

Music Therapy: An Alternative Treatment for Tourette's Syndrome

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Abstract

Around 1.4 million people in the U.S. are diagnosed with Tourette's Syndrome (TS), also referred to as Tourette Disorder (TD), which is a condition that affects the nervous system. It is typically presented with sudden, repeated motor and vocal movements known as tics. Its symptoms in addition to the tics are diverse, with people often retaining other conditions such as attention deficits, obsessive-compulsive disorder, anxiety and depression, learning disabilities, etc. The symptoms of TS and its associated conditions often lower one's quality of life. Unfortunately, the exact pathophysiology processes behind TS are largely unknown, although it is likely a cause of various complex genetic factors. As a result, a curative measure for this condition has yet to be found. Due to the lack of definitive treatment, part of the effort of studying TS is to find means to alleviate its symptoms. Medications and behavioral therapy have been applied in the past decades. Music therapy, while not thoroughly explored as an alternative to improving symptoms of TS, has shown to be a promising alternative treatment. It has been used to treat similar conditions to TS before, such as Parkinson's Disease, Huntington's Disease, etc. During music therapy, the patient listens or plays various types of instruments and genres, or discusses the meanings of such with a music therapist. Scientists have been able to link the decrease of tics with activities incorporating a substantial amount of focus, such as with athletics or music. There is evidence showing that the areas of the brain affected by TS also had some changes associated with listening to music. These studies have shown that music therapy is a viable option for lessening TS symptoms, and potentially an alternative to medications with some unique superiorities as compared to the medications presently in use: no side-effects, non-invasiveness, be enjoyable, and improvement of overall health.

Intro/Analysis

This paper aims to determine the effectiveness and significance of music therapy as an alternative, noninvasive treatment to Tourette's Syndrome with minimal side effects compared to other forms of treatment and the plausibility of music therapy being implemented in the future as a more widespread, standard form of care. Tourette's Syndrome (TS) is a neurological disorder that is characterized by, and usually causes, rapid and/or repeated involuntary sound and movements – called tics. There are two major groupings, vocal (sounds) and motor (movements). The severity of these tics fluctuate. The symptoms (tics) can be exaggerated by many factors – environmental, external and internal, etc. Studies have shown that anything from fatigue and anxiety to distraction, and even being observed could affect tic rate in those afflicted (NHS, 2017; Royal Children's Hospital Melbourne, n.d.; Hasan, 2020; Cleveland Clinic, n.d.). While TS can be chronic, it usually isn't – it onsets during childhood and tends to recede with age, especially during late teens and early adulthood. TS also occurs more often in males as opposed to females. TS was discovered in the 19th century around 1884-1885, by a French doctor named Gilles de la Tourette, who studied under Jean-Martin Charcot, who is largely believed to have been the “father of modern neurology” (Lajonchere et al., 1996). While there are no cures, there are a few different treatment options that aim /to reduce the general symptoms and aid in the controlling of tics, such as dopamine-reducing medication, injections, antidepressants, and various types of therapy (Mayo Clinic, n.d.).

The cause of TS is largely unknown. It is believed that the deviation of a few neurotransmitters may contribute to it. In TS patients, the amount of dopamine, a neurotransmitter that aids motor and reward systems in the brain, was found to produce in excess in the striatum (Leisman and Sheldon, 2022). The striatum is one of the places where dopamine is located. It is involved in reward processing and function. It also has other important functions, such as motor (which correlates to TS, i.e. body movement spasms) and executive functions (Bamford and Bamford, 2019). Executive functions refers to everyday, basic tasks, such as planning, following distractions, and self-control (Harvard University, 2019). This signifies importance in this area of the brain and its correlation to TS.

