AN EXAMINATION OF THE EFFECTS OF BODY MAPPING INSTRUCTION ON SINGERS' STATIC STANDING POSTURE AND POSTURE WHILE SINGING

by

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ABSTRACT

Physical posture is one of the fundamental aspects of vocal technique, and voice pedagogues suggest that effective alignment is necessary for healthy vocal production. Body Mapping (BMG) is a somatic method that focuses on the understanding and correction of errors in a person's body map to facilitate effective movement for musical activity. Because this method has balance, physical alignment, and posture as foundational, it may be an effective way to begin to instruct students. This study investigated whether the use of the BMG method, which teaches posture through movement, scientific pictures, and anatomical models, would result in a significant difference in postural alignment. This study also examined whether there was an association between posture and breath capacity while singing.

In a pre-test/posttest study, the Vicon motion capture system was used to measure 49 undergraduate choir students on six postural alignment points (Atlanto-Occipital joint, shoulder joints, lumbar region, hip joints, knee joints, and ankle joints). Chest expansion was also measured to look for changes in breath capacity. Participants stood in a static position for 20 seconds and then sang “Happy Birthday” three times. Participants were distributed into a control group that received basic postural instruction and an experimental group that received BMG instruction. Participants were again measured for postural alignment and breath capacity.

Statistical analyses comparing the two groups found that the experimental group (n = 24) improved significantly more than the control group (*n* = 25) in static lumbar alignment. Comparisons of the pre-test/posttest data for each group showed improved static and singing A/O alignment for the experimental group and improved static lumbar alignment for both groups. An overall improvement was also found for the experimental group in the singing position. Analysis of the breath data showed significant improvement across the entire sample. These results provide preliminary evidence that BMG is an effective method for teaching static and singing posture.

CHAPTER 1: PROBLEM

Introduction

There are many different methods for teaching a person how to sing, an activity that is often considered to be a natural use of the voice. The WorldCat library database includes almost 3,000 items that may be categorized as vocal instruction sources. An internet search for the phrase “how to teach singing” may also yield many thousands of results. As early as the 16th century, the Italian musician Giovanni Camillo Maffei wrote a letter detailing his thoughts about the philosophical and physiological aspects of vocal pedagogy (Bridgman, 2001). In subsequent centuries, musicians and scientists have continued to study the voice and its potential uses.

Physical posture is one of the fundamental aspects of vocal technique. Singers give specific attention to the positioning of feet, knees, arms, and shoulders in an effort to produce the most effective sound. Vocal pedagogue William Vennard (1967) suggested that the quality of a singer’s sound may be aided or hindered by the position of various parts of the body. Vocal professor Scott McCoy agreed that “Good posture alone cannot guarantee good singing; poor posture, however, will almost certainly impede vocal progress” (McCoy, 2010, p. 44). Moreover, researchers have explored the benefits of medical therapies for the improvement of posture for athletes, elderly people, and those suffering from neurological disorders. Similarly, artists, physicians, and therapists have developed educational methods designed to address tension and extraneous movement in relation to posture. The practitioners of somatic methods recommend that students approach movement based on their individual kinesthetic perception. The primary focus of somatic methods such as the Alexander Technique and the Feldenkrais Method is the release of physical tension during movement. Feldenkrais and the Alexander Technique are well-known in the musical community (Isley-Farmer, 2005).

Body Mapping (BMG) is a newer somatic method that was developed by Barbara Conable and William Conable, certified Alexander instructors who sought to make somatic methods specifically applicable to musicians (Moreno, 2016). Its primary focus is the understanding and correction of errors in a person's body map to facilitate effective movement for musical activity. The body map is a representation of the body that exists in a person's brain and is dependent upon both visual and proprioceptive input. The BMG method relies heavily on the accuracy of this representation.

In recent years, a growing number of qualitative and quantitative studies have yielded information regarding relationships between the somatic concepts of visualization and proprioception. Researchers have found that the body map is informed through a combination of visual and tactile information (Constantini et al., 2011). This map has been found to exist in children as young as age 4 and may be altered throughout a person's life as a result of natural development, illness, or injury (Caggiano, 2020; Imamizu, p. 92). These alterations may also be the result of intervention techniques such as visual comparison or movement activities (Giurgola et al., 2020; Palmiero et al., 2019; Tosi et al., 2018). Changes in singers' body maps may also bring about alterations in their posture and breathing while singing.

Problem

Voice pedagogues suggest that effective alignment is necessary for healthy vocal production. Researchers agree that the body as a whole cannot function at its optimal capacity if it lacks balance (Adkin, 2001; Yim-Chiplis and Talbot, 2000; Yoo et al., 2018). Similarly, a body that is not correctly aligned may cause the singer to have difficulty breathing, which may further inhibit optimal singing (Iwarsson, 2000; Thomasson & Sundberg, 1998). Many voice educators use a variety of general instructions for teaching posture to singers, rather than a predetermined method or technique. Because the BMG method has balance, physical alignment, and posture as foundational, it may be an effective way to begin to instruct students. There is a dearth of quantitative research concerning this method, however.

Purpose of the Study

The primary purpose of this study, therefore, was to systematically examine the effectiveness of the Body Mapping (BMG) method of posture instruction. This study investigated whether the use of the BMG instructional method, which teaches posture through scientific pictures and anatomical models, would result in a significant difference in posture between the group that received the treatment and the group that did not. This study also examined whether or not there was an association between posture and breath capacity while singing.

Justification

Posture and breath management are largely understood to be central tenets of vocal pedagogy (Doscher, 1994; Garcia, 1894; McCoy, 2010; Miller, 2004; Vennard, 1967; Ware, 1997). Voice educators may adhere to the posture suggestions of notable pedagogues merely because such suggestions are easily understood and implemented, or because there is a limited amount of quantitative literature regarding singing posture. Many vocal technique manuals emphasize specific postural considerations: a balanced head and neck, relaxed shoulders, a lifted chest, pelvis slightly tipped and tucked forward, knees slightly bent, and feet slightly apart (Doscher, 1994; Garcia, 1894; Miller, 2004; Vennard, 1967; Ware, 1997). Likewise, BMG creator Barbara Conable (2000b) also emphasized the vertical alignment of the head/neck, shoulders, lumbar vertebrae, hips, knees, and ankles, suggesting that this alignment would allow for more effective breath capacity. The voice education materials listed below explain the importance of these considerations for singing:

- Misalignments of the singer's head and neck (particularly the Atlanto-Occipital joint) can cause tension and forced movement of the larynx, which may inhibit production of the desired vocal quality (McCarther, 2014).
- A singer's shoulders that sit too high or too far forward may limit freedom of the sternum and ribs. This may limit free inhalation and exhalation, thereby inhibiting a singer's breath management (McCarther, 2014).
- A singer's upper body that leans too far forward or backward can cause misalignment of the lumbar vertebrae, thus inhibiting the movement of the diaphragm and ribs necessary for breathing (Malde et al., 2020).
- Misalignment of the hip joints can cause the pelvis to be tipped too far forward, thus restricting diaphragmatic movement and consequently the amount of breath necessary for singing. Similarly, a singer's pelvis that is tipped too far back may result in a sunken chest, a condition that limits rib movement and breath activity (McCarther, 2014).
- A singer's locked knees may prevent blood from flowing throughout the body, resulting in loss of consciousness. Conversely, knees that are bent too much may cause the singer's upper body to lean too far forward, resulting in misalignments of the aforementioned locations and the resulting singing difficulties (Malde et al., 2020).

- Misalignment of the singer's ankles (such as wearing shoes with high heels) may cause unnecessary muscular tension as the body works to remain upright in an unnatural position. This tension can also make it more difficult to breathe and sing (Rollings, 2018).

Voice pedagogues also emphasize that specific movements during inhalation can facilitate the effective movement of air through the lungs by allowing the external intercostal muscles to contract and allow ribs to swing upward and outward. The diaphragm can then fully descend within the thoracic cavity and the muscles of the abdominal wall can contract freely. The shoulders should remain free, with only minimal movement (Doscher, 1994; McCoy, 2019; Ragan, 2020; Sundberg, 1993; Vennard, 1967). Poor posture has been shown to have a negative impact on breath activity:

- A singer's shoulders that are slumped forward may reduce the ability of the ribs and thoracic muscles to move freely, thus limiting the ability of the lungs to expand (Al Dajah & Muthusamy, 2015; Landers et. al, 2003).
- A sedentary lifestyle may contribute to a decline in thoracic postural strength, thus limiting the mobility of ribs, thoracic muscles, diaphragm, and lungs (Al Dajah & Muthusamy, 2015).

Conversely, the postural considerations associated with formal vocal training have been shown to have a positive impact on optimum breathing practice while singing. In a study by Salomoni, van den Hoorn, and Hodges (2016), classically trained singers exhibited a greater percentage of rib structure and abdominal wall movement during singing as compared to movement used during non-singing activities. In another study, trained singers demonstrated greater inhalatory lung volume and ability to manage breath usage during sung phrases (Thomasson & Sundberg, 1997). Vocal training which includes posture instruction has also been linked to the prevention of unnecessary vocal tension of singers while performing (Iwarsson, 2000).

A further justification for the present study is that most of the extant data is qualitative. Although a number of articles and dissertations describe the benefits of BMG in positive terms, they largely lack statistical data to support the findings. The few quantitative studies that exist are primarily focused on participant experiences with BMG and their perceived value of the methodology. Almost no work has been done on the relationship between BMG instruction and quantifiable change in posture. It is therefore the purpose of this study to provide quantitative data regarding the use of BMG in vocal instruction. Specifically, this study will examine the impact of this methodology on the improvement of singers' posture and breathing.

Hypotheses

This study was guided by two hypotheses:

1. There will be a significant difference between the amount of deviation from the six points of postural alignment both when standing still and subsequently while singing between the group receiving the BMG instruction (experimental group) and the group that received verbal instructions only (control group).
2. There will be an association between the quality of singers' posture and their breath capacity (defined as the degree of chest expansion and measured by the distances between the sternum, the T10 vertebrae, and the lowest costal margin of the left and right ribs) when standing still and subsequently while singing.

The following research questions will be addressed:

Postural Variables

1a. Will the experimental group show better alignment of the Atlanto-Occipital joint as measured by less deviation from proper alignment while standing as well as while standing and singing than the control group?

1b. Will the experimental group show better alignment of the shoulder joints as measured by less deviation from proper alignment while standing as well as while standing and singing than the control group?

1c. Will the experimental group show better alignment of the lumbar region as measured by less deviation from proper alignment while standing as well as while standing and singing than the control group?

1d. Will the control group show better alignment of the hip joints as measured by less deviation from proper alignment while standing as well as while standing and singing than the control group?

1e. Will the experimental group show better alignment of the knee joints as measured by less deviation from proper alignment while standing as well as while standing and singing than the control group?

1f. Will the experimental group show better alignment of the ankle joints as measured by less deviation from proper alignment while standing as well as while standing and singing than the control group?

Breath Variable

2a. Will better postural alignment correspond with greater breath capacity while standing and also while singing?

Limitations

Two limitations for this study relate to the participant population. First, the participants are all members of existing intact groups. Additionally, the population includes both music majors and non-music majors due to the intended design of the groups. It is possible that the music majors and non-music majors may respond differently to the postural instruction.

Another limitation is the amount of time available for instruction. The treatment includes six 15-minute instructional sessions that must be completed over a period of six weeks. The amount of time devoted to the treatment was short because of scheduling difficulties.

The COVID-19 pandemic is responsible for two additional limitations. The first is the potential impact of masks on breathing measurements. Some singers may choose to continue wearing masks for safety and may thus find it challenging to reach the same breath capacity when wearing a mask as compared to not wearing a mask. The second limitation is the potential for mortality due to pandemic-related illness or absence. If participants miss a session, they may be able to make it up by viewing a video recording of the session. However, if participants contract or are exposed to the virus and have to be quarantined at the beginning or end of the study, it is possible they may not be able to have measurements taken and will need to be removed from the study.

Delimitations

This study did not attempt to examine whether participants enjoyed the BMG methodology. I chose not to work with minors because the participants I had were readily available in the university setting. Additionally, working with adults did not require parental consent. I did not provide instruction on the improvement of breath capacity because posture was the primary focus of the study. The purpose for the inclusion of the breath assessments was to examine whether or not there was an association, rather than a cause-and-effect relationship between breathing and posture. I made no attempt to assess participants' body maps because this study focused on the BMG methodology and its effect on physical postural change, rather than the measurement of change in the body maps in the brain.

Intonation was not included as a variable. Although tools exist to measure intonation, it may be easily affected by factors not related to posture such as physical health or emotional stability. Timbre/tone was also not included as a variable. As with intonation, it can be easily affected by many factors not related to posture. Additionally, timbre may be considered to be a more subjective quality of singing, making it difficult to measure quantitatively.

Definitions

Alexander Technique: A somatic method of instruction developed by F.M. Alexander. This method is focused on altering harmful physical movement patterns in order to promote natural and efficient movement.

Association for Body Mapping Education (also known as ABME; formerly Andover Educators): The organization dedicated to the research and promotion of the Body Mapping method (referenced within the ABME community as BMG).

Body map: The literal neuronal picture individuals have in the brain that dictates human movement. “The body map is [a person's] mental representation of [the] body's structure, size, location, and function” (Malde et al., 2020). This map changes over time through physical development, injury, and healing. Errors in the body map may lead to physical tension or injury. Other terms for the body map include body model, body image, body schema, and internal representation.

Body Mapping method (BMG): A somatic instructional method developed by William Conable and Barbara Conable. BMG methodology draws heavily on information and ideas central to the Alexander Technique, such as exploration of individual movement patterns or habits and the release of physical tension. The pedagogical technique includes the use of scientific pictures and models to teach posture and balance. The intent of the BMG method is to provide an understanding of how the many and varied parts of the body work together to produce effective, coordinated movement in music.

Breath capacity: The amount of space inside the upper thoracic region, as measured by the distances between the sternum, the thoracic vertebrae, and the costal regions of the lowest ribs.

Breath management: The coordination of physical balance, muscular activity, phonation and resonance in the use of breath. Effective breath management requires freedom (lack of tension) of rib and muscle movement during inhalation, as well as regulation (control) of exhalation (Malde et al., 2020). Breath management is referred to as breath control, breath support, or breathing technique (Hoch, 2016; McCoy, 2019).

Dynamic balance: The ability of a person to maintain an upright position while also experiencing movement. Dynamic balance can also be described as “Postural adjustments to voluntary movements, and reactions to outside perturbation to posture” (Ragnarsdottir, 1996, p. 370-371).

Feldenkrais Method: A somatic method developed by Dr. Moshe Feldenkrais to address symptoms of medical ailments in the body, “based on principles of physics, biomechanics, and an empirical understanding of learning and human development" (Feldenkrais Guild, 2019). Feldenkrais lessons are designed to identify and train efficient movement habits within the body to eliminate extraneous tension.

Kinesthesia (kinesthetic): A person's perception of the body's movement and position in space. This awareness is informed by information received from sensory receptors (proprioceptors) in muscles and joints.

Mis-mapping: Error(s) in a person's mental image about the size, location, or function of a body part. Mis-mapping may be the result of an injury, illness, or inaccurate education.

Postural tone: The ability of skeletal muscles to maintain limb position and coordination so that the body does not collapse (Cacciatore et al., 2011).

Proprioception: A person's sense of limb or joint movement. This awareness may be informed by both active and passive joint position sense (Physiopedia, 2021).

Somatic instruction: The teaching of coordinated physical movement to provide the individual with greater mental and kinesthetic understanding of how the body functions as a single unit. This type of instruction is often used to alleviate pain and increase range of motion. Instructional methods may include physical exercises, manual therapies, visualization techniques, meditation, and direct instruction. Examples of somatic methods include yoga, Alexander Technique, Feldenkrais, and Rolfing.

Somatosensation: The connections between internal tactile sensations and external body awareness. It is the process by which the brain detects, processes, and responds to physical touch or movement.

CHAPTER 2: RELATED LITERATURE

The related literature in this chapter is divided into the following sections: 1) Relationships between breathing and singing; 2) Posture education and applications for vocal use; 3) Measurements and methods for the improvement of posture and balance; 4) Somatic instruction for posture and balance; 5) the principles and applications of the Alexander Technique, and 6) the principles and applications of the Body Mapping method.

Posture Education in Voice Pedagogy

Vocal instructors utilize many different methods for teaching posture and balance. The following are typical recommendations for singing posture, as described by notable vocal pedagogues. First, the head should be erect and balanced forward and up (Doscher, 1994; Garcia, 1894; Miller, 2004; Vennard, 1967; Ware, 1997). To aid this balance, the neck should be lengthened in the back, shortened in the front, and free from tension (Miller, 2004; Ware, 1997). The shoulders should be relaxed and thrown back without stiffness (Garcia 1894; Miller, 2004). The chest should be high but not pushed out, and the rib structure should be expanded (Doscher, 1994; Garcia, 1894; Vennard, 1967; Ware, 1997). The pelvis should be slightly tipped and tucked forward (Vennard, 1967). Finally, the knees should be slightly bent and the feet placed roughly 6 to 8 inches apart with weight balanced towards the front of the body (Doscher, 1994; Miller, 2004).

Many pedagogical materials include these recommendations but neglect to explain why this positioning is important or how it may enhance singing. Singers' knowledge of breathing while singing may typically be confined to the torso and neck, regarding the “reciprocal relationship between the joints of the lower body to those of the upper body” (Isley-Farmer, 2005, p. 293). Allen et al. (2016) have suggested that every part of the body is a contributor to singing: “When your body is balanced, any movement that is inherent to the structure and flexibility of your body will be available to you” (p. 15). The remainder of this chapter will discuss some of the tools used to evaluate posture, as well as methods for the improvement of posture.

Postural Balance and Vocal Use

Just as balance is a necessary part of daily activities, it also plays a role in vocal usage such as speaking or singing. Many researchers have examined the relationship between balance and elements of vocal output such as loudness, tone quality, pitch, and breath. Arboleda and Frederick (2008) suggested that voice therapists would be better suited to make the recommendations if they possessed a broader knowledge of the muscular relationships concerning posture. The scope of this type of research can be grasped by noting the studies included in a 2017 meta-analysis conducted by Cardoso, Lumini-Oliveira, and Meneses. The analysis examined studies that explored relationships between posture, voice, and dysphonia (a condition in which the voice experiences difficulty producing natural sound). In this review, the researchers identified 1,319 studies associated with relationships between posture and the voice. Twelve of these studies (Bigaton et al., 2010; Carneiro, 2013; Franco et al., 2014; Gilman and Johns, 2016; Johnson and Skinner, 2009; Lagier et al., 2010; Mautner, 2015a; Mautner, 2015b; Menacin et al., 2010; Miller et al., 2012; Miller et al., 2014; Troni et al., 2006) were further identified as showing the existence of distinct postural-vocal relationships with particular regard to craniocervical position:

> In a forward head, backward head, and cervical extension positions, the voice becomes more acute, with more tension and worse quality when compared with a straight/neutral position. Additionally . . . in a backward head position and cervical extension, an increased loudness can be observed. (p. 124.e4)

These results give evidence that correct posture is necessary for efficient vocal production: “An effective posture allows a subject in a static posture or while moving to more easily shift the tension between muscles, allowing for a free movement of the larynx without blockages and with benefits to voice production” (Cardoso et al., 2017, p. 124.e11).

Additional researchers have also examined the impact of postural change on the singing voice. For instance, Luck and Toiviainen (2007) conducted a pilot study that analyzed the relationships between posture and singing. Fifteen participants sang a familiar song while being measured for vocal timbre (sound quality) and postural energy. Changes in the vocal timbre were associated with postural changes for the head and neck for the entire sample, causing the researchers to suggest a positive relationship between posture and singing. Moreover, Gilman and Johns (2015) examined possible connections between physical posture and self-perceived phonatory effort and how such connections might be understood as a means of reducing vocal fatigue. For this study, 46 adult singers sang a sustained /a/ vowel 18 times while standing or sitting in specific postural positions. Following each repetition, the participants communicated their perceived level of vocal effort using the following labels: “least effort,” “habitual effort,” and “increased effort.” The results showed that there was a significant difference in measurable vocal effort when singers stood with locked knees as opposed to standing with soft knees. The highest ratings of perceived vocal effort were indicated for singing with the head leaning (either forward or back).

Vocal quality and range may also be affected by singers’ changes in posture. In one study, Di Carlo (2002) investigated how singers might alter their laryngeal position to sing higher pitches. An operatically trained soprano experiencing age-related vocal fold calcification sang a series of notes extending into her upper register while X-rays were taken of her head and neck. The X-rays showed compensatory postural movements that caused the hyoid bone to move upwards and backward, allowing the thyroid cartilage to tilt for higher notes. In another study, Peultier-Celli et al. (2020) analyzed the postural control of 17 lyric singers who were performing under various sensorimotor conditions (e.g., standing upright, standing in a learned singing posture, standing while singing). The researchers used a force platform to measure postural sway for the lyric singers and a control group of 12 participants. The singers in the experimental group demonstrated greater postural stability than the control participants. The researchers suggested that this result was because of the attention given to posture in singing instruction.

External influences such as clothing or shoes may also affect a singer's postural control. Rollings (2017) investigated how the heel height of a singer's shoes might affect posture while singing. In this study, 30 university music students sang a musical theatre piece three times while barefoot and three times wearing the same style of heel. Video recordings showed changes in students' angles of the head and neck, and an audio analysis quantified changes in amplitude. Seventy-six percent of the total variance found was accounted for by the change of head position (nodding up or down) when moving from silence into singing, suggesting the usage of a posture specific to singing. The entire sample showed a significant decrease in the number of head position measurements when singing. That is, participants lowered their heads to a greater extent while wearing heels than when barefoot. Additionally, the audio analysis showed significant differences in amplitude for 70% of the sample. Because postural changes are sometimes associated with changes in vocal quality, the amplitude data caused the researcher to affirm a relationship between heel height, posture, and vocal output.

Relationships Between Breathing and Singing

The relationship between breathing and singing has been the subject of several research studies. For instance, Salomoni et al. (2016) investigated differences in breathing patterns of professionally trained singers and untrained singers. Each participant spent one minute breathing quietly and then sang a piece of music. The researchers measured lung volume by using inductive plethysmography bands to determine the total expansion of singers' thorax. A pneumotachography mask was placed over singers' mouths and noses to measure airflow. During the singing tasks, measurements for the trained singers showed significant activity in both variables (Lung volume: $F(1,9) > 28.87$, $p < 0.001$; Mean airflow: $F(1,8) > 8.9$, $p < 0.05$). The researchers stated that these measurements were significantly different for the untrained singers.

Similar results were found in a study of professional country singers. In 1996, Hoit, Jenks, Watson, and Cleveland compared singers' respiratory behavior in speaking activities with those demonstrated in singing activities. Each participant performed a speaking activity by reading a paragraph of preselected text at a normal volume and then repeating it a second time at a louder volume. The singing activity was to perform "The Star-Spangled Banner," followed by a fast country song and finally by a slow country song. For each performance, measurements were taken for rib cage expansion, abdominal wall expansion, and vital capacity (lung volume). These measurements were compared to determine the impact of rib and abdominal movement on vital capacity. No significant difference was found between the speaking activity and the singing activity. The researchers attributed this finding to a general lack of formal vocal training among country singers, as well as the speech-like nature of many country music songs. Such findings were similar to those of studies with untrained singers, leading the researchers to suggest the need for vocal training in their participants.

Thomasson and Sundberg (1998) used similar methods to study the breathing patterns associated with operatic singing. Five professional opera singers performed three songs. The researchers analyzed the individual phrases of each song by measuring initiation lung volume (ILV) and termination lung volume (TLV) for each phrase that was sung. The analysis showed mean initiation and termination lung volumes of 70% and 30%, respectively. These results were 10 to 20% higher than those associated with breathing patterns of regular speech and suggested a strong relationship between breathing patterns and singing.

Tang, Boliek, and Rieger (2007) studied the impact of laryngeal and respiratory behavior on pitch modification. Nine formally trained female singers sang two ascending and descending scales while being measured for vocal fold movement and breath activity. Vocal fold movement was observed through nasal endoscopy, and inductive plethysmography bands were used to measure vital capacity. Singers who had studied for at least 4 years demonstrated greater and more consistent vital capacity measurements (maximum %VC: $r = 0.72$, $p = 0.02$ and minimum %VC: $r = 0.69$, $p = 0.04$) than singers who had studied for a shorter period of time. Singers with more training also demonstrated a greater variety of vocal fold length measurements, or the ability to sing a wider range of pitches (Nishizawa, 1989; Sonninen et al., 1999; Titze & Talkin, 1979). The researchers concluded that a singer's laryngeal and respiratory behaviors were linked with the length of time they had been studying voice. Cowgill (2009) compared the breathing tendencies of athletic singers (higher percentages of muscle mass and larger bone structures) with those of non-athletic singers (higher percentages of body fat or lower percentages of muscle mass). Twelve participants were divided into groups based on their body types. They sang a portion of the Italian art song "Caro mio ben" while being video recorded. Strips of colored tape were placed in specific locations on the chest and abdomen to measure breath movement during singing. The results showed clear relationships between body types (e.g., higher percentage of body fat or higher percentage of muscle) and breathing patterns (F (1.5, 13.6) = 5.05, p = .03, $\eta 2$ = .36):

> Anecdotal observations were made that singers with more body fat had a tendency to breathe lower than those who were lean or muscular. The results of the research demonstrate that people in this study with more fat tended to breathe lower in the thoracic region than those who were more lean or muscular. (Cowgill, 2009, p. 146)

Other researchers have focused on specific breathing elements for singing, such as breath support and pitch modification. Thorpe et al. (2000) examined the respiratory patterns of five professional opera singers who used the same method of abdominal support in which the singer encourages “a particular increase in muscle contraction in the lateral abdominal region” (p. 87). Each singer sang an aria twice while being audio recorded. Measurements of the anterior-posterior and lateral dimensions of each singer’s ribs and abdomen were taken, as well as measurements of estimated lung volume. The audio recordings were analyzed to determine the projection (loudness) levels for each sung phrase. The results showed a pattern of increased rib measurements (M = 0.04, SD = 0.23; $t(4)$ = -.05, p < 0.0001) that corresponded to a significant increase in projection levels (average increase of 2.4 decibels).

