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A Literature Review of Uses and Attitudes Towards the Acceptance of Assistive Real-Time Technology in the Voice Studio

Jeanine F. Wagner
jwagner@siu.edu

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A LITERATURE REVIEW OF USES AND ATTITUDES TOWARDS THE
ACCEPTANCE OF ASSISTIVE REAL-TIME TECHNOLOGY IN THE VOICE STUDIO

by

Jeanine Wagner

B.M., Southern Illinois University, 1980
M.M., Southern Illinois University, 1981
D.M.A., University of Illinois, 1987

A Research Paper
Submitted in Partial Fulfillment of the Requirements for the
Master of Science Degree

RESEARCH PAPER APPROVAL

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for the Degree of

Master of Science

in the field of Communication Disorders, Speech and Language Pathology

Approved by:

Sandie Bass-Ringdahl, Ph.D./CCC-A, Chair

Graduate School
Southern Illinois University Carbondale
November 1, 2013

AN ABSTRACT OF THE RESEARCH PAPER OF

JEANINE F. WAGNER, for the Master of Science degree in SPEECH AND LANGUAGE PATHOLOGY, presented on NOVEMBER 1, 2013, at Southern Illinois University Carbondale.

TITLE: A LITERATURE REVIEW OF USES AND ATTITUDES TOWARDS THE ACCEPTANCE OF ASSISTIVE REAL-TIME TECHNOLOGY IN THE VOICE STUDIO

MAJOR PROFESSOR: Sandie Bass-Ringdahl, Ph.D./CCC-A

The human voice is a tool that not only communicates ideas and feelings, but also expresses and elicits emotions. Since the age of Manual Garcia (1805-1906), the inventor of the laryngeal mirror, singers and voice teachers have discussed, argued and philosophized about the most efficient manner in which to train any voice to reach its optimum capability. Singing techniques and the subsequent voice qualities have been strongly divided by cultural and personal preferences. Empiricists carefully guarded their teaching methods and shunned ideas that any other fields might have anything worthwhile to contribute to voice instruction. Voice teachers have been slow to embrace the use of visual feedback that is generated by technological sources. A review of literature published since 1967 traces the trends of acceptance of assistive real-time technology in the voice studio.

Keywords: voice, singing, technology, voice teaching

DEDICATION

This Research Paper is dedicated to Margaret Simmons, who has kept me sane through four college degrees, and my father, Lavern J. Wagner, who set the incredible example of being a lifelong learner.

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CHAPTER 1

INTRODUCTION

The human voice is a tool that not only communicates ideas and feelings, but also expresses and elicits emotions. Since the age of Manual Garcia (1805-1906), the inventor of the laryngeal mirror, singers and voice teachers have discussed, argued and philosophized about the most efficient manner in which to train any voice to reach its optimum capability. Singing techniques and the subsequent voice qualities have been strongly divided by cultural and personal preferences. Empiricists carefully guarded their teaching methods and shunned ideas that any other fields might have anything worthwhile to contribute to voice instruction.

Essentially, they considered singing to be an art, not a science, and they maintained that as such, its teaching should not be standardized or methodical. They stressed that singers could obtain control over their voices (if "control" were even a goal to be pursued) only through indirect methods: developing a mental concept of their ideal tone quality, and attempting to reproduce that quality over and over, trying and failing, until at last the sung tone matched the concept, consistently, and throughout the compass of the voice. Finally, in direct contradiction to the vocal scientists, the empiricists believed that singing a beautiful tone was the cause of the proper motions of the vocal organs, not the result of it. (*Singerspace, Chapter IV*)

Voice teachers have been slow to embrace the use of visual feedback that is generated by technological sources. In the article entitled *Real-time feedback in the singing studio* (Music Education Research, Vol. 7, No. 2, July 2005), the authors make note of the following:

Detailed investigation of the professional practice of fifty teacher of singing in Australian higher education institutions (Callaghan, 1997) revealed a significant disparity between singing pedagogy and voice science. Although the teachers had a strong commitment to experiential learning and individual development, they often demonstrated an incomplete knowledge of underlying vocal physiology and acoustics, leading to the possibilities of misinformation during the singing lesson. (p. 227)

Subsequently, a singer or professional voice user who suffered a vocal catastrophe was left to seek help from specialists whose interest in the voice was limited to the scientific or medical realm with little to no support from the voice teacher. The singer lacked the background to even ask pertinent questions in his/her own treatment, much less actively participate in the process. Likewise, a doctor may not be aware of the most current protocols in care of the ailing vocalist. The combination could easily create a situation that was worse than that presented by the original problem.

