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# The Science of Singing: A Voice Lesson from Anatomy and Physiology

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## The Science of Singing: A Voice Lesson from Anatomy and Physiology

Vocal pedagogy and performance practices have changed over time. There have been many theories on singing and how to use one's vocal cords in the most aurally pleasing and physically propitious way possible. The advancement of medical technology and scientific study of the vocal folds influenced a change in vocal performances practices and pedagogical approaches to singing. From the early church singers, to sixteenth century *bel canto* style, all the way to current techniques used today, there have been many changes in the approach to singing and proper vocal usage. The voice is a delicate instrument of which good and purposive care must be taken. Much research has been done to explore and discover the most healthy and successful way to sing. There is much science involved in the learning and knowing of vocal music.

The earliest roots that we can trace of voice training dates way back to the fourth century. In this time period, singing was foundational to church worship, and singers were being ordained into the church to lead the singing of the worship service.<sup>1</sup> These clergymen were dedicated to studying the art of song and finding the most beautiful sound for their song. They trained their singers to sing professionally. In the very early church, singing wasn't allowed to be congregational, because only the trained choir was allowed to raise their voices to the Lord to assure that the most pure sound was their sacrifice of worship.<sup>2</sup> This early voice training paved the way for centuries of changing vocal techniques and training strategies. The church was the foundation for vocal music for many centuries, and directly influenced the singing styles that historically followed.

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<sup>1</sup> Cornelius L. Reid, *Bel Canto: Principles and Practices* (NY: J. Patelson Music House, 1950), 5.

<sup>2</sup> *Ibid.*, 6.

In the earliest surviving record of music, the prevailing style of music was monophonic a cappella music. Monophony was unison singing that was somewhat simple and easy to follow. It was based on the text, usually Latin liturgy, more than it was based on a beautiful melody.<sup>3</sup> The focus was not on the sound of the singing, but on the words. After monophony, polyphony became the new style of singing. Polyphony, meaning “many-voice,” is music that is sung in harmony by a choir or multiple voices. There is evidence of primitive harmony as early as the eighth century.<sup>4</sup> Choral polyphony created all voices equal, and was primarily melodic. These melodies were stacked on top of one another, but there was no emphasis on any one part more than another. Polyphonic music was more about the whole than the individual, and did not lend itself to soloistic singing.

The church did not believe in virtuosic displays of musicality, because it was seen as selfish and was not glorifying to God.<sup>5</sup> According to Reid, because the church was the principal sponsor of the professional musician and the central hub of the music industry at that time, it took quite a long time for professional vocalists to be able to establish full-time, reliable careers in vocal performance outside of the church as individual performers.<sup>6</sup> This directly influenced the public entertainment locale. Secular vocal styles and genres were formed outside of the church for the sole purpose of entertainment and enjoyment, which is where professional singers were able to find their place and career in society. Some of these early professional vocalists were called minstrels and troubadours. Often times these professional musicians would travel and sing or play in different towns to entertain the locals.

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<sup>3</sup> Matthew Hoch, *So You Want to Sing Sacred Music: A Guide for Performers*, (Lanham, MD: Rowman & Littlefield, 2017), 35.

<sup>4</sup> *Ibid.*, 36.

<sup>5</sup> Cornelius L. Reid, *Bel Canto: Principles and Practices*, 6.

<sup>6</sup> *Ibid.*

By the sixteenth century, Italian *bel canto* style singing was the most highly regarded vocal technique.<sup>7</sup> Italy cornered the market of singing techniques. The world looked at the Italian singers to display proper and beautiful vocal performances practices. Vocalists from Germany, France, and other countries tried to achieve the same level of artistry in singing, but to no avail. No other country could rival the Italian singing style in all its majesty.<sup>8</sup> Italy had the most highly sought vocal talent because of the beautiful *bel canto* training that they had. The “Golden Age of Song” flourished in Italy during the Renaissance Era.<sup>9</sup> While many believe that *bel canto* singing began with opera, it was only magnified through it.<sup>10</sup> The Italian approach was focused on the “*bel canto*” or “beautiful singing” sound and how to produce it. The training focused on quality of sound rather than the most efficient use of the voice. They focused on just a few components to singing that all had to do with the performing aesthetics. The main components included: proper tone production, musicianship, and character.<sup>11</sup> These three components are still the basis of vocal training today, but have shifted slightly and make up the bare bones of current study.