An additional consideration for researchers may be that of participants’ self-perception. McCoy (2005) collected data on the perceptions of 55 professional opera singers regarding their breath management. The singers used a 6-point scale (1=least important, 6=most important) to rate their perceptions of the importance of thoracic movement during breathing. Both male and female participants emphasized that breath muscle activity in the lower thorax was significant (male rating = 4.23; female rating = 4.87). Additionally, the female participants also emphasized the importance of the pelvic floor (rating = 4.11).

Measurements for Posture and Balance

A variety of tools and tests exist for the measurement of posture and balance. The Berg balance scale (BBS), which provides scores for both dynamic and static balance, is one of the primary tools for the measurement of balance. The BBS was originally intended to measure balance in older adults (Kwak et al., 2016; Olimpio et al., 2018). Patients were scored as they performed a series of 14 functional activities such as reaching, stooping to pick something up, and moving from one chair to another. The BBS has also proven effective in the identification and diagnostic assessment of people who experience multiple falls. Therefore, researchers have used it for the development of recovery and therapy programs for stroke patients (Berg et al.,1992; Conradsson et al., 2007; Duarte et al., 2002; Muir et al., 2018; Tyson & De Souza, 2004, Tyson & Connell, 2009).

The Dynamic Gait Index (DGI) is also commonly used to assess fall risk by analyzing a person's ability to adjust gait when confronted with imbalance or dizziness (Dye et al., 2013). The DGI data are collected by the researcher for a series of eight movement tasks that challenge balance (e.g., side-to-side head turns, pivot turns, moving over obstacles). The resulting scores indicate the nature and amount of impairment a person may have encountered during those tests (Dye et al., 2013; Kara et al., 2016; Kwak et al., 2016). Marchetti and Whitney (2006) determined that a shortened version of the DGI, using only four movement tasks, could be as effective as the longer test for assessing fall risk. The BBS and the DGI have been used primarily in studies focused on the balance of older adults and patients suffering from neurological conditions rather than with singers. The BBS and DGI could, however, provide beneficial information for voice teachers working with singers who suffer from balance difficulties.

Technological advancements have also allowed researchers to quantify elements of posture and balance more accurately. One of these, surface electromyography (EMG), is an imaging process that allows researchers to analyze muscular activity through corresponding electrical signals in the brain. Electrodes are attached to the desired location(s) on the body to capture the electrical sound or noise generated by the muscular energy. Wires connecting these electrodes to audio equipment such as amplifiers and digitizers allow the noise to be analyzed and interpreted as muscular activity (Chowdhury et al., 2013). Researchers have used EMG data as a means of detecting the onset and offset of muscular activity (Adkin, 2001); peak muscle contraction (El-Kerdi, 2016); anticipatory muscular activity (Girolami et al., 2011; Ramli et al., 2019); and coordinated muscular function (Sundberg et al., 1991).

While the EMG provides insight into muscular energy, it is insufficient to quantify muscular function for movement and balance. Some researchers have therefore used EMG in conjunction with force-plate posturography, a technique that quantifies a person’s ability to adapt balance while standing on a force platform (Adkin, 2001; Girolami et al., 2011). This platform can oscillate at different speeds and intensity rates, allowing researchers to quantify a person’s ability to maintain balance under different conditions. Some force platform systems, such as the Balance System™ SD, utilize static and unstable platforms to demonstrate a person’s physical balance capability (Kara et al., 2018). More complex systems such as the Biodex Balance Master™ test a person’s ability to maintain balance in all directions and even experience training programs to improve that balance (Srivastava et al., 2009). Although EMG and force platforms are effective tools for measuring dynamic balance, their applications for singing have been limited to the analysis of the movement of laryngeal and thoracic muscles (Kirkpatrick & McLester, 2012; Pettersen, 2005; Pettersen, 2006). It does not appear that these measurement tools have been used as yet to measure singers' standing posture (which is typically more static) (Doscher, 1994; Garcia, 1894; Miller, 2004; Vennard, 1967; Ware, 1997).

Breath Mechanism Measurements

Another element of the current study that has been widely researched is the relationship between breath management and vocal output. In studies focused on respiratory activity and behaviors, many researchers have relied on inductive plethysmography to collect reliable data regarding lung volume. In 2016, Salomoni, van den Hoorn, and Hodges compared the lung volumes of seven classical singers to the lung volumes of four untrained singers. Respiratory inductive plethysmography bands were placed around the ribs and abdomen of each singer to quantify breath movement during singing and quiet breathing. Although there was no significant difference for the untrained singers, the results showed a significant difference between the two activities in the trained singers. Iwarsson (2000) found that singers who achieved a lung volume of 70% capacity while actively pushing out their abdominal wall also experienced a lowered vertical larynx position. Moreover, lung volumes have been found to be 10-20% higher for operatic singing than for normal speech (Thomasson & Sundberg, 1997).

Other respiratory tools employed by vocal researchers include the linear magnetometer, which provides data on the anterior-posterior and lateral measurements of the ribs and abdomen (Thorpe et al., 2000; Hoit et al., 1996). The Phonatory Aerodynamic System is a pneumotachography device that may measure inspiratory and expiratory pressures (Ray et al., 2017; Salomoni et al., 2016). In addition to lung activity, researchers have also collected data on vocal fold activity through electroglottography (EGG). Because the EGG waveform is sensitive to laryngeal activity, the wave shape responds directly to changes in laryngeal shape (Haji et al., 1986; Henrich et al., 2003). As found by Hampala et al. (2015), this sensitivity requires the vocal folds to achieve contact at a higher rate to more effectively measure their shape.

Each of the aforementioned measurement tools is effective in its own right. Motion capture systems, however, enable researchers to study both posture and breath elements with one set of equipment, thereby minimizing the time and cost for data collection.

Motion Capture Balance Analysis

Rapid technological advancements have aided in the design of numerous motion capture systems. The Microsoft Kinect game console (first released in 2010) “can be thought of as a 3D markerless motion capture system because it gives you a simplified skeleton in real time” (Fernández-Baena et al., 2012). Furthermore, the Kinect does not require a person to wear sensors to track movement. Researchers have used this system to create balance rehabilitation programs using fitness games (Olímpio et al., 2018). It is particularly valuable for the measurement of the kinematics of the sagittal hip plane and knee (Pfister et al., 2014). For reasons of cost, portability, and the need for minimal equipment, the Kinect may be an effective tool for measuring joint angles in the human body. Another device called the OptiTrack is a newer and less expensive system that captures physical movement by tracking sensors on a person’s body (Muyor et al., 2017). It has been shown to be accurate and reliable in a variety of studies related to the management of low back pain and measurement of sagittal spinal curvature (Carse et al., 2013; Charry et al., 2011; Muyor et al., 2017).

Despite the demonstrated capabilities of the Kinect and the OptiTrack, researchers have agreed that they need further development before they can be effectively used in health care (Carse et al., 2013; Fernandez-Baena et al., 2012; Pfister et al., 2014). The Vicon motion analysis system is a well-known alternative to these systems. Moreover, researchers have used it as a standard against which to test the validity of other motion capture systems (Carse et al., 2013; Davenport et al., 2009; Mjøsund et al., 2017; Pfister et al., 2014). The Vicon's ability to capture minute detail within a significantly larger space (Yang et al., 2012) has led researchers to recommend it as a viable tool for collecting kinematic data. Such data could be useful for the development of prosthetic limbs and implants, as well as for diagnostic and therapeutic applications (Bevins et al., 2009; Guerre et al., 2015; Merriaux et al., 2017; Ould-Slimane et al., 2017).

Additionally, the Vicon system can accurately examine joint movement by providing real-time photographic data of at least 120 frames per second (Dobrian & Bevilacqua, 2003). The Vicon's ability to accurately measure elbow movement suggests it may also accurately measure the other joints in the current study (Guerre et al., 2015). Vicon sensors may also be placed around the chest and abdomen to measure thoracic movement and document breath activity (Appelt, 2012; McNamara et al., 2007). The Kinesiology department at the University of North Dakota maintains a Vicon system in their BiPed lab, which was available to the researcher. Thus, for a variety of reasons, the Vicon was chosen as the data collection instrument for the present study.

Methods for the Improvement of Posture and Balance

There are many methods for the improvement of posture and balance. Balance training often includes a combination of static activities, such as standing on one foot or squatting on one leg (El-Kerdi, 2016; Hirsch et al., 2003); dynamic activities, such as balancing on a narrow ridge without falling (Otten, 1999); and functional balance activities, such as walking (Nordin et al., 2006; Shin et al., 2011). As mentioned previously, a force platform may be used to measure and improve each of these forms of balance. Studies using these platforms often require participants to complete various movement tasks while also focusing their vision on either a stable or a moving target (Kara et al., 2018; Srivastava et al., 2009).

Chiropractic and physical therapy have been widely used for the treatment of postural and alignment problems. The primary techniques of chiropractic therapy include hands-on directional thrusts and the use of percussion hammers to adjust bone positions manually and relieve muscle and tissue pain (Dag Kjersem, 2018). Chiropractors may also recommend specific exercises to be done by patients between visits to provide faster and more complete recovery (Fortner et al., 2017). Physical therapy is also widely used in the improvement of postural balance. Letafatkar et al. (2019) selected a series of exercises to address specific points of postural imbalance in 48 participants. One exercise involved the rolling of the chin downward to strengthen the cervical spine. Another exercise required the participant to sit against a wall to strengthen the mid-thoracic region. Modified push-ups against a wall were also recommended to patients to strengthen the shoulders and trapezius muscles. These and other similar exercises have been shown to significantly change the forward head angle, protracted shoulder angle, and pain reduction in patients.

Exercises that include the use of resistance bands may be desirable methods for the improvement of posture and balance in people suffering from significant muscular weakness. Kwak et al. (2016) examined the efficacy of resistance band training for improving balance and gait function with a group of 45 elderly physical therapy patients. An experimental group participated in exercises that targeted the strength of their ankles and knees by challenging their flexion and extension. One end of a resistance band was wrapped around a stable object such as a bed frame, and the other end was wrapped around the participant's foot or leg. The patient then practiced moving the joint in question either forward or backward to strengthen the muscles. The results showed that there was a significant improvement in the balance and gait functions of the participants.

There are also non-therapeutic methods for the study and improvement of postural control. Researchers of biology and psychology have studied motor imitation, or the extent to which a person's physical behaviors are impacted by movements they visually observe (Iacoboni et al., 1999; Brass et al., 2001; Thirioux et al., 2009). Earlier studies required participants to observe simulations of a hand lifting or tapping a finger and then imitating the movement. The response movements were significantly faster when there were no additional stimuli (Iacoboni et al., 1999; Brass et al., 2001). A subsequent study by Thirioux et al. (2009) used a full-body simulation of someone walking on a tightrope. Participants watched the simulation while simultaneously holding a long metal bar and walking back and forth along a line on the floor. The results showed a high correlation between simulated movements and those of the participants (mean slope: 0.66; $r^2 = 0.99$), suggesting that there were connections between their mental imagery and motor behavior.

Ergonomic Methods for the Improvement of Posture

Some methods for the improvement of posture have been developed for specific activities. For example, ergonomics is designed to improve posture by altering the equipment in a workspace (*What Is Ergonomics*, 2014). In studies with office workers (Bohr, 2000; Habibi & Soury, 2015) and teachers (Shuai et al., 2014), researchers used ergonomics lessons to provide information on muscles and musculoskeletal disorders, ideal postures for the workplace, equipment positioning, and general health and wellness. After receiving this instruction, participants reported less physical pain, a clearer perception of their health, and a better understanding of how the principles of ergonomics could positively impact their work.

Direct instruction in ergonomics may also be effective for school-age children (Sellschop et al., 2018). A university physiotherapy lecturer presented 127 eighth-grade students with a lecture and PowerPoint presentation on posture and a series of stretches for the shoulders, neck, and back. The students demonstrated significant improvement in their posture after receiving the instruction. In a pre-test/posttest study, Geldhof et al. (2016) successfully adapted this intervention method for even younger students. In this study, a physical therapist provided lessons to 193 students ages 9 to 11, using two comic characters to teach simple spinal anatomy and posture. Large posters of these principles were displayed in classrooms to reinforce the instruction. The posttest results showed that there was significant postural improvement ($p < 0.001$) across the sample. The educational treatment method used in these studies is similar to that of the study undertaken by the present researcher.

Multimedia and software programs have also been effective tools when combined with direct instruction for providing ergonomics education in the workplace

(Taieb-Maimon et al., 2012). In this study, individual photos were taken of 60 participants demonstrating correct posture (as described in the ergonomics instruction). For three weeks, a webcam software program frequently showed these participants the photo of their correct posture. These photos were shown next to an image of the participants' current sitting posture to encourage them to make any necessary changes. Although participants in both groups immediately demonstrated positive posture change immediately, participants in the webcam software group maintained this change for a longer period following the study's conclusion. In a similar pre-test/posttest study with elementary students, participants reported reduced physical discomfort after receiving the ergonomic intervention (Dockrell et al., 2010). The researchers used printed photos of students to determine their understanding of correct posture. The students looked at their photos and were then asked to identify which pictures showed correct posture. They also determined what areas of their classroom needed to be rearranged to facilitate better posture. As with the lecture-only protocols, these methods resulted in significant and positive postural change for the participants ($p = 0.00$).

Somatic Methods for the Improvement of Posture and Balance

In addition to the aforementioned methods, somatosensory training may be yet another option for the improvement of posture and balance. Somatosensory methods teach a person to maintain mental focus while engaging in specific physical activity. Whereas exercises or stretches are often performed for a particular purpose, the physical awareness encouraged by somatic instruction may be applied to a wider variety of activities (Jain et al., 2004). Dictionary.com (2022) defines somatic as "of the body; bodily; physical." Healthline.com expands on this, stating: "Somatics describes any practice that uses the mind-body connection to help you survey your internal self and listen to signals the body sends about areas of pain, discomfort, or imbalance." According to somatic educator Sarah Warren, somatic movements should be performed slowly, with conscious attention, and in an exploratory manner (Warren, 2016).

Many different somatic methods are currently taught throughout the United States. Practitioners work with clients and students in clinics, studios, educational institutions, and online settings. Proprioception and mental imagery are key elements in somatic education. Sarlegna and Sainberg (2009) defined proprioception as "the component of somatosensation that provides information about the orientation and motion of body segments and the state of the muscles." In their view, the proprioceptive sense, therefore, interacts with the visual and tactile senses to allow the brain to understand the shape and size of individual limbs, their location concerning one another, and how they can move through space.

Stone et al. (2018) investigated this multisensory interaction in a study of body representation. In their study, 24 subjects participated in three tasks in which they examined their mental perception of the size and shape of their legs. The visual task required participants to describe the differences between a distorted photo of their leg and their actual leg. For the tactile task, participants were blindfolded and asked to estimate the distance between two physical points on their legs. The proprioceptive task required participants to locate a place on their leg without being able to see the leg. Although the study results showed a distorted mental representation of the leg for all participants, the distortions were similar across the different types of tasks. The researchers agreed that a person's body representation was based on the integration of visual, tactile, and proprioceptive information.

These findings align with those found by Tosi, Romano, and Maravita in their 2018 study of 45 stroke survivors who suffered from stroke-related weakness in one arm. Participants placed both arms on a table and performed simple hand movements such as tapping the fingers and opening/closing the hand. The impaired arm was hidden from their view by a mirror that reflected only the healthy arm. This activity took place for 10 minutes, after which participants repeated the activity without the mirror, allowing them to see both arms. The researchers assigned the following scores for both conditions: 0 = both hands moved in sync; 1 = both hands moved simultaneously but in different ways; and 2 = only the healthy hand moved. Before and after these activities participants were scored for muscular strength in their forearms, response to visual stimuli, and response to tactile stimuli and the hands. The results showed that there was improvement in the participants' responses to visual and tactile stimuli after the mirror activity. This improvement suggests that there was interaction between the visual and tactile senses.

> In this setting, observing the reflection of the intact limb in the mirror, while the affected one is hidden behind the mirror, can exert a positive influence upon different clinical conditions from chronic pain to motor deficits. Such results are thought to be mediated by a process of embodiment of the mirror reflection, which would be integrated into the representation of the affected limb. (Tosi et al., 2018, p. 1)

Some studies have found proprioception training to be effective and beneficial for the improvement of balance ability. Yoo et al. (2018) investigated the balance improvement in 30 Taekwondo Poomsae athletes by using a series of 18 proprioceptive lower body strength exercises. Each exercise required the participant to stand on one leg with the knee flexed while also stepping forward or throwing a ball. Participants completed half the exercises while standing on the floor and half while standing on a balance board. At the end of 6 weeks, results showed an improvement in all standing balance measures. As found by Bucci et al. (2016), proprioception may be impacted by a significant physical alteration such as surgery. The researchers studied the balance ability of 23 children with strabismus, a condition in which the eyes do not focus in the same direction at the same time. Postural recordings were collected for each child before and after eye surgery to determine if there had been any change in postural stability. The results showed a significant improvement in postural stability after surgery, leading the researchers to affirm the role of visual input in proprioception.

Proprioception may sometimes be confused with visualization, or mental imagery. A simple distinction may be that proprioception is specific to physical position and movement, whereas mental imagery may refer to any image or action the brain can conjure. An expanded version of this distinction was provided by Sarlegna and Sarlegna (2009) as follows:

> Vision provides extrinsic, world based coordinate information and is used to plan spatial features of movements toward visual targets. Proprioception provides intrinsic information about limb configuration and movement, as well as muscle state, and predominates in transforming a spatial plan into commands that result in muscle forces and joint torques. (2009, p. 5)

Proprioception and mental imagery may each be of great importance for musicians, as they must often work with their bodies and external instruments. According to Keller (2012), the mental imagery associated with musical activity may interact with action simulation (mimicking or mirroring actions performed by another person) and internal models (the ability of the brain to predict outcomes of a given action). For a musician, action simulation could take the form of adjusting one’s posture based on that of another person. An example of performers’ internal models could be the adjustment of their posture to produce a different quality of sound through their instrument. These mental imaging techniques rely on the proprioceptive sense, which is heeded by the performers when positioning the body accordingly. Although many proprioception studies focus on training programs for athletes or those suffering from single-joint injuries (Collins, 2010; Heggernes, 2013; Yoo et al., 2018), some studies have shown musical activities to be an effective treatment for the improvement of balance in neurological patients (Bucci et al., 2016; Ghai & Ghai, 2019).

Somatic education in all its forms seeks to improve the use of the body's structures. It does not seek to teach specific activities but enables the performance of any activity to be done economically, efficiently, and with good body use. This form of instruction can be applied to the movements of athletes. (Lowndes, 2012) Actors may also draw on their mind-body connection to intensify their characterization. For a musician, the strength or weakness of the mind-body connection may directly impact their musical output as follows:

- Flutists might produce a better tone by changing the angle of their arms.
- Pianists might minimize back pain by adjusting their balance while sitting.
- An accurate understanding of the shoulder joint and the arm structure might help violinists move their bows with better technique.
- A singer might alter the position of the hip joints to more fully support the upper body.

Some researchers have found that students who achieve a heightened level of awareness experience greater fulfillment during a musical performance. In Paparo's (2011) study on the use of Feldenkrais lessons with high school choir students, participants reported experiencing positive changes in posture, breathing, resonance, and vocal coordination. Similarly, 75% of participants in a Body Mapping study reported experiencing improved breath, tone, posture, and confidence during a performance (Buchanan and Hays, 2014).

Many voice teachers have incorporated somatic methods in their studios and classrooms. In a survey of 55 professional voice instructors, Neely (2012) found that most were familiar with the Alexander Technique, the Feldenkrais method, yoga, and Pilates. More than 50% of the participants reported using Alexander or yoga themselves, and close to 50% used those same methods with their students.

The Feldenkrais method is a somatic method that was developed by Russian scientist Dr. Moshe Feldenkrais (1904-1984). An active participant in activities such as soccer and judo, Feldenkrais suffered several serious knee injuries that never fully healed, causing him to begin his investigation into rehabilitation (*Moshe Feldenkrais*, n.d.). As he began to incorporate tiny changes into his body movements and focus on the impact of those movements on the rest of his body, he regained functional use of his knees and reduced his pain (Jain et al., 2004).

The Feldenkrais methodology is of two types: Awareness Through Movement (ATM) and Functional Integration (FI). ATM is the more commonly used treatment and is generally intended for group practice, although it can also be used in individual sessions. ATM sessions often require students to sit or lie on the floor while receiving verbal directions to move body parts in specific ways. These movements are usually performed at a very slow pace, giving students time to experiment individually. The process is also intended to be experienced with ease and gentleness:

> The lessons are designed to improve ability, that is, to expand the boundaries of the possible: to turn the impossible into the possible, the difficult into the easy, and the easy into the pleasant. For only those activities that are easy and pleasant will become part of a man's habitual life and will serve him at all times. (Feldenkrais, 1987, p. 57)

It is common for practitioners to guide students through a series of movements on just one side of the body, to gain greater sensory awareness of any change that has occurred (Brummer et al., 2018; Feldenkrais, 1987; Lyttle, 1997). The information gained from this awareness is then used to either encourage continued movement or suggest the need for alternative movement. “In order to arrive at the right movement, it is first necessary to think of better movement rather than right; the right movement has no future development” (Feldenkrais, 1981, p. 92). If students become aware of any physical fatigue or strain during these movements, they may choose to perform the movement more slowly, alter the direction of the movement, or cease the movement entirely. It combines the verbal instructions and slow pace found in ATM with direct physical contact by the teacher. The concept of FI is not as widely used as ATM due to its inclusion of hands-on work by the teacher.

Researchers have studied the efficacy of the Feldenkrais method for many different purposes. Hillier and Worley (2015) conducted a systematic review of Feldenkrais studies to determine if there was any research to support the use of Feldenkrais training for the improvement of physical ailments. The reviewers examined 20 studies that used Feldenkrais classes as the treatment but were otherwise diverse in participant populations, methodologies, and findings. The researchers reported that the results in most studies showed that the treatment resulted in significant positive results for the participants such as greater neck flexion, improved balance, and improved agility. These results caused the researchers to recommend Feldenkrais instruction as a beneficial method for the improvement of some physical deficits.

One of the studies Hillier and Worley (2015) investigated utilized a program based on Feldenkrais methods for the improvement of balance in elderly participants. In their study, Vrantsidis et al. (2009) provided Feldenkrais classes to elderly participants who suffered from impaired balance ability. The participants experienced improved dynamic balance and gait speed after receiving the treatment. There were no significant differences, but this may have been due to the small number of participants (N=15) in the study. In a different study, Connors et al. (2009) used classes similar to those of the

Vrantsidis study, focusing specifically on the transfer of weight from one side of the body to the other and the adjustment of pelvic tilt to improve balance while standing. These techniques were employed to help participants gain a stronger awareness of their feet in connection with the ground. After the study, all participants showed significant improvement in gait speed and balance confidence.

Lundqvist et al. (2014) investigated the efficacy of Feldenkrais training for the treatment of chronic neck pain. The treatment group consisted of 30 visually impaired participants who also suffered from neck or scapular pain. This group took part in a 12-week Feldenkrais course that incorporated group and individual training, while a control group of 31 similar participants received no training of any kind. Before the treatment, all participants rated their levels of pain and physical well-being on a series of surveys. All participants were evaluated after the treatment and again one year later. Whereas the post-treatment evaluations showed no change in the pain measurements for those in the treatment group, the control group demonstrated a significant increase in muscular pain, leading the researchers to recommend Feldenkrais training for the mitigation of neck/scapular pain.

Brummer et al. (2018) studied the benefits of Feldenkrais's Functional Integration (FI) method for the improvement of muscle relaxation. The researchers used a pressure sensor to measure the percentage of contact between the participants' bodies and the surface on which they lay. The participants included 30 healthy physiotherapy patients who lay supine on the pressure mat for the collection of baseline data for chest and pelvic regions. They remained on the mat while receiving an FI treatment to one side of the body, followed by a second data collection. They then received the FI treatment on the other side of the body. This was followed by the third and final data collection. The results of the statistical analysis showed a significant increase in pelvic pressure, suggesting that there had been increased relaxation of the muscles in that region.

