UNIVERSITY OF TARTU

Institute of Sport Sciences and Physiotherapy

Joshua James Viinalass

The Physiological and Psychological Impact of Music on the Performing Artist

Muusika füsioloogiline ja psühholoogiline mõju esinevale muusikule

Bachelor's Thesis

Physical Education and Sport

Supervisor:
Associate professor, A. Pehme

Tartu, 2016

TABLE OF CONTENTS

ABBREVIATIONS

CNS - Central Nervous System

CuP - Choking Under Pressure

DA - Dopamine

LLD - Lower Limb Dystonia

MPS - Music Performance Anxiety

NA - Nucleus Accumbens

PRMD - Playing Related Musculoskeletal Disorders

TOS - Thoracic Outlet Syndrome

INTRODUCTION

Music is a widely spread and historic movement that has been impacting the human race ever since the beginning of time. It is bold but true to say that every human on the face of the earth throughout time has had contact with music and been affected by it to some extent. This is why I have chosen to do some research on the physical and psychological affects music has on the creators of music. Musicians are artists who use their talents to express themselves through making music. I also consider myself a musician, even though as a drummer, this is sometimes questioned.

The music industry is constantly growing and becoming more about precision and musical purity. This standard has had its affects on musicians since musicians are constantly pushing themselves to the limit to meet the expectations of the business and the listeners. The constant work to improve one's self has resulted in the growth of injuries among musicians. The injuries can be both physical, due to repetitious use of muscles and tendons, and emotional, due to the stressors experienced while playing an instrument and the stressors that surround the musician in their every day environment. Musician's injuries are important subjects to study due to the increase of musicians and injuries, and due to the minimal amount of qualified medical and psychological assistance that is available for the affected and often disabled musicians. The reason for choosing to look deeper into the scientific material concerning emotionally and physically injured musicians has been influenced by the witnessing of the loss of jobs and the loss of passion for music among some of my close friends and family. As an active participant in physical activity and being a trainer and musician, it is interesting to find out about the possible cures for these issues and it is also in my best interest that there are methods for preventing emotional and physical stress. These are principles I can practice in my own life, with clients and hope for a healthier impact on generations to come.

Keywords: Musicians, physiology, playing related injuries, psychological disorders, treatment, prevention.

Märksõnad: Muusikud, füsioloogia, pillimänguga seonduvad vigastused, psüühilised seisundid, ravimine, ennetamine.

1. GENERAL OVERVIEW OF MUSIC AND ITS EMOTIONAL AND PHYSICAL IMPACT ON HUMANS

Plenty of people (especially young people) dream of becoming a musician, and the more famous the better. The process of becoming a musician is one to which most of them give little thought, and still fewer ever spare a moment's consideration for the physical toll the life of a committed musician will demand on their body.

The process begins with inspiration. A person sees, hears and feels something that some other musician has done, and has a desire to do, experience and give something similar – usually the dream for something even greater awakens. This is the beginning to a path of commitment and much practice, not merely to play an instrument, but to make that instrument an extension of their own body and to command it just as naturally as breathing. Listening and understanding music has also been made easy with the highly capable human ear that is capable of hearing music and also processing it in the brain, leading each human to feel a certain way.

Instruments are used across all musical genres to create sounds, each of which must first be played by the strongest "muscle" in the artist's body – the mind. Every genre has its own characteristics; every different kind of melody and lyrical content can also affect the actions of the musicians and listeners. Each note of each instrument has its own roll to play in the composition of any piece of music, from a serene classical passage to the most intense offer of heavy metal rock. Playing different types of music is just like every fiber of an athlete's trained body, where it's not just one muscle or limb doing the work, it’s rather the symbiosis of many muscles and muscle groups working in harmony that produces a winning athletic symphony.

1.1. Physical Impact of Music on the Artist

Reaching peak performance however, is not the result of a passing interest, but it comes only with many years of constant practice and dedication. All performing musicians, as with top athletes, are known to practice long hours each day, (Kenny and Ackermann, 2012). This amount of practice, along with producing tremendous musical results, can have a remarkable impact on the musicians physical health - and practice is only one of the musician's many physical stressors.

Aside from long hours of playing their instruments in awkward positions in practice, musicians also have to withstand the physical rigors of long stretches of concert performances. This too is draining and requires vast energy expenditures. Long hours of practice and performances also put a large neuromusculoskeletal demand on the musician and

can lead to developing performance-related musculoskeletal disorders (PRMDs) (Chan and Ackermann 2014) This is very similar to elite atheletes, who also put many hours a day into practicing and end up putting in much physical effort on the day of the competition, having to perform complex motor skills while simultaneously processing huge amounts of sensory information. (Altenmüller et al., 2000). This strenuous life style can lead to musicians suffering from many sprains, strains and overuse injuries. These injuries are mostly located in the musicians upper limbs and in some cases, notably drummers, in the lower limbs.

Being fit and physically ready to perform is just as important for a musician as it is for an athlete and the effects of a performance-limiting neuromusculoskeletal disorder can perhaps be even more devastating for a musician. It may take months to regain ones capability to perform and practice, but while most professional athletes may continue to be paid during periods of recovery, taking a couple of months off work is a luxury that most musicians cannot afford. Musicians also have bills to pay and mouths to feed, so not being able to work for several months due to an athletic injury may also be injurious to a musician's career.

1.2. Emotional Impact of Music on the Artist

This can lead into the downward spiral of not having work, not being able to practice and not feeling financially secure. This automatically triggers anxiety and stress about not being able to survive and provide. Anxiety and fear around performing and expressing oneself is something that an artist already has to deal with on a daily basis. The clinical diagnosis of this is called Music Performance Anxiety (MPA).

Being a musician and studying music can also have a positive physical and psychological effect. Learning an instrument means learning discipline and commiting to hours of practice. A large part of playing an insrument is being able to perform fine motor movements, also learning an instument increases brain plastisity, increases listening skills, linguistic skills, mathematical skills and also social skills (Miendlarzewska and Trost, 2014).

Even though there are many positive sides to being a musical artist, there are still musicians who stuggle with coping with the stressors that follow the lifestyle of a musician. Rehabilitating and preventing PRMDs is a priority in increasing the life quality of performing musicians. This can help prevent physical uncomfort and also decrease the amount of psychological stressors such as MPA and depression. The physical therapy performed on athletes is similar but not specific enough to be of major influnece to all musicians (Guptill 2005), this is why it is important to emphasize the significance of injury prevention among musicians and musical instructors.

2. MUSIC'S IMPACT ON THE HUMAN ORGANISM

Music is very abstract. It is not physical, and although it can not be touched by anyone, it touches everybody. Even though music is not seen by the eyes or touched with the hands, it is experienced with the ears. The way the ear can interpret sound and music is fascinating. The ear is a complex organ made out of three major parts: the outer ear, the middle ear and the inner ear (Bronwell, 1997). These three parts of the ear all work together to transfer music all the way from the outer ear where it is received, into the brain, where it is interpreted. When music reaches the brain it stimulates the pleasure center called the nucleus accumbens (NA). This important part of the brain is in charge of releasing dopamine (DA) which is called the 'crown' of the NA due to its significant roll in the human reward system (Mavridis, 2014).

2.1. Neurological Impact

The amount of DA released depends on the individual because each individual listening reacts to music in different ways. Neuroimaging studies show the difference in stimulus level of brain pathways while listening to single notes versus listening to melodies combined from individual pitches (Zattore and Salimpoor, 2013). Listening to melodies involves the use of arteriovenous and posterodorsal pathways of the brain (Zattore and Salimpoor, 2013). The amount of reaction a human has to music also depends on their previous experience, knowledge of music and exposure to music (Zattore and Salimpoor, 2013). The more music humans are exposed to the greater their experience "file folder" grows and the more they react to musical stimulus – regardless of whether it is a new piece or a old song from deep in the files.

2.2. Music's Impact on the Brain

Music also can penetrate into the heart and emotions of people. The vast influence of music on human emotions and moods (Mavridis, 2014) is surely one of the reasons why music has evolved into such a large part of our everyday life. Music has a major influence on the primary areas of our brain that trigger emotions. One of them is the amygdala, which consists of two mayor parts: the superficial amygdala and the laterobasal amygdala (Koelsch, 2014). The superficial amygdala is sensitive to faces, sounds and especially positive music (Koelsch, 2014). The laterobasal amygdala has been found to be associated with the evaluation of both pleasant and unpleasant music (Koelsch, 2014).

As mentioned earlier, the NA is related to rewarding. The primary and secondary rewards given are related to food, drink, sex, money and power (Koelsch, 2014). The NA has

also been reported to be active during rewarding experiences with music, therefore releasing dopamine into the body (Koelsch, 2014). Another key component of the brain that has a large roll involving the human emotions is the hippocampus.

In contrast to the NA, the hippocampus is not activated by money, food or sex related rewards, but is still activated when music reaches the brain. This indicates that emotions related to music are not only based on receiving rewards. The hippocampus is involved with the feeling of music produced positive emotions and reducing cortisol levels. The hippocampus is among one of the most sensitive cerebral structures, because it is the only brain structure that is prone to be damaged by negative stressors such as: stress involving helplessness, despair, post-traumatic stress and sexual abuse (Koelsch, 2005). On a more positive side however, since the hippocampus is activated via engagement with music, this can lead to positive effects on the brain merely through the social function music has, whether in singing, clapping or dancing, as well as something as minor as tapping ones foot along with the music.

