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Practical Science in the Studio, Part 3: “High-Tech” Strategies

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[Editor’s Note: This article, an initiative of the NATS Voice Science Advisory Committee, concludes a three-part series that seeks to introduce readers to practical and cost-effective strategies for using science to enhance singing instruction. The three articles in this series are divided into “no-tech,” “low-tech,” and “high-tech” segments. (RDS)]

RECENT ADVANCES IN VOICE SCIENCE can help move us closer to evidence-based practices in our teaching, but adopting new tools can be challenging. In the first two articles of this series, we examined teaching tools based in voice science that require little, if any, technology to implement. In this final article, we will introduce high-tech tools that can improve our teaching—and technophobic readers are encouraged to keep reading! Technology can come with a steep or even intimidating learning curve, as many of us have experienced in the current pandemic and the transition to online instruction. Teachers are busier than ever, and our administrative loads (and the concomitant emotional labor) have been high. We rightly ask, “With everything I am juggling, why should I adopt this technology?” or, “How is all this helpful?” The tools in this article center on perceptual training to help students better understand: 1) vibrato using a voice synthesizer; 2) the air pressure needed for singing (spoiler: more is not necessarily better); and 3) the acoustics of the voice by visualizing sound spectrographically. These tools for perceptual training represent only a small portion of the many useful ways that technology can be successfully incorporated into the teaching studio. The authors hope that these three tools—and, indeed, this series of articles as a whole—will convince the reader that science is not only for an exclusive cohort of specialist-trained teachers. Science is for all of us.

As mentioned previously, the tools presented here deal with perceptual training, but what exactly does this mean? Singing produces a torrent of simultaneous sensory stimuli. Sound is conducted, often at very high intensity levels, through our bones and through the air to our ears;¹ vibrations in the chest, head, and throat give us proprioceptive feedback,² and other physical systems, such as heart rate and blood pressure,³ can be affected. These complex stimuli are processed in the brain as we evaluate our singing: “Is my jaw relaxed? Does my throat feel tense? Am I singing in tune?” The neural networks responsible for making these judgments are directly linked to the

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motor centers that control singing,⁴ that is to say, our perceptions of voice are tightly coupled with the vocal sounds we produce.⁵ Voice begins and ends in the brain, and therefore a substantial portion of training students to sing involves training their perceptions of singing.⁶

PERCEPTUAL TRAINING FOR LISTENING TO VIBRATO

Vibrato appears in many genres of singing as either a continuous element or as an expressive device used at specific points in the text or the melodic line. A number of different types of vibrato exist, but by far the most obvious ones are frequency and amplitude vibrato.⁷ A very important skill for voice teachers to possess is the ability to clearly detect changes in individual aspects of vibrato within the totality of a singer's sound, as vibrato can be a bellwether of subtle (and not so subtle) aspects of voice production.⁸ Fortunately, through the use of voice synthesizer programs, one can control and vary some of these aspects quite independently from each other, and thus learn how to listen in a very discriminating fashion. What follows is a discussion of how to use the free voice synthesizer Madde (available for download at <http://www.tolvan.com/index.php?page=/madde/madde.php>) in doing this type of auditory training.

Madde was developed by Swedish researcher Svante Granqvist during his time on the faculty at Kungliga Tekniska Högskolan (KTH), Royal Institute for Technology in Stockholm. It has become a favorite of singing teachers and researchers for its easy to use interface and its free price tag.⁹ (Ian Howell recently made a manual for the program available, which can be downloaded at https://www.dropbox.com/s/1f9eicw0te0tp3i/MADDE-The-Missing-Manual-Rev-1_0.docx?dl=0 or <https://tinyurl.com/IanMaddeManual>.) More pertinent to our current discussion, coauthor Nix has made a YouTube video on using VoceVista and Madde to create an effective model of one's voice in Madde: <https://www.youtube.com/watch?v=a2sOBsV5O4w> (caveat: newer versions of VoceVista Video Pro have a synthesizer built into the software). The video shows how to measure the location and bandwidth of one's vocal tract resonances and the rate and extent of one's vibrato, as well as how to input this information into Madde. An example of mea-

sured values from a singer input into the user interface is shown in Figure 1.

To use the program for training greater discriminatory listening in young teachers, once values for vocal tract resonances and bandwidths are input, the following options are possible.