The Alexander Technique

Frederick Matthias Alexander (1869-1955), who developed another somatic treatment known as the Alexander Technique, began his professional life as an orator and stage actor in Australia (de Alcantara, 2013). As his career progressed, he began experiencing “... a persistent tendency to hoarseness and respiratory trouble that affected the quality of his voice during recitations” (Gelb, 1994, p. 11). Although Alexander sought help from physicians, none could offer medical help (de Alcantara, 2013). The problem appeared to occur only during a performance and not during regular speaking activities, causing Alexander to consider that some element of formal recitation was the cause of the problem (Gelb, 1994). In 1888, he began to investigate the issue on his own:

> Using mirrors to observe himself, Alexander first noticed three things he was doing while reciting which were possible causes of his hoarseness: he pulled his head back, depressed his larynx, and sucked in his breath. Dispensing with the mirrors, Alexander knew that he simply needed to remember to bring his head forward and up to resolve the issue. However, despite his best intentions, the problems remained. (Franklin, 2016, p. 43)

Alexander began by examining small, individual movements of his body and the impact of those movements on other locations in his body. If he found a movement to be harmful, he worked to retrain his body to move differently. He analyzed the efficiency of movement patterns and then consciously directed his body to move according to the most efficient pattern. Alexander later referred to these conscious decisions as Inhibition and Direction. (Gelb, 1994)

Alexander developed his discoveries into a formal method and began publishing such works as *Man's Supreme Inheritance* (1910), *Constructive Conscious Control of the Individual* (1923), and *The Use of the Self* (1932). He moved to London in 1904 and opened a practice (Gelb, 1994). During this time, he became acquainted with Dr. John Dewey, a leading figure in American education during the early 20th century. Dewey began studying with Alexander and subsequently wrote introductions for three of Alexander's books. As a leader of the pragmatist philosophy, Dewey believed that a person's habits could be altered by making consistent, intentional changes in actions, movements, and their environment:

> A man who has a bad habitual posture tells himself, or is told, to stand up straight. If he is interested and responds, he braces himself, goes through certain movements, and it is assumed that the desired result is substantially attained; and that the position is retained at least as long as the man keeps the idea or order in his mind (Dewey, 1923, p. 29).

Dewey's belief that people can consciously change their habits may have attracted him to the Alexander Technique. He studied the method regularly for over 35 years, first with Alexander and later with Alexander's brother, Albert (Jones, 1976).

AT Principles

The Alexander Technique is based on several principles that may be applied individually or together. The first of these principles is the Use of the Self. This principle states that the mind and the body are designed to work together, and that each functions best when they do so. The functional success of the self may be seen in the efficiency of a person's movements. This is in keeping with what Alexander called the "Means-whereby" principle: one action cannot happen unless another action happens first. The happening of the first movement is the means whereby the second movement is possible (de Alcantara, 2013). Alexander described the impact of this principle concerning controlling breath activity: "As the breathing mechanism is *unconsciously* controlled, it is necessary, in order to regain full efficiency in the use of it, to proceed by way of *conscious* control until the normal conditions return" (Alexander, 1946, p. 193). Dewey described the process not as thinking about *what* must be done but *how* it must be done, thus emphasizing the importance of the process (Dewey, 1923).

The second principle, according to Alexander, is Primary Control. This principle posits that the head and the neck should lead any full-body motion. Therefore, in order for other parts of the body to work efficiently and effectively, the head and neck positions must first be free and balanced.

> The significance of the Primary Control is that it serves as a key to coordinating the organism as a whole. If we can develop an understanding of the subtleties of balancing our heads, we can then begin to take responsibility for our righting reflexes, thereby freeing ourselves from fixed attitudinal responses (Gelb, 1994, p. 51).

The emphasis of the principle of Primary Control in treatment may stem directly from Alexander's personal experience of it. One of the first harmful tendencies he had noticed in himself was a proneness to pull his head back and down in conjunction with other bodily movements, both on stage and in daily life. Upon discovery of this head movement, Alexander realized that many other movements often took place simultaneously (possibly due to the head movement): lifting the chest, arching the back, forcing the larynx downward, and forcefully sucking in a breath. He concluded that addressing the initial head movement could result in avoiding the other movement as well, thereby supporting his principle of Primary Control (Barker, 1981).

The third and fourth principles of Inhibition and Direction work together in yet another demonstration of the previous principles. According to AT theory, the body will act instinctively based on kinesthetic memory. The kinesthetic memory must be active for the movement to be effective or coordinated. This demonstrates the AT concept of

Inhibition, that motor memory will inhibit the body from producing a different action or movement. It is also possible that the habitual and familiar nature of the ineffective movement has caused the brain to perceive the new, more effective movement as negative or uncomfortable. The AT theory of Direction suggests, however, that Inhibition can be overcome by practicing new body movements. Thus, the kinesthetic memory can be retrained to replace the ineffective movement with a new, more coordinated one (Gelb, 1994).

> For all purposes, ‘sitting down’ and ‘bending the knees’ are two different acts, associated with two different sets of sensations, and triggered by two different mental commands. One act is habitual, performed mostly without awareness, and characterized by the pattern of misuse . . . the other act is unfamiliar, performed with awareness and uncontrolled control, and characterized by the well-coordinated working of the whole organism. The second gesture is not an improvement on the first one: it is a change from it, which is the ultimate goal of the Alexander Technique. (de Alcantara, 2013, p. 50)

Dewey described the relationship between Inhibition and Direction as “thinking in activity” because students cannot simply think about choosing a new movement but must do the movement (Franklin, 2016).

There is not a set of specific exercises to be used in every AT lesson. Instead, the teacher explores with the student the physical habits that need to be retrained (de Alcantara, 2013). AT lessons are designed to be ongoing interactions between teacher and student, and lessons are individualized for each student according to need. The teacher uses verbal description to provide information on anatomy, emotional awareness, kinesthetic considerations, and concurrent instruction for immediate application. There are, however, fundamental elements of AT theory that are intended to guide AT instruction. Alexander Technique texts often include entire chapters devoted to breathing anatomy and activities to facilitate effective breath management. Students who demonstrate ineffective breath habits (Inhibition) may benefit from studying their movements in order to replace the negative habits with better habits (Direction). After a student demonstrates a clear understanding of breath management and Primary Control, an AT teacher may use a variety of specific activities such as the monkey, the lunge, and table work (de Alcantara, 1997; Dasovick, 2004; Lewis, 1980).

The monkey encourages the student to be aware of multiple locations and sensations throughout the body. In this activity, the student places feet in a wide stance and points the toes slightly outward. The student bends the knees slightly and leans forward from the hips joints, allowing the spine to lengthen. The torso should remain at a slight angle, and the pelvis should be balanced over the legs. This position allows the body's weight to be evenly distributed while indicating excess tension.

> The monkey is a position of mechanical advantage. It coordinates the use of the back and legs, a precondition to improving other parts of the self, such as the upper limbs or the lips, tongue and jaw. The monkey is an apt way of examining the issues of tension, relaxation, balance, posture, position, movement, control, inhibition, and direction. (de Alcantara, 2013, p.100)

The lunge is a variation of the monkey, with two notable differences: 1) the left foot is slightly forward to the right foot, and 2) the left knee is bent, and the body's weight is supported over the left leg. As with the monkey position, the torso should be angled slightly forward from the hip joints.

Table work is an activity in which the student lies face up on a table (or another flat surface) with knees bent and feet placed flat on the table. This position allows the student's body to respond to external touch or manipulation "without having to bear one's weight or be responsible for maintaining one's equilibrium" (de Alcantara, 2013, p. 152). The student may be instructed to remain in this position and focus on breathing or relaxation within the body. The teacher may also gently move the student's limbs in different directions to encourage awareness of tension or resistance to the movement. Whatever the activity, the primary focus of AT instruction is to foster in students an understanding of how the individual movements function within the context of the entire body to lead the student to a deeper awareness of the Use of the Self.

AT Studies

The primary goal of the Alexander Technique (AT) is the replacement of extraneous movement with effective movement to minimize pain or tension in the body (Jain et al., 2004). AT lessons focus on actions such as sitting, standing, bending from the knees, and using the bones and muscles of the shoulder structure when lifting the arm.

Woodman and Moore (2011) reviewed 18 studies that investigated the effect of AT lessons on chronic health issues in elderly participants. These studies examined the efficacy of AT instruction on participants suffering from chronic lower back pain, poor balance, post-surgery posture problems, decreased respiratory function, vocal stuttering, and Parkinson's disease. Interventions in these studies included individual and group AT sessions. Patients with Parkinson's who received 24 AT lessons demonstrated improved arm balance even 6 months after the intervention (Stallibrass et al., 2002). In another study, a training period of only 6 weeks produced positive change lasting up to a year after the conclusion of the training (Little et al., 2008). Each study described in the review reported significant improvements for the associated outcome measures, causing the reviewers to recommend further study in AT instruction for these and other health issues.

Another AT review investigated the effectiveness of AT instruction for musicians (Klein et al., 2014). Participants in each of the 12 corresponding studies received AT instruction in individual or group sessions weekly or bi-weekly. The intervention periods varied from as little as 6 weeks up to 18 months. Researchers measured participants in music performance and performance anxiety, posture, and respiratory function. Although none of these studies showed a conclusive relationship between the instruction and respiratory function, several studies did suggest that there was a positive association between AT instruction and performance anxiety.

Austin and Ausubel (1992) found that AT lessons had a positive impact on respiratory function. A sample of 10 students participated in 20 individual lessons with certified AT instructors for 7 months. Each participant underwent standard spirometric testing before and after receiving the lessons. At the end of the study, the spirometric data showed that there had been a significant positive change in four of the eight respiratory measurements.

As found by Cacciatore et al. (2014), training in this method may be effective in both the short and long term. In this study, a group of certified AT instructors who had had at least three years of experience with the method were measured for individual postural tone in the neck, trunk, and hip. Patients suffering from low back pain (LBP) were measured for the same items after receiving 10 weeks of AT instruction. The study results showed greater measurements of postural tone in the AT instructors, as well as significant improvement in the postural tone of the LBP participants.

Becker et al. (2018) utilized EMG technology to examine the benefits of AT training for 10 participants who had suffered from neck pain for at least six months. Electrodes were placed on each participant’s neck to measure muscular fatigue while the participant played a video game for five minutes. Photographs were used to document head position as measured by “the angle between the tragus, the spinous process of the seventh cervical vertebra (C7), and the top of the manubrium” (Becker et al., 2018, p. 82). The researchers stated that a smaller angle for this region would indicate poor alignment. Participants attended 10 hour-long AT classes that provided instruction in the application of ergonomic principles to everyday activities. The researchers administered one pre-test and two posttests (one immediately after the intervention and one five weeks later). The results showed positive differences on both posttests. Muscular fatigue was significantly less after the intervention ($F(3,27) = 7.3$, $p = .001$) and the head position angles were larger than during the pre-test ($F(3,27) = 2.6$, $p = .07$, $\eta 2 = 0.22$).

AT instruction has also been shown to minimize the frequency of playing-related musculoskeletal disorders (PRMDs) for instrumental musicians. Davies (2019) distributed two questionnaires to music students registered for a university AT course. The first questionnaire asked participants to rate the frequency and intensity of pain related to playing musical instruments. More than half (65%) of the participants reported experiencing some level of playing-related pain on a frequent basis. The second questionnaire was distributed after the course and asked participants to rate the extent to which they believed the AT instruction had been beneficial for pain management. Participants in the sample ($N = 23$) reported that the AT instruction had helped reduce their playing-related pain.

Alexander and Feldenkrais Comparison

Both Alexander and Feldenkrais emphasized the value and necessity of using the mind and body together when doing movements used for daily life. Moreover, they both theorized that the body could not change habitual movements and patterns without direct instruction from the mind and that the mind could not effect any change in the body without first having a detailed awareness of the existing movement patterns. Hall (1991) described the primary focus of each method: "The focus [of AT] is on the ‘how’ of movement . . .. The focus [of Feldenkrais] could be on the how, what, when, where or why of movement." Lessons and classes for both methods are offered worldwide by a number of professional organizations. Alexander organizations such as the American Society for the Alexander Technique (AmSAT) and the Feldenkrais Guild of North America (FGNA) also provide opportunities for students to find teachers and workshops in their local area or abroad. In Figure 1, this author has provided a brief outline of some notable differences between the Alexander Technique and the Feldenkrais method.

Figure 1
Differences between the Alexander Technique and the Feldenkrais method

Alexander Technique	Feldenkrais Method
Learning must take place under the instruction of a trained AT teacher.	Instruction may be provided by a live Feldenkrais instructor or through printed/recorded materials that are explored by students on their own.
Uses a hands-on approach between teacher and student.	Hands-on techniques are used only in Functional Integration sessions.
Students are encouraged to pay attention to proprioception and visual cues from the teacher.	Information comes by way of verbal cues from the instructor and the kinesthetic feedback obtained by doing the exercises.
Instruction and exercises are specific and focused.	Learning involves movement exploration for the student.
The origin of any movement is possible from a static position.	Movement is intended to progress in a specific direction.
Emphasis is on knowledge of the skeletal structure and dynamic posture.	Emphasis is on free movement rather than on posture.
Exercises are focused on specific actions such as standing from a chair or lifting an item.	Exercises are focused on developmental movements such as crawling and rolling.

The Body Mapping Method

The Body Mapping method (BMG) is yet another somatic strategy. It was developed in the 1970s by Alexander instructors William Conable and Barbara Conable. They attributed their initial discovery of the “body map” to William’s assumption that a violin student's inability to bend her arm may have been the result of errors in her mental image, or mis-mapping, of her elbow joint (Buchanan, 2014). This discovery led William Conable to theorize that the body map could be corrected, a process that would later be formally known as the Body Mapping method, or BMG. During the next two decades, he and Barbara continued to teach the principles of AT with a new emphasis on the understanding of the body map. Barbara published the first relevant text in 1991, *How to Learn the Alexander Technique*, explaining in detail how AT could be applied to musical activities. Barbara later developed the course "What Every Musician Needs to Know About the Body" (WEM) that would become the foundation for all BMG instruction. In 1998, she founded Andover Educators (renamed the Association for Body Mapping Education in 2020), an organization dedicated to providing BMG instruction to musicians worldwide.

In 2000, Barbara Conable published the introductory BMG text, *What Every Musician Needs to Know About the Body*. This text was designed to accompany the WEM course, providing descriptions of and interactions between individual areas of the body. The text included diagrams of the skull, the spine, various muscles, and limbs to explain how the musician may move the body in such a way as to experience balance and freedom. Barbara Conable also provided insights into how incorporating these movements may minimize the potential for performance-related injury:

> If you're in pain as you play, your doctor can tell you if you're diseased or injured and will probably cure you. If your pain comes from mis-use you need to retrain your movement until it's free and efficient and elegant, before your misuse causes an injury . . .. The goal of Body Mapping is to alleviate the misery of body mis-use by changing misuse into movement in keeping with the elegant design of the body. (Conable, 2000b, p. 49)

The authors of BMG texts have defined the body map in various ways. In the WEM text, Barbara Conable referred to the body map as "one's self-representation in one's own brain" (2000a), stating that "we conceive neurally what we're like (structure), what we do (function) and how big we are (size)" (2000b). BMG training teacher Jennifer Johnson took a more scientific approach in her definition: "It [the body map] is the literal, neuronal picture we have of ourselves in the brain, and dictates how we move" (2009). Other BMG specialists have explained that the body map develops due to a person's physical experience and may be altered throughout life (Mark, 2004; Jankowski, 2016; Pearson, 2006).

The WEM course consists of six individual hour-long units. These units may be taught consecutively or spread out over a period of time and are usually taught in the following order:

- Section 1: Introduction to Body Mapping. This section provides definitions and descriptions of the body map, Body Mapping, attention, and inclusive awareness. Students are taught that movement is central to music-making and that all movement depends on the accuracy of the body map. They are encouraged to focus their senses of hearing, vision, touch, and kinesthesia as each of these senses contributes to the accuracy of the body map. Students who complete this section should understand the basics of the body map, sensory awareness, and inclusive awareness.
- Section 2: Balance. This section introduces the Six Places of Dynamic Balance for standing and sitting. Teachers use a combination of skeletal models and images to teach students about the spine, the A/O joint, the shoulders, the lumbar region, the hip joints, the knee joints, and the ankle joints. Activities such as sitting, standing, walking, and bending the knees may be used to help students become more aware of balance throughout the body. If an individual has an inaccurate body map of these places, the total balance may be adversely

affected. Students who complete this section of the course should be familiar with the six places of dynamic balance, be able to sit and stand with dynamic balance and be able to start identifying personal mis-mappings.

- Section 3: The Arms. This section describes the four arm joints in relation to each other, the spine, and the entire torso. Students are taught to distinguish three types of rotations of the arm and a neutral position for the arms. Movement awareness activities may include raising and lowering the arms, shrugging or slumping the shoulders, and exploring the different rotations of the shoulder and elbow. Students who complete this section should be familiar with the joints of the arm and wrists and the three main types of rotations of the arm. They should also be able to implement more efficient arm use by drawing on their understanding of the arm's connection to the spine.
- Section 4: Breathing. This section explains how to map the structures and movement of breathing. Students are taught about the location, size, and movement of the ribs, diaphragm, and lungs and how these locations work together during inhalation and exhalation. Activities include slow inhalation and exhalation, with attention given to the movement of individual areas in the body associated with breath activity. Students who complete this section should be familiar with the structures and movements of breathing as related to their bodies. They should understand and be able to demonstrate effective inhalation and exhalation and how posture and balance impact breathing.
- Section 5: The Legs. This section describes leg movement for standing and sitting. Students learn about the integration of the legs in balance and breathing. Students also learn about the location, size, and rotations of the hip joints, knee joints, and ankle joints. Awareness activities include movement of the legs at

each of these joints in seated, standing, and lying down positions. Students who complete this section should be able to map the pelvis and leg joints with regard to their entire bodily structure.

- Section 6: Practical Application. This section provides individual lessons for either two or three students (Conable, 2000b). It is designed to be a master class during which the teacher offers BMG instruction specific to a student's performance.

The principles laid out in WEM seem to have been influenced by four primary principles of the Alexander Technique: Use of the Self, Primary Control, Inhibition, and Direction. Inclusive awareness (Section One) expands on the Use of the Self by emphasizing not only self-awareness, but also situational and locational awareness. Primary Control is essentially the first of the BMG Laws of the Spine, which are taught in the Balance section:

1. The head must lead spinal movement [from the A/O joint].
2. The vertebrae must follow [the head] in sequence.
3. The spine must be free to lengthen and gather in spinal movement.
4. Spinal movement should be concentrated across the whole spine.
(Conable, 2000b, p. 19)

Together, the principles of Inhibition and Direction relate directly to the primary definition of BMG, as laid out by Barbara Conable in the WEM text: "Body Mapping is the conscious correction and refining of one's Body Map to produce efficient, graceful, and coordinated movement. Body Mapping, over time, with application, allows any musician to play like a natural" (p. 5).

A number of BMG teachers have adapted *What Every Musician Needs to Know About the Body* for flutists, pianists, dancers, trombonists, violinists, oboists, and children. Other BMG specialists have contributed to a series of breath management manuals for oboe, trumpet, horn, trombone, euphonium, and tuba. Allen, Malde and

Zeller (2016), authors of *What Every Singer Needs to Know About the Body*, have taken the overall scope of BMG and applied it to the singer. Each chapter focuses on a different aspect of the singing activity: core of the body and balance, breathing, creation of sound, resonance, etc. The text is designed to facilitate an individual singer's "experimentation and discovery" (Allen et al., 2016, p. xi) of how the body functions while singing.

The Six Places of Dynamic Balance

In her second book, *The Structures and Movement of Breathing*, Conable (2000b) adapted some of the main concepts from her first book specifically for singers, with a particular emphasis on the breathing apparatus. It was in this text that Conable (2000b) first introduced the six points of dynamic balance, theorizing that placing them into accurate vertical alignment would allow for more effective singing: "Balance around our weight-bearing spines and legs is the best postural condition for singing. Our singing structures are supported by our bony architecture and our superficial muscles are free to gesture beautifully" (p. 15). BMG Educator Heather Buchanan (2014) agreed: "Explaining the concept of breath support is done more easily and effectively when singers begin with an accurate understanding of the structures and movement of breathing" (p. 168). The six places of dynamic balance are (from top to bottom): the Atlanto-Occipital joint (henceforth referred to as the A/O joint), the shoulders, the lumbar vertebrae, the hips, the knees, and the ankles. Figure 2 shows these places in alignment.

The A/O joint is the topmost place of balance within the body. It is comprised of the C1 vertebra (also known as the atlas) and the occiput (the base of the skull). The A/O joint is responsible for facilitating only a minimal amount of movement from front to back, approximately 15 to 20 degrees (Swartz et al., 2005). BMG specialist MaryJean Allen (2020) described the importance of balancing this joint: “Mapping the location of your A/O joint is crucial because balance at the A/O joint allows the muscles in your neck and the rest of your body to release, thus allowing you to move easily and expressively while you sing” (p. 43). The exact location of this joint can be seen in Figure 3 (above).

Figure 2
Balance Mascot with Places of Dynamic Balance

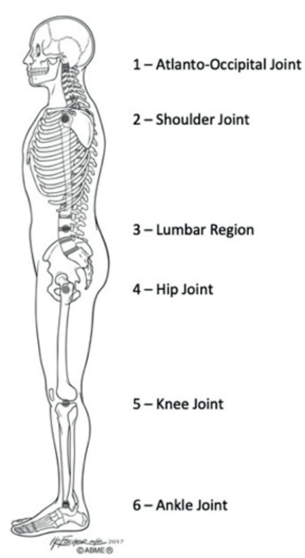

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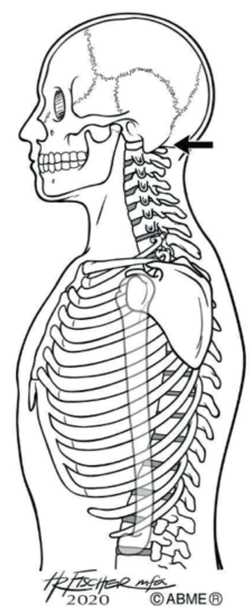
Figure 3
Atlanto-Occipital Joint



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The second place of balance is the shoulder joint, a ball-and-socket joint in which the humerus (the upper arm) is connected to the scapula (the shoulder blade). The scapula is also connected to the clavicle (the collarbone), which extends toward the center of the body to meet the sternum and, by extension, the ribs. BMG literature states that the positioning of the shoulder joint has a direct impact on rib movement and thus on breath activity as well: “If, however, the dynamic balance of the arm structure is interfered with by dragging the arms downward, the collarbones and shoulder blades will get in the way of the up-and-out excursion of the ribs during inhalation, and the singer will not be able to breathe fully and freely” (Allen, 2020, p. 252).

Figure 4
The Shoulder Joint in Context of the Arm

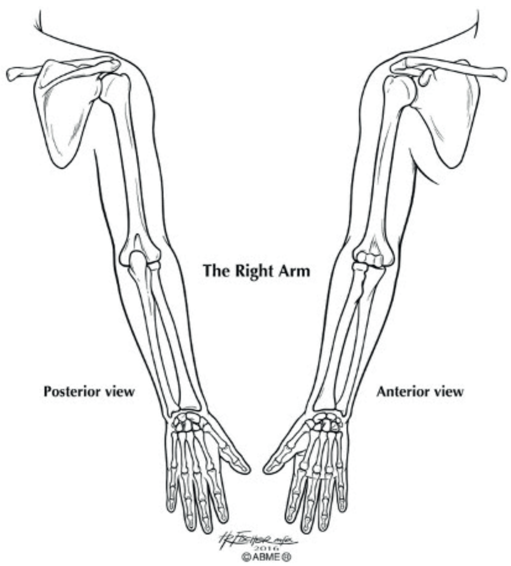

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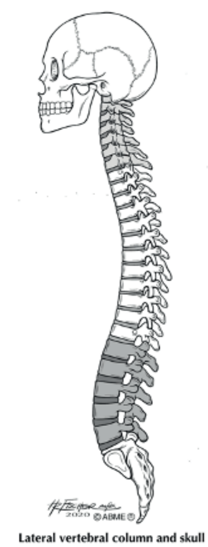
Figure 5
The Lumbar Region of the Spine (shaded)



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The third place of balance is the lumbar region, which consists primarily of the five lumbar vertebrae (the shaded area in the image above). These vertebrae are the largest bones in the spinal column. The thickest portion of the lumbar region sits directly behind the belly button and extends almost halfway through the torso from front to back. The front of the spine supports the weight of the head and the torso and delivers that weight into the surface a person’s body contacts (i.e. the chair if sitting, or the floor if standing). In order to more fully understand this area, it is helpful to also be aware of the sacrum (the lowest portion of the spine, also known as the tailbone) and the pelvis. Any movement of the lumbar vertebrae will also impact the sacrum and the pelvis. The lumbar balance area should be aligned directly below the A/O joint when standing/sitting at dynamic balance (see Figure 6).

