening and Magnetic Resonance Imaging (MRI) data acquisitions of an ASD brain. This information was used to describe the objectives that proved the author's hypothesis.

ASD is a neurodevelopmental condition that accompanies differences in brain anatomy and connectivity (Shahidiani, 2014). Neuroimaging studied the ASD brain focusing on spatial and temporal characteristics of the brain. Shahidiani developed the study to investigate brain sources of information by examining magnetic resonance metrics in a sample of children and adolescents with ASD. Some topics examined were age-related differences, structural connectivity, and diffusion tensor imaging. There were also mapping techniques that measured the cortical anatomy including the thickness and surface areas of the brain (Shahidiani, 2014).

The article, "Functional and Dysfunctional Brain Circuits Underlying Emotional Processing of Music in Autism Spectrum Disorders," explained how music had an impact on emotions and responses by neurotypical individuals. This study looked at Asperger, autism spectrum disorders, emotions, and fMRI. A total of 22 individuals volunteered for the study. Eight participants had ASD with ages ranging from 19-37 years with a mean age of 24. There are also 14 neurotypical individuals ranging in age from 19-32 . Selection criteria included that all participants had no music education, a clinical diagnosis of ASD and no history of major psychiatric disorders. Six of them, however, received a diagnosis of ASD.

The study used both qualitative and quantitative methods of research. The study measured intelligence using the Wechsler Adult Intelligence Scale-Revised (Wechsler, 1981). All individuals were subject to written consent, and the process and procedures were approved by a committee at the University of Toronto. The study procedure included the use of stimuli

with assorted styles of music ranging from happy, sad, and controlled. Musical classical compositions were administered to each of the participants and utilized non- musical intonations. The musical pieces consisted of tones and melodies that assessed the emotional states of the participants. Behavioral data consisted of measurement of valence, which included the effects of musical connotation factors that measured different arousal and responses to a favorite style of music consisting of sad and happy excerpts. In both groups, with ASD and NT, individuals agreed that happy music produced more arousing emotions, and sad music produced fewer arousing emotions. Valence scores were recorded to measure the emotional levels and musical interactions the participants experienced.

Several problems existed in the study, including the fact that certain music excerpts used were not pre-evaluated before the research began. Also, there was no way to previously screen the individual music selection to properly evaluate the level of emotions that impacted the researched individuals. There were facial expressions that did not correlate with how the ASD individuals were accurately measured. It did not occur to researchers to use better technology to do so did not occur in this study. There were many strengths in the study. The study included use of neuroimaging which provided the researcher accurate information in measuring the neurobiological deficits. Different brain regions were examined to measure the various levels of music. ASD individuals were found to process musical stimuli better, and this study helped support that.

The author's conclusion included that social stimuli experiments have been explored while there are less non-social studies competed. The measurement of the social and emotional levels was clearly identified in autistic individuals when they listened to the music. The study

also showed some sort of need for music therapists to work on emotional skills with autistic individuals.

A related study, “Emotion Perception in Music in High-Functioning Adolescents with Autism Spectrum Disorders”, observed how students with autism (ASD), had high success rates in performing and completing different musical tasks. Music is not about playing the notes and instruments, but feeling it as well. The ASD students who participated in this study were given the chance to rate emotion intensity while still recognizing their emotions and how they changed when listening to a particular type of music. The question that was asked in the study included how individuals with ASD perceive emotions conveyed by music (Quintin, Bhatara, Poissant, Fombonne, & Levitin, 2011).

Two groups of 26 people, (typically developing and ASD) with a total of 52 participants were included. The range of ages included ASD=13:7, range of 10:10 to 19:4 TD: M=13:6, range of 9:11 to 17:9. The final ASD group consisted of three adolescents with autism, 13 with Asperger’s and 10 with PDD-NOS. The participants were also recruited by word of mouth along with advertisements placed at the university posts in four schools in Montreal, CA. This was a qualitative research study, included as an instrumentation and experimental procedure. The study measured the abilities of the individuals with ASD and TD to see if they could recognize certain emotions in music.

The summary of the results concluded that the mean performances of the ASD group were slightly below the TD group. “There was no significant interaction between ‘intended emotion’ and diagnostic group, showing that some emotions were recognized with greater accuracy than others and that this pattern was similar for both groups” (Quintin, Bhatara, Poissant, Fombonne, & Levitin, 2011). The authors’ conclusion was based on the deficit

amounts in emotion recognition and allowed for a test of the amygdala theory of ASD with how the authors related to the perceptual levels in the musical domain. There were many participants who left the group after not being able to take part fully by either playing instruments or proving effectiveness during the testing phase. This was one problem that the authors conceded. The raw scores were found to be inconsistent with adolescents who have ASD and were not as correct as adolescents with TD who recognized full emotions of happy, sad, scared, and peaceful. There was a lack of interaction between intended emotions with both groups. There was, however, a greater accuracy with TD participants that was the same with the ASD participants. Some emotions measured could can be easier to recognize in music, and verbal ability could be related to the ability to make judgements accurately (Quintin, Bhatara, Poissant, Fombonne, & Levitin, 2011).

