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PEDAGOGICAL EFFICACY IN THE SINGING VOICE STUDIO:

WORKING WITH SELF-ASSESSED "TONE DEAFNESS"

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CHAPTER ONE

I. RESEARCH OBJECTIVE

Introduction

"Sh! He's drunk and singing-a most unpleasant racket. How clumsy and out of tune! He'll be sorry for it…let's teach the untutored oaf how to sing."
---*The Cyclops* by Euripides

Inspiration from Informal Case Studies

A student once gave a disclaimer before singing her very first note in her first lesson with me, proclaiming that she "really can't sing"; she in fact apologized for the sound I was about to hear. Another student, without acknowledgement, never quite matched the notes I was playing or singing in her warm up exercises. Still another chanted away in perfect rhythm, but far below the written melody line of the song he had prepared.

Working with students who presents as "tone deaf" can be frustrating and a bit perplexing. Yet, when provided with specific, guided instruction, these students progress toward accurate production. They can learn to map and successfully reproduce melodies in lessons and may even find this surprising. Witnessing such drastic improvement and growing confidence can be very gratifying as a teacher

It is my belief that it may be out of these students' initial control to fix the problem, bringing disappointment not only to the student but also the teacher who is repetitively playing the goal note to the same inaccurate result. Although there are several commonly used techniques when teaching inaccurate pitch-matchers, I would argue that for the majority of cases, hearing the pitch isn't the core issue and therefore shouldn't be the focus of instruction. I have observed many teachers explicitly addressing the goal pitch and training the singer's awareness of its characteristics in order to help him/her match it vocally. However, when the underlying vocal coordination is addressed, the students gain the motor skills and sensory awareness of singing and the pitch problem is inevitably resolved. Tools and strategies for developing this coordination have been studied with vocal performance students and professional singers, as well as with clients of speech therapy.

These informal observations sparked my curiosity about comparative efficacy of training. Multiple approaches have been presented as effective, but in separate studies, with different research teams which often do not include a skilled and knowledgeable vocal pedagogue. These investigations also used different populations, different research designs, and found efficacy to varying degrees. How are voice teachers to efficiently glean the relevant supportive information in order to decide the most beneficial approach for self-assessed "pitch-inaccurate" students?

My study tracked and measured the vocal progress of individuals who claimed they could not sing on pitch accurately. Participants were each given a pre- and post-test to measure their production accuracy, as well as gather other descriptive data. Between testing sessions, they received eight individual 30-minute voice lessons in one of five randomly assigned instructional protocols. One of the groups was a control group, which received no instruction until after the post-test. With the comparative and illustrative information gained from this investigation, I hope to bring more practical and worthwhile information to voice teachers about working with this population.

My Biography as a Voice Teacher

My singing training, as well as my training in vocal pedagogy, is based in traditional Western singing styles (i.e. Western Classical singing, Musical Theatre, Jazz, etc.), so that is the cultural context for the technical focus of my teaching. I received my Bachelor of Music in Vocal Performance and Music Education from Ithaca College, my Master of Music in Vocal Performance from New York University Steinhardt, and a Certificate of Vocology from the National Center of Voice and Speech. I studied Vocal Pedagogy at NYU, and have taught voice for fifteen years. Working with the NYU Voice Center at Langone Medical Center, I collaborated on a voice team to help singers recover from injuries or

functional issues. While at NYU, I taught undergraduate vocal performance and music education majors, as well as non-music majors. While this was by majority in one-on-one instruction, I also taught group voice classes of eighteen non-music majors simply wanting some beginner experience singing. These lessons and classes, along with my pedagogical studies and observations, cultivated my interest in working with the inaccurate pitch-matching population as well as the established singers. I taught in public schools for three years, and now teach in a private all-boys school. When facing a chorus of adolescent boys in varying stages of voice change, teaching efficacy is a constant curiosity. The first thing some notice when listening to a changing-voice choir is pitch instability and insecurity, but that is just the beginning. That is the "what" of the issue. My concern as a teacher must go further – towards the "why" and ultimately, the "how" they can improve.

Research Question

Can approach(es) to singing training effectively improve pitch production accuracy?

Problem Statement

"The longer the correction [of singing] is delayed, the more negative personality reactions develop and the more difficult it is to correct the problem." (Gordon 1979, p. 56).

There are many misunderstandings concerning people described colloquially as "tone deaf": those unable to correctly imitate pitches or sing in tune with others. Through this study, I aim to clarify these common misunderstandings and explore the potential for improvement for these individuals by investigating the efficacy of teaching methods. This study will also help develop knowledge about differences within this population, described in this study as "inaccurate pitch-matchers." Within this group there is such diversity that research is needed to help us understand the various causes and solutions for a very complex condition that is often a source of pain and embarrassment.

Furthermore, as it is shown in psychological and neurological research, investigating a malfunctioning system can often be extremely helpful in explaining the functioning system. I aim to study the inaccurate pitch-matching population to clarify what instructional connections are necessary to complete the gap between musical perception and accurate production.

The teaching of singing is limited by the reliance on language alone; we cannot instruct technique or musical accuracy by fixing finger placement on keys or hand position, as in the case of other instruments. Therefore, the training must

elicit the desired response without direct sight or manipulation of the instrument. The instruction is filtered through the student's experience and preconceived definitions, not to mention the student's auditory perceptual system, motor coordination, and ability to integrate information across multiple senses. This is tricky business and although several approaches to teaching inaccurate pitch-matchers exist, there have been no studies systematically testing these teaching strategies and no recent longitudinal studies investigating instructional efficacy.

Statement of Purpose

> "Challenging the label of 'tone deafness' may involve changing people's belief that their difficulties are caused by a permanent impairment, through demonstrating this possibility of improvement." (Wise & Sloboda 2008, p. 20)

The purpose of this study is to systematically describe and compare the relative effectiveness over time of four instructional approaches to singing-voice training on the pitch-production accuracy of adults: (1) auditory awareness training of the goal pitch, (2) sensory/proprioceptive awareness training of the vocal mechanism itself, (3) visual awareness training of the goal pitch, and (4) neutral instruction for regular musical exposure and singing practice. Participants were randomly assigned to receive one of the approaches for all of the private lessons. In addition to these instructional groups, however, there was also a

control group, which received no lessons until after the post-test, thus making five total participant groups. This design allows comparisons to illuminate whether there are differences between specific training approaches and the inclusion of a neutral and control group will explore whether there is a difference between training, general music exposure (neutral group), and no training (control group). Differences in performance between these groups can inform singing teachers about the relationship between instructional technique and the progress of attaining pitch-matching accuracy as related to simply singing on a regular basis, while controlling for as many voice production variables as possible within the provided singing exercises. I included both male and female participants in order to get a fuller sample of the inaccurate pitch-matching population, instead of solely accepting one sex. In this way, I kept the potential participant pool slightly larger, since this population is already quite small.

Sub Purpose Statements

1. To systematically compare the relative effectiveness of four commonly used instructional approaches to singing voice training on pitch production accuracy, one of which being simple music exposure (neutral group), in order to account for the basic act of going to music lessons without active instruction.

2. To assess the four experimental groups against a control group receiving no training in order to examine the relationship between instructional approaches and pitch production accuracy above and beyond natural maturation and everyday experiences.

3. To describe these approaches and the development process observed in the participants.

4. To control for as many voice production variables as possible across the groups within the provided singing exercises, e.g. vowel formant frequencies, breath management and sustainability, registration, range and tessitura, etc.

Significance of Study

Statistics and Other Numbers

A reported 4% of the population (Kalmus & Fry 1980) has a condition known as *congenital amusia*[1]*:* a lifelong deficit in musical perception, popularly known as tone deafness (Peretz 2001). Even this minor percentage is debated and could potentially be smaller still globally, since Kalmus and Fry's study exclusively involved four samples of adults in London, England. However, a proposed 10-17% of the population assess themselves as being "tone deaf"

[1] For more detailed neurological information on congenital amusia, see Peretz, Brattico, Jarvenpaa, & Tervaniemi 2009

(Cuddy, Balkwill, Peretz & Holden 2005; Dalla Bella & Berkowska 2009; Pfordresher & Brown 2007). In other words, within the group of people considering themselves to have a perceptual deficit, current research suggests that only a small percentage is truly tone deaf.

The potential causes and factors of *non-amusic* inaccurate singing will be explored further in the related literature review, but I also propose that there might be a misunderstanding or mistranslation of "tone deaf" in the general population. Within the neuroscience and psychology research communities it is understood to mean a *perceptual* deficit, but in general it seems laypersons use it to mean that they do not accurately *reproduce* pitches, intervals, or melodies.

Need for Study

Through my study I will explore the efficacy of varied techniques to teaching pitch-matching accuracy. This comparative information can provide actual information about what instruction was effective and can give teachers specific guidance and recommendations for what to do when working with a student inaccurately matching pitch. Comparing pedagogical techniques and goals for pitch-matching inaccuracy can better clarify what connections guide the perception-to-production practice. Furthermore, studying teaching efficacy in this specific population can shed light on general teaching practices within voice

studios. How can we better understand not only the workings of the voice, but the teaching and learning process involved in developing this intricate and internal instrument?

This inquiry contributes to a larger conversation about the dynamics of voice, musical perception, the brain, instructional feedback, sensory integration in the learning process, and theories of fixed versus growth mindset. Though it is focused on teaching efficacy with a specific population, it has potential interdisciplinary resonance beyond the field of vocal pedagogy.

Important implications for future study include applied methods for group singing voice instruction, application to general music education in early childhood and elementary school, pitch-matching training possibilities for the congenital amusic population, fine-tuning professional singers' voices, cultural factors affecting pitch-matching ability and training, and teaching efficacy at large regarding instructional focus and goals.

Definitions

Chest voice: A term typically referring to the mode of vibration in which the bulk of the thyro-arytenoid muscle is in contraction and the vocal folds vibrate with a higher ratio of contact time, leading to a richer spectrum of harmonics. In general, it makes up the majority of the male singing range. (related term: Head voice).

Congenital amusia: Commonly termed "tone deafness"; a deficit solely in pitch perception and processing for music, without interference or deficits in speech, memory, and intellectual capacity.

Feedback: Used here in terms of motor learning theory; the information that people receive about their attempts of performing a goal action or skill; can be during or after the task, and can be intrinsic or extrinsic.

Glottis: The space between the vocal folds.

Head voice: A term referring to the mode of vibration in which the vocal folds are stretched (thus its correlation to higher pitches), less of the mass of the vocal folds are involved in the vibration which then involves less collision during the cycle of oscillation and they remain closed for less time than chest voice. In general, it makes up the majority of the female singing range physiologically, although it is not always employed in frequent practice. This final point of the rarity of head voice use in the general population holds large bearing on working with untrained singers. Females typically strain to reach higher pitches using chest voice, which will not allow the higher frequency of vibration, leading them to think unnecessarily that they possess a limited range and cannot match higher pitches accurately. (related term: Chest voice).

Hertz: Named for Heinrich Rudolf Hertz, it is the unit of frequency defined as one cycle per second. Therefore, if the complete cycle of oscillation of the vocal folds occurs 440 times per second, then it is 440 Hz. Our Western division of the

musical scale into twelve semitones, however, is logarithmic. With every octave higher, frequency in Hertz doubles. Therefore, the frequency difference in Hertz of a lower octave will not be the same as the frequency difference in Hertz of a higher octave. Using our example of 440 Hz (an A4), the A below it is 220 Hz, but the octave above it is 880 Hz. So, the frequency span of the lower octave is 220 Hz, where the frequency span of the higher octave is 440 Hz. This makes comparisons between higher voices and lower voices (male and female ranges) impossible using the Hertz scale alone.

Intonation: Referring to the relationship, or ratio, between frequencies being sung or played (including unison when discussing pitch-matching). Due to its prevalence in popular culture, the study is based on Western music's 12-note division of the octave in well-tempered tuning. Given the straightforward pitch-matching nature of the tasks, and the ease of assessing by comparison, the participants' recordings are based on the difference in Hertz (measure of frequency) between the presented pitch(es) to the sung response. Since the Hertz scale is logarithmic, this value is normalized using cent variations in order to compare participants of different sexes; 100 cents equal a semitone or half step.

Kodàly hand signs: Borrowed from the teaching of Curwen, these are positions of the hands (much like sign language) that uniquely correlate to each step of the Western scale to the syllables *do, re, mi, fa, sol, la, ti* and *do*. The shape of each is designed to show the function of that note within the larger scale. Kodàly added

directional movement to the hand signs, so that learners can watch the melodic notes move higher or lower physically with the hand movements: the lower *do* is usually at waist height and *la* sits around eye-level.

Passaggio: Literally "passage"; a bridge between registers in the voice, varying in pitch ranges depending on the voice type. Colloquially, it is often known as a "break" in a voice – where something changes mechanically (whether perceived or not) in order to keep singing higher or lower. This is a point of instability and through rigorous vocal training is smoothed out in order to balance out the registers of one's entire singing range. In untrained singers and beginners however—even young trained singers—this bridge can be tricky to negotiate and often is the cause of intonation issues on its own.

Proprioception: From the Latin proprius, meaning "of one's own," this is the sense of feeling one's own body parts in relation to each other. It is an internal awareness referring to position, motion, and equilibrium. For example, a person can be aware that her foot is lifted off the ground without having to see it.

Range: The full available span of pitches; can be in reference to the melody line of a song, or the pitches that a person is able to sing.

Semi-occluded vocal-tract posture: A vocalise sung with the mouth partially closed or narrowed. This includes lip trills and raspberries, where the lips or tongue are oscillating. Either way, pressure is built up at the mouth, which takes

pressure off of the vocal folds themselves, helping to develop vocal ease and efficiency.

Tessitura: A smaller subset of a song's range, this is the area in which a majority of the song's melody is situated, usually a small interval such as a fifth; not influenced by intermittent extreme notes of a melody, rather it defines the part of the range that is most consistently used. It is also often listed in relative reference to where it lies within a singer's range, e.g. medium, high, medium-low, etc. "Medium voice" typically refers to the interval of notes situated between the lower and upper passaggi regions for women, and starting a fifth below and up to the beginning of the first passaggio for men.

Timbre: Also referred to as tone quality or tone color, it is the characteristic descriptive elements of a sound which sets it apart from another, not including the loudness or pitch level, e.g. bright, brassy, dark, rich, strident, warm, nasal, sweet. This perceived distinctive sound is determined by the sound's harmonic spectrum and waveform envelope.

Vocal folds: Colloquially called the vocal cords, these multi-layered folds of tissue, which include the paired thyro-arytenoid muscle, are located in the larynx and serve both as a valve to protect the trachea from foreign objects and, when vibrating, as the source of phonation.

Vocalise: A vocal exercise sung on vowel sounds—sometimes preceded and/or followed by consonants—for the purpose of developing some technical aspect of the voice.

Voice register: Has been used to describe perpetually distinct regions of vocal quality that can be maintained over some ranges of pitch and loudness (Titze 2000). It also refers to a range of pitches which the voice creates with the same laryngeal function or vibratory pattern, but this can be affected by acoustical events as well. Examples are chest voice, head voice, mixed voice, vocal fry, falsetto, and whistle register.

CHAPTER TWO

II. RELATED LITERATURE REVIEW

"As long as we live, there is never enough singing." -Martin Luther

For the purpose of clarity within this review I will categorize the source literature under the four headings of vocal production, historical principles of teaching singing, neuropsychological roots of singing, and theories and application of motor learning. Though these topics share information at times, given the volume of literature on the subject of vocal pedagogy, separate classifications allow for more involved discussion.

Source of Data

Vocal Production

In order to understand how to potentially remedy *inaccurate* singing, a knowledge of vocal production is essential. In broad terms singing can be broken into four components: breathing, phonation, resonance, and articulation. Celebrated pedagogue Barbara Doscher mapped these areas to the following parts

of the vocal tract: lungs (air or force), larynx (vibrator), resonance cavities (selective sound filter), and aperture (mouth or emission linkage) (1994 p. xviii). These four components are interdependent and function simultaneously during singing.

Fundamental frequency (interpreted as pitch) and intensity of sound are determined by vocal fold tension (glottal resistance), aerodynamic power (subglottic pressure to air flow), length of the vocal folds, and mass of the vocal folds (Doscher 1994, p. 64). When producing high pitches, the vocal folds are longer and thinner and the number of vibratory cycles increases. The reverse is true for lower pitches; the folds are shorter and more lax, causing more vertical phase difference in their slower vibratory cycle, as shown in Figure 1. Additionally, the thyro-arytenoid muscle is more contracted in chest register, assisting in vocal fold contact. In lower frequencies glottal resistance predominantly regulates pitch and intensity, but in higher frequencies air-flow becomes the primary factor (p. 64).

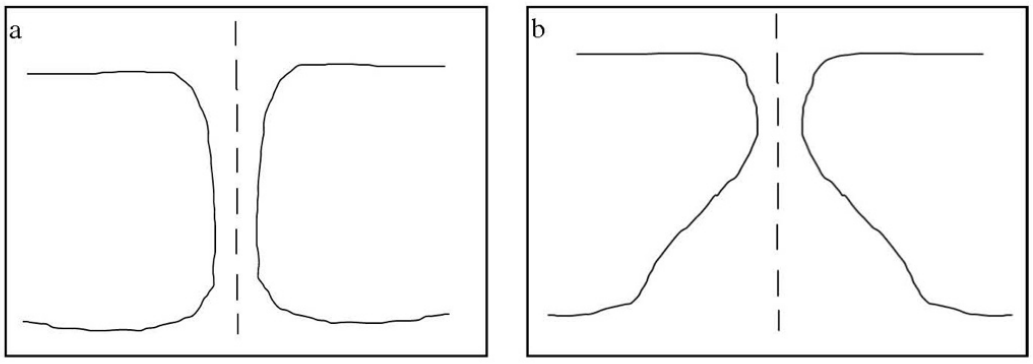


FIGURE 1. Vocal fold vertical phase difference. A coronal section in (a) chest register, producing lower pitches, and (b) falsetto register, producing higher pitches. Note the difference in vertical alignment and vocal fold connection due to levels of thyro-arytenoid (TA) muscle contraction and stretched length of the folds. The lower pitches don't stretch the vocal folds as much, so more of the depth of the vocal folds come together for vibration in the chest register, whereas the folds are longer and tighter in falsetto register, so less of the vertical depth will be lax enough to fully vibrate, as shown by the small upper portion of (b).

While the vocal folds determine the source signal of sound, the resonance cavities above them filter that information and affect the perceived vocal timbre. "Resonance cavities" refers to the pharynx and the mouth, together forming the vocal tract. The acoustic signal produced from vocal fold oscillation includes a fundamental frequency (F0) as well as additional harmonics,[2] or integer multiples of the fundamental (e.g. if F0/H1=440Hz (A4), H2=880Hz (A5), H3=1320Hz (E6), etc). While initially, the fundamental is the strongest relative presence in the

[2] Commonly termed "overtones" or "partials," each of these terms carries a slightly different definition and are not interchangeable; I purposely use "harmonics" to include the fundamental frequency and each integer multiple thereafter.

complex sound, when this acoustic information propagates in the vocal tract, it is adjusted and filtered, as is seen in Figure 2.

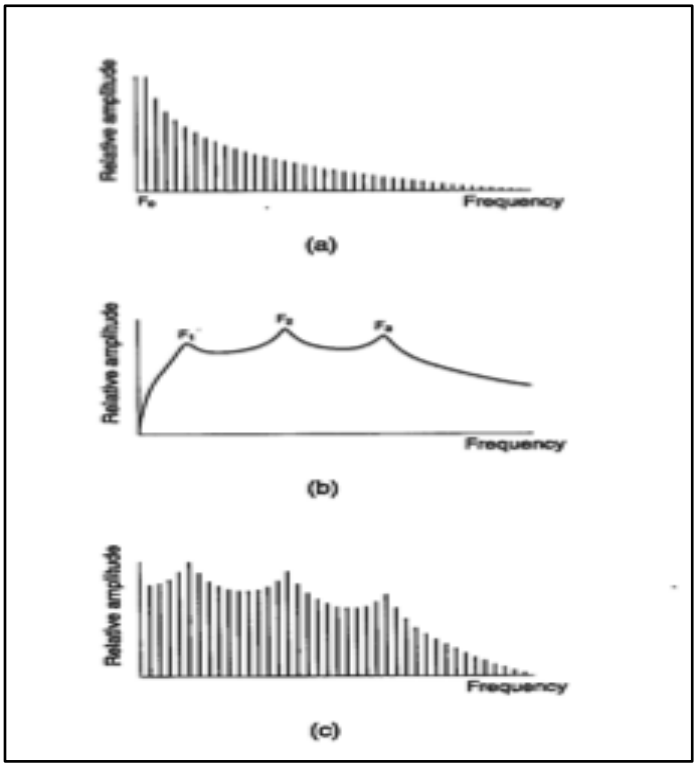


FIGURE 2. Source signal, formant energy, and impulse response. The vertical axis of each is the relative amplitude of the sound, and the horizontal axis of each is the frequency. (a) original signal from the glottis of evenly distributed harmonics, which get progressively weaker as the frequencies rise, (b) filter of potential energy bands (formant frequencies) within the vocal tract shape, and (c) the acoustic signal response showing the initial frequencies from (a) as they are sent through the potential energy bands (formant frequencies) in the vocal tract. The end result is that some harmonics are given energy boosts and others are dampened depending on the proximity of the formant frequencies. (from Titze 2000, p. 175)

Formants are resonances of the vocal tract and they function similarly to band pass filters, meaning that they boost frequencies within their range, and dampen frequencies outside of their range. Johan Sundberg explains that resonance exists when the sound fed into the vocal tract, or resonance tube, is helped by the sound traveling back and forth within it (Sataloff 1998). There are infinite formant frequencies but only the first several are of significance. The first two formants determine the vowel that is perceived and therefore they are known as the "vowel formants" (Sundberg 1987). The descriptive timbre of one's voice is created by a number of elements in the sound: the number and distribution of harmonics produced, the relative amplitudes of these harmonics (influenced by formant frequencies), the total intensity, the presence of any inharmonics, as well as the fundamental frequency itself (Doscher 1994).

Articulation is the coordinated movement of the lips, tongue, soft palate, jaw, and vocal folds. These voluntary adjustments by the singer tune the vocal tract, modifying the vowel formant frequencies so that they cooperate with a given sound being produced. These vowel modifications are based on several rules, which govern how formant frequencies will shift given certain shape adjustments within the vocal tract (Miller 2008; Titze 2000). Berton Coffin outlined extremely clearly the progression of properly tuned vowel sequences for each voice type based on the location of the passaggi (Coffin 1980; Coffin 1987). Most singers are innately aware that certain vowels are easier to sing in certain

pitch ranges even if they don't know why. When written vowels are modified towards the ideal vowel for a specific voice type on a specific pitch, the singer becomes aware of an ease of effort due to the acoustical aid and no longer must rely as heavily on extra subglottal pressure and muscular tension in order to sustain the desired sound. The harmonic display and relative amplitudes are visible when sung into a spectrogram program such as *VoceVista*. High level professional singers smoothly and consistently shift resonance tuning and harmonic amplitudes in order to pass through passaggi regions imperceptibly (Miller 2008).

Renowned voice teacher Richard Miller wrote, "Anyone who practices an art form must first learn to deal with all of its components. That is why the singer needs to learn systematic coordination of the motor, the vibrator, and the resonator. Only then can the art of performance become a holistic event" (Miller 2004, p. 248). The sound that radiates from a singer's mouth into a room is the product of coordinated breathing, adequate but not excessive vocal fold resistance during phonation, and a properly tuned vocal tract through the shaping of the articulators. Singing is most certainly a complex network of interdependent systems, all brought together through technique in order to make art. Therefore, working with adults whose singing voices are not functioning optimally does not necessarily have a straightforward answer. There are many parts to the vocal mechanism that could be the causes of the issue. This is also only taking into

account the vocal instrument itself; we also must consider the techniques of teaching, and the processes of learning.

Historical Principles of Teaching Singing

In developing the coordination of these components, singers are taught using various techniques, approaches, and tools that hopefully elicit a desirable response. Since the singer is the instrument, the teacher is limited to using techniques that work towards vocal function circuitously most of the time, rather than being able to immediately and visibly manipulate the technique as often done with other instrumentalists, such as fixing a fingering or arm position. Since this investigation is about what is possible in singing training interventions with a particularly tricky population, it is crucial to outline the guidance left by prominent vocal pedagogues.

The philosophies and principles of teaching singing have shifted and evolved over time and although many ideas and theories have been supported by the current technological advancements and measurements of vocal production, at times personal beliefs of teaching have caused outright public arguments between pedagogues. There was a long-lasting dispute between renowned singing teachers Francesco Lamperti and Manuel Garcia II based on, among other things, vocal onset.

Given that teaching efficacy is the goal of my investigation, I find complications in the historical findings compelling. Lamperti's teaching wisdoms are known to us as written by his student (and next-generation pedagogue) William Earl Brown in the form of maxims, which unfortunately are by majority extremely vague (Lamperti & Brown 1957). Examples of this include: "Until there is a relationship between the vowels you cannot sing" (p. 93), "Sing from your head downward, because your head is the instrument" (p. 23), "Your voice begins first. Your breath comes next. Your energy enters last" (p. 48), and "Do not 'hold' your tone, spin it. Hold your breath" (p. 29). These demonstrate the necessity for interpretation in order to fill out the picture of Lamperti's teachings. Furthermore, some concepts seem to have been disproven by current knowledge of anatomy, physiology, and acoustics. Examples of this are "The inside muscles attached to the vocal ligaments and cartilages of the throat (larynx) are tensed only while producing sound. They are not used during silences" (p. 41) and "The gradation of this letting go is controlled by the diaphragm, which however is never relaxed" (p. 47). The laryngeal musculature is in fact used during silence, since the primary purpose of the larynx is to protect the airway from foreign objects. Secondly, the diaphragm does release during expiration (when singing) although one can infer that he meant the concept of *appoggio*, which involves the continued contraction of the diaphragm during the first phase (only) of expiration. Lamperti was a master teacher, but we are left guessing what he actually meant by

these maxims, which is unfortunate because contemporary teachers may be unknowingly distorting the *bel canto*[3] teachings. If this is the case, and voice teachers are misinterpreting or misusing these maxims, then we are still lacking teaching efficacy as a whole community of educators.

Garcia wrote his technical teachings in multiple books, however he must have realized that some of his writings were being misinterpreted because he clarified many points of his *Traite complet de l'art du chant* in the later *Hints on Singing.* Attempting clarity and objectivity, he also reported his trailblazing findings on anatomy and physiology and is generally supposed to be the inventor of the laryngoscope, although this has been called into some doubt (Stark 1999; Coffin 1989).

Voice teachers depend on language and instruction in order to transmit ideas and technique through the desired response. Therefore, the words we choose can in fact affect the actual response we hear from the student. Garcia is not the only person who saw a need for clarification of teaching language. Medical specialist Friederich S. Brodnitz disapproved of the widely popular use of the word "relax" in voice studios, which he believed was being misinterpreted by singers as an absence of activity (Brodnitz 1965; Stark 1999). His view was therefore that it is muscles working in balanced equilibrium that gives the singer a

[3] The age of *Bel Canto*, which literally means "beautiful singing," was a period of vocal music in the 18th century and early 19th century originating in Italy and spreading throughout most of Europe. Though it is often nostalgically referred to as the golden age of singing, its exact interpretation remains ambiguous and varied.

sense of *release,* instead of *relaxation.* Many years later Doscher took issue with the extremely fashionable word "support" in the voice studio, preferring instead "breath energy," which she explained elicited a healthier response of air flow, rather than the muscular tension and air pressure often brought about by the idea of "supporting" the voice (Doscher 1994). I completely agree with this term substitution but find it unfortunately still enjoying widespread acceptance. In my study, I used teaching language that has been shown to elicit healthy vocal responses, and will avoid the contradictory terms such as "relax" and "support."

Coffin, another pedagogue bridging the gap between science and singing, applied existing principles of acoustics to the singing studio. His books are extremely detailed with exercises formed using vowels specifically chosen for the sung pitches, and he outlined his reasoning behind lining up the formant frequencies (Coffin 1987).

From Coffin's work, we know that *what* we sing affects *how* we sing it (Coffin 1980, Coffin 1987). Shirlee Emmons, a vocal pedagogue, wrote strongly about Coffin's influence on vocal instruction:

> Amazingly, his exercises function not only as a training tool, but are remedial as well…Into my studio come singers searching for their high range, which many have lost in spite of a successful career. Overtones of Bel Canto enables me to help them find it again. This is because the Coffin exercises are science-driven, yet thoroughly practical. They answer voice teachers' quest for the "how-to-do-it" information. (Emmons 2016)

Proper vocalise construction and repertoire assignment is crucial for the training of singers. This is still an area of development and confusion, because how someone assigns a difficulty level to a song is very individual and is based on many factors such as range and tessitura, vowel arrangement, necessary breath sustainability, melodic structure and movement, required musicianship skills, as well as many personality trait factors. John Nix, a student of Doscher's (herself a student of Coffin's), compiled his teacher's notes on assigned repertoire outlining all of these factors and more and assigning a difficulty level in a reference catalogue (Doscher & Nix 2002). However, one finds that many songs listed in this catalogue as advanced difficulty appear in young singers' teacher-assigned repertoire because the songs are beautiful, popular, and/or familiar to the teacher. This misclassification affects studies on singer ability when the experimenters assign an "easy" song to the participants, not taking into account all possible factors that might, in reality, make it quite difficult to maneuver accurately, especially for untrained singers. Taking this repertoire-singer relationship into account, I have assigned songs that will not confound the participants' abilities with vocal production difficulties such as an overly large range, mismatched vowels in passaggi areas, long phrases, too many ascending phrases, and disjunct melodies with large leaps. In this manner, I have tried to be more accurate in my study of participants' abilities, because I adjusted for the difficulty of the task itself.

Miller clearly understood the complexities of teaching voice, and accepted as part of his job not only to educate his voice students, but also other voice teachers who were looking for answers in a cloudy haze of indeterminate pedagogical language. Although his *The Structure of Singing: System and Art in Vocal Technique* is a more involved book with scientific and procedural details in singing (Miller 1986), he wrote *Solutions for Singers* based on questions that singers and teachers alike asked him over the course of his career during presentations, master classes, and conferences (Miller 2004). This book is more of an open, candid discussion about how the voice works and how we should teach singing. However, Miller still admits that because people are created differently and we are all individual, there is no one single way to teach everyone. Doscher certainly agreed with the idea that a teacher cannot approach every singer the same, and that instead must keep in mind the principles of anatomy, physiology, resonance, and acoustics, while working with a trained ear in order to best choose exercises and songs that will hopefully form the most efficient path (Doscher 1994, p. xiv).

Emmons wrote that when she began teaching in 1964, "most voice teachers invariably used for their students...the methods under which they themselves had studied" (2016). Unfortunately, despite the massive literature, many voice teachers today still teach by this same principle. They teach what they themselves do successfully, or what their own teacher taught them - thus treating

each student not only the same, but like a younger version of themselves. This is problematic in and of itself, given the advice and guidance from pedagogues in the literature, but it is additionally vexing when it comes to the pitch-inaccurate singer. This is because it is unlikely that voice teachers (professional singers) had to be taught fundamentally how to hear and match pitches, therefore they have no personal experience or protocols from which to draw in teaching this skill. Consequently, teachers would do well to instruct based on what works for the student in front of them as opposed to what works for their own singing.

Some of the information in the annals of vocal pedagogy is vague, confusing, and seemingly contradictory. However, there is a strong tradition of voice teachers attempting to clarify instructional language, collaborating with outside sciences in order to better educate and inform their teaching, connecting with other teachers and sharing ideas and practices, and inviting flexibility into the teaching philosophy and approach. These trends are currently evidenced by the attendance and interdisciplinary lectures at conferences such as the Voice Foundation in Philadelphia, the newly formed Pan-American Vocology[4] Association, the National Association of Teachers of Singing, as well as the growing number of integrated voice centers made up of medical doctors, speech language pathologists, and voice teachers collaborating together in order to understand all perspectives of teaching and learning voice production.

[4] voice science, termed in relation to audiology

In light of this history, I used specific teaching strategies that elicit a desired response (e.g. semi-occluded vocal tract postures, "friendly" vowels, agreeable range, etc.) so that the students learn by doing and I used language that made sense to the student (preferably introduced by the student) in describing the result of the teaching strategy.

Neuropsychological Roots of Singing

The neuropsychological roots in music perception and voice production are currently being researched by examining the neural pathways with neuroimaging data from healthy persons and also studying how these pathways are affected by lesions in the brain or congenital amusia. By discovering which affected connections influence music perception and voice production, brain researchers are able to develop a clearer concept of what areas are involved in the complex action of singing (Peretz 2008; Zaidel 2005; Zarate 2013). As written by Michael McCloskey, "Complex systems often reveal their inner working more clearly when they are malfunctioning than when they are running smoothly" (McCloskey 2001, p. 594). It might also be illuminating to investigate inaccurate singing remediation since perhaps talented singers are just able to make things work, rather than truly being due to the type of instruction. By working with "malfunctioning" voices, I hope to shed light on instructional protocols that

address the source of the production issue and offer useful guidance pertaining to the "how" of singing training. Too often, we stop at the "what" is happening in a voice (i.e. out of tune), or even the "why" (i.e. hearing it wrong, singing too low). What I propose is an investigation into the "how"—what helps a student move from the current issue (in this case, inaccurate pitch-matching) towards a solution?

It is important to know how the brain processes the musical and vocal information, so that the instruction can help to make the necessary (but perhaps missing) connections between the two. Researchers are investigating potential music-specific areas of the brain—akin to the speech center, Broca's area—with some success. Isabelle Peretz in 2001 already found the support for "such specialized neural networks…compelling" (p. 154). More recently, Zatorre and Zarate reported evidence from several studies suggesting that a pitch sensitive region exists in the brain (Zatorre & Zarate 2012, p. 264). An investigation by Zarate, Wood and Zatorre looked specifically at the voluntary and involuntary vocal responses to pitch shifts of auditory feedback in experienced singers and outlined the cortical regions of the brain that may govern larger vocal corrections under voluntary control (2010, p. 616). These inquiries all point to perhaps more of a pitch-sensitive network of structures, rather than a distinct area of the brain solely dedicated to melody.