Figure 6
Comparison of Thoracic and Lumbar Vertebrae

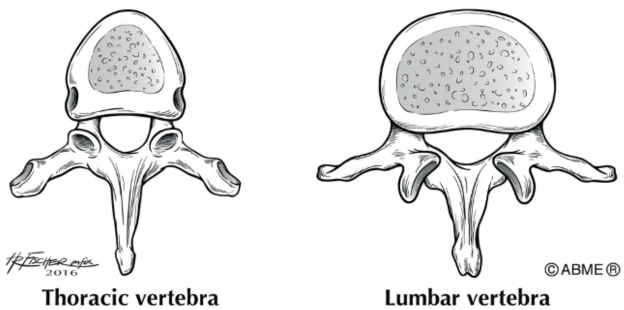

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Figure 7
Seated Balance

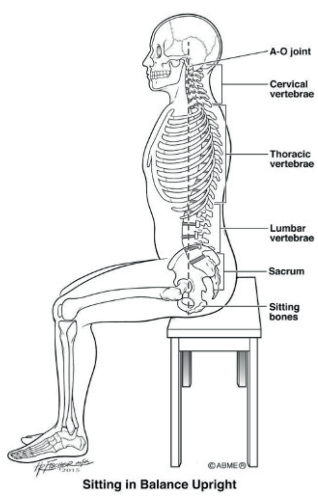

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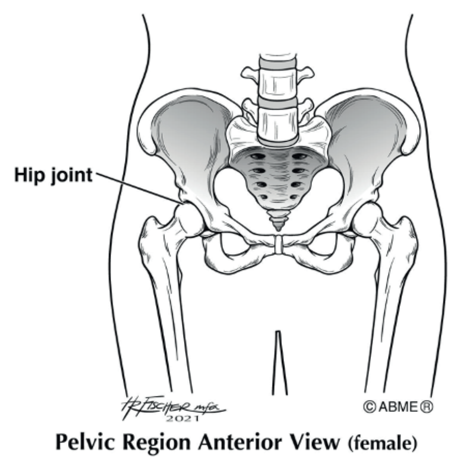
Figure 8
The Hip Joint in Context of the Pelvis



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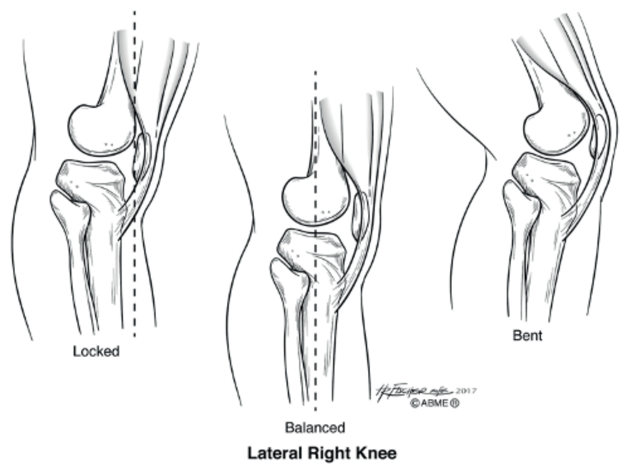
The hip joint is the fourth place of balance and is geographically related to the lumbar region. The hip joint is a ball-and-socket joint on the side of the body, where the femur (thigh bone) connects to the side of the pelvis. BMG materials state that the hip joint is the middle point of the body, and it is at this joint that the legs and torso move in relationship to each other (Conable, 2000b; Draina, 2019; Malde et al., 2020.

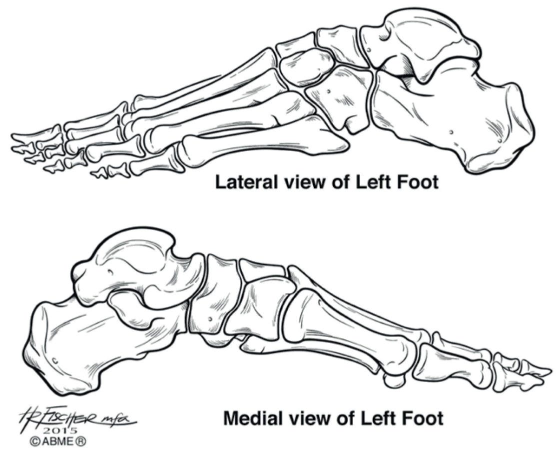
Figure 9
The Knee Joint



The knee joint is the fifth place of balance. This joint may be most familiar to singers as one that should be kept loose and unlocked to allow blood flow while standing (Garretson, 1990). The knee is the grouping of three bones: the femur, the tibia (lower leg), and the patella (kneecap). The knee is the largest joint in the human body and is a modified hinge joint, which means it can move in multiple directions: forward and back, and a slight side-to-side rotation.

The sixth and final place of balance is the ankle joint. The ankle joint is located where the bottom portions of the tibia and fibula (the two lower leg bones) meet with the talus bone or the top of the foot. People tend to mistake the bumps at the lower ends of the tibia and fibula for the ankle joint, but the joint is the entire connection between these and the talus. It is also important to realize that this joint is not at the very back of the foot but is rather between the back and the center. It sits right above where the front of the heel meets the arch of the foot.

Figure 10
The Ankle Joint



BMG Resources

A number of publications provide guidance for the implementation of BMG in applied music instruction. In addition to Barbara Conable's seminal text, BMG texts have been written for the piano, trombone, violin, oboe, singer, and dancer. These publications are textbooks, providing in-depth information that is best suited to a teacher or professional musician who can understand and integrate the knowledge into his or her own practice. Mountain Peak Music, a publishing company owned by BMG educator David Vining, publishes a series of books focused on breathing instruction that may be more suitable for musicians who are unfamiliar with BMG or simply less experienced in singing or playing their instrument. The series includes texts for the oboe, trumpet, horn, tenor trombone, euphonium, flute, and singer. Each book is divided into sections on the places of dynamic balance and other physical considerations specific to the instrument in question. There are accompanying breathing, singing, or playing exercises. BMG educator and AT instructor Kay Hooper designed her book *Piano Moves* precisely for piano teachers to use with students. Each chapter centers on a particular mapping consideration (e.g., the head, the spine, the upper arm) and provides clear anatomical information, images, and movement activities. The text also includes instructional scripts and hands-on activities that may be used in regular piano lessons.

Most of the BMG dissertations consulted by this researcher provide instructional guidance, as well as the history and theoretical underpinnings of the method. Jeon (2015) discussed BMG as a resource for piano teachers and students. She provided in-depth mapping information about sensory awareness, sitting balance, and the complete arm structure. She also gave examples of literature treating the application of this knowledge to the playing of the piano. Bindel (2013) expanded the potential for pianists to benefit from BMG by creating a syllabus centered on providing BMG instruction for collaborative pianists. Holt (2016) provided a similar BMG resource for trumpet teachers and students. He provided in-depth mapping descriptions of the spine and the arm structure, as well as a physical and tonal description of the trumpet.

In addition to these documents related to instrumental instruction, Moreno (2016) compiled a resource for singers and private voice teachers. He created a set of three in-depth lessons on physical alignment, breath management, and vocal resonance. Moreno’s observations of BMG instruction caused him to suggest that this method may contribute to a stronger sense of musicians’ physical ownership, stage confidence, and overall improvement of technical skills.

Because the treatment of the present study centers on the six places of dynamic balance, the aforementioned work of Bindel (2013), Holt (2016), and Moreno (2016) were used as reference material in designing the experimental treatment for the present study. None of these researchers collected any data to determine whether BMG was more effective than other instructional methods, however. Therefore, one difference in the present study is the inclusion of data that are generated and statistically evaluated.

Surveys Regarding BMG Instruction

Surveys completed by BMG practitioners and students and practitioners have shown a positive perception of the instructional method and its effect on breath, mitigation of performance anxiety, and release of muscular tension. Knaub's 1999 qualitative study on BMG instruction provided perhaps the first insights on the efficacy of the method. Knaub collected and analyzed approximately 500 reports and journal entries written by music majors who had taken an Alexander Technique course taught by William Conable. The purpose of the study was to investigate differences and similarities between male and female perceptions of BMG concepts and applications for musical activities. The analysis results showed that students reported having a greater understanding of body parts and joints after receiving the instruction. Students also communicated an appreciation for the variety of learning activities (movement, anatomical images, self-observation) employed by W. Conable.

Buchanan and Hays (2014) explored participants' perceptions regarding BMG instruction in a university music program. Twelve undergraduate students received BMG instruction as part of an elective performance course. The participants recorded journal entries describing their experiences and perceptions of the instruction. Upon analysis, the researchers found several primary themes throughout the journal entries:

- Individual knowledge of BMG principles
- The ability to incorporate BMG into personal practice
- Use of BMG principles for musical expression, technique, and performance practice
- Enhanced self-awareness for participants

The results of the analysis showed that 75% of the student sample (*N* = 12) considered BMG instruction to be valuable for each of the primary themes.

In a similar survey, Salonen (2018) found that 12 university music students who experienced BMG instruction considered the information to be highly valuable and beneficial for musicians. The participants were enrolled in a course on occupational health for musicians. The course provided information on common injuries and risk factors for musicians, performance anxiety, BMG principles, an AT workshop, and master class opportunities for practical application. Data were collected from participant journals and interviews, as well as questionnaires that were distributed before and after completion of the course. Salonen found four primary themes: panorama (general thoughts on the instruction), physical awareness (posture, muscular tension, and breathing), psychological awareness (self-evaluation and performance anxiety), and musicianship (practice habits and connection to music). Participants communicated positive perceptions of the course and BMG related to each of the primary themes.

A few quantitative studies have examined the efficacy of BMG studies for specific instruments. Slade (2020) analyzed the piano performance of 38 piano performance majors in a pre-test/posttest study. Each participant played a series of C-major scales and arpeggios on a MIDI-equipped piano or keyboard. The MIDI capabilities allowed the researchers to measure note accuracy, tempo consistency, and evenness of tone and articulation. Participants received the complete WEM course in a one-day intensive setting between the pre-test and the posttest. The analysis results showed no significant change in any of the variables between the pre-test and posttest. The researchers, however, felt that measurable change could be possible in studies that utilized an extended intervention period, legitimate pieces of repertoire (as opposed to scales and arpeggios), and different instrument groupings.

Summary

The studies of posture and singing in this chapter have covered a broad spectrum of methods, variables, and outcomes. Researchers have studied the impact of specific postural changes on the singing voice, but few of these studies have recommended changes in pedagogy or methodology. Although many therapeutic and instructional methods have been designed, examined, and applied for the improvement of posture and the use of the singing voice, much of the existing pedagogy for singing has relied upon postural recommendations that have simply been passed down by teachers based on their individual experience and observation. The Body Mapping method (BMG) is one such instructional method that has garnered recognition within the musical community for its observed benefits. To date, very little scientific research has yet been done to examine the efficacy of this method.

CHAPTER 3: METHODOLOGY

Description of Participants

This study involved 52 undergraduate adult students attending a large state university in North Dakota who were members of the university Allegro or Bards choral ensembles. This volunteer sample included 19 male and 33 female participants from these two primarily non-major choral ensembles. The participants in the sample included predominantly non-majors ages 18-25. Fifty percent from each ensemble was assigned to the control group and 50% to the experimental group. The control group consisted of sopranos and tenors, and the experimental group consisted of altos and basses.

Treatment

The instruction was delivered to participants during a period of 6 weeks. A conducting assistant delivered the instruction to each group. This assistant was a university senior pursuing a degree in music education. She had previously conducted two other university ensembles and was recommended by the ensemble directors to this researcher. Prior to administering the instruction in the study, the assistant had become familiar with BMG by attending some introductory sessions facilitated by the researcher. The assistant received specific training from the researcher in the treatment protocols for the study. The researcher also provided scripts, images, and models for the conducting assistant to use in each lesson (see Appendices D, E, and G). Each group received six 15-minute posture instruction sessions delivered by the conducting assistant. Each session addressed one of the following places of balance: the A/O joint, the shoulder joint, the lumbar region of the spine, the hip joint, the knee joint, and the ankle joint. Groups moved to a separate location at the beginning of rehearsal for treatment sessions led by the conducting assistant. During this time, the ensemble director led the remaining group in a different musical activity not related to the study variables.

The experimental group received BMG instructional treatments, and the control group received basic postural instruction without the BMG activities. The lessons were written as scripts to be delivered verbatim. (See Appendix D for experimental lessons). Referenced images of the body were included at the end of each lesson and referenced anatomy models were made available for all presentations. During the video delivery of the lessons, participants were given the opportunity to share their feedback as comments or external messages. To ensure the accuracy of the Body Mapping language and method of delivery, each lesson was developed with the guidance of Lisa Marsh, Licensed Body Mapping Instructor and Training Teacher.

During the BMG treatment for the experimental group, the conducting assistant provided in-depth instruction on the 6 places of dynamic balance. Each BMG lesson began with a movement exercise, in which students used their hands to physically locate the place of balance. They also moved the body parts involved to engage their kinesthetic sense. Following the movement exercise, the conducting assistant used scientific images and models to show the accurate anatomical location, size, and shape of the place of balance (see Appendices E and G). At the conclusion of each lesson, students were instructed to adjust their posture according to the images and information. The assistant then asked students to focus on these adjustments as they sang vocal exercises for the remainder of the session.

Each control instructional session included a brief explanation and movement demonstration of one of the six places of dynamic balance, with only a verbal reference by the instructor of that place's location within the body (See Appendix E for control lessons). No images or models were used in the control group instruction. Participants were asked to focus on awareness of the location of the body part while they sang vocal exercises for the remainder of the session.

The shortened duration of the instruction in the current study was deemed to be an acceptable length of time to effect positive postural change in participants because the BMG introductory course, “What Every Musician Needs to Know About the Body” (WEM), was designed to be delivered in six hour-long sessions. The 6 places of dynamic balance are taught during one of those sessions. The expectation was that participants would gain new information and experience positive changes in their bodies even during that limited amount of time.

Dependent Variables

The researcher collected the data for the dependent variables (i.e., A/O joint, shoulder joints, lumbar region, hip joints, knee joints, ankle joints, breath capacity) with assistance from the UND Kinesiology department. The Vicon motion capture system was used to track the movement of a series of 35 markers that were attached to each participant’s clothing (see Appendix H for the marker placement). Participants wore fitted clothing, so the markers remained in place. The participants stood still in a static ready position for 20 seconds. The participants also completed three trials of singing Happy Birthday in a range that felt comfortable for their voices. The Vicon system captured several thousand frames for each trial.

The Vicon cameras captured high-speed images of these markers to track the angles of the A/O joint, the shoulder joints, the lumbar region of the vertebrae, the hip joints, the knee joints, and the ankle joints. Additional markers were placed on the sternum, the T10 vertebrae, and the lower costal region of the left and right ribs. These markers allowed the Vicon system to provide data on the breathing variable of chest expansion by measuring distances between the sternum, the thoracic vertebrae, and the costal regions of the lowest ribs. The associated computer software transformed the data from these frames as numeric angular measurements based on each of the 35 markers.

Pilot Study

The researcher conducted a pilot study with 10 participants to evaluate the efficacy of all treatments and protocols. Pilot study participants underwent the pre-test and posttest protocols as described above and received all of the treatment lessons via video delivery. The researcher collected and analyzed the data and determined whether or not any changes were necessary for the main study. Following the pilot study, the following modifications were made to the main study:

- The participant instructions were made more specific concerning the type of clothing they needed to wear.
- The amount of time per participant visit was reduced from 30 minutes to 15 minutes because of the speed with which it was possible to collect the data.
- The treatment was delivered in person, and videos were made available only for absent participants. This change was made because the participants were available as a group during a specified rehearsal time.
- The Vicon provided data on all 35 markers. However, only those associated with the six places of balance were used in the main study.

Procedure

Prospective participants were given a brief presentation on the second meeting day of the ensemble by the cooperating principal investigator regarding the project and what it would mean for them to participate. The ensemble directors then sent participants an email containing a Qualtrics link that included a detailed description of the study, the potential benefits and risks of participation, and the methods for maintaining confidentiality. Following this information was an opportunity to either decline or confirm participation with a digital signature (See Appendix C for Consent Form). Once research participants completed the Qualtrics form, they received an automated email including the information and their signature for their records. No data were collected unless the informed consent document had been returned and signed. All protocols involved in the study were in compliance with the requirements of the University IRB. All data were reported as group results and could not be linked to individuals. Randomized participant numbers were implemented to minimize the risk of breach of confidentiality. All data were kept on a password-protected computer. Any document which could pair participants with their assigned participant number was kept separate.

Participants were free to discontinue their participation in the study at any time. In the case of injury or distress, participants were referred to their health provider, student health, or the UND Counseling Center.

Before beginning the treatment, each participant reported to the UND BiPed Lab for pre-test measurements. Participants were fitted with 35 anatomical markers to capture a complete 3D representation of participants' movements. This process took between 5-10 minutes. Once the data had been collected, participants needed to have the 35 anatomical markers removed. Overall, the total time per data collection per person was approximately 15 minutes. Each participant needed to have a total of two collections conducted. Thus, a total of no more than 3 hours was required for participation in this study.

Postural instruction was given during choir rehearsals in a group setting, so there was no need to protect participants' privacy during the treatment phase of the project. In addition, the data collection phase took place on an individual basis so that only one student at a time was being tested. Therefore, no other participants observed these tests.

The names were coded so that the data obtained could not be associated with a specific individual. The only reason for obtaining the participants' names was to record who had completed the data collection task. Therefore, only the scores for participants with pre-tests and posttest results were included in the data. The list of participants was destroyed after the study.

All data, as well as consent forms collected in this study, were stored in room B001 (BiPed Lab) at the University Health Building. All data were kept in either a password-protected computer or a locked cabinet. Any document which could pair participants with their assigned pseudonym or participant number was kept separate. This included informed consent documents. The only people with access to data were the primary investigator, the professor in charge of the BiPed lab, and the BiPed lab assistant. Informed consent documents were to be kept for five years and then destroyed by shredding. Additionally, all stored data are slated to be deleted, shredded, or burned after a period of five years.

Before instruction began, students went to the Vicon lab for collection of pre-test data. Each ensemble met on Tuesdays and Thursdays. One met in the early afternoon and the other in the later afternoon. At predetermined times during each rehearsal on

Tuesday of Week 1, the experimental groups moved to a separate location to receive BMG Lesson 1 from the conducting assistant. During this time, the control groups participated in a different musical activity chosen by the ensemble director. At the same predetermined times during rehearsals on Thursday of Week 1, the control groups moved to a separate location to receive Posture Lesson 1 from the conducting assistant. During this time, the experimental groups participated in the same activity chosen by the ensemble director. The procedures for the remaining five weeks of treatment were identical to those of the first week. A lesson related to a new place of balance was taught each week. The other places of balance were taught in the following order: the shoulder joints in Week 2, the lumbar region in Week 3, the hip joints in Week 4, the knee joints in Week 5, and the ankle joints in Week 6.

Upon completion of the treatment, posttests identical to the pre-tests were administered. All participants visited the BiPed lab and wore the same fitted clothing they had worn during the pre-test session. The researcher placed markers on the students' clothing at the same places as during the pre-test. Students stood still in the ready position for 20 seconds and then sang “Happy Birthday.” As they were singing, the researcher used the Vicon system to collect the posttest measurements for participants on the A/O joint, shoulder joints, lumbar region, hip joints, knee joints, and ankle joints.

CHAPTER 4: RESULTS

The primary purpose of this study was to investigate whether the use of the BMG instructional method would result in a significant difference in posture between the group that received the treatment and the group that did not. This study also examined whether or not there was an association between posture and chest expansion while singing.

The initial sample for this study consisted of 52 ($N = 52$) undergraduate university students who were members of a university choir. The participants were distributed into control and experimental groups based on the choir sections in which they sang (e.g., soprano, alto, tenor, bass). Due to some errors in the data collection process, no posttest data were collected for two control participants and one experimental participant, and they were removed from the study. The control group consisted of 15 sopranos and 10 tenors, and the experimental group consisted of 15 altos and 9 basses. The final sample consisted of 49 ($N = 49$) participants (see Table 1).

The researcher used the Vicon system to collect pre-test and posttest measurements for each variable. Data collection markers were placed on the shoulder, hip, knee, and ankle joints. Data for the Atlanto-Occipital (A/O) joint were determined by markers placed on the back of the neck just below the skull. Data for the lumbar region were determined by markers placed in the lower costal region of the ribs. These measurements were exported to a spreadsheet and analyzed using t-tests and ANOVAs in SPSS. There were no significant differences when comparing pre-test measurements for static posture singing posture between the control and experimental groups.

Table 1
Demographics of Sample

Group	*n* (49)	%
Ensemble		
Allegro	30	61.2
Bards	19	38.8
Voice Part		
Soprano	15	30.6
Alto	15	30.6
Tenor	10	20.4
Bass	9	18.3
Study Group		
Control	25	51
Experimental	24	48.9

This study was guided by two hypotheses:

1. There will be a significant difference between the amount of deviation from the six points of postural alignment both when standing still and subsequently while singing between the group receiving the BMG instruction (experimental group) and the group that receives verbal instructions only (control group).
2. There will be an association between the quality of singers' posture and their breath capacity (defined as the degree of chest expansion and measured by the distances between the sternum, the T10 vertebrae, and the lowest costal margin of the left and right ribs) when standing still and subsequently while singing.

Results for Postural Variables

This study addressed the following research questions regarding posture:

Question 1: Will the experimental group show better alignment of the Atlanto-Occipital (A/O) joint as measured by less deviation from proper alignment while standing as well as while standing and singing than the control group?

No significant difference was found between the experimental and control groups on the static test ANOVA ($F(1,43) = 1.675$, $p = .202$; see Table 2) or on the singing test ANOVA ($F(1,43) = .000$, $p = .997$; see Table 3).

Question 2: Will the experimental group show better alignment of the shoulder joints as measured by less deviation from proper alignment while standing as well as while standing and singing than the control group?

No significant differences were found on the static test ($F(1,41) = .212$, $p = .647$; see Table 2) or the singing test ($F(1,40) = 1.119$, $p = .297$; see Table 3).

Question 3: Will the experimental group show better alignment of the lumbar region as measured by less deviation from proper alignment while standing as well as while standing and singing than the control group?

A significant difference found on the static test, $F(1,40) = 13.493$, $p = <.001$ (see table 2). No significant difference was found for the singing test, $F(1,39) = 1.799$, $p = .188$ (see Table 3). Although no significant differences were found for the singing tests, these results may suggest that both the BMG treatment and the control group instructional sessions were effective for the improvement of static standing alignment in the lumbar region.

Question 4: Will the experimental group show better alignment of the hip joints as measured by less deviation from proper alignment while standing as well as while standing and singing than the control group?

No significant differences were found on the static test ($F(1,40) = .888$, $p = .352$; see Table 2) or the singing test ($F(1,37) = .014$, $p = .905$; see Table 3).

Table 2
Static Posttest Comparison for Each Place of Balance Between Groups

Postural Angle	Value	*F*	Hypothesis *df*	Error *df*	Sig.
A/O	0.963	1.675	1	43	0.202
Shoulder	0.995	0.212	1	41	0.647
Lumbar	0.748	13.493	1	40	<0.001*
Hip	0.978	0.888	1	40	0.352
Knee	0.990	0.312	1	30	0.581
Ankle	0.997	0.905	1	38	0.347

* $p < .05$
Note. The lumbar results were significant in favor of the experimental group.

Question 5: Will the experimental group show better alignment of the knee joints as measured by less deviation from proper alignment while standing as well as while standing and singing than the control group?

No significant differences were found on the static test ($F(1,30) = .312$, $p = .581$; see Table 2) or the singing test ($F(1,30) = .183$, $p = .671$; see Table 3).

Table 3
Singing Posttest Comparison for Each Place of Balance Between Groups

Postural Angle	Value	*F*	Hypothesis *df*	Error *df*	Sig.
A/O	1.000	0.000	1	43	0.997
Shoulder	0.973	1.119	1	40	0.297
Lumbar	0.952	1.799	1	39	0.188
Hip	1.000	0.014	1	37	0.905
Knee	0.994	0.183	1	30	0.671
Ankle	0.989	0.415	1	36	0.523

* $p < .05$
Note. No significant results were found.

Question 6: Will the experimental group show better alignment of the ankle joints as measured by less deviation from proper alignment while standing as well as while standing and singing than the control group?

No significant differences were found on the static test ($F(1,38) = .905$, $p = .347$; see Table 2) or the singing test ($F(1,36) = .415$, $p = .523$; see Table 3).

Additional Postural Analyses

In addition to the analyses specific to the research questions, a series of ANOVAs was used to analyze the difference over time for each place of balance within each group. These analyses show that there was improvement in the A/O and lumbar measurements for each group between the pre-test and posttest (see Tables 4 and 5). The data were also analyzed on a larger scale, comparing composite data for the control and experimental groups (see Table 6). Significant differences were found in the lumbar region for the control group ($t(20) = -.518$, $p < .05$) and the shoulder joint for the experimental group ($t(19) = -2.578$, $p < .05$). The fact that there were significant results for only two variables suggests that the participants may have had a limited understanding of the postural differences between standing and singing before participating in this study.

Table 4
Mean Difference Between Static Pre-test and Posttest for Each Place of Balance

Postural Angle	Control				Experimental			
	M Difference	*SD*	*F*	Sig.	*M*	*SD*	*F*	Sig.
A/O	-2.86	21.92	0.41	0.53	10.38	16.15	8.68	0.008*
Shoulder	.512	5.31	0.21	0.65	0.35	6.88	0.05	0.82
Lumbar	5.22	9.71	6.92	0.02*	5.57	8.99	6.90	0.02*
Hip	0.56	12.84	0.04	0.84	2.93	10.74	1.41	0.25
Knee	-0.18	281.61	0.000	0.99	-50.76	204.2	0.80	0.39
Ankle	-1.87	15.92	0.32	0.58	-3.91	22.54	0.51	0.49

* $p < .05$
Note. Results for the A/O joint were significant for the experimental group. The lumbar results were significant for both groups.

Table 5
Mean Difference Between Singing Pre-test and Posttest for Each Place of Balance

Postural Angle	Control				Experimental			
	M	*SD*	*F*	Sig.	*M*	*SD*	*F*	Sig.
A/O	-5.08	18.75	0.67	0.42	5.09	15.17	4.67	0.04*
Shoulder	-.39	9.05	0.29	0.59	3.52	10.02	1.89	0.18
Lumbar	1.70	10.23	0.22	0.65	3.13	12.76	0.69	0.42
Hip	-2.29	13.62	0.41	0.53	2.83	12.55	0.20	0.66
Knee	-25.05	108.87	0.08	0.79	-6.28	200.5	0.00	0.99
Ankle	-1.85	16.39	0.32	0.58	-2.75	27.52	0.51	0.49

* $p < .05$
Note. The results for the A/O joint were significant for the experimental group.

