Children's and Instructor's Perceptions of Using VoceVista in a Voice Exploration Session Focusing on Gentle Onset of Phonation and Articulation of Consonants

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Abstract

Previous studies have explored the use of real-time visual spectral feedback with adult and teenage singers. The purpose of the present investigation was to examine the perceptions of children (N=54), ages 7 to 13 years, relative to the use of visual feedback provided by real-time spectral analysis software (VoceVista) in a voice exploration session focusing on gentle onset and articulation of consonants. Participants completed a two-part survey. Part One consisted of demographic items. Among results, (a) 94% of participants had prior musical experience outside of a school setting (b) 89% of participants used a computer at home and/or at school for at least 15 minutes a day, (c) 65% of participants described their computer skills as competent or very competent, and (d) 22% of participants had had private voice lessons, with (e) 33% having other singing performance experiences. Part Two of the survey asked for responses to three items: (a) What two activities in this session did you find most helpful to learning about and improving singing? Why? (b) What two activities in this session did you find least helpful to learning about and improving singing? Why? and (c) Overall thoughts about the use of VoceVista in this session. Participants were also asked to rate the overall helpfulness of VoceVista in teaching gentle onset and articulation on a 5-point Likert scale. Content analysis of responses in Part Two of the survey indicated no negative perceptions of VoceVista overall. Furthermore, 70% of participants thought that VoceVista was the most helpful activity in the voice exploration session. Participant responses to scale items likewise indicated overall favourable perceptions to using VoceVista in teaching gentle onset (*M* 3.99) and articulation (*M* 3.93). Results were discussed in terms of limitations of the study and suggestions for further research.

Introduction

Human beings perceive the world through the three primary senses: "visually, auditorily, and kinesthetically (Thurman & Welch, 2000)." Teachers of singing traditionally teach vocal techniques through spoken concepts or imagery, combined with vocal modelling and occasional movement exercises (Callaghan, 1998: Howard, *et al*., 2004). Because internal operations of the human larynx, respiratory system, and vocal tract cannot be viewed directly by the human eye, opportunity for visual feedback during voice instruction has heretofore been limited largely to such indirect means of observation as viewing one's self in a mirror while singing.

Today, however, visual real-time feedback (VRTF) technology affords opportunities for increased visual feedback in voice lessons through computer-based displays of voice spectra.

We live in an age when almost every child in this country [the United States] has access to a computer either at home or at school. Seventy-five percent of students in the United States in 1998 had access to computers at school and between twenty-two and ninety-one percent of children had a home computer (Becker, 2000). By 2001, that number had grown significantly, with ninety percent of students having access to a computer at home and/or school. There were a variety of reasons for this growth, including an increasing number of school systems that supplied a laptop computer to each student. Rochelle, Pea, Hoadley, Gordin, and Means (2000), found indications that computer technology could be utilized to enhance four fundamental characteristics of learning: (a) active engagement, (b) participation in groups, (c) frequent interaction, and (d) feedback and connections to real-world contexts.

Several studies have examined the use of VRTF software in individual voice instruction with teenage, college-age, and adult students as well as use in college-level choral rehearsals. Callaway (2001) tested the usefulness of real-time spectrographic displays in private voice lessons with female college students (N=10) over 10 weeks. Callaway found that the spectral data was predominantly consistent with the instructor's assessment and thought to be helpful to the student. Students also reported that it was helpful to have a visual representation of their sound. Welch, Howard, Himonides, and Brereton (2005) found that new technology could have a positive impact on teachers and students because of more meaningful feedback. Half of the participants (n=4) received voice lessons that involved the use of real-time visual feedback technology. In a follow-up study, Howard, *et al*., (2004) used an advanced software system in singing studios that provided teachers (N=2) and singers (N=8) with up to eight different feedback displays. Through case studies, it was found that the use of technology had a positive impact on the learning process. Studies also have been done with other real-time spectral programs such as Acoustic and Laryngeal Biofeedback Enhancement in Real-Time (ALBERT) with professional singers to assess fundamental frequency, jitter, and larynx closed quotient (CQ) (Rossiter, 1995).

Nix, Mabry, and Mathews-Muttwil (2007) studied the use of VoceVista during a rehearsal of an undergraduate women's chorus. Real-time display of acoustic parameters was projected through VoceVista onto a screen during rehearsals. Participants (N=43) thought that their rehearsal experiences were enhanced by this visual feedback.

