ABSTRACT

Title of Dissertation: THE EFFECT OF ATTENTIONAL FOCUS ON SINGING: AN INTERDISCIPLINARY MODEL TOWARDS THE EXPERIMENTAL INVESTIGATION OF SINGING PEDAGOGY

Michael Mentzel, Doctor of Musical Arts, 2016

Dissertation directed by: Professor Carmen Balthrop, School of Music

Instructional methods employed by teachers of singing are mostly drawn from personal experience, personal reflections, and methods encountered in their own voice training (Welch & Howard, 2005). Even in Academia, singing pedagogy is one of the few disciplines in which research of teaching/learning practice efficacy has not been established (Crocco, et al., 2016). This dissertation argues the reason for this deficit is a lack of operationalization of constructs in singing, which, to date has not been undertaken. The researcher addresses issues of paradigm, epistemology, and methodology to suggest an appropriate model of experimental research towards the assessment of teaching/learning practice efficacy. A study was conducted adapting attentional focus research methodologies to test the effect of attentional focus on singing voice quality in adult novice singers. Based on previous attentional focus studies, it was hypothesized that external focus conditions would result in superior singing voice quality than internal focus conditions. While the hypothesis was partially supported by the data, the researcher welcomed refinement of the suggested research model. It is hoped that new research methodologies will emerge to investigate singing phenomena, yielding data that may be used towards the development of evidence-based frameworks for singing training.

THE EFFECT OF ATTENTIONAL FOCUS ON SINGING VOICE QUALITY: TOWARDS THE INTERDISCIPLINARY EXPERIMENTAL INVESTIGATION OF SINGING PEDAGOGY

by

Michael Mentzel

Dissertation submitted to the Faculty of the Graduate School of the
University of Maryland, College Park, in partial fulfillment
of the requirements for the degree of
Doctor of Musical Arts
2016

Advisory Committee:
Professor Carmen Balthrop, Chair
Professor Michael P. Hewitt
Professor Seppo Iso-Ahola
Professor Marcia Marinelli
Associate Professor Janet Montgomery

DEDICATION

To Steve, without whom this could have never been possible.

To Joy, Robert, and Julian, my raisons d'être.

ACKNOWLEDGMENTS

I heartily thank my brilliant dissertation committee – Professor Michael P. Hewitt; Professor Seppo Iso-Ahola; Professor Marcia Marinelli; Professor Janet Montgomery; and especially my advisor, Professor Carmen Balthrop – for believing in me, and for their gracious support and encouragement. Thanks to Dr. Stephen Wendel and to Md. Ismail Hossain for their assistance in data analysis, and to Christopher Heffner, for his assistance in acoustic analysis.

Table of Contents

List of Tables

List of Figures

Chapter 1: Introduction

> Of all the performance arts, the art of singing is the most complex. Its preparation and its practices are fraught with controversy. Tonal ideas vary. Techniques for producing those sounds abound. A survey of viewpoints found within the vocal pedagogy literature bewilders. (Miller, 2011)

Singing is a complex, dynamic, multi-dimensional voluntary behavior that requires the integration of multiple motor, perceptual, and cognitive functions (Pfordrescher, 2015). Because it involves so many facets, a thorough investigation of this phenomenon would necessarily lead one to extra-musical disciplines. Singing is relevant to such wide-ranging disciplines as otolaryngology, music therapy, cognitive science, psychology, and speech-language pathology, to name only a few.

Not surprisingly, the teaching and learning of skilled singing introduce even more complexity, bringing up issues of motor learning, skill acquisition, and the nature of so-called talent. Because very little systematic, theoretically-founded documentation of singing pedagogy exists (Himonides, 2009), any investigation of current practices must rely on inferences and anecdotal evidence. The few available data suggest substantial variability exists among its practitioners (Callahan, 1998; Burwell, 2006; Crocco, 2016). Instructional methods employed by singing teachers are mostly drawn from personal experience, personal reflections, and methods encountered in their own voice training (Welch & Howard, 2005).

The Singing Lesson

The typical singing lesson is a one-on-one meeting of voice teacher and student occurring one hour per week. This format is usually the same regardless of age, skill level, or context (e.g. academic/conservatory, private voice studio, etc.). The singing lesson is usually iterative in nature, encouraging and responding to elements of singing behavior, such as focus melodic fragments, phrases, or complete songs (Welch & Howard, 2005). The teacher may indicate the vocal tasks by playing a pattern of notes on the piano, singing the pattern, a combination of both, or simply requesting that a certain song be sung. The student would then attempt to sing the task, after which the teacher would provide some kind of feedback, followed by subsequent attempts. If the student fails to successfully perform the task, the teacher would be obliged to diagnose the nature of the failing and prescribe adjustments necessary to correct the problem.

The Problem in Context

When a student continually fails to execute desired singing behavior despite multiple interventions, the teacher is left to surmise the nature of the problem. Has the student reached the limit of her ability? Has she practiced poorly, or not frequently enough? Is the problem related to a cognitive impairment (e.g., a misunderstanding of directions or expectations)? Do the student's self-beliefs mitigate her singing performance? Is a medical or psychological pathology contributing to the problem?

Poor performance may indeed be the result of student deficiency. It may, however, be the result of ineffective instruction. Or, perhaps more likely, it may be some combination of both or other factors. Without objective means to answer these questions, vocal pedagogues are at great risk of incorrectly diagnosing vocal faults. For example, the teacher may decide that a particular student simply lacks the requisite "talent" for singing and assure her that further attempts to acquire singing skill would be in vain, when in reality, one of the afore-mentioned factors could be the root cause of the student's lack of progress. Because of the tremendous import of the applied voice instructor/voice student relationship on the future of the student, such misdiagnoses would likely inform a student's decision on whether or not to pursue a professional singing career.

The Problem

The underlying problem is the absence of standards of good voice teaching practices in the field of vocal pedagogy. As we will see in the next chapter, such standards should be grounded in a robust body of scientific research, as in the fields of education and the movement sciences. A thorough examination of the literature will reveal that very few studies have been carried out to investigate the efficacy of teaching/learning practices. A recent systematic review of peer-reviewed studies involving teaching/learning practices in classical singing training found only nine such studies to exist (Crocco, et al., 2016). Of the nine studies, the overall quality was found to be low, and none developed an evidence-based framework for singing training (Crocco, et al., 2016).

The fundamental barrier to the development of evidenced-based frameworks for voice teaching is the lack of experimental research on the efficacy of teaching/learning practices. The lack of research, in turn, is due to a lack of clear operationalization of variable germane to singing, leaving critical methodological questions unanswered.

This dissertation will construct a theoretical framework upon which the subsequent research study will be built. Using an Interdisciplinary approach, the case will be made for the applicability of research from the field of motor learning to assessing the efficacy of teaching/learning practices.

Singing Voice Quality

In the historical singing literature, the closest thing to a conceptual definition of ideal singing voice quality is the term bel canto, which in Italian literally means "beautiful singing." This term is widely used in the classical singing discipline to connote an ideal manner of singing, yet it is also used to describe various "golden ages" of singing and multiple stylistic idioms, and there is no universal agreement. Stark (2003) defines bel canto as "a [type of] singing in which the glottal source, the vocal tract, and the respiratory system interact in such a way as to create the qualities of chiaroscuro, appoggio, register equalization, malleability of pitch and intensity, and a pleasing vibrato."

Classification of Singing

Singing can be classified in diverse ways. It is at once a motor behavior, a musical endeavor, and a means of communication between human beings, to name only a few. It is important to avoid conflating the elements of one aspect of singing with another. To understand how various aspects of singing can be conflated, consider the case of what was once called "tone deafness." Data from numerous studies suggest that poor-pitch singing (the inability to accurately match target pitches) is not merely a fault in hearing (i.e., pitch perception), but can also be related to memory and/or problems in motor coordination (reference, 2000). If a music teacher were to focus only on the auditory skills of a poor pitch student when in actuality the fault was related to memory, the student would not likely improve. If such errors in the pedagogical praxis of singing are to be avoided, the singing phenomenon must be carefully operationalized.

Attentional Focus Research

For nearly two decades, research investigating the effect of attentional focus on performance has been done within the field of motor learning. This research has yielded a robust body of data showing that the adoption of an *external attentional focus* (EAF) leads to superior performance compared to that resulting from the adoption of an *internal attentional focus* (IAF, Wolf, 2013). An *external attentional focus* directs attention to the *effect* of the movements (e.g., getting a ball to a particular place on the field), while an *internal attentional focus* directs attention to the parts of the body involved in the movement required to carry out an action, e.g., bringing the arm across the body, keeping the elbow down, etc. (Wulf, 2013). McNevin, Sheas, and Wulf (2003) posited the *constrained action hypothesis* to explain these effects of attention on performance. This hypothesis holds that an external attentional focus facilitates motor performance by promoting automatic control of movements, while an internal attentional focus disrupts this automatic control in lieu of a conscious, manual control of movements. The implications for teachers of motor activities are clear: instructions that direct a learner's attention to the movement's effect should be preferred to those that direct attention to movement mechanics. It is unclear whether or to what extent these findings are applicable to singing. Data from Atkins and Duke's 2013 study of attentional focus on singing seem to further support the *constrained action hypothesis*, yet in the face of questions regarding the scientific study of singing, the authors have called for further investigation.

Singing "Talent"

The question of whether skilled singing requires natural "talent" has not yet been answered conclusively by scientific research. Writings from the historic vocal pedagogy literature suggest that anyone capable of speech is equally capable of skilled singing. These writings mostly consist of personal memoirs and singing manifestos, and as such tend to rely heavily on subjective terminology, which can cause confusion as to the precise meaning (Stark, 2003). One interpretation of passages that seemingly suggest that singing skill is ubiquitous is that all humans who possess the capacity for speech are inherently capable of achieving the sensorimotor coordination associated with highly skilled singing. Some vocal pedagogues have hypothesized that the key to unlocking this innate ability lies in the interconnectedness of singing and speech (Brown, W.E.; 1957, Brown, O., 1996), although this theory has failed to garner the attention of fields that study singing.

Based on this largely unexplored theory, I designed a novel External Attentional Focus condition framed within a communicative situational context to use the *desire to communicate* as the impetus for a singing behavior. This novel EAF condition is based on the assumption that the impetus or inducement for executing a singing task is the desire to execute the task accurately, e.g. to achieve the precise pitches, or to hold the pitches for the correct durations. In this paper, I intend to provide support for the hypothesis that any singing task that is framed within the context of a desire for accuracy will inevitably result in an Internal Attentional Focus, thus leading to inefficient performance. I will assert that attentional focus manipulation/redirection in singing is a cognitive enterprise involving how the singing task is conceived.

To date, the foci of all treatment conditions used in attentional focus research have consisted of inanimate objects, such as a spot on a dartboard or the rim of a basketball hoop. This paper will report on a study to test whether a general EAF improves singing voice quality relative to IAF in novice adult singers, as well as whether a novel EAF condition framed in a communicative context would improve singing voice quality relative to both IAF and a traditional EAF.

Definition of Terms

Critical to any investigation of singing is a clear, thoughtful use of terminology that has the potential for confusion. Because a wide range of topics is covered related to numerous disciplines, the following terms are defined in Table 1-1.

Table 1-1. Definition of Terms

Term	**Conceptual Definition**
Sing (verb)	"Make musical sounds with the voice, especially words with a set tune." (Oxford dictionaries, 2016)
Pedagogy	"The method and practice of teaching, especially as an academic subject or theoretical concept." (Oxford dictionaries, 2016)
Vocal/singing pedagogy	One-on-one
Skill	"The ability to do something well; expertise." (Oxford dictionaries, 2016)
Ability	"Possession of the means or skill to do something." (Oxford dictionaries, 2016)

Attention	"The mental faculty of considering or taking notice of someone or something." (Oxford dictionaries, 2016)
Attentional Focus	Directing attention externally to the effect of a movement on the environment

Chapter 2: Literature Review

Statement of Purpose

The purpose of this dissertation was to construct an experimental methodology capable of testing the efficacy of teaching/learning interventions in one-on-one singing instruction using a mixed methods approach. Using this methodology, a study was undertaken to investigate the effect of attentional focus on singing voice quality. The following research questions were addressed in the research study:

1. Will an external attentional focus (EAF) result in superior singing voice quality in novice adult singers versus an internal attentional focus (IAF)?
2. Will an EAF involving communication (EAFc) result in superior singing voice quality relative to both IAF and EAF?

The ultimate goal of this dissertation was to make a contribution towards the development of evidenced-based practices in singing pedagogy.

As the primary methodological structures were drawn from the motor learning field, a review of this literature (specifically, attentional focus) will provide a context for the investigation. A survey of relevant singing pedagogy texts follows, examining relevant history, culture, and practices. An examination of mixed methods research will be followed by a review of speech development research to explore similarities between speech and singing. The student's cognitive functioning, subjective experience, and self-beliefs in relation to singing instruction will also be considered.

The following literature review used traditional academic information sources.

Hard copy and digital sources included books, peer-reviewed journals, dissertations, and periodicals. All were accessed through the following University of Maryland resources: online Research Port, Clarice Smith Performing Arts Library, and McKeldin Library. Care was taken to present any hypotheses unsupported by research data in their appropriate context, and when possible, provide competing or opposing points of view. Section summaries are provided, including research implications and explanations of how the literature has shaped the researcher's understanding of the material, and how this understanding contributed to the construction of the conceptual framework.