1. While not showing your computer screen to your student(s), maintain a constant vibrato extent (shown in Figure 1 on Madde as Amplitude [ST]) and adjust the Vibrato rate (shown in Figure 1 on Madde as Freq [Hz]) upward and downward. The value in the box can be adjusted by clicking and typing in the value you desire. You can adjust the rate with the synthesizer constantly playing or pause it while adjusting. For best perceptual training effect, pausing between playing samples with different rates appears best, in order for listeners to compare a pair of tones that are matched in all other aspects. Initially make the changes large, for instance from 5.0 Hz to 5.5 Hz. Ask the class or student what the change was between the two tones. In subsequent presentations, vary the rate of one of the tones in either direction, increasing or decreasing, asking the student(s) to identify whether the rate remained unchanged, increased, or decreased from the first to the second. As students gain more experience, make the changes smaller and smaller. You can vary the rate by increments as small as 0.00001 Hz, but such changes are far beyond the noticeable difference threshold. The range of values possible is from 0 to 9.99999 Hz.
2. While maintaining a constant vibrato rate, now adjust the vibrato extent. The extent control on Madde is in semitones, so the value of 0.5 shown in Figure 1 means the frequency variation during the vibrato cycle will change 0.5 semitones, or 50 cents, above and below the central pitch of A₃, 220 Hz. As was done with vibrato rate, adjust the extent incrementally to help the students accurately notice the direction of change between presented tones (did the extent get wider or narrower?) and the magnitude of change (how big a change was made?). Begin with large changes and gradually use smaller and smaller differences between tones.
3. Once rate and extent are trained separately, next begin to introduce changing either rate or extent. Students can be asked which vibrato characteristic changed,

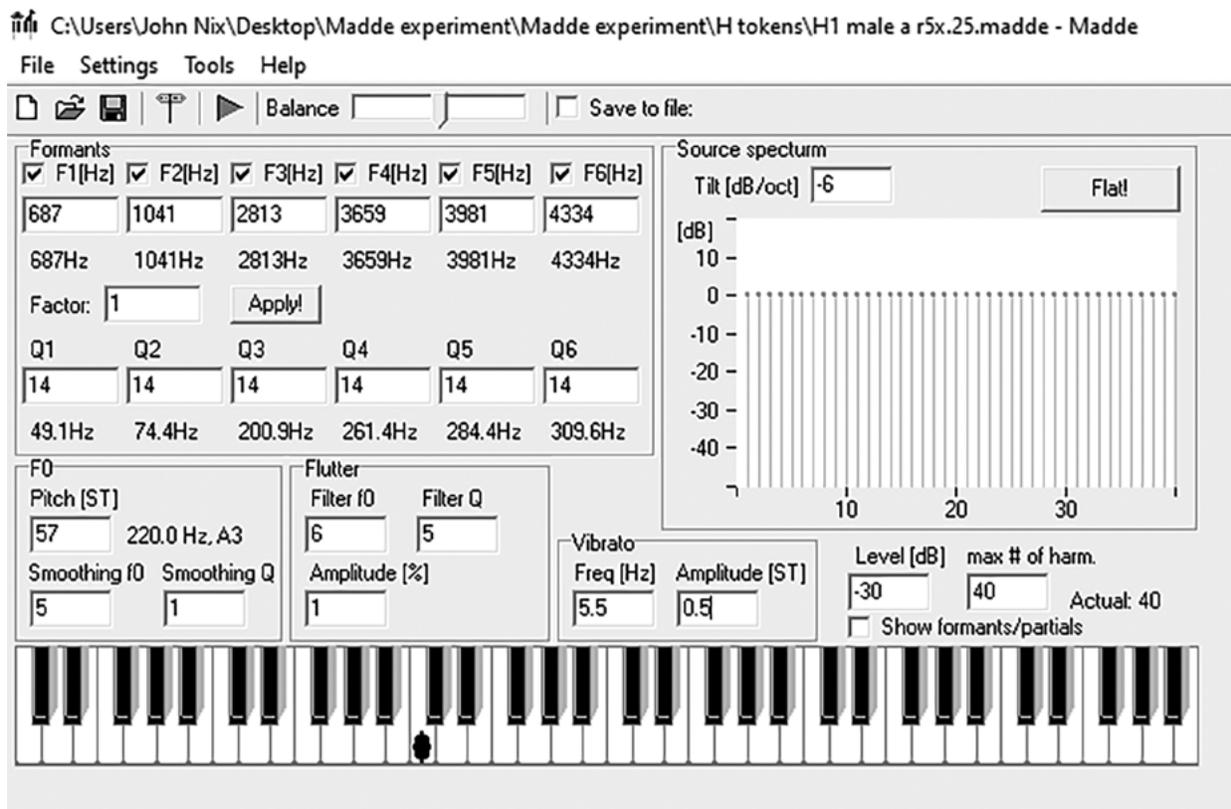


Figure 1. The Madde user interface, with resonance frequency peak values, resonance bandwidths, vibrato rate, and vibrato extent based upon measurements of the author's /a/ vowel.

which direction it changed (faster/slower or wider/narrower), and the magnitude of the change.