In another study, Miller and Schutte (2002), one of the creators of VoceVista,[1] used VoceVista to study the singing of seven professional singers in the Metropolitan Opera's Young Artist Development Program.

The goal was to document aspects of exceptional voices for aspiring singers and their teachers. Singers (N=7) were recorded performing various vocal exercises, such as scales, arpeggios, and sustained tones. These exercises were examined and baseline information on certain aspects of the singers' voices was obtained.

However, Welch, Howard, and Rush (1989) examined the use of visual feedback with children. Their study focused on development of pitch accuracy in the singing of primary schoolchildren. The research found that there was a significant improvement of pitch matching ability in the experimental groups compared to the control group. Howard and Angus (1998) refined the software program and used it to study pitch accuracy among primary school boys and girls as compared with adults.

The purpose of this study was to assess the perception of children (*N*=54), ages 7 through 13 years, who participated as singers in a voice exploration session wherein VRTF was used to explore gentle onset phonation and the articulation of consonants.

The following questions guided this investigation:

(a) What will participants mention as the most helpful and least helpful activities in the voice exploration session?
(b) What are participant perceptions overall with respect to the use of VoceVista?
(c) How will participants rate the use of VoceVista in learning gentle onset and consonant articulation?
(d) Do these perceptions vary among participants according to age, grade in school, sex, subject areas they like or dislike in school, previous singing experience in voice lessons and choir, and self-described computer skill?
(e) What were instructor perceptions of the strengths and weaknesses of using VoceVista in this voice exploration session according to ex post facto analysis of a videotape of this experience?

Method

Participants

Participants in this study were children (*N*=54), ages 7 through 13, who were enrolled in a summer musical theatre workshop. Participants included 49 females (91%) and 5 males (9%), in the following age groups: 7 years old (*n*=6), 8 years old (*n*=11), 9 years old (*n*=8), 10 years old (*n*=12), 11 years old (*n*=11), 12 years old (*n*=4), and 13 years old (*n*=2). The median age of the participants was 10 years.

Participants had a varied experience base in elementary school choir, community choir, musical theatre performance, church or synagogue choir, solo singing experiences, private voice lessons, and other singing experiences. Fifty-one participants (94%) had prior musical experience outside of a school setting. Twenty-three participants (43%) had at least one year of experience in elementary school choir. Seven participants (13%) had at least one year of experience in middle school choir. Eight participants (14.8%) had experience in community choir. Thirty-four participants (63%) cited experience in musical theatre performance. Twenty participants (37%) said they had experience in a church or synagogue choir. Ten participants (18.5%) had had at least six months of private voice lesson instruction. Other singing experiences cited by participants included karaoke, school plays, and school talent shows. The participants (*n*=10, 18.5%) with private voice lesson experience gave a mean score of 4.3 in VoceVista's helpfulness to learning gentle onset of phonation and a mean score of 4 regarding VoceVista's helpfulness in learning articulation of consonants.

Section One of the survey also surveyed computer use, expertise, and availability. Eighty-nine percent (*n*=48) of participants used a computer at home and/or at school for at least 15 minutes a day. Sixty-five percent of the participants described their computer skills as competent or very competent. The participants rating themselves as "very competent" in terms of computer skills gave a mean score of 4.3 on a 5-point scale to VoceVista's helpfulness in

teaching gentle onset of phonation and a mean score of 4.15 regarding VoceVista's helpfulness in teaching articulation of consonants.

Voice exploration session

All participants attended a 45-minute voice exploration session. For purposes of this study, a voice exploration session was defined as an educational activity in which children were invited to sing a song excerpt of their choice for a teacher in order to explore vocal possibilities. The workshop grouped participants according to grade level for its various activities. This configuration was maintained for the voice exploration sessions: (a) Participants entering second and third grades (*n*=12) attended Session One; (b) Participants entering fourth grade (*n*=14) attended Session Two; (c) Participants entering fifth grade (*n*=12) attended Session Three; (d) Participants entering sixth, seventh, and eighth grades (*n*=17) attended Session Four. All participants attended one grade-level voice exploration session during their time at the summer workshop.