Looking more specifically at impaired pitch production, it was long believed to be due primarily to a deficit in pitch perception. This is no longer the predominant theory. Although *hesitantly* disputed (Hutchins, Zarate, Zatorre, & Peretz 2010), many researchers have found that perception and production do not have a significant relationship (Bradshaw & McHenry 2004; Dalla Bella, Giguère, & Peretz 2007; Dalla Bella, Giguère, & Peretz 2009; Loui, Alsop, & Schlaug 2009; Pfordresher & Brown 2007; Zarate et al. 2010). Hyde and Peretz found that most normal subjects have no problem discriminating pitches differing by more than a quarter of a semitone, which illustrates the probability that pitch-matching deficit is not perception based, given the volume of inaccurate pitch-matchers within this normal perceptual designation (2004). Pfordresher and Brown admitted that perception is a plausible cause for certain individuals but asserted that it does not fully explain the majority of cases. They outlined three other potential causes of poor pitch accuracy in addition to the perceptual deficit: a motor deficit, an imitative deficit due to a mismapping of pitches onto the motor gestures, or a memory deficit (2007). Hutchins and Peretz proposed the additional factors of motivation and practice (2012). Both of these studies concluded that the most likely factors affecting the majority of pitch-matching inaccuracies are those of motor deficits and sensorimotor mismapping. In other words, it is potentially either that the vocal mechanism itself is uncoordinated (which makes sense given the complexity of the vocal mechanism outlined earlier for the high demands of

singing[5]), or that somehow the heard pitch is mismapped onto the mechanism due to timbral differences (thus referring to the factors listed previously affecting vocal timbre). These elements can be seen as part of the vocal sensorimotor loop in Figure 3. Furthermore, Dalla Bella et al. discovered that even some of the amusic participants sang accurately despite severe perceptual deficits (2009). The idea that the un-coordination of a voice could lead to pitch problems is not a new one. In fact, Joyner listed this as the most important factor when working with children. He suggested that vocal training could in fact improve musical perception, not the other way around (1969).

[5] For more in depth details on the complexity of the neural control of vocalization and singing, see Zarate 2013.

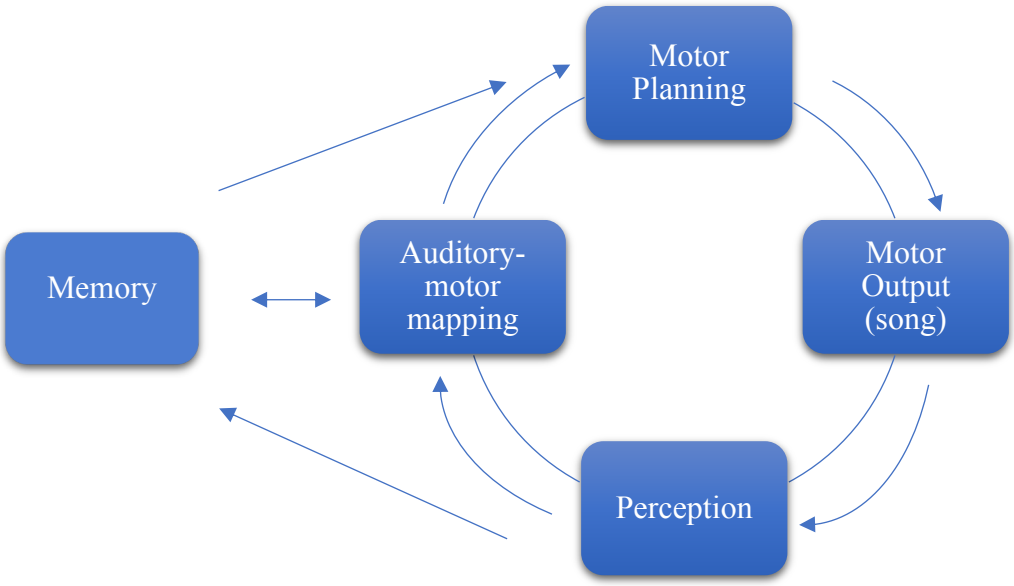


FIGURE 3. Vocal sensorimotor loop (VSL). Representation of the VSL from hearing a pitch (perception), figuring out how that would work in the voice (auditory-motor mapping), planning to reproduce it (motor planning), reproducing it (motor output), and evaluating the accuracy of it while it is being sung (perception again)—all while forming the basis of a memory representation of this action. (simplified from Dalla Bella et al 2012, p. 339)

There is a trend of contradiction among the field's findings concerning what training interventions are helpful. For example, some training studies working with inaccurate pitch-matchers have found that a visual representation of the pitch(es) helps (Anderson, Himonides, Wise, Welch & Stewart 2012; Wilson, Lee, Callaghan & Thorpe 2008), and others found that visual information on the pitch(es) does not help (Hutchins & Peretz 2011). Some research reports that auditory feedback helps (Mürbe, Pabst, Hofmann & Sundberg 2002), and others report that auditory feedback does not help (Hutchins et al. 2010; Pfordresher & Brown 2007). Clearly the inventory of reports show conflicting results and this

issue of tuning pitch-matching inaccuracies is more complex than it may at first appear.

The results are not necessarily as contradictory as they seem, however, since due to differences in experimental method and study populations the findings could simply not have been measuring the same thing. For example, Anderson et al (2012) found that concurrent visual feedback was beneficial to congenital amusics' pitch accuracy while Hutchins and Peretz (2011) found that visual representation of pitch was not influential at all. Looking closer at these findings, Anderson used *Sing and See*, a computer program that represents real-time visualization of the pitch being sung, as part of weekly group singing workshops while Hutchins and Peretz used a visual representation of a custom-built slider tool (used in another of their experiments to demonstrate pitch perception without vocal production) in an individual single session study. Group versus individual singing should not necessarily be directly compared, nor should two different versions of visual information, especially since *Sing and See* offers information on the target pitch whereas Hutchins' slider visualization purposefully did not in order to serve as a comparison to his other slider experiment. Additionally, the weekly sessions Anderson gave may have allowed for more improvement, since Wilson et al. found that use of *Sing and See* may in fact hinder the practice, but improve the performance long-term. Also, Anderson did not limit her workshops to visual information, but rather included this as part

of a “broad-brush intervention approach” (p. 345), which certainly should not be understood to mean that visual information on its own was responsible for all of the participants’ improvement.

Many of the other seemingly contradictory findings can be investigated in this same manner to discover either that they simply cannot be compared, or that they in fact potentially could support each other due to vocabulary differences. This is further reasoning to support a comparative study that also includes vocal production protocols. From a pedagogical perspective, it would be nice to allow even more of the information readily available on vocal resonance and acoustics to inform the neuropsychological research and vice versa. Factors of vocal motor-control and sensorimotor mapping could be more fully investigated without being confounded by acoustical mistunings of vowels and registration struggles.

There are reports that found that beginner singers may be more sensitive to changes in auditory feedback than advanced singers (Scheerer & Jones 2012) and that imitation helps (Apfelstadt 1984; Tremblay-Champoux, Dalla Bella, Phillips-Silver, Lebrun & Peretz 2010). More specifically, imitative models that are closer to the participant’s own voice are more helpful (voice instead of piano, voice instead of sine wave, live voice instead of recorded voice, same sex voice model as participant, same age range model as participant, recorded voice of participant as model) (Burnett & Larson 2002; Granot, Israel-Kolatt, Gilbos & Kolatt 2013; Hutchins & Peretz 2011; Moore, Estis, Gordon-Hickey & Watts 2008; Price

2000; Yarbrough, Green, Benson & Bowers 1991). Slowing the tempo is reportedly helpful (Dalla Bella et al 2007; Dalla Bella & Berkowska 2009; Mürbe et al 2002), as is singing on a neutral syllable like /la/ instead of words (Berkowska & Dalla Bella 2009; Dalla Bella et al. 2009). Lastly, pitch-accuracy is observed to be task-specific (Welch, Sergeant & White 1997). This means that singing a single note is not the same as singing a short phrase, or singing a full song. These are tasks of varying difficulty that might affect a person's ability to sing on pitch.

These conclusions informed my study design in that I used a male singer for the male participants' stimulus recording and a female singer for the female participants' recording. In this way, the sound was more similar to the participant's own voice, and thus potentially easier to match. I also included a task which removed the words from the songs and replaced them with a neutral syllable, in the hope of making it easier to focus on the melody and match the pitches. I included tasks of varying difficulties—single pitches, short patterns, and full songs—giving participants different opportunities to match pitch in an array of settings. During lessons, I slowed the tempo down in all lessons as we worked on a phrase or song, to give the participants a chance to find their way. Thus, my design and exercises were adapted based on the findings of the neuropsychological literature. What this current investigation offers is a direct

comparison in one single study of the different sensory-based instructions, and a link to the vocal pedagogy information.

Theories and Applications of Motor Learning

Since singing is an act requiring coordinated activity of multiple motor movements, it is sometimes mis-categorized solely as a motor skill. It is, however, uniquely different than the more recognizable motor skills such as walking, dancing, playing a sport, or playing piano because the motor movements involved in singing are more internal and not all visually observable. Richard Magill defines a motor skill as "a skill that requires voluntary body and/or limb movement to achieve its goal" (2004 p. 3). In describing examples, he cites skills that involve external limbs or whole body and head movement, whereas singing is internal muscle movement. Furthermore, he specifically defines it as voluntary and singing involves some voluntary actions of course, but approximation of the arytenoid cartilages (to adduct the vocal folds in order to make sound) and the oscillation of the vocal folds themselves cannot decisively be called voluntary, even though they are not always involuntary either. There is certainly sub-cortical coordination in addition to aerodynamic principles at work in the adduction and oscillation of the vocal folds.

Gentile's Taxonomy of motor skills is a classification system based on action function and environmental context. The category most similar to singing is: no movement and no object manipulation while under stationary regulatory conditions with inter-trial variability. Magill's examples of motor skills in this category include "standing on different surfaces" and "swinging a baseball bat at different ball locations without a bat or a ball" (p. 12). Notably, these actions are distinct from singing in that they are simple, discrete, external, visible motor skills.

Interestingly enough, nowhere in his textbook on motor skills does Magill mention singing, nor does Richard Schmidt in his *Motor Control and Learning: A Behavioral Emphasis* (1988). They both mention other musical and artistic activities such as dancing and playing a piano, but do not include singing as a motor skill example. This could be due to oversight or lack of research in singing as a motor skill, but it also could mean that it does not fit neatly into the classification and therefore does not follow all of the trends in motor learning. There is, in fact, a great divide between the motor learning theory research and the vocal pedagogy research. This crossover information would specifically address "behaviors in miniscule structures not available to vision" (Verdolini Abbott 2012 p. 6). Recently, articles and presentations in voice research (concerning both singing and speech related training) have begun citing Magill and Schmidt and have posited that all of the motor learning principles directly apply and should be

followed in voice training protocols. However, a lack of research supporting this direct connection leaves only assumptions and speculation to defend it.

Schmidt and Lee defined motor learning in 1999 as "a set of processes associated with practice or experience leading to relatively permanent changes in the capability for movement" (Verdolini Abbott 2012 p. 21) Katherine Verdolini Abbott adapted this definition to include its function for vocalization in speech. "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" (Verdolini & Titze p. 219). While I agree that learning itself cannot be directly observed in any circumstance, this adaptation still does not put singing squarely in a motor skill category. Therefore, the principles of motor learning may be applicable in certain circumstances, but one should perhaps avoid adopting the guidelines en masse.

The motor control theory that seems to connect most to singing is that of dynamic systems, which describes stable patterns of movement brought about by external parameters (Magill 2004, p. 64). For example, if frequency is an external controlling parameter, then the mode of vibration of the vocal folds is a variable moving into (and out of) stability. As discussed in the vocal production section, lower pitches will bring about a different vocal fold connection and vibration than higher pitches; they create a different registration. Many people possess the natural ability to switch into the required stable pattern of movement when they

reach the critical frequency, much like when you speed up, walking will eventually switch to the categorically different pattern of running. However, other people need to learn this adjustment. If a pitch is out of a person's existing range and he or she seems to strain to reach it (or simply does not match it at all), perhaps what is needed is sensory exploratory training and practice of the new pattern of movement (e.g. vibrational mode and registration) in order to reach the new frequency. Within this theory of motor control and development, cognition is relatively ignored, so it may not account for the entire problem of inaccurate singing. For example, as Verdolini Abbott explains, the concept of dynamic systems describes how to initially find the behavior, but not how people learn to stabilize and carry over that behavior into regular life (Verdolini Abbott 2012).

It should be understood that motor learning does in fact involve cognitive elements such as memory and attention. However, there are distinctions between the processes of learning facts (declarative knowledge) and learning how to perform an action (procedural knowledge) (Magill 2004, Schmidt 1988, Verdolini Abbott 2012). Since procedural knowledge, in contrast to declarative, informs us "how" to do something, it often cannot be verbalized (Magill 2004, p. 174). Verdolini Abbott notes that "notions of an entirely 'clean distinction' between declarative and procedural learning have been challenged" (2012, p. 28) and indeed it is likely that singing is a crossover activity, since it involves knowing facts *and* knowing a process. Teachers should also be aware of the distinction

between working memory, which is a limited temporary store and processing center, and long-term memory, which is a relatively longer-lasting storage where information is kept once processed by working memory (Tamis-LeMonda 2012). Therefore, in order to ensure that a person retains information or a newly acquired ability, a teacher must provide a way for that student to connect or process it into long-term storage (e.g. practice processes: repetition, chunking into smaller bits, multisensory connection, relating to past knowledge, etc.).

Connecting newly acquired motor skills with an image or a verbal cue, such as an image of a round ooh shape or the cue "hooty" for head voice, can help make the skill more meaningful, which will aid in retention (Magill 2004, p. 183). In fact, based on two major models of learning, the initial learning is governed more by cognitive elements. For example, Posner and Fitts' three-stage model (Schmidt 1988, p. 460) defines the first stage of learning motor skills as cognitive, second as associative stage involving refining and the third as automatic. Gentile's two-stage model (Magill 2004, p. 210) describes the initial stage as developing the movement coordination pattern and as learning to discriminate between different regulatory conditions, and the later stage involves adaptation, consistency and gains in economy of effort. Therefore, when working with an uncoordinated singer, images or verbal cues that make sense to the singer attach to the new skill early in acquisition so that it can be better processed and retained for later recall. Moreover, within cognitive research, Tulving's encoding

specificity hypothesis shows that memory retrieval is dependent on a match between cues present at the initial encoding and those present at the test (Richmond & Nelson 2007, Tamis-LeMonda 2012). Verdolini Abbott reports that the type of cue matters; metaphoric imagery (such as "let your breath support be a tube of toothpaste being squeezed") was not as successful in speech therapy training as perceptual processing information (i.e. target awareness like noticing the sensation of how much air is left over at the end of a phrase) (2012).

Varying types of sensory feedback are often used in motor learning. Magill cautions, however that "learning is specific to the sources of sensory feedback available during practice" (Magill 2004 p. 221). Said another way, the type of sensory feedback used during early learning and practice will be depended upon by the learner for successful performance. The learner needs the guiding sensory information to accurately perform once he/she has practiced it into the behavior. It is believed to be because the "sensory feedback becomes part of an integrated sensory component of the memory representation of the skill" (p. 221). Together with Tulving's encoding specificity hypothesis, this suggests that proprioceptive feedback during practice might be advantageous since it is the most likely sensory feedback to be present at all instances of singing. Auditory feedback would certainly be the next most likely to remain present at performance, but what a person hears of him or herself is subject to change based on many factors such as room conditions and competing sounds.

Attentional focus is an important factor in motor skill acquisition. The action effect hypothesis states that "actions are best planned and controlled by their intended effects" (Magill 2004, p. 259) meaning that instructions should focus on the movement outcomes rather than on the movements themselves. Research on dancers demonstrates that when both learning and highly skilled dancers focus on the intended effect of the movements the performance is better than if they focus on the movements themselves. A golf study by Wulf, Lauterbach and Toole (as cited by Magill 2004, p. 260) supports this hypothesis since golfers who were instructed to focus on the pendulum movement of the club performed better than those who were told to focus on their arms. The action effect hypothesis would suggest that singers should be instructed to have an external attentional focus, such as a visual representation of the pitch or the sound of their voice itself (the intended effect). It is also possible that the intended effect could be interpreted not always as the sound but rather the sensation, since once again the action of singing is not visually available. One could be concentrating on the effect of the vocal fold movement experienced within the vocal tract itself, not necessarily after it is released into the room. Thus, all three of the instructional approaches included in this proposed study could be *interpreted* as supporting the action effect hypothesis.

This hypothesis is the foundation of the distinction between types of instructional feedback referred to as knowledge of results (KR) and knowledge of

performance (KP). This portion of motor learning theory has been reported more often than others within recent singing research. Magill defines KR as "externally presented information about the outcome of performing a skill or about achieving the goal of the performance" (p, 270). KP is "information about the movement characteristics that led to the performance outcome" (p. 271). Lynn Maxfield does an excellent job of outlining examples of each of these types of feedback within a singing voice studio (2013). A diagram is provided for clarity in Figure 4.

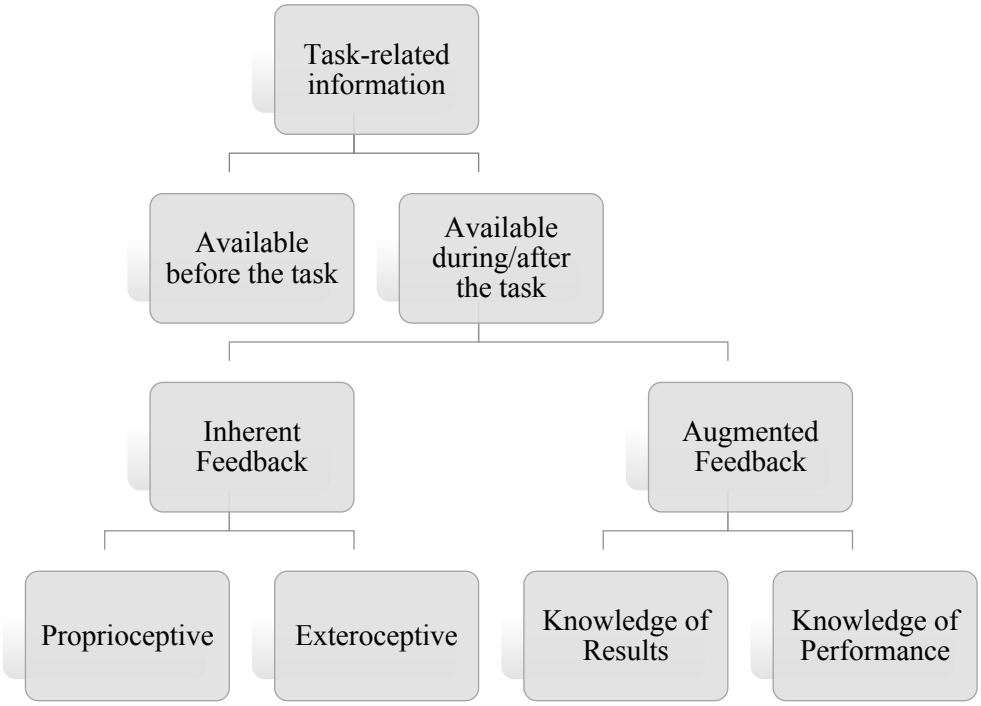


FIGURE 4. Types of instructional feedback. Task-related information is either available beforehand, or during/after the task, also referred to as concurrent or delayed feedback. Concurrent or delayed feedback can be inherent feedback (some part of the performing the task itself), or augmented feedback (information provided by an outside source, such as a teacher or device). Proprioceptive inherent feedback is internal sensory information such as muscle movement, rib expansion, skin sensation, etc., and exteroceptive feedback is from external sensory information such as vison, hearing, room temperature, etc. Knowledge of Results is just what it seems: in this case, how close to the goal pitch the sung attempt was, and Knowledge of Performance reports the quality of the attempt's performance (how efficient or energetic the sung attempt was). (Adapted from Maxfield 2013, 472.)

Motor learning and control is an area that is fairly well researched. Unfortunately, its relevance in singing is weak and warrants further review. Connecting information from sports research, physical therapy, and even a closely related field of speech therapy is advantageous, but it could also be dangerous to

accept principles of teaching and learning as true before testing them within the specific and complex field of singing.

Conclusion

There are many methods of teaching that apparently work. However, singing is a complex system of interconnected components—not all directly visible—and there are many factors involved in the teaching and learning process. There are disagreements throughout history in vocal pedagogy on what is most effective. More specifically to the population of inaccurate pitch-matchers, the field of neuropsychological research offers possible answers to the question of "why", but the answers to "how" vary and sometimes even contradict each other. Motor learning research suggests theories of "how", but the direct application to singing is uncertain. My question of how to help students move from obstacle to success remains unclear. Teachers don't need more options that may or may not be helpful. We need guidance on how to address the core issue as clearly as possible and provide feedback that supports retention and independent consistency.

CHAPTER THREE

III. METHODS

"He who sings frightens away his ills." -Miguel de Cervantes, *Don Quixote*

I have divided this chapter into sections to make clear the justifications for the study design and its components. The first half of the chapter is dedicated to explaining the theories behind the study's components and integrating my sub-purpose statements into the design. The second half provides more specific information about the instructional groups, protocols, testing sessions, and data analysis.

Stance of the Researcher

In the introduction, I provided informal case study observations of my past students and my use of one of the approaches used in this study primarily in my voice studio. While the approach of vocal coordination is central to my regular teaching, I do not fully discount the other approaches being studied. Each instructional technique has been found helpful to the inaccurately singing

population and therefore I can still be an equal advocate for each intervention group. The reasoning behind this research at its core is to discover comparative information on teaching efficacy that is not currently available. Even though I use one approach in most cases, I often use others as supplement or as replacement with certain students, demonstrating the fact that there are multiple factors at play, and exemplifying that teachers should be malleable depending upon each student they encounter. Since there are no absolute answers to any research problem, I proceeded in the attempt to challenge my own pre-existing assumptions and knowledge.

Trustworthiness

Crucial to the validity of this study is the honest participation of the subjects without pretense, hesitation, or appeasement. The following measures were taken to ensure this. All subjects signed an official consent form approved by New York University's Institutional Review Board before participating and they were notified that the information gathered would be coded anonymously so that they would not be able to be identified later. In this way their actions, singing attempts, and statements could be less guarded. Surveys distributed at the end of the study were anonymous within intervention groups so that participants could feel free to respond honestly with their thoughts and perceptions of the process.

Therefore, they were also assured that statements and responses would not be personally praising or hurtful to me. What they wrote could be truer to their unique experience instead of being what they assumed I wanted to hear.

In order to maintain strength and consistency of protocols and design, I reviewed the study and its measurements before running it not only with my dissertation committee, but also with three eminent researchers in this field: Dr. Isabelle Peretz, the creator of the Montréal Battery of Evaluation of Amusia (MBEA) and co-founder of the International Laboratory for Brain, Music and Sound Research (BRAMS); Dr. Robert Zatorre, neuroscientist using fMRI imaging to study music in the brain and other co-founder of BRAMS; and Dr. Steven Demorest, music education professor at Northwestern University and specialist on music perception and singing accuracy remediation.

Participant Selection

"My singing voice is somewhere between a drunken apology and a plumbing problem." -Colin Firth

Through advertisement such as flyers and postings on relevant social media, I recruited individuals who claimed to be poor singers. Persons interested in participating contacted me via a study-specific email address to ask further questions and to express their desire to participate. This self-designation being the

first prerequisite for participation, an administered pre-test also served as a selection tool. Since my research concerns the specific population within the 10-17% of people who say they are inaccurate pitch-matchers but *not* including the 4% who are amusic, I accepted only individuals who did *not* accurately match pitch in the singing voice tasks and who scored within the normal range of Steven Demorest and Peter Pfordresher's pitch discrimination test (which correlates with the more time-intensive MBEA). In this manner, I studied inaccurate pitch-matchers in the absence of a perception deficit, a population termed *false amusics* by Cuddy (2005, p. 320).

I originally hoped to enlist the participation of 10 individuals per group, totaling 50 people randomly distributed between the five groups (three instructional approaches, one neutral group, and one control group). I was able to recruit 41 people, but dismissed ten at the pre-test, so I proceeded with 31 participants (15 male, 16 female) across the five groups.

Since I acted as the instructor, complete anonymity could not be maintained throughout the study, but confidentiality was assured and measurements and recordings were coded without personal information.

Discussion of Methods

Quantitative Study Design

As stated in the first two sub purpose statements, my primary goal was to use an experimental design that allowed for the comparison of five groups in total, including a control group which received no lessons at all. In order to show a worthy result, I attempted to reduce confounding variables through the study design. Within comparison research interventions there are established designs that can assist in minimizing threats to internal validity, and to a point external validity. Before examining the design, I will discuss these threats below in order to keep them in mind while presenting my chosen approach.

Internal validity threats are those that compromise the conclusions made by the study: rival hypotheses that could also explain the difference between the groups in addition to the researcher's hypothesis. These include history (any events that occurred in the participants' lives between the time of the measurements), maturation (changes that may have occurred in the participants' measurements due to natural passage of time), testing (effects of taking a measurement a second time), instrumentation (changes of data due to quality of the measuring instrument itself), statistical regression (effects due to participants who have been selected based on extreme scores), attrition (participant dropout), order effects (changes due to the order that the intervention was given),

participant influence on other participants, non-compliance, low participant number, low participant variance (similar data across groups, suggesting that there is an unexamined factor at play instead of the current hypothesis), placebo effect, experimenter effects (any subconscious bias influencing the collection, analysis, and/or interpretation of data), and subjects simply appeasing the experimenter.

External validity threats are those that compromise the ability to generalize from the conclusions of the study. If a study has strong internal validity and the researcher is able to confidently make assertions from the data collected, the external validity must still be strong for that researcher to state that these assertions are generalizable to the larger population. Threats to this validity include the selection of subjects (this pool could be simply a unique sample of the population), experimental settings (these could be specific and without reproducibility in other studies), multiple treatment effects (participants could be involved in another unrelated study creating confounding results), and test reaction (an interaction between the pretest and the intervention). These threats are more difficult to control for within the study design, but can be accounted for in the data analysis.

Considered the gold standard of experimental designs is the randomized control study, shown graphically in Figure 5. It is respected because of how it reduces all internal validity threats. By randomizing the participant assignments to groups, the researcher effectively creates comparable groups since any specific

classification of participant is just as likely to have been placed in one group as in another. Campbell and Stanley, in a textbook analysis of experimental designs, refer to the randomized control study as the "Design...in which *equivalent* [emphasis added] groups as achieved by randomization are employed" (Campbell & Stanley 1963, p. 13). All groups are tested the same number of times and with the same instrumentation, so any differences in posttest measures can no longer be attributed to testing effects or to instrumentation calibration.

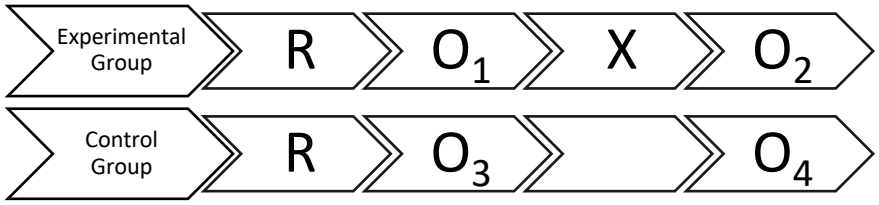


FIGURE 5. Randomized Control Study Design. Randomization is represented by "R," a measurement or test by "O" and an intervention or training by "X." The top line shows the experimental groups and the bottom line is the control group. It is important to keep in mind that "X" does not refer to simply a single session but rather the intervention as a whole, no matter many sessions occur as part of the training before the next measurement. Therefore, in my study, the "X" represents eight 30-minute lessons, received only by the four experimental (instructional) groups. For purposes of clarity, the measurements have been numbered to refer specifically to the experimental groups pretest (O_1), experimental groups posttest (O_2), control group pretest (O_3), and control group posttest (O_4).

> Note however, that even with individual sessions, history can be uncontrolled if all of the experimental group is [sic] run before the control group, etc. [A randomized control study design] calls for simultaneity of experimental and control sessions. If we actually run sessions simultaneously, then different experimenters must be used, and experimenter differences can be a form of intrasession history confounded with X. (Campbell & Stanley 1963, p. 14)

This point of simultaneity and experimenter differences is an important one. Every researcher must decide priorities, and there is a balance between the rival hypotheses of history and experimenter differences. If differences between participants, between pre- and post- measures, and between groups can be explained by some external event that affected scores, then the internal validity is threatened. However, it is also threatened by the explanation of differences in experimenters (i.e. teacher effectiveness, teacher likeability, student perception of teacher capability, etc.). Teaching effectiveness has been shown to be extremely difficult to measure (Napoles & MacLeod 2013) and is a complicated confound to limit. There is a benefit to keeping one constant experimenter and scheduling both the control and intervention groups as close together in time as possible. As long as no one group is fully served before another, there will be participants spread over the full intervention period from each group. Through randomization the simultaneity problem is then minimized. I served as the sole instructor here and scheduled all groups as close together in time as possible in order to hold constant the experimenter and risk the variable of history.

In an experimental study, one can never fully answer the question of what

would have happened if an individual hadn't had the intervention, once that individual has in fact had it. However, a randomized control study design is the closest we have to this answer, since groups are assumed equivalent through randomization. Accomplishing my second sub purpose statement will require comparing the intervention groups to the control group by way of randomization.

Qualitative Research

While quantitative research has the potential to give a more objective analysis of a situation, its richness and complexity can sometimes get lost. Qualitative data can provide multiple interpretations and account for differences between individuals in the learning process. Merging methods can help to clarify the rationale and process behind the chosen analysis, generating a clearer interpretation of the results, and hopefully providing a more comprehensive answer to the research questions.

Commonly used methods of collecting qualitative data are field journals and observations, open-ended questions, and interviews. Patterns and themes emerge and are interpreted by the researcher within the social context of the experiment.

I kept a field journal of my observations of each participant after training sessions, describing their progress and/or obstacles. This is a major benefit of my

being the only teacher across all groups: I was able to illustrate the process of all participants in addition to pre- and posttest evaluation, providing deeper insight to the narrative. Additionally, participants completed a survey after the experiment which asked for their responses to the process, in order to include their perceptions of their progress and of the experience as a whole in the analysis.

Describing the lessons, the process, and the more human elements such as frustration and celebration is difficult using objective numbers. The pre- and post-test measures were helpful in finding the end result, but failed to capture the sense of accomplishment that I witnessed during lessons when a participant finally sang the notes correctly. For narratives such as this, I rely on my lesson journals as well as the participant post survey. These journals tracked each participant through all the exercises and lessons to mark progress during and between lessons. For instance, when a participant improved during the course of a lesson, but regressed back to where she started at the next lesson, or when a participant stagnated for a few lessons, but then finally made a connection and improved. I also described how I was feeling during the lesson, especially when I was feeling frustrated and stuck with a certain instructional protocol due to the study design rigidity. If I had to adapt a lesson plan, I made note of the changes in my journal. All of these pieces of the puzzle are important to know when searching for a practical approach in the teaching studio.

Integrating Vocal Production Information

Given the neurological research finding that motor deficits and sensorimotor mismapping are primary potential causes for inaccurate singing in the absence of a perceptual deficit, it is crucial that this study control for as many vocal production confounds as possible. Although previous studies contend that motor deficits would result in random inaccurate attempts throughout the range (Hutchins & Peretz 2012; Pfordresher & Brown 2007), I believe that motor deficits can also result in regular mistakes due to a lack of motor coordination in the vocal mechanism. When a person continually attempts to sing the same note in the same uncoordinated manner, he will most likely repeat the same inaccurate result a number of times without instruction.

As discussed in the vocal production section of related literature, certain vowels are acoustically friendlier for certain pitches due to the first two formants of that vowel shape. If a formant frequency is in the same range as a sung harmonic, then the produced sound is assisted and even can receive an increase in volume. When there is a mismatch however, the original signal being produced at the glottis is attenuated. Even trained singers sometimes falter on pitch accuracy due to sudden excess of subglottal pressure and/or muscular activation in a subconscious effort to compensate. A common mismatch occurs when a singer will attempt to sing a pitch that is higher in frequency than the first formant of the

vowel to be sung. Acoustically this note cannot be sung without modifying the shape of the vowel, since there is no potential energy in the region of any of the harmonics being sung; the frequencies disagree to the point of total destruction of sound. Beginner singers do not often have the innate knowledge or instinct to modify vowel shapes in order tune the first formant, however, so given pitches are sung inaccurately.

Registration is commonly a confound in pitch accuracy studies since beginner singers frequently attempt to sing higher pitches using their chest voice and find that they cannot adequately stretch the rigidly tensed vocal folds and/or cannot provide the necessary airflow to initiate or sustain vibration. Any of these coordination issues can lead to an inaccurately produced pitch and often the singer simply believes that the note is "too high" for them, when in fact the vocal mechanism is simply ill prepared to produce it.

Likewise, the pitch range in which the exercises are provided can confound results. In pitch matching research on children within the music education domain, the descending minor third of G4-E4 has been used as a testing pattern (Yarbrough et al 1991). The minor third has been shown to be one of the first intervals that learners are able to perceive and produce (Jones 1979, p. 180). However, even though these pitches have been used in adult studies (Price 2000), they should not be the sole patterns used in adult singing research due to the existence of difficult-to-navigate passaggi regions in the voice often located in

these pitch ranges. Donald Miller, using spectrographic imaging to defend his statements, writes that there is a qualitative shift in the female voice at F4 and one for male voices between D4 and G4 (Miller 2008, p. 47-48). Both of these designated regions correspond to the minor third interval being used in pitch accuracy trials. Doscher wrote that "it is instructive to note, though, that as a voice grows in size and in focus, intonation problems generally occur first at these bridges" (p. 177). Certainly then, if intonation is a matter of concern for developing singers within the passaggi, then they should not be relied upon solely as testing pitches for inaccurate pitch-matchers.

All groups received appropriate vowel-pitch assignments within exercises and worked with shorter phrases within passages and songs so that breath management was not a confounding factor. In addition, I used a majority of test patterns which descend melodically so that at the beginning of the breath (when presumably the singer has the most air of the cycle) the participant sang the highest note of the phrase (which demands the most breath).