These emotional impacts music has on a human being frequently result in physical movement and activation of the body with a range as wide as merely tapping your foot to breaking out in dancing. For some people a song can bring back either good or bad memories or induce certain emotions. Along with emotions from music come physical reactions such as the increase in heart rate, sweating, and the sudden urge to dance along to the music.

2.3. Musical Genres and Their Influence on Humans

There are many different characteristics that define a certain style of music. There is the sound of the music, the emotion of the music, the instruments and equipment used to play the music, the image of the music, the culture of the music, the aim of the music and the lyrics of the music. All of these different layers are considered in making and listening to a certain style of music. In today's rapidly evolving musical world if even one small element in a genre changes, then a sub-genre is produced which develops its own niche and its own listeners and performers, thereby creating an impact on the people involved.

2.3.1. Musical Genres Affect on Behavior

It only takes a few seconds of listening to a song to determine whether the music is pleasurable or not. This is an indicator that people have their own unique taste in music. Different genres of music are made for various people and target groups. In most cases, it is the listener that chooses the music, not the music that chooses the listener. It is common for people who easily accept new experiences to be open to blues, jazz, classical, and folk genres,

while people who are outgoing and affable tend to prefer music from the pop, religious, soul, funk, electronic, and dance genres (Rentfrow and McDonald, 2009).

The sound of music can have an influence on the emotions of the listener. It is clear that consonant music is more pleasurable than dissonant music (Koelsch, 2005). Already these two factors can cause variations of emotions in listeners and performers. Hearing music that is easy to listen to, is pleasurable for most people. This is why pop music has become so popular (Ballard et al., 1999). Everything about this genre of music is simple; the melody, rhythm and vocals. These basic aspects of a song are attractive to a typical listener even with out the lyrics, because the pop song resounds within them. (Christenson, 1992).

Pop music, heavy metal music and rap music lyrics almost exclusively refer to drugs, alcohol, sex and aggressive behavior (Ballard et al., 1999). Despite the fact that these topics are relevant and not hidden in the 21st century, the lyrics of music can have a large impact on the musician. In the case of pop, heavy metal and rap, the themes of the lyrics can have a direct impact on the behavior of the musician due to the fact that the music becomes symbolic of the personality and character of the musician. As the author - or even as the performer of a song, a certain image follows with the type of music being made and there is a pressure that is put upon the musician to live up to the image created by the music the artist creates. In the case of these specific genres this can lead to overuse of drugs and alcohol and sexually transmitted diseases which all have a direct negative influence on the health of the musician. This effect is by no means limited to the musician but as an example in the wider society, their actions are passed down to the listening public. A study performed by Ballard, Dodson and Bazzini (1999) on 160 undergraduate psychology students, showed that the antisocial lyrics of a song can significantly produce antisocial behavior.

Many different retail and commercial environments use music to create a pleasant atmosphere for people. The use of music in shopping centers though, can have a manipulative impact on people when used in the right way in the right context. During the morning, the music encourages shoppers to take their time and probably buy more, while as closing time approaches, the music invariably tries to hurry shoppers out the door. In addition to the many approaches to get people to buy as much as possible while shopping, music is also used to encourage customers to spend more. Since music mostly lifts people's moods then it has a specific impact on impulse buyers, because a positive mood is usually what impulse shoppers depend on while making purchases (Dingfelder, 2005). Recorded and also live music is used in casinos to create the right atmosphere for gambling and to create the right emotion within the casinos (Bramley et al., 2016). To achieve this, casino managers manipulate the tempo, volume and genre of the background music (Bramley et al., 2016).

2.4. Effects of Playing Various Common Instruments on the Human Body

Instruments, like sea waves, rise and fall, but some seem to have been around as long as the seas themselves. Some instruments are so familiar that they are instantly recognizable in a song. They accompany people at work, rest, and play, and their mastery demands endless hours of practice. Each instrument has its own certain position in which it is optimally played. Before the first false note of every beginner with aspirations of fame and fortune can be heard, the positioning of the body is already drilled into students. Eventually that posture has some effects on the musician's body for as long as they continue their musical career. This chapter will describe the cumulative physical impact the playing of these instruments can have on a musician's body.

2.4.1. The Violin Family

Let us consider the violin family. All instruments in the violin family have a similarly shaped body, four strings, a fingerboard and a bridge that is placed under the strings to elevate them. With regard to handedness, they are played by placing the left fingers on the fingerboard to determine the pitch while the right hand holds a bow that is drawn across the strings to make them vibrate – thus creating a sound. The violin and viola are played similarly, either by sitting down or standing up with the instrument resting between the left shoulder and chin (Lee et al., 2013). The importance of the position of the viola and violin player is demonstrated in a study by Spahn et al.(2014), where the difference of position in relation to the music stand can affect the physical health of the musician. Incorrect sitting or standing in front of the music stand can cause uneven bodyweight distribution and restricted bowing movements with resultant risks to both axial and appendicular skeletal injuries.

Also in the violin family is the mammoth contra bass, which is played perched atop a high stool or standing up due to its size. This is a common reason for back pain in contra bass players because they need to lean into the instrument to both correctly support and play it. Also, due to the size and weight of the contra bass the transportation of this instrument is a risk factor for back pain (Lee et al. 2013).

2.4.2. The Guitar

The ubiquitous guitar and all of its cousins is likewise hardly free of physical collateral damage to its master. Classical and non-classical guitarists often experience musculoskeletal problems due to the rapid movement on the fret board along the long neck of the instrument and also highly repetitious movements with fingers (Brandfonbrener 2003).

The fret board is similar to the fingerboard of the violin family instruments. These are used to determine the pitch of the sound created. This is done by the fingers of the left hand pressing on the stings to make a note is which called “fingering”. All string instrument players must do this very precisely to ensure that the right pitch is achieved. Fingering requires the hyper flexion of the left elbow and wrist and also can cause the forearm to be extremely supinated (Lee et al. 2013). Moving in and out of these positions can develop into forearm pain and joint symptoms in the wrist and fingers (Lee et al. 2013).

2.4.3. The Piano

As for the piano, piano players are known to practice continually for many hours during which their posture tends to worsen. Pianists tend to start to lean forward and raise their shoulders after multiple hours of practice (Brandfonbrener 2003). This can produce fatigue and pain in the entire back but especially in the thoracic paraspinal muscles and the upper trapezius (Brandfonbrener 2003).

2.4.4. Brass Family

The least problems are reported in the brass family. According to the International Conference of Symphony & Opera Musicians (ICSOM, 1987) the least number of adverse musculoskeletal effects are found in players of brass instruments, although with an incidence rate of 32 percent, that is hardly cause for a standing ovation. The main problem brass players face is the fatigue of small face muscles, which compromise the work that the mouth has to do while playing the instrument (Brandfonbrener 2003).

2.4.5. Percussion Family

Percussionists and drummers have possibly the most dynamic job when it comes to musicians. Their job is to physically strike their instrument to create sounds. There is a wide range of instruments for the percussionist to play, which means a large amount of various techniques must be acquired. Hand drummers are very susceptible to soft tissue injuries of their hands due to the repetitive striking of the drums (Brandfonbrener 2003). In addition to the different types of instruments, percussionists must master playing with various sticks using diverse highly repetitious grips. It is important to note that all of the different drums played are tuned to different tensions, so artists hands must cope with beating against surfaces with varying resistive properties (Brandfonbrener 2003). Due to the variety of rapid and constant movements, percussionists and drummers must utilize particular muscles to create unique sounds.

Percussionists mostly experience injuries in their arms and wrists and also in their feet and ankles. A large amount of work is done also to stabilize the body of the artist while rapid movements are made. Core muscles such as the transverse abdominal muscles, the *m. Multifidus,* the *m. Erector Spinae* and also the diaphragm are pressed into long hours of service to stabilize the lower back and keep proper pressure inside the abdominal cavity in order to prevent incorrect posture (Eskelinen and Kokko, 2009). Weakness in the abdominal muscles can lead to a downward deflection of the sternum and ribs and cause the head to be pushed forward (Eskelinen and Kokko, 2009). Since the head weighs approximately as much as a bowling ball, many muscles are necessary to hold it in place and aligned correctly. Some of the larger muscles used to do this are the *m. Scalenus Medius*, *m. Trapezius* and the *m. Sternocleidomastoid* (Eskelinen and Kokko, 2009). Movement can become uncomfortable and painful when these muscles are irritated from either improper posture or overwork (Workman, 2006).

3. BECOMING A PERFORMING MUSICIAN

Music in general can play a big role in shaping the life of a human. It is time-consuming and requires effort and dedication to achieve professional status in the music industry. During this time of developing into a musician, not only the honing of innate musical skills is required but also skills necessary in other areas of life are acquired. This chapter will describe both positive and negative aspects of children starting their musical studies at a relatively early age.

3.1. The Beginning of Musical Studies

One of the reasons students are enrolled into music school early in their childhood is the fact that there is a sensitive period in which the child's neural circuits operate in a way that allows the brain to accept and store information in a manner that is more permanent (Knudsen, 2004). In the musical context, this early start carries a major impact in the tempo and ability to master an instrument, with clear early advantages on the path towards becoming a professional musician.