The Pedagogy of Singing

The idiosyncratic nature of modern vocal pedagogy is likely a result of its oral tradition, in which teaching methods were passed down from teacher to student (Stark, 2003). What was passed down was a priori knowledge, and was thus prone to personal and cultural bias, and undermined by lack of experimental controls and testability. Manuel Garcia II (1805-1906) was among the first to use scientific methods in the investigation of singing phenomena (Stark, 2003). His invention of the laryngoscope in 1855 allowed for the real-time empirical observation of the vocal mechanism, and his treatise *L'Art du Chant* (1840) was highly influential in later scientific investigation of the voice, as well as the formation of pedagogical practices (Toft, 2013). His method represents the first to be principally derived from knowledge acquired from direct observation rather than oral tradition (Stark, 2003).

Towards the middle of the 20th century, figures such as William Vennard (1909-1971), Ralph Appleman (1908-1993), and Richard Miller (1926-2009) began to employ scientific understanding of anatomy, physiology, and acoustics to describe the nature and function of the vocal instrument. Today, many post-secondary voice performance programs include vocal pedagogy coursework for both graduate and undergraduate students. Although no meta-analysis of twentieth-century writings on singing is known to exist, the present review found the vast majority of the literature to be restricted to topics involving anatomy, physiology, and acoustics, such as breathing, posture, *appoggio*, phonation, registration, voice classification, resonation, and articulation. Other disciplines such as psychology, neurology, and the cognitive sciences are rarely referred to, if at all.

Singing and Academic Research

Because the academic curriculum of singers and teachers of singing at the post-secondary level does not typically include training students in the scientific method, it has been largely left to members of other fields for whom singing is of relevance to conduct singing research. A survey of American academic and artistic (e.g., conservatory) post-secondary institutions found that only three of the six institutions that offer a Doctor of Musical Arts (DMA) in Vocal Pedagogy include courses training students to carry out scientific research, such as research methods and statistical analysis (Meyer & van Leer, 2015). Despite the laudable effort by these institutions to develop and foster singing research, it represents a miniscule minority of academic singing programs in the United States. This deficit in experimental research training of singers prevents those closest to teaching and learning phenomena of singing from having the tools needed to understand them. Many ideas for research studies may not occur to those in non-music-related fields, as they would not be privy to observing phenomena that occur in the one-on-one applied voice studio.

Operationalization of Singing Quality

Although many terms are used to describe voice quality, very few are widely accepted. Barsties and Bodt (2015) assert there are two main approaches to measuring voice quality in the clinical diagnosis of speech pathology: objective measurement based on the application of algorithms to quantify certain aspects of voice production, and the subjective assessment based on one's judgment of the voice. These approaches are also used in the assessment of singing quality, although not all measurements are equally suited for this purpose. The following section will examine the most frequently used objective and subjective assessment approaches in current voice and singing research.

Acoustic Analysis

> Quantifying voice is essential to assess outcomes of treatment, as well as to assist in diagnosis and management. Perceptual evaluation of voice alone is not adequate (Kiesenwether & Sataloff, 2014).

Although the above quotation was written regarding clinical speech language pathology, it is relevant to anyone desiring objective assessment of the singing voice. As technology has advanced in the last several decades of the twentieth century, acoustic analysis of the voice emerged as a means of quantitatively assessing the resonant quality of vocal sounds. Acoustic analysis of voice is used in clinical, scientific, and educational domains of various fields. Clinical uses of acoustic analysis include the assessment and/or diagnosis of voice-related pathologies by speech pathologists, and are favored because the information attained from its use is objective and can be gathered non-invasively (Master, 2006). The use of real-time acoustic analysis by voice teachers is becoming increasingly popular as a means of attaining real-time feedback during the one-on-one voice lesson (Bozeman, 2013). To accomplish this, singing sounds captured by a microphone are analyzed by an analysis software program, which converts the numerical data into visual data. The visual data, usually displayed on a monitor in the voice studio, allow the singer and teacher to immediately observe changes in the sound.

Acoustic analysis is also used in scientific studies relating to speech and singing. Many such studies have attempted to pinpoint which specific attributes of the singing voice, and whether these attributes correspond to the subjective descriptions used among voice practitioners and professional voice users. A survey of such studies shows a lack of agreement regarding which acoustic measure or set of measures constitute a true measure of voice quality (Kenny & Mitchell, 2004; Bhuta, 2004). And while some studies suggest a correlation between acoustic parameters and perceptual evaluation, most involve a small sample size and use differing study methodologies (Ekholm et al., 1998; Bhuta, 2004; Kenny, 2007). Because no standard criteria for the evaluation of ideal singing exist, the current research employed five of the most frequently used acoustic measures divided into two categories: measures of voice quality, and measures of voice perturbation.

Acoustic Measures of Voice Quality

Voice quality is most frequently evaluated by Long-Term Average Spectra (LTAS) analyses, which are measures of the spectral distribution of sound over a period of time (Larrouy-Maestri, Magis, & Morsomme, 2014). Nordemberg and Sundberg (2003) stated that the LTAS particularly "reflects the contribution of the glottal source and the vocal tract for voice quality," making it an ideal measure of singing quality. In research involving voice quality, the LTAS is most frequently measured in terms of the Singing Power Ratio (Omori et al., 1996; Brown, Rothman, & Sapienza, 2000; Lundy et al., 2000; Björkner, 2008).

The Singer's formant (Fs) reflects an increase in intensity in the third, fourth, and fifth formants associated with skilled singing (Sundberg, 1987). This refers to the acoustic phenomenon, often described as a "ring" in classically trained singing voices, that allows a singer to be heard unamplified in a concert hall, even over a large orchestra (Sundberg, 2001).

The Singing Power Ratio (SPR) is a measure intended to quantify the Singer's Formant by determining the ratio of the highest spectral peak, between 2 and 4 kHz, to that between 0 and 2 kHz (Omori et al., 1996). In the analysis of singing, a higher SPR indicates a greater presence of the Singer's Formant in a given sample. Although frequently used as a measure of voice quality, it has not been found to consistently agree with perceptual assessment of singing quality (Kenny & Mitchell, 2006).

Measures of Voice Perturbation

In musical sounds, the fundamental frequency (F_0) is the lowest periodic frequency produced by an instrument, and is almost always the only perceivable pitch by human ears. Jitter, shimmer, and harmonic-to-noise ratio (HNR) are used to determine aspects of periodicity, or the tendency for the sound waves to occur at regular intervals, while median dB is simply a measure of the mean amplitude of the fundamental frequency over the course of a sample.

Jitter, also known as pitch perturbation, is computed as the mean difference between the periods of adjacent cycles divided by the mean period, while shimmer is made on peak-to-peak amplitudes (see Fig. 2-1). In singing, jitter is used to measure the frequency variability of a sung pitch, while shimmer is used to measure its amplitude variability. Because pathological voices tend to exhibit speech with greater degrees of jitter and shimmer, the belief is that such measures can be used to differentiate between healthy and unhealthy singing, although this claim has not been substantiated.

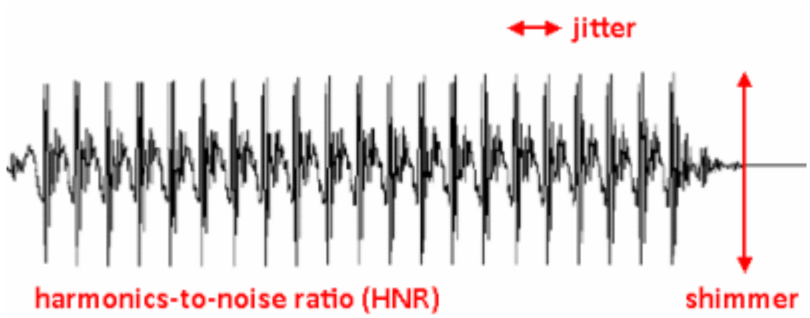

Figure 2-1: Visual representation of HNR, jitter, and shimmer (Williamson, 2014)

Sounds generated by the vibrating vocal folds are made up of two types of sound waves: periodic, or regular/repetitive, and aperiodic, or irregular/non-repetitive. Aperiodic sound waves are attributed to a lack of ideal glottal closure contributing to vocal noise, which can result in a diminishing of vocal clarity. The HNR is the ratio of periodic to aperiodic waves in a vocal sound.

In addition to clinical use in diagnosing vocal pathologies, voice perturbation measures have also been used in studies of singing (Lundy, Roy, Casiano, Xue, & Evans, 2000; Bhuta, Patrick, & Garnett, 2004; De Felippe, Grillo, & Grechi, 2006; Larrouy-Maestri, Magis, & Morsomme, 2014).

Perceptual Evaluation of Voice Quality

Because of the idiomatic nature of the human voice, even highly trained listeners struggle to describe the relative quality of an individual singer. While descriptive terms such as “warm” or “bright” are frequently used at the highest level of singing adjudication, they are highly subjective and fall far short of quantitative measurement (Aithal, 2011). Scott McCoy (2011) suggested the following 12 qualitative aspects of the singing voice should be considered on a continuum (e.g., a scale of 1 to 10).

- Bright to Dark
- Twang to Loft
- Forward to Back
- Light to Heavy
- Clear to Breathy
- Clean to Raspy
- Healthy to Damaged
- Conversational to Ringing
- Nasal to Non-Nasal
- Free to Forced
- Vibrant to Straight Tone
- Wobble to Flutter

While McCoy’s tool was not necessarily intended for research, others have developed instruments to aid in the qualitative assessment of voice quality.

Acoustic-Perceptual Assessment

Acoustic-perceptual assessment refers to a subjective means of judging a sound. Until late in the twentieth century, this was the sole means of assessing singing quality. Several tools have been designed to standardize the acoustic-perceptual evaluation of speech, including the GRBAS scale, Consensus Auditory-Perceptual Evaluation of Voice (i.e., CAPE-V), and Laver’s Voice Profile Analysis (Kreiman & Gerratt, 2010). More recently, Wapnick & Ekholm (1997) and Oates, et al. (2006) have developed ratings instruments towards the standardization of acoustic-perceptual assessment of singing. The ratings scale developed by Oates, et al. (2006) was found to be associated with reasonable face validity, good levels of rater reliability, and good internal consistency. However, it is important to note that the number of singers and judges in their research was small, and the authors have called for further investigation to ensure construct validity.

Singing Terminology

A major source of confusion among students and teachers of singing is the ambiguous terminology used to describe singing phenomena. In 2014, The American Academy of Teachers of Singing (AATS), in conjunction with the National Association of Teachers of Singing (NATS), released a statement entitled "In Support of Fact-based Voice Pedagogy and Terminology," which acknowledges the need for a common terminology among voice practitioners (Edwin, et al., 2014). Although terms such as support (referring to control of the expiration of breath), ring, posture, voice placement, head and chest voice, support or *appoggio*, open throat, etc., are widely used, an acknowledged gap exists between them and actual physiological function (Welch, 2005). Acknowledgement of this gap is not merely a recent occurrence. In 1986 Richard Miller called for a unified terminology of vocal phenomena in his landmark text, *The Structure of Singing*, remarking that "as in any field, the transfer of information is possible only if a common language exists between writer and reader, teacher and student (Miller, 1986)."

Motor Learning

Scientific inquiry of motor skills is typically divided into three disciplines: motor learning, motor development, and motor control. Motor learning research seeks to understand issues relating to motor skills acquisition, with motor development focusing specifically on motor skill acquisition in infants and children. Motor control seeks to understand the nature of control and coordination in the execution of motor tasks (Magill, 2006). Motor skill can be broadly defined as voluntary motions generated by the coordination of brain, nervous system, and muscles. Or, more specifically,

> Motor learning is a process, inferred rather than directly observed, which leads to relatively permanent changes in the general capacity for motor performance, as the result of practice or exposure (Schmidt & Lee, 2011).

Fitts and Posner's 1967 model of skill acquisition provides an explanation of how skills are actually learned by dividing the process into three temporal stages: the *cognitive*, the *associative*, and the *autonomous* stages (Fitts & Posner, 1967). In the *cognitive* stage, the nature and goal of the task are identified, and used to determine the means to carry it out. The *associative* stage sees the learner focusing on specific elements of the action, breaking it down into parts and attempting to coordinate them. Finally, the learner is said to be in the *autonomous* stage when the action is automatized and can be carried out without conscious control. Understanding which stage a learner is currently in is critical if the teacher is to provide appropriate instruction.

Attentional Focus Research

For almost two decades, research investigating the effect of attentional focus on performance and learning has yielded a robust body of data showing that the adoption of an *external attentional focus* (EAF) leads to superior performance relative to the adoption of an *internal attentional focus* (IAF) (Wulf, 2013). These findings extend to a wide range of motor activities, including golf, swimming, dart throwing, basketball, windsurfing, weight lifting, rowing, and tennis, among many others (for full list, see Wulf, 2013). To explain these effects of attention on performance, McNevin, Shea, and Wulf (2003) posited the *constrained action hypothesis*, which holds that an external focus facilitates motor performance by promoting automatic control of movements. Conversely, an internal focus disrupts this automatic control because it induces a conscious, manual control of movement. Although the *constrained action hypothesis* is considered a model for the attentional focus effect in general, several studies have supported it directly (McNevin & Wulf, 2002; Vance et al., 2004; Kal et al., 2013).

