

Harmonizing Voices and Bodies: A Desktop Study Exploring the Integration of Physical Exercise into Voice Training Via Exercise Science Principles and Muscle Bioenergetics

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Glossary of Terms:

Physical Exercise:	A subset of physical activity, defined as any skeletal muscular movement requiring energy (World Health Organization, 2022), that is planned, repetitive and progressed in order to improve or maintain fitness of the musculature and body overall (Caspersen, Powell & Christenson, 1985). Physical exercise ranges from walking to strength training and incorporates exercise science principles to optimize results.
Physical Effort:	Also known as exertion, is the expenditure of energy during physical activity including exercise (Caspersen, Powell & Christenson, 1985). This can range from low effort with light exercise to intense and strenuous work with high energy expenditure.
Vocal Athlete:	“Individuals who use their vocal mechanism under high vocal demand conditions. Given the varied vocal and physical demands placed on current-day performers...the vocal athlete must incorporate multiple levels of fitness...in order to effectively meet industry demands and performance expectations within a competitive arena” (LeBorgne & Rosenberg, 2018, p.88)
Vocal Effort:	Is a debated and complex topic that has been described as increasing intensity of sound or straining physiologically to create sound, either at the vocal or postural level (Hunter et al., 2020). This is related to both vocal load and vocal demand. Vocal effort is not quite understood because it is not yet as quantifiable as physical or skeletal limb muscle effort (Primov-Fever et al., 2014; Sandage, Connor & Pascoe, 2013; McHenry, Johnson & Foshea, 2008).

Portfolio:

Introduction:

Physical exercise (PE) incorporation with voice instruction is an emergent field that has the possibility of aiding vocal athletes in habilitation and rehabilitation of the voice (LeBorgne & Rosenberg, 2019). There is a plethora of research (Elliot, Sundberg, & Gramming 1992; Sataloff, Sandage & Hoch 2018) on the use of exercise science principles (ESP) on the voice, but literature regarding the application of various exercise forms and the ramifications on the vocal musculature, acoustics and performance are limited due to the intrinsic nature of these small muscles (Johnson & Sandage, 2021). The training regulation, demands, and dedication required in vocal athletics share similarities with those in sports athletics (Lawrence, 2022; Branca et al., 2020; Friedlander, 2018). Because of this, our understanding of the voice and the intrinsic laryngeal skeletal muscles (ILSM) has been primarily based on studies conducted on the larger skeletal limb muscles (SLM) of the body (Sandage & Pascoe, 2010; LeBorgne & Rosenberg, 2018, 2019). While this research has provided valuable insights, it is important to recognize that the ILSM possess unique characteristics and functions. They are smaller, intricately positioned, and responsible for intricate control and coordination. Therefore, applying general exercise science principles (ESP) and training regimens to the specific intricacies may not be as readily applicable. To effectively train and care for the voice, it is necessary to consider the specific nature and requirements of these ILSM, tailoring training approaches and methodologies to their specialized functions and capabilities.

As a vocal athlete with a vast vocal and athletic background, I have noticed how general PE and fitness have positively impacted my career through increased stamina, endurance, kinesthetic awareness, and coachability. As a voice coach, I work with vocal athletes of all ages focusing on a variety of genres. Drawing from my experience, I always recommend my students to partake in comfortable PE to supplement their voice training to support their physical and mental health, however I never understood the deeper possible ramifications of these suggestions. To better understand the incorporation of the voice and exercise fields, I began studying toward my Personal Training Certificate, turned to literature and began researching to best prepare and train vocal athletes. Through previous research on voice teachers' and students' qualitative thoughts and opinions on voice and PE incorporation (Holden, 2023), I found that all student and teacher participants noticed how fitness and PE positively affect the voice, however no participants could recall literature or tactics on how to ethically and productively integrate PE into voice instruction. These themes and findings sparked this further

investigation to establish PE and voice tandem training practices focused on ESP, bioenergetics and vocal and physical health.

The incorporation of PE and ESP into voice instruction has gained significant attention in recent years, with researchers exploring the potential benefits of exercise on vocal performance and vocal health (Nesbitt, 2023). Early literature in this area predominantly focused on adapting ESP, primarily derived from limb muscles, to the context of vocal training (Heimdal et al., 2006). The understanding that voice production involves intricate coordination between the respiratory, phonatory, and resonatory systems prompted researchers to investigate the relationship between limb muscle conditioning and vocal outcomes (Freer, 2011; Johnson & Sandage, 2021). As research has progressed, there has been a growing recognition of the need to delve into the biomechanics of the ISLM, which play a crucial role in vocal production and exercise (Hoh, 2005; Leell, Newkirk & Johnson, 2019).

Due to the fact that the amalgamation of exercise and voice training is an emergent field, it is noticeable that there is no common language or common ground within literature (Hunter et al., 2020). For example, “physical exercise” and “fitness” are very broad in order to not leave out any aspects of exercise, and due to this vast definition, research can lack specificity. PE ranges from general fitness activities such as cardiovascular exercises, strength training, and flexibility exercises to more specialized techniques targeting specific aspects of muscular function (Caspersen, Powell & Christensen, 1985). In terms of this study, fitness will refer to as a vocal athlete’s competency “suitable to fulfill a specific role or task” within the industry (Oxford English Dictionary Online, 2023). PE definitions of note include aerobic physical action, typically lasting longer than 2 minutes, involving oxygen to enhance cardiovascular efficiency (Chamari & Padulo, 2015) and anaerobic physical activity without oxygen that requires quick bursts of energy over a short period of time (Chamari & Padulo, 2015). Recognizing these PE term’s oxidation requirements and biomechanical pathways is crucial to comprehending their effect on the voluntary, somatic governed skeletal limb muscles (SLM) that account for bodily movement (LeBorgne & Rosenberg, 2018) and ultimately the vocal mechanism and ILSM.

Historically, the scope of ILSM, the compact muscles responsible for airway protection, respiration and phonation, has been solely based on the knowledge of and relation to SLM (Hoh, 2005). Because of this, vocal load, vocal demand, muscle fibers and biomechanics of the ILSM have not been thoroughly researched and quantified. Hunter et. al. (2020) aimed to clarify the terms vocal load, and vocal demand, as well as vocal effort, defined above, because of their perceptivity and auditory restraints. The professional consensus was that vocal demand is the

vocal intensity requirement necessary for a specific scenario (Hunter et. al., 2020) and vocal load is the perceived vocal effort that is cyclically affected by vocal demand. Vocal load, effort and demand are all very important to avoid vocal misuse and dysfunction and because of this, it is vital to continue the conversation and research to clarify and quantify these terms (Sataloof, Sandage & Hoch, 2018).

The use and levels of exercise, ranging from ESP to PE, are a subject of debate in the field (LeBorgne & Rosenberg, 2018, 2019; Schneider, Dennehy, & Saxon, 1997).

Speech-language pathologists and voice therapists have employed ESP and motor learning principles for rehabilitation since the 1800s (Stathopoulos & Duchan, 2006), but in contrast, voice coaches have only recently started incorporating exercise science and physiology principles into vocal learning (Lawrence, 2022; Johnson & Sandage, 2021; Sandage & Pascoe, 2010). Vocally, exercise examples following the specificity and ESP such as breath support exercises, vocal warm-ups, and vocalization exercises are common. However, not fully PE, these vocal function exercises still aid in skill acquisition and adapt the ILSM (Sandnes et al., 2013). A step forward, the possible benefits of incorporating PE into voice instruction are multifactorial (Holden, 2023). Apart from enhancing vocal health and performance, regular PE has been associated with improved breath control (Ray, Trudeau & McCoy, 2018), increased lung and cardiovascular capacity (Corsi et al., 2022), enhanced body awareness, and reduced muscle tension (Sandnes, et al., 2013; Riordan, 2021; Richie, 2013; Rohrer, 2018; Nesbitt, 2023; Holden, 2023).

Vocal athletes are "multidisciplinary performers" (Morton, 2020, p.296) that require specific training to upregulate their vocal bodies to meet the demands of the industry (Chandler, 2022). With this in mind, it is vital to habilitate, and at times, rehabilitate. Habilitation is a process to attain, maintain or progress skills and functioning for daily life and rehabilitation can be seen as a restoration of skill or health after dysfunction or injury, which can then be sustained habitually (Hayton & Dimitriou, 2019). The significance of incorporating PE into voice instruction lies in its potential for both habilitation and rehabilitation purposes (LeBorgne & Rosenbergm 2019). For individuals with healthy voices, PE can serve as a preventive measure, enhancing overall vocal fitness, endurance, and stamina. On the other hand, for individuals with voice disorders or those in need of vocal rehabilitation, targeted exercise interventions can aid in restoring vocal function, reducing vocal fatigue, and improving vocal quality. Ragan (2020) and various other pedagogues, define cross-training as a regimen to create a well rounded, efficient

vocal mechanism regardless of genre and movement pattern in order to be successful in the industry.