The Voice Foundation, founded in 1969 by Dr. Robert Gould, was the first comprehensive attempt to bring seemingly disparate fields of performance, speech pathology, voice research and medical care of the voice together to join in constructive dialogue. This organization has led to a closer relationship and much clearer understanding of the workings of the human voice. Yearly, world-renowned specialists

in each of these fields meet to share their most current knowledge and research on the human voice.

Technology and singing have been on a collision course for many years. The new generation of voice teachers has been instructed in an atmosphere that embraces technology. Audio-feedback was recognized early on as an effective teaching tool to help the student recognize pitch and, as microphones became more sensitive, quality. The requirement that a student record his/her voice lesson has been a part of many voice syllabi since the advent of the cassette tape recorder. Now recording apps are ever-present in the teaching studio on the students' smart phones.

Visual feedback has been slower in becoming available to the voice teacher and singer. Although the means with which to analyze sound has been around in the scientific world for decades, the expense of including such equipment in a music studio has been cost prohibitive. Moreover, the use of such information is best done in real-time, thus creating an additional requirement for practical use by singers. During the past ten years, software for the spectrographic analysis of sound has become increasingly more affordable and hardware has become much more portable. Where singers and voice teachers of the recent past ridiculed scientific research as not having a place in a field driven by emotion and personal taste, now there is an expectation by those professional voice users that those with whom they work to thoroughly understand and utilize all of the latest tools available to them. The unsteady march from rejection to acceptance and actual use may be followed through vocal pedagogy publications over the past six decades.

CHAPTER 2

EARLY ATTITUDES

The artistic and scientific communities often run parallel paths. The latter half of the 20th century saw many developments in vocal science that were quite applicable to the singing voice, yet voice teachers appeared to be relatively unaware of advancements or perhaps merely resistant to seeing the worth of incorporating new knowledge into the work in the voice studio. William Vennard was considered to be an early pioneer of interfacing technology and voice teaching. In the Preface to his book, *Singing: the Mechanism and the Technic*, published in 1967, he fully addresses the attitudes of combining science and art expressed in that day: "There are those teachers who feel that applying science to an art is quackery, but I believe that our only safeguard against the charlatan is general knowledge of the most accurate information available." (Vennard, 1967, Page iii) This book cites both experiential and scientific research in an effort to convince the reader that an objective approach to teaching voice is readily combined with the aesthetic. Vennard incorporates not only scientific knowledge of the day, but also some of the current psychological theories to his teaching methods.

Mechanistic pedagogy is applied behavioristic psychology… "The mechanistic voice teacher assumes that singing is a complex skill made up of simple skills, and that when a singer is less than perfect it is because one or more of these skills is deficient." (Vennard, 1967, p. 209)

In an effort to assuage the teacher who rejects a more mechanical method of singing, he goes on to include Gestalt psychology in his philosophy.

> …when all details of behavior are assembled there emerges a *form* greater than any or all of the details. This results in the holistic approach, ignoring or seeming to ignore skills or lack of skills and appealing to the whole personality. Such a pedagog teaches not sing*ing* but sing*ers.* (Vennard, 1967, p. 209)

According to Vennard, his primary reason for writing this text had to do with the lack of information available to the singing teacher when approaching the voice from a physiological standpoint. Throughout, he urges the singing community to embrace science rather than eschew the contributions possible to the field.

> The important thing seems to be whether or not the knowledge is accurate and practical. Therefore, are we not obligated to acquire as much information as possible in order that we may test it? Should we refuse to learn a laboratory fact simply because we cannot test it immediately and directly? Perhaps it will provide the basis for our arriving at something else, or at least avoiding some superstitious error. (Vennard, 1967, p. 210)

The attitudes towards utilizing scientific information, much less any sort of technology, in the teaching studio of the day are clearly those of non-acceptance. However, Vennard was not the only voice teacher of the day who saw the value of science in the studio. D. Ralph Appelman, a long-time member of the voice faculty at Indiana University (IU), was well-known among early vocal pedagogues by his scientific approach to the demystification of vocal production. His book, *The Science of Vocal Pedagogy,* also published in 1967, was one of the first texts widely used by voice

teachers and vocal pedagogues to combine the physics of sound with the production of the singing voice. He recognizes that "Vocal pedagogy by necessity is both aesthetic and scientific" and that "Singers and teachers who interpret the act of singing as wholly aesthetic find it difficult to accept scientific terminology, for it is hard to abandon the feeling that the unfamiliar is absurd and illogical." (Appelman, 1967, p. 3) However, he encourages the singer/teacher to keep an open mind when reading his text. He states the following:

> An implement used to form the bridge between scientific fact and the art of vocalization must be both objective and subjective in nature, it must have stability and permanence, it must be universally employed in the singing act, and it must be adaptable to all conditions of research." (Appelman, 1967, p. 5)

Appelman incorporates information gleaned from technological advances throughout his text. He makes reference to the platogram and linguagram (Appelman, 1967, p. 217) in an effort to help the singer conceive vowel sounds physiologically rather than tonally and includes radiographs in the text as examples of using kinesthetic awareness for vowel production. To further his quest of uniting the fields of science and music, he contributed to the cadre of hardware directly applicable to the teaching of voice through his invention, the vowelometer.