The Expertise Continuum

One important consideration attentional focus researchers must decide is whether to involve participants with a novice skill level, or to involve more advanced-skilled or even experts in the activity to be studied. Although the data suggest the effect is generalizable across a wide range of skill levels (Wulf, 2015), this point has very recently become called into question. In a lively debate between Wulf and Toner and Moran, the latter have suggested that too little evidence exists that EAF is superior to IAF in experts to have practitioners recommend it to their clients (Toner & Moran, 2015). To date, a complete meta-analysis has not been completed, but Wulf has acknowledged that the bulk of attentional focus research has involved novices (Wulf & Su, 2007). Only one of the nearly 80 studies in the 15-year review of AF research is indicated as involving "experts" (Wulf, 2013). The concern here is not about whether the data showing the AF effect in experts are sufficiently robust. Rather, the point is that the data showing EAF leads to superior performance versus IAF in *novices* are indeed robust. Moreover, there is a conspicuous lack of consistent, objective measurement of expertise in sport psychology research (Swann et al., 2015), or in expertise research in general (Ackerman, 2014). Because the current investigation involves the early stages of learning (cognitive, associative) the criticism raised in this debate are not of relevance.

Atkins & Duke, 2013

In a recent study, Atkins & Duke (2013) sought to examine the effect of attentional focus in singing. This study, entitled "Changes in Tone Production as a Function of Focus of Attention in Untrained Singers," is the only known published experimental study on the effect of AF on singing. In this study, researchers examined vocal tone quality under different focus of attention conditions, asking whether instructing an untrained singer to focus on internal and external loci would produce differences in the tone production in a short singing task. The researchers hypothesized that the external foci would result in superior tone production. Tone quality was measured via acoustic analysis and expert listeners' evaluations.

The study involved 30 untrained singers, all of whom were enrolled in an instrumental performance class taught by the primary researcher. The study raised important questions on how to deal with potentially ambiguous terminology, although it seemed to lack a thorough operationalization of the dependent variables. Researchers used the term “tone production” and “tone quality” interchangeably to indicate what was to be measured and manipulated, but it was not clear why those terms were chosen or how they were to be defined. The independent variables included both internal and external attentional foci that were elicited via the following instructions:

- Feel “throat vibrations” (through hand placed on throat) (INTERNAL)
- Direct sound to fingers placed on “mask” area of face (INTERNAL)
- Direct sound to microphone 18” distal (EXTERNAL)
- Direct sound to point on wall 18’ distal (EXTERNAL)
- No instructions (baseline condition)

The study employed a repeated measures design, with each participant starting with the baseline condition, then performing the remaining conditions in a partially counterbalanced order (Latin square), with order assigned randomly to each participant. Each condition consisted of three trials for a total of 15 trials, which were recorded and stored, to be analyzed at a later time by expert panel assessment and acoustic analysis. For acoustic analysis, harmonic-to-noise ratio and Singer’s formant (Fs) were employed. The expert panel consisted of the primary author ranking the performances from 1-5 (1 = best) for each participant in terms of overall tone quality, considering together the noise content, ring/resonance, evenness/consistency, and relaxed/free tone.

The researchers found no significant effect of condition based on the acoustic analysis, but a significant effect of condition on vocal quality was found per expert listeners’ ratings of overall tone quality, although it was unclear what the effect actually was. While the current study serves as a continuation of these investigations, a number of key methodological departures were taken, which are addressed in the following chapter.

Issues to Consider in Studying Attentional Focus Effect in Singing

Classification of Singing as Motor Skill

Motor skills are classified based on the nature of when, how, and why they are performed. Any attempt to understand a motor skill would presumably begin with its classification. Schmidt (1982) categorized motor tasks as being *discrete*, *continuous, or serial*. Discrete tasks have a clearly defined beginning and end, such as hitting a baseball or taking a basketball shot. Continuous tasks have no distinct beginning or end, thus the person performing the task determines these parameters. Swimming and running are examples of continuous tasks. Serial tasks consist of a series of separate discrete tasks that coalesce into a larger activity. Singing does not fit neatly into any of these three categories, although arguments can be made for how it could fit in one category over another. For example, singing is continuous insofar as the inspiration-expiration/phonatory cycle, yet is discrete as it has a precise beginning and ending. Perhaps it is best framed as a serial task: a series of discrete inspiration-expiration/phonation tasks coalescing in the performance of a song.

Unique Aspects of Singing Among Other Motor Activities

Many of the biological mechanisms involved in singing are either partially or completely involuntary, thus partially or completely inaccessible to the singer (Wyke, 1974). Numerous instances exist of this issue being addressed in the literature, as in the following excerpts.

> Voluntary control must be instituted over muscular responses whose participation is purely involuntary without recourse to mechanistic controls. This involves learning how to permit movement without moving (Reid, 1972).

> When we establish essential coordination for singing, we cannot separate out those aspects over which we have control from the large number that are the result of reflex responses over which we have no conscious control. Therefore, almost all of the process of coordination that produces successful singing must be incorporated into a psychological attitude (Miller, 1986).

While many have acknowledged the problem and described the solution, the question of how the teacher should help a student to coordinate the various processes involved in singing goes unanswered.

One aspect of singing that separates it from virtually all other motor activities is anatomical/physiological inscrutability. Because the vocal mechanism is shrouded in flesh, singing does not afford visual observation. Therefore any modeling of singing behavior is devoid of visual information. Unlike the tennis student, who, when the teacher models an ideal serve, is afforded visual information with which to form a mental concept of the movement, a student of singing is left with only aural cues with which to form a mental concept. Without explicit visual information, it stands to reason that forming a mental representation of the movement is impossible. Thus, the singing student has less information with which to generate what may be for her an abstract vocal sound.

Gallwey (1974) was one of the first to present anecdotal evidence suggesting novice learners need not think about the details of their actions while performing a skilled task. Gallwey, a tennis instructor, found that repeated modeling of movements was more effective than verbal instructions in the student achieving the desired movements. For students who seemed to be "trying too hard," he developed strategies to distract them from focusing on their own movements, such as focusing on some outside object or point of focus while performing an action. From these and other anecdotes, Singer (1988) developed a Five-Step Approach designed to help beginning students effectively learn skilled movements (Table 2-1).

Table 2-1: Singer's Five-Step Approach

1. *Readying*: Think positively as to performance expectations; attain an optimal attitudinal-emotional state; attempt to do things in preparation for performance that are associated with previous best performances; try to attain consistency as to preparatory mechanics.
2. *Imaging*: Briefly mentally picture performing the act—how it should be done, and how you can do it at your very best; visualize from the results of the act to its initiation; feel the movement.
3. *Focusing*: Concentrating intensely on one relevant feature of the situation, such as the seams of the tennis ball to be hit, think only of this cue, which will block out all other thoughts.
4. *Executing*: Do it when you feel you are ready; do not think of anything about the act itself or the possible outcome.
5. *Evaluating*: If time permits, use the available feedback to learn from; assess the performance outcome and the effectiveness of each step in the routine; adjust any procedure next time, if necessary.

Note: Adapted from Singer, 1988.

Interdisciplinary Research (IDR)

The National Academy of Sciences defines Interdisciplinary research (IDR) as "a mode of research by teams or individuals that integrates information, data, techniques, tools, perspectives, concepts, and/or theories from two or more disciplines or bodies of specialized knowledge to advance fundamental understanding or to solve problems whose solutions are beyond the scope of a single discipline or area of research practice"

(2004). This type of research, sometimes referred to as *multi*-, *cross*-, or *trans-disciplinary*, is recognized as an important means of investigating topics or problems too big or complicated to be meaningfully addressed by a single discipline. Because each discipline has its own epistemology, concepts, theories, and methods, IDR is meant to transcend existing knowledge traditions and disciplinary jargon by bridging disciplines together to find potential commonalities and develop an integrated approach to collaboratively solve complex problems (Repko, 2008).

Mixed Methods Research

Mixed methods research (MMR) is a research approach that has been advocated by prominent social scientists such as John W. Creswell, Abbas Tashakkori, Anthony Onwuegbuzie, Burke Johnson, Charles Teddlie, and David Morgan. Over the last decade, it has emerged as a major research approach, with two journals published since 2007 dedicated solely to scholarship employing its approach (i.e., *Journal of Mixed Methods Research* [JMMR] and *International Journal of Multiple Research Approaches* [IJMRA]). Today it is frequently regarded as a methodological movement and a third research paradigm. While the essence of MMR is the collection of both quantitative and qualitative data, its proponents are quick to point out that, in addition, it entails integration of both kinds of data and drawing conclusions based on the combined strengths to provide a better understanding of the research problem (Creswell, 2015).

Although a full description of MMR is outside the scope of this literature review (for this, see Denscombe, 2008), its core characteristics, as described by Creswell (2015), are in Table 2-2.

Table 2-2. Core Characteristics of Mixed Methods

Collection and analysis of quantitative and qualitative data in response to research questions
• Use of rigorous qualitative and quantitative methods
• Combination or integration of quantitative and qualitative data using a specific type of mixed methods design, and interpretation of this integration
• Sometimes, framing of the design within a philosophy or theory

Note: Adapted from Creswell, 2015.

While the first two characteristics are self-explanatory, the question of how to integrate quantitative and qualitative data and interpret the results can be a matter of considerable confusion.

Worldview (Paradigm)

Mixed-methods research is often referred to as the third research paradigm, in that is meant to be an alternative to purely quantitative and qualitative approaches (Lopez-Fernandez & Molina-Azorin, 2011). In the attempt to legitimize this approach, many writers have worked to develop its philosophical foundations.

There are typically three paradigmatic approaches for the mixed-methods researcher: the a-paradigmatic approach, the multiple paradigm approach, and the single paradigmatic approach. The a-paradigmatic approach is one in which the matter of paradigm is ignored altogether. In the multiple paradigm approach, two or more paradigms are synthesized. The single paradigm approach, which is among the most frequently approach used in mixed methods research, selects only a single paradigm in which to operate.

Table 2-3 lists six research paradigms of mixed-methods research, although some disagreement currently exists regarding the inclusion of at least one of these.

Table 2-3. The Six Major Mixed-Methods Research Paradigms

Positivism	**Ontology**: Realism. There is a "real," objective reality that is knowable **Epistemology**: Objectivist. The researcher can, and should, avoid any bias or influence on the outcome. Results, if done well, are true. **Methods**: Tends towards quantification and controlled experiments.
Post-Positivism	**Ontology**: Critical Realism. There is a "real," objective reality, but humans cannot know it for sure. **Epistemology**: Modified Objectivist. The goal is objectivity, but pure objectivity is impossible. Results are "probably" true. **Methods**: Includes both qualitative and quantitative methods. Seeks reduction of bias through quantitative validity techniques (e.g., triangulation)
Critical Realism	**Ontology**: Historical Realism. Reality can be understood, but only as constructed historically and connected to power. **Epistemology**: Knowledge is mediated reflectively through the perspective of the researcher. **Methods**: Focused on investigator/participant dialogue, uncovering subjugated knowledge and linking it to the social critique.
Constructivism	**Ontology**: Relativist. All truth is "constructed" by humans and situated within a historical moment and social context. Multiple meanings exist of perhaps the same data. **Epistemology**: Researcher and participants are linked, constructing knowledge together. **Methods**: Generally qualitative, research through dialogue.

Transformative/Participatory/Advocacy	**Ontology**: Varied **Epistemology**: The distinction between researcher and researched breaks down. Insider knowledge highly valued. **Methods**: Works with individuals on empowerment and issues that matter to them. Tends toward social, cultural, or political change, using any appropriate method.
Pragmatism	**Ontology**: Varied. Pragmatists may be less interested in what "truth" is and more interested in "what works." **Epistemology**: Accepts many different viewpoints and works to reconcile those perspectives through pluralistic means **Methods**: Focuses on a real world problem, by whatever methods are most appropriate, and tends toward changes in practice.

Note: Adapted from Creswell 2010, 2014

In selecting a paradigm, it is important to remember that because singing voice quality (once properly operationalized) can be measured quantitatively, it is possible to conduct controlled experiments involving singing. Thus while most social science mixed methods research is conducted in a pragmatic paradigm, the post-positivist paradigm appears best suited for singing research. It is important to point out that the differences between positivism and post-positivism are believed by many researchers to be negligible, while others do not even recognize the former as a viable mixed methods research paradigm (Hall, 2012). Because the post-positivism paradigm accepts the basic ontological tenants of realism, further elucidation of the nature of reality or the understanding of existence is not necessary. Similarly, the positivist epistemology is shared by that of the natural sciences, and can be simply stated as such. However, it is the post-positivist paradigm allowance of the collection of both quantitative and qualitative data that justifies the methodology of the present study.

