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Recommended Citation

Bellisle, Rachel F. and Decker, Jessika, "The Biomechanics of Music Performance" (2017). *Senior Honors Projects*. Paper 564.

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The Biomechanics of Music Performance

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Abstract – When first learning to play a wind instrument, beginner musicians are taught how to hold their instrument and correctly position their body. They are taught how to sit, where to put their hands and fingers on the keys, and how to hold their arms. This initial lesson on posture and hand positioning is often short, as one quickly moves on to learn the embouchure and breathing techniques that allow sound to be produced. As a musician progresses in skill, positioning is emphasized more, and they learn that it can affect their risk of strain or injury and improve their sound quality. Throughout a musician’s lifetime, one may often find themselves in pain in one area of their body or another. This can normally be prevented by modifying or correcting their body in an optimal position to play as well as to prevent strain and pain. Common points of pain for a musician include the neck, shoulders, lower back, and wrists, depending on the type of instrument and other variables.

Musicians have developed several methods to teach the best positions to play instruments. Most of these methods are developed by experimentation, to decide what position feel the best and minimizes the pain they are receiving when they play. One such method is body mapping, which in general terms, allows a musician an understanding of their body and allows them to better learn to apply it. One can consciously correct their body position to produce more efficient and graceful movements. The evidence of success is a reduction of pain and improvement of playing ability and sound quality.

“The Biomechanics of Music Performance” is a study explaining the reasons why body mapping and the recommended positions for holding instruments are effective. An engineer’s perspective is used to explain the basic concepts of physics and biomechanics in a musician’s motion and details the related anatomical workings. The study has been narrowed to two specific instruments, the flute and the oboe, and focuses on the neuromuscular involvement of the upper limbs and body.

With both instruments, there are risks for many injuries similar to those seen in computer overuse. This includes carpal tunnel syndrome, tendinitis, and more. For example, for a flutist, concentrating on the extension of the wrist and ulnar deviation in the right arm is important, and physics can explain why the optimal position of the right elbow can change the amount of pain that is produced in the right wrist. Similarly, oboists often experience strain in their right wrist and hand, and again, this can be alleviated by adjusting the angle of wrist extension and ulnar deviation.

Through “The Biomechanics of Music Performance” the mechanisms of musical performance will be examined and accepted positioning will be studied to prove and explain their effectiveness. Through a new perspective on the subject, the goal is to introduce concepts to a new audience to increase the understanding and ability of musicians and their body positioning and movements.

I. Introduction

The repetitive nature of playing a musical instrument may cause a musician to experience discomfort, pain, or injury during the

course of their life. This pain is often the result of repetitive movement or overuse of the tendons, nerves, and/or muscles referred to as a repetitive strain injury. One common repetitive strain injury is carpal tunnel syndrome, which occurs due to constant pressure and irritation of the carpal tunnel. For a serious musician, the occurrence of repetitive strain injuries is very troublesome and if resulting in serious injury, can affect their profession and lifestyle. Therefore, it is vital to recognize any discomfort and strain in order to prevent further injury or damage to the body.

Musicians have developed several methods to find the best positions to play instruments without pain and to prevent injury. One such method is body mapping, which in general terms, allows a musician an understanding of their body’s anatomy in order to properly position themselves in a manner that reduces or eliminates pain and increases playing ability. This method is also related to the Alexander Technique.

“The Biomechanics of Music Performance” aims to detail the recommended playing positions and related techniques based on multidisciplinary sources, including body mapping, physical therapy, ergonomics, and others. This study demonstrates to musicians why body mapping and the recommended positions for holding instruments are effective, specifically focusing on the flute and the oboe. The goal is to provide information and understanding to prevent bad habits in posture, position, and movement that can lead to unintended consequences.

II. Methods

The first step to understanding why the recommended positions for holding the flute and oboe are effective was understanding the common problem areas for flautists and oboists.

Common points of pain for musicians include the neck, shoulders, lower back, and wrists, but these problems vary per individual depending on their habits.

The next step was consulting with experts and doing research. Information was gathered from multiple sources and disciplines, to encompass a larger range of recommendations for musicians and further evidence to support known methods. First, was a meeting with a body mapping instructor who demonstrated instructions for properly handling and playing the flute and oboe. She also explained some of the anatomical structures that are important for musicians to understand.

Next, a physical therapist further explained the anatomy of the typically afflicted areas of a musician. He discussed some common conditions and injuries that can result from incorrect use and preventative measures for such conditions and injuries. This advice built upon and supported the recommendations from the body mapping method.

III. Results

Perhaps the most important lesson from body mapping is that the different parts of the body are all connected and can affect other parts of the body. For example, bad posture and scrunched shoulders could result in problems in the wrists, particularly if nerves are affected (3).

Pain is another factor that can affect positioning. Pain can cause a person to shift their position to attempt to alleviate the pain. If done incorrectly, this can often cause more problems by leaving the ergonomic position (5).