Equipment and room set up

Figure 1 shows the configuration of the room in which all voice exploration sessions occurred. Equipment used included: (a) a Dell 6240 lap top computer with internal microphone set on a (b) Wenger Classic 50 music stand for easy adjustment of height, with the stand placed approximately 10 inches from participants; connected to (c) a smart board attached to the front wall of the room; and (d) a Sony video camera, placed in the back of the room for ex post facto review of the sessions.

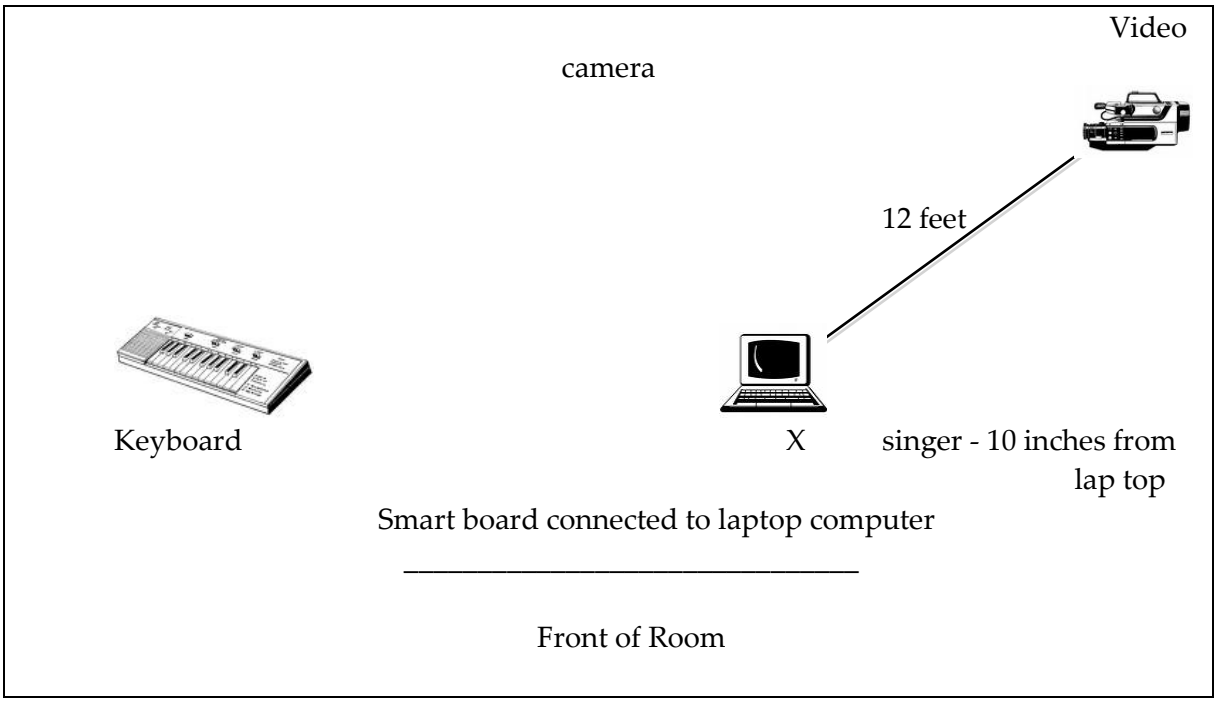

Figure 1. Equipment and room set-up for voice exploration sessions.

Session procedures

Each session followed a master class format, wherein each participant sang an a cappella one to two minute song excerpt of his or her choice before working with the instructor in the presence of other participants who attended that session. Particular attention was paid to gentle onset phonation and consonant articulation in the singing of each participant.

The VoceVista software throughout each session displayed through continuous visual representations of sound spectra. During individualized work with the instructor, reference was made to the visual display as deemed appropriate by the instructor or, sometimes at the request of the participant. If there was indication of need to work on gentle onset or clear articulation of consonants, singers were sometimes instructed to sing towards the laptop, watch the screen and take notice of what they saw. As they sang, spectrographic readings were recorded and saved in order to show the singers a "before and after" image. Observers were able to see the same real-time spectral feedback on the smart board at the front of the room. The instructor as well as the singers highlighted certain aspects of the display: (a) breath (black space), (b) overtones and harmonics (stacked lines), (c) onset (lines after blank space), and (d) clearly articulated consonants (vertical lines).