In addition to impacting the neural circuits, musical training also creates plasticity in the brain (Altenmüller et al., 2000). Neural plasticity is the brains ability to organize the thousands of experiences that are collected throughout the day (Altenmüller et al., 2000). This allows children to be more receptive to the different aspects of learning a musical instrument. Schlaug et al. (2005) tracked the influence musical training had on brain activity in children aged five to nine, who where just commencing their musical studies. These children were compared to 25 similar socio-economically and verbally and age- matched non-musical children. After 14 months of tests and musical training the musical and non-musical children were retested. Substantial gaps were discovered in fine motor skills and the ability to recognize differences in even the smallest unit of sound in a language between the two groups. Though musical training was found to be useful for the plasticity of the brain there was no difference in gray and white matter volume and also no significant differences in verbal, visual-spatial and mathematical skills found in comparing the musical children and control group. When looking at the impact that music has on the cognitive functions of a child, it is therefore important, from the perspective of the parent, to know which form of art contributes the most towards the cognitive development of a child. Other common options are sports and dance groups although neither of these have beneficial long-term effects on cognitive development to match the studying and practice of a musical instrument (Miendlarzewska and Trost, 2014).

3.1.1. Physical and Psychological Risks of Musical Training on Young Students

In order to acquire the skills necessary to become a professional, practice and performances must be taken seriously. Musicians go through years of extensive training, starting from early childhood, during which playing any instrument can have a serious physical impact. This extensive training lasts throughout stages of increasing physical change in adolescence and the constant, prolonged and repetitive process of improving sensory-motor programs, can have an even greater impact on the developing body of a young musician (Altenmüller et al., 2015).

Along with the physical stressors that children can experience follows the psychological stress that adolescence experience when playing a musical instrument. A large part of learning an instrument and becoming a performing musician at a young age is performing in front of audiences. A study by Simon and Martens (1979) shows the psychological impact of performing a musical instrument. In their study of 749, 9-14 year old boys, who had participated in sport activities, test taking and musical performances; the greatest level of anxiety was experienced in performing a solo on a musical instrument. In comparison to team sports activities, playing in a band created higher amounts of anxiety. This type of anxiety is called MPA which is a psychological phenomenon experienced not only by adult professional and amateur musicians but also by younger musicians (Kenny and Osborne, 2006). Children in general are not opposed to performing and enjoy the attention of an audience but most children experience a phase where the enjoyment of performance and attention is replaced by thoughts of embarrassment and uncertainty. This is due to factors such as the child's innate personality, the increase of cognitive capacity, and self-reflective functions – to say nothing of external factors such as parenting and the surrounding environment. In addition to these the young musicians technical skill, ability to learn and previous performance experiences can have either a positive or negative outcome on the anxiety level of musical performances (Kenny and Osborne, 2006). These psychological stressors can have effects that can last through out a musician's entire career or have effects that can apply the brakes to the otherwise great potential to become a performing artist.

Each student is different in the way they cope with physical and psychological stressors. This can depend on the physical condition or technique in playing an instrument and can also depend on the mentioned psychological factors such as personality and ability to self-analyze. While an environment that encourages musical studies cannot be over-rated, much of a child's musical potential is dependent on the genetics of the instrumentalist. In the process of studying music certain chromosomes are implicated with skills such as: singing and music

perception, ability to have perfect pitch, perceiving rhythm and sound, music perception, music memory, ability to listen to music and creativity (Tan et al. 2014)- all key components in becoming a successful performing artist.

3.2. Similarities of Performing Musicians and Professional Athletes

When thinking of the comparison of the stereotypical athlete and the stereotypical musician, one would not likely imagine a very close similarity in the two at first glance, but a closer examination of the lifestyle of a professional musician reveals remarkable similarities to the life of a professional athlete.

3.2.1. Common Physical Challenges

After the basic genetic requisites which have been previously discussed, the next major hurdle in becoming a performing musician is the endless hours of physical exertion without which all the genetic advantages with which one can be born are of little benefit (Baadjou et al. 2015). In his excellent book on the matter, Gladwell (2008) concludes that a minimum of 10,000 hours of practice, after reaching substantial competence, is required to achieve professional success. This includes multiple hours of practice each day for years before even beginning to take on the workload of regularly having to give performances.

The key to championship success for an athlete is the amount of work put into achieving peak form to constantly develop and hone new skills and moves for better results at the highest level of competition. Regularly attending sport-specific events and competitions is as important for an athlete as attending and giving concerts is for a musician. The pursuit of improvement is never ending for each of them. Both the athlete and musician go through similar processes such as warming up before practice or a training session and cooling down and stretching thereafter (Paull and Harrison, 1997). Zaza and Farewell (1997) proved that warming up before practice, taking regular breaks during practice and cooling down after practice and performance can help prevent PRMDs. This similar rhythm of pre and post physical activity care is an indicator of similar personality traits between musicians and athletes.

The amount of effort put into becoming either a professional musician or athlete means a determined mindset and willingness to take on a long-term commitment. Musicians usually start learning an instrument at a young age, sometimes before age six (Altenmüller et al. 2015). Likewise, eventual professional athletes typically indulge in physical activity at an early age – many hockey players, are said to have been, “born with skates on”. During a humans younger years there is a sensitive period during which a child’s neural circuits operate

in a manner that allows the brain to store information more permanently (Knudsen, 2004). This is a crucial similarity since playing sports and playing an instrument both involve the constant activity and development of fine motor skills (Altenmüller et al., 2000).

Then there is a worrying similarity in top tier athletes and musicians: while musicians may not perform with the sustained intense exertion of athletes, nevertheless there is a growing problem of PRMDs occurring among professional musicians due to the load of physical work that must be performed to successfully play an instrument. Just as professional athletes must grow stronger and faster at ever decreasing ages to both attain and sustain their professional careers, so musicians in an increasingly demanding professional climate must develop early and perform late to stay on top of an extremely competitive music world.

The occurrence of injuries and musculoskeletal ailments among musicians and athletes are also due to similar reasons. Mainly over -practicing or over -training can result in damage to the musician or athlete. Add to that the tendencies toward insufficient rest breaks, poor posture, poor physical condition and other stressors of the demanding lifestyle and you may easily end up with the chronic health problems and musculoskeletal injuries which can even jeopardize a career, be it athletic or musical (Cruder, 2013).

3.2.2. Common Psychological Struggles

In addition to similar physical impacts, musicians and athletes also have common psychological stressors that have an equal impact as physical stressors. Artists and athletes both need to constantly maintain peak form, endure extended periods of solitude mixed with extreme public exposure, always be self-evaluating their performances and coping with the high standards and opinions of managers and audiences about their performance. All of this must be done while constantly traveling, spending time away from family and friends and constantly living in close proximity to their colleagues (Kenny and Ackermann, 2012).

As though these physical and psychological impacts were not enough, there follows the many emotional struggles through which musicians and athletes must live. Often musicians are haunted by the thought that there is always a colleague who plays faster, louder and more beautifully (Alternmüller et al. 2015). This is also true in sports where ones success is based on comparison with others (Alternmüller et al. 2015).

Finally there are the financial stresses involved with physical injuries. Chief among them is the fear of losing ones career, losing the opportunity to work with passion and becoming financially insecure. In an interview by Guptill (2010) of ten professional musicians in Onatrio, Canada, an injured musician Robert says the following: “There’s some people who I don’t want them to know that I’m hurting. I’m not gonna jeopardize what

somebody thinks of the way I might play and interpret it in light of ‘well he’s hurt,’ you know. There’s a certain sports analogy there I think. I mean you’re not gonna tell the coach you’re hurting or he’s not gonna put you in.” To sum up the situation it can truthfully be said that in both athletics and music the survival of the fittest is the rule of the jungle.

4. THE BODY OF A MUSICIAN

Sound waves are produced by the vibration of an object, which causes the surrounding air to vibrate with these waves, which when they reach the ear, are registered as different sounds. These can be familiar or strange, loud or soft, with a myriad of tones in each category. To cause vibration, movement must be present which is caused by a force. All sounds that instruments make are a result of vibration. Musicians cause this vibration, and depending on the instrument and the musician, the whole body can be active physically. This chapter will describe the different parts of the body used to musically perform with an instrument.

4.1. Musicians Need for Musculoskeletal Work

Since musicians are most often compared with athletes due to the physical work that must be performed, then it is obvious that musicians also use their muscles in their profession. Since the work that musicians do with their muscles typically involves fine motor skills, musicians are often referred to as "small muscle athletes" (Altenmüller et al., 2015). Even though musicians' movements are often smaller and considerably more repetitive (Brandfonbrener, 2003) then the uses of all types of muscles are required to work in different regimes. Clarinet and oboe players hold their instruments statically with the muscles of the right thumb (Brandfonbrener, 2003). In contrast to woodwind players using static work regimes to play their instrument, percussionists and drummers must use more dynamic movements in order to play their instruments. Most musicians use their upper limbs to play their instruments (Brandfonbrener, 2003) but drummers differ because they must use all four limbs while performing and practicing. Muscles from the upper trunk and shoulder girdle such as the *m. Trapezius, m. Serratus aneterior, m. Rhomboideus major* and *minor,* the *m. Levator scapulae,* the *m. Deltoid* and the *m. Pectorialis minor* are all actively involved in playing the drums though most of the movements are performed by the arm muscles such as the *m. Biceps brachii, m. Brachialis, m. Brachioradialis, m. Triceps Brachii* and the *m. Anconeus*. The flexors, extensors, pronators and supinators in the arms all work in concert to make all the movements, which are key in all drumming techniques (Eskelinen and Kokko, 2009). The lower limbs are also actively pressing down on pedals forcing the antagonist muscles *m. Quadriceps* and *m. Biceps femoris* and the *m. Tibialis anterior* and *m. Gastrocnemius* muscle to make repetitive and fast movements (Lee and Altenmüller, 2014). In addition to the awkward and static position of holding their instruments, playing the viola and violin also includes holding and rapidly drawing the bow, thus causing the right arm to constantly dynamically work, while the left arm is statically holding the correct posture (Lee

et al., 2013). Brass players such as trumpet players create and vary the sound produced by forming their lips, cheeks and tongue to the correct position and sustaining contractions for extended amounts of time (Potter et al., 2015).

