The science of singing

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Singing, like other forms of speech, is fundamental to human communication. In my experience, most linguistics classes ignore or even avoid talking about singing and other vocal music. But I think there’s a place for vocal music in phonetics and laboratory phonology classroom, so I tried it out a couple years ago at USC by designing and teaching an articulatory phonetics course called “The Science of Singing”. The feedback I received from the students I taught and my colleagues who observed me indicated that this course was pretty successful, so I’d like to share it with you.

In this video, I’ll give you an overview of my class, “The Science of Singing”, including some highlights from the course. Then I’ll offer my thoughts on why vocal music is a good fit for laboratory phonology classes, and offer some suggestions for how you can put vocal music in your courses to get some of the same benefits without having to create a whole course dedicated to vocal music.

“The Science of Singing” has, at its core, many of the same properties you can expect from many practical phonetics courses. It’s a speech production course, with a focus on articulation and the tools linguists use to study those articulations. Students practice collecting data from a consultant, making measurements, and performing some simple analyses. And there’s a focus on several different aspects of speech production, including breathing, laryngeal and epilaryngeal anatomy as well as the harmonics produced by the vocal folds, the resonant properties of the vocal tract tube, and a variety of articulations that can be used to make constrictions in the vocal tract.

“The Science of Singing” takes this formula and puts a musical spin on it.

When picking what kinds of speech production to study and analyze, we adopt the anthropophonic perspective. The anthropophonic perspective is an inclusive approach to speech science that emphasizes the value of studying the total sound-producing capabilities of a person, especially behaviors like marginal speech (like many forms of singing, which communicate linguistic messages but are rarely studied) and non-speech (like beatboxing, which does not communicate a linguistic message but which nonetheless can be informative as a contrast to speech).
When it comes to gathering and analyzing data for homework and projects, students are encouraged to lean into the anthropophonic perspective and see what they can learn from vocal artists. For example, my favorite project is to have them compare the size of the vowel spaces of sung and spoken speech by measuring formants in Praat and plotting the results as a vowel chart.

Finally, the best way to understand a behavior is by studying experts, so we study vocal artists who specialize in pushing some aspect of vocal sound production to its limits. Opera singers spend decades working on their breathing (and resonance too). Heavy or Death Metal singers make a career out of complex laryngeal and epilaryngeal control. Overtone singers masterfully exploit the source-filter properties of the vocal tract to make harmonics resonate loudly enough to be audible as separate tones from the fundamental. A seasoned beatboxer can produce practically any obstruent you can think of, then surprise you by making a dozen sounds you never thought possible.

At the end of each unit, I brought in a guest singer of one of those vocal styles to perform and be analyzed in our class. I want to give you a sense of what happened on these guest singer days by sharing some of the data we collected and the kinds of conversations that emerged. So, in the next few moments, you’re going to hear the first lines of the United States national anthem performed by our opera singer, heavy metal singer, overtone singer, and beatboxer. (But note that the pictures accompanying each recording are just for flavor, and are not pictures of the performers you’re hearing.)

Our breathing unit was our Opera unit, so I asked an undergraduate vocal performance major from USC to come sing for us.

singing
O say can you see
By the dawn’s early light
What so proudly we hailed
At the twilight’s last gleaming

In class, we learned about the anatomy and physics that leads to breathing, but we also discussed the different breathing patterns commonly observed in singing: clavicular breathing, chest breathing, abdominal or belly breathing, and appoggio which is a mix of chest and abdominal breathing. After talking to our guest opera singer, my students politely insisted that our guest demonstrate the different breathing patterns and talk about her experience with breathing. My students vigilantly watched for each guest’s breathing patterns after that.
Breath travels through the larynx, and so did our course, leading us naturally to learn about heavy metal screaming. You'll notice that in this recording of our consultant singing the national anthem, the amplitude of this recording changes a few seconds in; that's because the student working the microphone didn't realize how loud the singing was going to be and adjusted the gain on the fly. It should be fine for your speakers, but I just thought you should know.

*singing*
O say can you see
By the dawn's early light
What so proudly we hailed
At the twilight's last gleaming

We learned all about the complex culture of heavy and death metal music, including the phonation categories defined by the metal community and the “invisible oranges” metal singers sometimes hold in their hands while they sing. Our performer described his voice as low, somewhat voiced (or somewhat voiced) variety, not unlike the character Cookie Monster. The students observed that our singer adopted an accent when singing: his mild Chicago accent transformed into a much more rhotic “pirate-y” style. This gave us a chance to talk about co-phonologies and to preview future lessons on articulatory targets. They also noticed prominent clavicular breathing, a breathing pattern that our operatic guest avoided.

Overtone singing is a catch-all term for singing styles in which a harmonic above the fundamental is amplified, through vocal tract resonance, to be audible as a separate tone. This behavior comes at a cost: as far as I know, it’s impossible to amplify individual overtones and produce intelligible words at the same time. Still, our guest overtone singer didn’t mind providing some national anthem data all the same.

*overtone singing the tune of the United States national anthem*

For me, the highlight of this guest’s visit was when he took 20 minutes to teach my students how to overtone sing themselves—though without the fine tonal control that only comes with lots of practice. They learned to change which harmonic was amplified by moving through different vowel postures, which helped them understand the relationship between formant frequencies and vowel constrictions. More generally, overtone singing helped clarify the difference between harmonics, vocal tract resonances, and formants—a set of concepts that I find students often mix up for a while.
You’d be hard-pressed to find someone who knows more about consonant constrictions than a beatboxer, and our beatboxing guest was no exception. She taught us all about the different kinds of beatboxing sounds, then laid down the national anthem for us by beatrhythming—which is when a single person beatboxes and sings simultaneously.