Table 6
Comparison of Pre-test Static and Singing Measurements

Postural Angle	Control			Experimental		
	M	*SD*	Sig.	*M*	*SD*	Sig.
A/O	-1.26	11.37	0.31	5.17	14.35	0.11
Shoulder	1.60	6.63	0.15	-4.36	7.57	0.02*
Lumbar	4.06	9.05	0.03*	1.19	11.59	0.65
Hip	2.27	16.11	0.26	2.28	13.70	0.50
Knee	30.28	198.55	0.28	-43.94	291.12	0.61
Ankle	-1.39	18.72	0.37	0.04	18.08	0.99

* $p < .05$
Note. Results for the lumbar region were significant for the control group and the results for the shoulder joints were significant for the experimental group.

Similarly, composite posttest static and singing measurements were compared for each group (see Table 7). In both groups, there was significant difference for the A/O joint and the lumbar region. These results suggest that the participants in both groups, although they had received different instructional treatments, had gained a greater awareness of postural balance in these areas.

Table 7
Comparison of Posttest Static and Singing Measurements

Postural Angle	Control			Experimental		
	M	*SD*	Sig.	*M*	*SD*	Sig.
A/O	2.15	3.35	0.004*	2.31	2.82	<0.001*
Shoulder	-0.74	1.87	0.06	-0.73	2.13	0.12
Lumbar	-0.97	1.96	0.02*	-1.44	1.78	0.001*
Hip	0.38	2.14	0.40	0.41	1.43	0.24
Knee	25.11	105.34	0.27	5.63	57.82	0.70
Ankle	0.74	2.91	0.22	0.49	1.32	0.16

* $p < .05$
Note. Results for the A/O joint and lumbar region were significant for both groups.

The final posture comparisons used ANOVA tests to analyze the composite data between pre-tests and posttests. The comparison of the static pre and posttests showed an overall difference for the control group, $F(7, 10) = 13.73$, $p = <.001$. A significant difference was found for the experimental group in the A/O measurements, $F(1,20) = 8.68$, $p = .008$. Additionally, significant differences were found for the lumbar measurements of both groups (Control: $F(1,23) = 6.918$, $p = .015$; Experimental: $F(1,17) = 6.9$, $p = .018$).

Table 8
Comparison of Composite Pre-test and Posttest Measurements

Composite Test	Value	*F*	Hypothesis *df*	Error *df*	Sig.
Control Static	0.91	13.73	7	10	<0.001*
Control Singing	0.95	16.65	7	6	0.002*
Experimental Static	0.94	6.83	7	3	0.071
Experimental Singing	0.96	22.60	7	6	<0.001*

* $p < .05$
Note. Three significant results were found in the composite analyses. 1) Control Static, $F(7,10) = 13.73$, $p = .001$. 2) Control Singing, $F(7,6) = 16.65$, $p = .002$. 3) Experimental group, $F(7,6) = 22.60$, $p = <.001$.

These results suggest that both the BMG treatment and the control treatment were effective for the improvement of the static standing posture of the participants.

Likewise, composite data were compared for the singing pre and posttests (see Table 8). The results for both groups show a significant difference (Control: $F(7,6) = 16.65$, $p = .002$; Experimental: $F(7,6) = 22.60$, $p = <.001$), suggesting that both the BMG treatment and the control treatment were effective for the overall improvement of singing posture.

Results for Breath Variables

This study also addressed the following research question regarding breath activity: Will better postural alignment correspond with greater breath capacity while standing and also while singing?

Table 9
Static Posture/Breath Regression Analysis ANOVA

Model	Sum of Squares	*df*	Mean Square	*F*	Sig.
Regression	4.0335.42	1	40335.42	51.05	<0.001*
Residual	30022.21	38	790.06		
Total	70537.62	39			

* $p < .05$

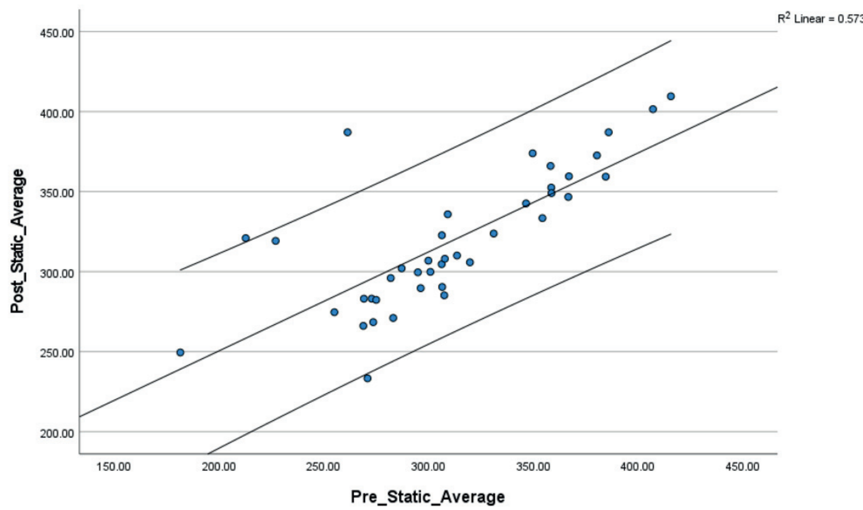
Table 10
Static Posture/Breath Regression Analysis Coefficients

Model	Unstandardized Coefficients		Standardized Coefficients	*t*	Sig.
	B	Std. Error	Beta		
(Constant)	126.95	27.29	40335.42	4.65	<0.001*
Breath	0.62	0.08	0.76	7.15	<0.001*

* $p < .05$
Note. The regression results were statistically significant, $R^2 = .573$, $t(38) = 7.15$, $p < .05$.

The data necessary to address this question was collected from markers placed on the bottom of the sternum and the lowest costal ribs (left and right). A linear regression analysis was utilized to compare the data from the static and singing pre-tests against the static and singing posttests for the entire sample. The results for the static test were statistically significant (R^2 = .573, $t(38)$ = 7.145, p < .05; see Tables 9 and 10).

Figure 11
Static Posture/Breath Regression Scatter Plot



Likewise, the results for the singing test were also significant (R^2 = .809, $t(38)$ = 12.76, p < .05; see Tables 11 and 12). These results suggest that the changes in postural measurements between the pre- and posttests had a definitive effect on the breath data between the same tests.

Table 11
Singing Posture/Breath Regression Analysis ANOVA

Model	Sum of Squares	*df*	Mean Square	*F*	Sig.
Regression	61558.37	1	61558.37	160.59	<.001
Residual	14566.12	38	383.319		
Total	76124.48	39			

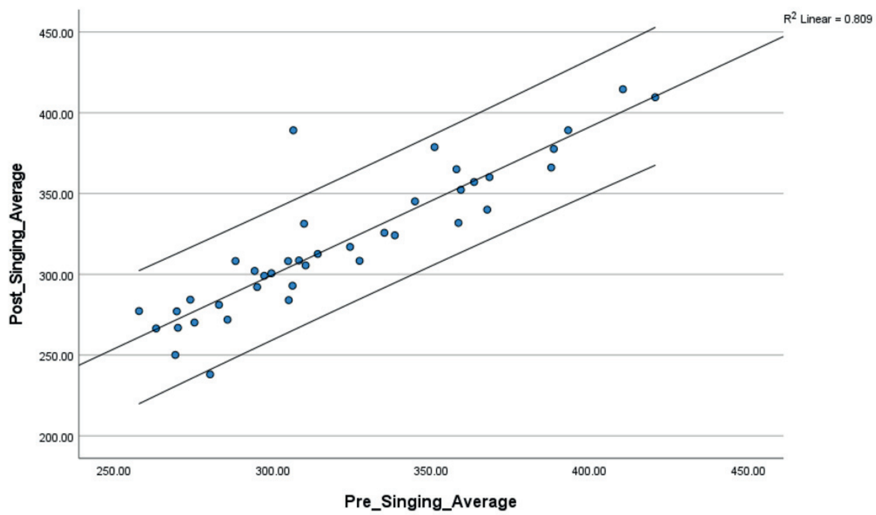
* $p < .05$

Table 12
Singing Posture/Breath Regression Analysis Coefficients

Model	Unstandardized Coefficients		Standardized Coefficients	*t*	Sig.
	B	Std. Error	Beta		
(Constant)	25.01	23.45		1.07	0.29
Breath	0.92	0.07	0.89	12.67	<0.001

* $p < .05$
Note. The regression results were statistically significant, $R^2 = .809$, $t(38) = 12.76$, $p < .05$.

Figure 12
Singing Posture/Breath Regression Scatter Plot



Discussion

As described above, these results suggest several different findings across the entire sample. Neither the control group nor the experimental group experienced any significant change in five of the six points of postural alignment (A/O, shoulder, hip, knee, ankle).

The control group did not receive the BMG treatment but was given generic instructions to simply think about the various joints as they sang. Despite the simplicity of this treatment, the control group experienced significant change for the lumbar region in both the static and singing positions. The control group also experienced a significant change in the overall singing results.

The experimental group did, however, experience significant changes that could support the use of BMG as an effective method for postural instruction. The experimental group's results for the A/O joint were statistically significant in each analysis that was used. Much of the literature associated with BMG pedagogy states that the A/O joint is of the utmost importance in helping to establish effective alignment for the rest of the body (Allen et al., 2016; Conable, 2000a; Conable, 2000b; Jankowski, 2016; Johnson, 2009; Mark, 2004; Pearson, 2006). It is, therefore, particularly noteworthy that these results agree with what BMG practitioners have so strongly asserted. Even more noteworthy were the results of the pre-test/posttest singing analysis. Despite the lack of significant change for several of the individual points of posture, those who received the BMG treatment demonstrated measurable change throughout their postural alignment. These findings suggest that the BMG curriculum may be an effective pedagogical method for the improvement of singing posture.

CHAPTER 5: CONCLUSION

The voice pedagogy literature suggests that misalignments of the body may have a negative impact on vocal production, thus indicating the necessity for teaching proper posture to singers. Many voice educators use a variety of general instructions for teaching posture, rather than a predetermined method or technique. Conversely, the Body Mapping (BMG) method teaches posture, balance, and physical alignment through the use of scientific charts and pictures of anatomy. The primary purpose of this study was to examine the effectiveness of the Body Mapping (BMG) method of posture instruction with university choir members.

The secondary purpose of this study was to examine whether or not there is an association between posture and chest expansion while singing. Numerous scientific studies have shown that there is a relationship between posture and breath capacity, while additional studies have shown strong connections between vocal training and breath management. In order to address these concerns, the following hypotheses were investigated:

1. Will there be a significant difference between the amount of deviation from the six points of postural alignment both when standing still and subsequently while singing between the group receiving the BMG instruction (experimental group) and the group that receives verbal instructions only (control group)?
2. Will there be an association between the quality of singers' posture and their breath capacity when standing still and subsequently while singing?

This study was conducted at a large university in North Dakota during the Fall 2021 semester. The researcher was assisted by the directors of two university choral ensembles, an undergraduate music education major, the director of the university's BiPed Vicon laboratory, and an undergraduate work-study student in the laboratory. The original volunteer sample included 52 undergraduate students who were members of the university Allegro or Bards choral ensembles. Three participants had to be dropped from the study due to data collection errors on the part of the researcher, resulting in a final sample of 49 participants (19 male and 30 female).

The participants were randomly assigned to the experimental group or the control group according to voice part (soprano, alto, tenor, bass). Each group received six weekly posture instruction sessions, delivered through 15-minute sessions. Each session addressed one of the following places of balance in this order: the A/O joint, the shoulder joint, the lumbar region of the spine, the hip joint, the knee joint, and the ankle joint. The experimental group received BMG instructional treatments that included movement exercises and the use of scientific images and models. The control group received basic postural instruction that did not include any movement activities, images, or models. After receiving the instruction, participants in both groups were asked to focus on awareness of the place of balance while singing.

Each participant reported to the UND BiPed Lab for pre-test measurements. Once there, they were fitted with 35 anatomical markers that allowed a complete 3D representation of their movements to be captured by the Vicon motion capture system. The participants stood still in a ready position for 10 seconds and also completed three trials of singing "Happy Birthday." After the conclusion of the treatment, participants returned to the BiPed lab to repeat these activities for posttest measurements.

The resulting data were analyzed using three types of statistical procedures in the SPSS software. A series of *t*-tests was used to analyze comparisons within the pre-test data groups or the posttest data groups. Comparisons between pre-test and posttest data groups were analyzed using ANOVA tests. The relationship between posture and breath activity was analyzed using regression analysis. On the basis of the data, the following summary of hypotheses can be reported.

1. Will the experimental group show better alignment of the Atlanto-Occipital joint as measured by less deviation from proper alignment while standing as well as while standing and singing than the control group?

   There was no significant difference between the two groups in the alignment of the A/O joints.

2. Will the experimental group show better alignment of the shoulder joints while standing as well as while standing and singing than the control group?

   There was no significant difference between the two groups in the alignment of the shoulder joints.

3. Will the experimental group show better alignment of the lumbar region as measured by less deviation from proper alignment while standing as well as while standing and singing than the control group?

   There was a significant difference in the alignment of the lumbar region on the static test ($F(1,40) = 13.493$, $p = <.001$) in favor of the experimental group. There was no difference on the singing test.

4. Will the experimental group show better alignment of the hip joints while standing as well as while standing and singing than the control group?

   There was no significant difference between the two groups in the alignment of the hip joints.

5. Will the experimental group show better alignment of the knee joints while standing as well as while standing and singing than the control group?
   There was no significant difference between the two groups in the alignment of the knee joints.
6. Will the experimental group show better alignment of the ankle joints while standing as well as while standing and singing than the control group?
   There was no significant difference between the two groups in the alignment of the ankle joints.
7. Will better postural alignment correspond with greater breath capacity while standing and also while singing?
   A positive correlation was found between postural alignment and breath capacity (Static: $R^2 = .573$, $t(38) = 7.145$, $p < .05$; Singing: $R^2 = .809$, $t(38) = 12.76$, $p < .05$).

These findings provide some support for the assertions of this study, as well as questions about further study. No significant difference was found between the control and experimental groups for five of the six points of postural alignment (A/O, shoulder, hip, knee, ankle). There was, however, a significant difference in alignment for the lumbar region for the experimental group. The lumbar region is arguably the most challenging of the six places of balance to teach and to sense in the body. Unlike the hip or the knee, the lumbar region is not easily visible because of its location in the center of the body. It is also not one joint, but rather a set of interconnected bones that move together in many different ways. This interconnectedness may mean that experiencing discomfort in one part of the lumbar region can result in discomfort for the entire region and even other parts of the body. However, achieving effective alignment in the lumbar region can positively impact alignment for the entire body. Although the significant difference for this region was found only on the static tests and not the singing tests, these findings do support BMG as an effective method for the teaching of singers' alignment of the lumbar region.

The individual statistical analyses showed that the experimental group's improvement was significant for the A/O joint. This place of balance is the first of the six to be taught in the "What Every Musician" course and in other BMG literature. It was, therefore, the first to be taught in the treatment for this study. This allowed participants to incorporate knowledge of the A/O into their singing activity for a longer period of time than the other places of balance. Because this was the first lesson, it is also possible that students paid more attention because of the novelty of the instruction.

Perhaps the largest number of significant results were found in the analysis of the experimental group's pre-test/posttest singing data. The data for the individual places of balance were organized into composite data groupings for the control and experimental groups to look for change in the overall alignment of the body. The results of these analyses showed improved alignment in the entire body for the experimental group. These findings may be directly related to the findings for the A/O joint and in agreement with the BMG method's Laws of the Spine:

1. The head must lead spinal movement [from the A/O joint].
2. The vertebrae must follow [the head] in sequence.
3. The spine must be free to lengthen and gather in spinal movement.
4. Spinal movement should be concentrated across the whole spine. (Conable, 2000b, p. 19)

This is not to suggest that effective alignment of the A/O joint will automatically cause the rest of the body to realign itself. Studies have shown that misalignment of the head and neck can contribute to muscular strain throughout the spine (Bonney and Corlett, 2002; Ibrahim, 2015; Knight and Baber, 2004). It therefore seems possible that if the entire body is to experience effective alignment, it must begin from the top. The A/O joint is the closest of the six places to the larynx and the point of origin for vocal production, and so it is possible that participants were more consciously aware of any change in position for this joint. A greater understanding and awareness of the A/O joint (and other places of balance) may have assisted Rollings' (2017) participants in making postural adjustments when wearing heels, something they did not find necessary when singing while barefoot. Furthermore, the positive impact of the BMG instruction on participants' posture agrees with the findings of the 2020 study by Peultier-Celli, Andouin, Beyaert, and Perrin, in which trained singers demonstrated greater postural stability than the untrained control group participants. Despite the lack of significant change for several of the individual points of posture, those who received the BMG treatment demonstrated measurable change throughout their postural alignment as shown by the results of the composite analyses. These findings suggest the BMG curriculum to be an effective pedagogical method for the improvement of singing posture.

The improvements found for the control group in the A/O joint and lumbar region suggest a different consideration: postural change can occur by merely thinking about one's posture, and in-depth instruction may not always be necessary. The treatment for the control group was minimal and generic: "Think about this joint while you sing." They did not engage in movement activities, did not receive instruction on the places of balance, and were not shown any images or models. The results, however, showed that they had improved in the lumbar region as well as the overall singing results. These findings call attention to the idea of the body map and its ability to change. The body map is not a physical element – it is entirely conceptual, based on information from what a person can see and feel. It does make sense, therefore, that a mental representation could be altered through mental activity, alone (Caggiano, 2020; Constantini et al., 2011; Giurgola et al., 2020; Palmiero et al., 2019; Tosi et al., 2018). Although this is not in direct keeping with the hypotheses for this study, it does suggest a relationship to BMG instruction that could be investigated further.

The results for the breath hypothesis were the strongest of all results in the current study, and the improvement of the breath capacity from the beginning of the study to the end may be related to the postural instruction that both groups received. This would be in keeping with studies in which trained singers demonstrated greater breath capacity and management (Salomoni et al., 2016; Tang et al., 2007; Thomasson and Sundberg, 1998; Thorpe et al., 2000).

As mentioned above, there was no difference between the groups for five of the six places of balance, and neither group demonstrated measurable improvement for four of the six places. Some flaws in the study may help to explain the results. Perhaps the intervention was not long enough. Participants in this study received one weekly 15-minute session for six weeks, for a total of one and half hours of instruction. It is possible that this length of time was too short to result in measurable change in postural habits. A future study might provide a larger number of slightly longer sessions to allow for better understanding and application of the concepts.

Another consideration may be the abbreviated nature of the BMG treatment that was used. The six places of dynamic balance constitute merely one facet of the curriculum. The WEM course provides in-depth instruction about whole-body balance (including the six places), the arms, the legs, breathing, and sensory awareness. Participants in qualitative BMG studies have responded positively to receiving a more complete curriculum, communicating perceived improvement in posture, breath, sensory awareness, and other intangible elements (Buchanan and Hays, 2014; Knaub, 1999; Salonen, 2018). While an understanding of the six places is a valuable and necessary piece of the curriculum, providing a more expansive BMG treatment may have resulted in greater postural change for the participants. If this study were to be repeated, the treatment could be replaced with the full BMG course.

A third implication for the lack of improvement in some of the places of balance may be related to the group session environment. Most BMG practitioners provide instruction in a one-on-one setting so the instruction may be tailored to the needs of the individual. The scripts used in the treatment for this study were adapted directly from BMG materials, but that does not mean they were effective for each participant. This study could be adapted for a group of participants to receive the treatment on an individual basis.

Another limitation of this study was the small number of participants. The study could be replicated with a larger sample size. A more highly specified demographic could also be used: the sample could perhaps consist either of participants with no singing background or of voice majors. The sample for the current study included a mixture of music majors and non-music majors. It is therefore possible that some of the participants possessed posture knowledge from previous singing activities. These participants may have demonstrated good posture at the beginning of the study, which could account for the lower degree of improvement across the sample. Selecting a specific population might have eliminated some potential differences in how participants responded to the treatment.

One last recommendation for further study would be to conduct a similar study focused on the improvement and measurement of breath activity. Although the current study included a breath component, it was merely a secondary item and was not examined within the context of a control group and an experimental group. Such a study could measure not only breath capacity, but other breath outcomes such as intonation, endurance, and management, or control.

In conclusion, I believe the significance of the findings from this study to be positive for the affirmation and promotion of the BMG method. I believe the results show BMG to be an effective method for the teaching of singers' alignment based on the improved alignment for the A/O joint and the lumbar region, improved alignment in the entire body, and improved breath capacity. As mentioned above, the positive results for the control group could be suggest that merely thinking about one's posture may also result in postural change. However, the body map is an internal representation, a mental representation, and so I believe these results are positively intertwined with the primary focus of this project.

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APPENDIX A: PILOT STUDY PARTICIPANT RECRUITMENT EMAIL

Hello (participant name),

I am writing to ask whether you would be interested in participating in a research study I am putting together for my graduate school work. Here are some of the pertinent details of the study:

- The study will take place in June of this year. It will require no more than 3 hours of your time, spread out over the course of roughly 2 weeks.
- You would report to the UND BiPed lab (address will be provided) to have measurements taken of your physical posture.
- You would participate in three 30-minute Zoom sessions, in which you will receive postural instruction specific to singing activities. (You may be able to watch a recorded session if necessary.)
- You would report to the UND BiPed lab a second time after watching the Zoom sessions to have an additional set of measurements taken of your physical posture.

There is no compensation for participation in this study. Should you decide to participate, you would receive further documentation to include a detailed explanation of all activities, assurance of your anonymity, and an informed consent document.

Please let me know whether you would be interested in participating in this study, and feel free to let me know if you have any questions at all.
Thanks so much,
Mandy Moreno

APPENDIX B: MAIN STUDY PARTICIPANT RECRUITMENT EMAIL

Dear Allegro students,

With Mrs. Popejoy's permission, I am writing to request your participation in my dissertation research study. Here are some of the pertinent details of the study:

- The study will take place during the Fall 2021 semester. It will require no more than 3 hours of your time, spread out over the course of roughly 2 months.
- You would report to the UND BiPed lab (address will be provided) to have measurements taken of your physical posture.
- You would participate in six 15-minute instructional sessions during rehearsal, in which you will receive postural instruction specific to singing activities. (You may be able to watch a recorded session if necessary.)
- You would report to the UND BiPed lab a second time after participating in the instructional sessions to have an additional set of measurements taken of your physical posture.

Please follow this link to either confirm your participation in the study and schedule your lab visits:
https://und.qualtrics.com/jfe/form/SV_d12auCuFMiZYc6O

Thank you for your time and consideration,
Mandy Moreno

Dear Bards students,

With Dr. Jilek's permission, I am writing to request your participation in my dissertation research study. Here are some of the pertinent details of the study:

- The study will take place during the Fall 2021 semester. It will require no more than 3 hours of your time, spread out over the course of roughly 2 months.
- You would report to the UND BiPed lab (address will be provided) to have measurements taken of your physical posture.
- You would participate in six 15-minute instructional sessions during rehearsal, in which you will receive postural instruction specific to singing activities. (You may be able to watch a recorded session if necessary.)
- You would report to the UND BiPed lab a second time after participating in the instructional sessions to have an additional set of measurements taken of your physical posture.

Please follow this link to either confirm your participation in the study and schedule your lab visits:
https://und.qualtrics.com/jfe/form/SV_d12auCuFMiZYc6O

Thank you for your time and consideration,
Mandy Moreno

APPENDIX C: INFORMED CONSENT FORM

THE UNIVERSITY OF NORTH DAKOTA
CONSENT TO PARTICIPATE IN RESEARCH

Project Title: **Examination of the Effect of Body Mapping Training (BMG) on the Posture of Singers: Main Study**

Principal Investigator: Amanda Moreno

Phone/Email Address: a.moreno@und.edu

Department: Music

Research Advisor: Dr. Barbara Lewis

Research Advisor Phone/Email Address: 701-777-2820 barbara.lewis@und.edu

What should I know about this research?

- Someone will explain this research to you.
- Taking part in this research is voluntary. Whether you take part is up to you.
- If you don't take part, it won't be held against you.
- You can take part now and later drop out, and it won't be held against you
- If you don't understand, ask questions.
- Ask all the questions you want before you decide.

How long will I be in this research?
We expect that your taking part in this research will last no more than 3 hours over the course of approximately 10 weeks.

Why is this research being done?
The purpose of this research is to gather initial data that will inform a future dissertation study.

What happens to me if I agree to take part in this research?
If you decide to take part in this research study:

- You will be asked to visit the UND BiPed lab at the beginning and end of the study. You will need to wear fitted clothing for these visits. A set of 35 adhesive markers will be attached to specific skeletal locations on your body so the Vicon motion capture camera system can track postural movement. This visit will last roughly 30 minutes.
- You will be asked to participate in six 15-minute instructional sessions to receive postural instruction. These sessions will take place once a week during Allegro or Bards rehearsal. You will be asked to sing with the group during these settings and to provide verbal feedback.

Could being in this research hurt me?
There are no risks in participating in this research beyond those experienced in everyday life.

Will being in this research benefit me?
- You might learn more about your individual approach to singing posture by participating in this study.
- You may have the opportunity to pursue further Body Mapping instruction by participating in this study.

How many people will participate in this research?
Approximately 90 people will take part in this study at the University of North Dakota.

Will it cost me money to take part in this research?
You will not have any costs for being in this research study.

Will I be paid for taking part in this research?
You may receive class credit equal to one day of participation credit.
Who is funding this research?
The University of North Dakota and the research team are receiving no payments from other agencies, organizations, or companies to conduct this research study.

What happens to information collected for this research?
Your private information may be shared with individuals and organizations that conduct or watch over this research, including:
- The Institutional Review Board (IRB) that reviewed this research
- Dr. Barbara Lewis, research advisor

We may publish the results of this research. However, we will keep your name and other identifying information confidential. We protect your information from disclosure to others to the extent required by law. We cannot promise complete secrecy.