Professional athletics often have a robust support system in place to cater to the needs of athletes (Andersen, Houlihan & Ronglan, 2015). This system includes professionals such as coaches, trainers, nutritionists, sports psychologists, and physiotherapists, who work together to optimize athletes' performance, well-being, and longevity. However, in contrast, vocal athletes often lack similar support professions that extend beyond rehabilitation (Phyland & Miles, 2019). While speech-language pathologists and voice therapists are available for vocal rehabilitation, there is a lack of dedicated professionals in areas like holistic performance coaching, vocal and body conditioning, nutrition for vocal health, and physiological support specifically tailored to the unique demands of the vocal profession (Holden, 2023). This absence of comprehensive support services limits the opportunities for vocal professionals to enhance their performance, prevent injuries, and optimize their vocal longevity. There is a need for the development of a broader support system in the vocal field to provide holistic care and guidance for vocal professionals throughout their careers.

This research is vital to understand how to train the whole body for performance, without detriment to the voice and is relevant to specifically train voice professionals on how to incorporate physical movement to benefit vocal athletes (McHenry & Evans, 2015; Roher, 2018; Lawrence, 2022). When it comes to vocal athletes, it is necessary to provide holistic instruction on how to cross-train their voice and body in order to meet the demands of the industry and role (Ragan, 2020; Chandler, 2022). In order to achieve this, it is necessary to identify and discuss the ethical constraints and muscular components of productive instruction of PE inclusion into the voice, in order to enhance the individual performer, performance and the industry as a whole (Roher, 2018). Speaking on fitness and performing exercises can be triggering for some (Gameiero et al., 2018), so an intended outcome to combat this, is understanding how to create ethical protocols that take the individuals experiences, physical needs, aspirations and consent into account before programming. This can address ethical concerns, health and physical limitations with disabilities, and even personal experiences such as body-dysmorphia or disordered eating or exercising.

PE and ESP incorporation in voice instruction holds the potential to make a significant impact on the field of vocal pedagogy and habilitation (Denizoglu & Ohron, 2021). This study aims to examine the potential ramifications of PE on the voice and performance. By synthesizing previous findings and highlighting how the existing literature has evolved over the

past 30 years, the review will provide insights into how PE can influence vocal health, vocal endurance, and overall performance, while shedding light on the anatomical, biomechanical characteristics, and PE adaptations of the ILSM. This information and advancement will guide the development of evidence-based PE methodologies to promote vocal health, reduce fatigue, and holistic teaching methods. Stemple (2005) defines holistic teaching and therapy methods as those that encompass all aspects of voice, breath, movement and mindfulness to support the multifaceted vocal body. One of the key outcomes expected from this review is the clarification of how the ILSMs adapt and respond to vocal and physical demands, and how they interact with the SLM. The findings from this study will contribute significantly as a foundation for future research and the insights gained will inform the creation of innovative and targeted PE protocols that maximize vocal potential and overall well-being of vocal athletes.

Planned Program of Study:

Intention:

The goal of this planned program is to understand how to create individualized, productive, and ethical PE regimen tailored for vocal athletes and the performance industry demands, to optimize the physical well-being and performance of individuals in the vocal arts. By recognizing the unique physical demands placed on vocal athletes and the ILSM, this study aims to justify the development of future exercise protocols that are specifically designed to address the needs of the vocal apparatus and support vocal production. By considering the physiological and biomechanical aspects of the vocal mechanism, as well as the demands of the performance industry, the research seeks to understand how exercise regimens that promote vocal health, prevent injury, enhance vocal projection, stamina, breath control, and overall performance from a holistic, body-focused perspective. Ethical considerations are integral, ensuring that the exercise protocols are safe, respectful of the individuals' autonomy, and aligned with professional standards and guidelines (Chandler, 2022; Johnson & Sandage, 2021; LeBorgne & Rosenberg, 2018, 2019; Morton, 2020; Stathopoulos & Duchan, 2006). In hopes of tailoring PE regimens to the unique needs of vocal athletes, this investigation aims to support their artistic development, prolong longevity, and contribute to the advancement of knowledge in the field of vocal performance.

Evidence-Based Developmental Foundation:

This study is proposed to fuel the research surrounding this emerging field. With the knowledge gained from this research, I hope to hypothesize and test regimented exercise protocols with vocal athletes in order to quantify and qualify ILSM characteristics and how the

exercise affects the athletes vocal quality and vocal health overtime. In order to understand how to ethically, effectively and safely engage in evidence-based, goal oriented research, it is vital to exhibit, acknowledge and synthesize relevant data to propel possible theories, specific goals and ultimately, findings through future modules (Grant, 2012).

Context:

Since I aspire to work with vocal athletes both in the studio and the gym, the information from the literature and resulting evidence-based data from this study will prove significant to ameliorate my professional knowledge and practice to impact teaching methods for vocal athletes and PE incorporation. With a holistic approach, I aim to integrate the findings from my research into the development of a comprehensive teaching program that addresses both the vocal fitness and physical fitness demands of the performance industry (Chandler, 2022). By incorporating evidence-based exercise protocols tailored to the specific needs of vocal athletes, I can design training sessions that promote vocal health, enhance vocal projection, breath control, and stamina, while also improving overall physical fitness using ESP and ILSM anatomy and knowledge of biomechanical composition. This will be similar to an athletic trainer specifying exercises for a high level sports athlete (Andersen, Houlihan & Ronglan, 2015) to promote progression through specified evidence-based comprehension. The teaching program will be developed with a strong emphasis on ethical considerations, ensuring the safety, well-being, and autonomy of the vocal athlete's physical body, as well as emotional and mental capacities. Ultimately, this evidence-based information will be refined through rigorous assessment, feedback and evaluation (Schuppli & Fraser, 2005), leading to an ethical program that will serve as a valuable resource for vocal athletes, providing them with the necessary tools and techniques to enhance performance while maintaining their vocal health.

<u>Aims</u>	<u>Objectives</u>
- Understand how ILSM bioenergetics and fiber types react to PE. - Investigate the effects of PE on the ILSM. - Examine the relationship between PE and vocal performance enhancement in vocal athletes. - Explore the potential benefits of PE in improving vocal endurance and reducing vocal fatigue among vocal athletes. - Assess the impact of PE on the strength,	- Identify and critically analyze existing literature on the effects of PE on the ILSM in vocal athletes. - Summarize and evaluate the current evidence regarding the relationship between PE and vocal performance enhancement in vocal athletes. - Identify a gap in the literature. - Review and synthesize studies investigating the impact of PE on vocal characteristics.

coordination, and control of the ILSM in vocal athletes. - Examine the optimal types and intensities of PE for maximizing vocal potential and overall well-being in vocal athletes. - Assess the potential of PE as a complementary approach to traditional voice training methods for vocal athletes. - Investigate the long-term effects of PE on vocal performance and vocal longevity in vocal athletes. - Understand how to effectively and ethically prescribe PE to vocal athletes to enhance performance.	- Evaluate the methodologies and outcomes of studies examining the effects of PE on the strength, coordination, and control of the ILSM in vocal athletes. - Assess the existing literature through comparison and contrast methods. - Examine the current evidence on the effectiveness of PE as a complementary approach to traditional voice training methods for vocal athletes. - Evaluate the long-term effects of PE on vocal performance and vocal longevity in vocal athletes based on available literature. - Organize the data in a visual aid. - Analyze the existing research on the relationship between PE and vocal technique improvement in vocal athletes. Note similarities, differences and limitations. - Synthesize findings using visual aid. - Create an action plan regarding the incorporation of PE into training regimens and its impact on their vocal abilities.
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The learning and development aims of this literature review encompass several key objectives. Firstly, the aim is to deepen understanding of the bioenergetics and musculature components of the ILSM compared to SLM by objectively identifying and synthesizing the current literature. This knowledge is crucial as it sheds light on the unique physiological characteristics of the ILSM and their role in vocal production. Understanding the energy demands, muscle fiber composition, and adaptation processes specific to the intrinsic laryngeal muscles in response to PE provides valuable insights into how vocal athletes can benefit (Røksund et al., 2014) and optimize their training modalities (Primov-Fever et al., 2013). This information aids in the development of evidence-based, targeted exercise interventions to enhance vocal performance, promote vocal health, and promote optimal vocal fitness. This research aims to deepen our understanding of the impact of PE on the ILSM and voice training for vocal athletes, ultimately informing the development of effective exercise protocols that optimize vocal performance and well-being. By using the research objectives above to provide measurable goals, evaluation and synthesis of existing studies will be completed, with narrative review methodology, on the effects of PE on the ILSM and voice training for vocal athletes.