Survey instrument

A survey was prepared to address the first three research questions of this investigation. An initial draft of the survey was piloted with three female singers, ages 11 to 13, who did not participate in the voice exploration sessions. Their comments and suggestions were used to craft the survey distributed to participants in this study (see Appendix A). The survey consisted of two sections. Part One surveyed demographic items including favourite and least favourite school subject, participation in musical activities such as school choir, community choir, voice lessons, and musical theatre performance as well as regular computer use and perceived level of computer knowledge. Part Two of the survey asked for a sentence or two responses to three questions: (a) What two activities in this session did you find most helpful to learning about and improving singing? Why? (b) What two activities in this session did you find least helpful to learning about and improving singing? Why? and (c) Overall thoughts about the use of VoceVista in this session. Part Two of the survey also asked participants to rate the overall helpfulness of VoceVista in teaching gentle onset and articulation of consonants on a 5-point Likert scale.

Procedures

Upon entering the room, participants sat down and filled out Section One of the survey prior to the start of the voice exploration session. The sessions began with a brief description of the purpose of the voice exploration session and a brief introduction to VoceVista. After participating in the voice exploration session, participants as a group completed survey Section Two. For 7 and 8 year old participants (n=9, Session One), the instructor read aloud questions sixteen through eighteen from Part Two of the survey and recorded participants' responses.

Ex post facto review

Following the voice exploration sessions, the instructor viewed a video recording of each session. Teaching, singer, and observer behaviour were noted.

Results

All participants returned surveys, yielding a response rate of 100%. Results of this study are presented in order of the research questions posed for this investigation.

Research Question One – Participants' perceptions of most helpful and least helpful activities

Research question one asked what activities in the voice exploration session participants would mention as most helpful and least helpful. Survey questions 16 and 17 addressed this matter. Among activities listed as most helpful (survey question 16), 70% of participants (*n*=38) mentioned the visual display. Other comments regarding the most helpful activities in the session included articulation and diction (*n*=6, 11%), posture (*n*=4, 7%), singing style (*n*=10, 18.5%), and listening to others (*n*=5, 9%).

Only one participant listed a least helpful activity (survey question 17), commenting that, "it (VoceVista) was kind of hard to understand." All other participants (*n*=53) wrote such comments as "none," "nothing," and "it was all helpful" in response to question 17.

Research Question Two – Participant perceptions overall with respect to VoceVista

Research question two inquired about participant perceptions overall with respect to the use of VoceVista. Survey question 18 addressed this matter by asking participants to share their thoughts overall about the use of VoceVista by writing specific comments.

Traditional content analysis procedures were used to organize, tabulate, and analyze those descriptions (Krippendorff, 1980). The researcher and a graduate student colleague first read all responses (*N*=60), then separated them into two exhaustive and mutually exclusive categories: (a) positive and (b) negative (see Appendix B). Thereafter, each of the responses was coded as per the above categories. Inter-rater reliability (agreements divided by agreements + disagreements) was .98.

Positive comments.

A significant number (*N*=58, 96.66%) of comments regarding the use of VoceVista were positive. Eleven comments (18%) referred specifically to a visual benefit of seeing a graphic representation of vocal phenomena. Such phrases as, "I liked seeing what my voice was doing," were common in this sub-category. The majority of positive comments (*n*=47, 78%), however, were more general in nature. Comments such as "it was neat" and "it's really helpful" were used often. Five comments specifically used the term "helpful" regarding VoceVista. Other

respondents used words such as "neat," "fun," "great," "cool," "amazing," and "awesome" to describe their thoughts on VoceVista.

Negative comments.

Two comments (3.33%) were made by one participant, who thought it took time to acclimate to reading the visual display. This participant commented that VoceVista was "fun at least after you could read it" and "it took a moment to learn how to read it."

Research Question Three – Participants rating of VoceVista

Research question three asked how participants would rate the use of VoceVista in learning gentle onset and consonant articulation. Participants scored VoceVista's helpfulness on a 5-point Likert scale. Mean and standard deviation were calculated for all participants (see Table 1).