In addition to muscles making the limbs work, the joints are also in a constant state of motion. Most instruments require a high-speed combination of complicated multi-joint movements of the fingers to be able to play at a professional level (Furuya et al., 2015). Even though musicians' movements are similar to athletes, the difference lies in them having to constrain muscular force while playing, opposed to sports where the amount of muscular strength determines the success of the movement, such as throwing a ball or sprinting (Furuya et al., 2015). In all of the different techniques musicians use to play their instruments, joints are involved in sagittal, frontal, transversal and rotational movements (Rondinelli and Gerhardt, 2001). The range of motion that musicians' joints are involved in can similarly result in injury (Sengupta et al. 2012). This is seen in violin and viola players, who despite various support devices (shoulder and chin rest) are caused to move their left shoulder up and press down to the left with their neck and jaw in order to securely hold their instrument. This is stressful for the neck, jaw, cervical spine and shoulder. Furthermore this position can reduce the range of motion of the left hand, and decrease the mobility on the fingerboard and the strings. In addition to the loss of musical quality this also causes pain and can develop into dysfunction of the cervical spine and temporomandibular joint (Brandfonbrener, 2003).

4.2. Stress on the Central Nervous System

Many professional musicians start their musical studies at early ages and have completed nearly 10,000 h of practice by the age of 20 (Sloboda et al., 1996). This early start to ones career is quite important due to the plasticity of the Central Nervous System (CNS) (Sloboda et al., 1996). The CNS continues to play a large roll in the capability and success of a musician. Due to the large amount of fine and accurate movements professional musicians must make in order to play their instruments and pieces of music, a large amount of work must be done by the CNS (Watson, 2006). Uniquely to music, the auditory system, a part of the CNS, is in charge of the musician making every movement in the correct tempo, rhythm, dynamics and feel, also the auditory system controls the ability of the musician to play the correct pitch on a key or fingerboard (Altenmüller et al., 2015).

4.3. Musician's Physical Stress Tolerance

To achieve the level of professional skill, the whole body must work in harmony and withstand the stress of playing an instrument with the additional physical stressors. Practicing

must become a lifestyle for professionals who want to stay in the music industry. The constant need for practice is already due to the steady change in repertoire and in the difficulty of the musical pieces artists must perfectly be able to play. Practice each day with the mindset of perfectionism can be physically strenuous to the musician. In addition to rigorous practice, musicians must often travel long distances in order to reach their performance venue. For many instrumentalists like the harpists and percussionists the transportation of these heavy instruments can be strenuous to the point of causing injuries (Brandfonbrener, 2003). Many other instruments also have awkward shapes (Kenny and Ackermann, 2012) and can be a nuisance to carry.

Additional physical stressors also include having to set up the instruments on different stages and venues (Kenny and Ackermann, 2012). Each venue has their own conditions, for example, different chairs, the temperature and backstage area (Kenny and Ackermann, 2012). Every new location also means spending the night in different sleeping quarters with varying suitability and comfort (Kenny and Ackermann, 2012). One poor combination of temperature, breeze, pillows and mattresses can deprive the performer of the sleep, which is vital to be able to perform properly (Kenny and Ackermann, 2012). Quality and amount of sleep can be affected by jet lag when musicians travel to further destinations (Kenny and Ackermann, 2012). All of the aforementioned physical hardships are endured for the sake of being able to perform. This is, after all, the goal in the pursuit of which all of that energy and time that has been spent.

4.4. Impact of the Performance on a Musician's Body

The performance itself is not any less of a physical challenge to the musician as all of the steps leading towards it. To perform successfully the musician needs to be at peak form and fully focused on their job, which is to play the music. For many musicians, playing their instrument is not easy and is physically demanding. In addition to the energy professional musicians use to play their instrument, a large part of a musical performance is the emotion and body gestures of the musical performers (Davidson, 2012). In a study by Davidson (2012) various movements of professional and non-professional flute and clarinet players were observed, while playing their instrument. The results of the study showed that different parts of the musical piece played resulted with a variety of physical gestures. For example; the rising and falling of a phrase was associated with the bending of the knees; sustained notes resulted in the crouching of the upper body; and rhythmic parts of the musical piece were associated with rocking, swaying and the tapping of toes. All of these gestures consume extra energy and can easily cumulatively physically drain the musician.

4.5. Physical Risks of Being a Musician

The previous chapters have described how the body works while it is being used to create music. This is often not an easy job for the body to manage as the physical stressors can be quite demanding. Learning and playing a musical instrument involves putting the musician's muscles and tendons through the overlearning of various movements and utilizing the auditory, sensory and motor systems of the CNS (Altenmüller et al., 2015). The musician, just like an athlete, must learn to balance the time used working hard in order to strive and succeed as a musician with resting to avoid serious injury and thus preserve what has been achieved at such great cost (Kenny and Ackermann, 2012).

4.5.1. Overuse Injuries

Even though the commonality of musician's specific injuries is difficult to determine due to the lack of scientific studies in this area (Guptill, 2010), it is generally known that most of the injuries that occur among musicians are injuries related to the overuse of muscles, tendons and joints (Dawson et al., 1998). It is also known that the preponderance of playing-related injuries are similar to the work-related injuries of newspaper workers, supermarket checkers and assembly line food packers (Zaza, 1998). These musculoskeletal disorders cause pain, disability and loss of employment (Zaza, 1998) and thus are a serious matter. Musculoskeletal symptoms have been reported to affect nearly 50% of musicians (Larsson et al., 1993). The overuse of muscles, tendons and joints are due to the strain caused by the repetitive nature of the required movements, the time necessary to rehearse and the positions in which musicians must play (Guptill, 2010). Pain in upper limbs of musicians can be a result of muscle tension in the neck and shoulders, scoliosis, kyphosis, leg length discrepancy and the lack of spinal mobility (Toledo et al., 2004). The overuse of the forearm is due to the lack of attention paid to the position of the wrist and fingers in musicians. In addition to the rapid use of the forearm, musicians, like violin and viola players, have their wrist hyperflexed during play and use much force while fingering the strings and gripping the bow (Toledo et al., 2004). This puts both hands of the musician at risk of injury. Overuse injuries common among violinists are: medial or lateral epicondylitis, also known as “tennis elbow”, myofascial pain and wrist tendonitis (Toledo et al., 2004). In addition to pain, these injuries also include symptoms like loss of endurance, loss in fine motor movements and loss of strength (Fry, 1986).

4.5.2. Hypermobility Syndrome

String musicians are often pushing the physical limits of their hands in order to play faster and more accurate. These factors and the need to move all along the stringboard forces the musician to move as ergonomically as possible and in the case of string players this means moving and stretching their fingers to reach the correct notes which often are on opposite ends of the stringboard. This constant enlargement on the range of motion can lead musicians to have hypermobility syndrome (Lee et al., 2013). Hypermobility, also known as hyperlaxity results in the instability of the joint and causes stress of the intrinsic and extrinsic muscles that have to compensate for each small movement (Brandfonbrener, 1990). This causes pain in the joints. In a more recent article Brandfonbrener (2003) debates whether joint laxity can be considered to be in the artist's interest or is it responsible for the decrease of musical ability. Some cases prove joint laxity can benefit a musician as long as symptoms of pain do not follow.

4.5.3. Nerve Damage

A common complaint of pain among musicians can be a result of having a peripheral nerve disorder (Toledo et al., 2004). The most common among these disorders is associated with entrapment neuropathies (Lederman, 2003). An entrapped nerve is most commonly associated with the compression, stretching or friction of the nerve (Lederman, 2003). A common reason for entrapped nerves are various playing related disorders (Zaza, 1998), as the previously mentioned joint laxity can cause joints to apply pressure on surrounding peripheral nerves which can cause severe pain (Stephens and Leilich, 1997). Thoracic outlet syndrome (TOS) is also a common peripheral nerve disorder (Lederman, 2003). TOS is caused by the excess pressure placed on neurovascular bundle passing between the *m. scalenus anticus* and *m. medius* muscles (Liveson, 2000) A musician who has TOS usually experiences pain in the forearm and the hand (Toledo et al., 2004).

4.5.4. Focal Dystonia

Focal dystonia or “musician's cramp” is a disorder responsible for the loss of control and degradation of fine and skilled hand movements (Altenmüller, 2003). It is a disorder that occurs among only 1% of musicians but is often a career ending condition (Lim et al., 2001). In its initial phase musicians experience symptoms such as: sudden loss of fine and trained movements, gradual loss of control while playing high tempo pieces, uncontrolled curling of fingers (Figure 1), lack of precision and irregularity while playing alternating notes (Figure1), sticking of fingers on keys, spontaneous flexing of the bowing thumb on strings (Figure 1)

and weakened control of the facial muscles and lips of brass and woodwind players. (Altenmüller, 2003).