4. Finally, play pairs of notes where there is no change between the pairs in either characteristic, a change in one, or a change in both simultaneously.

Next, try testing two vowels. In Figure 2, the author's values for the /i/ vowel have been input. By opening the Madde program twice, you can have two separate synthesizers on your desktop. Input values for one vowel (such as /a/) in one interface and values for the other vowel (such as /i/) in the other. Now play one vowel, pause its playback, and play the other vowel, testing whether your students judge the same rate and extent on both vowels as being equal. As before, slowly work back and forth, varying one parameter at a time and making the changes gradually smaller and smaller between the two vowels until students reliably identify small changes accurately. Last, try adjusting vowel, rate, and extent simultaneously.

One final training activity involves playing tones where the amplitude fluctuates markedly as well as the frequency. Figure 3 shows the Madde interface shown in Figure 1, but with a number of the harmonics of the "sung" pitch and the resonance frequency bands displayed on the keyboard at the bottom of the user interface.

To introduce the concept of amplitude vibrato, adjust the "sung" pitch by clicking on the keyboard at successively higher pitches. Notice that the sound becomes markedly louder when harmonics, especially lower numbered harmonics, approach and coincide with the first or second vowel resonance. Try aligning the second harmonic slightly below, exactly on, and slightly above the shaded area for the first resonance. Now try aligning the fundamental (first harmonic) slightly below, exactly on, and slightly above the first resonance. What you are doing is creating different interactions between the frequency vibrato rate and the amplitude vibrato rate. When the first or second harmonic is slightly below the