Rating	1	2	3	4	5	Overall *M*	Overall *SD*
Perceptions of all participants:							
VoceVista teaching onset			3	2	5 26 18	3.99	.98
VoceVista teaching articulation			3	0	13 20 18	3.93	.84

Table 1. Participant (N=54) perceptions of VoceVista's helpfulness in teaching gentle onset of phonation and articulation of consonants.

Research Question Four – Demographic disaggregation

Research question four asked whether participant perceptions would vary according to demographic information provided and grade in school, sex, subject areas liked or disliked, previous voice lesson experience, choral singing experience, and self-described computer skill. Cross-tabulation of results indicated no significant differences among responses according to demographic variables (see Table 2).

Measure	*M*	*SD*
Participants citing science or math as their favourite school subject (*n*=9)		
VoceVista teaching onset	4.1	1.62
VoceVista teaching diction	3.67	1.52
Participants citing writing or art area as their favourite school subject (*n*=36)		
VoceVista teaching onset	3.37	1.07
VoceVista teaching diction	3.26	.872
Participants with previous private voice instruction (*n*=10)		
VoceVista teaching onset	4.3	1.19
VoceVista teaching diction	4	1.18

Participants with previous choral singing experience (*n*=27)		
VoceVista teaching onset	4.2	.68
VoceVista teaching diction	4.13	.81
Participants citing themselves as very competent computer users (*n*=10)		
VoceVista teaching onset	4.3	1.15
VoceVista teaching diction	4.15	1.36
7 to 10 year old participants, entering grades 2 to 5 (*n*=38)		
VoceVista teaching onset	4	1.12
VoceVista teaching diction	3.88	1.14
11 to 13 year old participants, entering grades 6 to 8 (*n*=17)		
VoceVista teaching onset	4.13	1.17
VoceVista teaching diction	3.87	1.22

Table 2. Participant perceptions of VoceVista's helpfulness in teaching gentle onset of phonation and articulation of consonants according to demographic and experiential information.

Research Question Five – Instructor perspective on using VoceVista

Research question five inquired about instructor perceptions of the strengths and weaknesses of using VoceVista. After viewing videotapes of all sessions, several items of interest were noted. All singer names are pseudonyms in order to ensure participant anonymity.

Scooping.

When focusing on the skill of gentle onset of phonation, some students proved to have a difficult time singing the pitch in a gentle, yet accurate fashion. Furthermore, many of these singers "scooped" into certain pitches (see Figure 2). VoceVista proved to be an excellent tool for visual confirmation and explanation of scooping. Many of the singers were able to prevent further scooping while watching the spectrographic display of their singing. One young girl stated during her exploration session that this had not made sense to her before, but now that she could see what her voice was doing, it made sense.

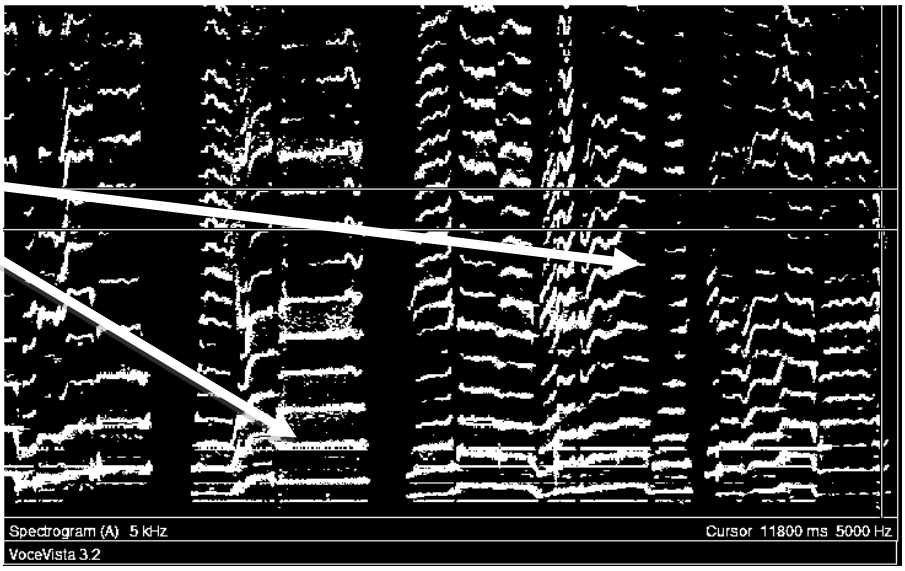

Figure 2. Spectrographic display of Isabel, a 12 year old female singing "Somewhere over the Rainbow" showing scooping (arrows).