In October 2013, during the Seattle International Singing Research Symposium, a group of researchers created the Seattle Singing Accuracy Protocol, or SSAP. This battery was proposed in order to create a baseline measurement for singing accuracy research which could be comparable across studies. At the time of my investigation, the pre-recorded stimuli were not available, but I followed the suggested procedures outlined by the battery as

closely as possible. The SSAP recommends first identifying a comfortable range for the participant, then singing imitation tasks kept within a small range of a fifth, two familiar songs, an adaptive pitch discrimination task, and a musical background questionnaire. The sung imitation tasks are designed so that each iteration consists of four notes to introduce but control for memory demands. In my study I followed this protocol, but used the first two iterations of four notes to mimic matching one single note. Then the following iterations provide more tonal context and are descending and ascending within the interval of a fifth. The songs that the battery suggests are "Jingle Bells," "Twinkle Twinkle Little Star" (or "ABC song"), "Frère Jacques" (or "Are You Sleeping?"), and "Happy Birthday." Due to the challenging ascending leap in "Happy Birthday" and the relatively lower familiarity of "Frère Jacques," I chose to use "Jingle Bells" and "Twinkle Twinkle, Little Star" in my testing sessions. I did, however, include the other two songs in training lessons.

Chosen Method

My design is a randomized control training study with four experimental groups and a control group. The participants all took part in pre- and posttest measures including a musical background questionnaire (pre-test only, see Appendix H), a pitch discrimination test proposed by the SSAP, designed by

Demorest and Pfordresher which highly correlates with the diagnostic MBEA (Peretz 2001), singing voice exercises and singing a simple familiar song, and a participant perception survey (post-test only, see Appendix I). Between pre- and post-tests, the four experimental groups received eight 30-minute lessons over the course of nine weeks, each group receiving a different training method.

Auditory Group

The first group received pitch accuracy feedback only by means of auditory awareness, with no sensory/proprioceptive or visual feedback. This manifested itself in learning by rote and echoing pitches and intervals presented both by the piano and the teacher's voice. Zarate, Wood, Delhommeau, & Zatorre posited that "if auditory discrimination training improves pitch discrimination overall, this may increase the chance of detecting vocal output errors during singing, which may result in improved vocal accuracy in non-musicians" (2010, p. 1)

Since the literature also suggests that the timbre matters and that in fact imitating the voice leads to a significantly better effect, sung pitches, intervals, and phrases were the majority of the stimuli.

Figure 6 shows example exercises and instructional feedback from me used throughout the lessons.

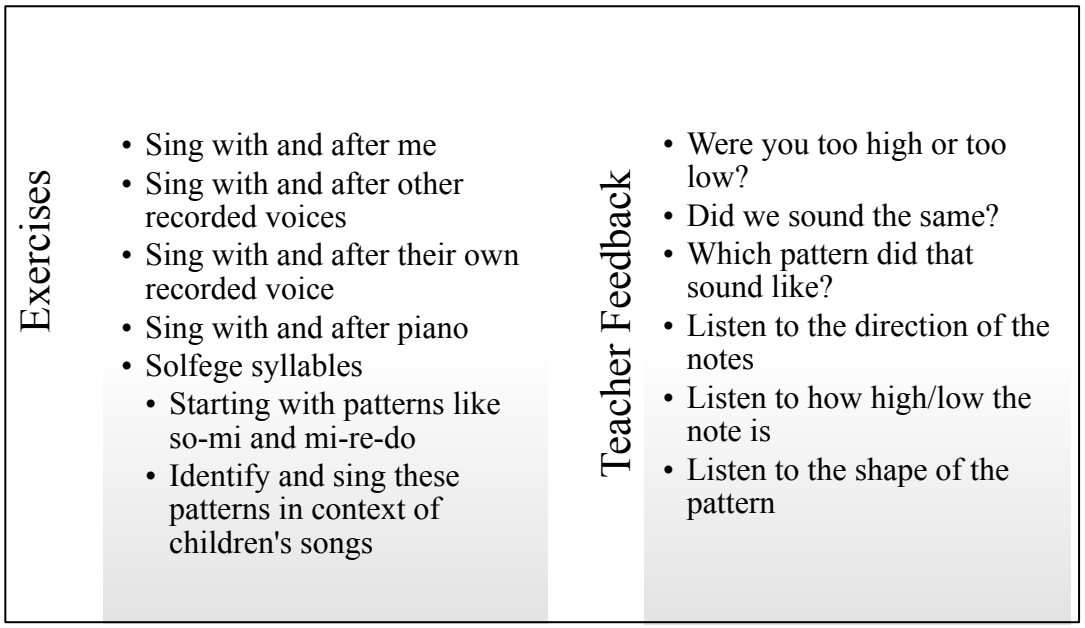


FIGURE 6. Auditory Group Training Overview. All exercises are based on listening to pitches and melodies and attempting to hear the consonance (or dissonance) between their own voices and the goal.

An example auditory lesson started by singing either "Twinkle, Twinkle, Little Star" or "Jingle Bells*"* with me and the piano. I played just the melody along with us for support without adding too much extra melodic information to sift through. Everyone sang both of these songs at their pre-test, so they were familiar with them already. I offered feedback based on what I heard and asked them to listen to their singing and try to make their voice match the melody they heard from me and the piano. I also had them sing this after me, as in an echo, as well as after the stimulus recording from the pre-test. Each time they sang, I asked

them what they heard, and if they knew whether they were matching the melody, or if they were too high or too low. We moved on to solfege patterns, starting with so-mi. This, again, was with me, after me, with the piano, and after the piano. I also recorded them singing the pattern, and had them listen to it immediately after. This way, they could better hear what they had sung, and could describe whether they were singing the correct notes or not. Then, they made another attempt as I recorded again. We sang "Mary Had a Little Lamb," which involves a musical range of a fifth, and moves step-wise by majority. This we sang together a few times, and discussed the melodic contour based on what they heard. We listened to a few singers and I asked them to describe the voice as a high voice or a low voice, and then we sang "Row, Row, Row Your Boat" together a few times and then in a round.

Proprioceptive Group

The second group received only sensory feedback on the vocal production and no pitch accuracy feedback. This manifested itself in using vocal exercises that have been shown to elicit strong sensory awareness and sympathetic vibrations. These sensations alert the singer of proper respiratory energy and forward/mask resonance. Examples include semi-occluded vocal tract postures

such as lip trills, raspberries, straw phonation, and humming (Nix & Simpson 2008; Titze 2013; Titze 2016) as well as kinesthetic exercises drawing the body's attention toward the energy necessary for producing the vocal tasks, such as an inhale through a finger placed at the lips to slow the inspiration, placing their hands at the ribs and abdominals to feel the expansion and contraction of breathing, and singing into a palm to feel the breath exhaled during singing (Miller, R 2004). The feedback given by the teacher was solely focused on sensory awareness: questions regarding the feeling, strength, and location of certain exercises and what the student noticed in his or her body.

Figure 7 shows examples of exercises and instructional feedback used throughout these lessons.

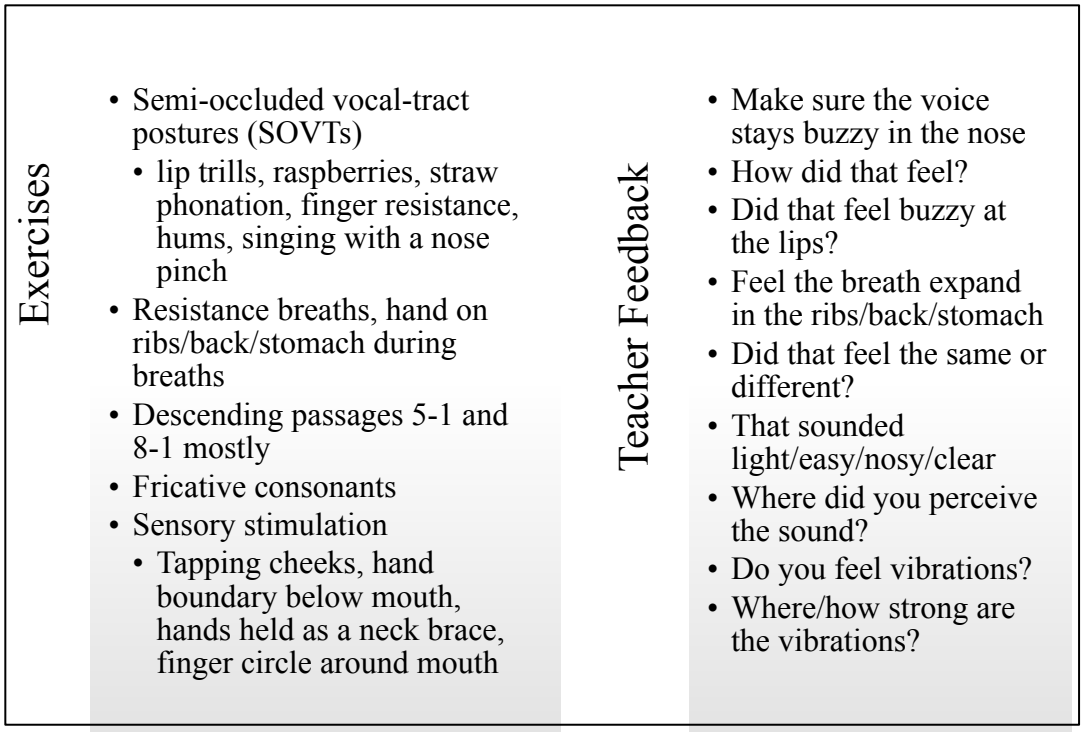


FIGURE 7. Proprioceptive Group Training Overview. All exercises give the participant a clear sensation of the energy or vibration of singing. SOVTs create pressure at the mouth or lips and typically a buzzing sensation is distinctly felt.

An example lesson of this group started by singing lip trills and/or a buzz on a /v/ sound. In the beginning, this was on any note and gliding around on the voice with the instruction to make the lips and front of the face buzz or tickle with the sound. (Eventually in lessons, these evolved into descending five-note patterns.) We then sang a warm up exercise: “shoo-ee/oo-ee/oo-ee/oo-ee/oo-ee” on a descending five-note scale. (Where the syllables are divided by slash marks the singer changes notes.) Here I introduced the straw as a singing tool. I asked the participants to sing through the straw (like humming) on this same five-note

pattern. The goal here is to feel the breath coming consistently through the straw's end, and feel vibrations either on the straw itself or on the lips. As the participant sang, I offered feedback about the breath energy or the level of apparent buzz. I also asked them to describe the energy and vibration sensation. We then did some un-voiced breathing exercises such as breathing in sustained over four counts and breathing out on a sustained /sh/ sound over twelve counts. In this way, they could monitor their ribcage movement and abdominal involvement over the course of the breath cycle. I introduced humming as another way to feel a buzzy sensation at the lips, while also finding a sense of ease as opposed to effort. I then asked them to sing either "Twinkle, Twinkle, Little Star" or "Jingle Bells" on /v/ buzz, a hum, a lip trill, on words, and/or through the straw. All of this invited feedback about the sensation of singing, either related to the vibrations, the breath energy and consistency, or the sense of ease. We then sang "Mary Had a Little Lamb" using the /m/ to relate to the hum and focusing on a breath energy increase at the third "little lamb" (which is the upward melodic leap). We sang melodic patterns together and separately on "doo". The feedback here was related to the shape of the lips and the consistency of breath– finding the roundness of the "ooh" and always exhaling throughout the pattern. We ended the lesson by singing "Row, Row, Row Your Boat" together, focusing on the /m/ of "merrily" and the breath energy increase that should accompany that word.

Visual Group

The third group received pitch accuracy instruction only by way of visual feedback, with no sensory/proprioceptive feedback. The visual information was provided both physically on the keyboard demonstrating direction and magnitude of pitch change, as well as digitally through the program *Sing and See*, so that the student could visually track his/her voice, becoming more aware of what the voice was actually doing, how close each attempt got to the target pitch(es), and which direction he/she needed to move in order to match it. As mentioned in the literature review section, studies have found visual information, especially *Sing and See* advantageous in training inaccurate pitch-matchers (Anderson, Himonides, Wise, Welch & Stewart 2012; Callaghan, Thorpe, & Van Doorn 2004; Wilson, Lee, Callaghan & Thorpe 2008).

I acknowledge that there is no way to definitely separate visual information on pitch from the auditory - participants admittedly still heard their own voices when they were singing and monitoring the visual cue. However, the instruction that they received was solely visually directed. Since my goal is to determine teaching efficacy, this direction will still be informing what the teacher can say or do to guide the student towards accuracy. Figure 8 shows example exercises and instructional feedback used throughout the lessons.

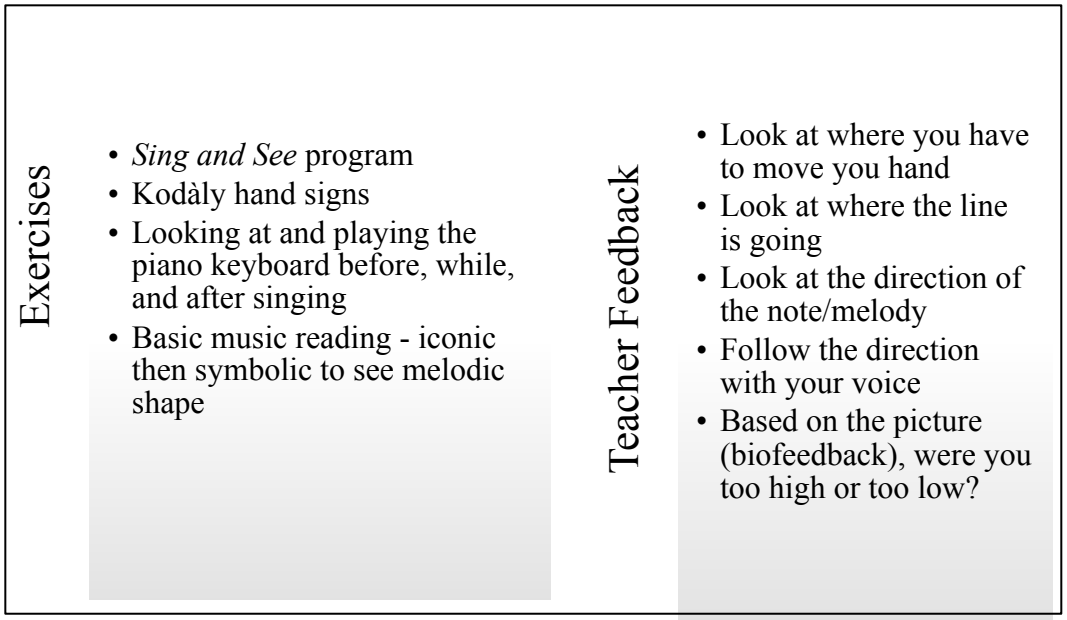


FIGURE 8. Visual Group Training Overview. All exercises are based on visualizing the pitch in a physical or digital representation so that the participants can easily see the pitch height and melodic contour. *Sing and See* is a biofeedback program that draws a line for the pitches on the screen in a certain color. A goal template can be drawn so that they attempt to match the template with a different color.

An example visual lesson started by introducing *Sing and See*, a biofeedback program which draws a visual representation of sound. We started by singing glides and drawing different shapes on the computer with our voices one at a time. This introduced the idea of the connection between the sound the voice makes and what was drawn on the screen. Then, I added structure to the activity by singing a pattern or playing it on the piano, drawing the pattern's shape on the screen as a template. I asked the participants to draw the same shape on top of it in a different color. They were able to see immediately whether they

were matching the pattern, how far off they were, and in which direction. This was their instructional feedback to use for another attempt. Then I showed them shapes I drew on paper and asked them to sing that shape with their voices. This way, they didn't have to match the pitches of the shape entirely, but rather find the directional contour of the shape in their voices. Then we sang either "Twinkle, Twinkle, Little Star" or "Jingle Bells" together, showing the general pitch contour with hand height. For instance, placing a hand on the first "Twinkle" at waist height, the second "Twinkle" at jaw height, "Little" at nose height, and back to jaw height for "Star." Instructional feedback here directed them to the visual of the movement of the hands. We did the same thing with melodic patterns, but I also introduced more specificity by using Kodàly hand signs—at first using only so, mi, and do (but sung on the neutral syllable, "doo"). I then sang these patterns on "doo" and asked them to show me the hand signs for them silently. This allowed for quiet practice of creating a visualization for pitches. We then watched a short excerpt of Bach's *Sonata in C Major* as a graphical score[6]. "Row, Row, Row Your Boat" ended the lesson, demonstrating the Kodàly hand signs for "merrily, merrily, merrily, merrily."

[6] An animated graphical score designed by Stephen Malinowski, available online at https://www.youtube.com/watch?v=gatRM040ktU. It shows visual representation of the final movement showing pitch height and note length extremely clearly.

Neutral Group

The fourth group served as an active control group since it received no feedback sensory awareness or pitch matching accuracy—simply music exposure. These lessons were conceived to mimic a general music class where the students listen to and sing along with music with no technical aspects of pitch accuracy or vocal production addressed. This is based on music education philosophy and parallels the learning of a language by way of immersion. In this way we will be able to see if it is simply being exposed to music on a regular basis that adjusts the pitch production and perception. Japanese violinist and music educator Shinichi Suzuki even called his method to learning music the "mother-tongue approach" ("About the Suzuki Method" 2016) because it is based in principles of language acquisition and focuses on listening, repeating, and teacher encouragement. Foxton et al found that with regular practice alone, improvement in pitch perception was made in participants with congenital amusia (2007), so perhaps tuning improvements are possible in the inaccurate pitch-matching population with practice as well.

In order to account for the minimal verbal instructions and need for discussion in this group, I included some other non-singing activities. One could explain any improvement in this group above the others by saying that the participants spent more time singing each week, so by adding non-singing

activities such as keeping a steady beat or reading rhythms, the total amount of singing during each 30-minute lesson is not a confounding variable. Furthermore, rhythmic learning or timing has been found not to influence melodic accuracy (Peretz & Zatorre 2005, Pfordresher & Mantell 2011).

Figure 9 shows examples of exercises and instructional feedback used throughout the lessons.

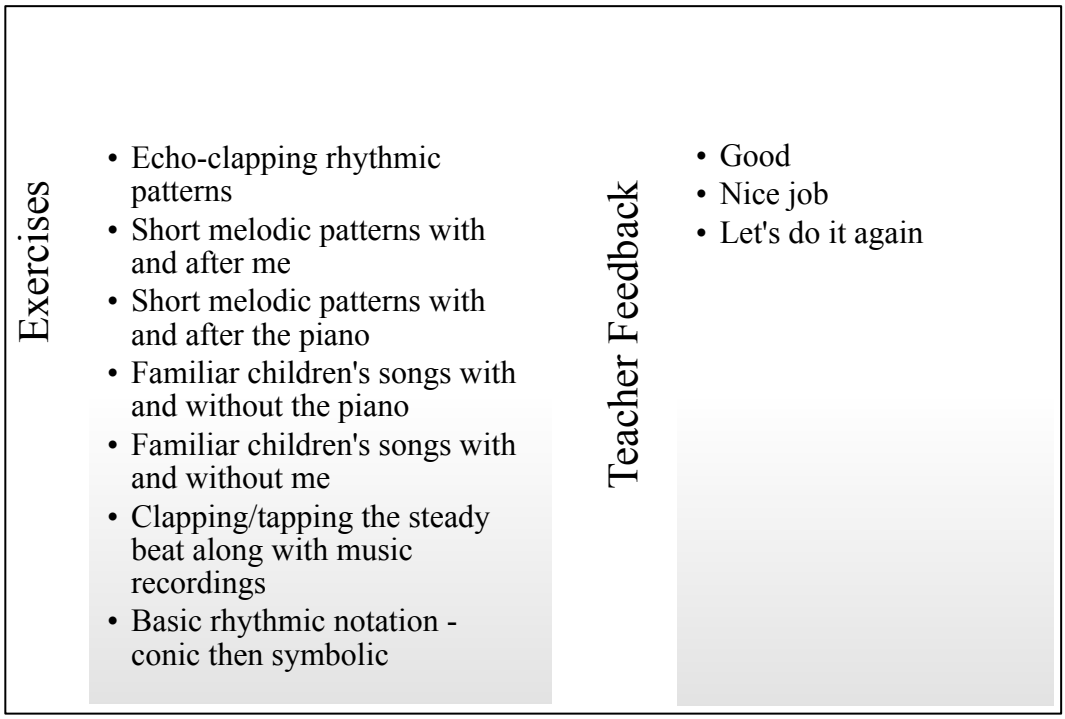


FIGURE 9. Neutral Group Training Overview. Exercises are provided to gain general music exposure and singing experience without specific guidance from the teacher.

An example neutral lesson started by singing either “Twinkle, Twinkle, Little Star” or “Jingle Bells” with me and the piano and then as a call and echo. Then I sang melodic patterns on "doo" and asked them to echo them back to me. Instructional feedback, as shown in Figure 9, was limited to generic statements which offered no guidance or information on the sung attempts. We sang the song at different speeds (tempi), with words and without, and we sang melodic patterns at different tempi, but I never made corrections. We then listened to music to find the steady beat. I asked them to tap the steady beat of different songs, exploring what tempo changes do to the speed of the beat. We also explored macro versus micro beats; that is, feeling a larger beat versus finding the smaller beats within that larger unit of time. We then sang “Mary Had a Little Lamb” together with the piano, and then without me but with the piano, then without the piano but with me, then on their own. I briefly introduced a rhythm matrix which is an iconic representation rhythm. Showing four boxes horizontally, the matrix displays an “X” in a box for a beat of sound and no symbol in the box for a beat of silence. We clapped a few examples of these rhythms, then moved on to singing *Row,* “Row, Row Your Boat” together, separately, and then in a round. Again, the instructional feedback offered no specific guidance—simply variations and the opportunity to try again.

Control Group

Finally, the true control group was wait-listed for instruction until after the post-test. They were still given both test measurements in the same time frame as the intervention groups (baseline pretest and then posttest), but did not receive any instruction during the intervention phase as represented in Figure 5 by the lack of [X] in the control group. They then received instruction after all the relevant data has been collected. In this manner, they still received free voice lessons for their participation in the study, but not until after they have served as a control. This group is important for this study in order to demonstrate the progress made by the intervention groups as compared to what can be effectively described as natural maturation or development in the absence of intervention.

Data Collection

The following measures were taken from all five groups at both testing sessions, except where noted differently. The testing sessions represent the [O] portions of the Randomized Control Study Design, as shown in Figure 5. The video recordings and instructor journals were not obtained from the control group, since they were collected in the [X] portion of the study design, which is only present for the experimental groups.

- Music Background Questionnaire *(taken only at pre-test)*
- Pitch Discrimination Test
- Recordings of sung exercises and songs at testing
- Video recordings of lessons *(not obtained from control group)*
- Instructor Journal on lessons *(not obtained from control group)*
- Participant Post-Survey *(taken only at post-test)*

Analysis

The issue of evaluating pitch accuracy brings with it challenges, and studies have approached it differently within the literature. Originally, researchers were by majority using evaluative measures such as aural recognition by the researcher or a panel of raters to determine the accuracy of pitches and intervals in their singing accuracy studies (Apfelstadt 1984; Cassidy 1993; Rutkowski 1990). Unfortunately, what also accompanied this usually was a designation of "correct" or "incorrect" based on an arbitrary cutoff point, instead of an actual measurement of how far from the desired pitch the participants had actually deviated. Some studies wrote vague descriptions for accuracy classifications, such as a "modulating singer" who "sings the melody accurately, but shifts tonal center one time or more" and an "uncertain singer" who "sings randomly with no reference

or tonal center" (Price 2000, p. 363). However, these classifications, although convenient, are not supported with enough evidence to hold substantial meaning.

Acoustic analysis for pitch accuracy is the more specific and informative technique. A computer program generates the deviation from the goal pitch using the steadiest (usually center) portion of each sung note in the recording. Early examples of this were programs such as *Visi-Pitch*, used by Goetze and Horii in 1989. More current programs available include *Praat*, *MATLAB*-based algorithms, *Multidimensional Voice Program (MDVP)*, and *Tony*. Advantages to using programs such as these are that they can support both the recording process and the analysis, for a higher level of control within one program. It is also simple to use *GarageBand* or *Audacity* to record sessions and input them separately into *Praat* (Anderson et al. 2012), *MATLAB*, or *Tony*.

Mürbe et al. went a few steps further with technological aids such as an electroglottograph signal (EGG), measuring the original signal from the vocal folds themselves, instead of the resulting acoustic signal in the room. The researchers then derived the fundamental frequency of the first note from the EGG signal and calculated the ratio of each consecutive pitch to the starting pitch, in order to be able to compare participants regardless of range or voice type. The absolute deviations, measured in cents instead of Hertz, were then used as the evaluative measure for accuracy (p. 46).

Another pertinent perspective to consider here is that of the motor learning research. Magill (2004) and Schmidt (1988) both make a distinction between discrete motor skills and continuous motor skills. The former has a specific beginning and end point whereas the latter, usually involving repetitive motions, has arbitrary end points. These skills therefore, within motor learning research and physical therapy assessments, have different techniques of measurement (Magill 2004, p. 23). Given the specific temporal nature of a discrete movement, it can be measured by absolute error, the magnitude of the deviation from the goal; constant error, the direction of the error from the goal; and variable error, the consistency (or lack thereof) over a number of trials represented by the standard deviation (p. 24). Continuous movements, however, require a root mean squared error (RMSE), which is the computer-calculated error for the entire duration of the skill (p. 26-27).

The singing tasks here include both discrete and continuous singing, which means perhaps they should be analyzed differently. Singing a single pitch is a discrete action, and as such can be analyzed independently for absolute and constant error, but singing a pattern or song is a continuous action, so performing an RMSE would be better fitting than separately analyzing each pitch. This could be why Mürbe decided to calculate the ratio of intervals rather than treat each not independently, in order to look at overall error over a longer singing task.

I used *Tony* to analyze the recordings of the sung performance tasks acoustically and found the absolute and constant error, in cents, for all short pattern pitches in relativity to the target pitches. RMSE served as a better comparison for the longer familiar song tasks. The benefit of translating these measurements into the normalized cents and RMSE values is that I will be able to compare participants across participant sex[7]. I originally planned to send a panel of singing teachers a randomized collection of unlabeled sung tasks from participants in order to include a perceptual analysis, but that brought with it many more problematic issues such as perceptual differences and the need for anchor training.

After the raw data was processed initially, I continued with the following comparative and correlative analysis:

- Comparison of sung responses for all participants pre- to post-test
- Comparison of any improvement between groups, as determined by the difference of post-test minus pre-test values.
- Comparison of the pitch discrimination test (PDT) for all participants pre- to post-test
- Correlation between any PDT changes pre- to post-test and sung responses changes pre- to post-test

[7] As described in the definitions, given the different octaves between the sexes, frequency deviations in Hertz must be normalized in order to be comparable. Otherwise, the Hertz scale will make deviations of females seem larger than those of males, even when the deviation is the same number of semitones.

- Correlation between PDT and Post Survey (PS) #16: “I felt that I improved my perception of music (hearing pitches accurately).”
- Correlation between sung response *improvement* and PS #17: “I felt that my training I received directly helped my performance on the test.”

Any differences between pre- to post-test gains of varying groups will be the foundation to establishing correlations between the type of training and the amount of pitch accuracy progress.

I evaluated the scores on the pitch discrimination test, participant perception survey, and the pitch accuracy data of the sung exercises in order to determine if there are any significant differences between or within the groups. Since the sample size was lower than I originally hoped, non-parametric statistics, more specifically the Wilcoxon signed-rank test, were employed as well.

I examined my journals (see Appendix L for excerpts) for themes and descriptive information about the participants’ progress throughout their lessons, including strengths, obstacles, statements, and perceived emotional state. I also analyzed any freely written responses on the Post Survey.

Example Pilot Analysis

As a pilot experiment, I met with one participant volunteer who claimed to be a “bad singer.” She told me she was terrified of singing and that she even once

ran out of a voice lesson that she tried to take. She never joins in singing "Happy Birthday" and said that music, and singing in particular, is a scary thing for her. For the purposes of full disclosure, I do have a friendly relationship with this participant but she approached me without direct solicitation to volunteer. However, since I was only meeting with one person and we know each other personally, the anonymity of the participant post-survey was compromised so I decided not to give her that measure. Additionally, for the purpose of showing a pilot analysis, it was only necessary to meet for one lesson, so we met for a proprioceptive awareness training session. All other tests and measures were followed as previously described. The statistics are different for comparing pre- and posttest scores of a single participant as well, since there is no array of scores to statistically assess by way of t-test, ANOVA, etc. Here, I will display the results graphically, analyzing means and standard deviations as applicable using *SPSS* and *Excel*.

Figure 10 shows her scores on the MBEA and the Pitch Discrimination Threshold (PDT) pre- and post-lesson. Both of these tests were employed to measure any actual melodic perceptual deficit. Note that her MBEA scores fall right around the cutoff for congenital amusia (score of 72.2%), and both perceptual measures actually worsened at post-test (a higher threshold of pitch discrimination means lower perceptual ability). This could be due to testing

effects, but interpreting data from a single participant is speculative and not generalizable.

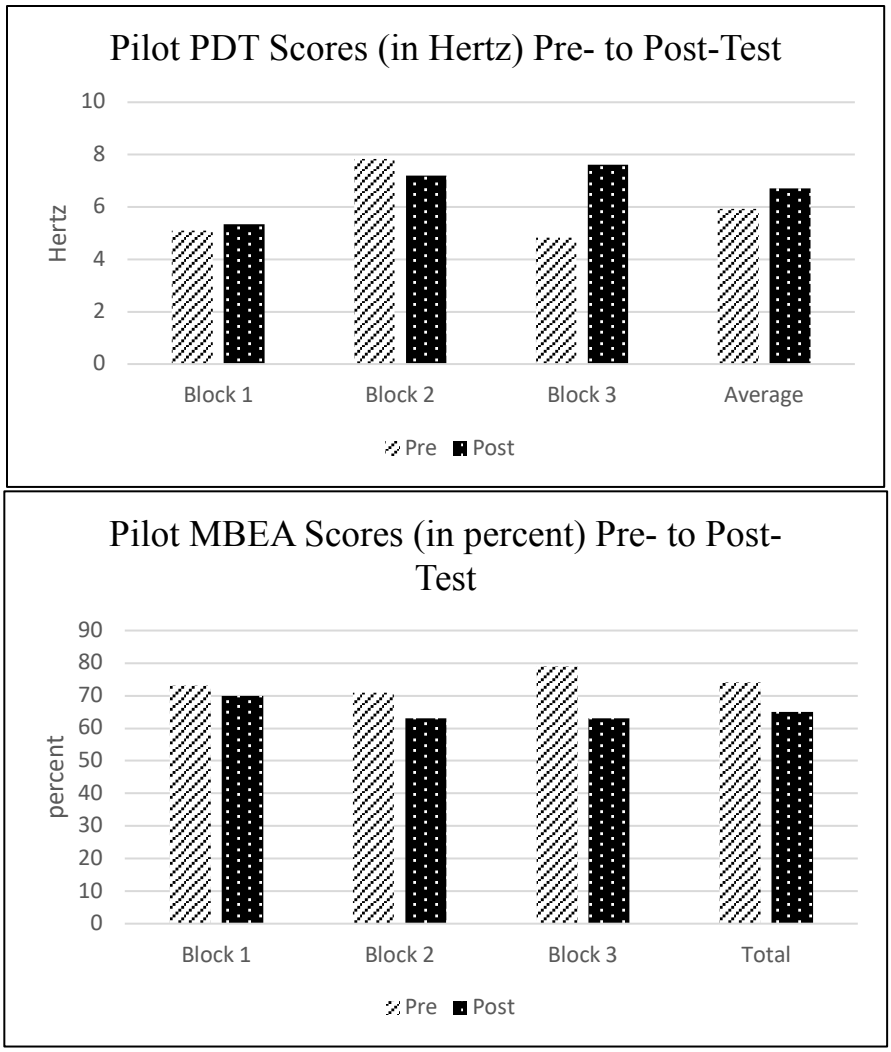


FIGURE 10. Pilot case Pitch Discrimination Threshold (PDT) and Montreal Battery of Evaluation of Amusia (MBEA) Scores. Note that a score of 70% on the MBEA is the cutoff for amusia. Lower scores on the MBEA mean worsened musical perception. The opposite is true for the Pitch Discrimination Threshold: lower scores on the PDT mean the pitch perception was more acute, so a fall in scores between testing show an improvement, whereas a rise in scores shows a regression.

Regardless of these low perceptual scores, she was not always grossly inaccurate in production, even in pre-testing. It is interesting to note, given the severity level of her perceptual impairment, that she still possesses the capability to produce pitches on call with relative accuracy. The sung pitches did improve in accuracy at posttest and the error decreased overall. Figure 11 shows the results from the sung tasks, taken from *Voce Vista*. This is the method of analysis that I originally had planned to use throughout the study. However, performing this pilot analysis in *Voce Vista* convinced me to change programs and use *Tony* for my analysis of the full group, due to user-friendliness, exporting ease, and availability of technical assistance.

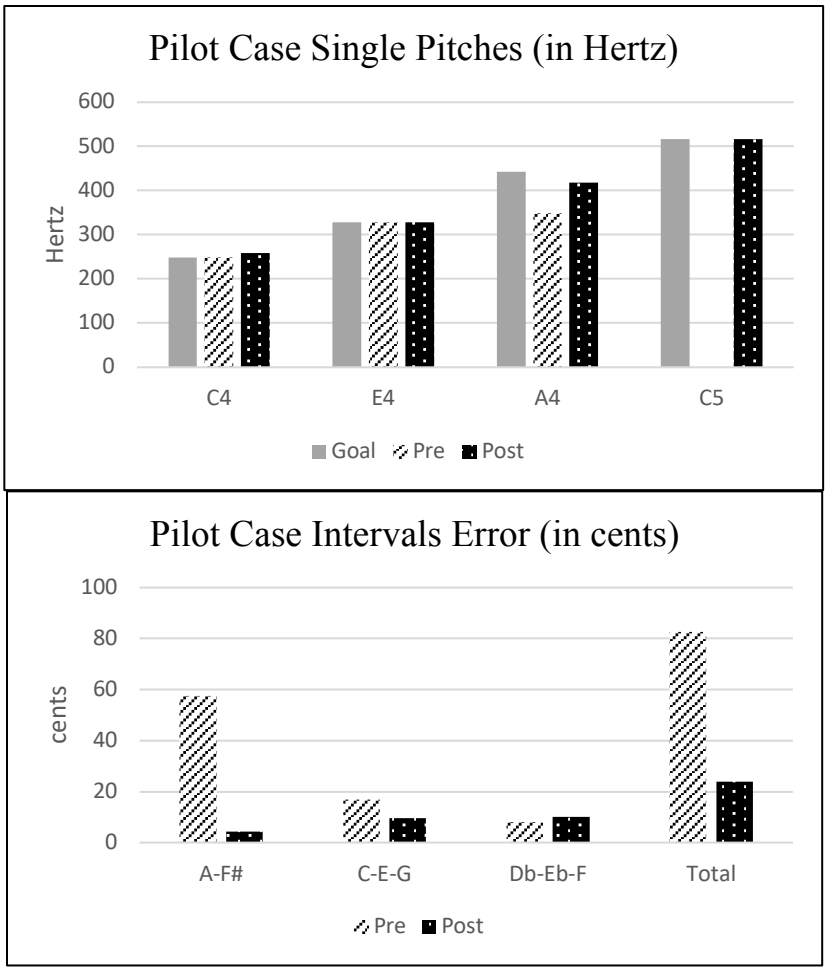


FIGURE 11. Pilot case Sung Task Results. (Top) The horizontal axis shows the pitches being sung with the octave designation (C4 is middle C, E4 and A4 are above that, and C5 is the next octave up). The vertical axis shows the actual frequencies of pre- and post-lesson attempts in Hertz as compared to the goal pitch, so the closer to the first bar the more accurate. Notice that there is no pre-test attempt of C5 in single pitches. I added the higher pitch after the training only, in order to test for transfer. (Bottom) The horizontal axis shows the pitches being sung—all are within a fifth above middle C. The vertical axis shows the error (in cents) from the goal pitch, so the closer to zero, the more accurate the attempt.