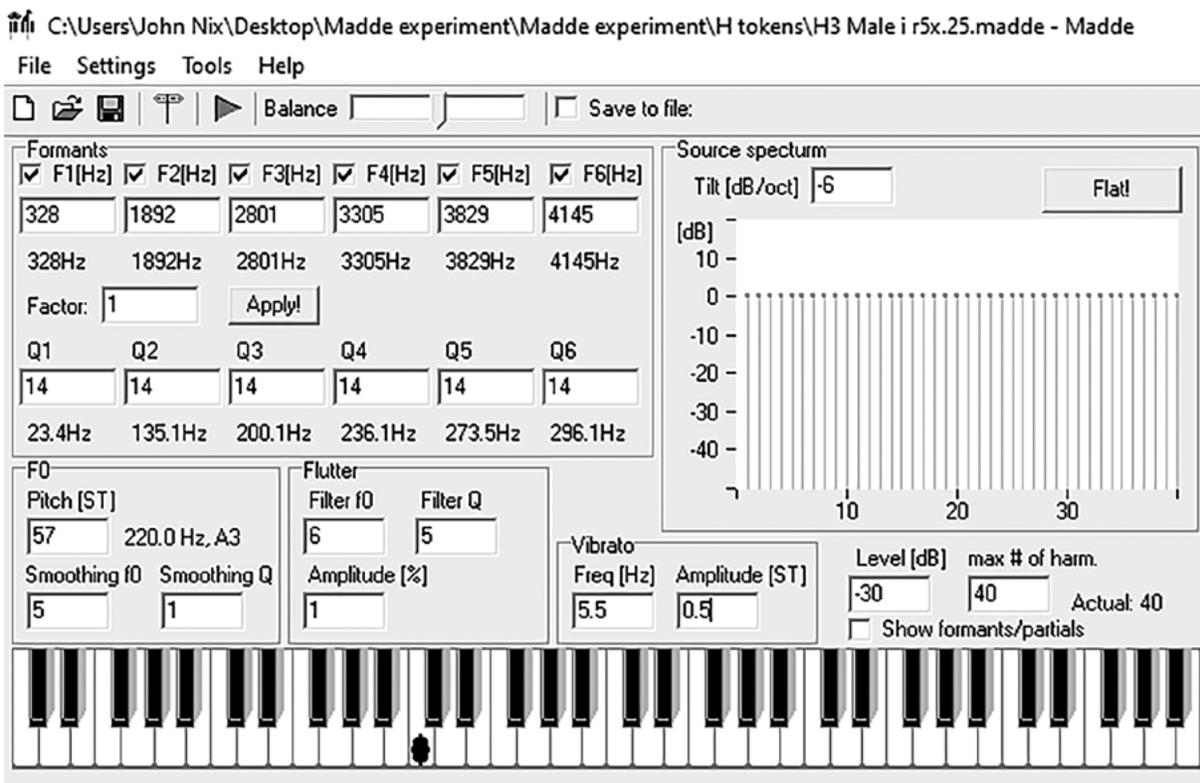


Figure 2. The Madde user interface, with resonance frequency peak values, resonance bandwidths, vibrato rate, and vibrato extent based upon measurements of the author's /i/ vowel.

first resonance, the amplitude will increase and decrease with the frequency swing as the harmonic swings toward and away from the boost given by the vowel resonance, so we would say the amplitude and frequency vibrato are completely in phase with each other. This pattern rarely draws our attention. If the first or second harmonic are exactly aligned with the center of the vowel resonance, however, the amplitude vibrato rate will be twice the frequency vibrato rate (the frequency swings through the center value twice each cycle). This pattern may be perceived by students as having a “flutter” or “beat” as the amplitude changes occur at a faster rate than the frequency swings. The effect is stronger as the extent of the vibrato grows larger. The last option, where the harmonic is slightly above the vowel resonance, creates a situation where the frequency vibrato and amplitude vibrato are completely out of phase with each other (when frequency is lowest, amplitude is highest, and vice versa).

If confused, watch this video, which features the author demonstrating many of these variations in set-

tings with Madde: https://youtu.be/rw4G9x_tM_0 or <https://tinyurl.com/NixMaddeDemo>. By following the procedures provided above, you will be able to fine tune your listening skills and those of your students. You will learn to hear very subtle changes in one key aspect of many singing styles, vibrato.

PERCEPTUAL TRAINING FOR FEELING LUNG PRESSURE

“Chi sa respirare, sa cantare” a phrase central to Italian bel canto voice treatises, states, “One who breathes well, sings well.”¹⁰ There is certainly truth to this time honored statement in some fundamental way, but many interpret it to mean more is better. How many of us have heard master class clinicians encourage the student to use more “support,” regardless of the problem being presented? Overbreathing may be as problematic as underbreathing, as both may lead to laryngeal tension.

Upon deep inhalation, lungs are stretched from their resting position. This activates sensory receptors