Glottal onset.

In addition to its visualization of scooping, VoceVista provided a graphic representation of hard, glottal onsets clearly discernable to participants. For example, a 12 year old female singing "Tomorrow" from *Annie* (see Figure 3) noticed without prompting (see Figure 3) glottal onsets depicted on the visual display, such as on the word "out" in the first phrase, in addition to scooping up to notes when beginning words.

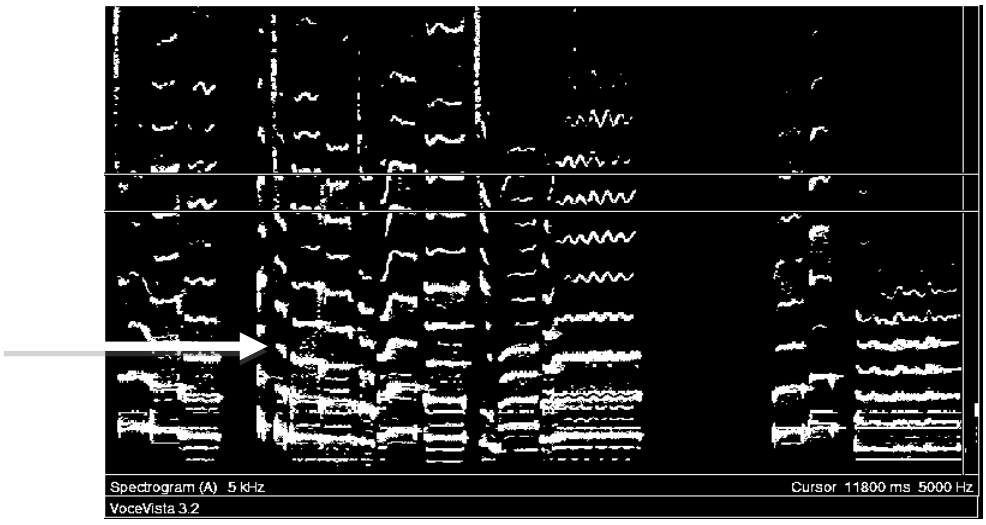

Figure 3. Arrow showing glottal onset of Hannah, a 12 year old female singing "Tomorrow."

Breathiness.

Yet another interesting observation was that students could easily identify breathiness in the tone, because it appeared on the spectrographic display as "fogginess." A 10 year-old boy singing "Edelweiss" from *The Sound of Music* (see Figure 4) noticed this "fogginess," particularly in the upper area of his display. He viewed it as negative, because he had not noticed this phenomenon on any other displays previous to his. However, this observation lead to a conversation about use of breath, stages of male voice change, and potential differences in spectrographic displays for voices undergoing change.

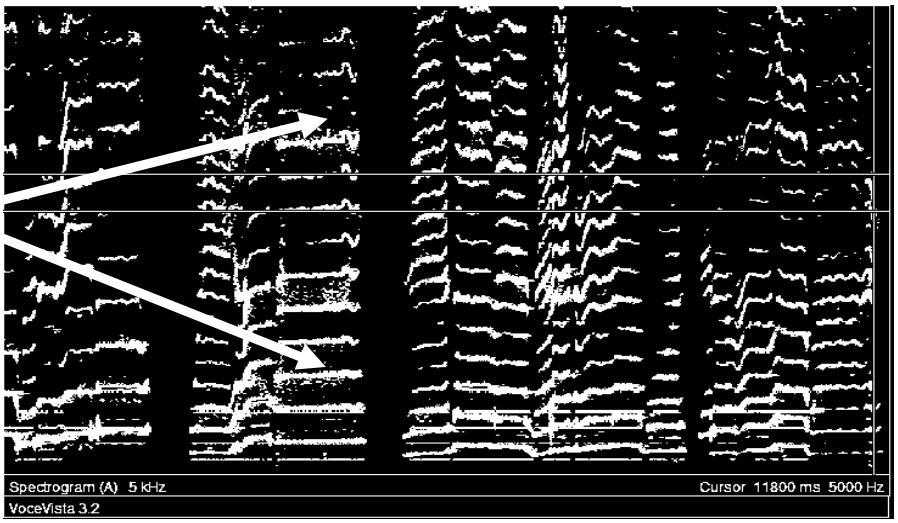

Figure 4. Arrows indicate foggy-looking areas of breathy tone production in the singing of "Edelweiss"
by Luke, a 10 year old boy.