Intended Outcomes:

Directly correlated to the aims and objectives above, the expected learning outcomes of the study are to enhance knowledge and understanding of the bioenergetics and musculature components of the intrinsic laryngeal muscles compared to skeletal limb muscles. In turn, this will contribute to a deeper comprehension of the unique physiological characteristics of the ILSM and their relevance to vocal production and adaptation to PE. By examining the existing literature and building off previous literature surrounding PE inclusion in voice training (Holden, 2023), the study seeks to identify evidence-based practices and exercise interventions that can optimize vocal performance, promote vocal health, and prevent vocal injuries. These anticipated learning outcomes will serve as a foundation for the future generation of targeted, effective, and safe PE programs for vocal athletes, to enhance performance capabilities while maintaining vocal fitness and health.

Methodology:

Due to the contemporary nature of this field, it is vital to discuss the current knowledge of the subject, which leads toward a narrative literature review (Snyder, 2019). Methodologically, narrative reviews cannot be generalized, reproduced or quantitatively devised, it is vital to create boundaries to reduce bias and protect the credibility and validity of the study (Rother, 2007). It is also imperative to focus on synthesis throughout the research process, rather than data regurgitation, which can be a pitfall for narrative reviews (Ferrari, 2015). Due to the variable evaluation of the literature, it is necessary for the researcher to consider insider research bias and ethical considerations to ensure the reliability of said synthesis and eventual findings (Winter, 2020).

When conducting a desktop-based research study, such as a narrative literature review, ethical considerations become paramount. It is essential to adhere to ethical guidelines to ensure the integrity and validity of the research. Ethical considerations include obtaining appropriate permissions to access and utilize published materials and accurately attributing credit to the original authors (Pautasso, 2019). Additionally, researchers must critically evaluate their biases and potential conflicts of interest that could influence the selection and interpretation of the literature (Winter, 2020). By employing rigorous ethical practices, the narrative literature review can maintain credibility and contribute to the advancement of knowledge in the field (Paul & Criado, 2020; Lim, 2022).

The procedure (Ferrari, 2015) of a narrative literature review in a desktop-based study involves several key steps. First, a broad research question was formulated from prior research

(Holden, 2023) to guide the review process and provide a clear focus. From there, a brainstorm map (appendix 1) was used to create search words to guide literature acquisition due to the topic's breadth of scope (Crowe & Sheppard, 2012). The list began with physical exercise and vocal athlete and extrapolated to musculature, of both the body and larynx, effort, aerobic, anaerobic, warm-up, vocal load, physicality, fitness, vocal function, body-focused and fatigue. These words, or a combination, were then imputed into the databases below to generate preliminary literature and advanced search techniques were used to ensure reputable sources and comprehensive literature (Ferrari, 2015).

Databases searched:	Search words/phrases:
Google Scholar UWTSD and The Voice Study Centre Database ASHAWire EBSCO Science Direct PubMed JStor	Physical exercise and the voice Aerobic Anaerobic Vocal Athlete Intrinsic laryngeal skeletal muscle Skeletal limb muscle Vocal load Physicality Fitness Vocal function Body-focused

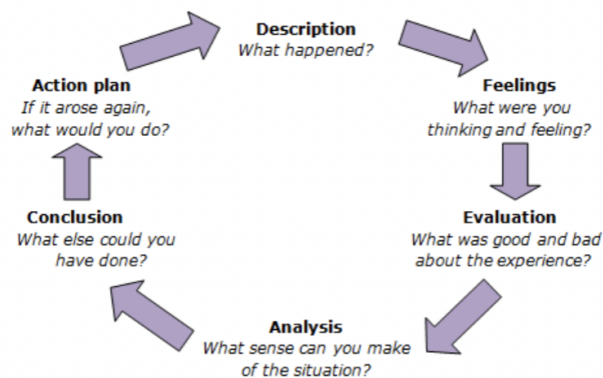
Critical evaluation is then conducted to assess the quality, relevance, and methodological rigor of the selected studies by reviewing the abstracts and study aims, procedures, and outcomes. The literature was then categorized into themes (appendix 2-3) using preliminary holistic coding methods (Saldaña, 2016) in order to organize my findings and mold my research. Deep evaluation and outline focused note taking that extracted and organized relevant information from the selected studies. Other study's references were scrutinized for any new and relevant literature to explore deeper, refine keywords and widen my research net (Lefebvre et al., 2019). After accounting all the practical literature and the note taking process, I developed a literature review map (appendix 2-3) to connect and interact with different literature (Crowe & Sheppard, 2012). This noted gaps in the literature and propelled review findings (Lim, Kumar & Ali, 2022). Using the literature review methodology, literature notes, and mind maps I fleshed out an outline to productively reflect my research process, data and findings to ensure adherence to university expectations and guidelines.

Finally, the process of refinement included revisiting the interpretations, tightening the arguments, and ensuring coherence and clarity in the narrative literature review to contribute to the existing literature (Lim, Kumar & Ali, 2022). Ultimately, I reflected on the process, both

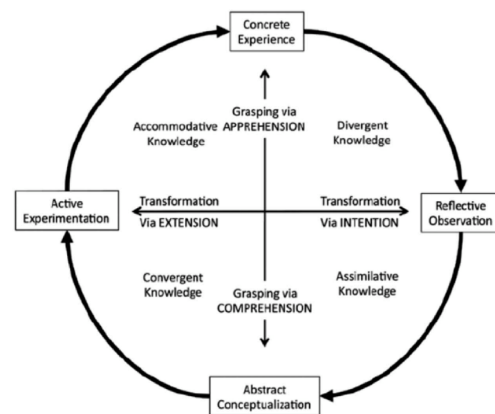
individually and from the view of the propelling field using reflective models. This reflection allowed me to brainstorm possible plans, programs and regimens to explore in future modules using the data, knowledge and experience from conducting this literature review. Below is the GANTT Chart of the process for this narrative literature review.

Critical Reflection:

Embarking on a desktop-based research project was an exciting endeavor that I eagerly anticipated to elevate my academic and instructional prowess. In this critical reflection, I will explore my personal struggles with perfectionism, procrastination, imposter syndrome, and time management, using various reflective models found in literature. By delving into my experiences, I hope to gain insights that will guide me in future endeavors. Throughout this reflection, I resonated with and found reassurance with Gibbs' Reflective Cycle (1988) and Kolb's Experiential Learning Cycle (1984), so their influence can be seen throughout my journal (appendix 4-5) organization.



Gibbs' (1988) Reflective Cycle



Kolb's Experiential Learning Cycle (1984)

Perfectionism:

Perfectionism became my constant companion throughout this project, exerting an overwhelming influence on my work (Ocampo et. al., 2019). Reflecting on this struggle through my personal journal and my slacked adherence to my Gannt chart above, I realized that I often set unrealistically high standards for myself, fearing that anything short of perfection would render my efforts meaningless. This mindset hindered my progress, as I found it difficult to move forward without scrutinizing every detail. Drawing from Gibbs' Reflective Cycle (Gibbs, 1988), I recognized the need to challenge and reframe my perfectionist tendencies, embracing the

concept of "good enough" and acknowledging that imperfection can still yield valuable outcomes. Rather than being paralyzed by the thought of imperfection, this idea and reformulation of thinking would have allowed me to make progress much sooner in the research process.

Procrastination:

Due to the perfectionistic lens I projected onto my work, procrastination lurked around every corner. Since I believed that the task I could do would not be up to par with my perfectionistic standards, I avoided them until the last minute and would productively procrastinate with trivial tasks (Ocampo et al., 2019). For example, I found myself going into too much depth in literature retrieval, assessing and organizing, rather than fully comprehending, synthesizing and furthering the information. Applying (Kolb, 1984), I realized during the reflective observation process, that procrastination was my way of avoiding the discomfort of facing challenges and the fear of failure, which in turn hindered progress overall. To overcome this obstacle, I adopted a proactive approach by breaking down the project into smaller, manageable tasks and setting realistic deadlines (Grant, 2012). Implementing these strategies gradually diminished the grip procrastination held over me. In the process, and while seeing progress, this also helped me manage my perfectionistic tendencies.

Imposter Syndrome:

Imposter syndrome emerged as an additional challenge during my research project. The persistent belief that I was not capable enough and that my achievements were a result of luck rather than skill weighed heavily on me. Recognizing the impact of imposter syndrome on my motivation and confidence, I turned to literature for guidance. Research by Clance and Imes (1978) shed light on the phenomenon of imposter syndrome and its prevalence among high-achievers. Understanding that imposter syndrome is a common experience helped me contextualize my feelings and realize that they were not indicative of my actual abilities. Engaging in positive self-talk, seeking support from mentors, and acknowledging my accomplishments gradually, all noted in my journal passages framed in the reflective practices (appendix 4-5), helped me overcome the grips of imposter syndrome. I found that the addition of a personal research journal, similar to that required from module 3, to be helpful in marking my progress and venting unproductive thoughts, which was the first step to converting that negative energy into a productive mindset that translated into my research journey. This in turn, allowed my self-talk and endeavor to be more positive and process based, rather than being driven by perfectionism.