> After 18 years of hard work, the director of IU's Institute for Vocal Research submitted a patent application for his vowelometer, a new innovation in the teaching of voice and language. Appelman developed the machine after realizing that there was a need for instantaneous visual recognition of vowel sounds. On the vowelometer, a scanner dot shows the position of the vowel

sound, sung live into a microphone or recorded, upon a two-dimensional graph displayed on the screen. Every position is phonetic. When a sound is uttered, the dot on the screen represents the phonetic position of the sound just made. The vowelometer allows students to see how close they are to making the correct vowel sound and lets them determine the physiological changes needed to produce the preferred one, Appelman said. This is the first time in history that singers have had visual verification of auditory judgment, he added. (Indiana University - Arbutus Yearbook, p. 297)

The device allowed the speaker/singer to visualize in real time the accuracy of his/her vowel placement by analyzing the acoustical properties of the phoneme and matching the placement with the appropriate vowel position on a black and white screen.   While not ever truly available for use by the average voice instructor or singer, the vowelometer marks one of the first forays into the inclusion of real-time feedback in voice teaching.

Appelman's scientific presentation of the act of singing is clearly documented throughout this text with descriptions and pictures. However, he is careful to assure the teacher/singer throughout the book that "the unification of the physical effort and vocalized sound is conceptual," (Appelman, 1967, p 17) and should be taught through a psychological method. The use of equipment for visual and/or aural feedback is not encouraged as a method of teaching. Appelman defers to the voice teacher whose primary teaching tool is visualization and personal interpretation of the subsequent results.

"The mechanism of diction and phonation can always be analyzed and directives can be given to the student which will enable him to produce a tone that may be evaluated and reproduced by all teachers. This is as far as science dares to go, for style and personality are aesthetic elements that give song its wings. From this point on the teacher's directives are at their very best." (Appelman, 1967, p. 247)

CHAPTER 3

SLOW PROGRESS

Nearly twenty years after Vennard and Appelman wrote their texts encouraging

closer communication between the fields of vocal science and singing, Richard Miller

addresses the need in his book, *The Structure of Singing: System and Art in Vocal*

Technique, published in 1986. The title alone gives insight into the chasm that still

remains between the medical community and the singing community. "Vocalism is

replete with faddism. At least once a year, it would seem, a new revolutionary approach

to the technique of singing appears." (Miller, 1996, p. 213) In the chapter titled,

Pedagogical Attitudes, Miller discusses the presence of three distinct types of teachers

according to their attitudes toward the application of scientific knowledge to voice

teaching. Each type appears to be completely satisfied with his/her approach towards

assisting a student. Their attitudes not only deny the incorporation of elements of other

approaches, but create rigid boundaries that squelch attempts to broach discussions of

other methods of instruction.

> The "Technically Intense Teacher"...feels compelled to work in exacting
> detail within highly organized pedagogies…Because of the largely invisible
> nature of the vocal instrument, vocal technique has about it an elusive character
> that can lead to a preoccupation with technical matters…Any teacher who takes
> pride in being a 'voice builder' should be wary lest constructing the technique of
> the singer, creativity is destroyed or obscured." (Miller, 1986, pp 209-210)

On the other side of the spectrum, Miller describes the "Interpretation-oriented Teacher" as one who believes that rather than take on technical aspects, "they have convinced themselves that there are no technical matters that cannot be solved through involvement in text and music." (Miller, 1986, p. 211) Such a teacher is not likely to incorporate any use of technology in the teaching studio.

Miller cites another type of teacher as being prevalent—the "Technique-Mystique Teacher."