The study, "Brain connectivity reflects human aesthetic responses to music," (Sacs, Ellis, Schlaug & Loui, 2016) involved, "using a combination of survey data focused on the behavioral and psychophysiological measure and diffusion tensor imaging, or (DTI). The study found that white matter connectivity between sensory processing areas in the temporal gyrus and emotional and social processing areas explains individual different in reward sensitivity to music. This study also suggested that social-emotional communication through the auditory channel may offer basis for music making as aesthetically reward for humans."

Humans can experience pleasure to certain stimuli with very little evolutionary advantage. Different aesthetic responses through finding and engaging with the arts activates the same reward network in the brain that also responds to basic, sensory pleasures including food, sex, drugs, and dopaminergic pathways (Blood & Zatorre, 2001; Salimpoor et. al., 2013, p. 98). One thing, referred to as the reward system, helped individuals in pro-social functions with

cooperation and self- disclosure (Tamir & Mitchell, 2012). Comparing aesthetic and social rewards had an affective hypothesis of high order pleasures that occurred when a stimulus driven process of the brain was involved in emotional reasons, responses, and appraisals (Huron, 2006).

Music provided an ideal stimulus such as the study of pleasure and reward approaches that explain why humans enjoy music (Tramo, 2013). Persons listening to music could feel mental and bodily sensations physically shown through chills, tingling sensations on the scalp and back of the neck (Panksepp, 1995). There have also been proof of changes in psychophysiological measures of the heart rate and skin changes (Steinbeis et al., 2006).

The emotion and reward systems are found in all humans, but not everyone experiences the same intense emotional responses to music as others (Grewe et al., 2005). The differences in music abilities, familiarity, engagement and in measures of one of the BG Five personality trains including openness were comparable. These reactions to aesthetic stimuli were not reported either (Nusbaum & Silvia, 2010). Sachs, et. al (2016) predicted that similar structure between the auditory and reward processing regions helped with responding to music aesthetically.

It was found that DTI was the most effective way of measuring the differences in structural connectivity looking at psychiatric and neurological disorders (Quintin, Bhatara, Poissant, Fombonne, & Levitin, 2011). Using DTI helps while controlling aesthetically responsive and unresponsive intervals, while controlling other factors helped decipher any neurobiological basis of an individual's aesthetic responses to music (Sachs, et. al, 2016).

A total of 237 people completed an online survey which assessed their individual background with music and collected from community and university email lists through the Boston, MA area (Gosling et al., 2003). Researchers reported there was a 10-Item Personality Measure Index, (TIPI) used and included questions from a questionnaire described as the Short

Test of Musical Preferences (STOMP) (Rentfrow & Gosling, 2003). The levels of emotional response to music were assessed based on answers to the Aesthetic Experience Scale in Music, (AES-M) (Sloboda, 1991; Silvia & Nusbaum, 2011). Basic demographic information was collected from the survey and included the total number of years the participant had musical training and personality measures.

Chapter 3

My data collection for this thesis was based on qualitative research. The questions to be addressed; Does music impact an Autistic individual's brain and how does this differ from a non-autistic individual's brain? How do we measure and identify the impact of music based on brain functioning? How do musical interventions benefit the emotional and social aspects of individuals on the Autism Spectrum? Does theoretical and practical research support the benefits of using music with students who have developmental and neurological disorders?

Music can impact an Autistic brain by observing the scientific, theoretical, and evidence-based information and how it is used in the classroom and home. We can look at the developmental stages and focus on an autistic person's brain development and consider how it differs from a neurotypical person's brain. This may be done by using MRI, fMRI, and different imaging techniques. Case studies have researched the neurological effect of music between autistic and non-autistic individuals when they listened to and engage in music activities in clinical, educational, and home settings.

Music therapy used in clinical and school settings can have positive lasting social and emotional effects for individuals with autism. The research in chapter two supports neurological evidence that music can affect areas of the brain including the auditory cortex, cerebrum, cribellum and limbic systems. Imaging and case studies were used to measure levels of dopamine and the pleasure centers of the brain. Music therapy looks at how the technique plays a role in educating individuals with autism and how the results benefit social, emotional, and academic behaviors.