A. Posture

A musician's position involves all parts of the body. On the largest scale, posture is essential and involves maintaining the normal curvature of the spine. The cervical and lumbar sections of the spine are curved towards the body. When the spine is aligned in this fashion, it is easier for the neck, shoulders, arms and wrist to be in a comfortable, efficient position.

This is extremely important for flautists who are at a greater risk of injury due to the asymmetric playing posture required (1). Flute players often stand in a posture that is symmetrical, despite the instrument being held to the right of the body, which is an asymmetric fashion.

There are two common positions flautists stand in that can cause pain and injury. The first stance is where the flautist stands with their feet together or shoulder width apart, the spine aligned, and the shoulders facing forward. This facing forward posture causing the right shoulder to be pulled backward and upward, creating pain in the neck area as well as the back. With the shoulder pulled back, the right arm pulls back as well, causing the wrist to extend, putting pressure on the carpal tunnel.

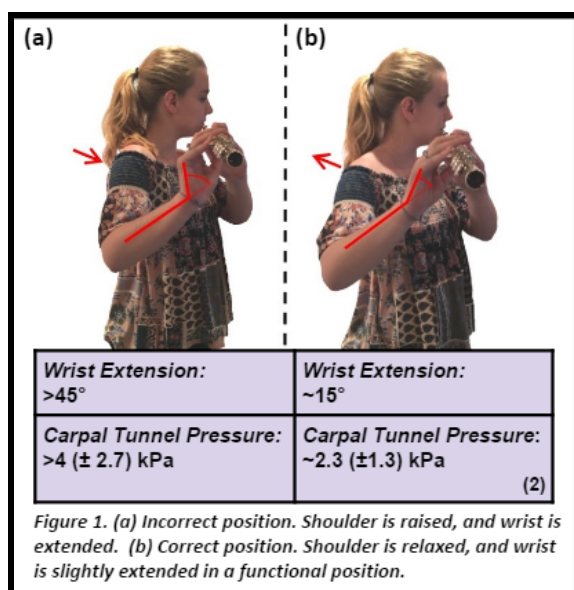
The second common stance is where the flautist turns their lower body at a 45-degree angle, when compared to their upper body. This allows the shoulders to be in a comfortable position but causes the spine to un-align. This twist in the spine prevents the proper support the upper body and head need, causing the back muscles to compensate and work harder than they need to.

A posture that prevents these strains is one that allows the spine to be aligned, the shoulders to be relaxed, and the wrist to be in its functional position, as discussed further in the paper. One can do this by standing with their feet in an asymmetric fashion. In this position, one should stand shoulder width apart. By turning their right foot at a slight angle outward and then stepping with their left foot forward and slightly to the left, can create such a position. This stance should be comfortable, with the weight of the person evenly distributed. Standing in this way will allow the spine to be aligned, the shoulders to be relaxed, and the right wrist to be aligned, limiting pain and injury (3). Figure 1 shows the comparison of the upper body during first stance, with the body facing forward and the shoulder pulled backwards and upwards, to the correct posture, with the feet in an asymmetrical position.

B. Shoulder

It is important to understand how the shoulder joint works. Beyond the generally known ball-in-socket joint (glenohumeral joint), the humerus, scapula, and clavicle (or collarbone) form four separate joints which are involved in shoulder movement. The scapulothoracic joint, where the scapula meets the back of the ribs, is not a standard joint structure. The scapula has no usual attachments, but it is stabilized by the surrounding muscle. The clavicle is also essential in shoulder movement. These parts provide a unique structure and movement in the shoulder. An understanding of these structures is important for a musician, so they are aware of their movements and can ensure the shoulder is free to move.

While playing an instrument such as the oboe, or flute, the upper arm should be slightly abducted. The shoulder should be kept as relaxed as possible and not raised or scrunched towards the neck. Maintaining a correct shoulder and arm position facilitates the correct playing position and aids minimizing the angles of the wrists. (see figure 1). In the flute, lowering the shoulder also assists in keeping the flute at the correct angle, normally 10 degrees below the horizontal (3).

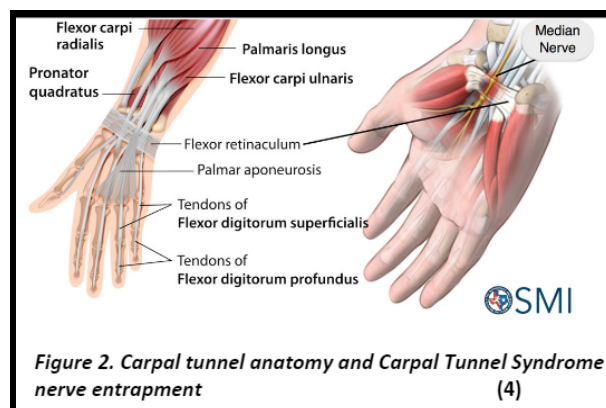


Scrunching the shoulder and neck can also cause tension or spasms which can trap nerves, specifically any of the nerves going from the neck to the arm. Many of these nerves go through the scalene neck muscles. Tightness in this area can compress nerves and can cause symptoms further down the arm, often mimicking carpal tunnel. Contracting muscles can also limit blood flow, resulting in pain (5).