> There is a type of teacher who approaches teaching with the confidence and zeal of the crusading prophet or prophetess. His highly committed teacher tends to give "technique" the trappings of a mystery cult. …Everything that takes place in the studio is part of the technical revelation not elsewhere available. (Miller, 1986, p. 211)

To one who proceeds with the above beliefs, the use of unquestionable visual feedback of any sort would not be acceptable. I personally experienced scoffing reactions towards the use of a spectrogram in the voice studio by teachers of the "technique-mystique" ilk. It is not surprising that Miller goes on to urge voice teachers to embrace the progress made in all fields as they relate to singing:

> There will be little danger of falling into errors of compensatory teaching, of becoming technically too intense, of relying solely on interpretation and style to solve vocal problems, of becoming the technique-mystery figure, or of stressing but one part of the complex technique of singing, if stability and willingness to respond to new ideas are kept in balance. To maintain this balance, we must know the heritage of the vocal art, know what is currently going on in fields

related to singing, and be informed on the literature of vocal pedagogy. (Miller, 1986, p. 213)

In this book, Miller never directly addresses the use of any type of real time audio or visual feedback in the teaching studio. However, he refers to studies done by a multitude of voice scientists and includes information on the voice as a physical-acoustic instrument in the appendices. The text is replete with illustrations, diagrams and radiographs. But, throughout the text, Miller assures the reader that, despite the scientific approach to the physics of sound and the physiology involved in singing, "…the art of singing can be learned only through singing, the systematic organization of vocal technique [that] is the most efficient rout to the realization of the primary goal: production of beautiful sound." (Miller, 1986, p. xxii)

Oren L. Brown, singer/teacher/pedagogue, was introduced to the subject matter included in his book, *Discover Your Voice: How to develop healthy voice habits,* also published in 1986, by personal experiences working with patients suffering with functional voice disorders in the Department of Otolaryngology at Washington University School of Medicine in St. Louis, Missouri in 1952. At the time, he was primarily a singer, but the head of that department, Dr. Theo Walsh, had observed that a number of patients with whom he was working did not respond to the "usual" treatment. Walsh reassured Brown of his ability to assist, stating, "…doctors were trained to use their eyes, but …I had been trained to use my ears; and ears were needed, he thought, to understand many vocal problems." (Brown, 1986, p. ix)

The whole of this book is based primarily on anecdotal and personal experiences as recalled by Brown. He does urge the teacher to understand the mechanics of singing

(Brown, 1986, p. 296) and refers to pedagogues who have come before. He upholds the need for technical understanding.

> Some have argued that a 'natural' voice needs nothing more than appropriate music. On the contrary, I observe that a natural voice needs training based on the physical laws of vocal production to blossom into a healthy singing instrument. There has never been any great performing art without great technique." (Brown, 1986, p. 96)

Additionally, fully one-third of the book covers the physical facts surrounding the science of sound. However, many paragraphs begin with a qualifying statement such as "in my observation,"(p. 111) "my own experience with this problem,"(p. 110), "I am reminded of…" (p. 66) or "a student once told me...," giving the reader the sense that becoming a fine teacher has more to do with personal experience and less to do with application and communication of knowledge.

The text comes with a CD that gives the reader aural examples of the sounds and exercises cited in the book. This is the only nod to technology that appears to be included for studio teaching. Brown is focused on a teacher's need for developing his/her discriminatory hearing ability, but, beyond the CD examples, gives very little assistance in that process. In an early chapter that covers beginning exercises, Brown cautions the singer/teacher to maintain coordinated use of the activator (breath) and vibrator (vocal folds) to elicit a pitch with the least amount of effort. Exercises are replete with words such as "feeling," "thinking," and "letting." He also describes visualizations such as "playing with a yo-yo" or "or being on "a roller coaster which starts from the highest point and then is carried over the next high peak by momentum." His suggestion

to use a tape recorder to "find out what you sound like" (Brown, 1986, p 46) is made in an effort to help the student "let the air flow do the work." (Brown, 1986, p. 45) "*Think* what you want and *let* it happen. Then *trust* the result." (Brown, 1986, p. 46) These rather ambiguous instructions, though based on an understanding of the actual workings of the singing voice, fall more under the canopy of Richard Miller's category of the "technique-mystique" teacher. Brown's folksy description of vocal technique and the manner in which is learned does not communicate the acquisition of depth of the knowledge necessary to be a successful singer/teacher.

Ten years after the publication of the books by Miller and Brown, Richard Miller again broaches the subject of technology and singing in his book, *On the Art of Singing,* published in 1996. Reliance on imagery and vocal voodoo rather than scientific fact in the voice studio is acknowledged as a persistent problem over many years, as Miller opens his book with a quote from W.T in a paper delivered to the Music Teachers National Association in 1935:

> When imagery becomes so vivid that it is transferred into the physical field and used to explain physiologic and acoustic phenomena, it becomes extremely dubious, unreliable and even false. It is this misuse which is largely responsible for the bitter controversies over vocal methods, as well as for their often comical expressions. (Miller, 1996, p.5)