*beatrhythming*
O say can you see
By the dawn’s early light
What so proudly we hailed
At the twilight’s last gleaming

When they’re not performing the national anthem, beatboxers are notorious for producing impossibly long percussive sequences without ever pausing to breathe. My students picked up on this immediately, which opened a discussion about how beatboxers use different airstreams mechanisms to make sound and inhale at the same time, and how some of those airstream mechanisms are used in speech too. If you teach your students about beatboxing, be warned: vocal percussion is very accessible to most undergraduates because the articulations so strongly resemble consonants, you’ll have to deal with your students subconsciously beatboxing under their breath for a while. But if that means they’re more likely to remember what happened in class, that’s a good problem to have in my opinion.

So that’s “The Science of Singing” in a nutshell: a phonetics class that uses vocal music as a vehicle for understanding speech articulation. Hopefully by now you have a taste of how a class about vocal music is not only a viable way to teach core concepts in phonetics and laboratory phonology, but also a whole lot of fun for both the teacher and the students. But if edutainment for edutainment’s sake isn’t enough of a motivator for you, there are plenty of other benefits to offering classes like “The Science of Singing”. I’ll just offer you five.

From an administrative point of view, “The Science of Singing” is flexible. It can work with or without prerequisites. You could certainly offer it with some phonetics or phonology prerequisites as an upper-division or graduate-level course and get students thinking about how musical speech informs and is generated by contemporary phonological theories. But my preference is to offer “The Science of Singing” as a freshman seminar. You’d of course have to be careful about how you pace the course, but it would be a great way to coax new students into a Linguistics major.

“The Science of Singing” is also good for cross-listing into your school’s music department, giving you access to a student population that might otherwise never think to study Linguistics.
Students learn better when they care about what they’re learning, and students in “The Science of Singing” are invested from day one. Most freshman have never heard of Linguistics or Phonology, but everyone knows what singing is, so they’re naturally curious. You won’t have to work nearly as hard for their attention as you might have to in less musical courses. More importantly, no matter their class standing or Linguistics background, students already have opinions about singing and a cultural frame of reference. You can easily leverage both of these into class discussions with lots of student engagement and diverse perspectives.

We know students learn better when they have an active role in the learning process, and we also know they like it when they can see their teacher learning a bit too—it makes us seem more human, I guess. Because vocal music is so rarely researched in our field, there are plenty of opportunities for you and your students to actively engage in learning together. In more advanced courses, revelations from the class might evolve into larger research projects and academic papers, giving your students a valuable chance to experience the scientific process.

Finally, the guest performers. If you can find them, get them. The investment of your time you have to make finding and arranging guests to visit your class is paid back a hundred times by the in-class experience. Bringing guest singers into the classroom contextualizes what you’re teaching, de-exotifying the singers and their cultures while injecting expert opinions into the course dialogue. And unlike some consultants you might usually bring into a Linguistics class, who can be uncomfortable in the spotlight in front of all your students, performers are ideal consultants because they thrive on the attention and are game to experiment with their voice as much as you and your students want. Add those benefits, then subtract the need to prepare a lesson plan for that day, and guest performers let you take an already great course and crank it up to eleven.

Assuming you don’t have the time to make a new laboratory phonology course about vocal music, there are still plenty of ways to make your courses just a little more musical. You could start by finding videos of different varieties of vocal music that help you demonstrate or explain tough concepts, like how overtone singing helps students differentiate harmonics and formants. But you can also talk about plenty of other things that I never got to address in “The Science of Singing”, some of which open up great class conversations about phonological theory.

One of them is the speech-to-song illusion, a fascinating speech perception illusion in which a spoken utterance begins to be perceived as music when it’s recorded and played on a loop.
Why does that happen, and what aspects of our phonological representations (if any) contribute to the perception of talking versus singing?

Contrastive features like lexical tone and vowel duration are perturbed by melodic constraints during singing. What kinds of perturbations can the listener tolerate? How does the singer balance intelligibility against aesthetics? Similarly, the spatial targets and temporal coordination of speech articulation changes depending on whether the speech is talked or sung, and further depending on the speaker’s accent or their singing style. Are there separate representations and coordinative structures for talking and singing? Are the productions distinguished in grammar?

Finally, you can really mess with your students’ heads by introducing surrogate speech systems, many of which encode vocal phonology into non-vocal music. My favorite is the Sambla balafon, a gourd-mounted xylophone that lets the speaker convey lexical tone by playing different notes. There’s also drum speech, and whistle speech that uses the frequency of the whistle to model either tone or formant contours. Surrogate speech is a great topic for stretching your students’ understanding of what a phonological representation can be.

Thank you for watching! And thanks as well to the graduate school at USC for the provost’s mentored teaching fellowship that sponsored “The Science of Singing”, and thanks the instructional designers at USC and Rachel Walker for their invaluable insights about everything you liked about the course (and nothing you didn’t like). The full references for this talk, as well as sample course materials for The Science of Singing and my other classes, can be found at reedblaylock.com. If you liked what I said in this presentation—or if you didn’t like it, and you want me to know it—send me an email at reedblaylock@gmail.com. And, if you really liked this presentation, I have great news for you: I am on the job market, and I would be delighted to bring “The Science of Singing” and my vocal music research to your institution. Thanks again for watching!