Speech and Evolution

The primary biological functions of the larynx are preventing air from escaping from the lungs, preventing foreign objects from entering the trachea, and forcibly removing foreign objects from the airway (Seikel et al., 2009). Phonation, which serves no biological purpose, might then be considered mere evolutionary serendipity were it not for the critically important role speech plays in communication. Singing is another phonatory behavior that might seem even less functional in biological or evolutionary contexts. And yet many anthropologists believe, as Charles Darwin (1871) did, that early *homo sapiens* employed sung vocalizations as a means of attracting a mate long before the emergence of speech (Skoyles, 2000; Fenk-Oczlon & Fenk, 2009). Other researchers consider the seemingly innate manner in which adults modulate their speech towards singing when communicating to infants to be further evidence of the pre-speech emergence of singing (Welch, 2005; Rinta, 2009).

Speech and Singing

Most humans acquire an *autonomous* level of speech skill at an early age. At approximately 2-4 months of age, infants begin eliciting quasi-melodic vocal sounds that display voluntary control of pitch and *glissandi* (sliding across a range of pitches), and have even been found to emulate the prosody of the native language (Welch, 2005). Although these sounds may not be perceived as singing per se, researchers have suggested that categorizing an utterance as either speech or singing has more to do with societal enculturation than actual acoustic characteristics of sounds (Welch, 2005). For example, while most people can readily differentiate between speech and song, studies have shown that some people, even those with minimal musical experience, perceive a spoken utterance as a sung utterance when it is repeated (Deutsch et al., 2011; Vanden Bosch der Nederlanden et al., 2015).

Neurology of Speech and Singing

Research in neuroscience seems to support the inherent singing ability of humans. Evidence is mounting to support the idea that singing and speech rely on shared neural correlates. Studies have also shown evidence of brain circuits that function to initiate innate affect vocalizations (Juergens, 2009). Several recent neuroimaging studies have found significant neural overlap in processing music and speech (Overy & Avanzini, 2009; Loui, 2015; Akanuma et al., 2015; Hymers et al., 2015; Peretz et al., 2015; Slevc & Okada, 2015), although further research is needed to confirm that the overlap is tantamount to neural sharing (Peretz et al., 2015). Implications of this research are not yet fully understood, but one theme that seems to be emerging is that speech and singing are more similar than was once believed.

"Si canta come si parla." *("You sing as you speak.")*

This is an adage that is familiar to many singers and teachers of singing. It is attributed to Giovanni Battista Lamperti (1839-1910), considered one of the great pedagogical figures of the Italian School of singing (Stark, 2003) who often spoke of the relative nature of speech and song.

> Realizations of the rudiments of melody and harmony, of the sensations of words in head, mouth, throat and chest, and of the inherent energy in the breath, could make of an orator a singer. In fact an orator has as much technic [sic] as a singer, but he has no realization of what to do with it when he tries to sing. No more "method" is needed to sing than to speak. But singing does demand definite realizations and co-ordinate [sic] activity that stimulate desire and reflex. (Brown, 1957)

Here Lamperti seems to answer the question of the type or extent of motor ability a person needs to sing skillfully by simply saying, "If you can speak, you can sing." However, this statement carries a significant caveat. Despite possessing the autonomic *capacity* for singing, the "orator" may not know how to *access* this capacity. A clue to this apparent paradox lies in the phrase "when he *tries* to sing." Lamperti continues: "'Why can't I sing?' Because you try. Do you make an effort to speak? Well, the same process, a thousand-fold intensified and refined is the source of song" (Brown, 1957).

Consider how a student "trying" might play out in response to the common pedagogical instruction, "Breathe from your diaphragm." Although the involuntary diaphragmatic function can be volitionally overridden (Leigh-Post, 2014), the greater problem with this type of instruction is the tendency of the student to exert excessive effort to perform the action, leading to excessive muscle antagonism, resulting in inefficient breathing. To frame this in the context of attentional focus, "trying" to perform the action is tantamount to an internal attentional focus, which, according to the *constrained action hypothesis*, disrupts the body's ability to carry out the action automatically.

The assertion that speech and singing share a common etiology has been a difficult concept for many in the singing discipline to grasp. It took Richard Miller six pages to give his explanation as to how these five words should be understood, in which he interpreted them to refer to acoustic and articulatory matters (Miller, 1986). Others seem to dismiss such views as unrealistic. "Why one may ask, if the techniques of *bel canto* are so simple and direct, has great singing always been the art of the few and not the many?" (Stark, 2003)

Although such objections are reasonable, it would seem that many have missed the essential meaning of Lamperti's maxim, which is that *the mechanisms responsible for bringing about speech are the same mechanisms that bring about singing, yet one is highly automatized and the other is not*. Inherent in these statements is that anyone is capable of skilled singing, but access to this ability is locked to those who try, that one must approach singing having adopted the belief that it needn't require any more effort than speech.

Oren Brown (1909-2004) took this idea even further by suggesting that "primal sounds" could serve as a bridge between involuntary biological mechanisms and volitional singing.

> Outbursts of anger or alarm are universal in the animal kingdom. We humans, like all animals, create sound to express our various states and needs. These sounds are involuntary; they spring from our emotions…the question is, how much can you trust the sounds you make when you are not thinking? Children rarely stop to wonder why they are able to cry or laugh or talk. Nor do they stop to think *how* they do it. They just let it out (Brown, 1996).

Cognition and Belief

The notion of singing in the same manner as one speaks may run counter to an individual's conception of how disparate these two behaviors actually are. If a person has come to believe that "speech requires no effort and singing requires extraordinary effort," any attempt to direct them to perform a singing task in the same way that they would speak may trigger cognitive dissonance. Festinger (1957)'s cognitive dissonance theory posited that an adverse psychological state is aroused when there is a discrepancy between attitudes, beliefs, and behaviors, and individuals will alter one or more of these attitudes, beliefs, or actions in the attempt to restore a balance between them. For example, if a student is asked to perform a singing task for which she believes she lacks the capacity, she might logically experience cognitive dissonance. Brown, while acknowledging the inherent difficulty, treats it as a simple matter of will. "It is difficult to trust what will happen if you let your primal sounds out, but that is exactly what we *must do* (author's italics)" (Brown, 1996).

Is it logical to expect anyone to intend and carry out any act that they believe is impossible? Miller (1996) seems to appreciate this quandary in relation to a student's fear of singing "high notes."

> Fear is not foolish if it derives from intelligent experience; fear *is* foolish if experience consistently proves there is no basis for it. It is, however, not sufficient to advise the singer to give up the foolish habit of being frightened about high notes; only when the singer has had good experiences in singing high notes under all kinds of circumstances will fears be replaced by confidence in performance situations. In executing the [singing task] both female and male singer must be willing to risk something, be willing to accept even the possibility of an occasional sound that fails (Miller, 1996).

Here Miller leads us into a paradox. He asserts that confidence is a prerequisite for successful experience, yet successful experience is a prerequisite for confidence.

Moreover, if a student has failed at the task many times in the past, she will rightly fear the result of an attempt. Any attempt to convince her otherwise would likely be met with considerable resistance.

Psychometrics

Psychometrics is the field associated with the study of psychological measurement. While fields relevant to education have developed instruments designed to assess abilities both general (e.g., IQ) and domain-specific (e.g., math, reading, etc.); the social sciences have been concerned with creating instruments designed to measure personality. Sometimes instruments are relevant to education and social science. For example, self-concept has been a key construct in academic research because it has consistently been linked to achievement (Weiss, 1987), but is also used in the field of psychology as a predictor for various behaviors (Back, Schmukle, & Egloff, 2009).

Self-concept, or self-competence as it is often called, is defined as a person's knowledge about herself, including personal awareness of one's competencies (Sherrill, 1998). Self-competence is similar to self-efficacy in many respects, as self-efficacy is concerned with a person's belief in her capability to produce a given attainment (Bandura, 1997). While self-efficacy would be the belief that a person could perform a particular task with the skills she has, self-competence would simply be the belief that a person has certain skills. Locus of control is a concept developed by Rotter (1974) that refers to the degree to which an individual believes she can control events affecting her. An individual with a strong internal locus of control would believe in a definite cause-and-effect relationship between her own actions and the events in her life. Research has shown a correlation between locus of control and achievement motivation (Fini & Yousefzadeh, 2011) and a correlation between locus of control and depression (Zawawi & Hamaideh, 2009). Both self-competence and locus of control can be general or specific, but many assessment scales are meant to be adapted to a specific domain. For this research study, only beliefs about singing were measured.

Capacity vs. Willingness

If skilled singing is evaluated based on specific resonant characteristics, and the presence or absence of these characteristics is what separates “talented” singers from “untalented” ones, what about the singer who has the capability to generate a sound with the type of resonant properties associated with skilled singing but refrains from doing so because the resulting sound is at odds with her personal conception of what “good” singing is? This hypothetical anecdote demonstrates the central role cognition and beliefs play in determining whether a failure to achieve ideal singing voice quality is due to a lack of ability or simply a disinclination to utilize the ability.

Summary of Literature Review

The aim of this chapter was to review the literature of fields relevant to the current investigation. The literature suggests the lack of evidence-based practices in the field of vocal pedagogy is due, in part, to a lack of operationalization of constructs (e.g., singing voice quality). The mixed methods research literature was found to be helpful in finding a suitable paradigm for the experimental investigation of vocal pedagogy methods. Because singing is a motor behavior, attentional focus research is relevant to singing, and its methodology can be adapted to singing research. Concepts within the vocal pedagogy literature asserting the ubiquity of singing ability, with comparisons to speech, drew parallels to speech development literature, which suggests speech and singing develop simultaneously early in life.

Chapter 3: Methodology and Research Approach

Purpose

The purpose of this dissertation was to construct an experimental methodology capable of testing the efficacy of teaching/learning interventions in one-on-one singing instruction using a mixed methods approach. Using this methodology, a study was undertaken to investigate the effect of attentional focus on singing voice quality.

Strategy and Rationale

As was argued in the first chapter, the use of traditional quantitative methods of scientific inquiry is insufficient to ascertain the efficacy of vocal pedagogy methods. Because of the multi-faceted nature of the singing act, as well as the complex process of facilitating the acquisition of singing skill, it is necessary to employ an interdisciplinary approach within the mixed methods research tradition to obtain a more comprehensive view of the relevant phenomena. Although all data collected in this study were quantitative, the mixed methods research approach was a useful template for clearly establishing the research paradigm, epistemology, variable operationalization, and methodology. Three measures were employed to quantify singing voice quality: acoustic analysis, expert perceptual analysis, and participant subjective self-assessment.

Research Design

A repeated measures within-subjects design was used in the study. Within-subject design provided control for variation of participant traits and abilities in its allowance for each participant to serve as her own baseline.

Only immediate effects of attentional focus on singing voice quality were considered. In other words, no assumptions will be made regarding whether, or to what degree, any behavior has been learned or a skill has been acquired. This is not considered a weakness, as the research aims involve determining singing capacity. Of course, the ultimate goal of the vocal pedagogue is for the desired behaviors to become learned by the student.

Research Sample

Participants were recruited via self-selection sampling, i.e. volunteers chose to participate of their own accord. Recruitment emails were sent through the University of Maryland system-wide announcements, which is received by students, faculty, and employees. As no affiliation with the university was necessary for participation, emails were sent to several local organizations in the surrounding communities. Participants were required to be aged 18 and older, must not have any current vocal problems preventing normal speech or singing, and must be avocational singers with no more than two years of singing training.

Forty-four (44) respondents completed a pre-study questionnaire online via Qualtrics, where they consented to participate in the study by electronic signature. Of that pool of participants, only 24 successfully signed up for and attended an appointment to participate in the study. Two participants were excluded from the study: one participant was unable to complete the tasks, and another participant's data were incomplete due to equipment failure. The final number of participants included in the study was 22 (14 female, 8 male). Ten (10) participants had some singing instruction, while 12 participants had none.

All research was carried out during the spring semester of 2015 on the University of Maryland campus in the School of Music. None of the participants had personal or professional relationships with the researcher (friendship, former students, family member, etc.). Thus issues of power disparity or conflict of interest had no effect on the study data.

Singing Voice Quality

To measure the effect of the attentional focus treatment conditions, each participant executed a singing task four times, once for each condition. Singing voice quality was measured via three methods: acoustic analysis, acoustic-perceptual rating, and participant self-assessment. Because real-time acoustic analysis and expert panel rating were not feasible, these measures were carried out on audio recordings of each participant's execution of the singing task. Participant self-assessment was carried out immediately after the execution of each of the singing tasks in the four conditions.

Independent Variable: Attentional Focus

Four attentional foci were selected for the study: 1. the participant's breathing (internal), 2. a point on the wall (external), 3. an imagined person in the audience (external), 4. an imagined group of children (external). The latter two attentional foci were created for this study to serve as novel external focus conditions designed to elicit *the desire to communicate* (heretofore referred to as *EAFc*). The purpose of the creation of this focus condition was to test the hypothesis that executing a singing task in a primarily communicative (versus an aesthetic or abstract) context would facilitate biomechanical efficiency as per the *Constrained Action Hypothesis*, positively affecting singing voice quality measures.

Although the effect of the independent variable (attentional focus) on singing voice quality was of primary importance to the researcher, it was believed that other variables, e.g., individual characteristics of participants, could mitigate the primary effect. Data were collected about each participant that would later be used as controls to protect the internal validity of the experiment.

Data Collection Procedures

First Questionnaire

Participants were sent an individualized link to the first questionnaire online via Qualtrics. They completed the questionnaire before they were scheduled for an appointment to come in to complete the singing tasks. The first questionnaire collected three types of data relating to the participant: demographic, vocal training, and personal traits (see Table 3-2).