Miller is much more direct with his admonitions towards those still resistant to the use of scientific knowledge in the voice studio than in his book of ten years earlier. The gentle encouragement of the previous publication has been replaced with a straightforward sense of urgency. Miller confronts opposition with direct and well-

documented reasoning. He starts by addressing the apparent overuse of imagery and potential resistance to the use of scientific knowledge by the performer-turned-teacher in the voice studio in the very beginning of this book. He says the following:

> Singing is largely a subjective action. It results from a *gestalt* that summons up previous experiences of physical coordination, proprioceptive sensation, and vocal sound. Fine singers seldom analyze the things they do in performance…When, however, the performer turns to giving instruction, communicative, objective language must be developed….Valuable preparation for the successful teaching of singing is to have solved one's own personal vocal problems, to have reached a good level of technical and musical proficiency, and to have benefited from the inestimable experiences of a successful career….There is a role for some imagery in the teaching of technique. Technical imagery, however, is mostly of value if it is associated with *already* established, repeatable functional freedom. (Miller, 1996, p. 3)

Throughout the book, similar reprimands are given. The reader is given a clear sense that Miller continues to encounter strong resistance to the incorporation of progress mad in voice science to instructional approaches. In a section entitled *On the Invasion of Vocal Pedagogy by Science*, Miller chides, "The avoidance of information regarding the physical aspect of singing is still the hallmark of some outmoded teaching." (Miller, 1996, p. 223) He also speaks directly to the scientific pessimist in a section entitled *Instinctive, Artistic Singing* with the following reproach:

> The instinctive habits that successfully propelled the artist-now-turned-teacher through technical difficulties do not rub off onto the less instinctive

student…The argument against the use of available scientific information is that voice teachers should leave acoustics to the acoustician and questions regarding physiological function and health to scientists and doctors. "Voice teachers should be teaching singing, not science." (However,) it is difficult to find a major treatise on singing from the past that does not deal in the then-current information regarding physiology and acoustic…Why…should a teacher of singing, who deals daily with acoustics, be afraid of knowing how the voice works acoustically?...Why deal in bad physiology and incorrect acoustics when fact is available? (Miller, 1996, p. 246)

Later in the same chapter, he goes on to say the following:

Perhaps the time has come for the teacher who believes that such information has "nothing to do with singing" to reassess the underlying reasons for such a viewpoint. If it turns out, as one hears at times, "that it just takes too much time to get into all of that," or that it is "too complex," one is tempted to suggest that perhaps the teacher should reconsider the extent of commitment demanded by the teaching of singing. Artistry is not just instinctive. It is also acquired. (Miller, 1996, p. 247)

The time for gently acknowledging a teacher's performance background as qualifying him/her to teach appears to have passed. Miller spares no words in voicing his opinions about the singer who refuses to utilize current scientific knowledge in his/her teaching practice. The assumption that may be drawn is that blatant resistance remains and is prevalent among voice teachers.

Late in the text, Miller acknowledges the importance of simply watching a student in order to observe physical changes that may affect voice quality, as well as listening closely to hear those changes. He states that teachers readily use mirrors, the "newer" tape recorder, and even video cameras as a regular addition to their teaching arsenal. Finally, he broaches the subject of utilizing new technology directly in the teaching process.

> Another instrument is now available for verifying what the teacher may attempt to describe through subjective terms such as "roundness" and "ring" and through vocal modeling. This instrument is the spectrograph, a machine that provides spectrograms, which are graphic representations of the harmonic components of vocalized sound (a sung phonation). (Miller, 1996, p. 276)

At last, a practical use of a tool that measures objectively is introduced directly to the voice teacher. However, cost and portability are still problematic. Miller utilizes spectrograms produced by Kay Elemetrics (now known as KayPentax) DSP Sona-graph 5500 in his discussion of specific vowels, voice types and vocal qualities. A quick look on eBay prices this now out-dated equipment as still being valued at $425. While seemingly inexpensive to the scientific community, this is still a cost that most voice teachers would not readily be able to afford. Moreover, because it is outdated, support for the system is quite limited.

Miller does not advocate the use of objective visual feedback as the sole means by which to teach singing. Rather, he defines it as an augmentative tool that may help a singer more clearly understand the sounds he/she produces.

Spectrographic analysis does not replace the musically ear, but verifies what the ear discerns. The spectrogram can identify unwanted features of a sung phonation. It offers teacher and student an additional feedback tool for clarifying the nature of desirable vocal timber for building on discernible excellence. Vocal quality can be both heard and seen. (Miller, 1996, p. 244)

He is also quick to point out the limitations of complete reliance on laboratory equipment in the section entitled *What the Vocal Arts Laboratory Can and Cannot Do* (p. 303).