Conclusion

Using the randomized control study with five groups in total was admittedly ambitious. However, my goal was to compare teaching methods side-to-side, and this was the most effective and reliable way to do this. I had four instructional groups, three of which gave varying specific guidance and the fourth of which offered neutral musical exposure week to week. The control group demonstrated the effect of having no lessons between testing sessions. Additionally, I used qualitative methods to more descriptively portray the process, as opposed to solely looking at the end product. This is crucial since I am interested in any progress and changes made during the course of lessons. This includes pitch-matching progress by the student, self-awareness changes of the student, and my own changes of insight or teaching preference.

CHAPTER FOUR

IV. RESULTS

"Challenging the label of 'tone deafness' may involve changing people's belief that their difficulties are caused by a permanent impairment, through demonstrating this possibility of improvement."
(Wise & Sloboda 2008, p. 20)

Participants volunteered by emailing an address set up uniquely for this experiment. A research assistant answered the emails and scheduled them for pre-test appointments, where they would be given the initial measures. If at this first appointment, they demonstrated that they could, in fact, sing perfectly on pitch as deemed perceptually by the graduate voice pedagogy students leading the tests, they were disqualified. This was the case for nine volunteers. In answering the advertisement for the study, they asserted a belief that they struggle singing on pitch, but in fact they sang so accurately that they were dismissed. One volunteer was dismissed because she reported a diagnosed vocal cyst, which would potentially confound results, since it could impair her vocal production ability. People were to be dismissed if their pitch discrimination results were so low that they could be categorized as *amusic*. Since this neurological condition falls outside the scope of my study, I wanted to use this as a narrowing measure. No volunteers were dismissed due to severely low perception scores.

I ran the study in two rounds, in order to increase the participant number. By offering two slightly different times of the year, university students were able to volunteer when they were more available. Since I was asking for quite a large time commitment (two testing appointments and eight half-hour voice lessons), I hoped that this would help attract more participants. In order to avoid a confounding variable of history, I made sure to include a randomized collection of all groups during both rounds, so that no one experimental group was fully served before another.

Forty-one volunteers signed up for pre-test measures across the two rounds, but after dismissing ten, 31 participants were given appointments for lessons: 15 male and 16 female. They were assigned a number (1-31 in order of pre-test appointment) and a letter (A, P, V, N, or C) as a participant identifier. The letters were assigned in a rotating fashion, so that participants were randomly assigned into an intervention group. "A" represented the auditory group, "P" represented the proprioceptive/sensory group, "V" represented the visual group, "N" represented the neutral group, and "C" denoted control. The control group was told that they had been wait-listed and were assigned a second testing date for the end of the first round of lessons eight weeks later. All other groups were scheduled for a first half-hour lesson with me within the following week. By the end of the study, four participants had dropped out, or simply didn't show up to

their post-test appointment, so my data are extracted from 27 participants total (12 male, 15 female).

At the pre-test, participants took a Music Background Questionnaire, Pitch Discrimination Threshold test, and completed a Voice Range Check and various Sung Responses to stimulus recordings matching the participant's sex. All of these measures, except for the Music Background Questionnaire, were given again at the post-test. A Post Survey was also given at the post-test to gauge participants' perception of the experience. These testing sessions served as the [O] portions of the randomized control study design as shown in Figure 5.

Voice Range Check

Participants were first asked to perform a voice range check. For all recordings taken of the participants' voices, they were 30cm from the *Yeti Studio* microphone, made by *Blue*, and recorded into *GarageBand*. The voice range check, as proposed in the Seattle Singing Accuracy Protocol (SSAP) (Demorest et al 2015), was simply to get a sense of the participant's "comfortable range" (Demorest et al 2015, p. 267). First, they were asked to slide their voice on an "ooh" from the lowest note they could sing to the highest, then the opposite way: from the highest note that they could sing to the lowest. Finally, they were asked to simply sing any note that's comfortable on an "ah, sustained for three to four

seconds. All participants were cleared to sing in the provided range of a fifth for the vocal tasks.

Sung Responses

Again, for all participant recordings, they were positioned 30cm from the microphone and recorded by *Garageband*. Male participants were played recordings of a male professional singer, a doctoral candidate in vocal performance. Female participants were played recordings of a female professional singer, a Master's student in vocal performance and vocal pedagogy. These stimulus recordings were played back through a wireless *Bose Soundlink Color* speaker. The protocol outlined in the SSAP served as the model for this measure. The task here was to repeat the sung recording as accurately as possible.

Short Patterns

The sung tasks varied in difficulty. The first six tasks were patterns of four notes, sung on "doo." Figure 12 shows the sung response tasks written out. The first and second tasks simply repeat the same note four times. In this manner, they serve as a single note pitch matching exercise, while controlling for difficulties

specific to task length (Demorest et al 2015). Sung response three, only slightly more involved, is a major second. Sung response four is a repeated descending minor third which is a fundamental interval in early music education, sung response five is an ascending triad, and sung response six is the same triad, but descending.

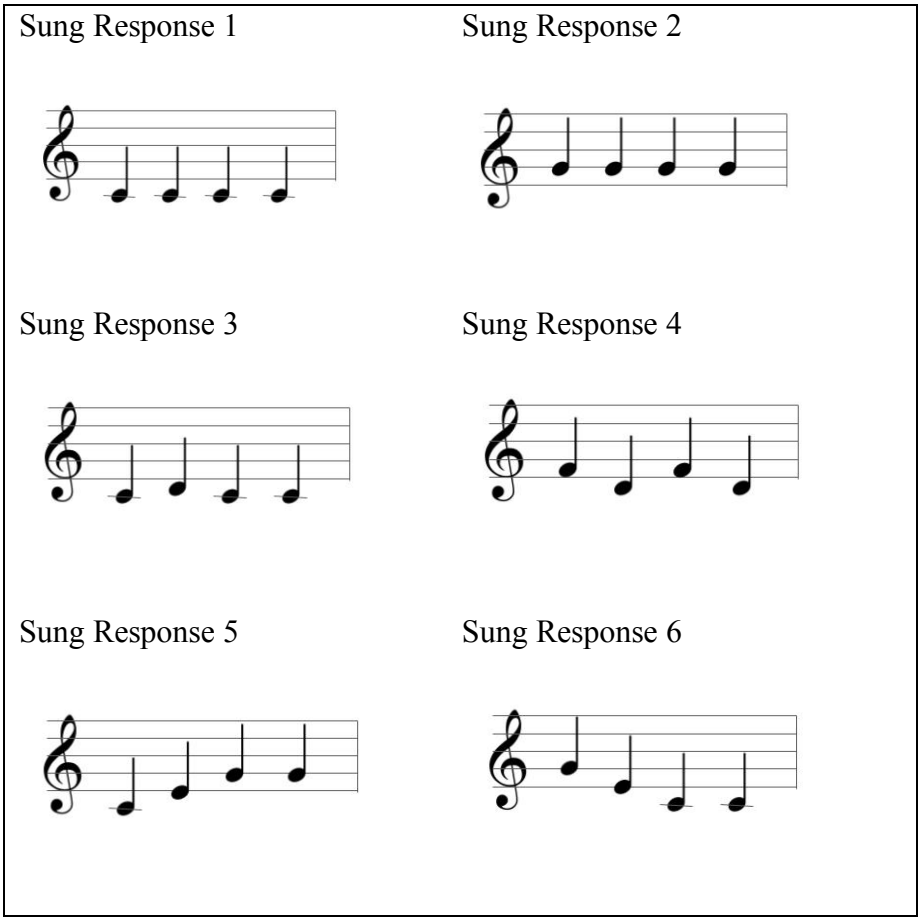


FIGURE 12. Sung Response Short patterns.

In order to analyze these results, I first edited all of the audio recordings in order to separate out each sung response. Then using *Tony*, I took the center 400 milliseconds of each note within the sung responses to avoid instability due to vocal onset and offset. Screenshots taken during this process are shown in Figures 13-15. Note the difference in Figures 14-15 between the sound wave patterns of each note from pre- to post-test. The pre-test waves tend to be irregular whereas the frequencies of the waveform in post-test smooth out visually.

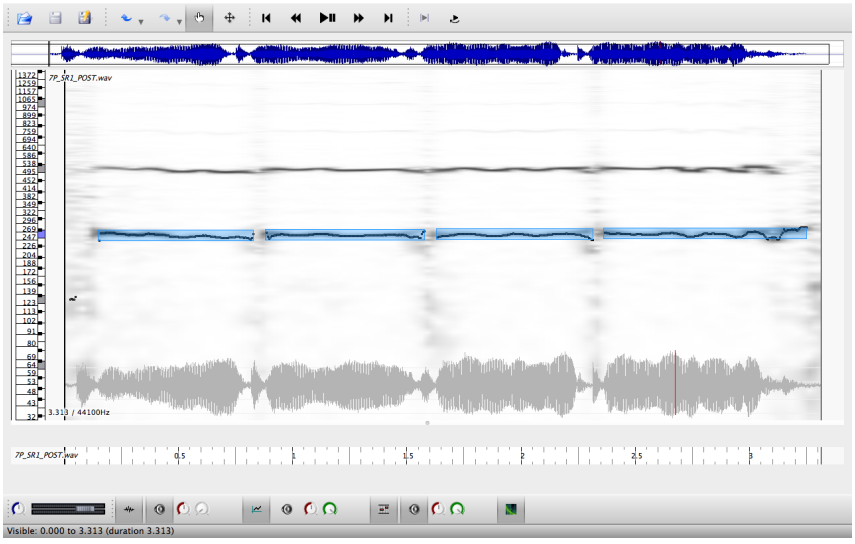
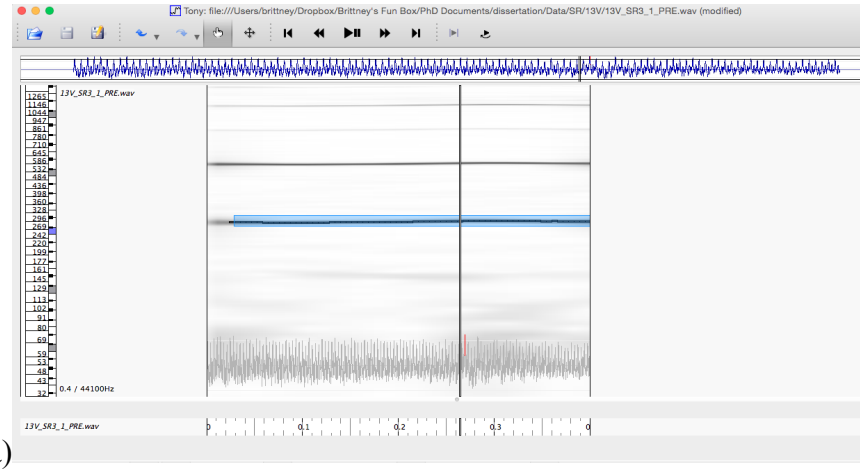
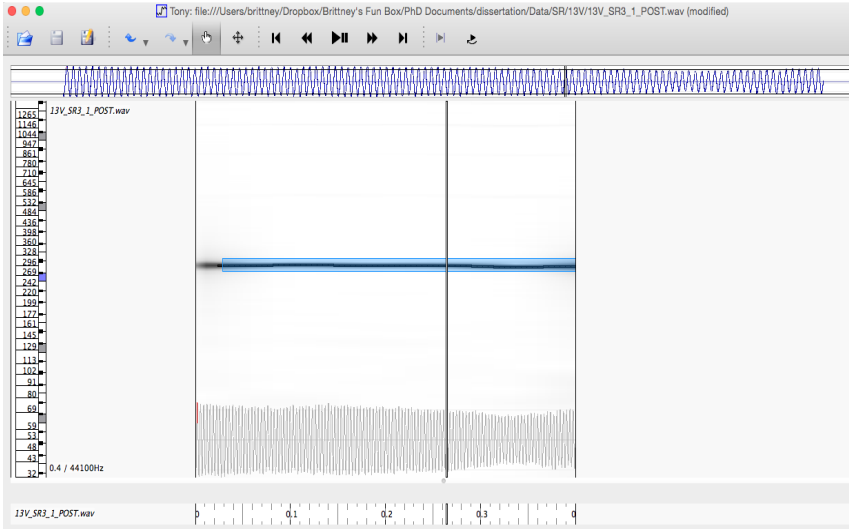


FIGURE 13. *Tony* display of participant 7P's entire sung response #1 post-test. At the top (dark blue) and at the bottom (grey) is the sound envelope which shows you the loudness (height) and duration (width) of the voice. In the center, the horizontal lines across the screen are the frequencies in the voice: the blue-highlighted line on the bottom is the *fundamental frequency*, which is the sung note, and any non-highlighted lines seen above that are harmonics.

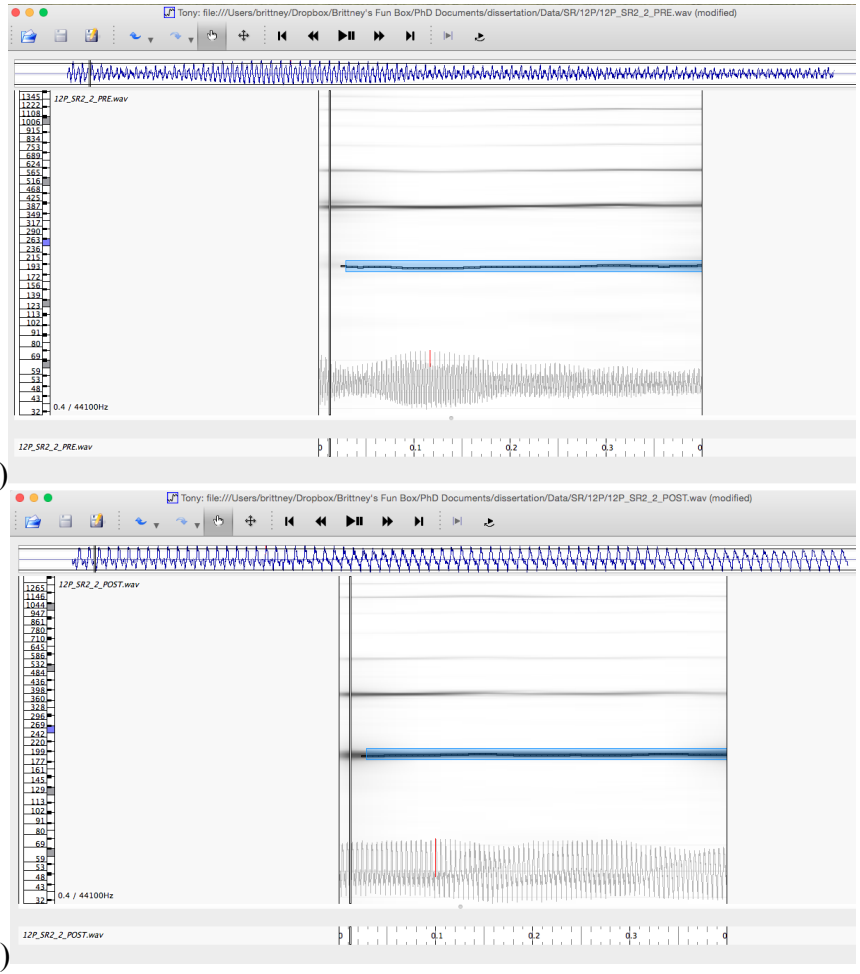


(a)



(b)

FIGURE 14. *Tony* display of the center 400ms of participant 13V's sung response #3, first note, (a) pre-test and (b) post-test. At the top (dark blue) and at the bottom (grey) is the sound envelope which shows you the loudness (height) and duration (width) of the voice. This zoomed in view shows you more characteristics of the vibratory wave of the voice in the sound envelope: (a) shows an irregular vibration and (b) shows a more even vibration.



(a)

(b)

FIGURE 15. *Tony* display of the center 400ms of participant 12P's sung response #2, second note, (a) pre-test and (b) post-test. At the top (dark blue) and at the bottom (grey) is the sound envelope which shows you the loudness (height) and duration (width) of the voice. This zoomed in view shows you more characteristics of the vibratory wave of the voice in the sound envelope: (a) shows an irregular vibration and (b) shows a more even vibration.

Using *Tony*, I extracted the pitch track data and took the average frequency of each 400 ms selection. This gave me a set of four frequencies for each short pattern sung response, per testing session, per participant. I then converted the difference of the sung frequencies from the recorded target frequencies to normalized cents values using the following formula Zarate and Zatorre's 2008 study: $100 \times [39.86 \times \log_{10}(f1 / f2)]$, where f1 is the sung note and f2 is the target note. This is so that progress can be comparable across participant sex. In order to condense the massive amount of data here, I averaged the absolute values of these deviation measures from each of the four notes within each sung response to produce one value per sung response per participant. Taking the absolute value at this point removes the direction of the deviation (flat or sharp) and simply reports how far away from the target pitch the participant was. Figure 16 shows the graphical representation of the absolute values of the average cents deviations pre- to post-test by group. Here, a smaller post value means an improvement.

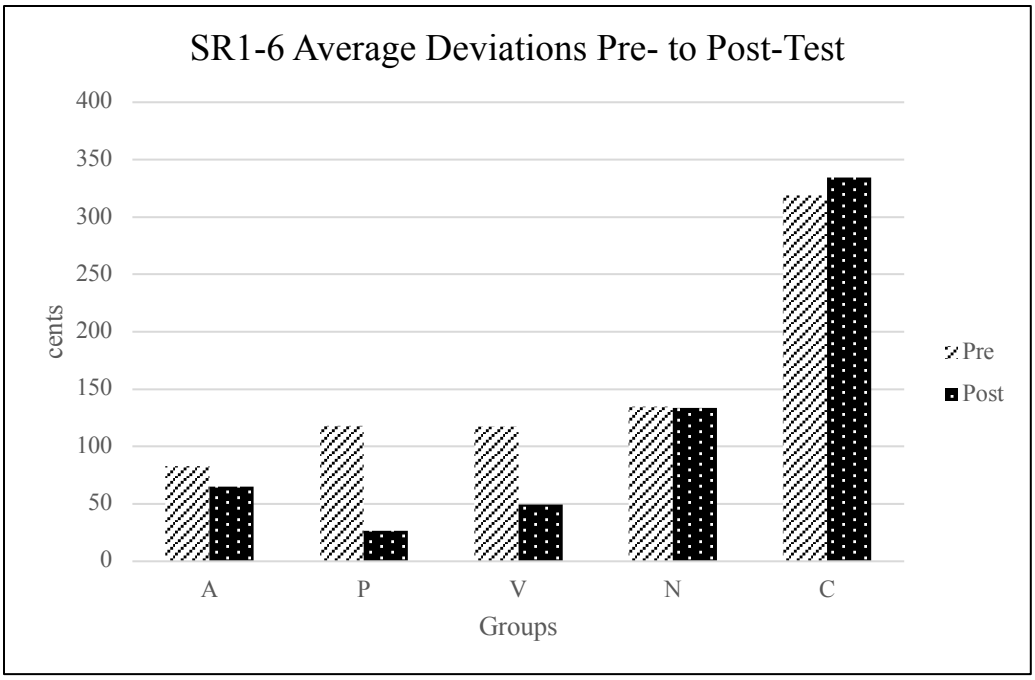


FIGURE 16. Absolute values of the average pitch deviations in cents from the target pitch across all short pattern response tasks by group. Here, A=auditory group, P=proprioceptive group, V=visual group, N=neutral group, and C=control. Less error means an improvement, so A, P, and V all show progress pre- to post-test.

Then I took the difference of the deviations pre- to post-test for each sung response, to measure any improvement. For this value, we are looking for the post-test deviation to be smaller than the pre-test's, so a negative value is improvement. All of these values are shown numerically in Figure 17. Again, negative values here indicate an improvement—reduced deviations from the target notes—whereas positive values are a decline in production accuracy. The

more negative or positive the value is, the more pronounced the improvement or decline, respectively.

ID	Group	SR1diff	SR2diff	SR3diff	SR4diff	SR5diff	SR6diff
1	A	14.382	-2.952	-0.880	16.362	15.135	-6.151
2	P	-1.952	-21.407	-31.465	1.519	28.719	-39.753
3	V	-0.723	35.080	-15.638	12.312	25.904	-21.497
4	N	-2.520	-2.736	-16.627	0.157	-27.635	-34.936
5	C	179.696	161.942	111.024	177.682	50.180	67.010
6	A	-7.225	-234.206	-155.009	-234.666	-186.675	-141.546
7	P	2.130	-0.559	-2.125	14.989	4.327	-75.029
8	V	-286.395	-418.736	-265.391	-336.856	-300.845	-318.022
9	N	1.167	7.295	-1.207	-6.482	4.282	3.128
10	C	28.141	-126.343	-448.398	12.180	-33.502	-33.581
12	P	-17.337	-12.879	10.865	-0.145	-11.188	13.011
13	V	-1.104	-13.282	19.107	-4.060	0.527	-5.813
14	N	50.040	74.074	-209.353	21.649	75.693	62.238
15	C	-20.680	-37.778	-12.857	-5.853	5.273	0.875
16	A	-35.806	-40.174	70.904	21.044	6.480	78.476
18	V	4.821	-11.652	-18.982	-8.289	-30.501	50.031
19	N	-13.451	4.241	-6.615	-2.793	21.361	-77.823
21	A	-4.627	1.980	-18.354	-9.637	-8.988	0.874
22	P	0.419	7.983	20.757	21.856	-118.287	-123.229
23	V	-41.485	-26.420	-37.150	-12.646	-22.656	-23.557
25	C	66.429	88.940	59.462	196.644	14.937	-117.225
26	A	-19.513	-2.740	-5.190	1.714	-10.830	2.060
27	P	-237.408	-674.474	-444.691	-574.519	-168.060	-311.177
28	V	-121.242	-82.583	11.240	-282.674	-5.239	97.226
29	N	-84.779	-136.016	79.372	-17.463	-19.520	220.464
30	C	-3.662	-15.618	-24.569	-5.985	115.877	18.158
31	A	692.776	-114.484	-61.327	-163.460	0.008	-95.473

FIGURE 17. Normalized cents values showing the pre- to post-test difference of deviations from the target patterns for the short pattern sung responses. The groups are labeled in letters so that A stands for auditory group, P stands for proprioceptive/sensory group, V stands for visual group, N stands for neutral group, and C stands for control. Cells highlighted in blue show a negative number, meaning an improvement. Magnitude of the number shows how much of an improvement (negative) or decline (positive) was made pre- to post-test.

The overall impression from Figure 17 is the prevalence of blue highlighted cells showing negative values and therefore improvement. Granted, the magnitude of the improvements vary but what is striking to see here is that all participants showed some improvement on at least one of the sung responses with only one exception from the control group (5C). Looking a bit more in depth, participants 8V and 27P seemed to show alarming progress across all tasks. They are not the only participants to improve on all tasks, but they show remarkable magnitudes of improvement.

The next step is to divide out the progress by group. Figure 18 show the graphical results of each of the short pattern sung responses by group.

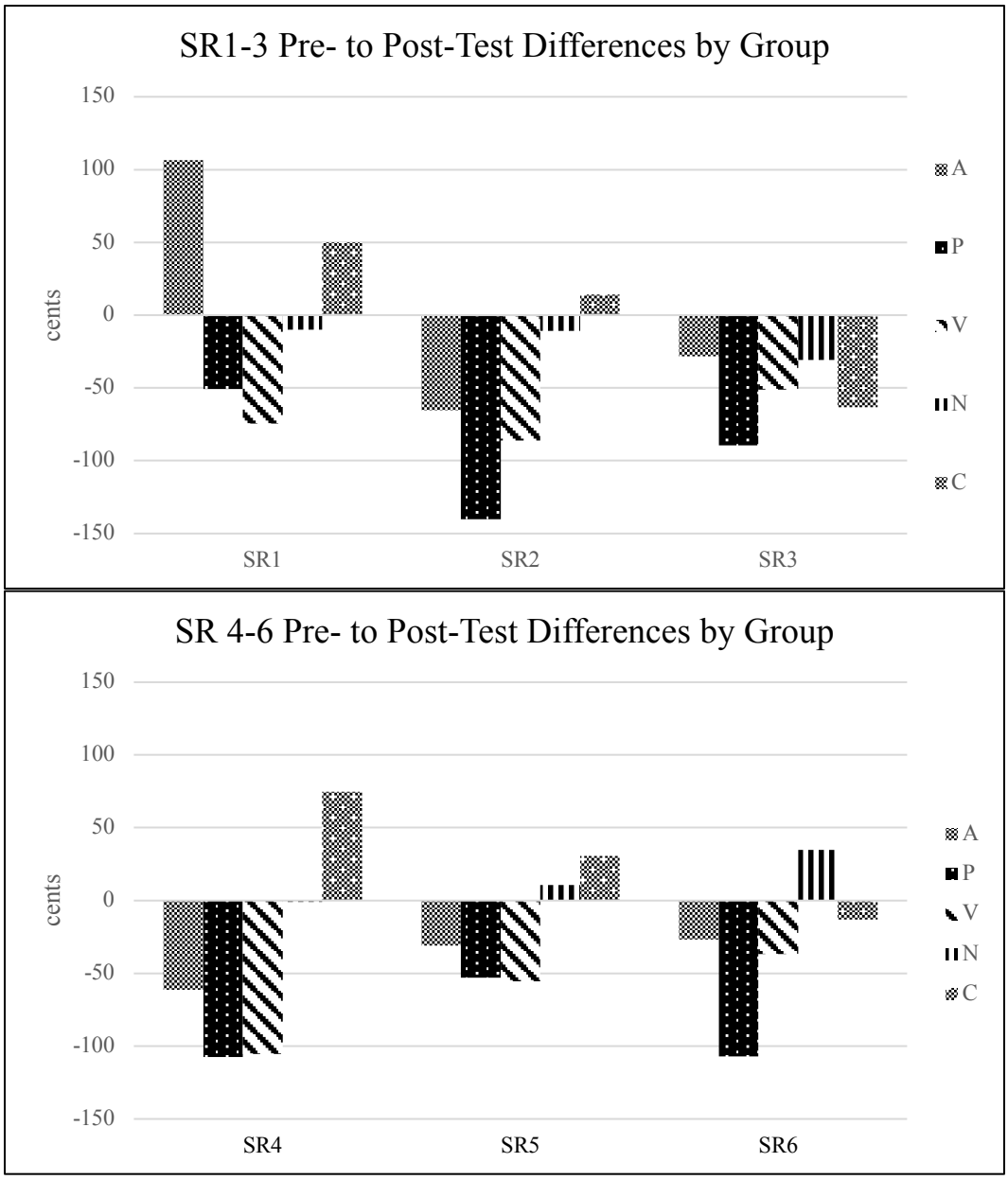


FIGURE 18. Pre-Post Differences in cents of each short pattern sung response (SR) by group. A=auditory group, P=proprioceptive group, V=visual group, N=neutral group, and C=control. Refer back to Figure 12 for the melodic patterns of each sung response.

The proprioceptive/sensory, visual, and neutral groups improved on sung response one (SR1), however the visual and proprioceptive groups appear to have shown much more improvement on average than the neutral. For sung response two (SR2), which was a higher single note, all the groups that received lessons (A, P, V, and N) improved to varying degrees, with the proprioceptive showing the greatest average improvement. Empirically, this makes sense since many participants began at the pre-test by trying to use their speaking range chest voice for this note, bringing up too much pressure and not enough vocal fold stretch, and they weren't able to reach it. However, those who used their singing voices on a regular basis navigated their way towards the higher note by the post-test. Additionally, those who were instructed based on sensory feedback seem to have been more able to find this new vocal production accurately in post-test. The graph for sung response three (SR3) shows that all the groups improved their accuracy on average, including the control group. Sung response four (SR4) was the minor third, which is generally considered to be the building block interval of music, found in almost all children's music and taught as the first solfege interval in early music education. All the specific instructional groups (A, P, and V) got very similarly better while the neutral group seemed to stay stagnant and the control group got worse. The first four groups all sang this interval in various presentations throughout their lessons. However, in the first three groups, participants received some kind of specific instruction to identify and focus the

outcome, whether that was by hearing it, visualizing it, or feeling it. The neutral group sang this interval often, but they did not identify it, nor receive specific guidance on how to tune it. The first three groups, again, all improved on sung response five (SR5) while the neutral and control groups got worse. This pattern, like SR2, was higher - an ascending triad. Concerning vocal production, there is a higher degree of coordination necessary in order to stretch to the top of the triad with breath energy without bringing up too much weight and pressure. The groups that sang regularly in this range and got specific feedback, explicitly identifying the directions in lessons, improved. Sung response six (SR6) was the same triad in descending order and once again, the first three groups all improved with the proprioceptive group showing the greatest improvement. While the control group did show minimal improvement, the neutral group regressed.

Due to the small number of participants in each group, I employed the nonparametric Wilcoxon signed rank test in order to compare the pre- to post-test difference for all participants as a whole in these response tasks. This yielded no significant results. A Kruskal-Wallis test, the non-parametric alternative to a one-way ANOVA, revealed no significant differences across groups. Graphically, from Figures 16 and 18, it seems that the progress of the short patterns by group would show distinction, but perhaps due to the variability of performance within each group, and within the tasks, statistical significance was not possible. It is an unfortunate limitation to having large variance within the group of participants.

Songs

The last four sung response tasks were familiar songs drawn from long-term memory: “Twinkle, Twinkle, Little Star” and “Jingle Bells.” Lyrics were provided for the songs, but each song was recorded two ways - with lyrics first, and then sung completely on “doo.” This measure was taken since it has been shown that singing on a neutral syllable helps with pitch production accuracy (Berkowska & Dalla Bella 2009).

Similarly to the short patterns, I first edited the recordings to separate each task. In contrast to the short patterns however, the duration of these notes varied, since they were in rhythm, so short notes did not last long enough to take the center 400 ms. Additionally, I wanted to analyze the song as a continuous task, as opposed to a discrete task. Therefore, I extracted the average frequency of each full note as it was sung within the song.

I limited my analysis to a smaller excerpt of each song. Although the participants all sang the songs in their entirety, I found that taking an excerpt would focus my investigation and avoid the overwhelming amount of data. “Twinkle Twinkle, Little Star” contains 42 notes and the chorus of “Jingle Bells” contains 50 notes. I used just the first 14 notes of “Twinkle Twinkle, Little Star,” which is the first two lines, and the first 25 notes of “Jingle Bells,” which is the first half of the refrain.

For the song analysis, I used the root-mean-squared error (RMSE) between the sung frequencies and the target frequencies. This is the common protocol in continuous motor task study and it is already a normalized value so is comparable across participant sex. The RMSE data is shown in Figures 19-20. Figure 19 displays the difference of the error from pre- to post-test for each participant on each sung response A negative value is an improvement, since it means the error on the post-test was smaller than the error on the pre-test. Negative values are shown here in shaded blue boxes. The graph in Figure 20 shows the RMSE values of each test as a sum of all individual error scores. As a whole, the error values decreased on all song tasks from pre- to post-test. However, each individual participant, here shown in color shades, varied in progress.

ID	GROUP	SR7diff	SR8diff	SR9diff	SR10diff
1	A	-0.232	-1.358	-0.145	-1.114
2	P	2.033	-0.197	8.498	-5.536
3	V	-30.685	-13.783	-8.196	-3.990
4	N	-2.948	2.246	0.793	-0.219
5	C	-18.745	33.500	-2.201	9.556
6	A	-21.685	-14.992	-6.388	1.806
7	P	-1.397	-0.750	0.873	-0.223
8	V	-59.638	-64.004	-70.519	-73.315
9	N	-1.350	1.358	-2.534	-8.433
10	C	-17.550	-24.524	5.191	0.211
12	P	0.299	0.761	-0.551	-2.464
13	V	0.915	-2.568	0.361	-0.918
14	N	-22.675	-20.385	2.989	0.658
15	C	2.881	-3.138	-0.467	-0.337
16	A	-69.217	24.896	-19.954	-11.444
18	V	-6.654	9.497	-47.281	9.752
19	N	1.183	-0.389	-21.310	-0.217
21	A	-0.382	-0.454	-1.300	-0.609
22	P	-5.021	4.409	-0.826	0.269
23	V	0.910	1.554	0.357	-0.266
25	C	0.278	-12.231	21.050	2.200
26	A	-3.079	-1.479	0.758	-2.833
27	P	-76.767	-75.513	-70.766	-73.542
28	V	-9.943	1.553	-3.410	2.981
29	N	-26.678	-4.696	-30.986	-36.756
30	C	-1.957	4.011	-1.319	0.014
31	A	-19.356	6.855	4.384	-1.595

FIGURE 19. Differences in root-mean-squared error (RMSE) values for all participants pre- to post-test. The shaded values are negative and thus an improvement. A stands for auditory, P proprioceptive/sensory, V visual, N neutral, and C control group. The numbers show the difference between the pre- and post-test accuracy for the sung responses: SR7 - "Twinkle Twinkle, Little Star" on lyrics, SR8 – "Twinkle, Twinkle, Little Star" on "doo," SR9 – "Jingle Bells" on lyrics, and SR10 – "Jingle Bells" on "doo." Again, negative numbers mean the deviations decreased from pre- to post-test, and therefore the participant improved in accuracy.