Time management:

Time management emerged as a critical aspect of my research project. In the process of searching for literature through the references of previously read articles and studies, I found myself digging too far deep into rabbit holes, thus keeping me stuck in the literature acquisition and reading phase of my project. As I delved deeper into the literature on time management techniques, I discovered the Pomodoro Technique (Cirillo, 1997, 2018), which entails working in focused, uninterrupted bursts with short breaks in between for an allotted amount of time before an extended break. By employing this technique while focusing on larger or intricate study tasks, I found that my productivity improved significantly. I also applied Covey's Time Management Matrix (Murphy et al., 2022) to categorize tasks based on urgency and importance, allowing me to allocate my time effectively and ultimately adhere to my research timeline. Reflecting on my journey, I realized the importance of setting clear priorities and establishing a structured routine to optimize my time and energy, which led to clearer advancements.

Coming out of a very hands-on research project with the use of participants, I felt as if I were flailing without the pressures and deadlines of collecting data from subjects. I found it arduous to strictly stick to the times and progress benchmarks that I set out for myself. In previous modules I have alluded to being very reflectively negative when it comes to my practice, and I believe it stems from feelings of inadequacy fueled by a perfect or nothing mindset, which also has adverse effects on motivation and drive (Ghaye, 2011).

Conclusion:

Tackling this desktop-based research project has been a transformative journey, rife with challenges that tested my perseverance and self-discipline. Through critical reflection, I gained valuable insights into my struggles with perfectionism, procrastination, imposter syndrome, motivation, and time management. I learned to challenge my perfectionist tendencies, embrace imperfection, and acknowledge the value of "good enough." I also adopted strategies to combat procrastination and time management issues, which proved pivotal in maintaining momentum. In the future, I will utilize these strategies and create attainable goal oriented deadlines (Grant, 2012) earlier in the planning phase, rather than waiting until they become a hindrance to my research process. By incorporating these strategies to overcome obstacles, I have grown both personally and professionally to meet the aims and objectives of this study delineated above. I look forward to propelling research on the integration of PE into the voice studio, as it represents a promising avenue to enhance vocal performance, physical well-being, and mental

resilience within the field. By embracing this holistic approach, voice performers can elevate their artistry and contribute to the advancement of vocal pedagogy.

Written Assignment

Introduction and Context:

Singing fundamentally requires muscular strength and coordination of multiple body systems and can be classified as a physical activity (LeBorgne & Rosenberg, 2018). However, research on the impact of PE on the larynx is limited due to the location and size of the musculature involved (LeBorgne & Rosenberg, 2019). Chandler (2022) acknowledges the use of PE to enhance performance due to the demanding nature of performing and the significance of physical and vocal longevity, however more research is necessary to understand training methods and their ramifications. In the field of exercise science, there is a large amount of research on the SLM including bioenergetics, muscle types and applications of training protocols (Sandage & Pascoe, 2010). Using this SLM research, vocal research is continuing to uncover how ILSM relates, to better understand and train the voice (Sandage & Smith, 2016; Snell et al, 2020;). This can also give insight on how PE affects the ILSM so that vocal athletes can prepare and train the entire body for performance. As research in this field progresses, a deeper understanding of the biomechanics and physiological adaptations of the ILSM is crucial for developing targeted exercise protocols to close the gaps in the support professions surrounding vocalists (Johnson & Sandage, 2021; Archambeault & Smith, 2019). Exploring and visualizing the specific mechanisms through which PE affects vocal function will pave the way for more evidence-based and effective approaches to voice instruction, habilitation, and rehabilitation.

Overview of Aims and Outcomes:

This review's objective is to explore the existing body of research on this topic, shedding light on the article's and study's aims, outcomes, and advancements in information in order to address productive PE and voice training methods. As delineated above, a growing body of evidence suggests that PE can play a crucial role in supporting vocal function (Holden, 2023), improving breath control, enhancing stamina, and preventing vocal injuries. As a result, voice teachers, vocal pedagogues, and vocal health professionals have started to incorporate exercise regimens into their teaching methodologies, however not many understand how to fully ethically and productively do so (Holden, 2023).

In recent years, there has been a notable shift in the research focus, with studies now investigating the specific adaptations of the ILSM to PE (Røksund, 2012; Rumbach et al., 2019),

some of which include visualization of ILSM (Maat et al., 2009; Tervonen et al., 2009) through videolaryngoscopy technology. These studies, whether focusing on acoustic parameters, perceptions or visualization techniques, further research into the specific components and biomechanical composition of the ILSM. Researchers have started exploring the unique biomechanics of the ILSM and its complex interplay with various PE, and this advancement unlocks the capabilities to create a more targeted approach in designing PE programs tailored to the needs of singers, addressing both their vocal and physical demands (Reed, 2021; Denizoglu & Ohron, 2021, Adela 2021).

By reviewing the latest literature and research findings, this narrative review aims to provide an updated understanding of the benefits of incorporating PE in the voice studio. It seeks to explore the outcomes of various studies, shedding light on the specific adaptations of the ILSM to PE, and highlighting the advancements made in this field over recent years. Ultimately, this review aims to contribute to the ongoing dialogue surrounding the integration of PE as an integral component of vocal training and vocal health maintenance. In the future, the data of this study can be used in the conceptualization, refinement and application of individualized PE protocols for vocal athletes to amplify performance and revolutionize the voice industry.

Justification:

As the understanding of the vocal mechanism continues to evolve within this emerging field, it is essential to explore and ameliorate the benefits, outcomes, and advancements in information and literature related to PE to improve practice. By conducting this comprehensive review, voice teachers, vocal pedagogues, and vocal health professionals can gain a deeper evidence-based understanding of the impact of PE on vocal performance and health and appropriate approaches (Reed, 2021).

In a previous study conducted, it was found that vocal athletes believe it is beneficial to engage in various forms of physical activity in order to individually train the body for performance aspects (Holden, 2023). That being said, none of the participants understood how this PE would affect the ILSM and vocal mechanism, and also did not know how to safely incorporate it. Some participants even noted that vocal influences in their careers had suggested them to participate in PE, but never had scientific-based exercises or regimens to propose (Holden, 2023). This review is designed to shed light on these limitations and gaps by proving the need for and benefit of individualized evidence-based PE programs, following

exercise science based protocols, for vocal athletes and how the ILSM are affected on a muscular and biological level.

Extended Literature Review:

To address the gaps in and limitations of the existing literature, said literature was categorized into themes in order to interact with the data, focusing on connections and overlap. The most notable themes are: overall need for PE via ESP application and warm-up practices, biomechanical composition, laryngeal visualization, and larger scope of programming within the field. These themes intertwine and portray the progression of the field of voice and PE inclusion over the past 25 years and highlight limitations through development and counterarguments. An expected outcome of this review is to utilize and explore the existing literature, and their relation to one another, to create new ideas to further propel the field of PE and voice training practices.

Overall Need:

PE plays a crucial role in upregulating and training vocal athletes for the demands of the field (LeBorgne & Rosenberg, 2018, 2019). Vocal athletes, like athletes in other disciplines, need to maintain a high level of physical fitness to optimize their vocal performance and ensure long-term vocal health (Chandler, 2022). Friedlander (2018) notes that voice production is not limited to the vocal folds alone and a vocal athlete needs to be trained and upregulated to take on the physical demand of singing. Overall physical fitness, coordination and strength provide a stable postural foundation for efficient breath control and vocal projection (Petterson & Westgaard, 2004). Chandler (2022) and Friedlander (2018:14) note that “generations of voice professionals have warned singers against vigorous exercise.” This is due to ideas of tension hindering vocal quality, but recent pedagogues (Roher, 2018; Lawrence 2022; Nesbitt, 2023; Archambeault & Smith, 2019) are combating these claims by highlighting how PE enhances breath stamina and endurance, improves postural alignment (Sneider, Dennehy & Saxon, 1996), and releases tension (Riordan, 2021).

Effective vocal performance requires adequate breath support and control and is categorized as an aerobic activity (Sandage & Smith, 2017). McHenry & Evans (2017) sought to determine how aerobic exercise affected the vocal warm-up and noted no decrease in vocal efficiency measured by sound pressure level after aerobic exercise. The study also suggests to “encourage singers to become conditioned enough to incorporate an aerobic warm-up in their performance preparation” (696). Regular aerobic exercise, such as running or cycling, helps improve lung capacity and stamina and in turn, increases the efficiency of oxygen uptake and delivery, allowing vocal athletes to sustain longer phrases and project their voice more

effectively (Snell et al., 2020). Unfortunately, the amount of aerobic exercise is vague and its effect on vocal characteristics, such as power, is a limitation. Fortunately, a study by Rotstein, Meckel & Inbar (2004) noted a positive correlation between exercise intensity and perceived speech difficulty, heart rate and oxygen consumption. This shows that if exercise becomes labored, vocalization may suffer. These findings were furthered by Sandage, Connor & Pascoe (2013) as they found that phonation threshold pressure (PTP) increased, perceived phonatory effort (PPE) decreased, and pharyngeal temperature decreased after moderate exercise. Increased PTP is notable here because of the higher respiratory rate post exercise, but the PPE, or amount of vocal fatigue, is most interesting following exercise. This means that the exercise did not strain the vocal effort of the healthy participants and can be translated to performance demands of vocal athletes, considering they regulate their aerobic fitness.