A vocal arts laboratory has two basic purposes: pedagogy and research. In contrast to the usual acoustics laboratory, its interest in research is dictated by pedagogical questions. Its findings are restricted to the application of research information to the enhancement of vocal pedagogy.

Richard Miller emerges as one of the first strong advocates of the practical application of technology in the singing studio. His thoughtful approach comes from that of an experienced teacher, singer and pedagogue. Miller presents the association between science and art as a logical and mutually beneficial union.

CHAPTER 4

A NEW GENERATION OF VOICE TEACHERS

Early on in his text, *Your Voice: An Inside View: Multimedia Voice Science and Pedagogy*, published in 2004, Scott McCoy focuses on the aesthetic attributes of singing. An exercise that includes listening and describing various singers' voices begins the book. As if attempting to gently ease the reader into the heart of the text—technology as it applies to singing—McCoy does not address the time-honored voice teacher qualms until the second chapter, broaching the subject with the following statement:

> Great singing is a miraculous, artistic event that has often been shrouded in mystery and secrecy. Because the vocal instrument is housed invisibly inside the body, and because sound can only be heard, not seen, singers and teachers historically have relied on intuition and imagery to build singing technique. Generations of singers have been taught to "breathe into their bellies," "sing through their third eye," "project the sound with their sinus cavities," or to "direct high notes through the tops of their heads." Are any of these time-honored and valuable images based in scientific fact?
>
> To answer this question we must enter the world of physics, acoustics and anatomy—foreign territory for most singers and voice teachers. Don't be intimidated! (McCoy, 2004, p. 15)

The comprehensive CD with this text gives examples of everything from the voices of country singers to sine waves. McCoy's approach to teaching voice is one of

a voice scientist, almost exclusively utilizing anatomical and acoustical terminology to describe the physical involvement and physics of singing. The use of technology within the voice studio is referred to through the video examples generated by *VoceVista*, software developed by Donald Gray Miller, Harm Schutte, Martin Rothenberg and Richard Horne. The original displays of VoceVista for MS-DOS were introduced in 1996. McCoy also encourages singers to make use of more specialized technology to assist them in the learning process.

> Singers who have access to a well-equipped voice laboratory could do the above experiment with the help of an electroglottograph. EGG devices have become both more portable and affordable in recent years, and user-friendly software has been developed that shows results in real-time. Using the EGG, open and/or closed quotients can be accurately measured and graphically displayed to provide biofeedback, allowing the singer to monitor and adjust his technique while singing. (McCoy, 2004, p. 122)

This statement is a strong indication of the voice teacher/singer's increasingly accepting attitude toward utilizing technology for an objective evaluation of technique. McCoy's reference to the portability and affordability of equipment demonstrates the need for these two aspects of technology to be in place before there can be wide usage on a daily basis. Here and elsewhere in the text, McCoy opens the discussion of devices that may be used to assess physical and acoustical features relevant to the singer. The reader is made aware of formant analysis and programs such as Real Analysis (Tiger DRS) and Sona-Match (Kay Elemetirics) that display vowel sounds. "Laryngeal position can be measured using devices such as the electroglottograph,

larygoscope or even a basic video camera; it can also, however, be effectively monitored by simply touching the thyroid cartilage." (McCoy, p 145)

McCoy encourages the use of the spectrogram, a graphic display that visually depicts the spectrum of sound, as a useful tool for monitoring control of vibrato, control of legato, balancing the first vowel formant with the singer's formant (2500Hz-3200Hz), and monitoring the duration of diphthongs. He acknowledges "feedback from real-time spectrograms often is ideally suited to … visual learners." (McCoy, p. 56) Gram, by R.S. Horne, and CSL, from Kay Elemetrics are cited as programs that create linear frequency displays.

Donald Gray Miller makes the bold step of having interactive technology available, affordable and accessible in his book, *Resonance in Singing: Voice Building through Acoustic Feedback,* published in 2008. The 130-page paperback book comes with a full version of VoceVista Professional voice analysis software included. The software, available only in PC format, affords the user a quantitative measure of harmonics, fundamental frequencies and decibels. As one would expect, the entire book is based upon the premise that real-time acoustical analysis is a crucial aspect in training the voice student. However, the author urges the reader to remember that maximizing acoustical output is only one aspect of the singer's job.

> The ability to see the acoustic consequences of various physiological, or even psychological, adjustments in vocal technique can greatly benefit autonomous efforts at learning; nevertheless, one should not forget that the training of a singer remains a task that is best accomplished with the help of a traditional teacher. (D. Miller, 2008, p. vii)

D. Miller also places the onus of interpretation of those visual results on the teacher rather than the student. Listening and interpreting are still a vital part of the instructional process. Never will technology replace the human element present in aesthetic interpretation.