A subsequent singer, an 11 year old girl, noted both the "fogginess" depicted by VoceVista and that her segments of phonation appeared, compared to other singers in her session, much shorter (see Figure 5). She then mentioned she was working with a speech pathologist because of recently diagnosed vocal nodules.

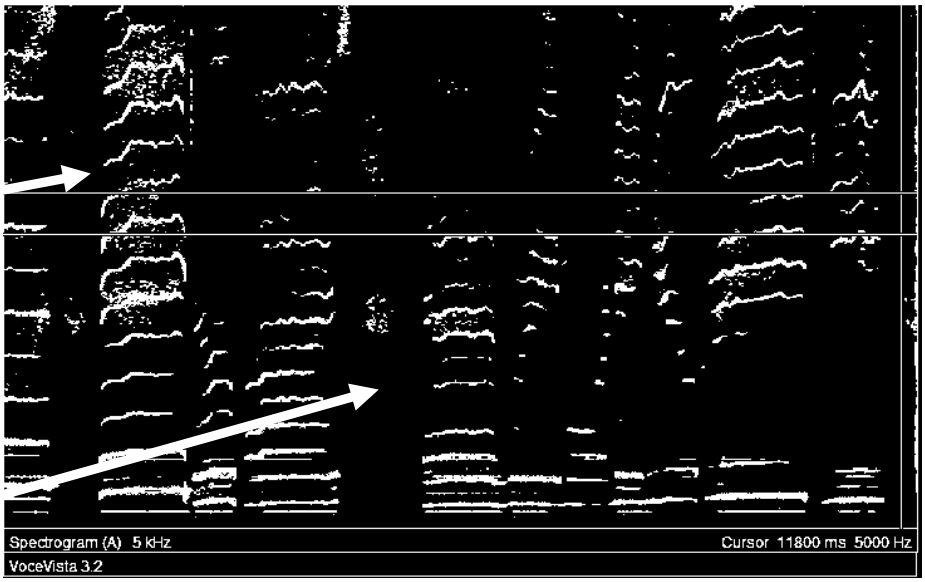

Figure 5. Outer arrows indicate examples of two of the many breaks in the sound. The middle arrow indicates an audible breath in Amelia, an 11 year old female singing "This is Me."

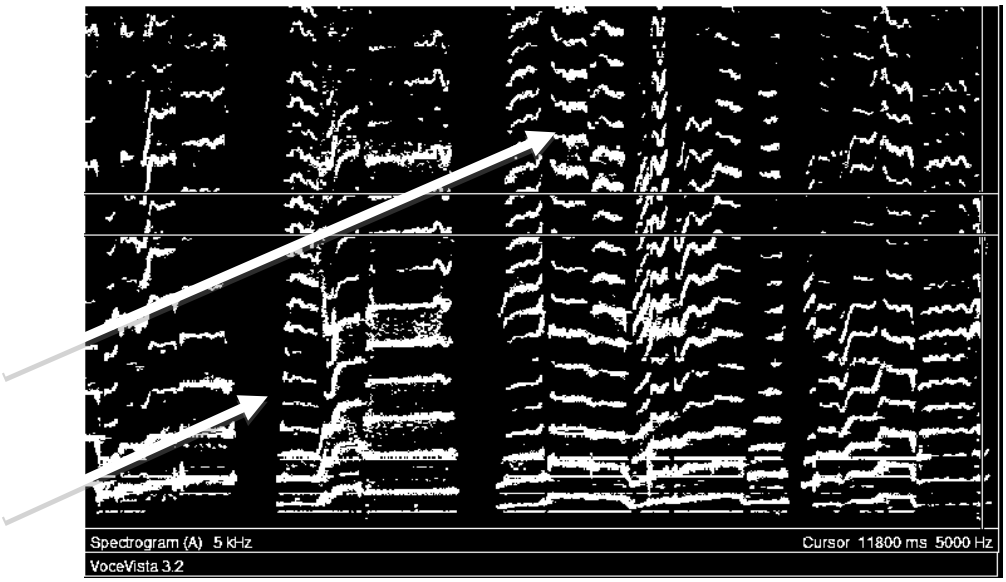

Figure 6: Arrows showing consonant articulation at beginning and end of words of Jacqueline, a 10 year old
female singing "Tomorrow."