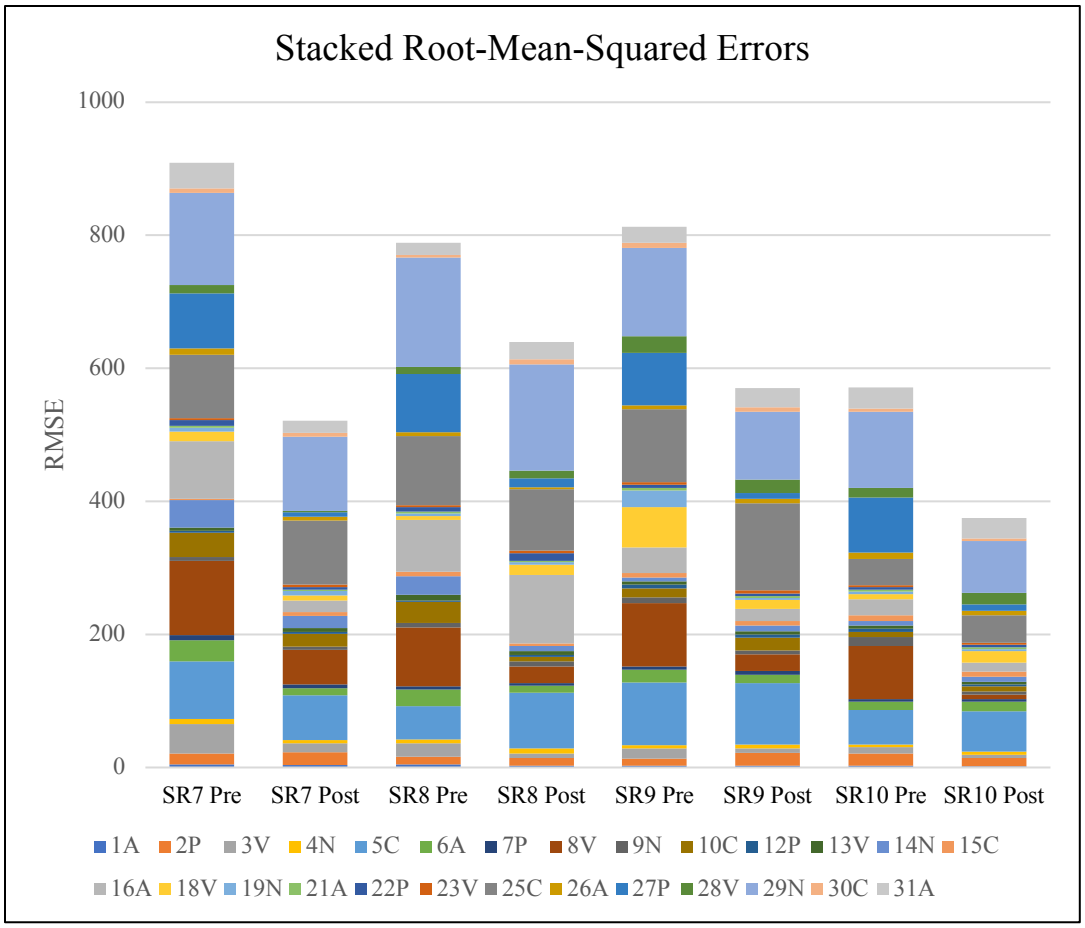


FIGURE 20. Root-mean-squared error (RMSE) values for all participants pre- and post-test. The columns are stacked as sums of all the participant error on each testing session, so note the difference of the height of the entire column from pre- to post-test to see progress on the songs. Inside each column, individual participant error values are differentiated by color shade. Here they are listed in order of ID number from bottom to top, as opposed to being listed by group. It's easy to see the variance of error across participants—some colors are large blocks, while others are barely visible. However, it is interesting to see that overall, the sum of error (the height of the entire column) decreases from pre- to post-test on all song responses.

Two-tailed t-test comparisons of the paired pre- to post-test sample revealed significant differences for the participants as a whole group on sung responses seven ($p=0.0022$) and nine ($p=0.0430$), which are the songs as sung on lyrics. There was also a significant difference between the progress of sung responses seven and eight, which is "Twinkle, Twinkle little star" on lyrics and "doo," respectively. This is not to say that the post-test for the song on lyrics was significantly more *accurate* by the end than the neutral syllable, but rather that the participants made more *improvement* from their initial testing when on lyrics. In fact, in all cases except for the post-test "Twinkle, Twinkle" responses, the neutral syllable versions (number seven and nine) of each song demonstrated less error for the participants as a whole group than on the lyrics (number eight and ten). During the pre-test and the post-test (except the aforementioned post-test "Twinkle, Twinkle") participants were more accurate when they sang on a neutral syllable than when they sang on lyrics. There was no significant difference between groups' progress on any of the familiar song tasks.

Pitch Discrimination Threshold

The next measure of the testing appointment was the pitch discrimination threshold. I used Demorest and Pfordresher's staircase measure of pitch discrimination centered around 500 Hz, which is free software accessible online at

http://www.musicianbrain.com/pitchtest/. It asks the participant to listen to two tones and determine whether the second tone is higher or lower than the first. This test measures ability to distinguish small pitch variations and correlates with the *Montreal Battery for Evaluation of Amusia* but takes much less time to complete. The results are shown in Figure 21. Since this is a measure of how small the distance between two notes has to be before you can no longer tell the difference, the lower the number the better the perceptual ability. A decrease in threshold from pre-test to post-test shows an improvement in pitch discrimination. Within participants - that is, at the individual level - a two-tailed paired t-test shows significant difference between the PDT pre- and post-test measures ($p=0.014$). Between groups, there was no significant difference of these scores. Therefore, type of instruction method did not have an effect on any changes that may have occurred in pitch perception.

ID	GROUP	PDTPre	PDTPost	PDTdiff
1	A	14	33.5	19.500
2	P	21	10.5	-10.500
3	V	4.375	95.9	91.525
4	N	72	71.6	-0.400
5	C	6.75	49.3	42.550
6	A	30	18.5	-11.500
7	P	16.5	8.1	-8.400
8	V	10.25	30.6	20.350
9	N	12.25	50.4	38.150
10	C	8.625	23.6	14.975
12	P	3.625	13.2	9.575
13	V	13.75	88.7	74.950
14	N	17.75	20.8	3.050
15	C	3.125	62	58.875
16	A	56	15.1	-40.900
18	V	18	0.8	-17.200
19	N	4.625	90.6	85.975
21	A	10.75	49.4	38.650
22	P	18.875	40.6	21.725
23	V	2.125	82.9	80.775
25	C	23.25	0	-23.250
26	A	8.75	43.3	34.550
27	P	68	53.9	-14.100
28	V	50.75	43.9	-6.850
29	N	22	8.4	-13.600
30	C	3.188	3.7	0.512
31	A	15.5	12.2	-3.300

FIGURE 21. Pitch discrimination Threshold (PDT) measures and the difference pre- to post-test. The shaded values are negative and thus an improvement, since that means that at the post-test the participant was perceptually identifying smaller intervals more accurately. A stands for auditory, P proprioceptive/sensory, V visual, N neutral, and C control group. Not as much improvement on the perceptual measure as on the production measure. Interesting that only half of the auditory group members improved here, though their lessons were focused on listening.

Music Background Questionnaire

The music background questionnaire was given last in the pre-test. This measure was included to gather more general information about the background and any musical training of the participants. This also helps to ensure a comparable pool of subjects across experimental groups. Although I collected information about the musical backgrounds of the participants, the specific effects of culture and artistic exposure on pitch production accuracy is beyond the scope of my current investigation.

Participants were asked to use a Likert Scale in order to rate the truth of various statements, answer questions, and rate their abilities. They reported an overall high agreement with "I like to listen to music" (9.06) and "I like to sing alone or with others" (6.96). However, for "I like to sing for others," the agreement dropped to 3.0. Statements such as " I think I have talent as a singer" (3.09) and "People tell me I'm a good singer" (2.61) asked participants to focus on others' reactions to their singing whereas tasks like "Rate your singing ability" (3.06), "Rate your sense of pitches" (3.80), and "How often do you sing in tune?" (5.19) turned their attention to their own perception of their singing ability and intonation. It is interesting that the average answer for how often they sing in tune indicated that they believe that they sing in tune about half of the time. The small

standard deviations, listed in Figure 22 show general agreement among the entire participant pool.

#	Question	Mean	SD
1	I like to listen to music	9.06	1.59
3	I like to sing alone or with others	6.96	2.881
5	I think I have talent as a singer	3.09	2.749
7	People tell me I'm a good singer	2.61	2.604
9	I like to sing for others	3.03	2.604
13	Rate your singing ability	3.06	2.18
15	Rate your sense of pitches	3.80	2.552
64	How often do you sing in tune	5.19	2.72

FIGURE 22. Answers on a Likert 10-scale pertaining to participants' view of their own singing ability and inclination, with the standard deviation (SD).

The questionnaire also asked general questions about their background and training in music. Native language is shown in Figure 23. This was mainly of interest because of the difference in pitch inflection in tonal languages versus non-tonal languages such as English. When perceiving small pitch changes is part of everyday communication, it is much less common for music perception to be a struggle (Deutsch, Henthorn, & Dolson 2004, Svard 2013). The majority first language was English, followed distantly by Chinese (three participants). Two

participants reported being bilingual: one was raised speaking Spanish and English and the other Chinese and English. It is interesting that Chinese (all Mandarin except for one Cantonese response) represented such a large percentage of the non-English speaking participants, given the tonal nature of Mandarin.

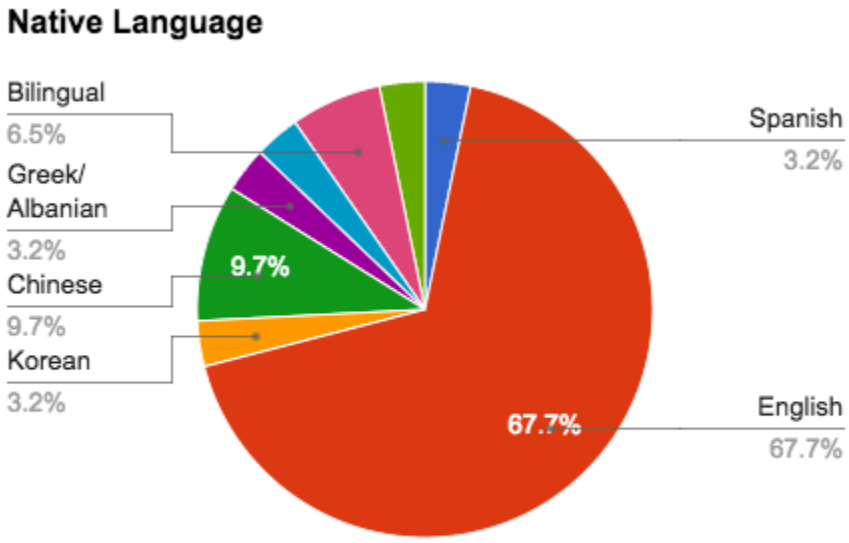


FIGURE 23. Native Languages of Participants

Although only three participants reported having sung in a chorus ensemble in school and three participants sang in a chorus in their free time, eleven participants answered that they had taken private voice lessons in school. There may be a safety in seeking individual training in lessons instead of singing with other singers in a performing ensemble. Almost half of the participants (18)

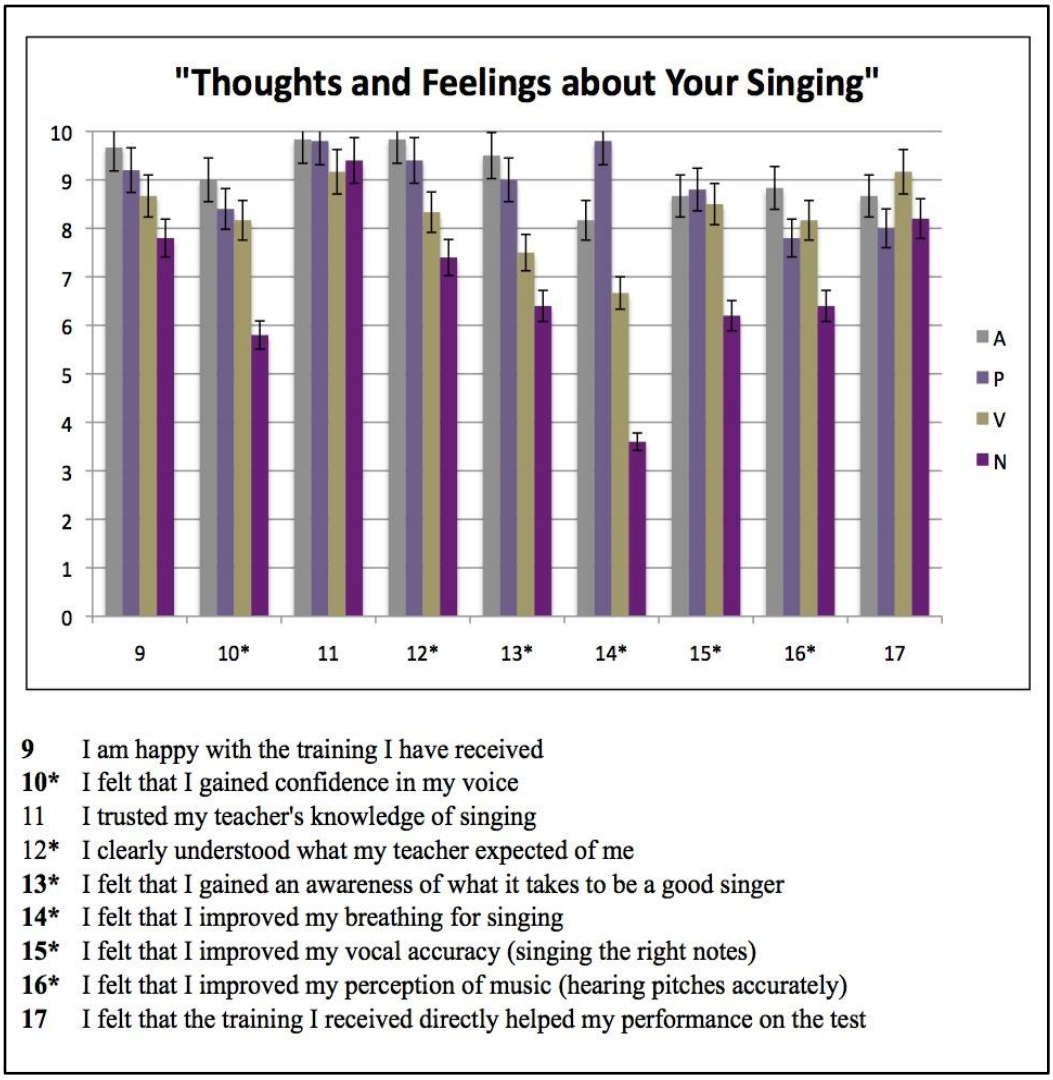
reported having musical family members and thirteen participants indicated that they read music.

Figure 24 shows a word cloud generated from the written answers to the open question "What words or terms do you use to describe your singing." This cloud shows the relative frequency of words in the written responses by size. It is clear to see that the most frequently written description was that they sing off pitch. There are many different adjectives describing their perception of the timbre of their voice, or the general skill level. A more creative description was "shower quality."

FIGURE 24. Singing Descriptions Word Cloud. Taken from the free response to "What words or terms do you use to describe your singing." The relative size of the words here represent their frequency in participants' answers.

Post Survey

At the post-test, participants were given a survey to gain insight into their perception of the process and to rate how much the lessons influenced their performance on the post-test. Figure 25 shows the results of these Likert Scale questions. The graphs show the 5% confidence interval and asterisks mark questions that show a significant difference in answers between groups. The legend on the right distinguishes the groups: “A” is auditory, “P” is proprioceptive/sensory, “V” is visual, and “N” is neutral. Since the control group had not had any voice lessons by the time of their post-test, they did not answer these questions.



9 I am happy with the training I have received
10* I felt that I gained confidence in my voice
11 I trusted my teacher's knowledge of singing
12* I clearly understood what my teacher expected of me
13* I felt that I gained an awareness of what it takes to be a good singer
14* I felt that I improved my breathing for singing
15* I felt that I improved my vocal accuracy (singing the right notes)
16* I felt that I improved my perception of music (hearing pitches accurately)
17 I felt that the training I received directly helped my performance on the test

FIGURE 25. Average Likert Scale answers by group to questions referring to participants' feelings about singing and the experience of voice lessons. The vertical axis shows the average number response (10 being the highest rating of agreement with the statement) and the horizontal axis shows the number of the statements (written out below the graph). Asterisks drawn by the statement numbers represent significant differences between groups based on the 5% error bars shown.

All three of the specific instructional groups felt that they gained confidence, whereas the neutral group scored lower on this point. Although closer together, there is a difference in the understanding what I as the teacher was asking between groups. The visual and neutral groups were lower on this point than the other two. The same distribution, although more spread, is revealed for gaining an awareness of what it takes to be a good singer: the auditory and proprioceptive/sensory groups rated highly, followed by the visual, and then the neutral. Improving breathing was only rated high for the proprioceptive group, which makes sense given that they were the only group that explicitly were taught about the sensation of breath energy. Vocal accuracy improvement and pitch perception improvement both were rated highly by the three specific instructional groups and lower for the neutral group. It is interesting to note that even the proprioceptive/sensory group, which did not address the target pitch at all received a high rating for pitch perception.

The relationship between participants' answers to question number 15, which was a Likert-scale agreement to the statement "I felt that I improved my vocal accuracy (singing the right notes)" and the objective progress reported in the sum difference of all sung responses is shown in Figure 26. This is shown without the control group, since they did not answer the post-test scale questions about the lessons. The slope of the linear regression is 208.577 with a y-intercept of -2200.627. The positive slope is curious, since this is saying that the higher

they rated their perception of improvement, the more positive the sum of the sung response differences became. Since improvement leads to a negative sung response difference, one might expect a negative slope here. The two outliers on the graph are participants 8V and 27P. These two both showed enormous cumulative improvement (negative y values), but rated their vocal accuracy improvement at a seven and an eight, respectively.

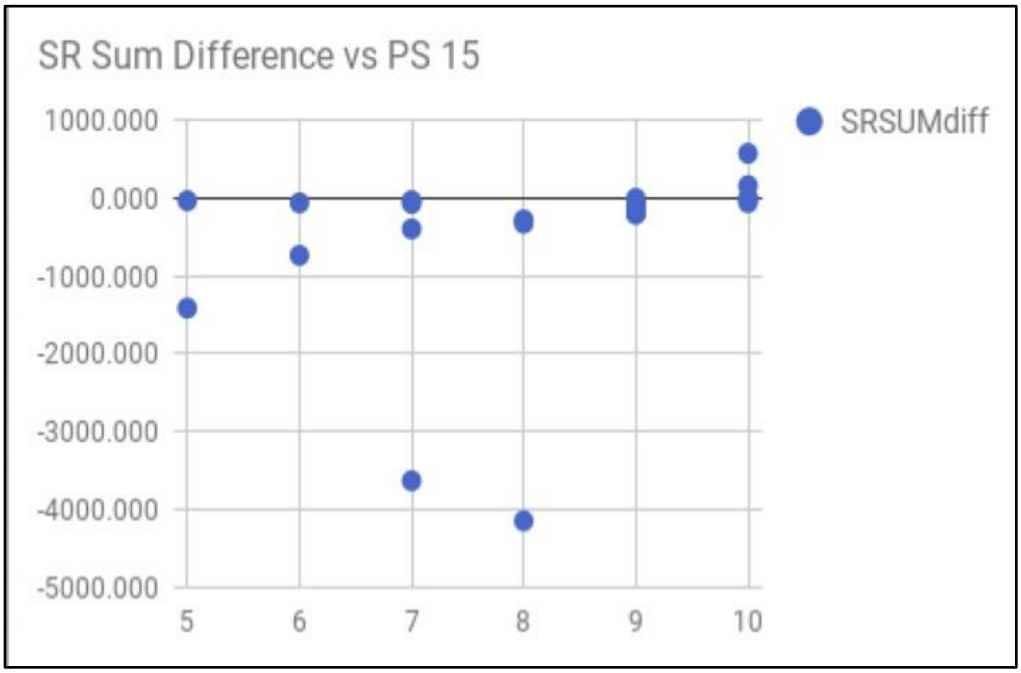


FIGURE 26. The sum of all sung response differences by participant versus the answers on the Post Survey for "I felt that I improved my vocal accuracy (singing the right notes)." The vertical axis shows the sum of all error differences pre- to post-test in cents and the horizontal axis shows the Likert scale numbers showing agreement with the statement. No one answered anything below a 5, so that is not shown here. Following the trend, note the general positive slope, meaning the more they felt they improved at singing the right notes, the less improvement they actually made between pre- and post-test at the sung responses (the more positive the sum error, the less improvement they made).

There was no apparent relationship between the participants' responses of agreement to the statement "I felt that I improved my perception of music (hearing pitches accurately)" and their objective progress on the pitch discrimination threshold measure.

The Post Survey also included some open-ended questions following the Likert-Scale questions. It asked "What did you feel you gained from this vocal training?" and "What could be done to improve the training?" The consistencies within groups and differences between them are clear.

For the first question, the auditory group participants wrote that they gained knowledge of their vocal range, how to sing in tune (this was repeated by a few participants), listening ability, singing intervals, holding a note, and understanding tone direction. The visual group's answers were similar: singing the right pitches, pitch distinction, distinguishing when a note is sung incorrectly, intonation, vocal accuracy and control, and singing "Twinkle, Twinkle" "like a champ." The proprioceptive/sensory group's answers had an understandingly different theme. They wrote that they gained understanding of breath and space, air flow, posture, vocal mechanics, how to sing ("instead of just hoping for the best"), and breathing. The neutral group wrote that they gained knowledge of rhythm and beats (repeated twice), singing accuracy, confidence, experience using the singing voice, a space to get used to the voice, and a sense of what it takes to sing.

The second question asked what could be done to improve the training. The distinction between the groups here is mostly between the three specific instructional groups and the neutral group. The answers from the first three groups focused on the word "more" - more songs, more sessions, more time, more practice, and more frequent lessons. While the neutral group answers did include a few similar "more" statements like more sessions, the majority here focused rather on more structure, more technique instruction, guidance on breathing, clear objective of training and desired outcome, and an incentive. They wanted more guidance - not just more of the same, but specific, clearer instruction. Neutral instruction was not enough in their view.

Journals

I wrote a journal entry after each lesson detailing my observations of the participants' abilities, strengths, progress, obstacles, statements, and displayed emotional state. I also included what we worked on, any deviations from the plan that day, and any technological issues. I also wrote about my own thoughts and feelings about the lessons - any frustrations about the protocol, obstacles, patterns, and reflections about my teaching habits in general. These journals kept me on task, and served as an outlet for me to voice my excitement, anxiety, and irritation during the process. A few examples of journal entries are shown in Appendix K.

It was challenging for me at times to restrain myself within the structure of the differentiated protocols. For example, in a lesson within the visual group, a female participant was struggling to reach a higher pitch for which she was taking up too much pressure in her chest voice. If I addressed making it breathier, lighter, or introduced a "flutey" head voice, she most likely would have succeeded right away. However, I was limited to guiding her based on the pitch that she produced and visually relating it to the target. This took many attempts and created more frustration for her in the progress when she still wasn't drawing the pitch line high enough after multiple trials, and across multiple lessons. Occasionally she would float to a lighter vocal mechanism and sing the correct pitch, so we would reinforce the accuracy there through *Sing and See*'s visual feedback. However, each new week she returned to attempting to sing in chest voice and complaining that her voice was cracking and that she was simply not able to sing that high. Three-quarters of the way through her seventh lesson, after pushing and straining and cracking on the high notes, she tried a different production and proclaimed her discovery to me proudly: "If I sing quieter, I can sing higher." She was using her head voice and had finally connected the dots. So, although participants in the proprioceptive group were able to access this lighter mechanism earlier in the process, I also have to wonder of the value of finding it herself. The limiting structure of what kind of feedback I could give was difficult in moments like this one (and there were many versions of this same journey), but

it was also intriguing to watch participants find their own way within the instruction.

A male participant in the auditory group described his voice as “horrible” within the first two minutes of the first lesson - before I’d even started recording. What is most interesting is that he was one of the most accurate participants from the start. He had a lovely sound, but was unstable and shaky. Immediately after beginning to work with him, I noticed the excess pressure with which he sang. This could be a large part of why he often fell flat. However, once again, I could not address the vocal production - only the product and its pitch height relative to the target. Then, in in his sixth lesson, we were practicing “Jingle Bells” by singing it together once, then recording him sing it alone. After listening back to the recording, I asked him to sing it again, making any adjustments he wanted to make based on what he heard in the recorded rendition. His second time through was different - much more accurate - and I pointed that out. He said that on the recording, the first verse was “breathy and airy, like cooing to a baby,” and the second verse was more “boisterous.” He decided to sing the second time completely in the breathier manner. He said that he sounded much better this way and it seemed revelational for him. So again, although adding ease and reducing pressure would probably have been a first lesson task for him in a proprioceptive lesson, he came to this manner on his own by necessity of making it *sound* better to him. Although I wrote a lot about feeling frustrated and limited within his

earlier lessons because I wanted to address finding a lighter mechanism, he still made his way there on his own. This, of course, did not fix everything for him, and he did not find this ease of production consistently, but overall I wrote at his final lesson that "he seems to really have improved his listening, perception, and discrimination ability over the course of the lessons...and [is] able to identify and label melodies by solfege pattern as well as producing melodies on call – mostly accurately."

As described in the last two examples, participants learned across modalities whether I mentioned it explicitly or not. Auditory group participants visualized melodies or felt the sensations of singing, visual group participants listened to themselves or felt vocal sensations, sensory group participants visualized or listened to the melodies and patterns, and the neutral group participants reported when things sounded or felt differently. I kept to the prescribed modality in my response to these reports or descriptions as best as I could, but it was interesting to see participants grasp at whatever helped them reach the instructional goal. Sometimes, it was simply saying "and that sounded better too" after having followed instructions to use more breath energy during a song. Other times, it was hearing that in order to make it *sound* correct, a participant unsolicitedly visualized a corresponding shape or gesture while singing.

The auditory and visual group participants, in general, tended to show more immediate progress within each lesson, which seemed to be very gratifying for them. However, each new lesson brought back the same issues from before. There was some overarching progress by the final lesson, but I wrote in many cases that participants were singing the same notes incorrectly that we had fixed the week before. On the other hand, the proprioceptive group on the whole made slow progress in each lesson and there seemed to be more in-the-moment grappling with abstract concepts. This made less of an immediately dramatic impact for the participants, but after a number of lessons they were retaining more that they had done before. The neutral group did not tend to go one way or the other in my notes; some participants seemed to stay at about the same level and others improved some throughout the lessons. One theme in this group was that they seemed to be enjoying the lessons. However, one participant mentioned in her final lesson: "I wonder if I've improved at all since the beginning. I've just sung this so many times."

A self-reflective topic that came up in my journals was that across groups I needed to keep my instructions simple and direct – finding the balance between challenging enough to keep attention but still achievable so as to avoid frustration. I also questioned along the way that perhaps it was less about the specific method of instruction and more about the delivery itself. This is outside the scope of the current investigation, but is relevant to note for future study.

Journaling added depth to the individual stories of the participants and served as a self-monitoring system. I was able to make quick adjustments and correct myself if I was starting to stray from the protocol or timing of activities.

Summary of Results

Thirty-one (15 male, 16 female) right-handed inaccurately pitch-matching participants were kept from forty-one volunteers. Four participants dropped out during the course of the lessons, or simply didn't attend the post-test, so the data are collected from 27 participants. As a whole group, participants improved on the familiar songs when on lyrics and on the pitch discrimination threshold measure, but there was no statistical difference between groups. Although empirically the participants seemed to improve on the short patterns, and individually many participants showed improvement on tasks at the post-test, the statistical significance is not present. This could be due to the low participant number per group and the high variance among the participants. It also might take longer than eight weeks to *retain* the vocal accuracy progress they demonstrated in lessons. During lessons, many participants showed clear improvement, especially in the first three specific instructional groups. Between groups, again the statistical significance is not present, but observationally and graphically it seems that specific instruction is better than neutral instruction, and perhaps giving students

information about *how* to fix the production (proprioceptively) is the most helpful for week-to-week progress. However, given the auditory or visual feedback about the target pitch seemed to give immediate satisfaction and then eventually create self-revelations about the vocal production requirements. It then becomes a matter of goal distinction: immediate change or retained change.

I was not surprised by the participants' keenness for the auditory and visual group feedback, because the goal is clear—especially in the visual group using *Sing and See*. What was surprising to me, however, was that they eventually made the progress and found a way to connect to other senses. For example, it took longer over the course of lessons for female participants to find their way into head voice and accurately reach higher notes in these two groups (as compared to the proprioceptive group's participants, to whom I gave specific instruction about the feeling of lightness, roundness, and hootiness). However, despite frustration beforehand, once they made the switch, they knew what it needed to feel like in order to reach the higher notes and they heard or saw the results clearly. Clarity of feedback and motivation of the student are both worthy factors in the process.

I also thought that the auditory group would have made more progress than it did. Based on motor learning theory's Knowledge of Results, this should have been just the clear external goal that tends to yield more successful results. Additionally, Tulving's Theory of Specificity suggests that success at the post-test

would rely on the sensory feedback available at the lessons. In this case, auditory and proprioceptive groups should have shown the most improvement, since those sources of feedback (hearing oneself and feeling the sensations of singing) were both inherently still present at the post-test. The visual group's feedback was no longer present at the post-test and yet, the participants were able to transfer their learning to the performance quite successfully. Perhaps the fact that the participants themselves switched sensory modalities during lessons (i.e. noticing the change in *sound* when the lesson focused on *sight*) helped them to retain the skills more effectively without the provided biofeedback.

The post survey revealed high marks for the perception of improvement not only on accuracy of pitches, but also on pitch perception, confidence for singing, awareness, and overall happiness with the lessons. Even though the linear relationship with objective improvement is not what we would expect, it suggests that the process was fruitful for the participants subjectively. Perhaps their fixed mindset of themselves as concretely poor singers could evolve after all.

The post survey's open questions showed certain distinctions between the instructional groups. Although all four instructional groups (the control group did not answer these questions about the lesson at post-test since they had yet to receive any lessons) had highly rated highly their happiness with lessons, there seemed to be a distinction between the groups on content focus of the lessons, and overall, what was lacking.

CHAPTER FIVE

V. DISCUSSION

"They must not be considered non-singers or referred to using the dreadful term *tone-deaf*. Just as all humans can learn to speak, they can also learn to sing."
Gordon 2004 Aural/Visual p. 14

Conclusions

This study showed signs that weakening the label of "tone deaf" affixed earlier in life is possible. Within lessons, every participant seemed to shed some of the layers of singing-related negativity. All four lesson groups answered that they felt happy with the training they received (8.83 rating) and that the lessons directly helped them on the post-test (8.50 rating). Those assigned to one of the specific instructional groups (auditory, proprioceptive, or visual) also reported strong affirmation of gaining confidence in singing (8.52 rating[8]), improved pitch accuracy (8.65 rating[9]), and improved pitch perception (8.26 rating[10]). Given specific guidance, participants were able to connect the pieces a bit more for themselves and see (or hear, or feel) the bigger picture.

[8] As opposed to the neutral group rating of 5.8.
[9] As opposed to the neutral group rating of 6.2.
[10] As opposed to the neutral group rating of 6.4.

Participants in the neutral group, although they seemed to enjoy themselves and the lessons, did not connect the musical experiences to direct singing improvement. This is consistent with my own journal observations as well. The neutral group often challenged my ability to restrain myself and keep to the study parameters. Since I could not offer any instructional guidance, participants were on their own as far as trying anything differently from one pattern or song to the next. This was not as fruitful an approach in lessons as the specific instructional groups, who were given something to focus on and improve or change. That focal point, regardless of modality, seemed to make a change in their perception of improvement by the end of the course of lessons. This was made clearest in the open-ended questions on the post survey. The neutral group answers wrote that they wanted more instruction on breathing, on technique, or on what the desired outcome was. Although they wrote that they had fun, this neutral instructional protocol was "confusing at times" and they wanted a clearer goal.

The three specific instructional groups also showed more observed improvement over the course of their lessons in patterns, exercises, and songs in my journal entries. The improvement varied; in the auditory and visual groups, I observed quick improvement within each lesson, but less retention between lessons, whereas in the proprioceptive group, I observed slow improvement during a lesson, but retention into the following lesson.

Each modality of these first three groups crossed into the others in some way. The participants mentioned transferring something they learned into another sense; for example, they *heard* the difference of the pitch, when we were specifically only addressing *feeling*, or vice-versa. Notably, the two groups that only addressed the target pitch without vocal function eventually made mention of finding an easier, or simply different, way of producing the note that helped them sing more accurately. Although their focus was on the *product*, they noticed when a changed *process* helped them achieve their goal. The proprioceptive group was asked to focus on the *process*, but the *product* was undeniably different as a result. The participants in the neutral group, given no instructional focus, also made connections and conclusions on their own about the product. Mostly, this was based on preconceived notions about difficulty of tasks, such as singing without the piano, or singing high notes. This also meant making general statements about their own progress, or observations between lessons. What was enjoyable to watch was when people surprised themselves by doing something after a few attempts that they initially thought out of their ability.

As stated in the results chapter, it is probable that the low participant number per group limited the statistical significance. It also could be that, as the participants suggested in their post survey, more lessons or more time was needed in order to show significant improvement in the post-test. Despite the lack of statistical strength, a few comparisons showed themselves to be noteworthy.

The proprioceptive and visual groups improved as a whole group on all short pattern responses, as shown in Figure 18. I found that the two top participants in terms of magnitude of improvement (shown in Figure 17) came from these groups as well. As stated in the Stance of the Researcher, I typically use proprioceptive feedback most often in my voice studio. However, I have found that since this study, I borrow from the visual protocols more often in order to include more sensory information with immediately clear feedback.

On the sung responses, all tasks improved as an entire group, though individuals' progress varied. Sung responses seven and nine, the familiar songs on lyrics, both showed significant differences from pre- to post-test as a whole group, but not by group. Looking individually, the RMSE data in Figure 19 showed a majority of negative pre- to post-test values, revealing improvement across most songs for most participants.