> If anything, the burden on the teacher's expertise is increased by the presence of the signals: the teacher not only has the primary and traditional task of evoking and recognizing the desired result in sound output, but also the added assignment of understanding the signals and their relationship to that result. (D. Miller, 2008, p. 35)

The continued reassurances to voice teachers that their expertise is not replaced, merely enhanced, represent thought of the time. Although the human ear is fallible, the ultimate judge of quality, whether unpleasant or thrilling, is the listener, not the machine. Adding an objective, visual measure to the art will never replace the need of the emotional response evoked by a well-sung piece of music. An artistic performance is experienced through each individual's filters of personal background, familiarity, feeling and understanding.

CHAPTER 5

THE FUTURE OF TECHNOLOGY IN THE SINGING VOICE STUDIO

Every indicator points to the progress made in voice science and technological developments being used more prevalently by voice teachers and students in the future. Singers of today have grown up with tools that allow them to speed from creation to completion in the blink of an eye. Any question they have may be rapidly researched online. Voice students of today expect technology to be a regular part of voice lessons. They are unhampered by prior notions that, in order to create a purely aesthetic experience, a clear separation between science and art must exist. Smartphone technology gives students easy access to programs that offer practical assistance to them in their quest for a beautiful sound. Free applications that record, play, interpret, distort or enhance sounds abound. It is now not only possible, but amazingly affordable for a singer to carry a basic spectrogram with them at all times.

On the other side of the piano, a major obstacle is disappearing. Skeptical teachers are retiring. The new voice teacher is technologically savvy and pedagogically trained. Every voice performance degree now includes an element of vocal pedagogy that introduces future performers and teachers to pertinent knowledge available to them. The Voice Foundation, an organization that encourages the sharing of discoveries and practices among voice scientists, otolaryngologists, audiologists, singing professionals, acting professionals and speech language pathologists from throughout the world, is thriving.

The fear of technological overuse that singers and voice teachers exhibited in earlier years was not completely unfounded. In the popular culture, perhaps the overuse of Auto-tune (a computer program that corrects pitch deviations) by pop artists may fall into the category of taking technology a step too far. Additionally, it is well known that recording engineers often use knobs and dials to create the "perfect" sound by adjusting frequencies and reverberation.

But "perfect" still remains in the ear of the beholder. Technology cannot override the human experience. Active listeners will continue to provide the final approval of any performance.

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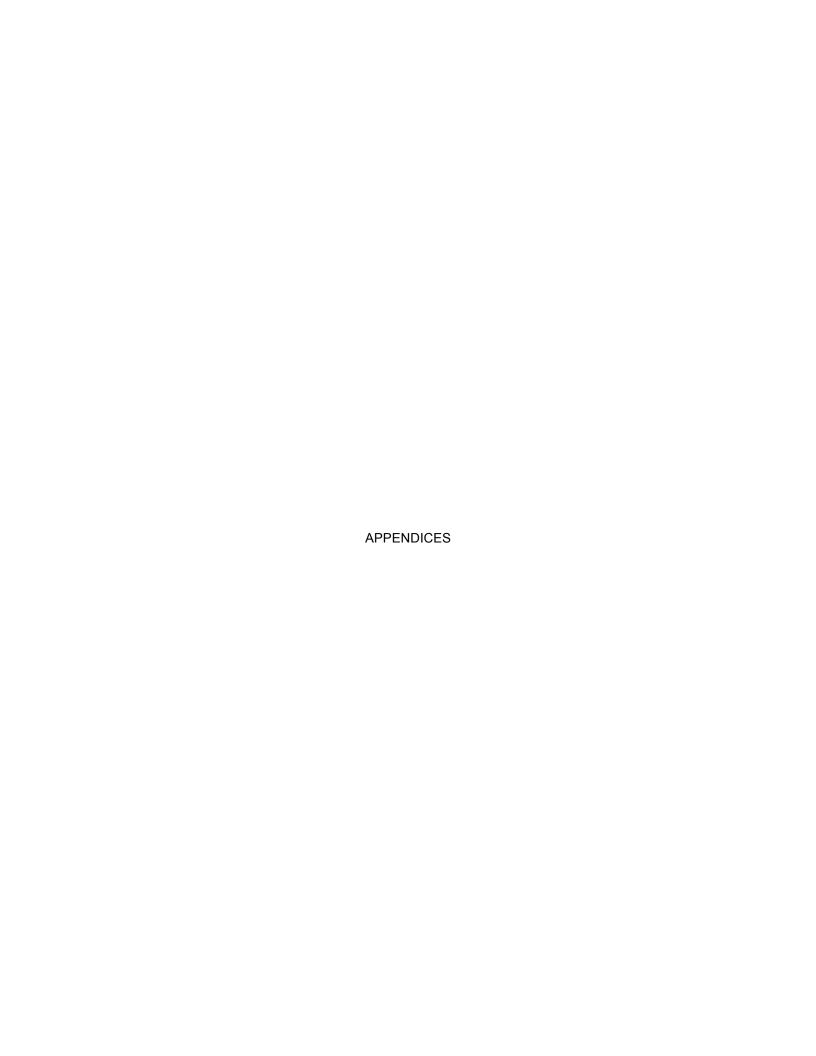
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APPENDICES