Proper body alignment and posture are vital for optimal vocal production and is “acquired through training postural muscle groups” (Schneider, Dennehy & Saxon, 1996:332). PE, particularly exercises that promote postural alignment, such as, strength training, Pilates or yoga, can help vocal athletes develop better body awareness, alignment, and control. Chandler (2022) and Freer (2021) go into depth on the motor learning and coordination advantages of strength training. The goal of upregulating the “capacity for muscles to do the work” (Chandler, 2022:338) to meet the demands of the industry can be done through balanced, intentional and modified training. Chandler (2022) and Friedlander (2018) both extrapolate on proper training modifications to protect vocal health and longevity, for example avoiding the valsava maneuver and being cognizant of glottal closure during exercise. However, in order to get a better understanding of the modifications necessary, visualization of the larynx during exercise would prove beneficial.

A study by Lopez et al. (2020) states that “vocal training heavily relies on bodily awareness” (124) and proved that musician tailored yoga programming was beneficial as a mind-body integration method. Findings showed increased strength, endurance, and flexibility of postural muscles and even cardiovascular endurance improvements. This flexibility, strength and endurance can be proof of a balanced vocal mechanism and reduced tension, which are crucial for optimal performance and postural alignment (LeBorgne & Rosenberg, 2018). Additionally, exercises that focus on relaxation and tension release in yoga and Pilates practices can help alleviate muscle tension and promote vocal relaxation.

PE is essential for vocal athletes to upregulate and train for the demands of their field. It strengthens support muscles, enhances lung capacity and stamina, improves posture and

alignment, and reduces tension overall (Riordan, 2021). By incorporating regular PE into their routine, vocal athletes can optimize their vocal performance, maintain vocal health, and ensure longevity. Pedagogues note that while PE is beneficial for vocal athletes, it should be approached with caution and under the guidance of professionals who understand the specific demands of vocal performance (Chandler, 2022; Friedlander 2018; Lawrence, 2020). Improper technique, such as grunting or forced glottal closure, in exercise can also pose risks to vocal health. Therefore, a balanced and individualized exercise regimen, tailored to the specific needs and goals of the vocal athlete, is recommended.

Exercise Science Principles (ESP):

ESP play a vital role in vocal training for vocal athletes (Johnson & Sandage, 2021; Sandage & Pascoe, 2010). By integrating these principles into their training regimen, vocal athletes can optimize their vocal performance, and enhance vocal health. ESP provide a scientific understanding and regulation of the physiological mechanisms involved in vocal production. Since the laryngeal musculature has similarities to the musculoskeletal structure (Sandage & Pascoe, 2010), most assume that the effects of PE on the larynx are congruent, without scientific evidence (Sataloff, Sandage & Hoch, 2018). The differences between muscle fibre composition are starting to be explored to provide insight on how ESP and PE can be safely and sustainably integrated into voice instruction (Sataloff, Sandage & Hoch, 2018; Johnson & Sandage, 2021; Sandage & Pascoe, 2010; LeBorgne & Rosenberg, 2018; 2019; Lawrence, 2022; Hoh, 2005; Stathopoulos & Dunchan, 2006; Tellis et al., 2004). This will be discussed in depth in the biomechanical component theme.

The main connection between ESP and the voice lies in motor learning through skill acquisition, which has been widely accepted for the past 30 years (Ragan, 2020; Lawrence, 2022; Schneider, Dennehy, & Saxon, 1997). Chandler (2022) highlights the shared use of ESP in athletics and singing enables coordination and develops and strengthens stamina and longevity in performers. Pedagogues who utilize ESP in training vocal athletes aim to optimize a strong, stable, balanced, and efficient vocal mechanism (LeBorgne & Rosenberg, 2018).

The ESP of specificity, also known as specific adaptations to imposed demand (SAID), is closely tied to the use of ESP in voice instruction and PE (LeBorgne & Rosenberg, 2018, 2019). This principle suggests that the body will adapt to the specific demands placed upon it during training (Sandage & Pascoe, 2010). The use of specific exercises tailored to the demands of singing can promote muscular strength, coordination, and endurance, aligning with the SAID ESP to enhance vocal performance. Therefore, the integration of ESP and the specificity

principle of SAID into voice instruction can provide targeted and effective training, allowing performers to develop and maintain a resilient and skilled voice (Stemple, 2005). Further research in this area is necessary to establish the precise impact of exercise on the ILSM and to enhance our understanding of the potential benefits of exercise in vocal training.

The understanding of how ESP, including skill acquisition and SAID, can target and stimulate relevant muscles for voice production, as well as coordinating the vocal body will allow vocal athletes and their trainers to develop targeted exercises that promote optimal vocal technique, function and performance (Hoch & Sandage, 2017). ESP, such as specificity, overload, progression, and individualization, have been used to guide vocal training programs, but data on habilitating singers is lacking (Sandage & Pascoe, 2010). It is proposed that future research take place to deepen ESP knowledge and translation to voice. However, it is noted that understanding ESP is crucial for designing effective warm-up strategies for vocal athletes (Hoch & Sandage, 2017). Principles such as SAID and overload can be applied to vocal warm-ups through skill acquisition and motor learning principles.

Warm-ups:

Encompassing both PE and ESP, the debated subsects of warm-ups for vocal athletes is a topic of interest within the field of vocal training (McHenry, Johnson & Foshea, 2009; Gish et al., 2012; McHenry & Evans, 2016). ESP and PE can help inform warm-up strategies to ensure the body and voice are ready to take on work. Traditional vocal warm-ups typically focus on vocal exercises aimed at gently preparing the vocal apparatus for performance (Duke, 2014). These warm-ups involve exercises that target breath control, vocal range, resonance, and vocal flexibility. Proponents argue that vocal warm-ups provide a direct and specific preparation for the vocal demands, relying on the ESP of SAID, enabling singers to fine-tune their vocal coordination and control.

Combined warm-ups integrate both physical and vocal exercises to prepare the entire body for vocal performance (McHenry & Evans, 2016; McHenry, Johnson & Foshea, 2009). These warm-ups acknowledge the interconnectedness of physical and vocal aspects, emphasizing the importance of overall body conditioning, posture, breath support, and muscle engagement. By incorporating exercises from various disciplines, such as yoga, Pilates, or functional movement, combined warm-ups aim to enhance body awareness, overall physical fitness, and breath management. Advocates suggest that integrating PE can improve vocal support, stability, and overall performance quality (Gish et al., 2012).

It is interesting to note that semi-occluded vocal tract exercises are commonly used warm-up techniques (Duke, 2014). These exercises increase back pressure and resistance, leading to improved vocal fold coordination, breath control, and vocal resonance. Many vocal athletes perceive these exercises positively, as they often report a sense of ease, vocal release, and improved vocal quality after incorporating them into their warm-up routines (Duke, 2012). This can be related to PE by its specific resistance training aspects for muscle adaptation, however more research must be completed on a biological level to prove this.

As noted prior, McHenry & Evans (2016) used warm-up methods incorporating aerobic exercises and noticed that combined warm-up strategies can enhance vocal fitness and respiratory efficiency. While some vocal athletes appreciate the positive effects of aerobic warm-ups on their overall physical readiness, Gish et al. (2012) noted that others may have concerns about potential vocal fatigue or breathlessness resulting from these exercises, so they avoid combined and aerobic warm-up methods.

Perceptions surrounding traditional versus combined warm-ups vary among vocal athletes, vocal coaches, and researchers (McHenry & Evans, 2016; Cook-Cunningham & Grady, 2017). Some argue that traditional vocal warm-ups provide a focused and specific preparation for vocal performance, while others support combined warm-ups, highlighting the benefits of integrating PE to enhance overall physical fitness and breath management. Either way, ESP plays a major role in the warm-up practices and skill acquisition of vocal training and should be further explored on a biological and anatomical level through the use of PE.

Bioenergetic Components of ILSM:

The bioenergetic composition is known as the conversion of energy into action (Denizoglu & Ohron, 2021) and is variable by fiber types, energy usage, and adaptation of the ILSM. This is necessary to understand how to effectively and ethically train the vocal athlete for the intricate and coordinated patterns necessary for voice production (Sandage & Smith, 2017). Highlighting the energy requirements and adaptations of these muscle systems allow vocal professionals to develop targeted training strategies to optimize vocal performance, prevent fatigue and promote vocal health. As previously mentioned, until recently, literature on muscle regulation was strictly based on SLM understanding and data. Although they differ anatomically, the SLM and ILSM do share some fundamental characteristics regarding bioenergetics and muscle fiber types (Sandage & Pascoe, 2010).