Data collected in this research might be de-identified and used for future research or distributed to another investigator for future research without your consent.

What if I agree to be in the research and then change my mind?
You are free to leave the study at any time without risk.

Who can answer my questions about this research?
If you have questions, concerns, or complaints, or think this research has hurt you or made you sick, talk to the research team at the contacts listed above on the first page.

This research is being overseen by an Institutional Review Board ("IRB"). An IRB is a group of people who perform independent review of research studies. You may talk to them at 701.777.4279 or UND.irb@UND.edu if:
- You have questions, concerns, or complaints that are not being answered by the research team.
- You are not getting answers from the research team.
- You cannot reach the research team.
- You want to talk to someone else about the research.
- You have questions about your rights as a research subject.

- You may also visit the UND IRB website for more information about being a research subject: http://und.edu/research/resources/human-subjects/research-participants.html

Your signature documents your consent to take part in this study. You will receive a copy of this form.

Subject's Name: ____

___________________________________ ____________________
Signature of Subject Date

I have discussed the above points with the subject or, where appropriate, with the subject's legally authorized representative.

___________________________________ ____________________
Signature of Person Who Obtained Consent Date

APPENDIX D: EXPERIMENTAL GROUP LESSONS

Experimental Lesson 1: The Atlanto-Occipital Joint

Black text = the script, to be delivered by the conducting assistant
Red text = refer to an image, diagram, or video
Blue text = provide a live/personal demonstration

These sessions will be dedicated to learning elements of the Body Mapping method and how to apply them to singing. I'd like to begin by giving a few brief definitions.

- The Body Mapping method is the conscious correcting and refining of one's Body Mapping to produce efficient, graceful, coordinated, effective movement.
- The body map is the literal neuronal picture individuals have in the brain that dictates human movement. This map changes over time through physical development, injury, and healing.
- Kinesthesia is a person's perception of the body's movement and position in space.

In these sessions, we're going to talk about 6 Places of Dynamic Balance in the human body. Understanding these places can help a person to experience better posture. Today, we will discuss the first of those places: the Atlanto-Occipital joint, or the AO joint. This joint is where your skull meets the top of your spine.
(Teacher points to the location on their own body.)
Take a moment to consider where this joint is in your own body. Feel free to move your head and shoulders as you do this.
Wait for a moment.

Now, consider your skull - its shape, its size, and the weight of your head including the brain.
Wait for a moment.
Take a look at this image to see if it is different from what you thought.
(Show Image 1)

Take a look also at this model to gain a clearer idea of the three-dimensional nature of your skull.
(Hold up skull model)
The weight of the head is roughly 10-12 pounds. This weight is delivered through the front of the spine. The front of the spine also supports the weight of the head. Was there any difference between these visuals and the information in your body map?
Allow 1-2 participants to verbally respond.

Next, consider the vertebra at the very top of your spine.
Wait for a moment.

Here is an image of the atlas, or the C1 vertebra, which is the topmost bone in your spine.
(Show Image 2)

The connection of the C1 vertebra with the base of the skull, or the occiput, creates the Atlanto-Occipital joint, or the AO joint. Here is an image of that joint.
(Show Image 3)

And here is the model showing that joint.
(Hold up the skull and vertebrae to demonstrate 3D connection)
How does this visual compare with the information in your body map? Was there a difference in size? Shape? Location?
Allow 1-2 participants to verbally respond.

We're going to do a few movement exercises so you can feel this in your own body. The AO joint is responsible for facilitating only a minimal amount of movement from front to back, no more than 25 degrees total.
(Demonstrate all movements while describing for participants.)

- The easiest way to imagine placement of your own A/O joint is to place your fingers below your ears and imagine a wire connecting them through the center of your head.
- Tilt your head centrally from front to back - even though the A/O joint facilitates only minimal movement, there are tons of sensory receptors in that joint.
- Look again at this image to see the central location of the joint between the front and back of your head.

(Show Image 3)

We are now going to put this knowledge to use in one of our songs. As you sing, pay attention to your AO joint, feeling the weight of your head being delivered through the front of your spine and the central location of that joint. When the head is balanced, it is not in front of the body. Additionally, the neck muscles are used for movement of the head, and not for holding it up.
Conduct group through a portion of repertoire.

Do you notice any change in your breath, your vocal output, or your posture?
Allow 1-2 participants to verbally respond.

Experimental Lesson 2: The Shoulder Joint

Black text = the script, to be delivered by the teacher
Red text = refer to an image, diagram, or video
Blue text = provide a live/personal demonstration

Today we will move to the next place of balance: the shoulder joint. These joints are the first point of connection between the arms and the rest of the body.
(Teacher points to the location on their own body.)
Take a moment to consider where these joints are in your own body. Feel free to move your arms as you do this.
Wait for a moment.

The shoulder is actually a combination of two bones: the humerus (the upper arm), and the scapula (the shoulder blade).
(Show Image 4.)
This ball at the top of the humerus fits into a small socket at this pointed end of the scapula.
(Demonstrate with individual bone models.)
Take a moment to move your arm in different directions and see if you can feel this ball-and-socket joint.
Wait for a moment.

The socket is actually inside the structure of the shoulder blade, and it's easier to find it from beneath, through the underarm region. Let's do an exercise together to find this socket.
(Demonstrate all movements while describing for participants.)
Raise one arm straight up in the air. Using your other hand, feel around with the fingers in the underarm region - right where you put your underarm deodorant. Hopefully you can feel that ball in the socket. Next, try to find the back rim of the socket.
(Point to location on the bone models.)
Walk your fingers up the outside edge of the opposite arm's shoulder blade, starting down at the tip and walking up towards the back of the underarm region. You are looking for evidence of a bony protrusion under many layers of muscle. It may be tender under your fingertips. This is the back rim of the shoulder blade's socket.

Now, consider the arm in your own body map - its shape, its size, its length. Consider also where the arm structure begins.
Wait for a moment.
Take a look at this image to see if it is different compared to this region of your body map.
(Show Image 5.)

Look at this image to see how this structure fits within the rest of the body.
(Show Image 6.)

Finally, take a look also at this model to gain a clearer idea of the three-dimensional nature of your arm structure.
(Hold up the arm structure model.)
Was there any difference between these visuals and the information in your body map?

Allow participants to respond.
Now that we know that the shoulder is PART of the arm structure, let's do an exercise to explore that entire structure.
(Demonstrate all movements while describing for participants.)

- Using your kinesthetic sense, use the fingers of your right hand to find the clavicle (collar bone) on the left side of your sternum (breast bone).
- Walk your fingers out along the clavicle, up and over the top and around the back over the scapula.
- Move the shoulder joint around again, and then stretch your left arm out to the side of your boy.
- Continue walking your fingers out along the length of the arm, all the way to the tip of the middle finger.
- Lastly, keep your left arm outstretched and bring your right hand back to the sternum, noticing the length of your arm structure.
- Now, let's repeat the entire exercise on the other side.

We are now going to put this knowledge to use in one of our songs. As you sing, pay attention to your shoulder joint, feeling the connectedness of your entire arm structure. When the shoulder is balanced, it is directly on the side of the body, not slumped forward or pushed back.
Conduct group through a portion of repertoire.

Do you notice any change in your breath, your vocal output, or your posture?
Allow 1-2 participants to verbally respond.

Experimental Lesson 3: The Lumbar Region

Black text = the script, to be delivered by the teacher
Red text = refer to an image, diagram, or video
Blue text = provide a live/personal demonstration

Today we will look at the third place of balance: the lumbar region.
(Teacher points to the location on their own body.)
Take a moment to consider where this area is in your own body. Feel free to move as you do this.
Wait for a moment.

The lumbar region consists primarily of the five lumbar vertebrae.
(Show Image 7.)

These are the largest bones in the spinal column, with significant difference to the smaller bones closer to the head.
(Hold up L5 and T1 vertebrae models to show size comparison.)
The thickest portion sits directly behind the belly button and extends almost halfway through the torso from front to back.
(Show Image 8.)

The front of the spine supports the head and the torso and delivers that weight into the surface you contact (i.e. the chair if you're sitting, or the floor if you're standing).

In order to more fully understand this area, it is helpful to also be aware of the sacrum (the lowest portion of the spine, also known as the tailbone) and the pelvis.
(Show these locations on the spine model.)
Any movement of the lumbar vertebrae will also impact the sacrum and the pelvis.
Lumbar balance area is directly below AO joint when standing/sitting at dynamic balance (place of least muscular work)
(Show Image 9.)

Was there any difference between these visuals and the information in your body map?
Allow 1-2 participants to verbally respond.

Let's do some movement exploration to become more familiar with the lumbar region in our own bodies.
(Demonstrate all movements while describing for participants.)
First, stand and put your body in a singing posture position.

- Using your kinesthetic sense, use your fingers to find your lumbar vertebrae by feeling for the spiny process, the part that sort of sticks out and can be felt through the skin. (Keep in mind that this is NOT the weight-bearing portion of the spine.)
- Lean forward by curling or slumping your torso from your lower back, paying attention to the movement of the bones beneath your fingers.
- Stand upright again and arch back in the opposite direction, still paying attention to the lumbar movement.

- Now let's sit with appropriate singing posture (with our A/O joint directly above our spine, as in Image 7) and do the same thing: first curling over your knees and then arching back over your chair.

Can you describe the movement of your lumbar vertebrae as we moved through these different positions?
Allow 1-2 participants to verbally respond.

We are now going to put this knowledge to use in one of our songs. As you sing, pay attention to your lower back and the center of your body.
Conduct group through a portion of repertoire.

Do you notice any change in your breath, your vocal output, or your posture?
Allow 1-2 participants to verbally respond.

Experimental Lesson 4: The Hip Joints

Black text = the script, to be delivered by the teacher
Red text = refer to an image, diagram, or video
Blue text = provide a live/personal demonstration

Today we will look at the hip joints, the fourth place of dynamic balance.
(Teacher points to the location on their own body.)
Take a moment to consider where these joints are in your own body. Feel free to move as you do this.
Wait for a moment.

The hip joint is a ball-and-socket joint on the side of the body. The top of the thigh bone is shaped like a large ball. This is the “ball” that fits into the “socket” on the side of the pelvis.
(Show Image 10.)

Notice that the socket does not completely enclose the ball.
(Hold up femur and pelvis models to show this relationship.)
A landmark for finding the location of the hip joint is the greater trochanter. This is the large bump on the side of the upper portion of the femur.
(Show Image 11.)

It is important to point out that the hip joint, and not the waist, is the middle of the body. At this joint, the legs move in relationship to the torso and the torso moves in relationship to the legs. Put simply, if you bend your body at the hip joint, you are bending your body basically in half!

To find this joint in your body, use your thumbs to find the top of the pelvic structure, an area called the iliac crest. Extend your third finger down to a place where you feel a small bump on the side (the greater trochanter).
(Hold up femur and pelvis models to show this relationship.)
If you’re having difficulty finding this gap, march in place and it may be easier to feel.

Now, let’s do a few activities to learn more about the location and movement of the hip joint.
(Demonstrate all movements while describing for participants.)
- Using your kinesthetic sense, bend forward from the hip joints to feel their movement. Now bend backward from the hips, noticing the movement.
- Now let’s move the legs from those joints. Lift one leg at a time and turn your foot from side to side to feel the rotation of the leg.

Can you describe the movement of your hips as we moved through these different positions?
Allow 1-2 participants to verbally respond.

It is also important to recognize the role the hip joints play in sitting.
(Show Image 12.)

Looking at this picture, we can see that our upper body is balanced on the sitting bones at the bottom of the pelvis, and NOT the legs. Let's sit for this last exercise.
(Demonstrate all movements while describing for participants.)

- Sit on your hands so you can feel the sitting bones. Gently rock back and forth, as well as side-to-side, noticing the shifting pressure of the sitting bones against your fingers and hands.
- Now, balance your upper body on those sitting bones and pay attention to the lumbar region. Bend from the hips, and then return back to neutral.

Can you describe the change in your balance as we moved through these different positions?
Allow 1-2 participants to verbally respond.

We are now going to put this knowledge to use in one of our songs. As you sing, pay attention to your hips and your overall pelvic structure.
Conduct group through a portion of repertoire.

Do you notice any change in your breath, your vocal output, or your posture?
Allow 1-2 participants to verbally respond.

Experimental Lesson 5: The Knee Joints

Black text = the script, to be delivered by the teacher
Red text = refer to an image, diagram, or video
Blue text = provide a live/personal demonstration

Today we will look at the fifth place of dynamic balance: the knee joints.
(Teacher points to the location on their own body.)
Take a moment to consider where these joints are in your own body. Feel free to move as you do this.
Wait for a moment.

As singers, our understanding of the knee joints typically focuses on keeping them unlocked, so as to not inhibit blood flow while standing.
(Show Image 13.)

However, there is much more to the knee joints than simply preventing fainting. The knee consists of two joints: one between the femur (upper leg) and tibia (lower leg), and one between the femur and patella (kneecap).
(Show Image 14.)

The knee is the largest joint in the human body. It is a modified hinge joint, which means it is able to move in multiple directions: forward and back, and a slight side-to-side rotation.
(Show Image 15.)

It's important to realize that the knee is NOT only the kneecap, but is the grouping of these three bones.

Now, let's do a few activities to learn more about the location and movement of the knee joint. We'll stay seated for the first explorations.
(Demonstrate all movements while describing for participants.)

- Using your kinesthetic sense, find the greater trochanter (the top of the thigh bone) and the bottom of the femur (upper leg) at the knee joint. Notice how long the femur actually is.
- Put your leg out in front of you and gently feel the location, size and shape of the kneecap. Then place both of your hands around the knee joint and kneecap. Notice that the knee joint is below and behind the kneecap.
- Now let's stand and carefully explore the range of motion for the knee joints. First, slightly bend your knees, then return back to sense the neutral position. If you have difficulty discerning the difference between balanced and bent knees, check in with the thigh muscles. They will be engaged when knees are even slightly bent. Now, take your knees back to a locked position, and then back to neutral.

Can you describe the change in your balance as we moved through these different positions?
Allow 1-2 participants to verbally respond.

We are now going to put this knowledge to use in one of our songs. As you sing, pay attention to your knees and your overall leg structure.
Conduct group through a portion of repertoire.

Do you notice any change in your breath, your vocal output, or your posture?
Allow 1-2 participants to verbally respond.

Experimental Lesson 6: The Ankle Joints

Black text = the script, to be delivered by the teacher
Red text = refer to an image, diagram, or video
Blue text = provide a live/personal demonstration

Today we will look at the final place of balance: the ankle joints.
(Teacher points to the location on their own body.)
Take a moment to consider where these joints are in your own body. Feel free to move as you do this.
Wait for a moment.

The ankle joint is located where the bottom portions of the tibia and fibula (the two lower leg bones) meet with the talus bone, or the top of the foot.
(Show Image 16.)

People tend to mistake the bumps at lower ends of the tibia and fibula for the ankle joint, when in fact the joint is the entire connection between these and the talus. It's also important to realize that this joint is not at the very back of the foot, but is rather between the back and the center. It sits right above where the front of the heel meets the arch of the foot.
(Show Image 17.)

Now, let's do a few activities to learn more about the location and movement of the ankle joints.
(Demonstrate all movements while describing for participants.)

- First, take a moment to explore your lower leg bones. Move your hands up and down the front of your tibia (shin bone) to fully realize its length. Move on to the lower part of your tibia and fibula. (The tibia will be on the inside of your lower leg above your ankle joint and the fibula will be on the outside.)
- Stand and find a position of vertical balance throughout your body. Using your ankle joints as a pivot point, move your body in a circle as if you are drawing a circle on the ceiling above your head. Notice the shift in movement around your ankle joints as you move in the circle.

Can you describe the change in your balance as we moved through these different positions?
Allow 1-2 participants to verbally respond.

We are now going to put this knowledge to use in one of our songs. As you sing, pay attention to your ankles and your overall leg structure.
Conduct group through a portion of repertoire.

Do you notice any change in your breath, your vocal output, or your posture?
Allow 1-2 participants to verbally respond.

APPENDIX E: CONTROL GROUP LESSONS

Control Lesson 1: The Atlanto-Occipital Joint

Black text = the script, to be delivered by the conducting assistant
Red text = refer to an image, diagram, or video
Blue text = provide a live/personal demonstration

Before beginning the lesson, conduct the group singing through a portion of their repertoire (main study).

In these sessions, we're going to talk a little bit about six specific locations in the human body that contribute to our posture. The first location is the Atlanto-Occipital joint, or the AO joint. This joint is where your skull meets the top of your spine.
(Teacher points to the location on their own body.)
Take a moment to consider where this joint is in your own body. Feel free to move your head and shoulders as you do this.
Wait for a moment.

We are now going to spend some time singing. As you sing, pay attention to your AO joint and whether or not your singing is impacted by its position.
Conduct group through a selection of their repertoire for the remainder of the session.

Control Lesson 2: The Shoulder Joint

Black text = the script, to be delivered by the conducting assistant
Red text = refer to an image, diagram, or video
Blue text = provide a live/personal demonstration

Before beginning the lesson, conduct the group singing through a portion of their repertoire (main study).

In these sessions, we're talking a little bit about six specific locations in the human body that contribute to our posture. The second location is the shoulder joint. This joint is where your arm connects to your torso.
(Teacher points to the location on their own body.)
Take a moment to consider where these joints are in your own body. Feel free to move your head and shoulders as you do this.
Wait for a moment.

We are now going to spend some time singing. As you sing, pay attention to your shoulder joints and whether or not your singing is impacted by their position.
Conduct group through a selection of their repertoire for the remainder of the session.

Control Lesson 3: The Lumbar Region

Black text = the script, to be delivered by the conducting assistant
Red text = refer to an image, diagram, or video
Blue text = provide a live/personal demonstration

Before beginning the lesson, conduct the group singing through a portion of their repertoire (main study).

In these sessions, we're talking a little bit about six specific locations in the human body that contribute to our posture. The third location is the lumbar region of the spine. This is the lowest and largest portion of the spine above the pelvis.
(Teacher points to the location on their own body.)
Take a moment to consider where this region is in your own body. Feel free to move your torso as you do this.
Wait for a moment.

We are now going to spend some time singing. As you sing, pay attention to your lumbar region and whether or not your singing is impacted by its position.
Conduct group through a selection of their repertoire for the remainder of the session.

Control Lesson 4: The Hip Joint

Black text = the script, to be delivered by the conducting assistant
Red text = refer to an image, diagram, or video
Blue text = provide a live/personal demonstration

Before beginning the lesson, conduct the group singing through a portion of their repertoire (main study).

In these sessions, we're talking a little bit about six specific locations in the human body that contribute to our posture. The fourth location is the hip joint. This joint is where your leg meets the pelvic structure.
(Teacher points to the location on their own body.)
Take a moment to consider where these joints are in your own body. Feel free to move as you do this.
Wait for a moment.

We are now going to spend some time singing. As you sing, pay attention to your hip joints and whether or not your singing is impacted by their position.
Conduct group through a selection of their repertoire for the remainder of the session.

Control Lesson 5: The Knee Joint

Black text = the script, to be delivered by the conducting assistant
Red text = refer to an image, diagram, or video
Blue text = provide a live/personal demonstration

Before beginning the lesson, conduct the group singing through a portion of their repertoire (main study).

In these sessions, we're talking a little bit about six specific locations in the human body that contribute to our posture. The fifth location is the knee joint. This joint is where the upper portion of your leg is connected to the lower portion of your leg.
(Teacher points to the location on their own body.)
Take a moment to consider where these joints are in your own body. Feel free to move as you do this.
Wait for a moment.

We are now going to spend some time singing. As you sing, pay attention to your knee joints and whether or not your singing is impacted by their position.
Conduct group through a selection of their repertoire for the remainder of the session.

Control Lesson 6: The Ankle Joint

Black text = the script, to be delivered by the conducting assistant
Red text = refer to an image, diagram, or video
Blue text = provide a live/personal demonstration

Before beginning the lesson, conduct the group singing through a portion of their repertoire (main study).

In these sessions, we've been talking a little bit about six specific locations in the human body that contribute to our posture. The last location is the ankle joint. This joint is where the leg connects to your foot.
(Teacher points to the location on their own body.)
Take a moment to consider where these joints are in your own body. Feel free to move your legs and feet as you do this.
Wait for a moment.

We are now going to spend some time singing. As you sing, pay attention to your ankle joints and whether or not your singing is impacted by their position.
Conduct group through a selection of their repertoire for the remainder of the session.

APPENDIX F: IMAGE PERMISSION LETTERS

Permission for Benjamin Conable Images

Sunday, March 27, 2022 at 18:51:29 Central Daylight Time

Subject: Re: Image Permission
Date: Sunday, June 6, 2021 at 10:22:39 PM Central Daylight Time
From: Alec Harris
To: Moreno, Amanda

Hi Mandy,

Thank you for writing. You can certainly use these images gratis in the context of your dissertation, so long as you include copyright credit for the source of the images along with the phrase "Used with Permission."

Best wishes with your project!

— Alec

Alec Harris
1-708-552-9800
1-800-442-1358 ext 800
alech@giamusic.com

GIA Publications, Inc.
7404 S. Mason Ave.
Chicago, IL 60638
www.giamusic.com

On Jun 5, 2021, 4:41 PM -0500, Moreno, Amanda <a.moreno@und.edu>, wrote:

> Hello,
>
> I am writing to inquire about obtaining permission to include images designed by Benjamin Conable in a forthcoming dissertation. I am also pursuing a PhD in Music Education from the University of North Dakota, with the Body Mapping method as the center of my dissertation studies. It is for this dissertation that I am seeking publication permissions.
>
> I have initial access to these images due to my status as a trainee with the Association for Body Mapping Education, studying with Lisa Marsh. I have attached the images in question and would appreciate any information on how best to continue this process.
>
> Thank you for your time and consideration,
>
> Mandy Moreno

Page 1 of 1

Permission for David Gorman Images (1/2)

Sunday, March 27, 2022 at 18:51:03 Central Daylight Time

Subject: Re: Image Permission
Date: Saturday, July 24, 2021 at 1:29:00 PM Central Daylight Time
From: David Gorman
To: Moreno, Amanda
Attachments: ngipiflldcadkkcj.png

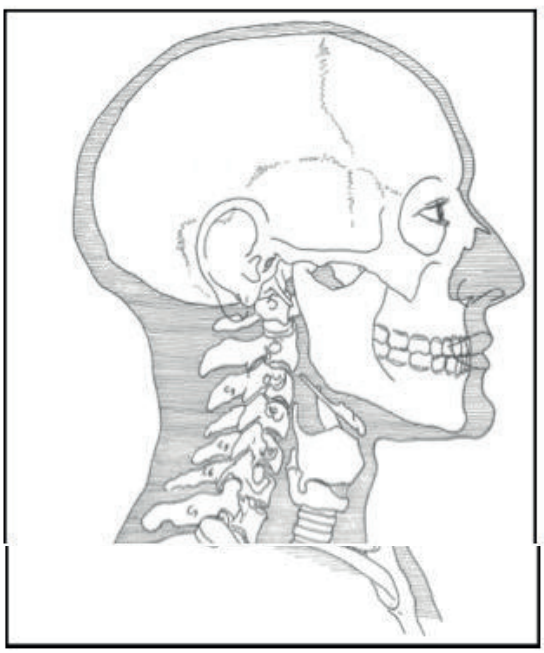
Hi Mandy,

Sorry for the long delay in getting back to you.