The information and applications I think are most important for my colleagues to know are based on the studies that used fMRI and MRI's to research the areas of the brain that are directly affected by music during music therapy. It is also important to look at the types of data that the research studies collected that include observations of the emotional, behavioral, and social changes when music was applied to a controlled group. These studies signified the benefits of music; including the engagement of the individuals in the study. The techniques applied affected the individual's to be receptive to the research activities.

Another piece of information that I contribute to help support my evidence that music is a valid technique for autistic students studies include comparing autistic and non-autistic participants. This is important because the individuals were observed in a group with others who had deficiencies, which helped the researchers collect information for a specific group (such as autism). When this occurred, the groups were able to carry out the activities when provided with appropriate accommodations. For instance, if the autistic group acquired certain tools or specified types of music that was appropriate, the researchers were able to conduct the study under a controlled environment to achieve the best results.

Data that researchers were able to conduct in the United States is sufficient because there are tools (such as the DSM-IV), locations and facilities available to replicate a controlled study. The population of autistic people is large enough to conduct broad or specific studies in larger cities in the United States. Education in the United States considers local, regional and global populations of people with autism. Information from the data stated it was hard to apply the same research practices when observing individuals with autism including the brain imaging and neurology research because the school programs and scientific tools are not available in all countries. This makes it hard to collaborate to gather diverse data from around the world.

My research also applies to education in Minnesota because of the standardized and clinical support that the educational system has with the Department of Education and many organizations such as Autism Speaks Inc., Autism awareness, and Autism Society of Minnesota. The contributions to these organizations help drive research, support, and funding to help conduct better research and hopefully treatments that pertain to autistic individuals.

School districts in Minnesota are starting to realize that music therapy is necessary in both the public and private school systems because music has been shown to provide beneficial social skills and enhanced academic growth in the school settings. It is important for the students in these settings to have an outlet for music because there is scientific support that music therapy and other incorporations of music have positive effects on children with autism. It was also noted that students of all disabilities can benefit from these services as well.

I did not investigate the neurological and technical research from some studies because of the specific neurology data. I was able to interpret some information that I read because I had a general idea of how and why music affects the brain.

My pool of research was limited because of biased information based on studies of solely male participants ranging in age from two-20 years. Because the majority of individuals with ASD are male the data on females is limited. This does not help differentiate research for female individuals and the effects of music on the female brain. I think this is a valid research question, because emotions, intellect and personality can differ from male and female persons. I want to find more research conducted on how music can affect a female with autism and also what affect music differs in their brain neurology and development. I am sure the research is out there, but I did not have access to articles for that gender .

I expected to find more information on which different musical techniques can be applied in an educational setting. I have experienced music incorporated with yoga calm which is a technique that is used in the public-school setting. This incorporates yoga and music as a therapy to help de-escalate children's unregulated behaviors and give students strategy and skills to help them self-calm. I have also used ME-moves which was developed by an Occupational Therapist in Hudson, Wisconsin. Me-moves is a video that incorporates movement and music to acquire the same affects as yoga calm, These activities have also been used by classroom teachers, when needed. I did not find research for these activities and how they are applied as therapeutic and music-enhancing methods.

The effects of music applied in classrooms cannot be conducted by scientists or the medical profession. School districts and school boards should offer classes that educate the positive effects of using music in our public-school systems to better train teachers with the methods to incorporate music into teaching. The trainings can inform and provide information to those who are not familiar with music methods or do not have enough knowledge about music. If training and higher education classes included some credits involving music education, it may impact how often we use music in our schools. Courses could also be provided as a continuing education credit or higher educator credits.

My school districted provided seminars to inform professionals about ADHD, (Attention Deficit Hyperactivity Disorder), and ADD (Attention Deficit Disorder). These classes help staff gain understanding in what to look for, ways different strategies can benefit students with ADHD, and how ADHD/ADD affects classrooms and life at home for students. The benefits of similar seminars regarding music could be just as crucial for educators.

Some questions I would like to pursue include: What happens to the brain when an autistic student is exposed to music who has never experienced it before? This could be through a music therapy program, playing an instrument or engaging in music as a hobby. I would like to read more studies about how the brain changes while performing in music activities.

If music can impact an autistic brain through listening, what are some ways we could study the brain with an individual playing music? What are different techniques that researchers could use to measure whether music has benefits for autistic individuals in different settings such as churches, choirs, and public settings such as malls. Since music can be found everywhere it is important to look at each setting and how music is being applied.

The questions I wanted answered throughout this thesis were: How does music impact an autistic individual's brain and how does this differ from a non-autistic individual's brain? How do we measure and identify the impact of diverse types of music on brain functioning? How do musical interventions benefit the emotional, social, and educational aspects of individuals on the Autism Spectrum? What theoretical and practical research supported the benefits of using music with students who have developmental and neurological disorders?

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