The understanding of the bioenergetic composition and training implications of the ILSM has evolved significantly over time (Tervonen et al., 2009; Røksund et al., 2014; Lenell, Newkirk

& Johnson, 2019). Advancements in muscle fiber typing techniques, metabolic profiling, and functional imaging have contributed to a deeper comprehension of the physiological characteristics and requirements of these unique muscles. Such knowledge has paved the way for more effective training methodologies and vocal therapy approaches (Naito; 2000; Yamaguchi et al., 1993; Snell et al., 2000). The bioenergetic composition of the ILSM is crucial for vocal athletes, as it directly influences their performance and vocal health (Smeltzer, 2017). By understanding the unique energy demands and fiber types of these muscles, coaches and trainers can optimize vocal stamina, endurance, and control. This knowledge allows for better programming and management of vocal athletes, helping them achieve their maximum potential while minimizing the risk of vocal strain and injury.

The bioenergetic demands of the ILSM differ from those of SLM due to their specialized function (Tellis et al., 2004). Vocalization requires precise and controlled movements, which necessitate continuous energy supply without significant fatigue. Therefore, these muscles predominantly rely on aerobic metabolism, utilizing oxidative phosphorylation to generate ATP (Sandage & Smith, 2016). The ILSM predominantly consist of type I, slow-twitch oxidative, and type IIa, fast-twitch oxidative-glycolytic muscle fibers (LeBorgne & Rosenberg, 2019; Sandage & Smith, 2017). Type I fibers possess high endurance and are suited for sustained contractions, while type IIa fibers provide a balance between endurance and quick force generation (Johnson & Sandage, 2021). Similar to SLM, the ILSM can undergo adaptations in response to training and ESP. These adaptations enhance energy production and utilization, resulting in improved endurance, upregulation of musculature and overall vocal performance (Denizoglu & Orhon, 2021).

A recent study by Snell et al. (2020) aimed at quantifying vocal power to identify vocal fitness necessary for demanding vocal tasks, similar to that of an anaerobic power test commonly used in exercise science. They concluded that the ability to quantify vocal power is a possible vocal fitness assessment and that ILSM muscle fiber compositions can be inferred from such performance tasks. They suggest these findings should be connected with emerging literature on bioenergetic pathways for ILSM to create holistic voice assessment protocols. Snell et al. (2020) concluded that vocal performance tasks can be utilized to infer muscle fiber components within an individual larynx. For this example it is important to note that type II muscle fibers rely mainly on anaerobic sources for muscle fuel. Knowing this, vocal function tasks that recruit type II muscle fibers can be identified during an anaerobic or resistance task.

This finding opens up possibilities for future voice assessment protocols to better comprehend the bioenergetic pathways and fiber components of the ILSM.

Interestingly, similar to SLM, ILSM of cadaver subjects show variability in percentages of type I and type IIa muscle fiber types between individuals (Rosenfield et al., 1982; Shiotani et al., 1999). This is proposed to be the culprit of varying native ability for vocal power (Johnson & Sandage, 2019) by having a higher perceived percentage of type IIa muscle fiber, also known as the power and speed variable in anaerobic power assessment (Snell et al., 2020).

Unfortunately the study carried out by Snell et al. (2020) is limited because vocal power is not solely dependent on the muscle fibers present, but also variable with the respiratory system. It would be interesting to research in tandem with respiratory muscle training proposed by (Johnson & Sandage, 2021), in order to gain a comprehensive scope of how muscle fiber typing affects vocal characteristics. This knowledge can be useful in cross training protocols for vocal athletes by playing to their individual, native strengths based on muscle fiber type percentages and the use of ESP.

The bioenergetic composition of the ILSM demonstrates unique characteristics that differ from SLM and by understanding the muscle fiber types, energy usage and adaptation, allows for appropriate and productive training strategies for vocal athletes (LeBorgne & Rosenberg, 2018). By incorporating this knowledge into training and programming, vocal athletes can gain an overarching idea of their vocal mechanism composition, enhance their performance, improve endurance, and maintain optimal vocal health. Ongoing research and advancements in this field will continue to refine training methodologies, benefitting the vocal athletic community and teaching methods to come.

Studies With Laryngeal View:

Visualizing the intrinsic laryngeal musculature during exercise provides valuable insights into the biomechanics and function of these muscles and the voice therapy in general, however it is not an easy task (Heimdal et al., 2006). Video laryngoscopy has emerged as a valuable diagnostic tool for visualizing the intrinsic laryngeal musculature while performing specific tasks. Heimdal et al's (2006) Continuous Laryngoscopy Exercise Test (CLE test) is used to assess the larynx via a trans-nasal laryngoscopy that captures real-time images and videos of the laryngeal structures during specific activities such as exercise (Røksund et al., 2014; Røksund, 2012; Maat et al., 2009). This technique provides detailed visualization of muscle activation patterns, movement coordination, and potential abnormalities, aiding in the assessment of vocal

performance and overall laryngeal health, but also comes with ethical restraints (Heimdal et al., 2006).

Heimdal et al. (2006:56) noted that the CTE test was “possible, feasible and well tolerated,” but that may not relate to healthy subjects. The studies of Tervonen et al. (2009), Maat et al. study, Røksund (2012), Røksund et al. (2014) and Heimdal et al (2006) used the CTE testing to visualize the larynx in real time on subjects experiencing vocal disorders. Due to the nature of the studies, the participants consented to CTE testing for diagnostic and treatment purposes. Unfortunately, although the laryngeal visualization method would be useful, ethical constraints of performing similar testing on healthy voices to strictly observe PE may be an ethical stretch. The limitations of the rarity and expense of the equipment should also be noted.

Visualizing the intrinsic laryngeal musculature during various exercises could be a pivotal tool for designing effective programming and training regimens for vocal athletes, but with ethical considerations for healthy vocalists and future research, it is possible. By observing muscle activation patterns and movement dynamics, coaches and trainers could tailor exercises to target specific muscles, improve coordination, and optimize vocal performance (Chandler, 2022). Real-time visual feedback can enhance the athlete's understanding of proper technique and aid in avoiding vocal strain or injury. It would be interesting to connect this to PE methods and specific strength training exercise form refinement.

In summary, visualization methods, such as the CTE test, have become a key tool in advancing research on the ILSM during exercise of subjects with diagnosed dysfunction. By overcoming previous limitations and offering direct observations, these methods enable researchers to explore complex phenomena, refine existing theories, and develop evidence-based interventions. The newfound knowledge obtained from these visualization techniques has the potential to revolutionize the field and contribute significantly to the understanding and management of vocal performance and vocal pathologies. Ethical considerations remain crucial in choosing appropriate visualization methods, prioritizing subject safety and informed consent.

Larger Scope of Programming:

Holistic, individual, evidence-based PE and voice training programming offer numerous benefits for vocalists and exercise professionals who experience voice disorders (Dallaston & Rumbach, 2015; Fontan et al., 2017). This approach to programming takes into account the interconnectedness of the body and voice, addressing the physical, physiological, and psychological aspects of vocal health. By combining PE and voice training, individuals can

enhance their vocal capabilities, improve vocal endurance, and prevent or manage voice-related conditions (Branca et al, 2020; Archambeault & Smith; 2019; Tellis et al., 2004; Doust & Patrick, 1981).

One of the primary advantages of a holistic approach is its focus on the individual (Stemple, 2005). Each person's voice and physical condition is unique, and tailoring exercise and voice training programs to their specific needs, biomechanic composition, fitness and experience allows for targeted interventions. By assessing the individual's strengths, weaknesses, and specific scenarios, professionals can develop personalized programs that address their specific challenges and goals (Grant, 2012).

Evidence-based practices ensure that interventions are rooted in scientific research (Grant, 2012), promoting effective and safe strategies for vocalists and exercise professionals with voice disorders. Through evidence-based programming, practitioners can rely on established protocols, techniques, and interventions that have demonstrated positive outcomes in previous studies. Collaboration between vocalists, exercise professionals, speech-language pathologists, and other healthcare providers is crucial for successful management of the vocal athlete (Archambeault & Smith, 2019; Denizoglu & Orhon, 2021). The larger scope of the field encompasses multidisciplinary teams that work together to provide comprehensive care. Vocalists benefit from a collaborative approach by receiving specialized assessments, exercise prescriptions, vocal techniques, and counseling, all tailored to their unique needs. Exercise professionals also benefit from collaboration by gaining a deeper understanding of voice disorders and how to modify exercise programming to support vocal health (Fontan et al., 2017; Dallaston & Rumbach, 2015).