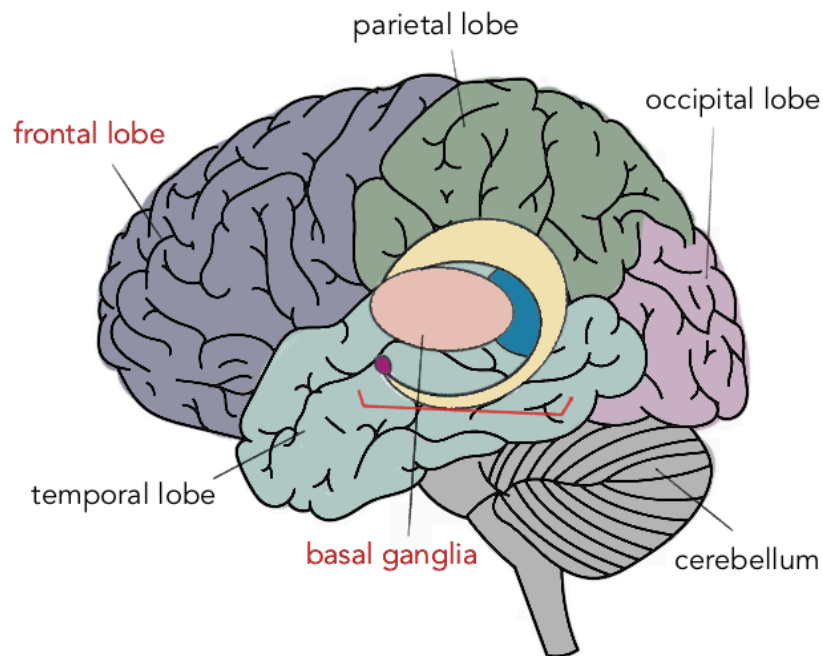


Fig. 1. Color-coded regions of the brain.

An overproduction of dopamine has often been linked to amplification in normal neurological behavior, such as increased aggression or lessened self-control. An overproduction of dopamine has also been associated with neurological disorders, such as schizophrenia and ADHD. The higher dopamine levels appear to trigger the shift of balance between the excitatory and inhibitory neural pathways more toward the excitatory side, producing more tics (Cleveland Clinic, 2022). Excitation and inhibition refers to the communication of neurons through electrical currents; excitatory pathways help to pass along information between neurons, and inhibitory pathways regulate this passage (Ippolito, 2020).

TS also appears to be associated with inhibitory nerve pathways, such as the levels of gamma-aminobutyric acid – GABA for short. These are the neurotransmitters that calm and lessen nerve cells' activities (Cleveland Clinic, 2022).

GABA is a key neurotransmitter for maintaining balance between excitation and inhibition in the nervous system in order for neural circuits to function properly. GABA specifically is an inhibitory neurotransmitter that is responsible for keeping excitation in check in neurons (Allen et al, 2024). A study has shown a decrease in GABA levels, specifically within the striatum, in those afflicted with TS (Draper et al., 2014). Additionally, those with other neurological disorders similar to TS, such as ADHD or even general anxiety, are found to have a similar reduction in GABA levels (Draper et al., 2014). In TS, both excitatory and inhibitory pathways function abnormally. As the affected child matures, changes in the brain and the rest of the body help to increase GABA levels, which then balance out the neural pathways (Schür et al., 2016). This re-balancing of neurotransmitters is most likely the reason for the lessened symptoms and TS rates in the adult.