Table 3-1. Participant Data Collected

Demographic	**Vocal Training**	**Personal Traits**
Age, gender	Amount of voice training (only participants with > 2 years were included in study)	General singing beliefs

Singing Beliefs Questionnaire

To assess each participant's individual beliefs about singing, a five-item survey (Appendix C) was included. The researcher developed the questionnaire by extracting the most relevant questions from the Perceived Competence for Learning Scale (Williams & Deci, 1996) and the Levenson IPC Scale (Levenson, Kiehl, & Fitzpatrick, 1973), tailoring them to the data needed for this study.

Collection of Singing Samples

An individual appointment was scheduled based on participant availability as indicated on the first questionnaire. The sessions lasted approximately 30 minutes and were conducted by the researcher. The singing samples were recorded using the Tascam DR-100 mkii digital recorder in MP3 format at the maximum sampling frequency (320 kb/s), and an Audix HT5 omnidirectional headset condenser microphone was used to capture the data. Each participant was fitted with the headset microphone positioned 7cm from the corner of the mouth to enable head movement without affecting input levels.

Participants were asked to begin by singing a familiar birthday song to allow them to become comfortable singing in front of another person. Once the recording levels were set, the researcher explained that they would now be asked to sing the first verse of "Amazing Grace" several times. First, the researcher played the melody two times on the piano. The first time the melody was played, participants were to listen only (although they could sing along "in their head" silently if desired), and the second time they were to sing along with the piano. Next, participants were asked to sing the song excerpt *a capella* (without accompaniment), and were told that all subsequent performances would be carried out in this manner.

A copy of the song lyrics was presented to each participant on a sheet music stand and placed in front of the participant. They were asked to adjust the position of the music stand to ensure they could read the words. Default male (F Major) and female keys (G Major) were preselected for the song with care to avoid common registral events, e.g., F4 for females, E4 for males.

Next, each participant sang the excerpt four times, one per experimental condition. To randomize the order assignment, I generated a list of all possible sequences, from which an order was selected using a random number generator. The researcher designed each set of instructions to direct the participant's attention to four different foci:

1) Their breathing (IAF)
2) A point on the wall (EAF)
3) An imagined person in the audience to whom they were to clearly communicate the words of the song (EAFc)
4) An imagined group of children whom they were to entertain (EAFc)

For each condition, instructions were read verbatim from the study script (Appendix B) before the task was performed, with great care taken to present each neutrally, without gesture or emphasis. Once the recording data had been obtained, they were transferred from the Tascam DR-100 mkii via SD Card to the researcher's personal computer, where they were coded to ensure they could not be identified by file name. After coding, the files were uploaded to a secure cloud storage drive for analysis, and to the Qualtrics website, where they would be embedded in the auditory perceptual ratings scale (described in the following section).

Second Questionnaire

The second questionnaire (Appendix D) involved collecting data to measure the subjective assessment of each treatment condition. These questions were administered via a laptop computer provided at the study site, and were answered by participants immediately following the completion of each condition. Having participants answer the questions after each condition served two purposes. First, it ensured the effect of each condition would be fresh in the participant's memory. Second, the time (approximately one minute) served as a measure of prevention against carryover effects between conditions.

Data Analysis

Acoustic Analysis

To analyze the samples (48000 Hz, 32-bit float), the software program *Praat* (Version 5.4.09, P. Boersma & D. Weenik) was used to calculate measures related to each recording as a whole (median dB, Singing Power Ratio), and for four vowels within each recording (HNR, jitter, and shimmer). The median fundamental frequency (F^0, in Hz) and intensity (in dB) was analyzed for each recording.

Long-term average spectra (LTAS) with a bandwidth of 100 Hz were obtained, with the unvoiced sounds and pauses being eliminated from the samples using the pitch-corrected version with standard settings. The Singing Power Ratio (SPR) was calculated as the power ratio between the frequency ranges of 0-2 kHz and 2-4.5 kHz for the male participants and 0-2.4 kHz and 2.4-5.4 kHz for the female participants, using an averaging method in dB. More negative values reflected steeper LTAS slopes. The median sound level measured in decibels was observed as a measure of overall intensity. Although not a measure of singing quality per se, higher median decibel indicates a greater volume of sound production capacity.

Perturbation analysis was also performed in Praat by labeling four vowels within each recording: the [ej] diphthong of "amazing", the [i] vowel of "me", the [ʌ] vowel of "once", and the [aw] diphthong of "now". Duration (sec), mean harmonics-to-noise ratio (HNR, dB), mean Jitter (local, %) and mean Shimmer (local, %) of these vowels were extracted independently and analyzed.

Expert Panel Assessment

A three-member panel of highly experienced voice teachers rated participant recordings using an auditory-perceptual singing assessment instrument (Appendix A). Panel members received an individualized link to access the recordings and assessment instrument on the Qualtrics website. Each audio recording was embedded above the ratings scale for the convenience of panel members. To ensure consistency of audio fidelity across panelists, each judge was given one pair of highly neutral reference headphones (Sennheiser HD600) and one amplifier/digital-to-analog converter (Schiit Fulla USB dongle). The panel was instructed to listen to each recording as many times as necessary for thorough assessment. They were advised that each recording should only be compared to the others of the same participant, to avoid cross-participant comparisons. Panel members were instructed, in case multiple sessions were needed to complete the evaluations, to ensure each session occurred at approximately the same time of day (e.g., morning, evening) to control for potential changes in alertness that could affect consistency in evaluation.

Panelists evaluated and rated the recordings via an auditory-perceptual assessment of singing according to the five criteria: ring, breath management, appropriate vibrato, strain, and overall performance, measured on an 11-point Likert scale (0 = poor, 10 = excellent). The assessment tool has been found to have excellent inter- and intra-rater reliability and a high degree of internal consistency among scale items (Oates, 2005).

Participant Self-Assessment

Participant self-assessment of treatment efficacy was measured via a tool developed in a previous attentional focus research study (Marchant, 2009). The assessment of participant attitudes regarding the efficacy of each treatment condition was an important part of the study's methodology.

Ethics

Although the study was considered "minimal risk," approval was acquired (Appendix D) from the University of Maryland Internal Review Board to conduct the research project based on what was found to be an appropriate ratio of risk/benefit and an optimal minimization of risk. Cautionary measures were taken to keep participants' identifying information secure, and to ensure that only the researchers had access to data records.

Great care was taken to select a study design that would ensure the highest degree of validity and reliability. Gathering of data by multiple methods, e.g., the selection of three separate measures of singing voice quality reflects this effort. Inter and intra-rater reliability was calculated for all ratings of auditory perceptual ratings by the expert panel.

Coding and Data Management

Qualtrics automatically assigned each participant a unique identification code upon completion of the initial questionnaire. This measure was used to avoid potential bias and to protect participant anonymity. All data were stored in a secure cloud-based storage drive, with access given only to the researcher. Temporary access was granted to those who assisted with analysis.

Limitations of the Study

As was illustrated in earlier chapters, the greatest limitation of the research of singing phenomena relates to the field of singing itself, which, due to its isolation from the greater scientific community, has not developed the necessary frameworks conducive to experimental research. Therefore, main limitation of this study was that the researcher was required to operationalize singing voice quality as a construct, i.e., select terminology, theoretical models, and assessment instruments, etc. Great care was taken to clearly document how and why these decisions were made.

Although the questionnaire used to assess each participant's individual singing beliefs was based on validated, reliable psychometric scales, it may have fallen short of the highest standards used in psychometric assessment. For future research, it is recommended that great care should be taken to utilize the most robust means of psychometric assessment.

Despite attempts to include as many participants as possible, the sample size was fairly small and may also be considered a limitation. Moreover, because mediating influences were not assessed, it is not known what, if any, mediating effect participant traits (age, locus of control, perceived singing competence, experience) may have had on the relationship between attentional focus and singing voice quality. Thus, it is possible, for example, that certain age groups may respond differently to the treatment conditions than others.

While a great number of studies have been done contrasting internal/eternal focus conditions, none are known to have introduced a novel attentional focus condition. The external attentional focus with the desire to communicate (EAFc) was the researcher's attempt to combine attentional focus with interpersonal communication. It was a departure from traditional attentional focus research, and as such would require further research and scrutiny from relevant research fields.

As in any repeated measures experiment, the within-subjects design presented the potential carryover effect from one condition to another. To prevent this, the researcher had participants fill out the questionnaire for each condition immediately after receiving it, supplemented with explicit instructions before the second, third, and fourth conditions to disregard any previous instructions and focus only on the present ones.

Another limitation was the potential for researcher bias in the researcher's involvement in implementing the treatment conditions. To minimize this possibility, the researcher adhered closely to the study script (Appendix B), reading it verbatim with no extraneous hand gestures or other movement. Because of an unforeseen family emergency, one member of the expert panel was unable to complete the study, leaving only two expert judges. Although intra-rater correlations were found to be reliable, a larger panel might have yielded more robust data.

Chapter 4: Results

Introduction

The purpose of this study was to determine the effect of attentional focus on the execution of a simple singing task by novice adult singers. In this chapter a detailed description of data analysis is presented, followed by a full report of findings that address the research questions proposed in the study. All statistical analyses were conducted using R (version 3.1.3) software.

Description of Analysis

In this study, there were three dependent variables examined. Singing voice quality as measured by acoustic analysis, expert panel assessment, and participant self-assessment. Four attentional foci were the independent variables: a breathing focus (internal), a single point on wall focus (external), a focus on clearly communicating to an imaginary person in audience (external with communication), and a focus on entertaining an imaginary group of children (external with communication). In order to measure which treatment condition would result in the best singing voice quality, participants executed the task four times consecutively under all four attentional focus conditions.

Data from a linear mixed-effects (LME) regression model fit by REML were used to model the relationship between variables in acoustic analysis and expert panel assessment, while the Cumulative Link Model fitted with the Laplace approximation was used for participant self-assessment variable modeling. All results were reported relative to Treatment A, which served as a baseline for analysis, as per regression analysis with nominal data. Because of the potential for personal traits of participants to affect the relationship between dependent and independent variables, a *dummy variable* was introduced into the regression to control for per-person fixed effects. Because there is currently no agreed-upon way to determine R^2 in linear mixed models, the effect size was not determinable. Note that because Treatment A (IAF, breathing) was used as a baseline for Treatments B, C, and D, t-values and p-values were irrelevant, and are thus not reported in the tables which follow.

Expert Panel Rating

Expert panelists evaluated each recorded performance of the sung task according to the five categories: ring, breath management, strain, appropriate vibrato, and overall performance (see Appendix A). Note that 'overall performance' was a separate category rated by panelists for each recorded performance rather than a mean or average of the other four criteria. Mean ratings of overall performance (Table 4-1a) for treatment C were significantly lower relative to treatment A, while no significant differences were found in treatments B or D relative to treatment A. Ratings for individual parameters generally reflected the ratings for overall performance (Figures 4-1b-e), although panelists found Treatments B and C as exhibiting less strain than Treatments A. The data indicate that the "clearly communicate the text" focus condition resulted in worse overall performance, ring, breath management, and appropriate vibrato than the "breathing" focus condition, but better in terms of amount of apparent strain.

Table 4-1a. **Expert Panel**: Average "Overall performance" by Condition

Treatment	Mean Value (intercept)	Std. Error	95% Confidence Intervals	Degree of Freedom	t-value	p-value
Treatment A INTERNAL (breathing)	4.23	.35	3.51, 4.94	63		
	Mean Difference from Treatment A					
Treatment B EXTERNAL (wall)	-0.29	.18	-0.66, 0.08	63	-1.56	0.12
Treatment C EXTERNAL (person)	**-0.64**	**.18**	**-1.00, -0.27**	**63**	**-3.46**	**<0.01**
Treatment D EXTERNAL (children)	-0.24	.18	-0.61, 0.13	63	-1.32	0.19

An intraclass correlation (ICC) was used to determine inter-rater reliability of expert panel data, which found a high degree of reliability (.754 [.72, .78], $p < .01$)

Table 4-1b. **Expert Panel**: "Ring" by Condition

Treatment	Mean Value (Intercept)	Std. Error	95% Confidence Intervals	Degree of Freedom	t-value	p-value
Treatment A INTERNAL (breathing)	3.98	.30	3.38, 4.60	63		
	Mean Difference from Treatment A					
Treatment B EXTERNAL (wall)	-0.18	.15	-0.47, 0.11	63	-1.24	0.22
Treatment C EXTERNAL (person)	**-0.38**	**.15**	**-0.67, -0.09**	**63**	**-2.56**	**0.01**
Treatment D EXTERNAL (children)	-0.08	.15	-0.37, 0.22	63	-0.52	0.61

Table 4-1c. **Expert Panel**: "Breath Management" by Condition

Treatment	Mean Value (intercept)	Std. Error	95% Confidence Intervals	Degree of Freedom	t-value	p-value
Treatment A INTERNAL (breathing)	4.90	.32	4.26, 5.52	63		
	Mean Difference from Treatment A					
Treatment B EXTERNAL (wall)	**-0.45**	**.17**	**-0.80, -0.11**	**63**	**-2.65**	**0.01**
Treatment C EXTERNAL (person)	**-0.48**	**.17**	**-0.83, -0.14**	**63**	**-2.83**	**<0.01**
Treatment D EXTERNAL (children)	-0.08	.17	-0.42, 0.27	63	-0.44	0.66

Table 4-1d. **Expert Panel**: "Strain" by Condition

Treatment	Mean Value (intercept)	Std. Error	95% Confidence Intervals	Degree of Freedom	t-value	p-value
Treatment A INTERNAL (breathing)	3.94	.34	3.25, 4.63	63		
	Mean Difference from Treatment A					
Treatment B EXTERNAL (wall)	-0.008	.19	-0.38, 0.40	63	-0.04	0.97
Treatment C EXTERNAL (person)	**-0.76**	**.19**	**-1.15, -0.37**	**63**	**-3.89**	**<0.01**
Treatment D EXTERNAL (children)	-0.36	.19	-0.75, 0.03	63	-1.87	0.07

Table 4-1e. **Expert Panel**: "Appropriate Vibrato" by Condition

Treatment	Mean Value (intercept)	Std. Error	95% Confidence Intervals	Degree of Freedom	t-value	p-value
Treatment A INTERNAL (breathing)	3.50	.31	2.87, 4.13	63		
	Mean Difference from Treatment A					
Treatment B EXTERNAL (wall)	-0.11	.14	-0.39, 0.16	63	-0.83	0.41
Treatment C EXTERNAL (person)	**-0.38**	**.14**	**-0.65, -0.10**	**63**	**-2.79**	**<0.01**
Treatment D EXTERNAL (children)	-0.21	.14	-0.48, 0.06	63	-1.56	0.12

Acoustic Analysis

There were no statistically significant differences across conditions for jitter, shimmer, or harmonic-to-noise ratio (HNR). Statistically significant results were found in two of the five acoustic analyses.