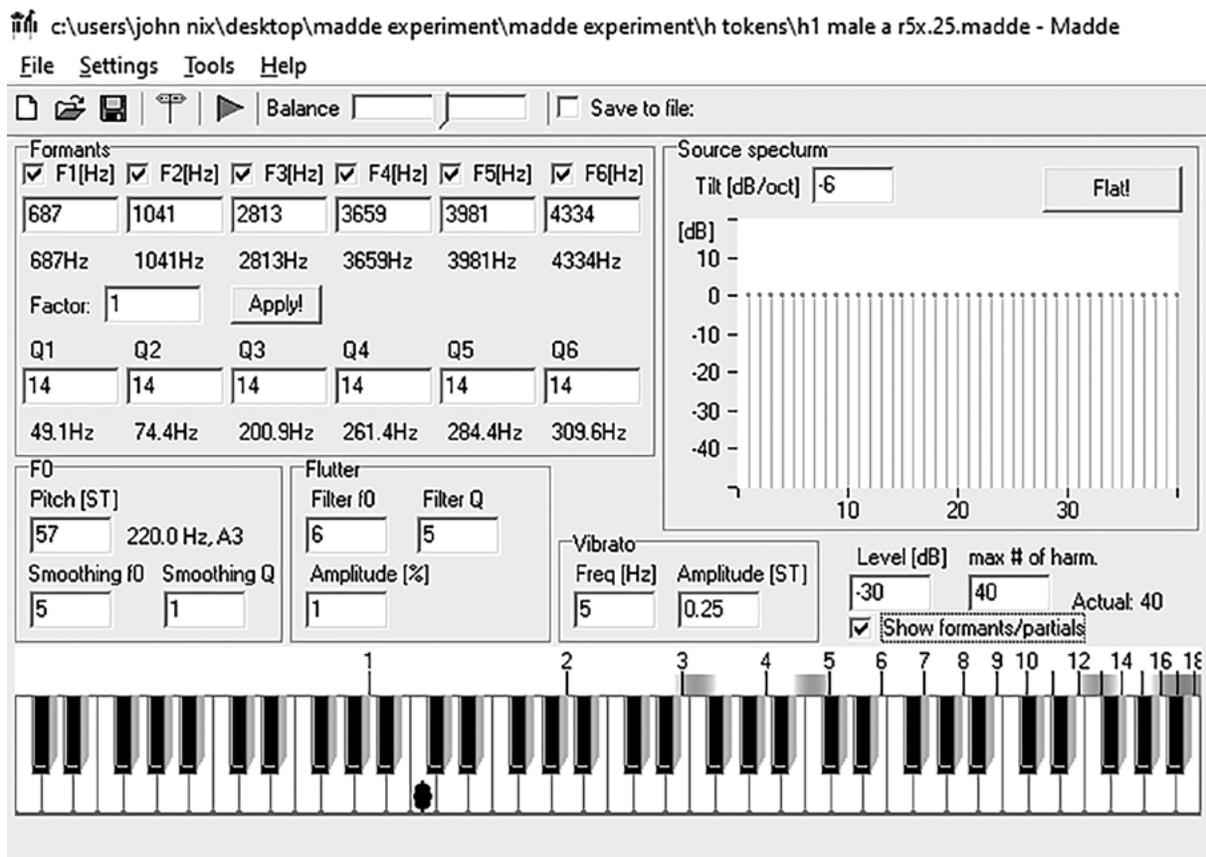


Figure 3. The Madde user interface, with resonance frequency peak values, resonance bandwidths, vibrato rate, and vibrato extent based upon measurements of the author's /a/ vowel. Note the checked box on the lower right, "Show formants/partial." Note also the numbered lines above the piano keyboard, indicating the location of each harmonic, and the bands, indicating the location and width of each synthesized resonance.

that may interfere with singing by triggering an urge to cough or an urge to immediately exhale due to the Hering-Breuer reflex.¹¹ The elasticity of lung tissues also makes them want to spring back to their pre-inhalation position, a phenomenon known as "recoil." The deeper the inhalation, the more the lung tissues resist being stretched.¹² The lung air pressure that powers singing depends on two things: 1) the relaxation air pressure produced by this recoil (which is greater for higher lung volumes), and 2) the antagonistic action of the inspiratory and expiratory muscles. Singers use this combination of forces (recoil and muscle contraction) to create the "breath pressure" (that is, the lung pressure) to power phonation.¹³ High lung volumes are often accompanied by hyperadduction of the vocal folds (i.e., glottal valving), because glottal adduction and lung volume reduction work together to control lung pres-

sure.¹⁴ For this reason, teachers should be mindful that prescribing *more* support when the student is experiencing vocal tension may potentially make matters worse by creating more unwanted muscle tension. The deeper the inhalation, the larger the recoil pressure that the singer needs to manage, which is to say, *more* breath is not necessarily *better*.¹⁵

We can train singers' perceptions of exhalatory air pressures with a device known as a manometer. A manometer is an instrument for measuring gas pressures, and it can be as simple as a U-tube manometer (see Titze and Verdolini-Abbott, *Vocology*, 169–171, for a description and a photograph of a U-tube manometer),¹⁶ but the authors recommend investing in a handheld electronic model. A keyword search in an online retailer shows dozens of appropriate models between \$35 and \$45, though if laboratory precision is required, the price

can be significantly higher. Because they have no moving parts, electronic manometers should provide years of service for a small initial investment.

Your manometer will likely measure pressure with several units, the most common of which are centimeters of water (cm H₂O), kilopascals (kPa), or pounds per square inch (PSI). These various measurement units are analogous to the English and Metric system units of inches and centimeters—both measure the same thing using different (and convertible) units of measure. For the sake of simplicity, set your manometer to cm H₂O.

Once appropriate tubing is attached to the manometer's input sensor and the correct unit of measurement is selected, seal your lips around the tube and breathe into it. You need to close off your velum (i.e., lift the soft palate) or plug your nose so that all your breath goes into the tube. Unlike breathing through a drinking straw where the air flows freely, exhaling into the manometer will feel like breathing into a closed or sealed tube. The display will measure air pressure the lungs are producing at that moment, and different levels of exhalatory effort will change the measured pressure. What is the maximum pressure you can produce? Most people can reach over 90 cm H₂O, and students can be particularly competitive with this task. Typical pressures needed for healthy singing range from 7–33cm H₂O, but our respiratory systems can clearly produce much more than is needed.¹⁷