On 2021-06-05 5:43 PM, Moreno, Amanda wrote:

> *I am writing to inquire about obtaining permission to include an image designed by David Gorman in a forthcoming dissertation. I am also pursuing a PhD in Music Education from the University of North Dakota, with the Body Mapping method as the center of my dissertation studies. It is for this dissertation that I am seeking publication permissions.*
> *I have initial access to this image due to my status as a trainee with the Association for Body Mapping Education, studying with Lisa Marsh. I have attached the image in question and would appreciate any information on how best to continue this process.*
> *Thank you for your time and consideration,*
> *Mandy Moreno*

Yes, I'd be happy to grant you permission to publish that image of a lateral view of the head and neck with bones showing (from the current 6th Edition of "*The Body Moveable*", page 152 of the 1st Volume, see the small copy of the image below):



Permission for David Gorman Images (2/2)

Publishing Permission for Image

Permission is granted for you to use the image in your PhD dissertation, under the following conditions:

1. that the image is used for the above use and no other purpose, though if you wish to use the image in another publication of any sort, you may apply again for permission

2. that credit is given, either near the image in small type or an acknowledgements section, with text similar to this:
"Image from "*The Body Moveable*" by David Gorman (bodymoveable.com)"

3. that you write back to me by email confirming your agreement to these conditions and quoting all the contents of this message (including the image and the conditions)

There is no fee for this permission, however, it would be appreciated if you could send me a copy of your dissertation (preferably signed by you) once it is published, *though this condition is optional*... If you do send me a copy, please address it to:

David Gorman
78 Tilden Crescent,
Etobicoke, ON M9P 1V7
Canada

warmly,
David Gorman

Permission for ABME Images

From: **Melissa Malde** melissamalde@yahoo.com
Subject: Re: ABME Image Request
Date: September 1, 2021 at 12:59 PM
To: Mandy Moreno mandymoreno12@gmail.com

Hi Mandy, If you are only using Holly Fischer images, you don't need to wait for approval. We just have the form so that we know where our images are going. Sorry I did not notify you!
MM

On Wednesday, September 1, 2021, 11:57:08 AM MDT, Mandy Moreno <mandymoreno12@gmail.com> wrote:

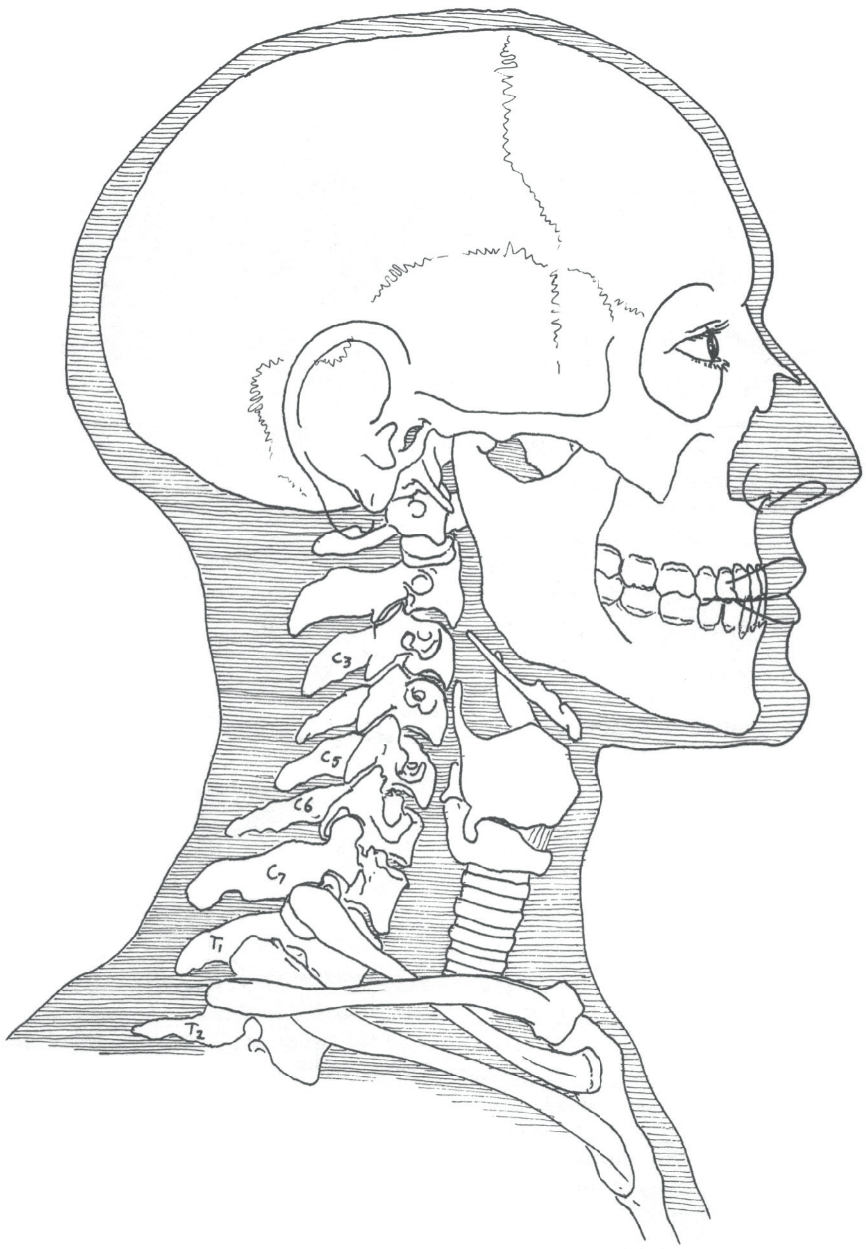
Hi Melissa,

I hope you are well! Kay Hooper suggested I contact you about an image request I submitted back in the summer. It included a number of Holly Fischer images to be used in my forthcoming dissertation. Should I expect a notification as to whether or not my request was approved? I want to be sure I have all my ducks in a row!

Thanks so much,
Mandy Moreno

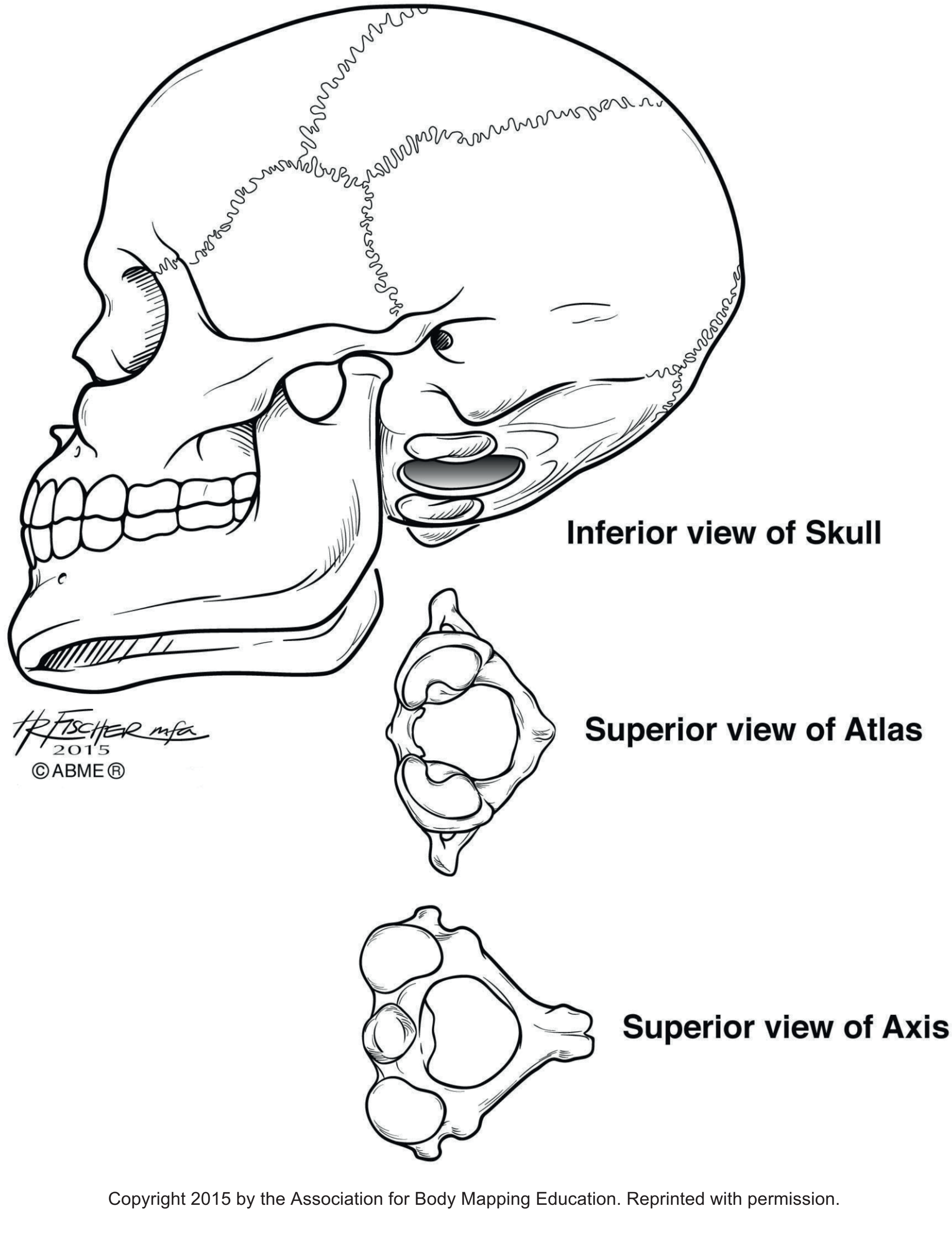
APPENDIX G: ANATOMICAL IMAGES FOR EXPERIMENTAL LESSONS

Experimental Lesson Image 1



From “The Body Moveable,” by D. Gorman, 2002, LearningMethods Publications (http://bodymoveable.com). Copyright 2002 David Gorman. Reprinted with permission.

Experimental Lesson Image 2



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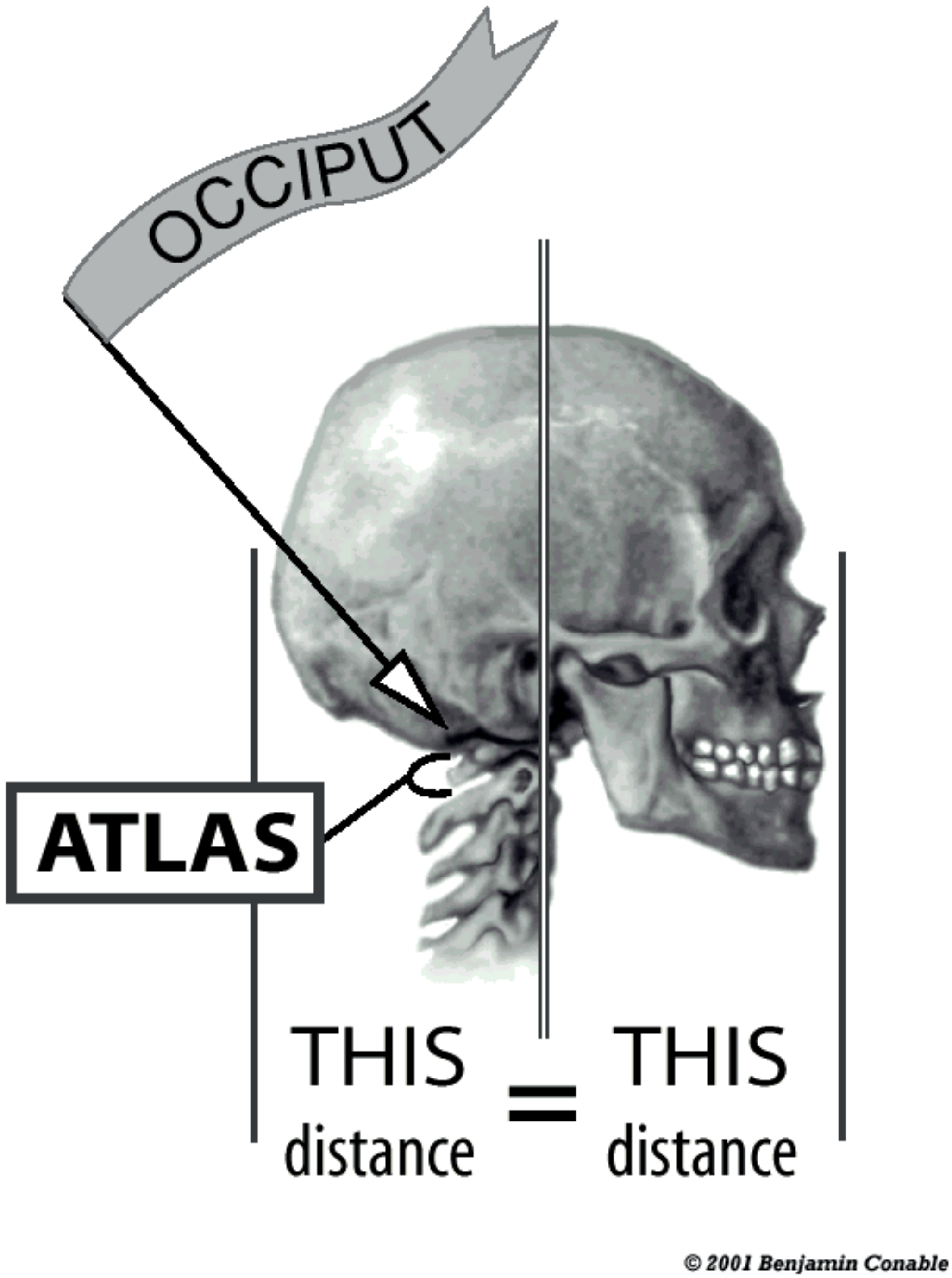

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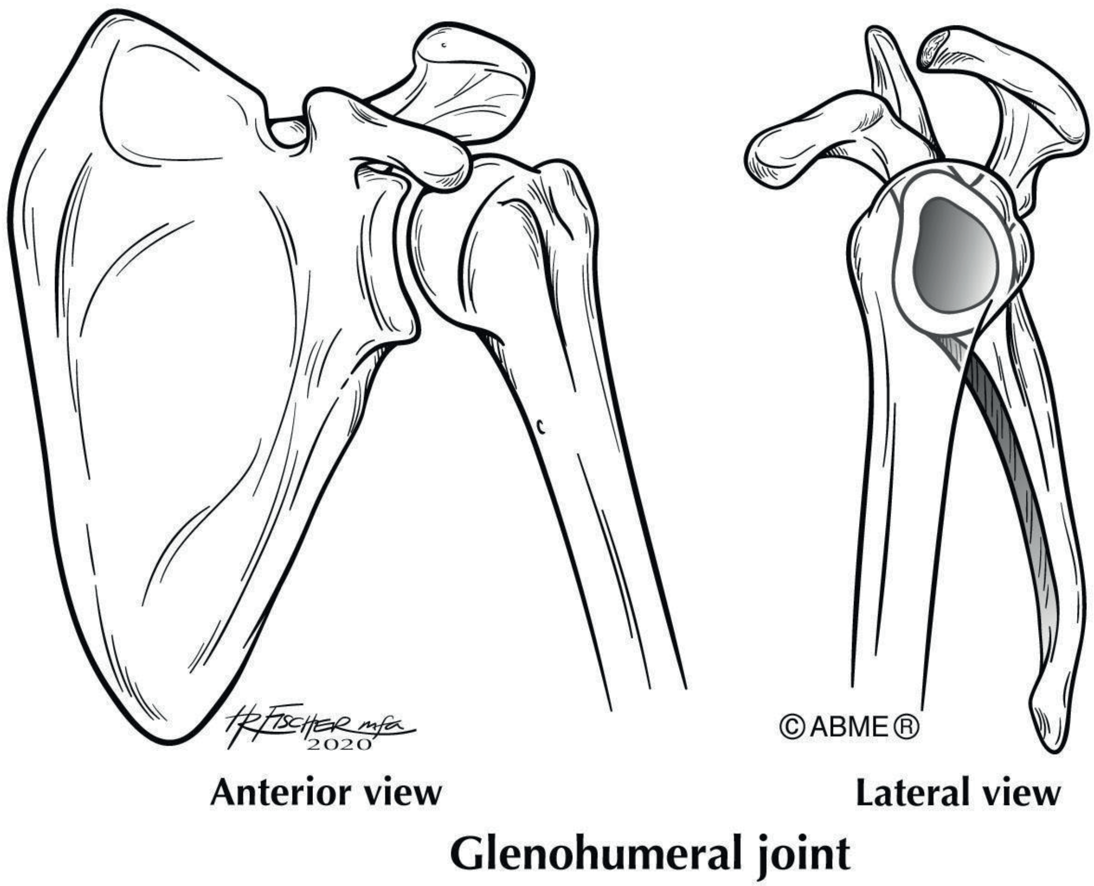

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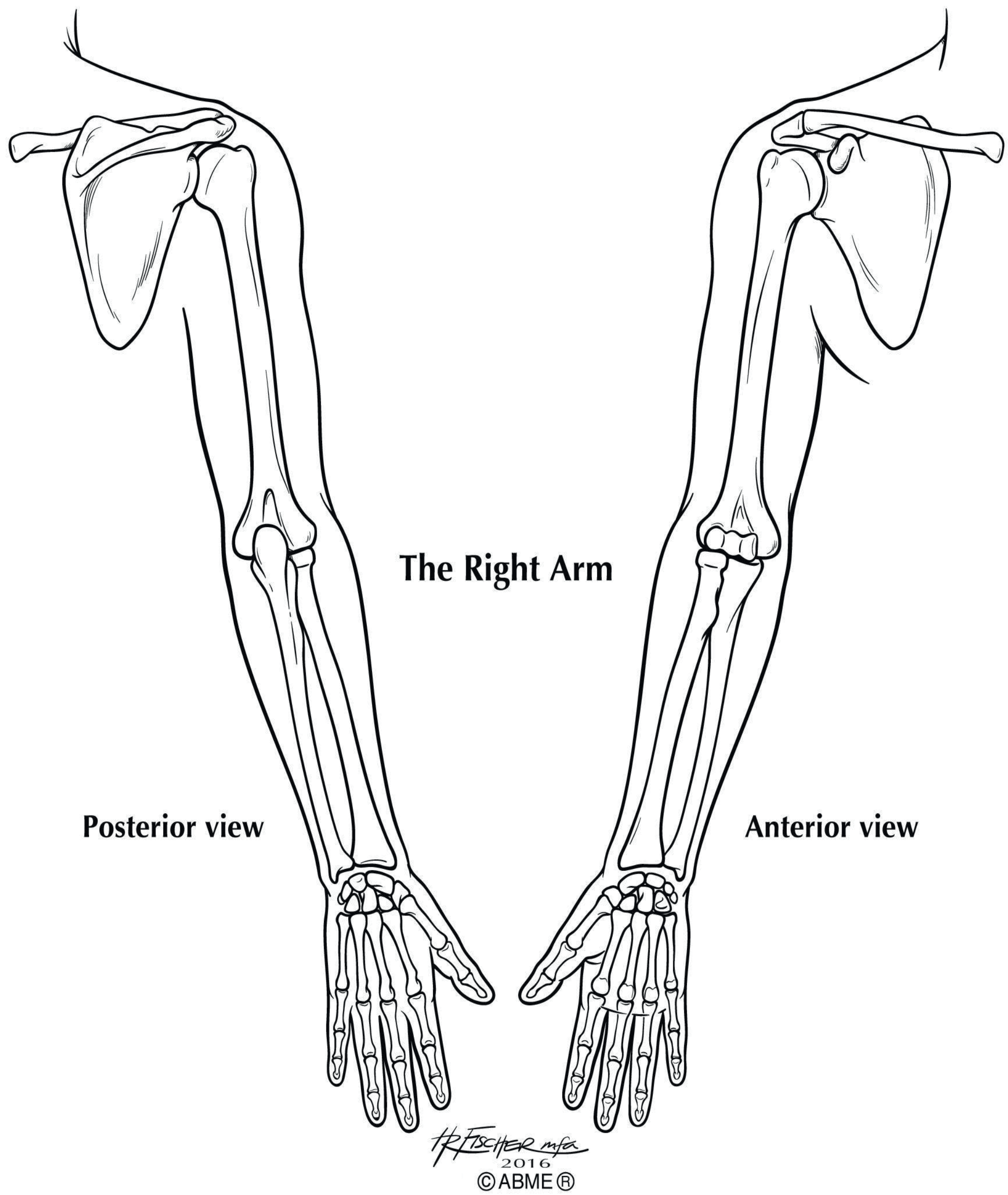

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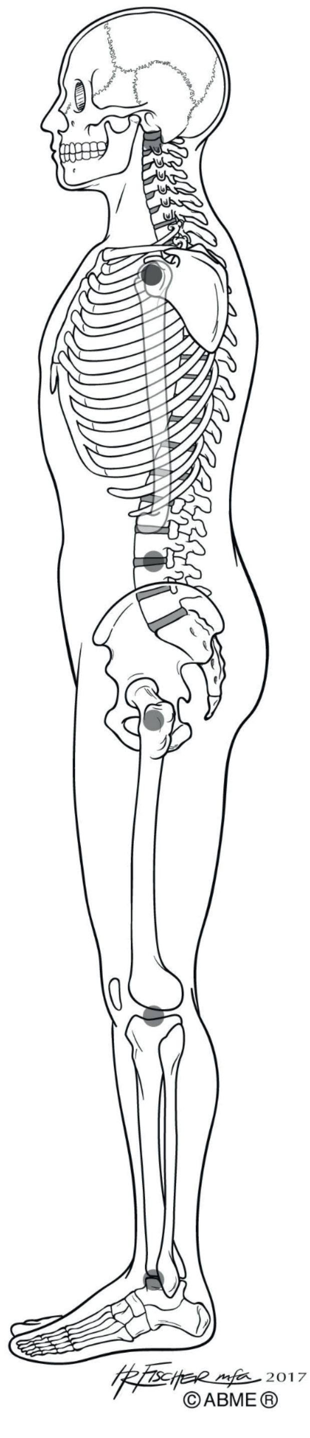
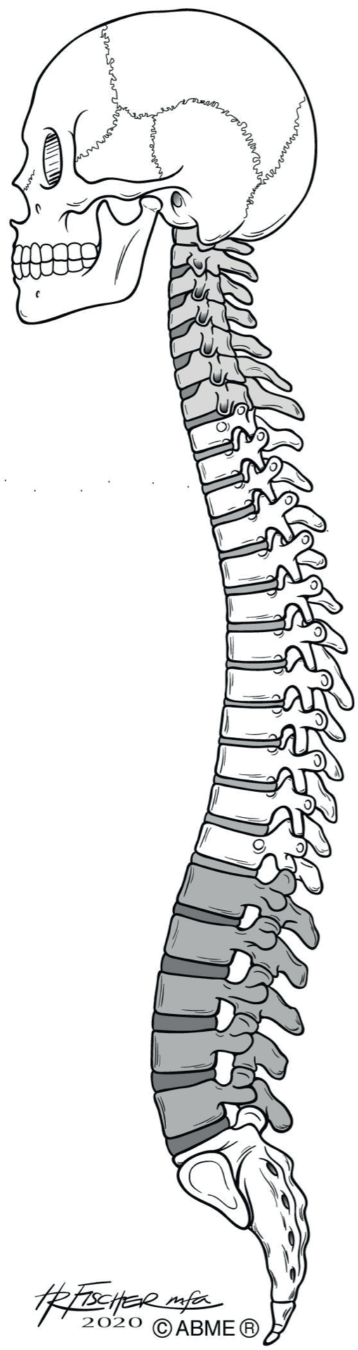
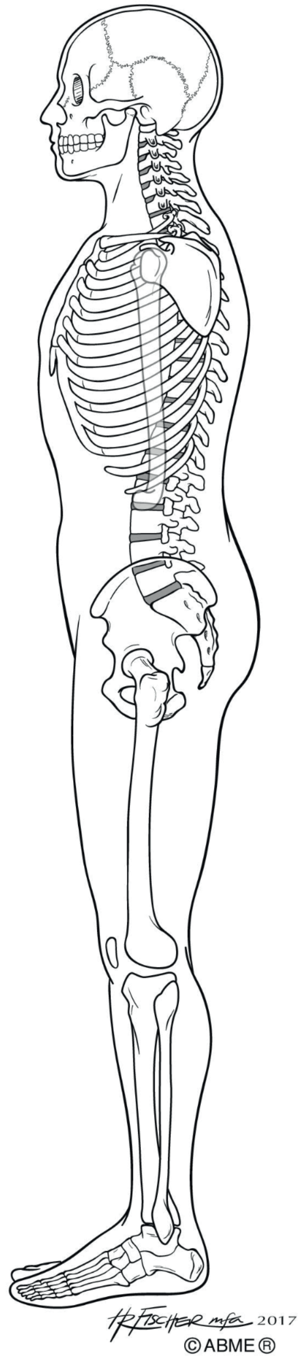