The RMSE sums in Figure 20 show that as a whole group, not only were the post-test responses closer to the target, but also the neutral syllable responses of each song at each testing session. This finding that the neutral syllable versions of familiar songs were more accurate than when on lyrics is consistent with the literature (Berkowska & Dalla Bella 2009; Dalla Bella et al. 2009), but seems in conflict with a description by music educator, Edwin Gordon:

> Think, if you can bear it, about the last time you heard a radio commercial with a typical person singing, a group of waiters and waitresses singing *Happy Birthday* in a restaurant, or fans singing the national anthem at a sports event. Without the words being used as support, the sound would have been even more disturbing. (1997 Learning Sequences in Music p. 10)

It seems that in fact, without the words, these participants were able to focus a bit more on the melody itself. By the post-test, participants as a whole showed significantly more improvement on the lyrics of "Twinkle, Twinkle, Little Star" than they did on the neutral syllable, which suggests that with practice they were able to learn to share the cognitive load with the melody and lyrics together.

What is intriguing is the linear regression analysis of the sum of all sung response differences pre- to post-test with the participants' perception of their improvement of vocal accuracy. One would expect a negative slope, showing that the more people perceived improvement, the more improvement they actually made. However, that is not what we see here. Even without the outliers, the slope is still positive at 137.972. The participants' ratings of improvement do not, therefore, correlate directly the way we would think to objective improvement. There must be another factor at play, such as their mental expectations of the potential for accuracy or their own internal standard of improvement. For example, someone with a high standard of achievement may not rate very highly on the post survey, even if she objectively improved a great deal. On the other hand, someone who previously believed his label as "poor singer" to be relatively

permanent but who surprised himself in lessons, may overrate his progress due to even a slight tendency towards improvement. This loosening of the fixed mindset is important, but certainly might have a strong effect on the relationship between perception of improvement and objective progress.

Possibly some of the most compelling differences between groups were shown in the post survey open questions. Although the statistical analysis shows no objective difference between groups in their sung responses, their written reactions to the study, as well as their behaviors observed during lessons, revealed certain characteristics. On the post survey, participants were asked to write what they learned in the lessons, as well as what they thought could be improved about them. The content of the lessons seemed to be slightly different between groups based on the instructional focus. This is completely understandable, and should be expected, since the instruction varied by group. This finding is a good confirmation for what the participants felt they received in the instruction based on the instruction that I intended to give. The auditory and visual groups, both focused on the target pitches by design, reported learning about vocal accuracy, intonation, and pitch discrimination. The proprioceptive group wrote that they learned about airflow, posture, the mechanics of the voice, and generally how to sing. The neutral group wrote that they gained singing experience, confidence, and learned about rhythm and beats.

Opinions on potential lesson improvements had a clear contrast between the first three specific instruction groups and the neutral group. The auditory, proprioceptive, and visual groups all wrote that the study should include more lessons, more time, more practice, and more songs. They seemed content with the instructional focus, activities, and material, but simply wanted more of all of it. The neutral group, however, wrote that there should be clearer instruction, more structure, guidance on breathing, and a clear objective. So although they were happy with the experience in general, digging a little deeper revealed that they realized something was up. They were not receiving the most targeted instruction, and they were craving that. They felt the need for more specific guidance, and a clear goal. Looking at participant perception of the experience is a valuable perspective to take into account when weighing the value of multiple instructional protocols. It seems these participants didn't want neutral instruction, or simply to gain musical exposure. They wanted to be guided, to be actively and consciously taught. The groups that were given specific instruction wanted more of it.

I have discussed the topic of this investigation with many people, and depending on the person to whom I am speaking, one of two things usually happens: either they say that they themselves or a close friend or family member is "tone deaf" and should be a part of this study, or they say that they will be surprised if I get many people to truly qualify for the study. The dichotomy of these statements alone reveals the gap between what the general population

believes about "tone deafness" and what the research says about it. In those examples, the latter response comes from people who are involved in music perception research in some way, and the former response comes from anyone else. The research shows that there are actually very few people in the general population who cannot match pitch within a few semitones. Reportedly however, close to 17% of the population claim that they are inaccurate pitch matchers. It seems empirically that even more people claim the term "tone deaf," when there is clearly a misunderstanding of to what that refers. When even some people with congenital amusia can match pitch accurately (Dalla Bella, Giguère, & Peretz 2009), even though they might not be able to tell when they hear it, it suggests that true tone deafness refers to the hearing of pitches, and not necessarily the production of them.

All of this makes it very interesting that forty-one volunteers replied to the advertisement for my study. It demonstrates the prevalent self-image of being a poor pitch-matcher. Ten of the forty-one were dismissed, so that I was left only with volunteers who were actually inaccurate at their pre-tests. Thus, one quarter of the people who answered the advertisement were dismissed because they were too perfectly accurate to qualify. Some of the accepted participants were only inaccurate by a small margin. Despite the common opinion that many share with me in conversation that they are, or know someone who is, "tone deaf," this inaccurate pitch-matching is in the minority.

This is not to say that it does not exist, or that it isn't a sore subject for many people. One conversation with a participant described her emotions behind singing:

> Music has always been such a big part of my life, but I've never been able to be a part of it. It's just this black hole. And that is very disconcerting. I imagine there are a lot of people like that...Half of my family is very musical and the other half is tone deaf. I was told I was part of the tone deaf side." *How old were you when you were told that?* "Oh, as long as I remember… It's not that I have aspirations to be a musician, but I lead a Passover Seder every year and no one can follow me.

As insecure and frustrating as it may be for the person struggling to sing on pitch, voice teachers can feel helpless as well when attempting to elicit change in these students. Since voice teachers probably never needed specific instruction on fundamentally matching pitch themselves, it is most likely outside of the realm of their personal experience. This is why it is crucial to have tools and teaching options other than one's own practice that will help guide the "how" of instruction for students. This study established that progress is possible; there are teaching methods that improve pitch production accuracy. More precisely, specific sensory-based instruction with clear goals are most useful in helping students find their way towards accurate production.

Limitations

One clear limitation of this study was the small participant pool per group. The division into five test groups, although necessary for any instruction comparison, limited the potential for statistical significance. More participants per group would be needed in order to truly parse out any differences between the instructional groups.

Another limitation was the heavy time requirement. This limited the participant pool as well, since it required at least nine weeks of regular meetings. I lost one participant early on because of the demands on her schedule, and another three because they didn't show up to the final testing session after attending all lessons.

I set up this study to look solely at the frequency of the voices without investigating any other characteristics of the vocal fold vibration. However, in looking at the sound envelope closely, it seems that even if the fundamental frequency did not move significantly towards the target note, the vibratory characteristics of many voices seemed to even out from pre- to post-test visually. Without the infrastructure in the study design from the beginning, it is difficult to examine this definitively. It would have benefitted from more specific evaluative measures such as electroglottography, like Mürbe et al, or even laryngoscopy in order to look at the vibratory pattern of the vocal folds beyond simply their

frequency. Another characteristic that would be noteworthy to have evaluated is the breath capacity and phonation threshold pressure[11]. Both of these could have been measured at pre- and post-test sessions in order to examine any changes in the respiratory system and in the efficiency of the vocal mechanism.

An unforeseen limitation of being completely absent in the testing sessions was a lack of ability to compare the qualitative degree of inaccuracy from pre-test to lessons to post-test. For example, giving research assistants a qualitative scale measurement with which to evaluate the severity of the pitch matching inaccuracy would allow for a comparative measure based on perception, in addition to actual frequency, which would then be able to compare with my perception of the participants during lessons. As it stood during this study, the testing sessions were the only objective measures, and the lessons were solely based on my perception - and I wasn't aware of the participants' starting point in pre-test.

Implications for Future Study

My findings here suggest that there is more beneath the surface in working with people who are struggling to match pitch accurately. Future study with this population could integrate the instructional protocols from each of the groups in

[11] Phonation threshold pressure (PTP) is the minimum lung pressure required to initiate phonation. It is linked to healthy vocal fold function, since a higher PTP correlates with more effort required just to create sound, whereas a lower PTP correlates with ease of vibration.

my study that were successful. For instance, using *Sing and See* from the visual group, but in tandem with semi-occluded vocal-tract postures and proprioceptive awareness training, so that the participants can more quickly navigate different areas of their voice, reach the desired range with minimal frustration, and immediately see the result on the program. I would be curious to see the progress of students in an integrated training program such as this. The design could return to the one-session study to document the change within one lesson in more depth, or broaden out to include a longer training time-frame. The latter of these certainly seemed to be the preference of the majority of my participants.

As mentioned in the limitations section, future studies could investigate the details of the vocal production mechanics during training, such as the characteristics of the vocal fold vibration, or the phonation threshold pressure. In this way, we could examine not only the product, or sung tone, but also the process, or function of the vocal mechanism itself. Perhaps participants are gaining more than simply accuracy, but also are developing their vocal technique and are finding more efficiency and coordination in their voices.

A costly and time-intensive, but certainly worthwhile, inquiry would be including functional magnetic resonance imaging (fMRI) in order to measure brain activity before and after training sessions. Measuring during training would also be fascinating, but is harder to accomplish since fMRI requires the participant to remain still in a very small space. Looking at the brain activity

would give us an inside view of what connections are being made and what areas of the brain are assisting to make the production changes. This might offer insight into what new sensory or motor cues are firing in order to make adjustments in the pitch matching production tasks throughout the process. Or, as I found in lessons, perhaps participants are integrating sensory cues themselves in order to complete the equation from heard pitch to correctly matched pitch.

Concerning the congenital amusic population, I am curious as to the potential efficacy of training protocols with these individuals as well. Since researchers have found amusics to sometimes match pitch perfectly, I wonder if it is possible to train others from the same population to accurately map pitches to their voices.

I believe that these findings also implicate new research in populations outside of the inaccurate pitch-matching one. Perhaps these findings could be replicated in a general music education or choral instruction setting. Many choral teachers lament having a handful of singers who aren't on the correct notes and bring down the choir's sound. I believe that the findings of this study offer suggestions, but future study could explore more specific applications in these group-singing environments. Additionally, I have learned so much about teaching efficacy with my students who do not struggle with pitch. Fine-tuning a voice still requires teaching skill and having multiple sensory teaching tools can help to motivate and inform students so that they take ownership of their learning. I watched the confidence build in participants that had no expectation of singing success, so I

wonder if these instructional protocols, adapted for the needs of the collegiate voice major, could offer exciting new options in the university voice studios as well.

Final Thoughts

Based on my observations working with adults who self-assess as struggling to match pitch or sing on key, improvement is possible. Even in the more severe cases, specific instruction, whether visual, auditory, or sensory - more than neutral or no instruction - empirically seemed to help participants find the right pitches in their voices. Participants' confidence also boosted from specific instruction and they were left more satisfied than in neutral or no lessons. That is to say they simply wanted to keep going to lessons, as opposed to wanting to change the type of instruction in the lessons. Statistical significance was not present, likely due to the small participant pool per group and high variance. Further investigation is needed for clarification and to look into any changes in vibratory characteristics beyond frequency after instruction.

Returning to the "how" of singing training, I found that giving a specific sensory goal is most helpful, above neutral musical exposure. Based on participant progress, my own journal observations, and participant perception of progress, my personal preference would be for proprioceptive feedback and visual

feedback. That is, directing the student to focus on the sensory feelings of energy and vibration created within his/her own body during singing as well as giving an immediate visual representation of the product. Since I found that the visual group made quick short-term progress and the proprioceptive group tended to make slow progress, but retain it between lessons, this integrated option could offer the best of both worlds. Further exploration is needed on the ratio of integration, but since both groups empirically improved, the potential is good. I have enjoyed the additional direction in my own recent studio teaching.

APPENDICES

A. CURRICULUM VITAE

Brittney Redler
66 Sherwood Pl * Greenwich, CT 06830 * (803)312-4134(cell)
brittney_redler@yahoo.com

EDUCATION

New York University, Steinhardt School, New York, New York
PhD Candidate (ABD) in Vocal Performance, expected completion Spring 2018

National Center for Voice and Speech, Summer Vocology Institute, Salt Lake City, Utah
Certificate of Vocology, July 2012

New York University, Steinhardt School, New York, New York
Master of Music in Vocal Performance, May 2008

Ithaca College, School of Music, Ithaca, New York
Bachelor of Music in Music Education and Vocal Performance, December 2003
-*Magna cum Laude*
K-12 Music Certification New York, February 2004
K-12 Music Certification South Carolina, July 2004

TRAINING

Voice: Brian Gill, Linda Larson, Kelly Samarzea, Constance Chase
Acting: John Simpkins, Meg Bussert, Hudson Valley Shakespeare Festival
Coaches: Grant Wenaus, Maida Libkin
Conductors: Lawrence Doebler, Janet Galván, Patrick Hansen
Directors: Noah Himmelstein, Meg Bussert, Martha Collins, Bill Wesbrooks, Beth Greenberg
Dance: Barry Blumenthal (tap), Lars Rosager (tap), Andrea Markus (modern)
Yoga: Carla Stangenberg, Ramit Kreitner, Liz Buehler-Walker, Kenzie Pause

PUBLICATIONS, PRESENTATIONS AND RESEARCH

*The Way You Sing Off-Key…*CAN *They Take That Away From Me?*, paper presentation, **College Music Society Northeast Regional Conference**, 2016

Guest Vocal Pedagogy Speaker, **Vanderbilt University**, Spring 2016

Vocal Health: This is your voice on anxiety, voice teacher panelist, **MusiCares Foundation**, Fall 2015

Master Class, **University of South Carolina**, Fall 2015

Exercises for Sustainability and Longevity, guest lecture for Vocal Pedagogy, **University of South Carolina**, Fall 2015

Vocal Pedagogy Workshop, guest lecture for Music Education Dept **NYU Steinhardt**, Spring 2015

Acoustics and Vocal Resonance, guest lecture at **NYU Steinhardt**, Fall 2013

The Show Must Go On: How Do Our Favorite Rock and Pop Icons Deliver World Class Vocal Performances Night After Night, Year After Year?...Or Do They?, presentation at **The Fall Voice Conference by NYU School of Medicine and Weill Cornell Medical College**, October 2012

Singer Training and Repertoire Assignment, **OPERA America** Web Site, Spring 2012

ORGANIZATIONAL MEMBERSHIP

National Association of Teachers of Singing, Pan-American Vocology Association, National Association for Music Education, New York Singing Teachers Association, The Voice Foundation, College Music Society, Connecticut Music Educators' Association

TEACHING EXPERIENCE

Choral Director and Theatre Teacher, Brunswick School, Greenwich, CT, 2016-present

I teach 5th-8th grade chorus and theatre arts at an all-boys private school. I also direct and music-direct the co-ed middle school musical production, and music direct the co-ed high school musical production.

Private Voice Studio, New York, NY and Greenwich, CT 2008-present

Maintain a private voice studio of students, teaching vocal technique and repertoire.

Adjunct Voice Faculty, NYU, Steinhardt School, New York, NY 2006-2008, 2011-2016
I taught private voice lessons to Vocal Performance, Music Education and Music Business undergraduate and graduate students. I designed and co-taught a graduate pedagogy class with the NYU Medical School on working with injured voices. I also taught group voice class to non-music major undergraduate students.

Singing Voice Specialist, NYU Langone Medical Center, Dept of Otolaryngology, New York, NY 2015-2016
I consulted and taught rehabilitating singer clients in collaboration with the ENT and speech-language pathologists in the Voice Center. Served as liaison between the Voice Center and Steinhardt's Vocal Performance program.

Music Director/Choral Conductor, Highbridge Voices Summer Program, Bronx, NY 2013-2014
Choose, teach and conduct the choral repertoire for a group of approximately 40-50 children grades 4-5 in a summer choir program. I also teach a music class for the same children, covering basic musical concepts and skills.

Vocal Instructor, Highbridge Voices, Bronx, NY 2009 and 2011-2013
Private weekly voice lessons to the 4th-12th grade students in Highbridge Voices' extended day choir program.

Music Teacher, Sunset Park High School, Brooklyn, NY 2010-2011
Taught 10th grade general music, led an extracurricular choral group after school and coached the track team. Sunset Park High School is a brand new school, having been opened for its first school year in 2009-10, so I conceived and planned the inaugural music program from the ground up, including purchasing instruments and materials, and establishing a foundation of general music knowledge among the students.

Music/Choral Teacher, P.S. 206 Joseph F. Lamb School, Brooklyn, NY 2009-2010
Taught K-5 general music as well as a chorus with students in grades 3-5.

Voice Captain, Norwegian Lines Cruises, Miami, FL 2005-2006
Supplemented the instruction of the musical director to the singers in the cast of the Marco Polo during the rehearsal month and maintained the musical integrity of the performances throughout the tour. Warmed up the cast before shows, evaluated recordings for hesitant parts, assisted in maintaining the vocal health of the cast.

Choral Director and General Music Teacher, Dubose Middle School, Summerville, SC 2004-2005
Taught chorus, women's ensemble, and select choir as well as one eighth-grade general music class with a curriculum of music theory, history, and several units of classroom instruments. Prepared students for State Festival, performed two main concerts and other small appearances throughout the school and community. Directed the school musical, coordinating all technical preparation and fundraising.

Private Voice Studio, Charleston, SC 2004-2005
Maintained a private voice studio with students ranging from junior high school to adult.

Substitute Teacher, Lexington Richland School District Five, Columbia, SC, 2004
Substitute taught in the elementary through high schools of the district in all subjects ranging from special education to elementary classroom teacher to AP Calculus in high school.

PERFORMANCE EXPERIENCE

Doctoral Recital, New York University, 2018
Serena, ***Bloomer Girl***, Provincetown Playhouse, New York University, 2014
Doctoral Recital, New York University, 2014
WORLD PREMIERE A Song for Susan Smith (libretto Mark Campbell), New York University, 2014
She Frowns, ***Windows***, American Opera Projects, 2013
WORLD PREMIERE Your Compliments (Royce Vavrek lyrics), National Opera Center, 2012
Magnanimous, ***Windows,*** NYU Contemporary Music Ensemble, 2012
WORLD PREMIERE Gretta, ***Breakfast,*** Metropolis Opera MOP Bucket 2011
Featured Singer, ***The Songbook Series,*** Bruno Walter Auditorium, 2010
Sorella, Novizia cover, ***Suor Angelica,*** Chelsea Opera, 2009
Featured Singer, ***Marry Me, America,*** The Spotlight Cabaret, 2009
Featured Singer, ***State of the Union***, The Spotlight Cabaret, 2009
Something Beautiful Somewhere, Table Reading, NYU Tisch CAP21, 2009
MuSE *Change the World* Concert, Juilliard School, 2008
Graduate Recital, New York University, 2008
Eurydice, ***Orpheus in the Underworld***, New York University Opera, 2007
Mrs. Nordstrom, ***A Little Night Music***, New York University, 2007
First Lady, ***The Magic Flute***, New York University Opera, 2007
Ensemble, ***L'Elisir d'Amore***, Opera for Humanity/Cancer Benefit, 2007
Fire, Nightingale, ***L'Enfant et les Sortileges*** , New York University Opera, 2006
Featured Singer, Norwegian Cruise Lines, 2005-6
Featured Guest, ***The Good Time Variety Hour***, Piccolo Spoleto Festival, 2005

Rapunzel, ***Into the Woods***, Village Playhouse Theatre, 2004-5
Rhett Barnwell ***Requiem Aeternum,*** Charleston Symphony Orchestra Chamber Group, 2004
Senior Recital, Ithaca College, 2003
Mother Jeanne, ***Dialogues of the Carmelites***, Ithaca College Opera Project, 2003
Vaughn-Williams ***Dona Nobis Pacem,*** Ithaca College Choir, 2003
Martin ***Mass,*** Ireland tour, Ithaca College Choir, 2003
Bach ***St. John Passion***, Ithaca College Choir, 2003
Junior Recital, Ithaca College, 2002
Penderecki ***Stabat Mater***, Ithaca College Choir, 2002
Flower Maiden, ***Parsifal*** (excerpt), Ithaca College Opera Workshop, 2002
Summer Concert Series, US Military Academy *Jazz Knights*, 2001-2
Amor (cover), ***L'Incoronazione di Poppea***, Ithaca College Opera, 2001
Fiona, ***Brigadoon***, James I. O'Neill Players, 1999
Babe***, Pajama Game***, James I. O'Neill Players, 1998
Performer, ***Jerry's Girls***, Stagedoor Manor, 1998

AWARDS AND SCHOLARSHIPS

Outstanding Graduate: NYU Steinhardt Classical Voice Program, 2008
Regional Finalist: Continuing Ed Division, Southeastern NATS Competition, 2005
C. Burnside Music Scholarship, Ithaca College, 2003
First Place - Collegiate Division, Empire State Vocal Competition, 2002
W Grant Egbert Music Scholarship, Ithaca College, 2000
Winifred Bouck Award, Ithaca College, 2000

ADMINISTRATIVE/RELATED WORK EXPERIENCE

Artistic Services Associate, OPERA America, New York, NY 2008-2009
Managed the "Making Connections" series, informative panel discussions with professionals in the field, as well as maintaining various databases, writing visa petition letters in support of member companies' applications for foreign artists.

Office Assistant, Remy Cointreau USA, New York, NY 2007-2008
Worked in the Finance and Accounting Departments of this major alcohol distributor's Corporate Office, organizing invoices from fiscal years 2006-2009. Created and established a new system of organization, compiled necessary files for communications with vendors and tax officials, and worked directly with superiors preparing files for the companies to which they pertained and sorted information to clarify billing.

Receptionist, Hermés of Paris, Corporate Office, New York, NY 2008
Screened and forwarded telephone calls, faxes and e-mails appropriately, Welcomed office visitors and while keeping them informed and comfortable, prepared the meeting room and Hermés individual for the appointment. Worked extensively in Lotus Notes as well as Microsoft Word and Excel. Worked closely with the Human Resources Department on various projects as well as recruiting for boutiques across the country. Read and sorted the resumés of applicants as well as scheduled interviews for the Human Resources Director.

Cruise Staff/Performer, Norwegian Cruise Lines, 2005-2006
Coordinated events, organized meetings, led social activities, and oversaw passenger gatherings. Mingled with passengers to ensure their satisfaction with the vacation, and directed them to assistance from the correct department if need be.

Assistant Coordinator/Head Counselor, Ithaca Community School of Music and the Arts, 2002
Worked with the coordinator to plan music, art, theater, and dance classes, as well as field trips and special presentations. Hired teachers for each of these classes and oversaw the teaching. Assisted with behavioral difficulties in the classes and throughout the day. Led the children on field trips on public transportation. Planned and led after-program theme-based activites.

Student worker, Ithaca College School of Music, Instrument Repair Shop, 1999-2003
Filed instrument, maintenance and secondary sign-out information Data Entry in the computer database for organization of files. Organized student locker sign-out and answered building maintenance requests.

COMPUTER PROGRAMS

Google: Classroom, Drive, Chrome; Microsoft: Word, Excel, Powerpoint, Outlook, Access; Audacity; Voce Vista; Tony frequency extraction; Sing and See; MATLAB; Quicktime Player; Screencastify; EDPuzzle; Mozilla Firefox, Internet Explorer, Safari; Blackboard

References available upon request.

B. UCAIHS EXPEDITED APPLICATION

New York University • University Committee on Activities Involving Human Subjects
665 Broadway, Suite 804• New York, NY 10012-2331 • www.nyu.edu/ucaihs/
(212) 998-4808 • fax: (212) 995-4304 • ask.humansubjects@nyu.edu

For UCAIHS internal use
HS# _____
Meeting date: _____

APPLICATION FOR REVIEW BY THE UNIVERSITY COMMITTEE ON ACTIVITIES INVOLVING HUMAN SUBJECTS (UCAIHS)

Instructions

Applicants must take the Humans Subjects Tutorial and pass the Certification Exam before submitting their application: www.nyu.edu/ucaihs/tutorial/

All Applications must be typed or word-processed (single spaced). Do not type on back.

Applicants should refer to the UCAIHS online tutorial for guidance available on the UCAIHS website at www.nyu.edu/ucaihs/.

Principal Investigator (PI)

First name: **Brittney** Last name: **Redler**

School: **Steinhardt** Department: **Music and Performing Arts**

Work phone: _____ Home phone: **803-312-4134**

PI mailing address: **35 W 4th St. 10th Floor, New York, NY 10012**

Email address: **blb285@nyu.edu** PI NYU net ID: **blb285**

Status *(check one)*:

☐ NYU Faculty ☒ NYU Student ☐ Other NYU ☐ Non-NYU

Student mailing address *(if not a faculty project)*:

Street: **135 Ocean Pkwy Apt. 6A**

City: **Brooklyn** State: **NY** Zip Code: **11218**

Faculty sponsor *(required for all students or non-NYU investigators)*:

First name: **Brian** Last name: **Gill**

School: **Steinhardt** Department: **Music and Performing Arts**

Faculty sponsor email: **brian.gill@nyu.edu** Faculty Sponsor NetID: **bpg1**

Co-investigator

First name: **Wayne** Last name: **Shuker**

School: **Steinhardt** Department: **Music and Performing Arts**

Additional investigators

First name: **Jessica** Last name: **Lee**

First name: **Julie** Last name: **Song**

First Name: Joshua Last Name: Glasner

Project Title

A Comparison of Training Interventions for Pitch Inaccurate Singers

Are you requesting **Exempt Status?** *(See page 3 for definition.)*

☐ Yes ☒ No *If yes, fill out Request for Exempt Status on page 3.*

Are you requesting **Expedited Status?** ☒ Yes ☐ No *If yes, complete expedited checklist*

UCAIHS Internal Use
HS Exam Passed:
☐ PI
☐ Faculty Sponsor
☐ Inv2
☐ Inv3
☐ Inv4

Investigator's Agreement

I agree to use procedures with respect to safeguarding human subjects in this activity that conform to federal, state, local and University policy. If significant change in investigative procedure involving human subjects is called for during the activity covered by this Application, I shall seek prior approval for such change from the UCAIHS and agree to follow the advice of the UCAIHS. If this activity is a continuation or renewal of an ongoing program, I affirm that the procedures followed during the current period conform to this policy.

Principal Investigator signature: _____ Date: 1/30/15

Faculty sponsor signature: _____ Date: 1/30/15

Has this study been **previously approved** by the UCAIHS?

☐ Yes ☒ No *If yes, what was the most recent approval date?* _____

If yes, what was the name of project as approved?

_____

_____

Have procedures changed since the most recent UCAIHS review?

☐ Yes ☐ No *If yes, provide details as part of this Application as appropriate.*

Will data be collected from or about any of the following protected populations? *(Check all that apply.)* **Note:** There are additional protections and procedures required for the use of protected populations as subjects in research. Please consult Chapter 13 of the UCAIHS tutorial at http://www.nyu.edu/ucaihs/tutorial/ to review these protections. Additional questions should be directed to the UCAIHS staff at 212/998-4808 or ask.humansubjects@nyu.edu .

☐ Minors (under 18 years of age) *If checked, specify age range:* _____

☐ Prisoners

☐ Pregnant women

☐ Fetuses

☐ Institutionalized mentally disabled (individuals residing as patients in an institution who are mentally ill or retarded; emotionally disturbed; psychotic; or senile)

Will the project involve any of the following? *(Check all that apply.)*

☐ Deception (research in which subjects are purposely led to have false beliefs or assumptions)

☐ More than minimal risk to subjects (i.e., risk greater than that of everyday life)

☐ Investigational new drug or device exemption *If checked, include IND/DE/510(k) information.*

If the Investigator is a student, indicate if the project is a:

☐ Thesis ☒ Dissertation ☐ Class project ☐ Other *(please specify):* _____

Is the application for a Pilot Study?

☐ Yes ☒ No

Is the proposed project being supported by any **external (non-NYU) funding or from an NYU competitive research program** or has such funding been applied for?

☒ Yes ☐ No

If yes, what is the name of the funding agency, organization or NYU program?

NY-FAHS Beck Award, Steinhardt Dissertation Grant, Mitchell-Leaska Dissertation Research Award _____

What is the status of the request for funding?

☒ Submission planned in near future ☐ Submitted & Pending

☐ Initial award ☐ Continuation award ☐ Renewal award

If already awarded, what is the award or grant number? _____

What is the title of the project as it appears in the submission for funding or award?

A Comparison of Training Interventions for Pitch Inaccurate Singers

_____

REQUEST FOR EXEMPT STATUS FROM FULL HUMAN SUBJECTS COMMITTEE REVIEW

Certain categories of research deemed very low risk under Federal regulations may be granted Exempt Status once the appropriate review has been conducted by the UCAIHS. If Exempt Status is granted, the study will not require continuing or other review unless procedures are revised which deviate from those originally approved by the UCAIHS.

Note that only the UCAIHS may grant Exempt Status. Therefore, applications for Exempt Status must include the completed remainder of the application in addition to the information requested below.

Part 1
Exempt status may be claimed under the following categories. **Please check all that apply.**

☐ **1.** Research is a study of normal educational practices in commonly accepted educational settings.

Note: This exemption does not apply to research with children when the investigator[s] participate in the activities being observed; for example, in classroom situations where the investigator is taking part in the classroom activities being studied, or if activities are introduced for the purpose of the proposed project and are not part of the usual curriculum or activities.

☐ **2.** Research involves:
- **a.** The use of educational tests, surveys, or interviews where identifiers are not recorded by the Investigator or where there is neither a risk of harm to subjects nor information sought concerning sensitive aspects of the subject's own behavior. (**Note:** This exemption does not apply to research involving surveys and interviews with children or to experiments such as computer simulations of decision making or laboratory tests of group interactions or to activities involving deceit or manipulation of beliefs); *or*
- **b.** Observation of public behavior where identifiers are not recorded by the Investigator or there is neither a risk of harm to subjects nor observation of sensitive aspects of the subjects' own behavior

☐ **3.** Research involves the use of educational tests, surveys, interviews, or observation of public behavior that is not exempt under the above category **if:**
- **a.** subjects are elected or appointed public officials or candidates for public office; *or*
- **b.** federal statute(s) require(s) without exception that the confidentiality of the personally identifiable information will be maintained throughout the research and thereafter.

☐ **4.** Research involves only:
- **a.** the collection or study of existing data, documents, records, pathological or diagnostic specimens, where publicly available; *or*
- **b.** the information is private but identifiers are not recorded by the Investigator.

Note: Recent Office of Human Research Protections guidance on types of data that do and do not require review and approval has changed the interpretation of category 4a. Please consult the UCAIHS web site at http://www.nyu.edu/ucaihs/apply/. In addition, Protected Health Information, as defined under the HIPAA Privacy Act, may not have secondary use without review and approval by the organization from which it is derived, as detailed on the following page.

☐ **5.** Taste and food quality evaluation and consumer acceptance studies, if wholesome foods without additives are consumed or if a food is consumed that contains a food ingredient at or below the level and for a use found to be safe, or agricultural chemical or environmental contaminant at or below the level found to be safe, by the FDA or the Food Safety and Inspection Service of the U.S. Department of Agriculture.

Part 2
Please complete the following Exempt Justification Statement.

I believe my research qualifies for exempt status under one or more categories indicated above, for the following reason(s): (*Enter supporting statement for exemption[s] by number using the space provided by the form.)*

NOTE ON PROTECTED HEALTH INFORMATION

The Health Insurance Portability and Accountability Act (HIPAA) is the Federal legislation that governs all uses and disclosures of Protected Health Information (PHI), also known as individually identifiable health information, in order to protect individual privacy. HIPAA protects PHI for both living individuals and decedents (as opposed to the federal Common Rule which governs research activities with human subjects in the U.S. and pertains only to the living).

New York University is classified as a "hybrid institution" encompassing both a "covered entity" (including the Medical and Dental Schools) involved in the creation and receipt of PHI and an "uncovered entity" (including most other University units). The UCAIHS serves as the IRB for the uncovered entity components of NYU. Specific HIPAA regulations govern the release of PHI for research purposes for or from covered entities and place regulatory responsibilities on investigators at uncovered entities who seek research subjects or information from or though the assistance of covered entities.

Therefore, investigators planning to make use of data obtained from or through other organizations that are covered entities (including the NYU Medical Center), must obtain approval for the use of that data from the covered entity as part of the required UCAIHS and cooperating institution IRB approvals.

PURPOSE OF STUDY

Please describe the purpose of your proposed research, making clear the question the research is attempting to address. Avoid the use of technical terms or discipline specific language. Your explanation must be clear to those unfamiliar with your field. References are unnecessary.

The purpose of the research is to compare the efficacy of commonly used approaches to improving students' pitch production accuracy in singing. There will be a pre/post test protocol in which participants sing single notes, intervals and a familiar song; take an accepted test on pitch perception and discrimination; as well as a survey on their musical background. In this manner I can systematically compare the different instructional approaches used by comparing the progress made from pre- to post-evaluation. The instructional approaches include focusing on learning to hear the goal pitch in order to match it correctly, learning to visualize the goal pitch in order to match it correctly, learning to coordinate the vocal mechanism itself (singing training without reference to the goal pitch), and regularly singing songs and patterns for exposure.

SUBJECT SELECTION AND RECRUITMENT

Part 1
Selection of subjects must be equitable, scientifically justifiable, and, in the case of protected populations such as children, prisoners, pregnant women, or mentally disabled persons, should reflect their special needs. In addition, investigators should be sensitive to the use of educationally and economically disadvantaged persons as subjects. If you are excluding women, children, or minorities or other specific populations from your subject pool, you must include a scientific justification for such exclusion.

Investigators are advised to consult with UCAIHS staff prior to planning studies with regulated access to special populations such as prisoners or the mentally disabled. In addition, investigators are **strongly discouraged** from proposing recruitment that includes their own classes, clients, patients, or similar groups, in order to avoid any potential for coercion.

Please answer the following questions:

a. What is the expected sample size (number of subjects to be included)? **80**

b. What are your criteria for inclusion of potential subjects (e.g., age range, country of birth or native language, medical status, grade in school, membership in a particular organization, marital or parental status)?

Anyone 18 years or older, willing to participate, who does not sing accurately

c. What are the criteria for subject exclusion (e.g., age range, country of birth or native language, medical status, grade in school, membership in a particular organization, marital or parental status)?

They should not possess the neurological perceptual deficit (amusia) that would explain the inaccurate pitch production (determined by pre-test)

Part 2

Describe in detail how the subjects will be recruited. Investigators should make every attempt to use indirect recruitment methods (i.e., methods in which the investigator does not make direct contact with potential subjects but rather makes information available on the opportunity to participate and how to contact the investigator if interested).

a. How will investigators identify potential subjects (how will they know whom to recruit)?