Figure 1. Typical example of musician's cramp in a pianist, a flutist, and a violinist (Altenmüller, 2003)

Mistaking focal dystonia for lack of technical skill is common among musicians and causes them to work and practice even harder, but this only deepens the root of the problem (Fry et al., 1998). Focal dystonia can go unnoticed and is typically reported only in advanced stages of the disorder due to the lack of symptomatic pain. Only muscular strain is present, due to the efforts of antagonist muscles, which are trying to compensate the work of the affected area (Altenmüller et al., 2015). The development of focal dystonia in musicians can be mapped back to the intense and lengthy actions, that are highly precise, trained and fast movements (Altenmüller, 2003).

The most ironic twist to focal dystonia is that the same genes, which gift musical abilities in the first place, may also impart a genetic predisposition and certain receptiveness towards sensorimotor disorders (Altenmüller, 2003). Most cases of focal dystonia are found in the upper limbs and embouchure of instrumentalists (Lederman, 2003), hence the high incidence of focal dystonia among classical guitarists, pianists, string players and brass and woodwind players, all of whom
are disproportionately prone to suffer from both hand and embouchure dystonia (Altenmüller, 2003).

Percussionists and drummers can also develop upper limb dystonia due to the rapid and high speed movements made with the arms. But very few reports of the impact that repetitive, stereotyped and skilled movements drummers lower limbs must make have been reported. Among the first to report drummers lower limb dystonia (LLD) were Rosset-Llobet, Fa`bregas-Molas and Pascual-Leone (2012), who reported two cases of drummers suffering from LLD-like symptoms; the loss of coordination, involuntary tension in the left toes, ankle and knee muscles, also symptoms like rising of the heels. This proves that musician's dystonia can occur in both upper and lower extremities and in fact in any bodily structures

that are subject to forceful repetitive movements over a long period of time (Lee et al., 2013).

4.6. Playing Related Musculoskeletal Disorders

All of the above- mentioned physical risks the musicians encounter could have a large affect on the artist's health. These pathologies can be summed up as “Playing Related Musculoskeletal Disorders” (PRMDs). PRMDs are musculoskeletal problems that affect more than just the person physically. PRMDs can also have a substantial affect on the emotional and social well-being of a musician (Zaza, 1998) and eventually financial difficulties can be experienced due to PRMDs as well: no-play-no-pay (Bragge, 2006). Zaza (1998) reports that Canadian musicians make on average $20,000 a year, having multiple jobs, but most of them are self employed and do not qualify for the compensation of social and health care, and this does not leave many options for the proper care of PRMDs.

5. PSYCHOLOGICAL SIDE OF MUSICIANS

Music is a universal language that speaks and reaches the emotions of humans in ways that words cannot. Music plays an increasingly large roll in an in a majority of peoples lives, and there is no reason why this musical tidal wave is likely to subside in this 21st century. After all, the wave has been growing across every culture known to humanity throughout history (Koelsch, 2014). For adults the primary goals in engaging with music is the regulation of moods and emotions experienced while encountering music (Juslin and Laukka, 2004).

5.1. Music's Impact on Cognitive Development

But music does not only have a strong emotional influence on the people who are listening; it also impacts the life of the performing artist (Studer et al., 2011). The impacts of music on the performer already start at a young age. The human brain is divided into sensory-motor area and association areas (Altenmüller et al., 2000). Making music is an example of our brains sensory-motor area working the hardest, having to use the cortical multi-sensory association areas to read music, play music, hear the music being played, give feedback on the accuracy, all while playing the instrument with correct form and feel (Altenmüller et al., 2000). Due to this constant engagement of highly complex and precise activity of the brain, musicians show increased plasticity of brain networks (Miendlarzewska and Trost, 2014). This plasticity can have a large impact in the way that children and adults develop and practice cognitive functions, which can have a great affect on the psychological health and capability of a human.

Hearing plays a large roll in the world of music. In a psychological sense hearing and listening are vital for humans. Humans need to listen and need to be listened to in order to maintain a healthy psychological state. Miendlarzewska and Trost (2014) write that musical education and skill also improves listening skills. This allows for increased ability of sound discrimination and therefore improved speech segmentation (Francois et al., 2013).

In addition to improving listening skills, musical training can also affect linguistic, mathematical, administrative and supervisory skills in young and adult musicians (Miendlarzewska and Trost, 2014). All of these skills are beneficial to the psychological well being of a human but the biggest beneficial factor of taking part in musical training is the social skill developed from emotional intelligence of musical education (Petrides et al., 2006). A large social ability that is enhanced by musical training is the higher development of perception and recognition of emotions expressed in human voices (Strait et al., 2009). In addition to this, most musical practices, lessons and performances are all performed in a group setting, which places the musician into a comfortable social environment (Strait et al.,

2009).

5.2. Psychological Stressors

Despite the many positive psychological affects of playing music, there are some downsides. With the amount of physical work that is involved in the work of a performing artist, injuries and disorders can occur which can lead to psychological stress. Physical impacts that are not PRMDs, such as regular criticism of their work, time spent alone, traveling to unknown distant destinations and coping with the constant changing of time zones, can have a great psychological impact on performing musicians (Kenny and Ackermann, 2012). This is all done in the absence of friends and family but is in forced close contact with colleagues (Kenny and Ackermann, 2012). This combination of occupational stressors and physical stressors can lead to psychologically difficult disorders, such as loneliness, homesickness, sexual frustration and breakdown of relationships (Kenny and Ackermann, 2012).

Playing a musical instrument at a professional level is a challenge to overcoming ones physical and psychological stressors (Schoeb and Zozzo, 2012). A great deal of psychological stress is felt due to the fear of performing, which is closely tied to MPA. Most people have experienced anxiety in a social setting due to simple things like: eating in front of others (Norton et al., 1997), test-taking (Elliott and McGregor, 1999), public speaking (Merritt et al., 2001), sports (Hall & Kerr, 1998), performing arts in dance (Tamborrino, 2001). MPA is more common among female artists, than male artists (Osborne and Franklin, 2002).

In a study by Osborne and Franklin (2002) the main reasons for experiencing MPA were related to the consequences of the performance. For example overwhelming thoughts of the abrupt ending of a musical career as the result of a single mistake or thoughts of audience negative feedback because of failure to meet their standards haunt them. These characteristics are similar to those highly cognitive anxious individuals described by Martens et al., (1990); displaying a negative self-image in terms of performance, skepticism of a possible negative reception from the audience or examiners and strong concerns about a poor performance.

5.3. Physical Impacts of Psychological Stressors

Further, the highly cognitive anxious performer is very likely to experience physical overtones from the psychological condition. The performer with somatic anxiety may experience physical symptoms during a performance such as muscle tension, dry mouth, “butterflies in the stomach” and sweating (Martens et al., 1990). Another psychological condition that can lead to the failing of motor control is “choking under pressure” (CuP) (Altenmüller et al., 2015). This disorder, also common in sports, is a situation in which an

individual's motor control and performance quality is reduced due to the feelings of fear, anxiety and arousal in a insurmountable situation (Altenmüller et al., 2015). Depending on the different anxiety traits of people, anxiety can have a positive or negative effect on the performance of a musician (Kenny and Ackermann, 2012). A musician with high trait anxiety will perform the best in a calm environment with a well practiced and easy piece while a musician with low trait anxiety will perform their best in a demanding environment with a challenging piece of music (Kenny and Ackermann, 2012).

A more severe case of anxiety among musicians is when performers start to feel anxiety about anxiety. This is a disorder called Anxiety Sensitivity, which is most frequently triggered by biological challenges, which stimulate exactly those bodily sensations most feared by the performer (McNally, 2002). Among these fears of a musician are: thoughts of missing notes, not being able to play correctly, leaving a bad impression on the audience, ruining ones reputation, losing their job, not being able to provide for their family and ending up in poverty. These thoughts produce physical reactions in the body such as: sweating, constricted breathing, tense muscles, which lead to the likeliness of a performance being unsuccessful (McNally, 2002). A study of 1,401 1st year cadets from the United States Air Force Academy, conducted a 5-week high stress training, including rigorous, highly demanding and uncontrollable mental and physical stressors. They found that those who had high levels of anxiety sensitivity where three times more likely to experience spontaneous panic attacks than those with a low anxiety sensitivity threshold (Schmidt et al.,1997).

5.4. Emotional Impacts of Psychological Stressors

Being a professional musician can have many affects, both physical and psychological, and both positive and negative. The proportion of musicians that experience injury, excluding minor injuries is approximately 43% (Zaza, 1998). According to a study by Guptill (2011) of 10 musicians with playing-related injuries experienced social abandonment due to their injuries. One participant in the study wrote the following: "All my friends quit calling me. And I'd go and sit in an orchestra rehearsal at university and I'd cry, and people would just put their stuff in their case and leave – it almost felt like I was contagious you know, and I was writing letters to people, 'please call me, please be my friend, please,' and no". This is a result of the fear musicians feel about talking about their playing related injuries (Guptill, 2011). This fear exists due to multiple factors such as the loss of employment due to having an injury and the opinion of colleagues (Guptill, 2011).

A musician's ability to cope with these psychological stressors is very individual, and the methods that musicians use to deal with their anxiety and loneliness also varies (Kenny

and Ackermann, 2012). What we do know is that one common, though unhelpful, strategy to overcome these psychological issues is the regular overconsumption of alcohol and drugs, for example beta blockers and marijuana (Kenny and Ackermann, 2012).