Experimental Lesson Image 7

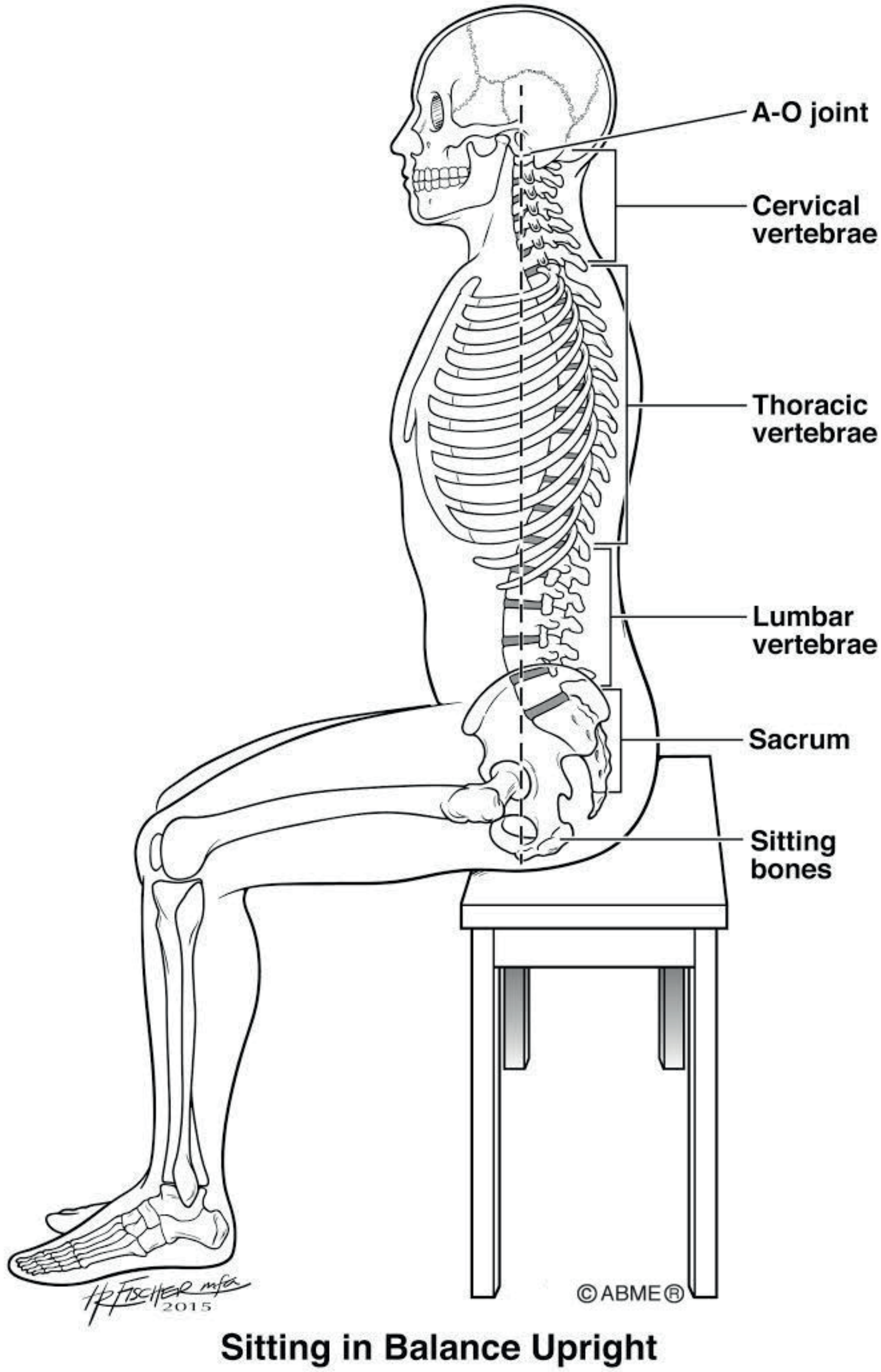


Lateral vertebral column and skull

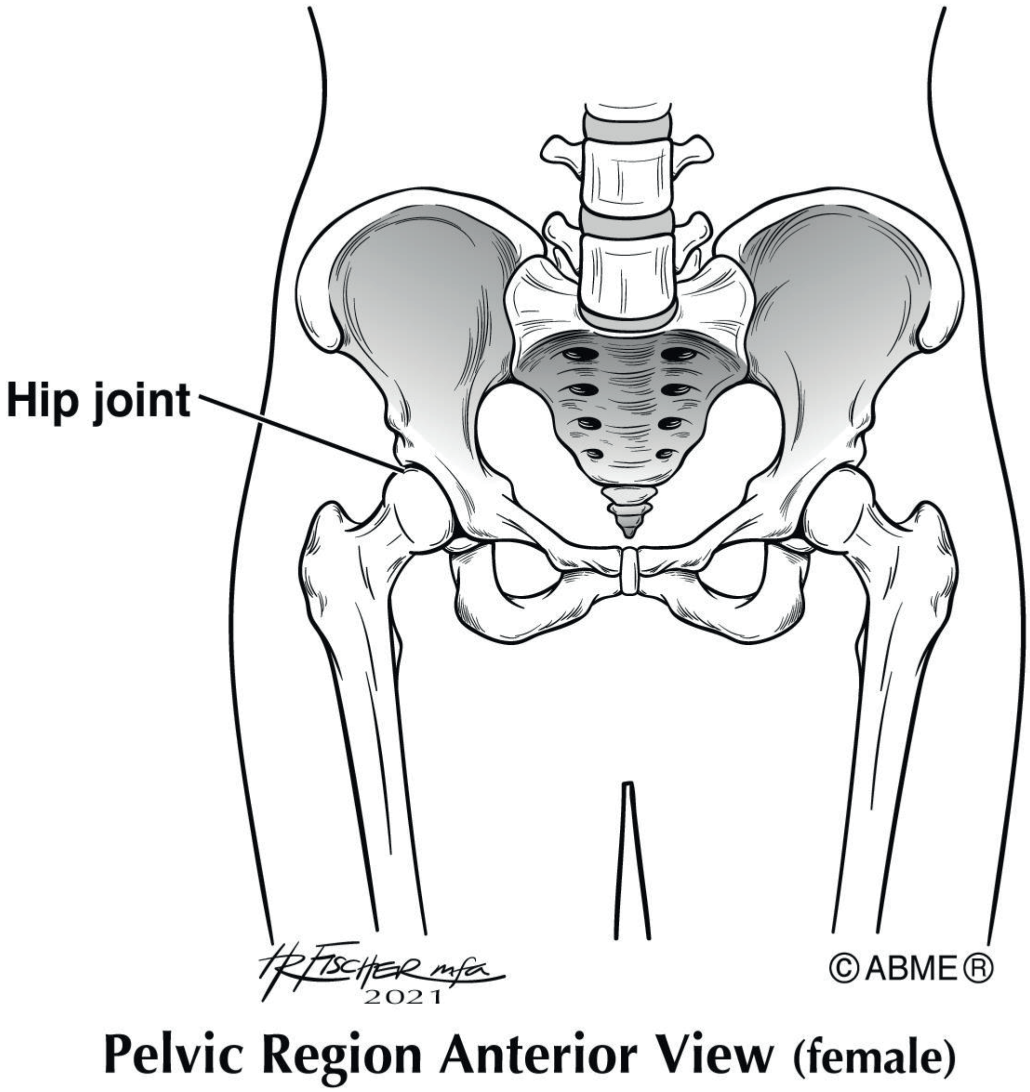
Experimental Lesson Image 8



Experimental Lesson Image 9



Experimental Lesson Image 10



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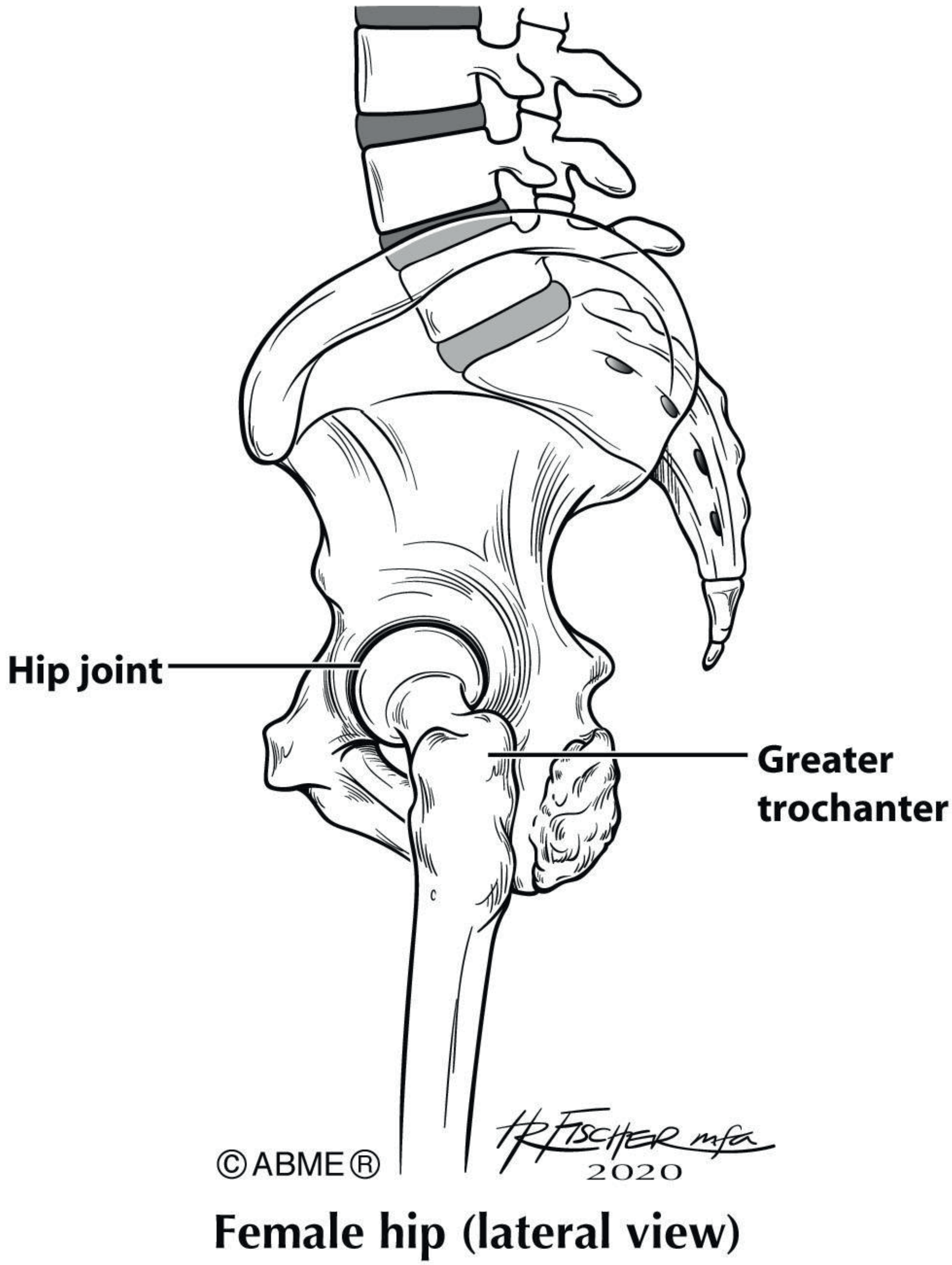

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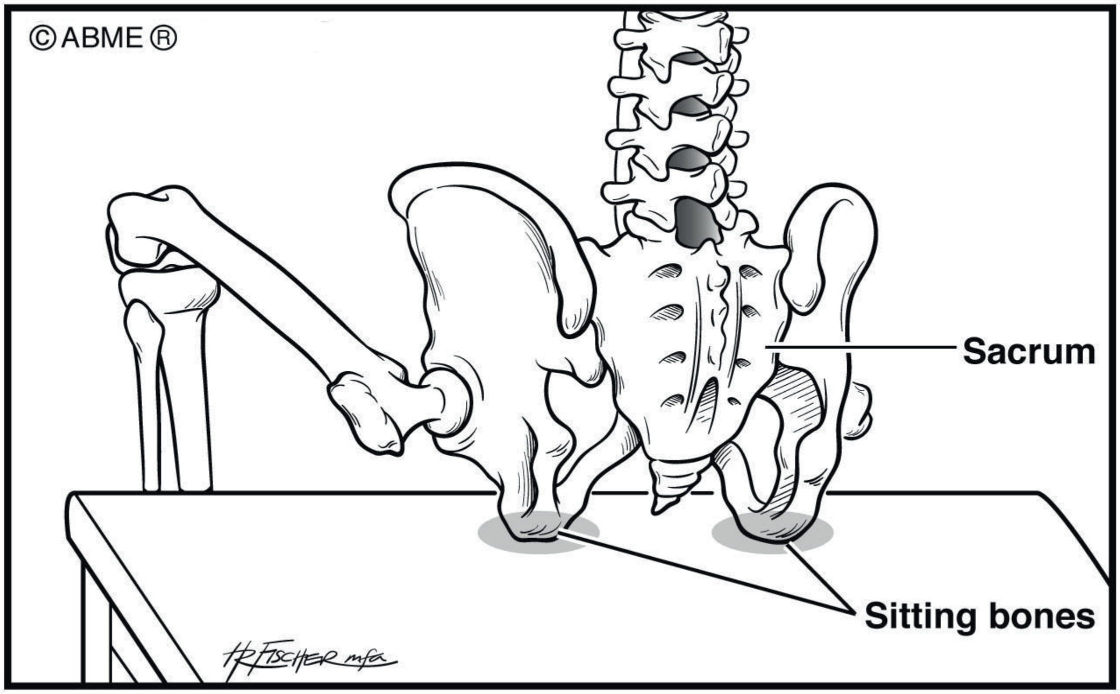

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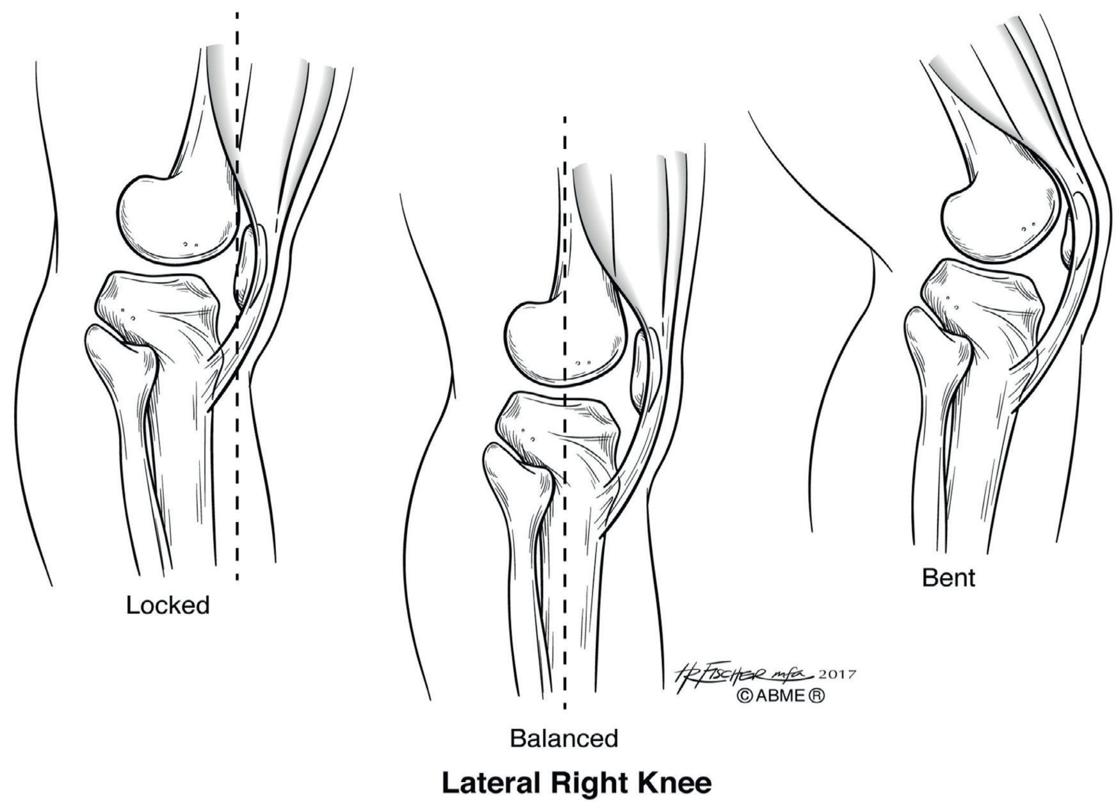

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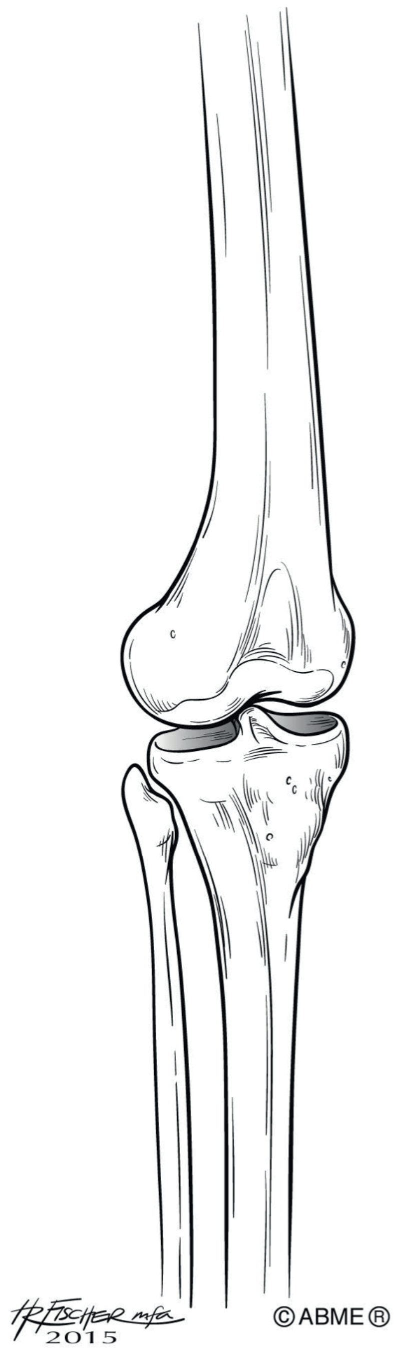
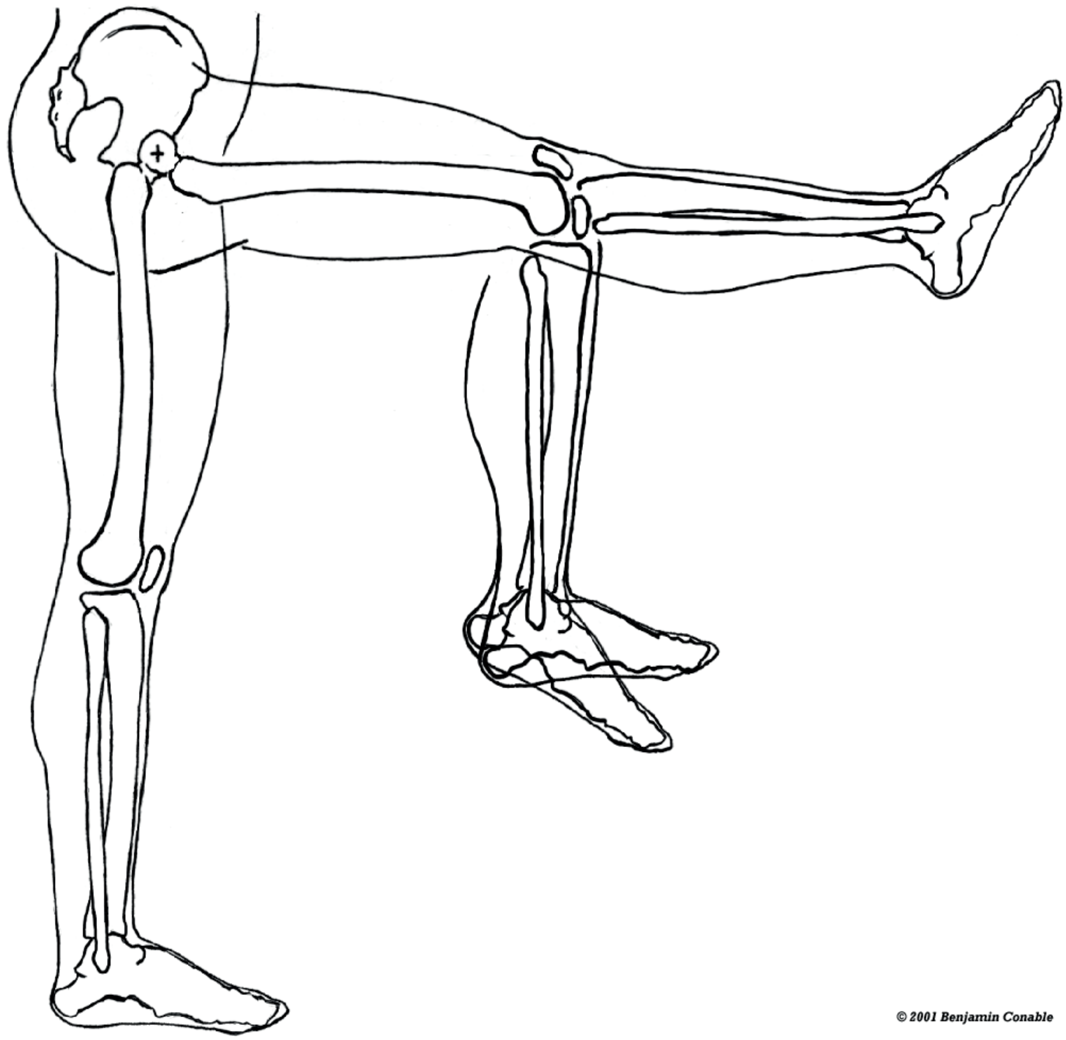


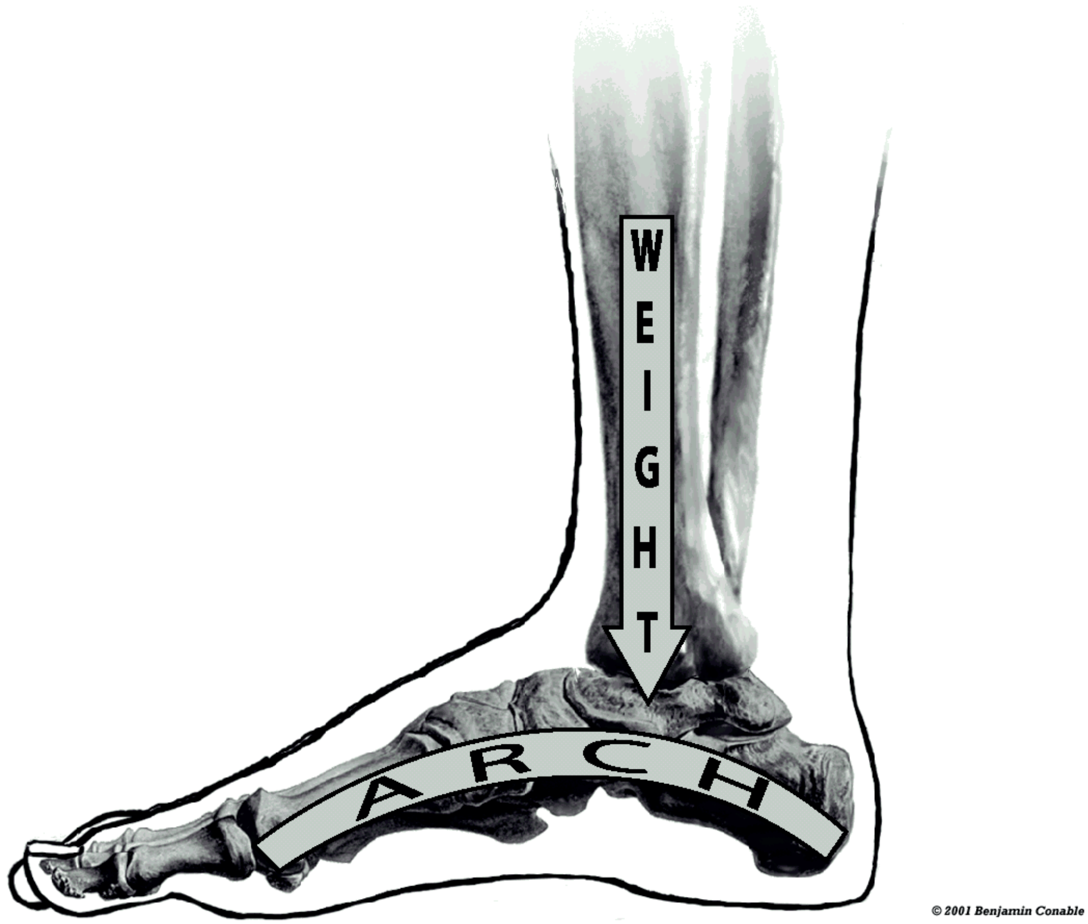
The Right Knee (standing)

Experimental Lesson Image 15

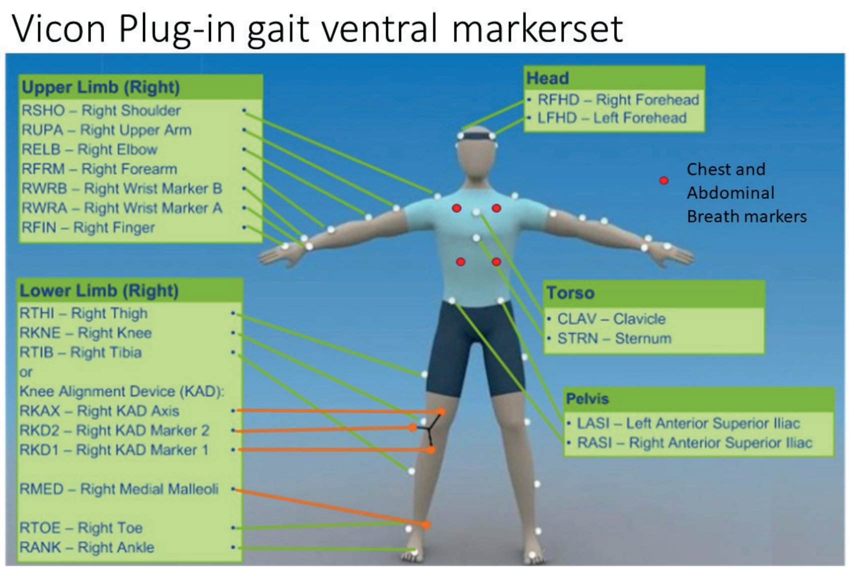


Experimental Lesson Image 16

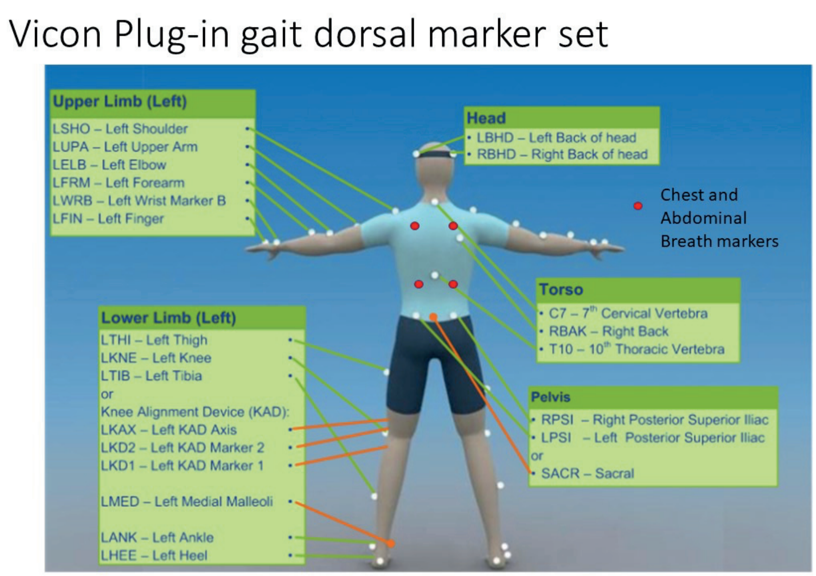
Experimental Lesson Image 17



APPENDIX H: VICON MARKER PLACEMENT



Dorsal (front) view Plug-in-Gait marker set. Copyright Vicon Motion Systems Ltd, 2005. Used with permission.



Dorsal (front) view Plug-in-Gait marker set. Copyright Vicon Motion Systems Ltd, 2005. Used with permission.