By the nineteenth century, the once-prevailing *bel canto* style began to diminish and no longer be taught. Some attributed this to the decline of properly trained teachers. This theory, however, is easily debunked, considering people were schooled in this technique for centuries, and many of these teachers remained through the nineteenth century.<sup>12</sup> Instead, “Many of the obstacles barring our understanding [of the decline of *bel canto*] have been of our own making and will only be removed after we have become aware of the inaccuracy of most of our present

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<sup>7</sup> Martha Elliott, *Singing in Style: A Guide to Vocal Performance Practices* (New Haven: Yale University Press, 2006), 136.

<sup>8</sup> *Ibid.*, 71.

<sup>9</sup> Cornelius L. Reid, *Bel Canto: Principles and Practices*, 5.

<sup>10</sup> *Ibid.*, 13.

<sup>11</sup> *Ibid.*, 19.

<sup>12</sup> *Ibid.*, 155.

opinions regarding the voice.”<sup>13</sup> This means that one must look beyond the old understanding of voice practices and look to what we now know to help us understand why this long-standing practice has now been replaced by new techniques and schools of thought.

Cornelius Reid, a man who studied vocal techniques intensively, said in his book, “In order that the correctness of any training procedure may be accurately estimated and its value determined, it is essential for every teacher and student of singing to have an exact knowledge of the mechanical capacities and limitations of the human voice.”<sup>14</sup> He believed that one must know the physiological functioning of the voice in order to be successful in both the teaching and the studying of singing. The instrument that allows for the knowledge of the anatomy and physiology of the voice is the laryngoscope. A laryngoscope is a device that enters the trachea via the back of the throat or up the nose in order to be able to see the inner parts of the larynx. The earliest records of primitive tracheal intubation date back to as early as B.C. 400.<sup>15</sup> The first recorded laryngoscope to ever have given a full view of the inner-workings of the vocal cords was in 1855 by a career vocal coach and professional named Manuel Garcia.<sup>16</sup> As a voice teacher, he understood that an anatomical knowledge of the vocal cords was necessary to achieve the fullest vocal capability. Medical advancements have allowed us to see the vocal chords and to study singing in a deeper and more tangible way.

Garcia’s original laryngoscope was a very primitive instrument made out of only a tube and a pair of mirrors. It used the sun as a source of light for refraction.<sup>17</sup> If Manuel Garcia, who was not a scientist, could discover such impactful knowledge about the voice because of the

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<sup>13</sup> Cornelius L. Reid, *Bel Canto: Principles and Practices*, 156.

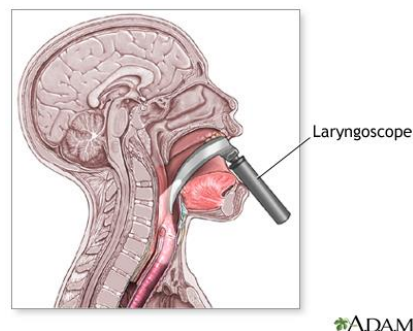
<sup>14</sup> *Ibid.*, 18.

<sup>15</sup> B.M. Pieters et al., "Pioneers of Laryngoscopy: Indirect, Direct and Video Laryngoscopy," *Anaesthesia and Intensive Care* 23 (2015): 4.

<sup>16</sup> *Ibid.*, 5.

<sup>17</sup> *Ibid.*

ability to see them in action, even with such a rudimentary tool, imagine what further technology would enable the vocalist to do! The most challenging aspect of the development of the laryngoscope was the ability to clearly see the vocalis muscles, which are the vocal cords.<sup>18</sup> The development included a series of mirrors, tubes, and catheters. Today, a typical laryngoscope is comprised of small tubing containing a video camera that goes down the nasal cavity or the back of the throat and allows for a somewhat clear view of the glottis and vocalis muscles.<sup>19</sup> While laryngoscopy is still considered a developing field, the advancements that have been made over the past several centuries have caused an incredible capacity for advancement in vocal science.