6. TREATMENTS AND PREVENTION OF PHYSICAL AND PSYCHOLOGICAL DISORDERS IN MUSICIANS

The risk of physical injury that constantly lurks in a musician's shadow, and the psychological impact of this knowledge, can have a serious, even career ending impact. The side effects of the physical conditions are pain and loss of strength in body parts necessary to perform everyday activities. The biggest loss that both physical and psychological stressors cause is the loss of ability to play music. This is why musicians who are injured strive towards a nearly impossible goal - complete recovery - which, as a general rule, is never achieved (Altenmüller, 2003). Mere improvements are not enough for the artist, as limitations to repertoire and technical capabilities are not easily accepted (Altenmüller, 2003). The solution to these ever-present dangers is clearly in preventing them from occurring to begin with: “An ounce of prevention is worth a pound of cure”.

6.1. Treatments and Prevention of Playing Related Musculoskeletal Disorders

Since the number one cause of PRMDs is the overuse of muscles and tendons, the first prescription that should be given to musicians is rest (Brandfonbrener, 2003). Instead of a longer period of absolute rest, relative rest is the best option for performing artists, due to the quick loss of musical skill and the rapid increase of anxiety and depression that follows a total halt of playing an instrument (Brandfonbrener, 2003). The next best possible treatment for musicians is exercise, which is uncommon for musicians due to the prevalent lack of childhood participation in sports (Brandfonbrener, 2003). The reason for this is because children spend most of their time practicing their instruments while at the same time parents try to protect their children from injuring themselves through participating in sports. (Brandfonbrener, 2003).

In addition to relative rest and exercise, antibiotics as well as thermal treatments are also used to speed up the healing process (Lederman, 2003). In more severe cases local injections or surgery is required, which is greatly feared by most musicians and is used as a last resort (Lederman, 2003). Surgery is also reserved for patients with nerve compression syndromes, who do not respond to milder treatments (Lederman, 2003) such as rehabilitation exercises, proprioceptive retraining and stretching (Ackermann and Adams 2005).

In looking for ways to improve stability in hypermobile joints, instrument specific exercises can be helpful. When hyperlaxity is evident the muscles in the affected area are either over-flexed or overextended. Therefore performing isometric strengthening exercises while holding ones instrument (Figure 2) can be helpful (Warrington, 2003). Treating hyperlaxity also includes temporary supports, exercises to improve stability (finger wall push-

ups) and sensorimotor training and the patient learning of healthy practicing habits (Warrington, 2003).

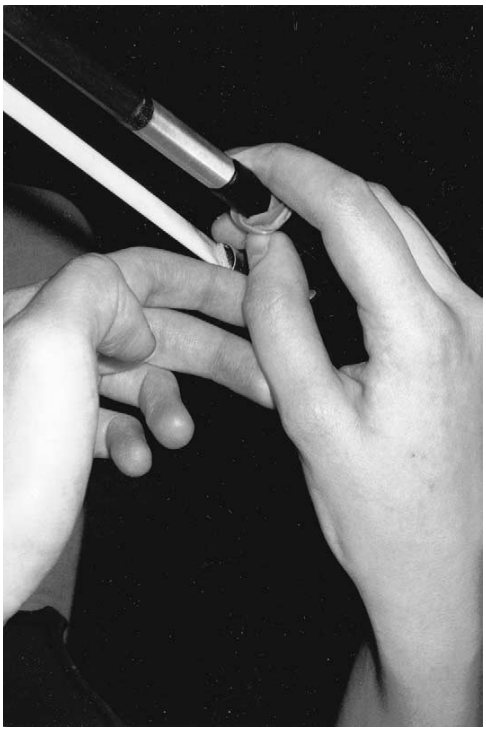

Figure 2. Isometric strengthening exercises for the right thumb while holding the bow (Warrington, 2003).

In the rare, but serious case of focal dystonia, the aim for treatment must be the establishment of a new sensorimotor program (Alternmüller, 2003). This can be achieved by various methods such as instrument specific movement modifications, for example the alternation of the positions of keys in woodwind instruments and retraining under experienced trainers for several years (Alternmüller, 2003). For musicians with hand dystonia a recurring problem is the uncontrolled cramping of a finger. The flexion of the other fingers help restore the position of the cramped digit (Alternmüller, 2003). In this case the compensating finger is splinted and exercises are carried out to help rehabilitate the dystonic finger (Alternmüller, 2003). A more surgical approach to the rehabilitation of a dystonic body part is the intramuscular injection of Botox which decreases the release of the neurotransmitter acetylcholine which results in the weakening of the muscle and lessening the intensity of the cramps (Alternmüller, 2003).

With the growth of the music industry and the increased number of PRMDs among musicians, the medical issues of performing artists is a field that is experiencing constant growth (Lee et al., 2013). Despite the visible global growth in investigating this area (which can be seen in that multiple terms for this specific field have been established, for example “Musician’s medicine” in English, “Musikermedizin” in German and “Medicine des Arts” in French (Lee et al., 2013)) it is still a field that needs to be improved. Most studies of

healthcare do not include training in PRMDs, which means professionals lack the knowledge of specific postures, physical conditions and the type of work musicians take part in (Guptill, 2011). In the same study, participants who are injured performing musicians, state that there is a lack of professionals who possess knowledge about the work of being a performing artist and lack the necessary skills to treat musician's injuries. In a previous study, Guptill (2005) reports that medical experts knowledge should come from experience of treating musicians or from familiarizing themselves with the literature of playing related and emotional problems that musicians experience. Especially in serious cases as focal dystonia where the most likely result is the end of a musician's career, it is important to keep in mind the associated psychological factors (Alternmüller, 2003).

6.2. The Treatment and Prevention of Psychological Disorders

The treatment of physical issues is much associated with the psychological issues of the musician. Anxiety and depression in a musician is often the result of an untreated and prolonged injury. This is why the treatment of the psychological issues that musicians experience is just as important as the physical – and sometimes is prerequisite. The most common and available treatment for psychological issues such as performance anxiety is the use of prescription drugs such as antidepressants, benzodiazepines and beta-blockers (Kenny and Ackermann, 2012). A more mild approach is the engaging in meditative interventions such as meditation and yoga, relaxation therapies, participating in exercise, being committed to lifestyle changes, music therapy and psychotherapy (Kenny and Ackermann, 2012). A study by Fancourt et al. (2016) showed that a 10-week program of group drumming decreased amounts of anxiety and depression and increased levels of social resilience.

As the best way to manage occupational injures is to prevent them, it is important to be aware of various factors that can cause these serious injuries. The most important issue to be aware of correct posture in practicing, performing and also during day-to-day activities (Kenny and Ackermann, 2012). According to Kendall et al. (1993) the best sitting posture is having a 90° angle between the hips and knees and also having a 10° inclination of a back support on the chair.

Associated with the prevention of PRMDS is the importance of having a regular schedule for musician's private practices (Zaza, 1994). The main reason for injuries is the sudden increase of practice and performance intensity (Chan and Ackermann, 2014). A regular practice routine, where intense practice is distributed throughout the day, can prevent the sudden change of intensity when playing hours fluctuate (Chan and Ackermann, 2014).

The training and educating health professionals will only have a minor impact but a

major impact would be to educate musicians about the potential risks that performing artists are exposed to, since this could have a key roll in the prevention of PRMDs (Baldwin, 2004). The lack of understanding one's injury can lead to seeking help from unreliable sources, putting the already injured musician at risk of further aggravating the injury (Chan and Ackermann, 2014).

In the case of preventing psychological issues, it is important to realize that most psychological diseases are caused due to childhood influences. This is why the roll in preventing psychological issues of musicians starts early and is largely the responsibility of parents (Barlow, 2000). It is important to create an environment that is supportive, where exercises and performances are age and skill appropriate (Gar et al., 2005). This contributes towards the protection against the development of anxiety and depression (Gar et al., 2005). Children are often forced into premature performances where they are critically evaluated (Kenny and Ackermann, 2012). Children should actually be offered frequent, low-stress environments to perform, so that young musicians can learn that performing can be an enjoyable part of playing music (Kenny and Ackermann, 2012). When young musicians are required to play in stressful conditions such as auditions, then their repertoire should be well learned and the musician should be physically and mentally prepared (Kenny and Ackermann, 2012). A large part of this is having a healthy diet and getting an adequate amount of sleep (Kenny and Ackermann, 2012).

7. CONCLUSION

Performing and listening to music can be an activity engaging the whole body at once. The impact is physical and emotional and too much stress caused by the amount of participation in musical activities can lead to emotional disorders and physical injuries.

Humans are created and exist in a way that is natural to perceiving music. Humans are capable of receiving and processing music physiologically with ears and emotionally by the help of various cerebral structures that also actively participate in the rewarding system of humans. Just like different humans perceive music in different ways, a major factor in the influence of music on the listener and performer is the type of music being listened to or being performed. Each genre has its own niche and brings forth different emotions. The melody and structure of the music has its own impact but so does the lyrical content of the music. Music is also used as a tool to influence humans in acting a certain way and can also be used with manipulative intentions.

In playing all types of musical genres different instruments are played in order to achieve the desired sound. Each instrument has a specific technique to be able to correctly make music. The different positions that need to be held when playing an instrument and the rapid, repetitive movements made, can have a physical impact on musicians when not done correctly, or when the muscles and tendons involved in playing are over used. The occurrence of diseases related to musical performance and practice are common among younger musicians also. Those in their adolescent years are more prone to experience anxiety related to the pressure that comes from being a performing musician at a younger age. Being young and participating in musical activities has a positive side. Musical training increases brain plasticity and improves skills that can have a life long impact on a human.

When studying the life and schedule of performing musicians it is quite similar to the ones of professional athletes. Just like athletes, musicians start their career young, take part in every day training, warm up before practice, perform fast repetitive movements and cool down after a hard practice. Practice is taken seriously because of the need to perform successfully. Both athletes and musicians perform in front of a crowd of watchful eyes thus they both deal with similar psychological issues.