In summary, holistic, individual, evidence-based physical exercise and voice training programming offer significant advantages for vocalists and exercise professionals with voice disorders. By considering the whole person, tailoring interventions, and incorporating collaboration across disciplines, professionals can help individuals improve their vocal abilities, manage voice disorders, and optimize overall vocal health.

Impact/Conclusion:

Looking ahead, I envision incorporating PE into the voice studio as a powerful strategy that will positively impact the field. Engaging in regular physical activity enhances cardiovascular health, endurance, stamina, increases lung capacity, improves muscular strength and postural alignment, and promotes overall well-being (Roy, Trudeau & McCoy, 2017). By integrating

exercise routines into voice training sessions, vocal performers can explore their full vocal body instrument, ultimately leading to improved vocal performance.

Understanding the biomechanical composition of the ILSM through research and voice assessment techniques provides valuable insights into muscle activation patterns, coordination, and potential abnormalities during exercise for when visualization is not manageable or ethical (Sandage & Smith, 2021). This knowledge allows coaches, trainers, and researchers to design and refine ethical programming methods that optimize vocal performance without compromising vocal health. Visualizing the larynx during exercise through CTE testing has the opportunity to play a vital role in fine-tuning exercises and techniques, and minimizing the risk of injury (Heimdal et al., 2006), however ethical constraints need to be discussed.

Moreover, introducing PE within the voice studio setting promotes a holistic approach to vocal training (Adela, 2021; Reed, 2021). By addressing both the physical and artistic aspects of singing, performers can develop a well-rounded skill set that encompasses technical proficiency, artistic expression, and physical fitness (Ragan, 2020). This integration aligns with the evolving understanding of voice training as a multidimensional discipline that encompasses mind, body, and voice (Lopez et al., 2020). To implement this strategy effectively, voice instructors should collaborate with fitness professionals to productively incorporate exercises specifically tailored to vocalists' needs in an evidence-based manner (Chandler, 2022; Friedlander, 2018).

Furthermore, the integration of PE through use of holistic programming, ESP, biomechanical understanding of the ILSM, and possible future visualization of the larynx during exercise holds immense potential for vocal athletes and the broader field of vocal performance (LeBorgne & Rosenberg, 2019; Friedlander, 2018; Chandler, 2022). This comprehensive approach addresses the unique needs of vocal athletes on individual and industry levels, enhances performance, and mitigates vocal health risks. Moreover, it tackles industry-wide challenges faced by both vocalists and exercise professionals (Dallaston & Rumbach, 2015; Fontan et al., 2017; Heidel & Torgerson, 1993; Rumbach, 2013; Newman & Kersner, 1998), creating opportunities for improvement and growth. However, more research and ethical consideration is needed to visualize the larynx during exercise of healthy participants to establish a consensus on the best programming methods and definitions for integrating the voice and exercise fields.

The impact of integrated programming extends beyond individual vocal athletes. Exercise professionals, who often suffer from vocal disorders resulting from misuse, can benefit from the applied biomechanical understanding and programming techniques designed to restore

and improve their vocal health through professional support (Archambeault & Smith, 2019; Dallaston & Rumbach, 2015). By integrating the voice and exercise fields, professionals can work towards defining best practices, establishing ethical visualization methods, and fostering collaboration to improve the overall well-being of vocalists and exercise professionals alike.

In conclusion, there is a clear need for PE, holistic programming for vocal athletes, supported by ESP, biomechanical understanding of the ILSM, and visualization of the larynx during exercise. This integrated approach enhances performance on an individual level by improving stamina, endurance, strength, and vocal technique. Moreover, it addresses industry-wide challenges faced by vocalists and exercise professionals, offering solutions to vocal health issues and promoting collaboration. Further research is necessary to ethically visualize the larynx during exercise and establish consensus on the best programming methods and definitions for the integration of the voice and exercise fields. By pursuing these advancements, we can unlock the full potential of vocal athletes and pave the way for a healthier and more productive future in the intersection of voice and exercise.

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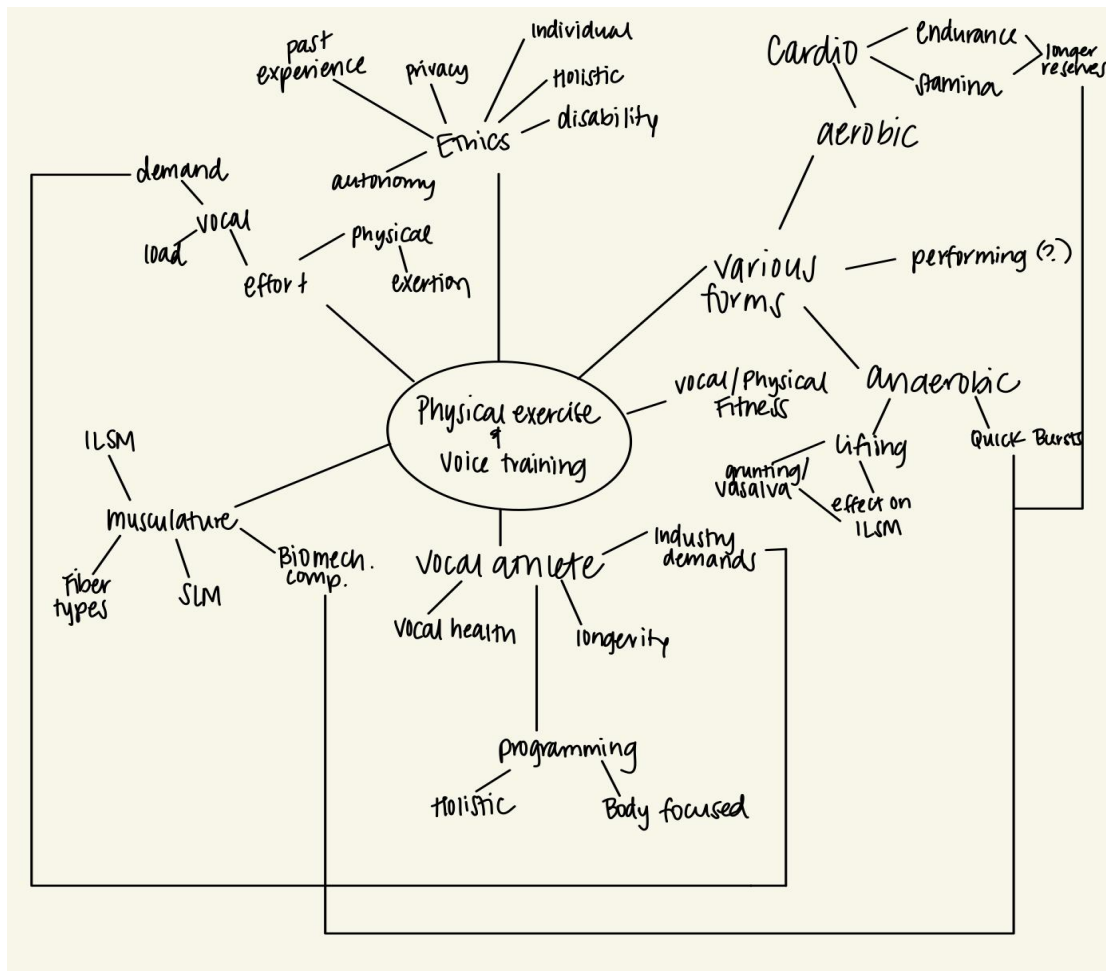
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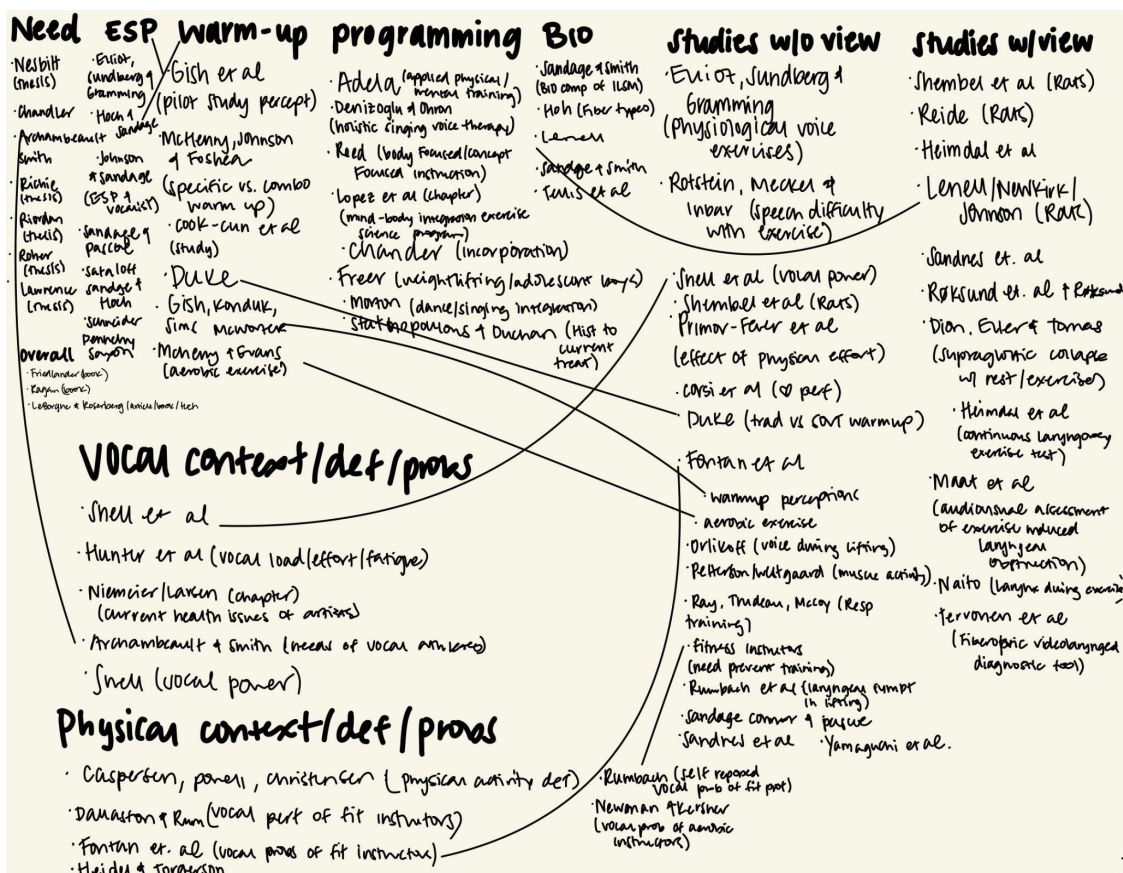
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Appendices