Singing Power Ratio (SPR)

Higher values (indicating better singing voice quality) of statistical significance were found for Treatment B ("spot on the wall" focus condition) for SPR (Table 4-3a) relative to Treatment A ("breathing" focus condition), but no other significant difference across conditions was found. This indicates that the "spot on the wall" focus condition resulted in better singing voice quality than Treatment A ("focus on your breathing").

Table 4-3a. **Acoustic Analysis**: SPR by Treatment

Treatment	**Mean Value (intercept)**	**Std. Error**	**95% Confidence Intervals**	**Degree of Freedom**	**t-value**	**p-value**
Treatment A INTERNAL (breathing)	-23.22	0.83	-24.88, -21.58	63		
	Mean Difference from Treatment A					
Treatment B EXTERNAL (wall)	**0.93**	**.43**	**0.07, 1.80**	**63**	**2.15**	**0.04**
Treatment C EXTERNAL (person)	0.67	.43	-0.20, 1.54	63	1.54	0.13
Treatment D EXTERNAL (children)	0.46	.43	-0.41, 1.33	63	1.05	0.30

Median Decibel (dB)

Higher values (indicating better singing voice quality) of statistical significance were found for Condition B (EAF) for median decibel (Figure 4-3b) relative to treatment A (IAF), but no other significant difference across conditions was found. This indicates that the “spot on the wall” focus condition resulted in better singing voice quality than the “breathing” focus condition.

Table 4-3b. **Acoustic Analysis**: "Median dB" by Treatment

Treatment	Mean Value (intercept)	Std. Error	95% Confidence Intervals	Degree of Freedom	t-value	p-value
Treatment A INTERNAL (breathing)	63.03	2.37	58.30, 67.77	63		
	Mean Difference from Treatment A					
Treatment B EXTERNAL (wall)	**1.07**	**.55**	**-0.03, 2.18**	**63**	**1.94**	**0.06**
Treatment C EXTERNAL (person)	0.14	.55	-0.96, 1.24	63	.25	.80
Treatment D EXTERNAL (children)	-0.53	.55	-1.63, 0.57	63	-0.96	.34

Participant Self-Assessment

Lower values of statistical significance of "effort needed to complete task" were found for Treatment B ("spot on the wall" focus condition) relative to Treatment A (Table 4-4a). No other significant difference across conditions was found. This indicates that participants found the "spot on the wall" focus condition to result in better singing voice quality than the IAF condition ("focus on your breathing"). Because the Cumulative Link Mixed Model was used for participant self-assessment data, values for Treatment A/intercept were also irrelevant and not reported in Tables 4-4a and 4-4b.

Table 4-4a: **Participant Assessment**: “Effort Needed to Complete Task” by Treatment

Treatment	Mean Difference from Treatment A	Std. Error	95% Confidence Intervals	z-value	p-value
Treatment B EXTERNAL (wall)	**-1.22**	**.59**	**-2.38, -0.07**	**-2.08**	**0.04**
Treatment C EXTERNAL (person)	-0.41	.58	-1.54, 0.72	-0.72	0.47
Treatment D EXTERNAL (children)	-0.36	.58	-1.49, 0.77	-1.56	0.53

Lower values (indicating a perceived worsening of singing voice quality) of statistical significance of “perceived improvement” were found for all external focus conditions (Treatments B, C, & D) relative to Treatment A (Table 4-4b). This indicates that participants found all three external focus conditions to result in worse singing voice quality than the “breathing” focus condition.

Table 4-4b. **Participant Self-assessment**: “Perceived Improvement” by Treatment

Treatment	Mean Difference from Treatment A	Std. Error	95% Confidence Intervals	z-value	p-value
Treatment B EXTERNAL (wall)	**-1.07**	**.58**	**-2.21, 0.08**	**-1.83**	**0.07**
Treatment C EXTERNAL (person)	**-1.69**	**.60**	**-2.87, -0.51**	**-2.80**	**<0.01**
Treatment D EXTERNAL (children)	**-1.33**	**.58**	**-2.46, -0.20**	**-2.30**	**0.02**

Compliance

Participant self-reported compliance levels were lowest in Treatment C (EAFc1), with Treatments B (EAF) and D (EAFc2) also lower relative to condition A (Table 4-5).

Table 4-5. Participant Reported Compliance by Treatment

Treatment	Mean Value (intercept)	Std. Error	95% Confidence Intervals	Degree of Freedom	t-value	p-value
Treatment A INTERNAL (breathing)	5.50	.23	5.04, 5.94	62		
	Mean Difference from Treatment A					
Treatment B EXTERNAL (wall)	-1.00	.20	-1.39, -0.59	62	-4.97	<.01
Treatment C EXTERNAL (person)	-1.42	.20	-1.83, -1.02	62	-7.06	<.01
Treatment D EXTERNAL (children)	-1.00	.20	-1.40, -0.59	62	-4.97	<.01

Summary of Findings

Three major findings emerged from the data analysis:

1. Expert panel ratings uniformly indicated worse singing voice quality for Treatment C (EAFc1) than all other treatment conditions.
2. Only 2 of 5 acoustic analyses yielded statistically significant results. SPR and median dB values indicated better singing voice quality for Treatment B (EAF) relative to Treatment A (IAF).
3. Participant self-reported compliance was low for Treatment C relative to Treatment A.

Conclusion

Overall, it is difficult to draw firm conclusions from the data. One prominent finding was the relative inefficacy of Treatment C (EAFc1) across conditions, although Treatment C also had the lowest participant compliance level. Although SPR and median dB values indicated better singing voice quality for Treatment B (EAF), jitter, shimmer, and HNR all yielded no statistically significant results. However, participants self-reported that Treatment B required significantly less effort to complete the task.

Chapter 5: Summary and Discussion

Introduction

Because scientific investigation is a sine qua non of the establishment of effective practices in any field, I have argued that critical issues of theory, methodology, and epistemology must be addressed before meaningful research of teaching/learning practices in vocal pedagogy can be undertaken. To this end, I have put forth a theoretical framework as a model of what such research might entail based on Mixed Methods Research methodology.

To test the model, I conducted a research study testing the efficacy of the adoption of an External Attentional Focus relative to an Internal Attentional Focus in adult novice singers. This was predicated upon the assumption that vocal pedagogy methods should be subjected to a thorough scientific investigation to determine their efficacy.

The aim of this chapter is to analyze, interpret, and synthesize the findings presented in Chapter 4. To this end, findings will be summarized, followed by a discussion of each treatment condition and method of data analysis.

Summary of Study

The study consisted of a self-selected sample of 22 adults from the general population. Within-subject randomized repeated measures design was used to collect audio recordings of performances, and questionnaires were developed to collect demographic data, assessment of singing self-beliefs, and subjective assessment of treatment efficacy. The study was based on the following two research questions:

1. Will the adoption of an external attentional focus (EAF) result in better singing voice quality (per expert panel ratings, acoustic analysis, and participant self-assessment) relative to an internal attentional focus (IAF) in adult novice singers?
2. Will a novel EAF condition, EAF with the desire to communicate (EAFc1, EAFc2) result in better singing voice quality (per expert panel ratings, acoustic analysis, and participant self-assessment) relative to both an external attentional focus (EAF) and an internal attentional focus (IAF) in adult novice singers?

The following two results were hypothesized:

1. EAF will result in better singing voice quality than IAF.
2. EAFc1 and EAFc2 will result in better singing voice quality than both EAF and IAF.

Summary of Findings

The first hypothesis was only partially supported by the data. The three measures that supported the first hypothesis were SPR, median decibel (dB), and participant self-assessment (effort needed to complete the task). The second research hypothesis was not supported by the data.

Discussion of Internal Attentional Focus (IAF)

The internal attentional focus (IAF) condition was designed to direct the participants' attention to their breathing. It was hypothesized that this condition would result in the worst singing voice quality of all conditions, yet scores were higher relative to the External Attentional Focus conditions with the desire to communicate (EAFdc, i.e., focusing on communicating the text to a person and focusing on entertaining children) in four out of five expert perceptual ratings categories and participant self-assessment (perceived improvement). Scores for the IAF condition were higher relative to Treatment D in one of five expert perceptual ratings categories (breath control), and in one of the two participant self-assessment measures (perceived improvement).

Although scores for the breathing focus were found to be higher relative to the foci designed to elicit communication (Treatments C and D), this was not found to be the case relative to the "point on wall" focus condition (Treatment B). Thus, these findings do not conflict with the overwhelming majority of attentional focus research (e.g., Wulf, 2012), which has consistently reported IAF to be inferior to EAF.

Discussion of the External Attentional Focus Condition (EAF)

The "point on wall" focus condition (Treatment B) was designed to direct the participant's attention to an "X" marking on a chalkboard 20 feet away from the participant. This treatment condition was similar to EAF conditions of traditional attention focus research studies. Mean scores for Treatment B were higher relative to A in four measures: strain (expert perceptual rating), effort needed to complete task (participant self-assessment), LTAS slope, and average dB (acoustic analysis). Again, these findings are consistent with the overwhelming majority of attentional focus research, which consistently report that EAF is better than IAF (Wulf, 2012).

External Attentional Focus with the desire to communicate (EAFdc)

The EAFdc conditions were designed to elicit the desire to communicate as the impetus to the completion of the singing task. In the first of these conditions (C), participants were instructed to sing the song with the intent to clearly communicate the words of the song to an imaginary person seated twenty feet away from the participant. In the second (D), participants were instructed to sing the song with the intent to entertain a group of imaginary children seated on the floor in front of them.

The first EAFdc condition (C) resulted in significantly higher scores relative to the IAF condition in four of the five expert perceptual ratings categories (overall performance, ring, breath control, and appropriate vibrato), as well as perceived improvement (participant self-assessment) and strain (expert perceptual rating). The data suggesting the negative singing voice quality effect (i.e., lower scores) of the first EAFdc (C) were nearly as robust as those suggesting the positive effect (i.e., higher scores) of the IAF condition. The data showed very little effect of significance from the second EAFdc condition (D), yet in both cases scores were lower. Because the focus conditions designed to elicit communication (Treatments C and D) have not been used in previous experimental studies, these findings are only discussed in the context of the current study.

One possible explanation for the overall negative effect of the EAFdc conditions is that participants found it difficult to relate to an imaginary person/group. Perhaps these conditions would have been more effective if actual people were present to serve as the focus subjects, although such arrangements were not feasible. Another potential explanation for the lack of statistically significant results could be related to the unsuitability of the song text and the imagined intended recipient(s). In the instance of the second EAFdc condition ("focus on entertaining children"), perhaps a children's song would be more effective, since singing this type of song might be more conceivable than singing "Amazing Grace." The EAFdc conditions were designed to intimate the natural human impulse that triggers the occurrence of a communicative utterance. Although attempts were made to select a highly evocative context for these conditions, participants may not have been able to suspend disbelief to overcome the artificial nature of the environment. Further, the imaginary nature of these treatment conditions requires a participant to role-play in front of a stranger (the researcher). Some participants may have reckoned that participating in such an activity would put them at risk of appearing foolish, rendering them recalcitrant to fully engage in the activity.

Another factor that could have mitigated the effect of the "focus on a point on the wall" condition (Treatment C) is participant misunderstanding of the instructions. The intended effect this condition was for the necessity of transmitting the song text to the imagined recipient to serve as the catalyst for the sung performance. It might not have been clear to participants that, despite the utilitarian underlying purpose, the resulting utterance needn't lose the normal characteristics of singing (e.g., sustained vowels). Thus, if participants wholly abandoned singing in deference to speech for this condition, this would explain such poor expert panel ratings.