Breathing into a closed tube is not the best analog for what we do in singing, however. To train perception of subglottal pressure, we can borrow a task from voice research: phonating a sequence of consonant-vowel syllables “pa-pa-pa” with a small tube in the mouth, where the tube is connected to the manometer.¹⁸ This task is used in the scientific literature at very soft dynamics (just above a whisper) to estimate phonation threshold pressure (PTP), the minimal amount of subglottal pressure needed to initiate and maintain vocal fold vibration.¹⁹ PTP is often used to indicate the general health of the vocal mechanism.²⁰ An inexpensive manometer may not have the resolution needed for a scientific study, but it is an ideal tool for perceptual training.

The task: Place the manometer tube between your lips close to the labial commissure—the corner of the mouth where your lips meet. Next, slowly sing or speak “bap-bap-bap,” and try to spend equal time and equal effort (constant lung pressure) on the consonant and

vowel sounds.²¹ Ideally, each [b] or [a] should last ⅓ to ½ of a second. Your lips must make a complete seal around the manometer tubing on each [b] sound, and take care to avoid blocking the tube with the tip of your tongue. The manometer should read close to zero cm H₂O during the vowel, but on the bilabial [b] or [p], your lips form a seal around the tube and your oral pressure (measured with the manometer) will be roughly the same as the pressure below the glottis (i.e., subglottal pressure). In addition to the repeated [b:a:p:] task, you can also measure intraoral pressure during a semi-occluded vocal tract (SOVT) straw exercise.²² For training the perception of breath pressure, try both loud and soft utterances at higher or lower pitches in the vocal range. How do your measured pressures change with your dynamic level? What about higher or lower pitches in your vocal range? For a video demonstration of using a manometer, see: https://youtu.be/wPD2PmZ_h0k or <https://tinyurl.com/ManometerDemo>.

A manometer can help build our awareness of breath pressures during singing. We typically use higher subglottal pressures for both louder sounds and higher pitches, but our bodies can produce much more air pressure than is necessary. Singing requires the sophisticated coordination of laryngeal adduction and vocal tract shaping to produce the desired sound quality, using the least necessary lung pressure and general muscular effort. And it goes without saying, more is not necessarily better.

PERCEPTUAL TRAINING THROUGH VISUALIZING SOUND

Several spectral analysis software programs are available for PC, Mac, and all manner of smartphones. To further explain, spectral analysis software typically features two important displays: the spectrogram and the spectrum. The spectrogram is a visual representation of all the component frequencies that make up a complex (and in our case as singers, musical) sound. Each harmonic's frequency and relative strength are shown. Additionally, these two aspects of sound are displayed over a given length of time, depending on the settings of the spectral analysis software. The second display provided by this type of software is called a spectrum. This element is an offshoot of the spectrogram, display-

ing detailed information about harmonic frequency and strength at a chosen moment in time, measured in milliseconds. This section will discuss the program VoceVista Video Pro (VVVPro) due to its widespread use in the singing community, its user friendly basic tools, and its versatile advanced research capabilities. A video has been made to accompany the text of this section. Visit <https://youtu.be/NChJalNL0Vs> or <https://tinyurl.com/VoceVistaVideoDemo> to follow along with what is described in the text.

Getting Started

To download the software, visit the SYGYT website (www.sygyt.com) and choose the VoceVista Video Pro 30-day free trial. Once the software is loaded, click on Help on the top menu bar. From that menu, clicking on Help Topics takes the user to a manual of the software, while clicking on Quickstart Tutorial opens a YouTube video demonstrating basic aspects of the user interface. Looking at the main user screen, on the far left you will see a small window with a piano staff and choral voice part ranges indicated in opaque gray color. Immediately to the right of that window is a working piano keyboard. Moving the cursor over the keys and left clicking will produce pitches that correspond to pitches on the piano staff to the left. When students understand the sequence of harmonics that occur with each pitch, they can begin to use this tool to help visualize where those harmonics occur on a music staff and to see how harmonics might align more closely with vowel resonances. Notice the Vowel Chart window open on the far right of the screen. Initially, this can be a fun way to have students hear vowel sounds and refer to the IPA symbols that correspond to them. Underneath Vowel Chart is a drop-down menu where one can choose to see and hear the vowel sounds that occur in English, German, French, Italian, Swedish, etc. This tool may be quite helpful for beginning and advanced students to explore the complexities of international languages, some with mixed vowels not found in English. The tool also may be helpful in addressing vowel pronunciation in one's native language, which can often be an even more difficult task. To try this out, left click on an IPA symbol and a computer synthesized voice will render the phoneme that corresponds to that symbol. From this point, focus attention on the two large windows in the middle of the