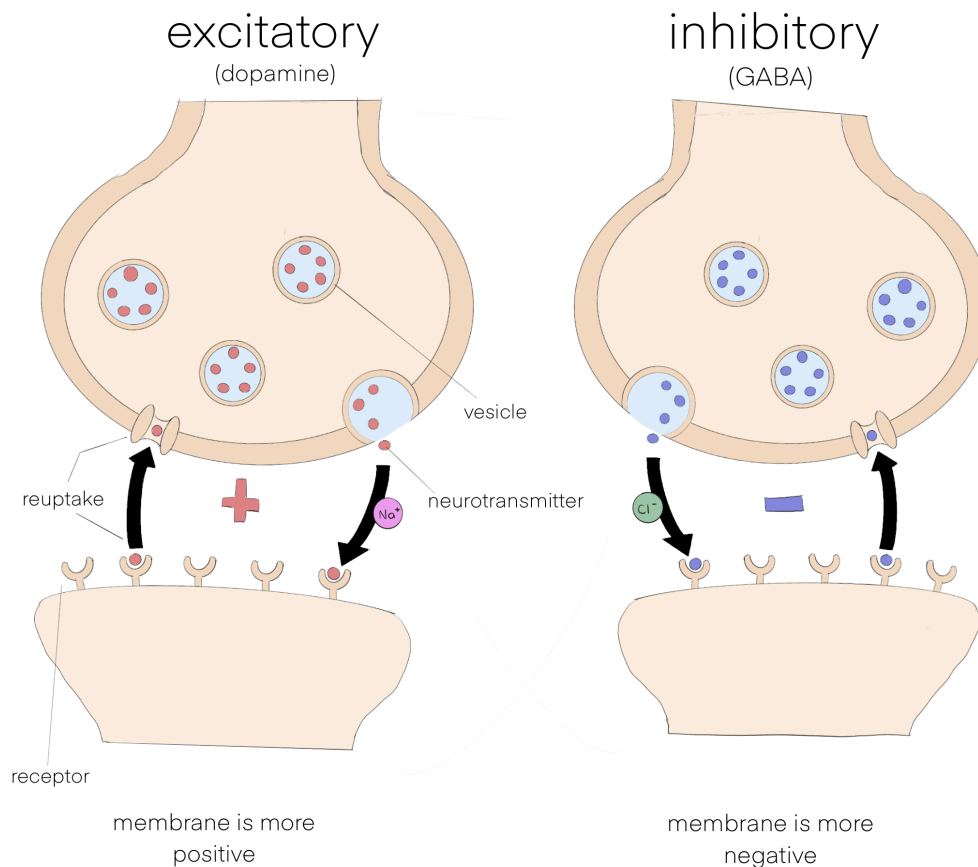


Fig. 2. Function of two amino acids according to the main (predominant) neurotransmitters.

In terms of medication treatment for TS, there are a few types. The first type is the medications helping reduce dopamine levels. Those medications include fluphenazine, haloperidol, risperidone, pimozide, and tetrabenazine (Mayo Clinic, 2018). Unfortunately, almost all of those medications carry a few significant side effects from weight gain to severe depression.

An additional treatment would be botulinum – mainly known as Botox – injections. Although most widely known for its cosmetic use, these injections can actually help to lessen tics as well (Burns, 2016). Botox functions by blocking certain chemical signals connecting nerves to muscle, which effectively weakens/paralyzes muscle tissue and stops it from contracting. Because of this, the muscle is unable to normally respond to the signals from the brain that would usually cause tics, and thus lessens the amount. There are a few different types of botulinum injections, including Botox, which is the most common, as well as Xeomin, Dysport, and Myobloc. However, although usually safe to use when a licensed health provider administers it, this treatment is relatively invasive compared to other common remedies. In addition, there are a few side effects to face, such as infection at the location of the injection. There is also a possibility that the treatment may spread to other parts of the body, which would result in unwanted muscle weakness, vision and/or breathing problems, allergic reactions, etc. (Mayo Clinic, 2018).

Medications used for ADHD are also a possible choice for treatment to help the decreased amount of focus, attention, and concentration as the major symptoms for both conditions. These medications usually involve the ingredients methylphenidate or dextroamphetamine. Besides having a possible allergic reaction, ADHD medications may actually increase the amount of tics for certain people with TS, although there is also contradictory evidence, making it a trade-off between different symptoms (Law and Schachar, 1999). It is well known that all of these treatments have side effects. Music therapy is an alternative treatment that may be able to alleviate the symptoms of TS, yet carries essentially no side-effects. It is non-invasive, enjoyable, and beneficial for overall health.

The main impacted parts of the brain in TS patients are the basal ganglia – of which the striatum is a part of it, and the frontal lobes. These areas are presumably responsible for the symptoms or tics (National Institute of Health, n.d.). As music has the ability to enable people to concentrate, it can be seen as a promising treatment. Music therapy may help to restore disrupted neural networks. In addition, the frontal lobe of the brain is also one of the key brain structures in decision-making and goal-directed behavior (Leckman et al., 2010). As music itself requires a significant amount of concentration and attention, as a means of training, listening to music might help pivot back to the neural balance of excitatory and inhibitory circuits, and accordingly alleviate the disrupting symptoms resulting from TS.

Music Therapy as Treatment

Music in general has a variety of benefits, including improving efficiency of general tasks, enhancing memory, improving anxiety symptoms, and even acting as a pain reliever (McCrary et al., 2022). Music is also something most people experience, due to it being easily accessible on a daily basis. Given all of the listed benefits of music, music therapy has naturally become a tool to help with a multitude of conditions, from bettering overall lifestyle to being the focus of research that may make it a feasible and effective alternative to treatment of neurological conditions such as TS.