Directions For Future Research

This research is conducted in the hopes that others will work towards the development of ontological, epistemological, and paradigmatic constructs of singing to facilitate experimental research. As suggested in this paper, some of these constructs may be readily adapted from fields such as motor learning and cognitive psychology. It is hoped that new research methodologies will emerge to investigate singing phenomena, yielding data that may be used towards the development of evidence-based vocal pedagogy. Much work is needed to pave the way for future singing research. Although attempts have been made herein to operationalize singing voice quality, it is by no means intended to be the final word. It is my sincere hope that others will take up the task of refining and improving upon this work.

Future experimental research of singing might benefit from separating measurements of singing voice quality from measurements of singing biomechanical efficiency, e.g., the use of electromyography. As was previously explained, whether or not a singer makes articulatory adjustments leading to vocal resonance indicative of trained singers (i.e., with greater resonance in formants 3, 4, and 5), she may be affected by acquired musical aesthetics or various cognitive factors. Moreover, it is strongly recommended that controlling for such variables be adopted if and when formant analysis is used as any kind of measure of singing voice quality in future singing research. An ideal way to measure biomechanical singing efficiency would be to use electromyography (EMG) to monitor levels of muscle recruitment during the execution of a singing task. Lower levels of muscle recruitment and muscle antagonism could then be compared to and corroborated with acoustic measures to determine a comprehensive and accurate measure of singing efficiency.

Again, it is my hope that this document will lead to the critique/refinement of the proposed model and/or the creation of alternative models toward the scientific investigation of teaching/learning methods of singing. I believe that cross-disciplinary collaboration ─ with meaningful interaction of artists, clinicians, and scientists ─ is crucial to this process.

Appendices

Appendix A: Acoustic Perceptual Rating Scale (Oates, 2005)

INSTRUCTIONS:

Please evaluate the following set of four recordings.

- **It contains the same person singing parts of a folk song.**
- **The singers are adult beginners, and may have had no singing training.**
- **Please rate each recording based on the five criteria below.**
- **For each criterion, evaluate the recordings by entering a number from 0 (poor) to 10 (excellent).**
-

POOR 0	1	2	3	4	5	6	7	8	9	EXCELLENT 10

- **Each person's ratings are considered in isolation of the other people (so a score of "5" for one person need not be equivalent to a score of "5" for another person).**
- **For consistency within one person's recordings, you may want to adjust your initial scores once you have heard all four recordings for that person.**

You may listen to the recordings as many times as you wish. Please use the headphones and AMP/DAC dongle that were given to you.

Recording 1 00:00 00:00 **Recording 1**

Recording 2 00:00 00:00 **Recording 2**

Recording 3 00:00 00:00 **Recording 3**

Recording 4 00:00 00:00 **Recording 4**

	Recording 1	Recording 2	Recording 3	Recording 4
OVERALL VOCAL PERFORMANCE *an overall rating of the aesthetic and technical quality of singing voice*				
RING *brilliance of tone*				
BREATH MANAGEMENT *efficient breath management*				
STRAIN *voice quality that gives impression of excessive vocal effort*				
APPROPRIATE VIBRATO *regular and smooth undulation of frequency of the tone*				

Appendix B: Study Script

Please make sure that all electronic devices are turned off.

[Put on microphone]

To start, I will ask you to sing the "Happy Birthday" song. This is simply to give you an opportunity to get used to the acoustics of the room. Feel free to start on any note that you wish. You may begin whenever you are ready.

[Participant sings "Happy Birthday" song]

Now you will be asked to sing the first verse of the traditional folk song "Amazing Grace." First you will hear the melody ***three*** *times to familiarize yourself with the tune, or, if you are already familiar with it, to refresh your memory. The first time the melody is played, you should listen only. The second time, you should sing along with the melody as it is played. The third time you will sing the melody by yourself, at which time I will check the recording levels. A copy of the song lyrics is provided for you on the music stand in front of you.*

I will now play you the melody. Remember, this first time you should only listen, although you may sing along "in your head" if you wish. Because of the folk nature of the song, there exist many different versions of the song. The melody in the recording is not definitive. If it is different from what you know, you needn't attempt to conform to it. Please sing whatever comes naturally.

[The researcher will play the melody.]

"Now I will play the melody a second time. This time, please sing along."

[The researcher will play the melody.]

"Now please sing the song without the melody being played. I will play the first few notes for you, wait a moment, then begin."

[The researcher will play the first few notes.]

For the next four times, I will give you different instructions about what to focus on while you sing. After each time, I will ask you to proceed to the desk with the laptop to answer questions about the instructions you were given. From now on you will sing the excerpt without the melody. Again, I will play the first few notes of the song for you on the piano. Remember that note accuracy is not important. Simply direct your attention to the points of focus I will give. Do you have any questions about what I have just explained?

[Commence the four focus conditions]

"Your participation in the study is now complete. We will contact you in the coming days about scheduling a debrief session and your complementary singing lesson/assessment, which I will be giving. Do you have any questions at this time? Thank you for participating in this study!"

Appendix C: Singing Beliefs Questionnaire

Directions: Rate your agreement with each statement.

	Not at all true	Hardly true	Moderately true	Exactly true
I believe myself to be a good singer.	❍	❍	❍	❍
I am able to sing "in tune" (i.e. accurately hit notes).	❍	❍	❍	❍
Others have reacted positively upon hearing my singing voice.	❍	❍	❍	❍
Singing ability is a talent that a person is born with.	❍	❍	❍	❍
A person with no talent can become a good singer with skilled instruction and hard work.		❍	❍	❍

Appendix D: Second (Post-Study) Questionnaire

Answer the following questions about your experience with the instructions you were most recently given.

	1 None at all	2	3	4	5	6	7 A great deal
How much attention was focused on the intended point of focus?	○	○	○	○	○	○	○
How much attention was directed toward your body?	○	○	○	○	○	○	○
How much attention was directed toward your breathing?	○	○	○	○	○	○	○
How much attention was focused on accurately hitting/singing the notes?	○	○	○	○	○	○	○
How much effort was needed to sing the song?	○	○	○	○	○	○	○
How distracted were you while singing the song?	○	○	○	○	○	○	○
How difficult was it to follow the instructions you were given?	○	○	○	○	○	○	○
How often did you use the instructions you were given during the song?	○	○	○	○	○	○	○
How successful do you think these instructions were in making your singing better?	○	○	○	○	○	○	○
	1 None at all	2	3	4	5	6	7 A great deal

Appendix E: IRB Approval

UNIVERSITY OF MARYLAND

INSTITUTIONAL REVIEW BOARD

1204 Marie Mount Hall
College Park, MD 20742-5125
TEL 301.405.4212
FAX 301.314.1475
irb@umd.edu
www.umresearch.umd.edu/IRB

DATE:	February 23, 2015
TO:	Michael Hewitt, PhD
FROM:	University of Maryland College Park (UMCP) IRB
PROJECT TITLE:	[488086-3] Attentional Focus and Singing Performance
REFERENCE #:	
SUBMISSION TYPE:	Amendment/Modification
ACTION:	APPROVED
APPROVAL DATE:	February 23, 2015
EXPIRATION DATE:	January 16, 2016
REVIEW TYPE:	Expedited Review
REVIEW CATEGORY:	Expedited review category # *6 & 7*

Thank you for your submission of Amendment/Modification materials for this project. The University of Maryland College Park (UMCP) IRB has APPROVED your submission. This approval is based on an appropriate risk/benefit ratio and a project design wherein the risks have been minimized. All research must be conducted in accordance with this approved submission.

Prior to submission to the IRB Office, this project received scientific review from the departmental IRB Liaison.

This submission has received Expedited Review based on the applicable federal regulations.

Please remember that informed consent is a process beginning with a description of the project and insurance of participant understanding followed by a signed consent form. Informed consent must continue throughout the project via a dialogue between the researcher and research participant. Unless a consent waiver or alteration has been approved, Federal regulations require that each participant receives a copy of the consent document.

Please note that any revision to previously approved materials must be approved by this committee prior to initiation. Please use the appropriate revision forms for this procedure.

All UNANTICIPATED PROBLEMS involving risks to subjects or others (UPIRSOs) and SERIOUS and UNEXPECTED adverse events must be reported promptly to this office. Please use the appropriate reporting forms for this procedure. All FDA and sponsor reporting requirements should also be followed.

All NON-COMPLIANCE issues or COMPLAINTS regarding this project must be reported promptly to this office.

This project has been determined to be a Minimal Risk project. Based on the risks, this project requires continuing review by this committee on an annual basis. Please use the appropriate forms for this procedure. Your documentation for continuing review must be received with sufficient time for review and continued approval before the expiration date of January 16, 2016.

References

Ackerman, P. L. (2014). Nonsense, common sense, and science of expert performance: Talent and individual differences. *Intelligence*, *45*, 6-17. http://doi.org/10.1016/j.intell.2013.04.009

Akanuma, K., Meguro, K., Satoh, M., Tashiro, M., & Itoh, M. (2015). Singing can improve speech function in aphasics associated with intact right basal ganglia and preserve right temporal glucose metabolism: Implications for singing therapy indication. *International Journal of Neuroscience*, *126*(1), 39-45. doi:10.3109/00207454.2014.992068

Atkins, R. L., & Duke, R. A. (2013). Changes in tone production as a function of focus of attention in untrained singers. *International Journal of Research in Choral Singing*, *4*(2), 28–36.

Back, M. D., Schmukle, S. C., & Egloff, B. (2009). Predicting actual behavior from the explicit and implicit self-concept of personality. *Journal of Personality and Social Psychology*,*97*(3), 533-548. doi:10.1037/a0016229

Bandura, A. (1997). *Self-efficacy: The exercise of control*. Macmillan.

Barsties, B., & De Bodt, M. (2015). Assessment of voice quality: Current state-of-the-art. *Auris Nasus Larynx*, *42*(3), 183-188. doi:10.1016/j.anl.2014.11.001

Bhuta, T., Patrick, L., & Garnett, J. D. (2004). Perceptual evaluation of voice quality and its correlation with acoustic measurements. *Journal of Voice*, *18*(3), 299-304. doi:10.1016/j.jvoice.2003.12.004

Bozeman, K. (2013). *Practical vocal acoustics: Pedagogic applications for teachers and singers*. Hillsdale, NY: Pendragon Press.

Brown, O. (1996). *Discover your voice: How to develop healthy voice habits*. Cengage Learning.

Brown, W. E. (1957). Vocal wisdom: Maxims of Giovanni Battista Lamperti. *New York*, *4*, 5–13.

Brown, W., Rothman, H. B., & Sapienza, C. M. (2000). Perceptual and acoustic study of professionally trained versus untrained voices. *Journal of Voice*, *14*(3), 301-309. doi:10.1016/s0892-1997(00)80076-4

Creswell, J. (2014). *A concise introduction to mixed methods research*. Los Angeles: SAGE Publications, Inc.

Creswell, J. W. (2010). Mapping the developing landscape of mixed methods research. *SAGE Handbook of Mixed Methods in Social & Behavioral Research*, *2*, 45–68.

Crocco, L., Madill, C. J., & McCabe, P. (2016). Evidence-based frameworks for teaching and learning in classical singing training: A systematic review. *Journal of Voice*. http://doi:10.1016/j.jvoice.2015.12.001

De Felippe, A. C., Grillo, M. H., & Grechi, T. H. (2006). Standardization of acoustic measures for normal voice patterns. *Brazilian Journal of Otorhinolaryngology*, *72*(5), 659-664. doi:10.1016/s1808-8694(15)31023-5

Deci, E. L., & Ryan, R. M. (2000). The “what” and “why” of goal pursuits: Human needs and the self-determination of behavior. *Psychological Inquiry*, *11*(4), 227–268. http://doi.org/10.1207/S15327965PLI1104_01

Deutsch, D., Henthorn, T., & Lapidis, R. (2011). Illusory transformation from speech to song. *The Journal of the Acoustical Society of America*, *129*(4), 2245–2252. http://doi.org/10.1121/1.3562174

Duke, R. A., Cash, C. D., & Allen, S. E. (2011). Focus of attention affects performance of motor skills in music. *Journal of Research in Music Education*, *59*(1), 44–55. http://doi.org/10.1177/0022429410396093

Edwin, R., LoVetri, J., Douglas, J., & McCoy, S. (2014). Nats visits Aats. *Journal of Singing*, *71*(1), 9–14.

Fant, G. (1971). *Acoustic theory of speech production: With calculations based on X-ray studies of Russian articulations*. Berlin, Germany: De Gruyter.

Fenk-Oczlon, G., & Fenk, A. (2009). Some parallels between language and music from a cognitive and evolutionary perspective. *Musicae Scientiae*, *13*(2 suppl), 201–226. http://doi.org/10.1177/1029864909013002101

Fant, G. (1971). *Acoustic theory of speech production: With calculations based on X-ray studies of Russian articulations*. Berlin, Germany: De Gruyter.

Festinger, L. (1957). *A Theory of cognitive dissonance*. Stanford, CA: Stanford University Press.