APPENDIX A

WEBSITES AND SOFTWARE

A myriad of websites have been developed over the past few to assist the technology-hungry musician. The singer is now able to download spectrogram apps to his/her smartphone and use the programs any time and in any situation. Larger displays of software readouts may be achieved by using iPads or other electronic tablets. Below are a few useful resources:

VoceVista - http://www.vocevista.com/

Electronic download of spectrogram software included with D. Miller's text *Resonance in Singing.* PC only.

WinSingad - http://www.davidmhoward.com/winsingad.html

In 2003, software was developed for an experiment in which real-time visual feedback of acoustical output was supplied for the voice teacher and student through use of spectral analysis. The software was initially available only for PC, but has subsequently become available for use with iPad and iPhone technology.

http://www.phon.ucl.ac.uk/resource/sfs/

Speech filing system that performs standard operations such as acquisition, replay, display and labeling, spectrographic and formant analysis and fundamental frequency estimation.

Speech Analyzer, Phonology Assistant, IPA Help - http://www-01.sil.org/computing/speechtools/

Speech Analyzer: for acoustic analysis of speech sounds. Phonology Assistant: for managing transcribed Speech Analyzer sound files and/or transcribed data without sound files. Provides extensive phonetic charting and phonological querying capability. IPA Help: to learn to hear, transcribe and produce the sounds of the International Phonetic Alphabet.

WaveSurfer - http://sourceforge.net/projects/wavesurfer/

WaveSurfer is an open source tool for sound visualization and manipulation. Typical applications are speech/sound analysis and sound annotation/transcription. WaveSurfer may be extended by plug-ins as well as embedded in other applications.

VTDemo - http://www.phon.ucl.ac.uk/resource/vtdemo/

VTDemo is an interactive Windows PC program for demonstrating how the quality of different speech sounds can be explained by changes in the shape of the vocal tract. With VTDemo you can move the articulators in a 2D simulation of the vocal tract cavity and hear in real-time the consequences on the sound produced.

APPENDIX B

SOURCE FOR VARIOUS PROGRAMS

http://techfortheclassicalsinger.wordpress.com/2012/07/28/spectrogram-apps-for-visualizing-the-overtones-in-your-voice/

One of the most interesting websites I came across was one that, although presented in an electronic medium, actually supplies links to vocal methods as taught by the singing masters as far back as the early 1600's. Technology for the Classical Singer, however, is much more than a reference to vocal treatises and workbooks of the far past. The author (blogger) discusses the various live spectrogram apps available for use by the classical singer who travels with an iPad or a smart phone. Additionally, there are links to 3D larynx anatomy tutorials on YouTube for the singer who is curious about the physiological processes involved in singing. On the purely practical side, the blogger also references websites and publishing companies that offer the singer accompaniment tracks for full opera roles and art songs. He includes a list of ways to use smart phone technology to store song texts and libretti so the singer might memorize in any situation, study diction rules of languages, scan scores and reference materials, locate music at libraries, and video tape rehearsals. For further use in the teaching studio, the author refers the reader to a myriad of virtual music staff paper usable to notate vocalises on the iPad.

VITA

Graduate School
Southern Illinois University

Jeanine F Wagner

jwagner@siu.edu

Southern Illinois University Carbondale
Bachelor of Music, Voice Performance, May 1980

Southern Illinois University Carbondale
Master of Music, Opera/Musical Theater, August 1981

University of Illinois Urbana-Champaign
Doctor of Musical Arts, Voice Performance, May 1987

Special Honors and Awards:
    Outstanding Performer, Phi Kappa Phi

Research Paper Title:
    A Literature Review Of Uses And Attitudes Towards The Acceptance Of
Assistive Real-Time Technology In The Voice Studio

Major Professor: Sandie Bass-Ringdahl, Ph.D./CCC-A

Publications:
    Simmons, M. R., Wagner, J. F. (2004). A new anthology of art songs by African
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