Knowing the science of the voice is important for vocalists because it changes the way that they view their voice. It is very difficult to study vocal anatomy and understand how it effects voice production and phonation, but it is very important that one does thorough research to better understand it. Those who take a scientific approach to vocal pedagogy study the physiological phenomena of the voice, and how their teaching techniques coincide with scientific and experimental findings.<sup>20</sup> Thanks to the medical advances in vocal study, a whole science has developed in researching the voice and how it operates. Up until the development of medical technology that made studying the physical aspects of the voice possible, all we knew about how the voice exerted itself in singing was mostly speculation based on sound and feeling. The vocal cords are muscles, but they have no nerve endings. Because there are no nerves, we cannot always tell if how we are singing is harming our voice. Now that we have technology that allows

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<sup>18</sup> B.M. Pieters et al., "Pioneers of Laryngoscopy: Indirect, Direct and Video Laryngoscopy," 8.

<sup>19</sup> Ibid.

<sup>20</sup> Victor Alexander Fields, *Training the Singing Voice: An Analysis of the Working Concepts Contained in Recent Contributions to Vocal Pedagogy*, (Da Capo Press, 1979), 243.

us to see the vocal cords in action, we can see how our vocal habits affect the physical health of our voices. This study of the vocal folds affects how we train singers to perform and take care of their vocal health.



Source: *Center for Care of the Professional Voice*

The vocal folds are very delicate muscles and need to be well taken care of. Knowing the anatomy of the vocal cords is important for all vocalists of any age or ability level. According to Peter LaPine, “Understanding the physical aspects of vocal production and the workings of the larynx are just the first steps on the road to good vocal hygiene.”<sup>21</sup> Not only is it the first step, but it is also the most important step. Just like how a physical therapist must know the physiology of the body to help it heal properly, a vocalist,

particularly voice teachers, must know the physiology of the voice in order to take care of it in a healthy and productive manner. While there are many different types of voice qualities, styles, and sounds depending on the singer, the one thing that remains steadfast and consistent among them all is that poor vocal health will always produce poor vocal sound.<sup>22</sup> Vocal and physical health will always affect a singer’s tone quality.

Based on what is known through scientific research of vocal anatomy, one can know what best to do in order to preserve vocal health. Singers need to be careful not to put too much pressure on the vocal cords, make them too tense, or use them vigorously for long periods of time.<sup>23</sup> When too much strain is put on the vocalis muscles, there are various health issues that

<sup>21</sup> Peter R. LaPine, "The Relationship between the Physical Aspects of Voice Production and Optimal Vocal Health," *Music Educators Journal* 94, no. 3 (2008): 24.

<sup>22</sup> Ibid.

<sup>23</sup> Ibid., 25.

can arise. The issue most often seen is a growth of lesions. There is great evidence of the link between poor vocal habits and the forming of lesions. Many case studies have been done to prove this connection and figure out the ramifications and repercussions of these vocal issues. Two kinds of lesions that can form are polyps and nodules. Typically, nodules appear on both the right and left vocal cords mirroring each other, whereas polyps usually only appear on one of the muscles.<sup>24</sup> These lesions are benign, but are a cause for concern because if left uncared for, they can cause permanent damage to the vocal folds.<sup>25</sup> Some signs of vocal lesions are hoarseness, breathiness in speaking or singing, a shortened vocal range, and vocal fatigue.<sup>26</sup> Because of the laryngoscopic technology available today, we are able to see these lesions on the vocal cords and take pictures of them.

Often times the best treatment to vocal health issues is a time of vocal rest and proper hydration.<sup>27</sup> Nodules are usually a result of improper use of the voice, including singing too loudly for too long and poor posture. Other times, these lesions, typically polyps, are caused by a medical problem rather than just vocal misuse. Gastroesophageal reflux (GERD), postnasal drip, or respiratory infections can easily cause vocal complications, along with a history of smoking.<sup>28</sup> It is important to know if vocal problems are being caused by vocal misuse or a more serious, underlying illness. Knowing what the cause of



\* Polyp formed on the vocalis muscle of a smoker.