The muscles and tendons that are used to play vary according to the instrument, but mostly upper body muscles are engaged with a few special cases for example drummers, who use all four limbs actively to play their instrument. The muscle of a musician must be able to

work in various regimes, having to hold the instrument statically while having to perform rapid and precise movements.

Musical performances also activate the use of joints and the CNS. The full use of the body while being involved with playing music can have an effect on the health of musicians and lead to musculoskeletal disorders, joint laxity and nerve entrapments.

Playing music and also listening to music has a certain psychological influence on humans. This can be either a positive or negative influence. On one side participating in making music can increase many skills vital for normal human functioning. On the other side much stress is involved in playing and practicing a musical instrument. Another reason for psychological illness is the high rate of injuries musicians encounter. Often musicians fail to find help for curing their injuries and this can lead to the end of one's career, which leads to a downward spiral of anxiety and depression.

There is hope for the musicians suffering from emotional and physical stressors. Many techniques and methods for curing both physical and psychological disorders of musicians have been developed. These include: relative rest schedules, exercises, medications, and surgical solutions for more serious injuries. In order to prevent disorders among musicians it is important to the raise awareness of these issues among in the musical and medical realms. Musicians need to keep good posture while playing and consult with professionals as soon as symptoms of injury occur.

Options for further studies of this topic should include a systematic physical exercise and risk awareness program which runs parallel to musical studies in schools and for those performing. Studies of the physical impact of different performance settings would give more specific information to musicians seeking help. With the further study of this area, there is higher hopes for future musicians to have a life long and healthy career.

REFERENCES

1. Ackermann B, Adams R. Finger movement discrimination in focal hand dystonia: a cellist case study. Medical Problems of Performing Artists 2005; 20: 77–81.

2. Altenmüller E, Gruhn W, Liebert G and Parlitz D. The impact of music education on brain networks: evidence from EEG studies. International Journal of Music Education 2000, 35, 47–53.

3. Altenmüller E, Ioannou CI, Lee A, Apollo's curse: neurological causes of motor impairments in musicians, 2015, 89-106. In: Altenmüller E, Finger S, F Boller, eds. Progress in Brain Research, Vol. 217. Amsterdam: Elsevier; 2015, 89-106.

4. Altenmüller E. Focal dystonia: advances in brain imaging and understanding of fine motor control in musicians. Hand Clinics 2003; 19: 523-538.

5. Baadjou VA, Verbunt JA, van Eijsden-Besseling MD, Huysmans SM, Smeets RJ. The Musician as (In)Active Athlete: Exploring the Association Between Physical Activity and Musculoskeletal Complaints in Music Students, Medical Problems of Performing Artists 2015; 30: 231-7.

6. Baldwin ML. Reducing the costs of work-related musculoskeletal disorders: targeting strategies to chronic disability cases. Journal of Electromyography and Kinesiology 2004; 14: 33–41.

7. Ballard ME, Dodson AR, Bazzini DG. Genre of Music and Lyrical Content: Expectation Effects. Department of Psychology Appalachian State University Journal of Genetic Psychology 1999; 160: 476-487.

8. Barlow H . Unraveling the mysteries of anxiety and its disorders from the perspective of emotion theory. American Psychologist 2000; 55: 1245–1263.

9. Bragge P, Bialocrkowski A, McMeeken J. Understanding playing- related musculoskeletal disorders in elite pianists. Medical Problems of Performing Artists 2006; 21: 71–79.

10. Bramley S, Dibben N, Rowe R. The Utilisation of Music by Casino Managers: An Interview Study. Journal of Gambling Studies 2016; 1: 1-15.

http://link.springer.com/article/10.1007%2Fs10899-016-9604-z 10.04.16

11. Brandfonbrener A. The epidemiology and prevention of hand and wrist injuries in performing artists. Hand Clinics 1990; 6: 365–77.

12. Brandfonbrener AG. Musculoskeletal problems of instrumental musicians. Hand Clinics 2003; 19: 231–239.

13. Bronwell EW. How the ear works - nature's solutions for listening. The Volta review 1997; 99: 9–28.

14. Chan C, Ackermann B. Evidence-informed physical therapy management of performance-related musculoskeletal disorders in musicians. Frontiers in Psychology 2014; 9: 3-6.

15. Christenson F. The effects of parental advisory labels on adolescents' music preferences. Journal of Communication 1992; 42: 106-113.

16. Cruder C, Fitness training to improve musicians' health, wellbeing and performance, Musician's Health and Performance; 2013 June 13-14; Pitea; Sweden, Lulea University of Technology; 4-31.

17. Davidson JW. Bodily movement and facial actions in expressive musical performance by solo and duo instrumentalists: Two distinctive case studies. Psychology of music 2012; 40: 595-633.

18. Dawson WJ, Charness ME, Goode DJ, Lederman RJ, Newmark J. What's in a name? Terminologic issues in performing arts medicine. Medical Problems of Performing Artists 1998; 13: 45–50.

19. Dingfelder S. Music motivates impulse buyers, not thoughtful shoppers. Monitor on Psychology 2005; 36: 17.

20. Elliot AJ, McGregor HA. Test anxiety and the hierarchical model of approach and avoidance achievement motivation. Journal of Personality & Social Psychology 1999; 76: 628-644.

21. Eskelinen S, Kokko K, Case study of the physical demands of rock drumming. Bachelor's Thesis. Jyväskylän: JAMK University of Applied Sciences; 2009.

22. Fancourt D, Perkins R, Ascenso S, Carvalho LA, Steptoe A, Williamon A. Effects of Group Drumming Interventions on Anxiety, Depression, Social Resilience and Inflammatory Immune Response among Mental Health Service Users. Plos One 2016; 11: 1-16.

23. Francois C, Chobert J, Besson M, Schon D. Music training for the development of speech segmentation. Cerebral Cortex 2013; 23: 2038–2043.

24. Fry HJ, Hallett M, Mastroianni T, Dang N, Dambrosia J. Incoordination in pianists with overuse syndrome. Neurology 1998; 51: 512–9.

25. Fry HJ. Overuse syndrome in musicians: prevention and management. Lancet 1986;2:728-31.

26. Furuya S, Oku T,Miyazaki F, KinoshitaH. Secrets of virtuoso: neuromuscular attributes of motor virtuosity in expert musicians. Scientific Reports 2015; 2: 15750.

27. Gar NS, Hudson JL, Rapee RM. Family factors and the development of anxiety disorders. In: Hudson JL and Rapee RM, eds. Psychopathology and the family. New York: Elsevier Science; 2005, 125–145.

28. Gladwell M. Outliers. New York: Little, Brown and Company; 2008.

29. Guptill C, The lived experience of working as a musician with an injury. 2011; 40: 269-280.

30. Guptill C, Zaza C, Paul S. Treatment Preferences of Injured College Student Musicians. Occupation, Participation and Heath 2005; 25: 4-8.

31. Hall HK, Kerr AW. Predicting achievement anxiety: A social-cognitive perspective. Journal of Sport and Exercise Psychology 1998; 20: 98-111.

32. Juslin PN, Laukka P. Expression, perception, and induction of musical emotions: a review and a questionnaire study of everyday listening. Journal of New Music Reaseach 2004; 33: 217–238.

33. Kendall FP, McCreary EK and Provance PG. Muscles. Testing and function, 4th ed. Baltimore: Williams and Wilkins; 1993.

34. Kenny TD, Ackermann B, Optimizing physical and psychological health in performing musicians, 2012, 390-400.

35. Kenny TD, Osborne SM. Music performance anxiety: New insights from young musicians. Advances in Cognitive Psychology 2006; 2: 103-112.

36. Knudsen EI, Sensitive Periods in the Development of the Brain and Behavior. Journal of Cognitive Neuroscience 2004; 16: 1412-1425.

37. Koelsch S. Brain correlates of music-evoked emotions. Neuroscience 2014; 15: 170-183.

38. Koelsch S. Investigating Emotion with Music. Neuroscientific Approaches 2005; 2: 1-7.

39. Larsson LG, Baum J, Mudholkar GS, Kollia GD. Nature and impact of musculoskeletal problems in a population of musicians. Medical Problems in Performing Artists 1993; 8: 73-6.

40. Lederman RJ, Neuromuscular and musculoskeletal problems in instrumental musicians. Muscle & Nerve 2003; 27: 549-561.

41. Lee A, Altenmüller E. Heavy Metal Curse: A Task-Specific Dystonia in the Proximal Lower Limb of a Professional Percussionist. Medical problems of performing artists 2014; 10: 174-176.

42. Lee H, Park HY, Yoon JO, Kim JS, Chun JM, et al. Musicians' Medicine: Musculoskeletal Problems in String Players. Clinics in Orthopedic Surgery 2013; 5: 155-160.

43. Lim VK, Altenmüller E, Bradshaw JL. Focal dystonia: current theories. Human Movement Science 2001; 20: 875–914.

44. Liveson JA. Peripheral neurology: case studies. 2000; 255-258.

45. Martens R, Burton D, Vealey R, Bump L and Smith D. The development of the Competitive State Anxiety Inventory. Competitive anxiety in sport 1990; 117–190.