By volunteering for the study, subjects are professing their inaccuracy at singing and their willingness to learn to improve

b. Where and how will potential subjects be informed of the opportunity to participate? *Include copies of recruitment letters, flyers, or advertisements, and/or a copy of the oral and written statements to be used at the time of recruitment of subjects.*

Flyers will be used, and postings in the university newspapers and on social media

c. How will subjects be able to let the investigator know they wish to participate?

Subjects will contact the investigator via a gmail account created specifically for this study (and included on the advertisement flyer

Please provide any additional information, if relevant.

Flyer attached

STATEMENT TO SUBJECTS

What will the investigator tell potential subjects once they indicate interest in participation about the study and how will the investigator tell them (e.g., by letter, phone call, email, presentation to a group)?

The statement to the subject should include information on the purpose of the study, what subjects will be asked to do if they participate, where the study will be carried out, how much of the subjects' time participation may take, and what type of information they might be asked to provide. It should also make clear that participation is voluntary and that subjects may withdraw from the study at any time.

Include a copy of any written statements or verbal scripts to be used. Statements to children should state that written parental permission is required for participation and be in language appropriate to the subjects' age.

The statement to subjects is attached

HARM OR BENEFIT TO SUBJECTS

Describe any potential harm/risk or benefit to the subjects. If there is no more than minimal risk to subjects (e.g., no greater than that of everyday life), then state that "there is no risk from participation beyond that of everyday life." If there is the possibility of greater than minimal risk, include a discussion of why the additional risk is justifiable. For approval of any study with more than minimal risk, the benefits must clearly be shown to outweigh the risks. If appropriate, include information on how risk might be managed. For example, an investigator could provide a list of community or University counseling services when there is potential for emotional distress.

Detail any direct benefits to subjects. If there are none, so state. Take care not to exaggerate potential benefits; research studies rarely provide direct benefits to subjects and that the results of research are often tenuous.

Note: Gifts or payment of any kind to participants are incentives or reimbursements, not benefits. If any gifts or incentives will be offered to subjects, provide details in the section on procedures. Information on incentives should be made clear in recruitment materials and consent/permission forms.

There is no risk from participation beyond that of everyday life. There may be no direct benefit to subjects, but a potential benefit is that they may improve at matching pitch when singing.

PROCEDURES TO BE FOLLOWED

Describe the procedures to be followed in carrying out the project, including:,

a. where the study will be conducted;

b. exactly what the participants will be expected to do at each stage of the project;

c. how much time each activity will require and the total time for participation;

d. who will supervise the participation or conduct interviews;

e. how material such as surveys will be distributed and returned.

f. any incentives or reimbursements for participants (describe and explain what participants receive if they withdraw before the study is completed).

a. LOCATION: The study will be performed in the music studio facilities in the basement of the Global Center for Academic and Spiritual Life at 238 Thompson St.

b. PROCEDURES: Participants during the pre-test stage will all be asked to take the Montreal Battery of Evaluation of Amusia (as both a pre-test comparison measure and a confirmation of the absence of perceptual deficit); a Musical Background Questionnaire; a Pitch Discrimination Threshold measure; and sing single notes, intervals, and a familiar song. The sung measures will be audio recorded in response to pre-recorded stimuli as played through headphones and they will try to match the tone(s) as best as possible.

Participants will be randomly assigned to one of five groups and given 8 weekly 30-minute individual lessons. Training in the different groups is based on 1. hearing the goal pitch in order to match it, 2. visualizing the goal pitch in order to match it, 3. coordinating the voice without reference to the goal pitch, and 4. gaining general exposure to music as well as 5. a wait-list control group which receives no instruction during this stage.

Finally, the post-test will repeat the measures from the pre-tes (excluding the musical background survey) and also include a participant post-survey asking about their experience during instruction.

c. TIME: Participation will take a total of 5 1/2 hours over the course of ten weeks. This consists of two testing times (45 minutes each) and eight weekly individual lessons (30 minutes each).

d. SUPERVISION: The scheduling and randomization procedures will be conducted by the research assistants (Wayne Shuker, Jessica Lee, Josh Glasner and Julie Song) as will the testing sessions. The instructional activities will be conducted and supervised by the principal investigator, Brittney Redler.

e. MATERIAL DISTRIBUTION: The research assistants will distribute and collect all surveys, questionnaires and tests. All paper responses (Musical Background Questionnaire, MBEMA, Participant Post-Survey) will be stored in a locked drawer in Dr. Brian Gill's (the faculty sponsor) locked office after they are completed by the participants. The pitch discrimination threshold measure is digital and the will be stored on the research assistants' password protected computers and accessible only by the research assistants themselves until after the post-test, at which point they will be transferred to the principal investigator's password-protected computer. The recorded sung responses will also be stored on the research assistants' computers. All responses (paper and digital alike) will be labeled with a randomly assigned number in order to track participants' progress and no identifying information (e.g., names, social security numbers) will ever be paired with the data.

f. INCENTIVES: Participation is voluntary. Subjects may withdraw at any time. Incentive is 8 free voice lessons and participants will be compensated $10 for each of two testing sessions.

*If applicable, attach **one copy** of any survey, questionnaire, testing protocols, and/or proposed interview questions to the **each copy** of the application for review **only.** If longer than 10 pages, attach 1 copy only to the original application*

CONFIDENTIALITY

If the data will not be obtained anonymously, describe the specific methods by which confidentiality will be protected (i.e., use of data coding systems or pseudonyms). **Data** can be anonymous if the investigator does not know the participants' names at all. If the study includes more than one session or instrument, anonymity may be achieved by assigning code names that track participants' data from one session or document to another but are unrelated to participants' true names. **Participants** are not anonymous unless the investigator never learns their names. Describe how anonymity will be assured. If any online surveys or responses are included in the procedures, describe the methods to be used to ensure that identifying material will not be transmitted or recorded electronically (e.g., email address, IP numbers).

In addition, please specify:

a. how and where data will be stored;

b. who will have access to data (faculty sponsors always have access);

c. how long the data will be kept (regulations require that all data, including consent forms, be kept for at least 3 years after the completion of the project;

d. what will happen to data after the study is completed (if it will be retained, state how confidentiality will be maintained; if it will be destroyed, explain how).

a. DATA STORAGE: Hard copies of the research materials will be stored in a locked drawer of Dr. Brian Gill's (the faculty sponsor) locked office. Computer files containing digital and recorded data will be stored on computers belonging to Brittney Redler and the research assistants, which are accessible only via a password known only to the aforementioned individuals. We note that at no time do we obtain identifying information (e.g., name, SSN) from our participants, so those with access to our data would have no ability to figure out which specific individual provided with specific responses.

b. ACCESS: Brittney Redler, her faculty sponsor, Dr. Brian Gill, and the research assistants will have access.

c. HOW LONG DATA WILL BE KEPT: Indefinitely

d. DATA RETENTION: Data will be retained, but as noted, confidentiality could never be breached because the data will not contain any identifying information.

Note: Pay particular attention to the protection of subjects' confidentiality in such settings as open or group situations. While investigators may promise to maintain confidentiality, they cannot guarantee that others in a group situation will do so. *Attach additional pages as needed.*

INFORMED CONSENT AND PERMISSION

Enter description of proposed consent procedure. ***Attach copies of all forms, scripts, etc. to be used to obtain informed consent from adult subject(s) in non-protected populations and, if subjects are under 18 years of age or institutionalized mentally disabled, from their parents or legally authorized representatives****. Explain how participants will be given the consent form, parental or other permission forms and/or assent script (where and when), and how signed forms will be returned to the investigator. Please see the UCAIHS website for Forms and Language for Consent Forms, Permission Forms, & Child Assent.*

Note:
In all cases in which subjects will be minors (under 18 years of age), a parental permission form is required. In addition:

- for minors over age 12, a **separate consent form** is required, and
- for children under age 12, an oral **assent procedure** and **script** appropriate to the age of the subject are required.

In cases in which minors are participants, and it is possible that suggestion of harm to the child or others may be elicited, the parental permission form and the consent form for a minor over age 12 should include a mandated reporting statement.

If video- or audiotapes are involved, the consent/permission form should indicate that the subject has the right to review all or any portion of the tape and request that it be destroyed. Parents may not review audio/videotapes of children.

If it is possible that the investigator might wish to quote or otherwise identify a subject in any publication, an attribution statement must be included and a justification for requesting attribution.
If the study involves focus group participation or other group activities, the consent form must include a statement of the limits of confidentiality in group settings, that is, while the investigator may hold all individual information confidential, he/she cannot guarantee that other members of the group will do so.

Subjects must be given a copy of the unsigned consent form before subjects' participation begins.

Any proposed changes to the standard written informed consent process must be clearly detailed and justified as part of the application. Unless there is a clear justification, consent/permission forms should use the UCAIHS Recommended Language.

If adult participation will be completing surveys of questionnaires anonymously, a Project Summary Statement containing all the information included in a Consent Form without a signature may be used in place of a signed Consent Form.

Informed Consent form is attached. Participants will receive a copy for their own records, and they will sign a copy that will be retained by Brittney Redler.

COOPERATING INSTITUTIONS

Investigators may submit an Application for Review prior to obtaining approvals from all cooperating organizations; however, final approval to conduct research at a particular research site will not be granted until a copy of that institution's written approval has been submitted for the Committee's files. Institutional Review Board approval is required from all organizations which have an IRB. A letter from an appropriate senior official, on letterhead, should be obtained from organizations that do not have an IRB. List all institutions expected to provide access to potential subjects, to data necessary to identify subjects, to data previously collected, or facilities where the research is to be conducted, etc., including:

- hospitals (Institutional Review Board approval is required);
- institutions of higher education (Institutional Review Board approval is required);
- health care providers (e.g., clinics, physicians' offices);
- schools (for New York City public schools, NYC Department of Education approval is also required); and
- agencies, associations, or membership organizations.

Please indicate the status of cooperating institutions' approval (i.e., attached, in process, not yet requested).*Attach originals of IRB approval or approval letters on the cooperating institutions' letterhead, from appropriate authorized officials at each institution listed or submit to the UCAIHS as soon as available.* Investigators should be aware that approval processes at other organizations, particularly school boards and hospitals, may take considerable time. Please take this into account in planning the study.

Not applicable (Data will only be collected at NYU)

INFORMED CONSENT AND PERMISSION

If applicable, provide the following:

- a description of the debriefing procedures to be used (i.e., for studies involving deception);
- a statement describing what actions you will take should the research reveal the possibility of a medical or other potentially troublesome condition, emotional distress in reaction to sensitive questions, or other adverse effects. Such information should also be included in all Consent & Permission forms.

Although we do not inform participants of all our hypotheses prior to their participation, we do not provide any misleading information to them. Following their participation we will provide a written debriefing form [included with this submission] and the investigator will be available to answer any questions that participants might have. Particiants will read the form in the presence of the investigator or a research assistant, and sign to indicate that they feel they have been adequately debriefed. Also, the debriefing form will have contact information for the investigator, should participants want to contact her.

C. SOLICITATION FLYER

Do you have trouble singing on pitch?

Please consider participating
in this singing study!

8 weeks of free voice lessons

You will be compensated for your time.

for info contact:
nyusingingstudy@gmail.com

D. STATEMENT TO SUBJECTS

Thanks for your interest in this singing study!

This study concerns the training of adult beginner singers. How do different types of instruction influence singing progress? The study takes place in the music rooms in the Global Center, located at 238 Thompson Street and the Kimmel Center, located at 60 Washington Square South. Participation consists of two testing times (30 minutes each) and eight individual lessons (30 minutes each). Participants will be asked to sing various patterns and songs and will receive complimentary voice lessons as well as compensation for testing time. No special talent or expertise is needed or desired!

In addition to singing, participants will take a test of musical perception, a questionnaire on their musical background, and a response survey noting their vocal progress at the end of the study. This study does not involve risky procedures or questions about 'sensitive' or 'personal' topics. Nevertheless, participants are free at any time to discontinue their participation if they wish.

If, after reading this information, you are still interested in participating, please respond to this email and we will arrange a specific appointment time and let you know exactly where the study takes place!

Best wishes,

Singing Study Team

E. TESTING SESSION PROTOCOLS

Pre-Test (approx 30 minutes)

1. **2-3 minutes:** Informed Consent Form Signed
2. **1 minute:** Voice Range Check *(2 slides up, 2 slides down, sing a comfortable note)*
3. **10 minutes:** Sung Responses: single notes, intervals, and familiar songs
4. **2 minutes:** Pitch Discrimination Threshold
5. **5-10 minutes:** Musical Background Questionnaire
6. Payment and receipt

Post-Test (approx 30 minutes)

1. **1 minute:** Voice Range Check *(2 slides up, 2 slides down, sing a comfortable note)*
2. **2 minutes:** Pitch Discrimination Threshold
3. **10 minutes:** Sung Responses: single notes, intervals, and familiar songs
4. **5-10 minutes:** Post-Survey
5. **2-3 minutes:** Debrief Form Signed
6. Payment and receipt

F. RESEARCH ASSISTANT SCRIPT

SCHEDULING:

- **One person should handle the scheduling.**
- **Allow 45 minutes for each participant.**
- **Participants should be scheduled so that I can meet them prior to pre-test.**
- **I do not need to be present for the post-test.**
- **A reminder email 24 hours prior to appointment as well as on the day-of will greatly help attendance.**
- **Always keep an eye on the money, so I can reload in advance when necessary**

Arrive at least 10 minutes before a participant is expected. And:

- Be sure that the research space is orderly and that everything is "ready to go" (e.g., Are the headphones and microphone out, ready to use?).
- Make sure you have enough materials. **All materials are available in the "Materials for the ACTUAL STUDY" folder in our shared Dropbox.**
- Look at the "Participant Log" to assign the participant correctly to an ID Number.

Once the participant arrives:

Materials: Binder (log-in sheet, script, 30cm marker, song lyric sheets, receipts, appointment card), $10, 2 consent forms, 2 pens, MBQ, PDT website loaded up, headphones, Sung Response music files, portable speaker with aux in cord, microphone, Audacity loaded up (record in WAV file)

Sign in the participant by ID Number [**no names on paper**]. You can tell them their ID Number and that it will be written on all forms and recordings instead of their names. I will say a quick hello first, then take participant to the testing room without me.

"Hello, welcome to our study of Singing Instruction! I'm <Jessica Lee; Julie Song; Wayne Shuker; Josh Glasner> and I'm a grad student working with Brittney Redler here at NYU. Before we get started, I need you to read and sign a consent form. If you have questions, please ask me. You'll need to give me a signed copy and I will give you a copy for your own records."

"All set? Let's go ahead and get started."

PRE-TEST

"Today we will just be taking a few measurements before your lessons start next meeting. We'll do this once now and then once again after all of your lessons."

FOR EVERYTHING BELOW – BE SURE THAT THE CORRECT ID NUMBER IS ON EVERYTHING.

I. **Voice Range Check (VRC)**

Materials: microphone, 30 cm marker, Audacity

"We'll start with some recordings of your voice. Come on over to stand by the piano – I'll need you to be a specific distance from the microphone for all the recordings."

Use the **30cm marker to measure distance from the mic to their mouth** – adjust the height of the mic as needed (put it on a book or the box, etc) so that it's level.

"First I'd like you to just slide your voice on an "ooh" from the lowest note you can sing to the highest when I point at you. We'll do that two times."

Allow a second of silence before the first slide, and then a few seconds between for the participant to reset.

"Great. Now let's go the opposite way – start at the highest note you can sing and slide all the way down on an "ooh" to the lowest when I point at you. Again, we'll do it two times."

Same thing – allow a second of silence before the first slide, and a few seconds between.

"Alright. Now just sing any note that's comfortable for you on an "ah". Try to sustain it for 3-4 seconds."

Allow for a second of silence, again, before he/she starts. This is done just once.

II. **Sung Responses**

Materials: microphone, 30cm marker, Audacity, phone/music player, portable speaker

If the participant is male, use the "M_SR" series, if the participant is female, use the "F_SR" recording series. Listen for their accuracy - we're selecting *inaccurate* singers for the study.

"So, now you will be singing a few different things: we'll start with short patterns of four notes, sung on "doo". Some notes will be repeated, others will change. Just sing the four notes back to me ***exactly*** *as you heard it, as* ***accurately*** *as you can. Any questions?"*

When the participant is ready, **confirm the distance from the mic with the 30 cm marker**, then start recording and then play each vocal stimulus one at a time, leaving 2-3 seconds between when the participant has finished singing and the next recording. [series 1-6]

"And now two songs. Do you know 'Twinkle Twinkle Little Star' and 'Jingle Bells'? Same thing here – you'll hear them sung, then you'll sing back ***exactly*** *what you heard as* ***accurately*** *as you can. We'll go through the songs two times each: once on words and once on 'doo'. The lyrics to the songs are written out here just in case you need them."*

[series 7-10]

When finished, stop the recording and **SAVE**.

III. **Pitch Discrimination Threshold (PDT)**

Materials: computer (website open), headphones

Close the recording windows and bring the PDT test site up.

"Okay, now you can come sit at the piano – you'll be at the computer for the next measurement. You will hear two different tones played by the computer. Your job is to identify whether the second tone is higher or lower than the first. The instructions are also on the screen as a prompt. The tones may get closer and closer together right until you're finished. Answer as best as you can, even if you feel like you're guessing – that's normal."

http://www.musicianbrain.com/pitchtest/

Enter the study's email into the online program and give the participant the headphones. Have the participant get started when ready. After they are done,

copy and paste the email response with the score into a Word doc and save with the Participant ID Number.

IV. **Musical Background Questionnaire (MBQ)**

Materials: MBQ, pen

"After this, we're all done for today. Please fill out this questionnaire. Let me know when you're finished and I'll give you your $10 for today's testing as promised."

If Participant is ACCEPTABLE:

"Thank you so much for coming in today!"

If Participant is A, P, V, or N: (see below for C)

"Let's schedule your first free lesson."

Open the google calendar associated with the nyusingingstudy email and find an available time slot THIS SAME WEEK if at all possible. If not possible just schedule them for as soon as they're able to make it. Enter it into the calendar and fill out an appointment card.

"Great! Here's an appointment reminder card for your first lesson and your $10 for your participation today."

Have him/her sign a receipt.

"Okay - Brittney will see you at your lesson! Thanks again."

If Participant is C:

"*You are waitlisted for lessons for a bit so let's schedule you for later this semester."*

Open the google calendar associated with the nyusingingstudy email and find an available time slot during finals week or the last week of classes. Enter it into the calendar and fill out an appointment card.

"Great! Here's an appointment reminder card for your next meeting and your $10 for your participation today."

Have him/her sign a receipt.

"Okay - Brittney will see you at your lesson! Thanks again."

If Participant is UNACCEPTABLE:

"Thank you so much for coming in today! Unfortunately you do not fit the profile that we're looking for in this specific singing study. There will be more

studies on singing coming out of this department in the future though. We really appreciate your willingness to participate. Here is your $10 for your participation today."

Have him/her sign a receipt.

"Thank you again - have a great day!"

WRAP-UP CHECKLIST

- **Participant has an appointment and a reminder card for his/her first lesson.**
- **Participant has his/her $10 for participation today.**
- **Participant SIGNED A RECEIPT. Receipts are in the binder with the subject log.**
- **After the participant has left, take the materials back to the storage locker.**
- **After the participant has left, paperclip the paper forms from this session and keep it in the storage locker.**
- **All computer files should be saved on your computer as "[IDNUMBER]_[MEASUREMENT]_PRE" in a folder marked BR_Dissertation.**
- **At the end of the week, collect all the paper forms from the locker and take them to Dr. Gill's office for more permanent storage.**

POST-TEST

"Thank you so much for participating in this study! Today we will be taking the final measurements, and then you're all set to go."

FOR EVERYTHING BELOW – BE SURE THAT THE CORRECT ID NUMBER IS ON EVERYTHING.

I. Voice Range Check

Materials: microphone, 50 cm marker, Audacity

"We'll start off today the same as we did at the pre-test. Come on over by the microphone for some recordings.

Use the **50cm marker to measure distance from the mic to their mouth** – adjust the height of the mic as needed (put it on a book or the box, etc) so that it's level.

"First, I'd like you to just slide your voice on an "ooh" from the lowest note you can sing to the highest when I point at you. We'll do that two times."

Allow a second of silence before the first slide, and then a few seconds between for the participant to reset.

"Great. Now let's go the opposite way – start at the highest note you can sing and slide all the way down on an "ooh" to the lowest when I point at you. Again, we'll do it two times."

Same thing – allow a second of silence before the first slide, and a few seconds between.

"Alright. Now just sing any note that's comfortable for you on an "ah". Try to sustain it for 3-4 seconds."

Allow for a second of silence, again, before he/she starts. This is done just once.

II. Pitch Discrimination Threshold (PDT)

Materials: computer (website open), headphones

"Come on over to the piano – you'll be on the computer for this. You will hear two different tones played by the computer. Your job is to identify whether the second tone is higher or lower than the first. The instructions are also on the screen as a prompt. The tones may get closer and closer together right until you're finished. Answer as best as you can, even if you feel like you're guessing – that's normal."

http://www.musicianbrain.com/pitchtest/
Enter the study's email into the online program and give the headphones to the participant. Have the participant get started when ready. After they are done, copy and paste the email response with the score into a Word doc and save with the Participant ID Number.

III. Sung Responses

Materials: microphone, 50cm marker, Audacity, phone/music player, portable speaker

If the participant is male, use the "M_SR" series, if the participant is female, use the "F_SR" recording series.

"So, now you will be singing a few different things: we'll start with short patterns of four notes, sung on "doo". Some notes will be repeated, others will change. Just sing the four notes back to me ***exactly*** *as you heard it, as* ***accurately*** *as you can. Any questions?"*
When the participant is ready, **confirm the distance from the mic with the 30 cm marker**, then start recording and then play each vocal stimulus one at a time, leaving 2-3 seconds between when the participant has finished singing and the next recording. [series 1-6]

"And now two songs. Do you know 'Twinkle Twinkle Little Star' and 'Jingle Bells'? Same thing here – you'll hear them sung, then you'll sing back ***exactly*** *what you heard as* ***accurately*** *as you can. We'll go through the songs two times each: once on words and once on 'doo'. The lyrics to the songs are written out here just in case you need them."*
[series 7-10]

When finished, stop the recording and **SAVE**.

V.**Post-Survey**

Materials: Post-Survey, pen

"Great, thanks. So, now we just have some questions about your experience. Please fill out this survey and let me know when you're finished."

V. Debrief

Materials: Debrief, pen

"This is just a little bit of information about what we were looking at over the course of this study. Please read it over and let me know if you have any questions. Then I'll just need you to sign the bottom for our records. In the meantime, I'll get your payment for today's testing."

"Thank you so much for your participation in this study! We know it was a lot of time invested so I hope you enjoyed being a part of it!"

WRAP-UP CHECKLIST:

- **Participant has his/her $10 for participation today.**
- **Participant SIGNED A RECEIPT. Receipts are in the binder with the subject log.**
- **After the participant has left, take the materials back to the storage locker.**
- **After the participant has left, paperclip the paper forms from this session and keep it in the storage locker.**
- **All computer files should be saved on your computer as "[IDNUMBER]_[MEASUREMENT]_POST" in a folder marked BR_Dissertation.**
- **At the end of the week, collect all the paper forms from the locker and take them to Dr. Gill's office for more permanent storage.**

G. INFORMED CONSENT FORM

NEW YORK UNIVERSITY
A private university in the public service

Music and Performing Arts' Professions

New York University
Steinhardt School of Culture, Education, and Human Development
35 West 4th Street, Suite 1077
New York, NY 10012
blb285@nyu.edu

Brittney Redler, Ph.D. Candidate

You are invited to take part in a study named A COMPARISON OF TRAINING INTERVENTIONS FOR PITCH INACCURATE SINGERS. The study is designed to learn more about beginner singing instruction. It is being conducted by Brittney Redler, the principal investigator, and is being advised by faculty sponsor Dr. Brian Gill.

You must be 18 years or older to participate. Participation will take a total of 5½ hours over the course of ten weeks. This consists of two testing times (45 minutes each) and eight weekly individual lessons (30 minutes each). If you agree to be in this study, you will be asked to sing provided exercises and songs individually with only the experimenter present. Your sung responses for the measurements will be recorded and labeled anonymously with no reference to you personally. Additionally, your lessons will be video-recorded and labeled anonymously, however only the experimenter will be in view in the video so that you will not be seen in the recording. Furthermore, you will take a test of musical perception, a questionnaire on your musical background, and a response survey regarding your experience at the end of the study. At the completion of the study, a thorough verbal and written explanation of it will be provided.

Although you will receive no direct benefits for participation in this study (other than instruction), it may make you more aware of music and singing techniques and help the investigators better understand the effectiveness of various types of instruction on singing.

Taking part in this study is voluntary. Not taking part or withdrawing after the study has begun will result in no loss of services from NYU to which you are otherwise entitled; and it will not affect your grades or academic standing in any way. You have the right to skip or not answer any questions you prefer not to answer.

Confidentiality of your research records will be strictly maintained by assigning unique, confidential identification number codes to your responses. The data from the study will be kept until at least 5 years after publication, as recommended by the American Psychological Association.

If there is anything about the study or taking part in it that is unclear or that you do not understand, if you have questions or wish to report a research-related problem, you may contact the principal investigator, Brittney Redler [blb285@nyu.edu, 35 West 4th street, New York, NY 10003.] For questions about your rights as a research participant, you may contact the University Committee on Activities Involving Human Subjects (UCAIHS), NYU, (212) 998-4808 or ask.humansubjects@nyu.edu, 665 Broadway – Suite 804, New York, NY 10012.

You have received a copy of this document to keep.

Agreement to Participate

_____ _____

Participant's Signature Date

ID NUMBER:_____

Musical Background Questionnaire

How much do you agree with the following statements according to the following scale?

1 2 3 4 5 6 7 8 9 10
*Disagree*_____*Completely Agree*

_____I like to listen to music

_____I like to play music alone or with others

_____I like to sing alone or with others

_____I think I have talent for music

_____I think I have talent as a singer

_____People tell me I am a good musician

_____People tell me I am a good singer

_____I like to perform music for other people

_____I like to sing for others

_____I would like to be a professional musician

MBQ 2
ID NUMBER _____

Please rate your overall interest in music according to the following scale (*circle the number)*:

*Not interested*_____*Very Interested*
1 2 3 4 5 6 7 8 9 10

Please rate your abilities based on the following scale:
*Poor*_____*Excellent*
1 2 3 4 5 6 7 8 9 10

_____Overall music ability

_____Singing ability

_____Sense of *rhythm*

_____Sense of *pitches*

_____Ability to distinguish different instruments within a complex piece of music

_____Ability to imagine feeling something without actually feeling it

_____Ability to imagine hearing without actually hearing it

_____Ability to imagine seeing something without actually seeing it

MBQ 3
ID NUMBER _____

About how many hours per week do you spend listening to music?
_____hours

What genre/style(s) do you listen to most? (*check all that apply*)

_____Alternative
_____Classical
_____Country
_____Gospel
_____Jazz
_____Musical Theatre/Broadway
_____Opera
_____R&B
_____Rock
_____Pop
_____Folk
_____Other_____

Most of the time, when you listen to music you are: (*check only one)*

_____not focused on the music, attending to a different task
_____passively listening
_____highly aware of musical nuances (such as key changes, harmonies, etc)
_____actively engaged (singing along, tapping to the beat, etc)

In the past year how many live concerts or other musical performances did you attend? _____

What style of music was presented at these performances?
_____

In which of the following places have you seen a musical performance?

_____At elementary/middle/high school
_____On university campus
_____On the street or outdoors
_____In a Broadway theater
_____In an opera theater
_____On television
_____At a bar or club
_____At a large arena (ex. Madison Square Garden)

MBQ 4
ID NUMBER _____

Which of the following did you do in school, religious institution or other venue? (*check all that apply*)

_____Play in a band *for how long:*_____
_____Play in an orchestra *for how long:*_____
_____Sing in a chorus or choir *for how long:*_____
_____Take private singing lessons *for how long:*_____
_____Take private lessons on an instrument *for how long:*_____

Were you involved in any other musical groups, clubs, or productions?
If so, describe:
_____

On your own decision (not as part of a *required* school curriculum) do you ever do the following things in your free time? (*check all that apply*)

_____Play in a band or orchestra
_____Sing in a group, chorus, or choir
_____Play a musical instrument on your own
_____Listen to music that you already know
_____Listen to music that you don't already know
_____Talk with your family or friends about music
_____Enter a music competition
*What competition?*_____
_____Go to a summer music program
*What program?*_____
_____Read a book about music or musicians
*What book(s)?*_____
_____Watch a show or documentary about music
*What show(s)?*_____

MBQ 5
ID NUMBER _____

Are you now involved in any musical ensemble?
YES NO

Do you have your own instrument?
YES NO
If yes, what instrument(s)?
_____

Do you read music?
YES NO

Did you ever study music theory?
YES NO

Is anyone else in your family musical?
YES NO
If so: who, and briefly describe their musicianship (i.e. professional/amateur, etc)
_____

Have you ever studied any form of dance?
YES NO
If so, what style(s) and for how long?
_____

Please rate your ability as a dancer on the following scale *(circle the number):*
*Poor*_____*Excellent*
1 2 3 4 5 6 7 8 9 10

MBQ 6
ID NUMBER _____

What words or terms do you use to describe your singing?

_____

_____

How often do you sing - alone or with others? *(circle the number):*

Never		Rarely		Sometimes			Often		All the Time
1	2	3	4	5	6	7	8	9	10

Have you ever sought information, help, or training in singing? (formal or informal)
YES NO
If yes: how did it go?

_____

Did you ever take private voice lessons?
YES NO
If yes: what are the names of your teachers (if you remember)?

_____

How often do you sing in tune? *(circle the number):*

Never		Rarely		Sometimes			Often		All the Time
1	2	3	4	5	6	7	8	9	10

What is your highest level of education (currently)? _____

What is your mother's highest education? _____

What is your father's highest education? _____

Did you enjoy school as a child?
YES NO

Do/did you enjoy classes now as an adult?
YES NO

What was your most current approximate grade point average? _____

How did you do in school? *(circle the number):*

Poor									*Excellent*
1	2	3	4	5	6	7	8	9	10

If you feel you did poorly, what led you to that conclusion?

_____

MBQ 7
ID NUMBER _____

Please number each of the following statements about your learning style in order of accuracy 1-5 (1 being the most accurate):

_____I consider myself a visual learner
_____I consider myself a logical learner
_____I consider myself a verbal learner
_____I consider myself a physical/kinesthetic learner
_____I consider myself an aural learner

Please mark on the scale where you most identify yourself *(circle the number)*:

*Solitary Learner*_____*Social Learner*

1 2 3 4 5 6 7 8 9 10

What is your native language?

_____

Please list all language(s) you can speak, the age at which you started to learn them, and circle your fluency level for each (in order from most proficient to least)

_____ age: _____
Poor Fair Functional Good Native

_____ age: _____
Poor Fair Functional Good Native

_____ age: _____
Poor Fair Functional Good Native

_____ age: _____
Poor Fair Functional Good Native

Have you ever experienced any hearing problems or deficiencies?
YES NO
If yes, please describe: _____

Do you have a cochlear implant?
YES NO

Are you right-handed or left-handed?
LEFT RIGHT

I. POST-SURVEY

ID NUMBER:_____

Pre-existing self-identity as a "singer"

You participated in a study involving singing. The statements below refer to your perceptions of yourself with regard to singing. Please indicate the extent to which you agree with each statement below using the following scale:

1----------2----------3----------4----------5----------6----------7----------8----------9----------10
Strongly Disagree **Strongly Agree**

___ I love to sing.

___ I have been singing my whole life.

___ I feel comfortable carrying a tune.

___ I am good at harmonizing.

___ I have sung in many choirs.

___ I have done a lot of solo singing in public.

___ I spend a lot of time singing.

___ I consider myself a singer.

PS 2
ID NUMBER: _____

Thoughts and Feelings about Your Singing

Today you participated in voice testing and training. The statements below refer to your perceptions of improvement. Please indicate the extent to which you agree with each statement below using the following scale:

1----------2----------3----------4----------5----------6----------7----------8----------9----------10
Strongly Disagree **Strongly Agree**

___ I am happy with the training I received.

___ I felt that I gained confidence in my voice.

___ I trusted my teacher's knowledge of singing.

___ I clearly understood what my teacher expected of me.

___ I felt that I gained an awareness of what it takes to be a good singer.

___ I felt that I improved my breathing for singing.

___ I felt that I improved my vocal accuracy (singing the right notes).

___ I felt that I improved my perception of music (hearing pitches accurately).

___ I felt that the training I received directly helped my performance on the test.

Write in your answers for the following questions:

What did you feel you gained from this vocal training?

Did you practice in between lessons? YES NO
If yes, how often?

What could be done to improve the training?

Any other thoughts or comments?

PS 3
ID NUMBER: _____

PANAS-X

This scale consists of a number of words and phrases that describe different feelings and emotions. Read each item and then mark the appropriate answer in the space next to that word. Indicate to what extent you **felt this way during the lesson phase of this study**.

Use the following scale to record your answers:

1	2	3	4	5
very slightly or not at all	**a little**	**moderately**	**quite a bit**	**extremely**

_____ cheerful	_____ sad	_____ active	_____ angry at self
_____ disgusted	_____ calm	_____ guilty	_____ enthusiastic
_____ attentive	_____ afraid	_____ joyful	_____ downhearted
_____ bashful	_____ tired	_____ nervous	_____ sheepish
_____ sluggish	_____ amazed	_____ lonely	_____ distressed
_____ daring	_____ shaky	_____ sleepy	_____ blameworthy
_____ surprised	_____ happy	_____ excited	_____ determined
_____ strong	_____ timid	_____ hostile	_____ frightened
_____ scornful	_____ alone	_____ proud	_____ astonished
_____ relaxed	_____ alert	_____ jittery	_____ interested
_____ irritable	_____ upset	_____ lively	_____ loathing
_____ delighted	_____ angry	_____ ashamed	_____ confident
_____ inspired	_____ bold	_____ at ease	_____ energetic
_____ fearless	_____ blue	_____ scared	_____ concentrating
_____ disgusted with self	_____ shy	_____ drowsy	_____ dissatisfied with self

J. DEBRIEFING STATEMENT

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A private university in the public service

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Brittney Redler, Ph.D. Candidate

A COMPARISON OF TRAINING INTERVENTIONS FOR PITCH INACCURATE SINGERS

Singing is an inherently shared human experience—one that is universal and spontaneous, present at almost all special occasions, and even suggested to have benefits through old age. In this technological age there is certainly no lack of access to music and you rarely find a person who has no interest in music at all. However there is a large percentage of the general population that self-assess themselves as inaccurate singers, sometimes going as far to say "tone-deaf". Though this assessment can be due to many reasons, it is my belief that it isn't a permanent condition. As my dissertation under guidance of my faculty committee, Dr. Brian Gill (NYU Steinhardt), Dr. Jean Mary Zarate and Dr. Martin Daughtry (NYU College of Arts and Sciences), I investigate the current approaches to teaching pitch accuracy. Is pitch accuracy learnable as an adult? Is there a difference in the effectiveness of teaching strategies?