Appendix 1: Keyword Mind Map



Appendix 3: Themes and Corresponding Literature Draft



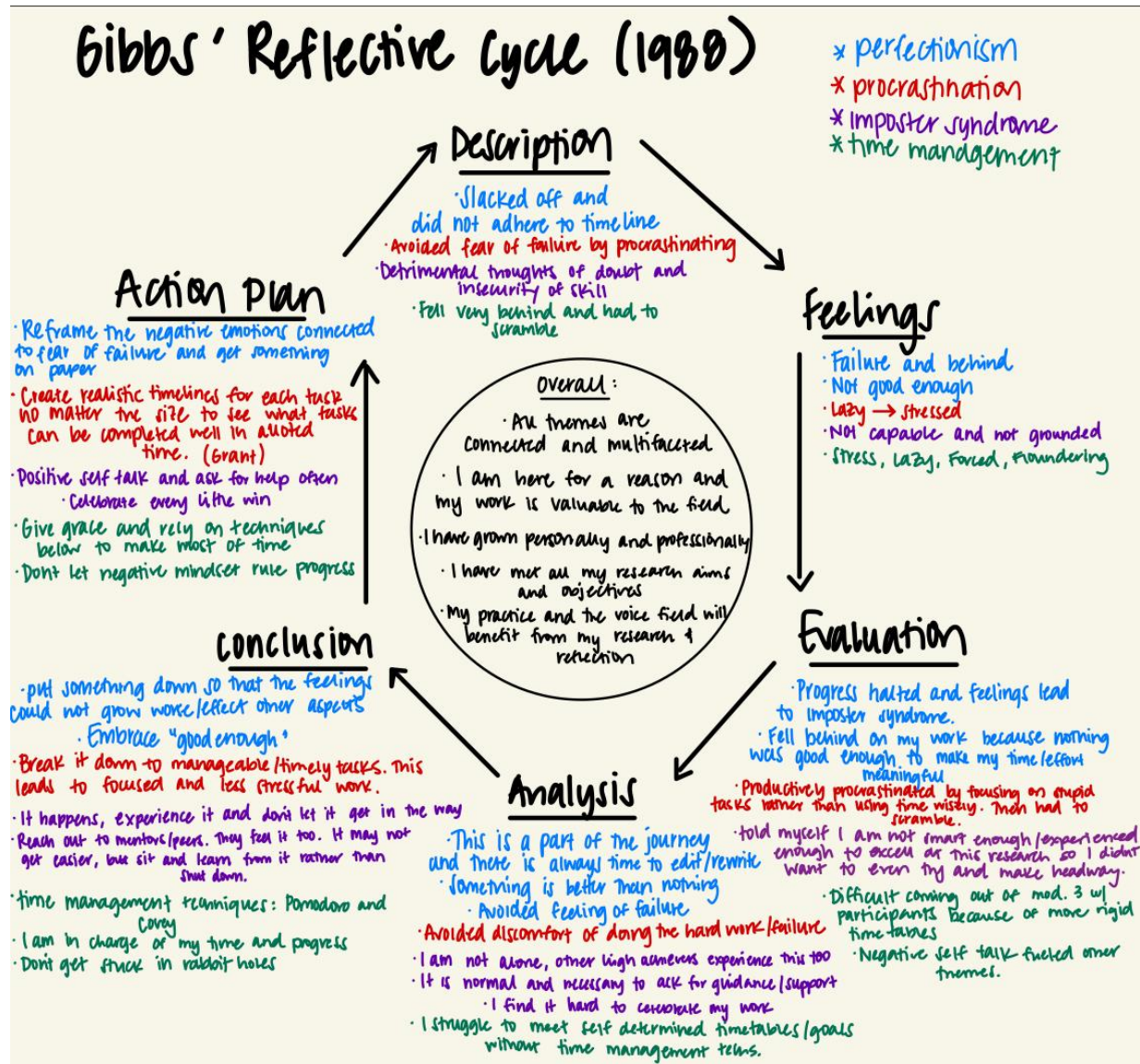
Appendix 4: Legible Copy

Overall Need for PE:	Exercise Science Principles:	Warm-Up:	Vocal and Physical Context, Definitions, and Problems:	Biomechanical Composition:
- Friedlander (2018) - Ragan (2020) - LeBorgne & Rosenberg (2018, 2019) - Nesbitt (2023) - Chandler (2022) - Archambeault & Smith (2019) - Richie (2011) - Riordan (2021) - Roher (2018) - Lawrence (2022)	- Elliot, Sundberg & Gramming (1992) - Hoch & Sandage (2017) - Johnson & Sandage (2021) - Sandage & Pascoe (2010) - Sataloff, Sandage & Hoch (2018) - Schneider, Dennehy & Saxon	- Gish et al. - McHenry, Johnson & Foshea (2009) - Cook - Cunningham & Grady (2017) - Duke (2014) - McHenry & Evans (2016)	- Hunter et al. (2020) - Branca, Marella & Mascherini (2020) - Corsi, Orlandi, Bini & Stefani (2022) - Archambeault & Smith (2019) - Snell (2020) - Snell et al. (2020) - Tellis et al.	- Sandage & Smith - Hoh (2005) - Lenell, Newkirk & Johnson (2019) - Sandage & Smith (2017) - Tellis et al. - Heimdal et al. (2006)

	(1997)		(2004) - Caspersen, Powell & Christensen (1985) - Doust & Patrick (1981) - Dallaston & Rumbach (2015) - Fontan et al. (2017) - Heidel & Torgerson (1993) - Rumbach (2013) - Newman & Kersner (1998)	
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Studies without Laryngeal View:	Studies with Laryngeal View:	Programming:	Larger Scope:
- Elliot, Sundberg & Gramming (1992) - Rotstein, Meckel & Inbar (2004) - Snell et al. (2020) - Primov-Fever et al. (2013) - Fontan et al. (2017) - Gish, Konduk, Sims & McWorter (2012) - McHenry & Evans (2016) - Orlikoff (2008) - Pettersson & Westgaard (2004) - Ray Trudeau & McCoy (2018) - Rumbach et al. (2019) - Sandage, Connor & Pascoe (2013) - Sandnes et al. (2013) - Yamaguchi et al. (1993)	- Reide (2011) - Heimdahl et al. (2006) - Lenell, Newkirk & Johnson (2019) - Sandnes et al. - Røksund et al. (2014) - Røksund (2012) - Dion, Eller & Thomas (2012) - Heimdahl et al. - Maat et al. (2009) - Naito (2000) - Tervonen et al. (2009)	- Adela (2021) - Denizoglu & Ohron (2021) - Reed (2021) - Lopez et al. (2020) - Chandler (2022) - Freer (2011) - Morton (2020) - Stathopoulos & Duchan (2006)	- All literature ties in here, but important to note the literature on vocal problems within fitness professionals: - Dallaston & Rumbach (2015) - Fontan et al. (2017) - Heidel & Torgerson (1993) - Rumbach (2013) - Newman & Kersner (1998)

Appendix 4: Reflective Journal Excerpt



Appendix 5: Reflective Journal Excerpt