Source: *Center for Care of the Professional Voice*

<sup>24</sup> Peter R. LaPine, "The Relationship between the Physical Aspects of Voice Production and Optimal Vocal Health," 26.

<sup>25</sup> Regina Martins, et al., "Clinical Practice: Vocal Nodules in Dysphonic Children," *European Journal of Pediatrics* 172, no. 9 (2013): 1161.

<sup>26</sup> Peter R. LaPine, "The Relationship between the Physical Aspects of Voice Production and Optimal Vocal Health," 26.

<sup>27</sup> *Ibid.*, 27.

<sup>28</sup> *Ibid.*



these vocal issues is allows for proper care and helpful solutions. Having the medical technology to see the vocal folds is pivotal to vocal health and care. Being able to see what is physically wrong with the vocalis muscle allows for the proper action to be taken to heal and prevent further damage.

Not only does knowing the anatomy and physiology of the vocal cords help when diagnosing vocal troubles, it also helps people to understand how to use the voice in the most healthy and efficient way possible. Proper care and maintenance are required for vocalists just like other instruments. Laryngoscope allow for us to visually see the health status of our vocal cords. There is scientific evidence for vocal hygiene practices. First and foremost, vocalists need to stay hydrated. Hydrating for days before a performance is important so that your body and your larynx can absorb the water and function in the most physically advantageous manner.<sup>29</sup> Resting the voice when needed, drinking tea, avoiding caffeine, and staying away from smoke are just a few ways that the vocalist can keep their voice at its peak. Proper use of the voice while singing is also of vital importance. Knowing not only how to take care of your voice but also how to use it in the most healthy way can impact vocal performance impeccably.

The history of vocal pedagogy and performance was altered largely due to the invention of the laryngoscope. It shifted from focusing on the sound and aesthetics of the voice to the production and quality of singing based on the physiological function of the vocal cords. Schools of vocal practice and technique that have been established over the past hundred years have been centered mainly on the scientific research that has been done on the voice.<sup>30</sup> The two main techniques that are used in vocal pedagogy today are the Alexander Technique and Estill Voice

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<sup>29</sup> Donald Callen Freed, "The Owner's Manual to the Voice: A Guide for Singers and Other Professional Voice Users," *Choral Journal* 55, no. 3 (October 2014): 93.

<sup>30</sup> "Research," *Estill Voice International* (2010).

Training. Both of these voice training techniques stem from the depth of knowledge that we now have about the voice due to the emergence of vocal science.

The Alexander Technique is a technique for all types of performers, not just vocalists. Frederick Matthias Alexander (1869-1995) was an actor. He experienced chronic laryngitis due to routinely using his voice for long periods of time. He believed that there must be a way to cure his laryngitis problem and better take care of his voice. When his doctors could not help him, he started to do his own studying.<sup>31</sup> After much research and trial and error, he discovered that he had too much tension in his voice, throat, and body while he performed. This tension, along with poor posture, put strain on his vocal cords and caused his chronic laryngitis. His solution was to come up with a performance technique that released tension and espoused proper posture. The technique that F. M. Alexander came up with began with a system to analyze one's body habits, and found solutions to fix them. This technique, now called the Alexander Technique, fixed his vocal issues and baffled the doctors who were helpless to cure him.<sup>32</sup> Though Mr. Alexander himself has passed, his technique is still taught to voice, instrumental, and theater students around the world.

The basic definition of The Alexander Technique, according to Dr. Alfred Flechas, is "The Alexander Technique is a way of learning how you can get rid of harmful tension in your body."<sup>33</sup> In this technique, the relationship of the head to the spine is of the most pivotal importance. The head must lift and only lightly rest on the spine, releasing tension and elongating the space between the head and the rest of the body. In doing so, one will minimize compression on the spine, improve overall posture, and release the tension that can result in

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<sup>31</sup> "What is the Alexander Technique?" *The Complete Guide to the Alexander Technique* (2017).