C. Wrist

The wrist and hand are perhaps the most common area of strain in musicians. First, a musician must understand that the wrist does not rotate. Any rotational movement should originate from the elbow and the distal end of the forearm, where the radius will cross over the ulna during pronation. Attempts to rotate the wrist itself can be problematic, so it is important for a musician to understand the structure and movement of these joints.

Wrist injuries in musicians are common and are usually categorized as repetitive strain injuries. The most well known repetitive strain injury is carpal tunnel syndrome, caused by the inflammation of the median nerve and the nine surrounding tendons that run through the carpal tunnel (see figure 2). The inflammation and swelling only compound over time with the constant motion of the tendons rubbing on the nerve. While surgery can be performed to treat carpal tunnel, it can cause the carpal tunnel to fill with scar tissue, making the problem even worse. To avoid pressure on the median nerve,



the wrist should be kept straight (5).

To keep the wrist straight, there are several motions to avoid, including flexion, extension, and ulnar deviation (see figure 1 and 3). To avoid ulnar deviation, the pinky should be aligned with the wrist. Radial deviation should also be avoided; however, the range of motion on the radial side is less than the ulnar side, so the effects are not as concerning. Additionally, as a functional position, the wrist may be kept slightly extended (5).

With the oboe, the majority of the instrument's weight is held by the thumb. While this requires no continual movement, the thumb requires strength to maintain this position and is susceptible to injury. This includes DeQuervain's Syndrome, a type of tenosynovitis and repetitive strain issue, causing inflammation in the Abductor Pollicis Longus and Extensor Pollicis Brevis tendon. This condition is similar to carpal tunnel (5).

IV. Discussion

When it comes to proper positioning when playing the flute or oboe, it is important to keep good posture throughout the body to prevent pain and injury. These postures include aligning the curves of the spine, relaxing

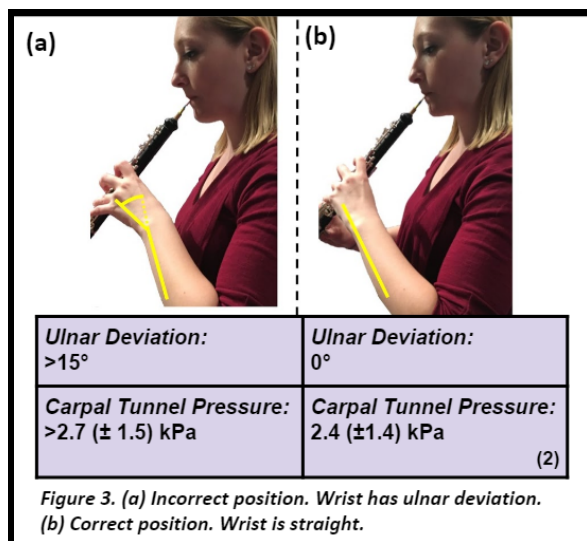


Figure 3. (a) Incorrect position. Wrist has ulnar deviation. (b) Correct position. Wrist is straight.

shoulders, and maintaining good wrist posture. Aligning the Lordosis curves of the spine, which are the Cervical (neck) and Lumbar (lower back) curves of the spine that curve outwards, allows support of the head. When the spine is not aligned correctly or the head is bent forward, the muscles of the neck and back must strain to hold the neck up, which can cause pain in the neck and back and can cause spasms. This also happens when the shoulders are scrunched upwards. Maintaining good wrist posture prevents excess pressure in the carpal tunnel, reducing pain and the probability of carpal tunnel syndrome.

In the case of pain or discomfort, it is important to know what preventative measures to take. Beyond ensuring correct positioning, the best actions to take include taking breaks to allow blood flow and release any pressure on the nerves and tendons. Stretching the muscles can also reduce pain, especially muscles that had been contracting throughout performance.

Even if these methods are used and done perfectly, some people are more prone to repetitive strain injuries and may experience more pain those who are not prone to repetitive strain injuries.

In some cases, instrument modifications are an option. However, these modifications may compromise sound quality and other factors of performance, so instrument modifications should be last resort.

The goal is to use the methods above to prevent or reduce pain before other methods such as instrument modifications or surgery are necessary.

V. Acknowledgements

We would like to thank Dr. Frederick Vetter (Department of Electrical, Computer, and Biomedical Engineering) for being our faculty sponsor and for advising our work for this project.

Additionally, we would like to Jane Murray (Department of Music) for her expertise in body mapping and for sessions of body mapping instruction.

Lastly, we would like to thank Dr. James Agostinucci (Physical Therapy Department) for meeting with us to share his expertise in physical therapy.

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