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Review Article

Embouchure Dystonia: Review and Perspective from a Horn Player

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Abstract

Musician's Dystonia is a type of Task-Specific Focal Dystonia that pertains to performing artists, impairing their interaction with their instrument and rendering them unable to perform effectively. Embouchure Dystonia is a sub-type of Musician's Dystonia that specifically pertains to wind (e.g. oboe, flute, clarinet) and brass (e.g. horn, trumpet, trombone) instrumentalists, affecting the oro-facial neuroanatomy.

The intensive and repetitive musical training that musicians undergo expands and refines (via surround inhibition) the physiologically relevant region of their sensorimotor cortex, improving their motor advantage and thus performance ability on their instrument. Maladaptive technique as it relates to their instrument and over-practicing can partially fuse regions of the sensorimotor cortex and defocus specific neuromuscular action which may lead to the development of dystonia. Treatment options for this disease may include monotherapy or combinations of motor retraining, ergonomic changes, botulinum toxin injections, sensory tricks, transcranial direct current stimulation and surgical intervention. It is unclear how effective these therapies are, how long their effects last, and their influence on performance ability in the musician (i.e. return to previous or greater playing ability or not). A healthy and balanced approach to practice and performing is essential to prevent the development of Musician's Dystonia. This includes appropriate rest from practice, mental practice, increasing efficiency of practice and instrumental technique, a healthy approach towards music-making and maintenance of general physical health.

Keywords: *Dystonia; Embouchure; Musician; Focal Dystonia; Musician Dystonia*

Introduction

Dystonia is a neurological condition that involves involuntary muscle contraction. Musician's dystonia (MD) is a task-specific movement disorder characterized by a loss of voluntary motor control, often occurring in highly trained muscles. MD typically manifests itself as a particular movement related to performance on a musical instrument. Seen in 1 - 2% of all professional musicians, MD is often career-ending for those musicians affected [1]. The predominant forms of MD can be categorized as focal hand dystonia (FHD) and embouchure dystonia (ED). The embouchure is the set position of facial muscles used to initiate and control the amplitude and force of airflow into the mouthpiece of a wind/brass instrument [2,3]. Thus, ED is a dystonia affecting the coordination of the lips, tongue, facial and cervical muscles, and breathing in brass and wind players. This article will review the anatomical basis, causes, development, treatment options and preventative strategies pertaining to MD, specifically ED, from the perspective of a brass musician.

Neuroanatomical basis of fine motor skills

Development of specific fine motor skills is essential as a musician when performing on an instrument. A musician's technical proficiency primarily involves the accuracy and precision of these skills, directly influencing their performance ability. Learning of fine motor skills involves several regions and structures in the brain, including the motor cortex, somatosensory cortex, and basal ganglia. The motor cortex is responsible for the planning, control, and execution of motor movements. Neurons in this region are adaptable to specific task requirements, encoding motor parameters such as direction, velocity, position and muscle activities, resulting in increased precision and uniformity of movements [4]. The somatosensory cortex is responsible for processing somatosensory input (e.g. touch), with neurons projecting into the motor cortex. In other words, the somatosensory cortex monitors what a musician sees, feels, and hears, while the motor cortex tells their body how to move in order to play the instrument properly. The term 'sensorimotor cortex' refers to the joint role of these structures. Training a skilled motor task prompts the reorganization and development of this region [5].

Procedural (motor) learning is the improvement of a motor performance task over several training sessions. Perceptual learning is how, through sensory interaction with the environment, sensory systems can respond to various stimuli. Both motor and perceptual learning follow a general pathway [6], as seen in Table 1, where the example of a musician preparing for an audition is applied.

Several cycles of steps 3 and 4 can be repeated as the musician prepares for the audition. Professional musicians spend years of dedicated practice using the above model (or similar) to develop a high level of proficiency, optimizing their anatomical interactions with their instrument.

Step	Learning Event	Example of Musician's Learning Process
1	Training occurs	Initially practicing an orchestral excerpt
2	Memory formation and within-session learning	Technical and musical proficiency gained in initial practice session
3	Consolidation of memory (stabilization and offline learning)	Passage of time, sleep and/or listening to recordings of the excerpt
4	Memory reactivation and modification	Additional practice and fine-tuning the excerpt
5	Long-term memory retention	Performing the excerpt at an audition or performance as intended

Table 1

Possible causes and development of ED

The world of professional music is marked by extremely high competition and laced with perfectionism, driving musicians to spend several hours practicing daily. Ineffective practicing, inadequate rest, and too many hours spent practicing can cause injury to the musician such that they are unable to adequately perform on their instrument. The initial symptoms of MD are typically disguised as a lapse in the musician's usual ability to perform on their instrument, often perceived as poor practice habits or insufficient preparation. This misplaced blame often prompts increased practice time, in addition to the anxiety and stress from their deviation from regular playing ability.