46. Mavridis NI. Music and the nucleus accumbens. Surgical and Radiologic Anatomy 2014; 3: 121-125.

47. McNally RJ, Anxiety sensitivity and panic disorder. Biological Psychiatry 2002; 52: 938-946.

48. Merritt L, Richards A, Davis P. Performance anxiety: Loss of the spoken edge. Journal of Voice 2001; 15: 257-269.

49. Miendlarzewska E, Trost JW, How musical training affects cognitive development: rhythm, reward and other modulating variables, Frontiers in neuroscience 2014; 279: 1-18

50. Norton GR, Cox BJ, Hewitt PL, McLeod L. Personality factorist associated with generalized and non-generealized social anciety. Personality and individual differences 1997; 22: 655-660.

51. Osborne MS, Franklin J. Cognitive processes in music performance anxiety. Australian Journal of Psychology 2002; 54: 86-93.

52. Paull B, Harrison C, The Athletic Musician: A Guide to Playing Without Pain, Lanham Md., London, The Scarecrow Press Inc.,1997.

53. Petrides KV, Niven L, Mouskounti T. The trait emotional intelligence of ballet dancers and musicians. Psicothema 2006; 18: 101–107.

54. Potter NL, Johnson LR, Johnson SE, VanDam M. Facial and Lingual Strength and Endurance in Skilled Trumpet Players. Medical problems of performing artists 2015; 2: 90-5.

55. Rentfrow PJ, McDonald JA. Music preferences and personality. In: Juslin PN, Sloboda J, eds. Handbook of music and emotion. Oxford: Oxford University Press; 2009, 669–695.

56. Rondinelli RD, Gerhardt JJ 2001. Goniometric techniques for range-of-motion assessment. Physical Medicine and Rehabilitation Clinics of North America 2001; 12: 507-527.

57. Rosset-Llobet J, Fa`bregas-Molas S, Pascual-Leone A. Drummer's lower limb dystonia. Journal of Neurology 2012; 259: 1236-1237.

58. Schlaug G, Norton A, Overy K, Winner E. Effects of music training on the child's brain and cognitive development. Annals of the New York Accademy of Science 2005; 1060: 219–30.

59. Schmidt NB, Lerew DR, Jackson RJ. The role of anxiety sensitivity in the pathogenesis of panic: prospective evaluation of spontaneous panic attacks during acute stress. Journal of Abnormal Psychology 1997; 3: 355-364.

60. Schoeb V, Zosso A. You Cannot Perform Music Without Taking Care of Your Body", A Qualitative Study on Musicians' Representation of Body and Health. Medical Problems of Performing Artists 2012; 27: 129-136.

61. Sengupta P, De S, Pal A, Maity P, Banerjee M, Dhara PC. Variation of Range of Joint Motion in Bengalee (Indian) Healthy Adult Subjects. Life Science 2012; 4: 123-133.

62. Simon JA, Martens R. Children's anxiety in sport and non sport evaluative activities. Journal of Sport and Exercise Psychology 1979; 1: 160-169.

63. Sloboda JA, Davidson JW, Howe DG, Moore DG. The role of practice in the development of performing musicians. British Journal of Psychology 1996; 87: 287–309.

64. Spahn C, Wasmer C, Eickhoff F, Nusseck M. Comparing violinists' body movements while standing, sitting, and in sitting orientations to the right or left of a music stand. Medical Problems of Performing Artists 2014; 29: 86-93.

65. Stephens J, Leilich S. Overuse injuries of the upper extremity in musicians. 1997; 401–13.

66. Strait DL, Kraus N, Skoe E, Ashley R. Musical experience and neural efficiency: effects of training on subcortical processing of vocal expressions of emotion. European Journal of Neuroscience 2009; 29: 661–668.

67. Studer R, Gomez P, Hildebrandt H, Arial M, Danuser B. Stage fright: its experience as a problem and coping with it. Health 2011; 84: 761–771.

68. Tamborrino RA. An examination of performance anxiety associated with solo performance of college-level music majors. Dissertation Abstracts International 2001; 62: 1636.

69. Tan YT, McPherson GE, Peretz I, Berkovic SF, Wilson SJ. The genetic basis of music ability. Frontiers in Psychology 2014; 5: 658.

70. Toledo SD, Nadler SF, Norris RN, Akuthota V, Drake DF, Chou LH. Sports and performing arts medicine. Issues relating to musicians 2004; 85: 72-4.

71. Warrington J. Hand therapy for the musician: instrument-focused rehabilitation. The Hand Clinics 2003; 19: 287-301.

72. Watson HDA. What can studying musicians tell us about motor control of the hand? Journal of Anatomy 2006; 208: 527-542.

73. Workman D. The percussionists' guide to injury treatment and prevention: The Answer Guide for Drummers in Pain, New York, Taylor and Francis Group, 2006.

74. Zattore JR, Salimpoor VN From perception to pleasure: Music and its neural substrates. Proceedings of the National Academy of Sciences of the United States of America 2013; 2: 10430-10437.

75. Zaza C, Farewell VT, Musicians' playing-related musculoskeletal disorders: an examination of risk factors, American Journal of Industrial Music 1997; 32: 292-300.

76. Zaza C, Fleiszer MS, Main FW, Mechefske C. Beating injury with a different drumstick: a pilot study. Medical Problems of Performing Artists 2000; 15: 39–44.

77. Zaza C. Playing-related musculoskeletal disorders in musicians: a systematic review of incidence and prevalence. Canadian Medical Association Journal 1998; 158: 1019–1025.

78. Zaza, C. Research-based prevention for musicians. Medical Problems of Performing Artists 1994; 9: 3–6.

RESÜMEE

MUUSIKA FÜSIOLOOGILINE JA PSÜHHOLOOGILINE MÕJU ESINEVALE MUUSIKULE

Muusika võib avaldada mõju inimese psühholoogiale ja füüsilise seisundile olenemata, kas muusikaga kokkupuutuv inimene on seotud selle loomisega või on lihtsalt pealtkuulaja. Muusikal on olnud läbi inimajaloo suur mõju ning avaldab ka mõju iga individuaalse inimese elu ajaloos, olgu see pisike imik, kes muusika rütmis põlve nõksutab, või suurem laps, kes osaleb muusikakoolis.

Edukaimate ja andekaimate sportlaste seas on need, kes on juba noorest east tegelenud ja harjutanud pidevalt oma spordiala. Muusika on paljuski seotud spordiga just sel põhjusel, et andekad muusikud alustavad samuti oma õpingud võimalikult varakult, sest inimese aju plastilisus on arenevas kehas suurem. See võimaldab paremini omandada liigutusi ja asendeid, mis on vajalikud instrumentide mängimised. Enamasti on need liigutused väga kiired ja koormavad pidevalt teatuid lihaseid, mis osati nõuavad muusikul staatiliselt oma pilli paigal hoidmist ja osati peenmotoorilisi kiireid liigutusi sooritama. Selline pikaajaline koormus võib põhjustada muusikus füüsilisi vigastusi. Kõige enamlevinumad vigastused muusikute seos on ülekasutamise tagajärjel tulenevad liigese ja lihaskonna haigused. Nende hulka kuuluvad tahtmatu lihaskontraktsioone tekitav haigus fokaalne düstoonia ja liigeste hüpermobiilsus. Muusikud samuti kannatavad ka närvikahjustuste all. Lisaks pilligamänguga seotud haigustele, ohustavad muusikuid ka mud tööalased stressorid, näiteks raskete pillide transportimine ja ülesseadmine, pidev reisimine, magamatus ja kesine dieet.

Muusiku elukutse hõlmab ka muud peale füüsilise koormuse. Muusiku töö on paljuski ka emotionaalne. Muusikud ei sarnane sportlastega ükses oma konstantsete oskuste arendmise poolest vaid ka oma loomingu ja meisterlikkuse esitamise poolest. Nii nagu atleedid käivad oma võimekust näitamas võistlustel, nii on muusikutel kontserdid, kus kuulatakse valvsa kõrvaga ja vaadatakse valvsa silmaga. See osutab muusikule suurt pinget tekitades esinemisärevust. Esinemisärveus võib mõjutada muusiku töötulemust negatiivselt, ning võib lõppeda depressiooniga. Vigastuse järgne depressioon võib tekitada tööpuudust, mis võib niigi vähe teenivale muusikule mõjuda tugevalt.

Kuigi muusikaaliste vaimsete ja füüsiliste vigastuste uuritavus on vähene, siis arstid ja psühholoogid on välja töödanud mõned meetodid kannatavate muusikute aitamiseks. Nende hulka kuuluvad: puhkamine, trenni tegemine, ravimid ja tõsisemate vigastuste puhul operatsioonid. Selleks, et vigastusi ennetada on oluline roll muusikutel jälgida enda rühti ja teadvustada ennast võimalikest ohtudest ning sümptomite ilmnemisel koheselt pöörduda professionaalse abi poole.

Non-exclusive Licence to Reproduce Thesis and Make Thesis Public

I, Joshua James Viinalass
(*author's name*)

1. herewith grant the University of Tartu a free permit (non-exclusive licence) to:

1.1. reproduce, for the purpose of preservation and making available to the public, including for addition to the DSpace digital archives until expiry of the term of validity of the copyright, and

1.2. make available to the public via the web environment of the University of Tartu, including via the DSpace digital archives until expiry of the term of validity of the copyright,

The Physiological and Psychological Impact of Music on the Performing Artist,
(title of thesis)

supervised by Assoc. Prof. Ando Pehme
(supervisor's name)

2. I am aware of the fact that the author retains these rights.

3. I certify that granting the non-exclusive licence does not infringe the intellectual property rights or rights arising from the Personal Data Protection Act.

Tartu, 06.05.2016