Fini, A. A., & Yousefzadeh, M. (2011). Survey on relationship of achievement motivation, locus of control and academic achievement in high school students of Bandar Abbas (Iran). *Procedia - Social and Behavioral Sciences*, *30*, 866-870. doi:10.1016/j.sbspro.2011.10.168

Fitts, P. M., & Posner, M. I. (1967). *Human performance*. Belmont, CA: Brooks/Cole.

Gallwey, W. T. (1974). *The inner game of tennis*. New York, NY: Random House.

Greene, J. and Caracelli, V. (2003) "Making paradigmatic sense of mixed methods Inquiry," in *Handbook of mixed methods in social & behavioral research,* Tashakkori, A & Teddlie, C. (Eds) 2003, Sage, CA.

Hall, R. (2012, May). Mixed methods: In search of a paradigm. *Innovative Research in a changing and challenging world*. Symposium conducted at the meeting of the Australian Multicultural Interaction Institute, Tasmania, Australia.

Hymers, M., Prendergast, G., Liu, C., Schulze, A., Young, M. L., Wastling, S. J. Millman, R. E. (2015). Neural mechanisms underlying song and speech perception can be differentiated using an illusory percept. *NeuroImage*, *108*, 225–233. http://doi.org/10.1016/j.neuroimage.2014.12.010

Jarcho, J. M., Berkman, E. T., & Lieberman, M. D. (2011). The neural basis of rationalization: cognitive dissonance reduction during decision-making. *Social Cognitive and Affective Neuroscience*, *6*(4), 460–467. http://doi.org/10.1093/scan/nsq054

Jürgens, U. (2009). The neural control of vocalization in mammals: A review. *Journal of Voice*, *23*(1), 1–10. http://doi.org/10.1016/j.jvoice.2007.07.005

Kal, E. C., van der Kamp, J., & Houdijk, H. (2013). External attentional focus enhances movement automatization: A comprehensive test of the constrained action hypothesis. *Human Movement Science*, *32*(4), 527–539. http://doi.org/10.1016/j.humov.2013.04.001

Kenny, D. T., & Mitchell, H. F. (2006). Acoustic and perceptual appraisal of vocal gestures in the female classical voice. *Journal of Voice*, *20*(1), 55-70. doi:10.1016/j.jvoice.2004.12.002

Kreiman, J., & Gerratt, B. R. (2010). Perceptual Assessment of Voice Quality: Past, Present, and Future. *Perspect Voice Voice Dis.*, *20*(2), 62. doi:10.1044/vvd20.2.62

Kupers, E., Van Dijk, M., McPherson, G., & Van Geert, P. (2013). A dynamic model that links skill acquisition with self-determination in instrumental music lessons. *Musicae Scientiae*, *18*(1), 17-34. doi:10.1177/1029864913499181

Kupers, E., Van Dijk, M., & Van Geert, P. (2015). Within-teacher differences in one-to-one teacher–student interactions in instrumental music lessons. *Learning and Individual Differences*, *37*, 283-289. doi:10.1016/j.lindif.2014.11.012

Larrouy-Maestri, P., Magis, D., & Morsomme, D. (2014). Effects of melody and technique on acoustical and musical features of western operatic singing voices. *Journal of Voice*,*28*(3), 332-340. doi:10.1016/j.jvoice.2013.10.019

Law, D. (2014). The good, the bad and the ugly …. *Perspectives: Policy and Practice in Higher Education*, *18*(2), 35-37. doi:10.1080/13603108.2014.933610

Leigh-Post, K. (2014). *Mind-body awareness for singers: Unleashing optimal performance*. San Diego, CA: Plural Publishing.

Levenson, M. R., Kiehl, K. A., & Fitzpatrick, C. M. (1972). Levenson IPC Scale. *PsycTESTS Dataset*. doi:10.1037/t10235-000

Lopez-Fernandez, O., & Molina-Azorin, J. F. (2011). The use of mixed methods research in the field of behavioural sciences. *Quality & Quantity*, *45*(6), 1459-1472. doi:10.1007/s11135-011-9543-9

Loui, P. (2015). A dual-stream neuroanatomy of singing. *Music Perception: An Interdisciplinary Journal*, *32*(3), 232–241. http://doi.org/10.1525/mp.2015.32.3.232

Lundy, D. S., Roy, S., Casiano, R. R., Xue, J. W., & Evans, J. (2000). Acoustic analysis of the singing and speaking voice in singing students. *Journal of Voice*, *14*(4), 490-493. doi:10.1016/s0892-1997(00)80006-5

Ma, E., & Yiu, E. (2011). *Handbook of voice assessments*. San Diego, CA: Plural Pub.

Magill, R. A. (2006). *Motor Learning and Control: Concepts and Applications* (8th ed.). Boston: McGraw-Hill Higher Education.

Marchant, D. C., Clough, P. J., Crawshaw, M., & Levy, A. (2009). Novice motor skill performance and task experience is influenced by attentional focusing instructions and instruction preferences. *International Journal of Sport and Exercise Psychology*, *7*(4), 488–502.

McCoy, S. J. (2011). *Your voice, an inside view: Multimedia voice science and pedagogy*. Gahanna, OH: Inside View Press.

McNevin, N. H., Shea, C. H., & Wulf, G. (2003). Increasing the distance of an external focus of attention enhances learning. *Psychological Research*, *67*(1), 22–29.

McNevin, N. H., & Wulf, G. (2002). Attentional focus on supra-postural tasks affects postural control. *Human Movement Science*, *21*(2), 187–202. http://doi.org/10.1016/S0167-9457(02)00095-7

Meyer, D., & Edwards, M. (2014). The future of collegiate voice pedagogy: Analysis of current practice and implications for the next generation. *Journal of Singing*, *70*(4), 437–444.

Meyer, D., & Van Leer, E. (2015, October). Collegiate voice pedagogy: Analysis of current practices. *PAVA Inaugural Symposium*. Symposium conducted at the meeting of the Pan-American Vocology Association, Greensboro, NC.

Miller, R. (1986). *The structure of singing: system and art in vocal technique*. New York, NY: Schirmer Books.

Nordenberg, M., & Sundberg, J. (2004). Effect on LTAS of vocal loudness variation. *Logopedics Phoniatrics Vocology*, *29*(4), 183-191. doi:10.1080/14015430410004689

Oates, J. M., Bain, B., Davis, P., Chapman, J., & Kenny, D. (2006). Development of an auditory-perceptual rating instrument for the operatic singing voice. *Journal of Voice*, *20*(1), 71–81. http://doi.org/10.1016/j.jvoice.2005.01.006

Ollner, L. L. (2008). *Analysis of voice signals for the harmonics-to-noise crossover frequency* (Doctoral dissertation, KTH Royal Institute of Technology, UPC, Barcelona, Spain).

Omori, K., Kacker, A., Carroll, L. M., Riley, W. D., & Blaugrund, S. M. (1996). Singing power ratio: Quantitative evaluation of singing voice quality. *Journal of Voice*, *10*(3), 228-235. doi:10.1016/s0892-1997(96)80003-8

Overy, K., & Avanzini, G. (2009). Part VII Introduction: Music, language, and motor programming: A common neural organization? *Annals of the New York Academy of Sciences*, *1169*(1), 446–447. http://doi.org/10.1111/j.1749-6632.2009.04883.x

Peretz, I., Vuvan, D., Lagrois, M.-E., & Armony, J. L. (2015). Neural overlap in processing music and speech. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *370*(1664), 20140090–20140090. http://doi.org/10.1098/rstb.2014.0090

Persson, R. S. (1994). Concert musicians as teachers: On good intentions falling short. *European Journal of High Ability*, *5*(1), 79-91. doi:10.1080/0937445940050108

Pfordresher, P. Q., Halpern, A. R., & Greenspon, E. B. (2015). A mechanism for sensorimotor translation in singing: The multi-modal imagery association (MMIA) Model. *Music Perception: An Interdisciplinary Journal*, *32*(3), 242–253. http://doi.org/10.1525/mp.2015.32.3.242

Reid, C. (1972). *Bel canto principles and practices*. New York: Joseph Patelson Music House.

Repko, A. F. (2008). *Interdisciplinary research: Process and theory*. Los Angeles, CA: SAGE.

Riley, W. D., & Carroll, L. M. (2015). Training and teaching the singer. In M. S. Benninger, T. Murray, & M. M. Johns III (Eds.), *The performer's voice* (2nd ed.).

Rinta, T. (2009). Children's speaking and singing voices are one voice: evidence from perceptual analyses of independent voice parameters. *Journal of Music, Technology and Education*, *2*(2), 127–140. http://doi.org/10.1386/jmte.2.2-3.127_1

Rotter, J. B. (1954). *Social learning and clinical psychology* (Vol. 9). Englewood Cliffs, NJ: Prentice-Hall, Inc.

Schmidt, R. A. (1982). *Motor control and learning: A behavioral emphasis*. Champaign, IL: Human Kinetics Publishers.

Schmidt, R., & Lee, T. (2011). *Motor control and learning: A behavioral emphasis* (5th ed.). Champaign, IL: Human Kinetics.

Seikel, A., King, D., & Drumright, D. (2009). *Anatomy & physiology for speech, language, and hearing* (4th ed.). Clifton Park, NY: Delmar Cengage Learning.

Sherrill, C. (1998). *Adapted physical activity, recreation and sport: Crossdisciplinary* *and lifespan*. Boston, MA: McGraw-Hill.

Skoyles, J. R. (2000). The singing origin theory of speech. In *Abstracts, 3rd Conference, "The Evolution of Language*."

Slevc, L. R., & Okada, B. M. (2015). Processing structure in language and music: a case for shared reliance on cognitive control. *Psychonomic Bulletin & Review*, *22*(3), 637–652. http://doi.org/10.3758/s13423-014-0712-4

Stark, J. (2003). *Bel canto: a history of vocal pedagogy*. University of Toronto Press, Toronto, Canada.

Sundberg, J. (1987). *The science of the singing voice*. DeKalb, IL: Northern Illinois University Press, IL.

Sundberg, J. (2001). Level and center frequency of the singer's formant. *Journal of Voice*,*15*(2), 176-186. doi:10.1016/s0892-1997(01)00019-4

Swann, C., Moran, A., & Piggott, D. (2015). Defining elite athletes: Issues in the study of expert performance in sport psychology. *Psychology of Sport and Exercise*, *16*, 3–14. http://doi.org/10.1016/j.psychsport.2014.07.004

Titze, I. R., & Abbott, K. V. (2012). *Vocology: The science and practice of voice habilitation*. Salt Lake City, UT: National Center for Voice and Speech.

Toft, R. (2013). *Bel Canto: A Performer's Guide* (1 edition). New York: Oxford University Press.

Toner, J., & Moran, A. (2015). On the importance of critical thinking: A response to Wulf's (2015) commentary. *Psychology of Sport and Exercise, 22, 339-340*. http://doi.org/10.1016/j.psychsport.2015.05.007

Vance, J., Wulf, G., Töllner, T., McNevin, N., & Mercer, J. (2004). EMG Activity as a

Function of the Performer's Focus of Attention. *Journal of Motor Behavior*, *36*(4), 450–459. http://doi.org/10.3200/JMBR.36.4.450-459

Vanden Bosch der Nederlanden, C. M., Hannon, E. E., & Snyder, J. S. (2015). Everyday musical experience is sufficient to perceive the speech-to-song illusion. *Journal of Experimental Psychology: General*, *144*(2), e43–e49. http://doi.org/10.1037/xge0000056

Wapnick, J., & Ekholm, E. (1997). Expert consensus in solo voice performance evaluation. *Journal of Voice*, *11*(4), 429-436. doi:10.1016/s0892-1997(97)80039-2

Weiss, M. R. (1987). Self-esteem and achievement in children's sport and physical activity. *Advances in Pediatric Sport Sciences*, *2*, 87–119.

Welch, G. (2005). Singing as communication. In *Musical communication: Dorothy Miell, Raymond MacDonald, and David Hargreaves eds.* (1st ed.). New York: Oxford University Press.

Williams, G. C., & Deci, E. L. (1996). Internalization of biopsychosocial values by medical students: A test of self-determination theory. *Journal of Personality and Social Psychology*, *70*(4), 767-779. doi:10.1037/0022-3514.70.4.767

Williamson, G. (2014, February 1). *Jitter, shimmer, and HNR*. Retrieved from http://www.sltinfo.com/instrumental-measurement-of-voice

Wulf, G. (2013). Attentional focus and motor learning: A review of 15 years. *International Review of Sport and Exercise Psychology*, *6*(1), 77–104. http://doi.org/10.1080/1750984X.2012.723728

Wulf, G. (2015). Why did Tiger Woods shoot 82? A commentary on Toner and Moran

(2015). *Psychology of Sport and Exercise, 22, 337-338*. http://doi.org/10.1016/j.psychsport.2015.05.006

Wulf, G., & Su, J. (2007). An external focus of attention enhances golf shot accuracy in beginners and experts. *Research Quarterly for Exercise and Sport*, *78*(4), 384–389. http://doi.org/10.1080/02701367.2007.10599436

Wyke, B. (1974). *Ventilatory and phonatory control systems: An international symposium*. Oxford University Press, USA.

Zawawi, J. A., & Hamaideh, S. H. (2009). Depressive symptoms and their correlates with locus of control and satisfaction with life among Jordanian college students. *PsycEXTRA Dataset*. doi:10.1037/e676802011-006