main screen. The one on the left is the spectrogram, and the one on the right is the spectrum. As was mentioned above, the spectrogram is a long-term view that provides visual representation of a sung or spoken tone over a given length of time. At the bottom of this window, time is indicated in seconds or minutes or hours, depending on the settings you choose in the software. Immediately to the right of the spectrogram window is the spectrum window, showing the relative intensity of each harmonic component of a complex sound in a single slice of time measured in milliseconds (ms).

Recording and Adjusting Settings

In preparation for recording, find the Settings Profiles window in the upper right-hand corner of the software. Left click on that tab. A drop-down menu will open with several options from which to choose. Find the Full Toolbar option and select it. A row of settings symbols will appear across the top of the screen underneath the original menus. Quick access to some of these settings will be important shortly. Now you are ready to record your first sound sample. In the upper left-hand corner, find the red record button and left click it. You are now recording. The long-term view or spectrogram should be quite active. Sing an [a] vowel on any pitch for about 3 seconds. Hit the spacebar when you are done; this will stop the recording. You have just recorded your first voice sample that you can begin to explore and analyze. Initially, the long-term spectrogram view and the short-term spectrum view may have very bright blue backgrounds. This is caused by the resolution of the software being set too high. To adjust this, find the slider next to the "sun" symbol on the toolbar at the top of the screen and move it to the left. Next, find the "moon" symbol immediately to the right of the small sun and adjust that slider to the left, as well. This will lower the brightness and the contrast of the background behind the signals and their intensity in both the spectrogram and the spectrum, making it easier to read the data from these two windows. Take your cursor and left click anywhere on the voice sample that you have just created. Immediately, the short-term window or spectrum will give you a detailed spectral representation of the sound being made at that given moment in time. A long green line or cursor in the long-term view indicates which moment in time is being analyzed by the spectrum.

Playback and Interpretation of Displays

Now that the sample has been created, one can isolate and immediately play back all or a portion of the sound that was just recorded. To do so, left click in the long-term view window at the place in the recording where you would like playback to begin, then press the spacebar. This quick auditory feedback capability is a wonderful tool for students who want to hear and understand immediately how they sound outside of their own head. Another important basic feature for tenor, baritone, and bass voices is the ability to see and monitor the relative strength of harmonics in the Singer's Formant cluster region. This can be done in real time as the singer is recording their sound sample. Click on the record button again. On the left of the long-term view is a list of frequencies running in ascending fashion from bottom to top. Ask the student to attend to harmonics lying between 2800 and 3500 Hz. If this frequency range in the spectrogram is showing bright orange and red colors (illustrating greater amplitude for those harmonics), we can infer that the singer has learned how to cluster vocal tract resonances three, four, and possibly five close together, and that he has learned how to generate high frequency energy at the glottal source. If a singer is producing a more breathy tone, this area of the spectrogram will tend to show little intensity.

Using VoceVista to Guide Vowel Production

VoceVista Video Pro can be very helpful in guiding a student's production of specific vowels through resonance tuning. Using the vowel chart window on the right side of the screen, select the desired language and vowels on which you wish your student to focus. Left click on that vowel. Two horizontal white bars will appear in the spectrogram. Those two bars indicate average frequency locations of the first two resonances of that vowel, f_{R1} and f_{R2} , which are crucial to the identity of the vowel.²³ (Caveat: keep in mind the values are averages only gathered from a specific study or series of studies, and that some individual variation is normal. High treble voices and low bass voices may be somewhat different from these averages.) Next, have the student sing the vowel chosen in the chart at a comfortable pitch, and without pausing, drop into vocal fry while maintaining the same vocal tract shape as the sung vowel. If the student

is producing the vowel accurately, the first two peaks shown in the vocal fry should align near the horizontal bars in the spectrogram window. If the peaks do not align, then the student can see that adjustments need to be made to achieve the accurate vowel production in singing. A brief bit of experimentation with the software running will demonstrate that larynx lowering and/or lip rounding lowers the frequency of both of the resonance peaks, while larynx raising and/or lip spreading raises both; fronting and raising the tongue will lower the first resonance and raise the second, while backing and lowering the tongue will have an opposite effect. Opening the mouth more will tend to raise the first resonance and lower the second, and closing the mouth more will have the opposite effect. All of these adjustments can be used to fine tune the formation of the vowel to better match the indicated targets.²⁴