Articulation of consonants.

Participants made several observations of the spectrographic readouts of their singers, including visual representation of consonant articulation. A 10 year old girl singing "Tomorrow" from *Annie* noticed that she could see voiced and unvoiced consonants predominantly represented as vertical lines or separation (see Figure 6). This observation led to exploration and discussion of voiced and unvoiced consonant sounds. The participant found

that she could see the consonants clearly in the spectrogram when she and others sang with steady and energized breath flow.

Discussion

Primary findings of this investigation indicate that respondents, many of whom had previous musical experience and computer skills, to a significant degree thought that VoceVista was helpful, and had an overall positive opinion of its employment in a voice exploration session. These findings are limited to the participants and methodology of this study. However, this snapshot of children's perceptions of using a visual display of spectra as part of an educational singing experience offers insights worthy of further investigation and practitioner reflection.

First, VoceVista is an accessible software program for these children, in that they readily appear to understand its benefit for learning about such things as gentle onset, consonant articulation, and breathiness. According to one participant, he would "sing all day!" if he had such a program at home. While previous investigations suggest the usefulness of visual displays of spectra in teaching teenagers and adults, the present study suggests children may benefit as well.

Many of the participants in this study, of course, describe themselves a computer literate. Yet, as some research suggests, that may be increasingly the case among children at large. For the most part, participants did not dwell on the use of technology *per se*, but rather showed curiosity about what looking at such a display could teach them.

Secondly, human beings learn in several different ways. For visual learners, having only aural feedback from a teacher may lead to some ambiguity, if not confusion. A combination of visual and aural feedback, on the other hand, appears to have been particularly appropriate for the children participating in this study. More research of the combination of visual and aural feedback in teaching children to sing, as contrasted with either type of feedback alone, is needed.

Perhaps surprisingly, some research to date (for example, Barnes-Burroughs, *et al*., 2008) indicates responding voice teachers are hesitant overall to use visual displays of spectra in their teaching. Among their concerns are difficulties with technology and replacement of an experienced human ear with computer-based acoustic analyses. Yet, as Nair (1999) states, VRTF is a "bridge technique" that is most helpful with micro events, such as the matters of onset and consonant articulation addressed in the voice exploration sessions serving as the focus of this investigation. In this sense, it would seem that displays like VoceVista could assist teacher's having more time to address the important macro-events of singing technique and artistry. Future research might well investigate the use of teacher time in contexts with and without VRTF.

Finally, some limitations of this study suggest avenues of further research. The 54 children in this study were asked simply for their perceptions. Moreover, because of the one-hour time limit per voice exploration session, completion of surveys could not be individually monitored and the time spent with each singer was circumscribed. Future studies could well assess more empirically whether instruction that incorporates VTRF over a longer period of time with

children yields measurable improvement in such variables as onset and articulation rather than simply the perception of such.

Voice education is a complex task. The children in this study were excited overall about the use of VoceVista. Such technology, of course, is a tool. What purposes it will serve and whether or not teachers will perceive its potential in working with children's voices are matters worthy of continued reflection and research.

Endnote

1. The evolution of VRTF began decades ago. In 1987, at the Groningen Voice Research Lab in the Netherlands, Harm Schutte and Donald Miller collaborated to integrate signals from a microphone and an electroglottograph into computer software that would analyze and display them on a computer screen. This program became known as VoceVista ("visible voice") and made its public debut in 1996 at the national conference of the National Association of Teachers of Singers (NATS) in St. Louis (www.vocevista.com). Meanwhile, Richard Horne, an electrical engineer and programmer who created a freeware spectrogram program named "Gram," joined Miller in a cooperative effort to upgrade VoceVista. VoceVista was introduced at a time when personal computers became powerful enough to perform real-time spectral analysis. Since then it has been further developed and is now in use in voice labs and facilities for training singers, particularly in the US, Germany, and the Netherlands.

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