A combination of dysfunction in the basal ganglia, somatosensory neural network and motor cortex are thought to be the main neuroanatomy implicated in focal dystonia [7]. Musicians who reach the professional level undergo many years of intensive motor training of

repetitive sequences, resulting in beneficial sensorimotor reorganization. This includes the increased excitability of the trained regions of the motor cortex and a higher sensorimotor plasticity potential. However, these changes may predispose musicians toward maladaptive brain plasticity, via overtraining, leading to abnormal sensorimotor processing and dystonic symptoms.

Maladaptive plastic changes in the sensorimotor network are seen in both focal hand dystonia and embouchure dystonia. In professional musicians the brain's representation of the fingers and embouchure has expanded from intensive and repetitive musical training. Observed as a less differentially organized pattern of sensorimotor representation, this provides musicians with a motor advantage in playing their instrument [8]. In MD patients, overtraining can produce further maladaptive reorganization of the sensorimotor cortex, resulting in less spatial differentiation and impaired intracortical inhibition [9]. In FHD, the digital (finger) representations in the somatosensory cortex are fused [10]. In ED, sensorimotor overactivity in the somatotopic facial representations within the bilateral primary sensorimotor cortex has been documented [7].

Certain neurotransmitter may also play a role in the pathophysiology of ED. Dopamine provides a fine modulation of synaptic plasticity, guaranteeing a balanced transmission in the sensory-motor loop of the basal ganglia. Decreased release of striatal dopamine during hand activation in patients with writer's cramp has been reported [11]. Further suggesting the role of this neurotransmitter, decreased dopamine uptake on (123I FP-CIT)-SPECT was reported in a drummer with focal dystonia [12]. Summatively, the regions of the brain responsible for the motor coordination of the embouchure muscles are likely overactive, disorganized, and misregulated, contributing to the lack of fine motor control of the embouchure.

Current treatment options for ED

Musician's dystonia typically only appears while playing the instrument, but in more severe cases can affect other activities. If left untreated, MD will render the musician unable to play their instrument, involuntarily ending their career. Several treatment modalities had been tried, including medications, botulinum toxin injection, ergonomic devices, pedagogical retraining, nonspecific instrumental exercises, and surgical procedure.

In a previous report, attempts to treat ED with anticholinergics or baclofen were unsuccessful. Botulinum toxin injections have been used in the treatment of MD including ED with limited success [13,14]. Another potential therapy for MD is the use of an ergonomic device in the retraining of playing one's instrument. Sensory motor retuning therapy was proven effective in temporary alleviation of dystonic symptoms in musicians with FHD [15]. Using a hand splint to isolate the movement pattern of specific fingers in the affected musician, this therapy induced plastic changes in the motor cortex of the subject, leading to a more normal sensory representation and reversed dystonic symptoms. In a case study of a 28-year-old trumpeter with an intermittent tremor of the lower jaw, the use of a custom dental splint was able to completely alleviate their dystonic symptoms [16].

Surgical procedures and direct stimulation of the brain have been used as alternative treatments of MD. In one case report, bilateral pallidotomy abolished ED in a saxophone player which allowed the patient to continue to play professionally [17]. A larger study showed fine motor control improvements in pianists with FHD from bihemispheric brain stimulation [18]. Both treatments are promising, however further assessment is necessary.

Brass motor technique, pedagogical suggestions and ED

In the past few decades, musicians, doctors, and scientists have come to better understand the nature and causes of Musician's dystonia. While there may be relative medical success in alleviating symptoms ED, this does not equate to a return to the previous playing abilities for the musician. ED is still not fully understood, and as such the most effective treatment methods have not yet been developed. In lieu of proven methods to restore professional musicians back to previous playing ability, prevention of development of dystonia remains

the best option, and will always be. Hence, we would like to focus on pedagogical suggestions and technique, using technique-related issues in focal embouchure dystonia in brass musicians as an example.