To examine these questions, I brought participants and randomly assigned them to one of five instructional conditions: feedback based on visualizing the goal pitch, on hearing the goal pitch, on the physical sensations of singing without reference to the goal pitch, general music exposure, and a wait-list control, which receives lessons after the post-measurement. My primary prediction is that there will be unique progress made by receiving instruction on the physical sensation of singing alone, which coordinates the singing mechanism itself. I will seek evidence for this progress by comparing the pre- and post- measurements as well as an observation journal I kept of the training process.

Thank you for your participation! If you have any questions, concerns, or comments, feel free to contact the principal investigator, Brittney Redler [blb285@nyu.edu, by phone at (803)312-4134 at 35 West 4th Street, New York, NY 10003.] If anything about this study caused you to feel distress or upset, I will refer you to a counselor or NYU administrator. If you would like to learn more about this topic, you may wish to look up research by Isabelle Peretz.

I feel that I have been adequately debriefed about the nature of the study. The investigator has explained the purposes of the research to me, and I feel that any questions I have asked were satisfactorily answered.

Participant's signature: _____ Date _____

K. SONGS FOR TESTING AND LESSONS

For Pre Test
Twinkle Twinkle Little Star
Jingle Bells

For Lessons
Twinkle Twinkle Little Star OR Jingle Bells
Mary Had a Little Lamb
Happy Birthday
Frere Jacques/Are You Sleeping Brother John
"Swing Low, Sweet Chariot"
O Music
S'Wonderful
Salley Gardens
Blue Skies
Blue Moon
I Could Write a Book

For Post Test
Twinkle Twinkle Little Star
Jingle Bells

L. JOURNAL EXCERPTS

4N Lesson5: 4/20 10:00am

She was a few minutes late because buses were delayed in the rain. We did a lot with rhythm versus steady beat today. She doesn't sound like she's getting more accurate or more vocally able/flexible, but her coordination is improving and she's growing musically. Her improvisations were quite nice today and she's much better at staying to the steady beat. She concentrates a lot in order to simultaneously tap the beat and the rhythm but she's able to get it with that great focus. She did that for "Jingle Bells" and also while listening to "Goody, Goody". Reading "Where the Sidewalk Ends" was great and she found the steady beat right away. She's also learning about rhythms being "off" the beat – from "Peanut Butter Sandwich" and now *"*Swing Low*"* and then "Where the Sidewalk Ends". Also, she learned *"*Swing Low*"* quite well by rote in whole-part-whole. She also learned a half note easily and wrote a nice challenging rhythm for herself to tap and say and then sing. So again, she's improving on the things that we're explicitly addressing: rhythm, steady beat internalization, general motor coordination, musicianship. However, it doesn't seem that vocally she's more capable or more accurate than she was before.

6A Lesson2: 4/2 10:00am

This lesson we started out with syllables call and echo. His lesson went a minute over. We did syllables with recording listenings, "Twinkle, Twinkle" with my comments, learned "Row Row" (he didn't know it before) by rote and then I asked him a few questions about pitch height and phrase direction which he got right every time. He still answers "I don't know" to the how did you do question. I told him even though he doesn't always know I'm still going to ask since that's something we are working to develop – his ability to monitor while singing. He still starts lower than the target every time. On "Row Row" he got better after we identified the solfege syllables that accompany the first line. Perhaps in the future we should label the syllables in "Twinkle, Twinkle" -as he gets to know them even more. That would be certainly instruction on the song itself. He did well on the labeling of solfege patterns as sung on "doo" – once he figured out what he was supposed to be doing. That's a great exercise I think for this group – based on listening and coding which of the known patterns it is. So having written lists of

solfege patterns to choose from – much like the guess the rhythm game but for melodies. I always feel bad about not giving any feedback on the how – the feedback is on accuracy only. There was one moment when we were starting "Row Row" and he was droning lower than me and we started just the first note and I was basically like that scene from *Modern Family* sing-speaking on the first pitch saying "a little higher"….[drone]…"still a little higher"…[drone] until we finally just started singing and he was still too low. He got a little closer to the target as the song progressed, but he still couldn't match the very first note. When we returned to "Twinkle" at the end of the lesson he was pretty accurate with himself but he didn't match the first note (C) so his song was just transposed. Yes he was still wobbly and unsteady and not completely accurate but he was inclusively more accurate than before. When I asked him what he heard he didn't notice that though. He said he heard that his volume was unsteady (when have we ever mentioned volume?) and that my "little" (which we had discussed earlier as being the highest note of the song which he needs to make a little higher) sound effortless whereas his sounded like he still needed to work a lot in order to get it. So it's interesting that he's noticing sensation in the sound as opposed to just accuracy. He's paying attention to what he feels as he's trying to sing the higher note. 1A noticed this too – that he sounded like he was strained. So without any information on sensation of ease, they're still monitoring that – perhaps even more than the heard accuracy itself. He was uncertain about his accuracy – he said "I guess pretty good" about how accurate he was – but after "what did you hear" he answered about the volume and the effort level. We also listened to Beverly Sills singing Twinkle variations – the theme he got right away that it's "Twinkle, Twinkle" – we listened to it again and confirmed – I told him that it's in French. Then I played the first variation for him. He said it was a totally different song. Then we listened to that again and I played the theme along with it (as she arrived at each note) and he said by *watching* me play the notes he could see that it could be Twinkle but she was singing other higher notes. So he only referred to the ornaments as higher, and he compared what I was playing to what she was singing by watching my fingers play – not by hearing the agreement. So he's really not seeming to learn by way of hearing. He's mentioning feelings, he watches my fingers play to see the distance and direction and he's never certain about what he hears when asked. The best exercise for this was the name that solfege pattern. I should include with that recordings of me singing these simple patterns so that there's nothing to watch in order to get the auditory information about the pattern.

8V Lesson6: 5/1 9:30am

Phew! She is doing much better and I think the piano playing and the Sing and See in combination was very good for her. The hand signs don't really help her at all; she stays droning away in a lower neighborhood while doing the hand signs. However – they have helped to put the piano keys and written notation into context, so that's good. She related the piano keys and the written patterns to the hand signs to figure out where to start playing the piano. When she plays along with herself she eventually ends up matching what she's playing! I don't know whether it's hearing the piano that's helping, but honestly, I can't see how that would be the cause, since when she sings along with me playing the piano and singing, she still is droning. So there is something to the fact that today she was playing it herself and she had to take responsibility for the directions of the notes and the magnitudes of the intervals in her fingers. Her finger dexterity is what one would expect of a non-pianist, so she plays slower in tricky spots than others, but it's encouraging that, in the key of C, she was eventually able to sing Jingle Bells in tune. Then I asked her to imagine she's still playing the piano, and could even move her fingers on her leg while she's singing into Sing and See. She retained some of it, but again, then she still had a visual crutch there, and it takes her many tries at first even just to match the first note, and then after that if she drifts off the right notes she gets overwhelmed, confused and can't find her way back. "Mary Had a Little Lamb" was very stressful for her. Afterwards when she finally got the "whose fleece" line correct on "doo" into Sing and See after going back and forth to the piano, she said "must rest. That was stressful." So even with the visual aids she had a high cognitive load it seems just to try to get her voice to follow where she knew it was supposed to go. However, she was in head voice for the majority of today without any reference to the vocal mechanism. She made it work and found her own way to sing higher enough to match the target.

9N Lesson3: 4/14 9:00am

She really is quite accurate so it's hard to tell small improvements. However, she does seem to be enjoying herself and she's certainly getting regular singing experience. She sounds like she's just pretty far back in her voice and she also tended to go sharp eventually when she sings a bunch of times unaccompanied. "Doo" is more accurate than words, but only slightly. We started with patterns and she's perceptually always on the right notes. Her voice is not strong and it wavers sometimes, but she's singing the right notes pretty much. The test song is the same – I was hoping that singing staccato and legato on words would inform

her implicitly about using more airflow through the phrases in order to steady out the voice but it didn't. She went right back to how she normally sings it after the legato. Also in the legato she just didn't breathe as much, so she had the same sensation of singing on not a lot of air. She's great on the rhythm matrices and the guess the rhythm game was admittedly very easy for her. She would guess the correct one before I'd even finished the rhythm. Then I had her perform a rhythm for me to guess. She did great with that as well. Then "Row Row Row Your Boat" together, then solo, then in a round 3 times in a row with her starting, then with me starting. She said that the "merrily" line is always hard for her, no matter who starts. Then we read two stanzas of Shel Silverstein's "Peanut Butter Sandwich", first finding the steady beat then clapping the rhythm. Then she moved to music and she found the beat easily and switched to micro and macro fluidly. Then I had her keep one in one hand and a slower in the other and switch between them. This also seemed to be getting easier for her. Then we did the same thing in the feet. She got it after a little negotiation. Then we added the even quicker one in the hands. This took some work and a lot of concentration, she said. She finally was able to get them all happening at the same time, but it feel apart often in trials. "Mary Had a Little Lamb" was good, then on doo, then back on words. Then we sang "Are You Sleeping" as call and echo then all together then with her as the caller and me as the echo. She did quite well with this but this is where we drifted sharp when she was the leader. The call and response was fun. She did well as the response, but when I shifted her to the caller she said she'd never done anything like that before – improvising a tune on the spot. She said that afterwards – she did well coming up with phrases – typically she used lower notes and sometimes the thinking of the next note slowed her down and she ended up adding beats. She noticed this. Then "Twinkle, Twinkle" again more like the test – I sang the whole thing, then her, then me on "doo" then her on "doo". We did the "doo" repetition twice because she wasn't getting all the way up to the /la/. I didn't say this but just asked to do it again. I used a lot more breath in my rendition but this didn't change hers. Then to end the lesson we went back to the guess the rhythm game but I sang the rhythms instead. This changed it a little for her. Then I asked her to sing a few for me to guess. That was nice. I should do that activity regularly. Improvisation is great.

12P Lesson2: 4/14 10:00am

He said he's very stressed today and also as soon as we started lip trills he started coughing and he said his roommate has bronchitis and although the roommate swears it's not contagious he's noticing himself coughing more. The coughing did slow down when we got going and especially when he started feeling the sound

more towards his lips and out of his throat. I wondered whether he's a smoker and regretted not having that on my background questionnaire…

He is extremely insightful and aware again about the sensations. The lip trill is amazing for him and he is completely aware of both the airflow and the buzzy sensation at the lips and out of his throat. The straw also was good for both of those things but would be difficult to sing a song on. He is able to just get the sound simultaneous to the air with the straw and it's helpful to remind him of the "slightly disconnected" feeling. The patterns were all better on lip trill than on "doo". I told him to focus on the roundness of the doo so that the lips could focus in and toward the center just like the lip trill. Then when we went to words on "Twinkle" he said the words make the mouth shape difficult. When we sang "Twinkle" on lip trill he said it felt trance-like because he was so aware of the breath and the feeling of front. He said he was more aware of the breath than even the tone itself. I said great. I asked him to sing it again but even more disconnected and he said it felt the same but breathier. It sounded completely different and much less pressed. He said this is not what he had associated with singing – that it feels much more focused and much more about the breath than he thought. I said start associating this feeling with singing – it's great. On sho sho sho sho she she she she he really felt the difference of air flow when we added a lip trill prep and then eventually was able to identify the difference that it made as the breath being exhaled in the beginning. He tried to replicate it and came close at the end with a lot of immediate air release. He said it felt more relaxed. He explains feelings surprisingly well and extensively. I didn't really even feel that I needed that many non-singing exercises since we talked so much. We didn't get to "Mary Had a Little Lamb". Most of the lesson was going back and forth between lip trill and syllables or lyrics ad trying to release the air. He describes the pressed phonation as "inhaling" while singing. I said it sounds like a jam-up of the voice – too much muscular effort – like a traffic jam. But when he releases the air it sounds like no traffic and smooth singing. I also explicitly identified the release of air and forward sensation during words as the goal. I said to keep thinking of the sense memory of the lip trill while singing on words so that we can get the air flow and the forward lips buzzing sensation even when singing the words. He's doing really well and he's actually quite receptive for a new singer. I get the sense he knows a bit about music, since he labeled the notes he had been singing by watching them on the piano. Oh also the other thing we discussed in detail was lower notes needing even more forward focus. Such intention to keep the sound forward so that it doesn't fall back. Again- with set intention and trance-like focus he's able to get it; not consistently yet, but when it's there it's great.

13V Lesson3: 4/16 6:00pm

We worked a lot with the hand signs today and just a little bit with Sing and See. A very little bit of the Beethoven String Quartet watching just to serve as an intro to looking at more specifics rather than generalities. It's very easy to see patterns in that, and I brought up using the staff as horizontal axes in order to keep track of the specifics of pitch heights. We had used Sing and See the same way with "Twinkle, Twinkle", in anchoring in to the "do" on C4 and noticed the four different times she should be back on C4 during the song. Then she sang it a few times and she drifted higher throughout the song so the goal was to return always to the middle of the C4 bar. So this was a connection to the staff on the Beethoven graphic notation and will be a step into writing/drawing her own phrases using a graphic iconic staff. (which I still need to print out.) She is slightly more precise when she uses hand signs and the amazing thing is that she is really starting to read the signs as if they are sign language. When she looks confused about a pattern that I've just called, she waits and then watches my hand and sings along with it as if the hand sign itself is giving her the pitch. So clearly this is starting to make sense to her, which is amazing. I told her explicitly today that the hand signs helped her sing more accurately. She said "really?" I said yes – you sometimes delayed, like took more time to figure out the logistics of the hand signs themselves, but the notes, when you sang them, were more precise. Perhaps she has the visual, perhaps she has more confidence, more awareness of the specifics of the pitch height and relationship? She is still very closed when she sings on do, but we sang some on dah today and that got more sound. I was hoping that she would automatically apply that from dah to the doo but she went right back to the closed down doo with the white noise of the air going through the teeth. She is very accurate and becoming literate as far as the hand signs are concerned. She seems to have a good inherent musical ability and understanding. We translated all of the songs that we sang today into hand signs. "Are You Sleeping," Row Row Row Your Boat," and "Twinkle, Twinkle." We also sang "Row" in around a few times and she was distracted on the "life is but a dream" line because that's when I'm singing merrily. I gave her the hand signs for it and her hand twitched to do them when she got to it within the round. She sang the line much more confidently and I asked her about the hand twitch. She said she was thinking the direction of the line. (It would have been too much to actually perform the hand signs while singing a round I think.)

16A Lesson3: 4/10 6:00pm

She was 23 minutes late because she thought it started at 6:30. She was very apologetic and we started right away. So this journal is very fast, since another participant is coming right after. We had to fix the same things as before in "Jingle Bells" – same words are falling off, and the same in "Row Row Row" – we spent the majority of the time within "Row Row" just on merrily with the syllables and finding that higher /do/ so that it's high enough. Within patterns we spent most of the time on a longer one that she had a hard time with. We broke it apart into two phrases so that she could chunk it and when they were separate she sang them perfectly but as soon as they got closer together again she messed it up by adding different syllables or singing the wrong notes to the correct syllables. Listening to the Beverly Sills song she took a while to decide that it was "Twinkle, Twinkle" and she said she was deciding between that at Jingle Bells. When we moved to the variation she heard that it was something completely different and had a hard time hearing the melody within the variation. She did much better with the guess the pattern game – we explicitly pointed out what each pattern's directions were and which one it would be *if*.... Then she got every one right at first hearing. She is very proud of her listening skills improving and says she listens to youtube at work and thinks she's hearing more things in the music. We didn't get to "O Music" today. Perhaps she is starting to hear things differently, because she mostly is able to say when she's off now, but her direction is sometimes off and I think she thinks that my voice is hers; either that or she just doesn't hear it correctly, or she has some kind of disconnection with the verbalization: saying she's too high when she really is referring to the fact that the target is too high. I would have a hard time believing the third with her though because she explains that she thinks she has a high voice and sings higher and struggles with low notes. She did say something today that was very helpful – she said sometimes she falls off at the end (totally true) and that it sounds more like speaking than singing. I said to make sure it always sounds like singing – as strange as that is to say. That even though the notes can be low – they're still singing and shouldn't sound like her speaking voice. That is, admittedly, a fine line of instruction that dances between auditory instruction and sensory – but the actual verbal instruction was bringing her attention to *hearing*; to the *sound* of the voice, albeit the timbre. If it was sensory information, it would be referring to the *feeling* of the different voice. Knowledge of this did not improve her performance though. She, again, improves within the lesson (more so on the listening exercise, now that we've explicitly outlined the procedure of elimination) but not really between lessons. All the specific work we did, just yesterday, on "Jingle Bells" did not stay put through to today. I also still get frustrated and helpless within the lesson because I'm limited and don't know what else to tell her or how to get her

to improve. I just keep saying – a little higher; now with me – track your voice to mine; still a little higher, etc. It's discouraging for me as the teacher in this setting when change doesn't happen – or when she just can't tell that she's not on it – or when she keeps mislabeling it: saying that she went too high when she was so clearly singing in the basement.

17P Lesson4: 4/23 6:00pm

Today was a turning point I hope. I finally made him laugh by dancing while he sang "Jingle Bells" along with the recording of Paul. Then we labeled the energy level 1-5 (as a 2) and the fact that it was nice when he laughed because it lightened up the sound and added energy to the song. We did a lot of physical things - windmill hands, leaning against the wall and pushing off, throwing an imaginary frisbee, balancing on one foot and shaking the foot off the ground, and tapping the sides of his mouth with his index fingers. It takes a lot of energy from me to get a little from him. I was more direct with my goal for him today. That the reason I'm being crazy is to get him to sing with more energy. I asked him for a 4. We got to a 3 but I told him a lot that I liked the direction he's headed. I asked him if he liked it and he said yes. He's just extremely scattered. He's looking in the mirror, checking out his bicep muscles, looking at his phone, looking at anything but me when I'm showing him something. At one point I was showing him the difference between lax embouchure with the finger taps and energized activated embouchure and he said "mhm" but wasn't looking at me so I called him out on it. Also, the hum seemed to be better for him today than before. We hummed "Are You Sleeping" and found the feeling of the sound at the front of his face ("trying to get out") and I said I liked it a lot better AND even more so when he added air (through the nose). He seemed happy with it. Then we went back and sang Jingle Bells with Paul's recording again with that energy and feeling. It didn't quite get there but it's moving in the right direction. When we sang patterns, I addressed the embouchure and asked him to open his mouth more so that the sound could come out there instead of having to redirect to the nose. He's fairly accurate when he actually sings out - especially after hearing it sung in his own octave. Also we did the posture roll-up. I asked him how it felt and he said uncomfortable. He said he needs to stretch a lot. I said I understand that but I liked the fact that it put him standing up on his own two feet with his head up. He stayed leaning on the wall. I had to - again - directly say, so don't lean on the wall. Stand on your feet and stand up straight. Then feel the ribs expand for the breath. It takes him a few times of every direction. When we sang "Are You Sleeping" with the sheet of paper sliding across the piano, he did it wrong first after I had JUST showed him what I

wanted him to do. Just the wrong phrase lengths and haphazard sliding. He got it sort of after another try. Then when we hummed “Swing Low” I asked him if it was more or less buzzy at certain times. He said it was buzzier at the beginning of each phrase because he had more air then. But as he ran out of breath it got less buzzy. I said don't go down without a fight. Combat the end of the breath by engaging your muscles in your ribs and you abdominals to get more air moving out all the way to the end of the phrase - instead of just letting it go. He's the most hypo-functioning person I've ever worked with!! I find myself jumping around just to get some kind of energy going in his lessons. At the end we went over when his next lesson was and I said be ready to SING on Monday!!! And he smiled and he said he would.

17P Lesson5: 4/27 1:00pm

Well, he is still ridiculously low energy but he seemed more focused than he was before (which is not saying too much, but it is saying a little). We started with breathing exercises and I tried the block breathing with him and it did not work. I switched fairly quickly to the counted sustained breathing. He just never really got the idea of exhaling on an /sh/ sustained sound. He tends to just let all the air out on a regular exhale like he just gives up – he doesn’t engage muscles or any kind of resistance. I introduced the candle today and he actually asked a good question: he said when you blow out a candle (which was the only way I could get him to send forced air out at all) it happens very fast and is not sustained, so how can you add voice onto it and have it be sustained? If I’m asking for the candle type breath, that is not sustained by nature. So I showed him how the finger resistance changes everything – since it controls how much air actually gets released, it makes the same energized fast-moving air sustain for longer than it would if the mouth were just open like blowing out a candle. He seemed to get it after a few trials – especially when I said to keep the cheeks puffed out no matter what, and to feel a strong stream of air leaking out from the finger the whole time. It still didn’t sustain too long, because his lips would get lax and let out too much air through the corners, but it was something. I said also to remember how last time we were talking about not going down without a fight – to engage the respiratory muscles and to really make sure that he kept the energy going and kept pushing air out. (This is active language that I don’t really use with other people, but it seems with him, it’s the only thing that will elicit any bit of change in the right direction at all – and even that is subtle.) Then we did patterns with Paul on

doo to try to get the mouth shape going, then after the piano. As long as he is not singing after my voice he is fine. He matches quite well if he lets the sound out. Then I had him hum after the piano instead and feel the buzz. Then we sang "Jingle Bells" with Paul then with the piano, then by himself. He is worst by himself, simply because the energy goes way down since he's solo. He also spaces out – he sang the first ending both times when he sang it by himself, and it's not because he doesn't know the second ending; he sang it correctly with the recording and with the piano, but he seems to just lose his place in the song and he basically started over. I had him sing on doo as well, and the same thing as ever happened: his doo was lazy with no activation in the embouchure and he shortens all the notes to an extreme version of the rhythm. I asked him to think of 4 things – constant air = smooth lines, round mouth shape, high energy, staying "up" on the word "all". (Thinking up actually helped that a lot – singing from the cheeks. He said he understood, but then again he says that to everything…) Then we sang "Swing Low," "Happy Birthday," and ended with "O Music." It's a common theme: more energy needed here. We addressed it in each song.

22P Lesson4: 7/14 11:30pm

He is really improving! When I play along with him he matches perfectly when he thinks about releasing the breath and maybe even rounding the lips (gathered embouchure akin to focusing a flashlight). However, when we did "sho" on 4-note patterns call and echo without the piano supporting him, he was inconsistent. Do-re-mi-mi would be echoed as do-mi-so-so – right direction but wrong magnitude. Other times, he was right on! So I did a little experiment on do-re-mi-mi where I played along with him (first time already he was accurate) and added more release of air and throughout the repetitions he got more secure – then I took away the piano and he inched back to the larger intervals – he couldn't sustain the same notes. So was there just no sense memory of the notes? Is his matching subconscious?

He is understanding the ease of releasing *while* singing and gathering in his lips. We sang patterns, "Twinkle, Twinkle," "Are You Sleeping," and *"*Swing Low*"* all just focusing on releasing the air and possibly gathering the lips. Keeping it simple is great for him because it really changes things it seems. He did a funny thing today, I noticed, when he exhaled *before* singing an exercise, so I brought it up and instructed him to start the exhale immediately after the nice inhale *on* the singing, since exhaling first would just be a waste. He got it and even noticed when he did it once later in the lesson.

It seems like a very slow process here. But he definitely can sing all of the notes that are in the testing sessions in tune if he remembers to breathe.

27P Lesson3: 7/22 2:45pm

Today we started with lip trills, which are getting SO much better! We went all the way up to an Ab on full scales and she was doing great. I asked her how her mind was doing, knowing that she was singing so high, and she said fine because it doesn't feel fine….it doesn't feel strained. I said wonderful! That's the idea! Then we did shui, finding a nice breath-based but full head voice and staying there as long as possible on the way down. It fought her a bit at the bottom, but then when it finally switched it didn't drop, which was excellent. She stayed breath-oriented, and even said that she noticed it switch but that it didn't feel like it switched. I said that's the game! Then we tried the straw and she kept trying to switch to the nose – like a hum – so it never quite worked. Normally I'd keep going with it to get it to work, but in this time crunch, I just moved on. I asked her to sing Jingle Bells on a doo as breathy as possible. She sang it quietly with hesitant air. I re-defined "breathy" and asked if it was safe to say that she had equated "breathy" with "quiet". She said yes – I said I wanted it to be crazy amounts of breath in ratio to the voice – really energetic airflow, like the lip trill. After this new definition clarification, she did great in a breathy "doo" and seemed to feel the difference right away. Then I switched her to words in the same breathy feeling. It was great, but the mouth was so undefined so everything just fell under-energized. Then I had her tap the corners of her mouth and activate the lips (she later clarified "pucker" as the word for her). She had an issue with the opening of the mouth – she dropped the jaw with this and therefore none of the words were understandable. She said she was thinking of too many things. So I said – just the breath and the lips. But pointed out that her tongue should be working. She also kept referring to her abdomen as the proper support for breathing. Where do people get that word?! I did not use that word when we talked about breathing before. At the end of the lesson, while singing "Row Row Row Your Boat," the merrily line we used on lip trill going then into words and when she sang that line directly after singing it on lip trill it was great, but then in context of the song it didn't have enough breath energy behind it. She said the lip trill reminded her to breath from her abdomen. She still couldn't put it in context. Then I said that earlier keeping her chest up seemed to give her the nice breath that she needed, so perhaps think of it as expanding more in your chest and ribs than in your abdomen. Then immediately it worked more like the lip trill.

So it seems like just a series of re-definitions, and energizing the breath out and focusing the sound with the embouchure.

28V Lesson4: 7/9 2:00pm

I find myself being really encouraging to him. I think maybe it's because this group is rather difficult. Judging the accuracy of something *only* by visual feedback is challenging. He can see immediately that he's not matching the pitch, and although that's great as far as ease of cognitive load and immediacy of self-reliance, it's tough because he knows exactly how often he is inaccurate and by how much. This can lead to frustration, so I'm seeing. He is a good sport about it, but for instance today – when we saw that he is off every time on something or another, but I point out the positives – like when he was consistently too high, but the relationship between the notes was pretty intact, he said "well, so as long as I'm singing alone I'm fine." It's funny, but it also does mean that he recognizes that he can't match with other people – therefore losing the social aspect. So I wonder if this method then points out the deficiencies without actually pointing them towards a solution. It just shows them when they're wrong and when they're right, but doesn't teach them *how* to fix it. He seemed to like the figuring out hand signs – he's good at that – and the sight-reading music representation. He quickly figures out the symbols that it should be, and then singing the pattern is the tricky part. He also doesn't seem aware yet of how bad it is until he sees is on Sing and See. When we sang "Row Row Row Your Boat" in a round I asked him how it went and he said he thought it went pretty well. It did not go pretty well. However, he thought he was fine. Then we added hand signs for the second half of the song and he put his attention there – which at first made it worse, and then I think it helped him a bit after he figured out the logistics. I actually thought about the learning curve and how typically people get worse as they're learning and then get better as they coordinate things. I wonder about that with him. I'm not sure how much he's *retaining.* I think he's retaining something – certainly he can sing the right directions in "Twinkle, Twinkle" now, at least. It's still not accurate but it's the right contour. He's thinking harder about singing it seems as well. Perhaps knowing the goal is giving him some kind of confidence?

29N Lesson5: 7/22 4:00pm

She seemed to have fun working with dynamics today. I also went step by step towards having her write her own little composition and she seemed impressed with that – with how difficult it was to improvise a melody, and the fact that she did it. We started with *Are You Sleeping* in call and echo and then with her singing the entire thing. Then we did different dynamics over the whole song together, then alternating the dynamics with her alone. We also did "Swing Low" with the rhythm, then with swaying to the steady beat, and reading rhythms and converting them to standard notation (then I had her write a 16 beat rhythm and say it, then eventually sing it on any notes she wanted it). When she "sings" a rhythm or a poem, she basically speaks it with varying inflection. When I asked her to make it more "extreme" when she changed notes for the rhythm she only broke into an actual singing voice when she jumped much higher for the "too" but then it was more like a slide – a sigh-sounding thing. However, it was the only sound that wasn't a spoken drone. The same thing happened when she created a melody out of two notes for the poem "The Loser". I gave her /mi/ and /do/ (neither of which actually made it into her melody) to choose from and switch between at will. We remarked that his poems are inherently musical – the notes are given pretty much from the inflection. However, what she was doing really was just reading it with more dramatic inflection. She seemed to think she was actually singing, though. Another thing she has difficulty with is tapping the rhythm of a song while singing it. (It's also unsteady when she keeps the steady beat but that seems to be improving.) When she taps the rhythm it's like she's figuring that out independently from singing – like that's a whole other task that she has to do, instead of lining it up with what she's already doing. I showed her that it should line up with my fingers playing the melody on the piano. That did not help. She seems to be recreating the wheel, so to speak, as she's singing, and thinking so incredibly hard; the tapping is extremely labored. Meanwhile she's rarely ever accurate on the pitch domain still. Singing quietly gets closer sometimes, simply because it's further from speech, but it still is not consistent or actually accurate. She does not seem to be improving from the exposure, but she says at least once every lesson that what we're doing is fun, and that she finds things challenging.

29N Lesson6: 7/28 2:30pm

She did actually very well today! There were a lot of times when, again, she was completely off pitch. However, there were some songs when she was with me

when I was singing with her and then afterwards, when I would stop singing she would fall off the pitch and notice it. Then, for instance, during "Swing Low", I had her sing "Coming for to carry me home" a few times with me, then I dropped out and she stayed on pitch! Then I asked her to sing the whole thing and I would come in and out – I barely needed to sing with her because she stayed relatively accurate! The only thing she did wrong was sing the second version of "comin for" as the first line as well, but she at least stayed in the key. I didn't point out when she was on or off, but we just kept going with and without the supports. It was interesting to hear, however, that she does hear how off she is when, all of a sudden, I'm not singing with her anymore. She asked if she was that off while I was singing with her or whether she just gets that off when I stop. I told her I couldn't answer that question. Also a way in was the poem "Where the Sidewalk Ends" – without going by way of finding the steady beat, I asked her to read it a few times. She reads exceptionally well (she said she has done radio), so I just asked her now to read it using her singing voice instead – I wouldn't even play notes for her to match. She did it – and although it wasn't completely her singing voice the first two times, as I instructed her to take more time on some notes and to go further with it – with letting the words have sound instead of only meaning – she came closer to singing. She really enjoyed that and she found it very interesting because she said she is a writer and often reads things back to herself to hear them, but never sings them.

31A Lesson2: 7/16 2:30pm

I definitely improved on my interaction with her. She brought up the feeling again a few times and the breath and questions of that nature, and I simply said that because of the research nature of this, I'm purposefully not answering all of her questions, but that what I can say is "explore that and try something else. I also can say to listen and use all of the information you get from *hearing* my voice." Later she said that during *Are You Sleeping* the highest line "morning bells" felt like it wasn't her full voice and that it changed somehow and felt strange. I said that's normal – and as long as it doesn't hurt she's okay, but I told her that it didn't sound like it hurt, and it sounded like it was doing exactly the right thing. Let it feel strange.

She has a good ear – she's not so adept at describing verbally what she's hearing but she takes instruction well and knows mostly when she's off. She doesn't hear the scoops all the time – or at least doesn't hear the degree to which she does them. However she definitely heard the inaccuracies with *Are You Sleeping*. That's where I should spend more time next lesson – so that we can work with

something that's actually a good deal off. She blames it on being dry (from medication) and from it being too high for her, but I keep telling her that it's only up to /so/ with a little /la/ so she can do it. She's even inaccurate on the lower notes, so that suggests to me not necessarily just the dryness – she *can* hit the notes. She just has to make the switch into a lighter mechanism and she has to know more specifically where the target notes are. She's still scooping and sliding on "all" in Jingle Bells – the /do/ is not precise. *Mary Had a Little Lamb* is good, but she's not completely accurate when she sings without the support of the piano. Singing patterns she does really well when we slow things down with me, her and the piano so that she can really match it and adjust. Then singing faster she is able to make that adjustment faster. /Fa/ was the only one in /do re mi fa so/ that never got completely adjusted from the very first second. It always went a little sharp and then she would let it settle down into the unison. She gets there every time; it just needs to be able to get there from the beginning and from an internal target instead of needing the external target. That's our goal – to get her to hear correctly in her own head so that she can monitor self-reliantly. She asked me at the end how her voice is doing- if she's getting better. I said "yes – just keep using your ear". I told her during the lesson that I'm going a different way in- using her ear as her strength and going from there, since she has a good ear. She can hear the differences, so let's start there – start from her strength.

She also seems to struggle a lot with labeling patterns on a neutral syllable or played on the piano with solfege syllables. She tried lots of responses to the first line of *Are You Sleeping* and never got it right. That's something we should do more – the guessing game.

31A Lesson4: 7/28 2:00pm

I had her singing almost the entire time so I took the last 3 minutes to play her the Beverly Sills "Twinkle". She correctly labeled it as "Twinkle, Twinkle" but was completely confused when we listened to the variations version. I told her what was happening and she said "she's doing the scoopy thing that I used to do when I started". We sang a lot – back and forth, and even when she's listening to me sing, she sings along quietly. We started with patterns and I added on to make it longer and longer of a sequence. Then I sang a few very short patterns on "doo" for her to label as syllables. She even sang those back to me on "doo" before she labeled them. Often she would sing them incorrectly but still label them correctly, or almost correctly. That's interesting to me. She struggles mostly only with intonation and then when she's without the support of me or the piano with her she gets very quiet, although not always more inaccurate, and she doesn't like

that. It seems to be pretty mental there. However, she seems to like being empowered by the direction to target. She just often talks about her voice and goes immediately to trying to figure out the "why" not just the "what", which is unfortunately what I'm focusing on here – the "what" – the target itself. So she doesn't always answer my questions the way I'm looking for her to answer them – she speculates on what happened to make it wrong. However, she's correcting mechanism things without my instruction – in order to match the higher notes. However, that's when it gets quiet and she doesn't like that so she tries to return to the louder singing, which won't always reach the higher notes.

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