Exploration of Register Transition Areas

Another use of spectrographic software such as VoceVista is for exploring the timbral shifts that occur during register transitions. To begin, have VVPro open and the record function active. Have your student sustain an [a] vowel on a pitch approximately a major third below where a register bridge occurs. Take note of which harmonics below 2000 Hz are dominant (they will be higher in the spectrum display, and more orange or red), as both of the two vowel defining resonances occur below 2000 Hz for back vowels like [a]. The consensus labeling method for harmonics is as multiples of f_0 , with the second harmonic labeled $2f_0$, the third harmonic labeled $3f_0$, etc.²⁵ Now, take note of which harmonics are the strongest as the student sings the [a] vowel at different pitches. Table 1 is a general guide for which harmonics will likely be dominant in women's and men's voices for various registers on that vowel.

The table applies only to the [a] vowel. Each vowel will have its own pattern of dominant harmonics, based upon the pitch being sung and the location of the vowel's resonance frequencies. Knowing what to expect in the display as these transitions occur can be very helpful to both student and teacher. For further information, readers are referred to books by Scott McCoy, Donald Miller, Garyth Nair, and Ken Bozeman.²⁶

As an example of how the use of this analysis software can be helpful, consider a student who is struggling to

TABLE 1. Typical dominant harmonics.

Women: [a] vowel	
M1 (Chest) Register:	$3f_o$ and $5f_o$ or $6f_o$
M1 (Belt)	$2f_o$
M2 (Middle) Register:	$2f_o$ and $4f_o$
M2 (Head) Register:	f_o
Men: [a] vowel	
M1 (Chest):	$3f_o$ or $4f_o$ and $5f_o$ or $6f_o$ at lower pitches, $2f_o$ and $4f_o$ higher
M1 (Belt):	$2f_o$
M1 (Full extension):	$3f_o$ or $6f_o$

address a rising larynx as he/she ascends in pitch. The rise in laryngeal position will raise the pitch at which these transitions occur. One strategy that may be helpful is to have the student face away from the screen, but leave the software running. Have the student sing a vocalise that crosses over the transition in question. Guide him/her/them on how to successfully navigate the register transition. Once that has occurred, turn back to the software, and stop the recording. Now scroll back in time to show the sample vocalise the student has just sung. Left click on the beginning lower pitch of the exercise in the spectrogram. Immediately, the harmonics and their relative strengths will appear in the spectrum (short-term view) to the right. You should be able to clearly see which harmonics are dominant and which are not. Compare those relative strengths with the table above. Now left click on the top pitch of the vocalise, above the register transition, in the spectrogram (long-term view) window. You should be able to see an immediate difference in the spectrum window of which harmonics are now dominant. This objective signal feedback can be very helpful to students as they overcome the technical difficulties associated with register navigation. This technology coupled with our instruction can offer a significant one-two punch in the practice room as the student works toward consistent register navigation and stable laryngeal position.

Final Thoughts on Spectral Analysis Software

VoceVistaVideoPro and other spectral analysis technologies can help students embrace an accurate representation of their sound that is void of personal bias. As teachers we have an obligation to avail ourselves of as

many tools as possible in order to assist in that process. Not every student will gravitate toward using this type of software while practicing, but some will, and those who are drawn to it are the ones who will benefit the most from its use. Once introduced to this technology, students can take the lead on how much or how little they would like to use it in and/or out of the studio.

NO-TECH, LOW-TECH, HIGH-TECH: MEETING THE NEEDS OF YOUR STUDENTS

We end this series of articles where we began, encouraging readers to explore the many scientifically grounded options now available to increase teaching effectiveness and enhance student learning. If the current pandemic has taught us anything, it has demonstrated that great teaching and artistic performance are not compromised by the presence of a computer in the room or on the piano; indeed, without digital means, most of us would have been unable to teach and collaborate at all. The plethora of streamed recitals, virtual choirs, and distance master classes that have sprung up since March 2020 stand as a beautiful reminder of the resilience and adaptability of artists who have continued to share their talents in exciting new formats. So, whether your preference is no-tech, low-tech, or high-tech, the authors hope you will come to regard the pandemic's necessitated introduction of technology into almost all aspects of musical life as a unique opportunity for growth and exploration.

NOTES

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And so thy thoughts, when thou art gone,
Love itself shall slumber on.

Percy Bysshe Shelley