<sup>32</sup> Ibid.

<sup>33</sup> Ibid.

vocal issues.<sup>34</sup> Knowing how the body works and its effect on the voice has radical implications for professional vocalists and the stability and longevity of their careers. F. M. Alexander believed that overall health of the body was important for the voice to be healthy. Even just a small portion of our bodies are radically affected by how we treat the rest of our bodies. A vocal music scholar and historian named Wendy Leborgne said that we must consider whole body wellness and engage in healthy body habits in order to achieve healthy vocal habits.<sup>35</sup>

Similarly, Josephine “Jo” Estill (1921-2010) was a voice teacher, researcher, and singing specialist. She understood deeply the connection between the anatomy of the vocal cords and their physiological function to how a singer ought to use their voice. Her technique, Estill Voice Training, was officially founded in 1988.<sup>36</sup> Her training focuses on voice production and the function of the vocal cords in singing. Jo Estill did years of research in the physiology of the voice. She was well-researched and profoundly knowledgeable about the vocal cords and how they work during singing. Her knowledge informed her teaching, and it was important to her that the way she and her students sang was first and foremost technically correct in the physical sense.<sup>37</sup> The uniqueness to Jo Estill’s approach to voice training is found in how she separates the mechanics of singing from the artistic and aesthetic expression of vocal performance.<sup>38</sup> This means that she chose to let the mechanics of the voice dictate the aesthetics and artistic expressions about the voice, and not the other way around. This technique turns vocal performance and pedagogy on its head, because centuries previously focused solely on the aesthetics of singing over the physiological production of the voice.

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<sup>34</sup> “What is the Alexander Technique?” *The Complete Guide to the Alexander Technique*.

<sup>35</sup> Matthew Hoch, *So You Want to Sing Sacred Music: A Guide for Performers*, 164.

<sup>36</sup> “Research.” *Estill Voice International*.

<sup>37</sup> *Ibid.*

<sup>38</sup> *Ibid.*

The greatest shift in the history of vocal music was the change of focus on aesthetics to focus on production. This shift was due to the advancement of technology and new information that was made available about the voice. While the Italian *bel canto* style reigned gloriously for years and produced many a talented vocalist, it took a backseat to science with the development of the laryngoscope, substantiated research of the vocal cords, and the subsequent establishment of new vocal techniques. There has not been much laryngoscopic research done on the classic *bel canto* style. However, since the invention of laryngoscopy it has been made clear that the old style was in need of being replaced with a more modern and practical technique, based on scientific evidence. One case study showed that vocalizing in classical and non-classical vocal techniques changed her sound dramatically.<sup>39</sup> It has been scientifically proven that the aesthetics of the voice are greatly improved when the focus of the singing is placed on the physical aspects of the voice and the anatomical functioning of the voice box during the act of singing rather than focusing primarily on the sound itself. Singing is science.

Mark Lee, a former music school director and voice teacher said that “voice training is an ongoing science.”<sup>40</sup> Vocalists must study the anatomy and physiology of the voice and understand how they function in order to sing with the utmost splendor and success. The advancement of medical technology and scientific study of the vocal folds influenced a change in vocal performances practices and pedagogical approaches to singing. Singing is so much more than making a sound; it truly is a science. One who wishes to pursue it as a career must fully devote themselves to the study of the voice as a mechanism as well as its history and its place in music. From the early church singers, to sixteenth century *bel canto* style, all the way to current

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<sup>39</sup> Robert Edwin, "From Classical to Pop: A Case Study." *Journal of Singing* 56, no. 3 (NATS, January 2000), 72.

<sup>40</sup> "Research," *Estill Voice International*.

techniques used today, the voice has been a marketable instrument. While musical styles have changed throughout the ages, the voice itself stays the same. It is the theory of performance practices and implementation of techniques that influence a change in the way we view the voice, and the way we choose to use it. There is much research in the realm of vocal science and vocal history, and both are important for proper care, use, and perspective on vocal music.

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