Playing in a brass instrument's upper register is physically more demanding for the musician, requiring finer embouchure control, higher air velocity, and higher muscular tension. In this register, the tongue is utilized to shape and increase the velocity of airflow into the mouthpiece (and through the instrument), allowing stable and accurate production of higher pitches. In two different studies, instrument-performance related orofacial movements of healthy professional brass players were compared to those with ED using real-time MRI [19,20]. These musicians performed a specific set of exercises covering the musical range of the instrument inside an MRI machine, using a modified, MRI-compatible trumpet or [French] horn. It was found that the anterior tongue was more involved in control of air-velocity than the posterior tongue and musicians with ED had a higher degree of variability of anterior tongue movement than healthy players [20]. When playing an ascending sequence of pitches, the healthy players would elevate and anteriorly displace their tongue, while the players with ED has significantly less tongue movement-termed, non-optimal.

The movement of the tongue is an essential factor in the production of sound on a brass instrument. As a significant regulator of air-velocity, the errant patterns of tongue movement seen in brass musicians with ED is certainly implicated in their dystonia. It is not clear whether the different tongue movement seen in ED is an adaptive strategy towards their dystonia or a possible cause of the dystonia [19]. Non-optimal tongue motor strategies likely result in lower air-velocity than is necessary to produce higher pitches on brass instruments. This inadequate air stream is then compensated for by excessive tension in the embouchure muscles. This can cause greater-than-necessary stressors on the body of the musician, possibly leading them down a path towards ED.

Based on the observation of a differential oral-lingual-facial movement pattern between healthy brass player and those with ED, we propose strategies (Table 2) to help develop healthy practice habits, reduce fatigue, and therefor hopefully reduce the development of a dystonia. Initial management of suspected ED symptoms should almost always include rest from playing one's instrument and medical evaluation should be sought as early as possible. Maladaptive neurological changes may be addressed by avoiding reinforcement of activities that produce dystonic symptoms. Training/retraining protocols for ED have yet to be developed, however management is likely to include reducing the total volume and intensity of playing sessions significantly. Consultation of both a physician (ideally a neurologist specially trained in movement disorders) and an experienced instrumental teacher are essential. Musicians should avoid making drastic changes to their equipment or setup prior to consultation with the aforementioned parties to promote the most informed approach possible. Recognition and awareness of this neurological condition is very important, and musician should explore various treatment options to reduce symptoms from an early stage.

Category	Technique	Description and Benefit(s)
Physical well being	Adequate rest	Reducing physical and mental fatigue.
	Shorter practice blocks	Greater focus, reduced intra-session fatigue, and increased productivity; may be able to increase frequency of practicing as well.
	Adequate sleep	Promotes consolidation of memories and can promote performance improvements [4].
Practice alternatives	Mental practice	Visualizing playing their instrument, keeping in mind exactly how they want the music to sound, i.e. tone quality, articulation, style, etc. This technique can improve movement accuracy and velocity, as well as promote motor anticipation [21].
	Part-singing	Singing one's part can help one experiment with stylistic choices, simplifying the part before adding the technical element of playing the instrument.
	Breathing exercises	Can help improve lung capacity, breath control, and airflow [22].
Efficiency	Practice journal	Tracking specific goals and tasks to be completed, increasing focus, reducing necessary and promoting a more informed approach to music making.
	Optimizing instrumental technique	Best addressed by an experienced teacher. Includes support of the embouchure with proper airflow, a centered and balanced (relatively) embouchure, and a concrete understanding of time (as related to coordination) promote proper playing technique. This also involves avoiding compensating for weak-points in technique—regarding equipment, alternative and less effective playing strategies, etc.—as long-term solutions to a short-term problem.
	Optimizing instrumental ergonomics	The ergonomics of an instrument may be modified to promote a more natural and relaxed interaction with the instrument, reducing unnecessary strain and/or body positioning.

Table 2: *Pedagogical suggestions.*

Conclusion

Seen in 1 - 2% of all professional musicians, Musician's dystonia is often career-ending. While intensive practice is required to become successful as a professional musician, too much practice and repetition, coupled with maladaptive habits may lead to abnormal sensorimotor network and resulted in dystonia. Several treatments tried for MD and while these treatments may improve the dystonic symptoms, it is unclear how many musicians were able to return to their previous level of ability. By developing healthy and efficient habits, Musician's dystonia can hopefully be avoided.

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Authors' Roles

Mr. Reddy previously studied Music Performance (BA; horn) at Case Western Reserve University and the Cleveland Institute of Music, and will be starting a MMus at the Royal College of Music in London, UK, in September 2021. Mr. Reddy was responsible for production of all aspects of this manuscript. Dr. Wu was responsible for assistance in writing, review, and critique of this manuscript.

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