Music therapy encompasses a number of musically-oriented activities, also known as rhythmic auditory stimulation, such as dancing to tunes, singing, instrumental performance, or even writing down one's particular feelings about a piece (American Music Therapy Association, 2005). Although not investigated as widely on TS, there have been studies done on similar movement-related conditions. In particular, a study on the effect of music therapy on Parkinson's Disease, which similarly affects the central nervous system and hinders intentional movement,

found that functions in the frontal lobe, which is the driving force of the executive control network, greatly improved (Devlin et al., 2019). The study also examined the effects of music therapy on other movement disorders, including TS. In particular, the study focuses on rhythmic auditory stimulation, also known as RAS. This particular type of music therapy makes use of a metronome or a music cue, adjusted to the patient's movements, typically gait or other 'biologically rhythmic' movements.

Parkinson's Disease is a movement disorder that is characterized by uncontrollable movements, namely tremors; it is linked to neuron damage in the brain, which causes dopamine levels to be lowered (National Institute on Aging, 2022). Other symptoms include mental and behavioral changes, which tend to progress with time, speech impairments, etc. Similar to TS, there are no curative treatment options available at present. The study found that there were significant improvements in the patients' balance and gaits, and noted that even within groups with music therapy (Devlin et al., 2019). Additionally, therapeutic singing was another tested intervention in the study. The study found that singing improved both cognitive and motor functions in patients with Parkinson's Disease, as well as general quality of life improvements. Although instrumental studies were conducted as well, they were often sparse and not well-organized; however, many showed some degree of improvements, suggesting that further, more organized studies may be needed.

Another tested disorder from the study was progressive supranuclear palsy (PSP) without definitive treatment methods. It occurs when cells in the brain, specifically cells that control body movements and coordination are damaged or destroyed (Mayo Clinic, 2024). Music therapy is one of the very few treatments that has been proven to relieve symptoms of PSP, and were able to have greater amounts of movement.

Though the effects of music on TS have not been widely studied, there are still a few studies showing the promising benefits of music on TS, which have found even greater success than those in other movement disorders. One study in particular looked into various types of music therapy on a few different movement disorders, such as Parkinson's Disease and Huntington's Disease, as well as Tourette's Syndrome. The types of therapy included rhythmic auditory stimulation, rhythmic speech cueing, auditory perception training, etc. The study found that TS symptoms were successfully reduced in all tested interventions (Devlin et al., 2019). Because of this, music therapy could be considered a novel treatment without the side effects or invasiveness of other forms.

Conclusion

Music therapy in most forms, especially during musical performance, is able to positively impact the symptoms of Tourette's Syndrome. While TS is often associated with decreased gamma-aminobutyric acid levels, music therapy may help increase GABA levels in key places in the brain, which subsequently restores the balance of neurotransmitters in the brain. TS also decreases with goal-directed behavior or increased focus and concentration levels, all of which is in the nature of musical therapy and training. Comorbidities of TS have also seen positive results with exposure to musical therapy. Thus, musical therapy might be a viable form of treatment for those diagnosed with TS. However, while the vast majority of studies point to improvements, there is still some conflicting evidence and basis behind the results of musical intervention and its connection to brain function. Much of this controversy could be alleviated with technological advancements allowing for better understanding of the brain's anatomy, functions, and in the case of TS, interaction between dopamine and GABA within the brain.

There are also various types of music and ways to express it, and because of this, certain types of music therapy and intervention may not work for some TS patients. This form of treatment may need to be individualized. Due to the vast amount of music genres and subgenres to choose from, one is able to fine-tune their form of musical intervention to their preference. Additionally, musical intervention appears to be slightly less effective for TS patients in certain situations, namely, that symptoms tend to return after therapy. Given the side effects in other treatments and the general benefits of music in life, it is an acceptable compromise much lower than that of other remedies. The fluidity and the plethora of musical forms in the world allows for a research window to have a better understanding of the disorder while looking for innovative cures and treatments that are sure to be studied further in the future.

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