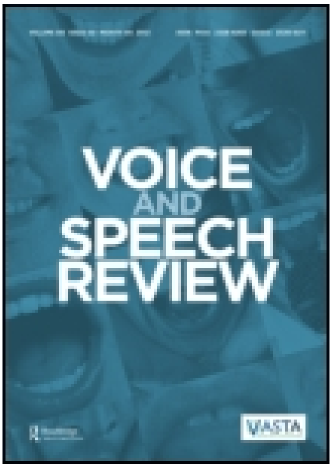

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Lunch talk, part 1: the glottis, driving pressures, & Bernoulli's big but

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(Scene: A teacher's cluttered office. Lights up on Tom sitting at his desk. He is eating a salad and scanning the web. Enter student, Bukola, carrying book-bag, guitar case, Pop-Tarts, and Cherry Coke. She knocks on open door, then after a few hellos ...)

Bukola: Why does my voice sound like it does?

Tom: Is something troubling you about your voice?

Bukola: Just thinking—in general. You know, like why do I sound different from others? Or, why, for that matter, does everybody sound different from everyone else? Just curious.

Tom: You want the long answer or the short answer?

Bukola: Ahhh … I got an hour?

Tom: Have a seat … but keep the door open … case you wanna quick exit.

Bukola: Gotchya.

Tom: Well, knowing you, you won't be happy with just a quick summary, so in an hour we can delve into a few big things …

Bukola: k.

Tom: The term "voice" can refer to many things … laughing, whispering, singing, breathy speech sounds … but by asking about differences from one person to another, you most likely are interested in the sound created by the vibration of your vocal folds …

Bukola: Vocal folds?

Tom: … the two lengths of tissue that vibrate and chop up the airstream into sound waves … look, these things here …

(He points at an over-sized plastic model of the larynx by his desk)

Bukola: I see. *(Smiles)* Only mine are from Nigeria and this says made in the USA. *(Laughing)* And mine are smaller …

Tom: Hey, dimensional difference in vocal anatomy is definitely something that makes one person sound different from another—man, woman, child, for instance. (Sundberg 1987, 11)

Bukola: Right.

Tom: But instead of the effect physical characteristics have on the sound, let's start with the effect usage has. Let's begin with how the voice functions, and the way you *use* it.

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Bukola: Cool.

Tom: Now think 'bout that. When you ask about differences from one person to another, you are in essence asking why your sound is individual to you. That's a very "personal" thing. (Sundberg 1987, 2) Voice teachers don't usually like to talk about this stuff with students. We like to work with them on it, and in a place where students are free to express themselves creatively with any special feelings that may arise. We want students to experience their vocal potential, not necessarily understand it academically. Too heady. Most, if not all, of the stuff that makes your voice work is best taught by working with your body—and, ok, maybe the part of your mind that works deep down in your subconscious brain—but we mostly like to steer clear of your rationalizing over-thinking brain. That's because, well, first off, it's just practical; because it is ability you're working on, after all, not essay papers. But secondly, in order to make the physical adjustments to work on your voice a student must feel the difference, not necessarily understand it. Look, the basis of our current understanding of the voice didn't even start till the mid nineteenth century. (Behrman 2007, 140) And there certainly was a lot of singing and acting going on before that.

Bukola: Yeah I had theatre history!

Tom: Uh, yes, but not voice and speech let me remind you.

Bukola: Mmm, my bad.

Tom: Even when I first studied voice for acting in the '70's one teacher I had still wasn't sure if breath moved the vocal folds or if the vocal folds were moved by individual neural impulses sent directly from the head. She was referring to something called the Neurochronaxic Theory (Behrman 2007). That has since been discredited. But anyway, there I was still working on my voice.

Bukola: Breath moving the vocal folds sounds way better than neural impulses.

Tom: Why do you say that?

Bukola: Because it seems more friendly and natural than coming from your brain.

Tom: See why teachers don't like to get heady! Friendly, natural, those are pretty non-technical terms. And indeed, breath creates oscillation, by pushing and pulling on the vocal folds. This idea has come to be known as the myoelastic-aerodynamic theory (Behrman) … "myo" meaning "muscle" in Latin. So anyway, this being the case, it makes sense that voice teachers like to concentrate on the breath and not the mechanics of the vocal folds, the surrounding larynx, or even the laryngeal tube just above the larynx.

Bukola: What about articulation?

Tom: What do mean by articulation?

Bukola: Diction, you know, the important stuff, the tip of the tongue.

Tom: True enough, voice teachers do deal with the tongue a lot. But tell you what; let's hold off on that question. Let's keep thinking through why your voice sounds like it does, then I bet we'll get back to it.

Bukola: Ok.

Tom: The myoelastic-aerodynamic theory figured that all you need to do to get the vocal folds oscillating is to bring them together and let the breath-stream flow between them. Bringing your vocal folds together is known as "adducting," which we do all the time, even when not talking. Sometimes, we even super squeeze'm together— like holding your breath in your throat for no particular reason at all, or grunting, or clearing our throats, like for a cough. Some people might refer to this super squeeze as "gripping in the throat." (https://www.youtube.com/watch?v=8VASwem4y44)

Bukola: *(A throat clearing and a few little coughs later ...)* Yeah, you have to grip … to cough.

Tom: Right. But to start oscillation, you only need to bring them together real easily and not even all the way. (Titze, 244)

Bukola: How do you know enough is enough and not mash them?

Tom: Well you certainly wouldn't want a voice teacher to say, "Now Bukola, easily constrict your *lateral cricoarytenoid muscle*."

Bukola: My what?

Tom: Precisely. And that again is why teachers don't like explaining academically. They'd rather elicit your experience, how it feels to you—perhaps stimulating your movement with imagery.

Bukola: Gotchya. So if I'm someone who likes to "adduct" my vocal folds too tight, and I don't wanna mash'm, it's best to concentration on the breath.

Tom: Yes, and give up excessive tension. The beauty of the myoelastic-aerodynamic theory for students is the emphasis on an engaged breath and a passive throat.

Bukola: Then the air-stream will blow them apart.

Tom: Right. But let's say "*move* them apart" instead. "Blow apart" sounds like … like …

Bukola: A video game.

Tom: Yeah. Now, air pressure moves the vocal folds apart, but they don't stay apart; they come back together for the next oscillation … (https://www.youtube.com/watch?v=1iESvUdlJcU)

Bukola: Well like yeah …

Tom: Careful not to take that for granted. I mean, why don't they just stay open?

Bukola: *(Shrugs)*

Tom: Two things …

Bukola: Two things …

Tom: One, is the natural elasticity of the tissue …

Bukola: They snap back. Myo-*elastic*, makes sense … and two?

Tom: Negative air pressures—partly from acoustic pressures above the vocal folds, and partly from the Bernoulli Effect.

Bukola: I've heard of the Bernoulli Effect! Cool. As air speed increases, surface pressure decreases. Right?

Tom: Right.

Bukola: Like how the air on top of an airplane wing moves faster than the air below, which lowers the pressure above the wing and creates lift.

Tom: You were an excellent pilot in our play, *Charlie Victor Romeo: CVR*. All those flight lessons with CUNY Aviation stuck, eh?

Bukola: "Power up!"

Tom: Now you couldn't ask for two more friendly and natural forces than elasticity and the Bernoulli Effect. No effort in that.

Bukola: But isn't just the elasticity enough to snap them back each time?

Tom: Well, that brings up a very important point. Imagine sitting on a schoolyard swing. You step back till your toes just touch the ground then pick up your feet. The swing will move forward, then back; but it's going to lose energy during that whole back and forth cycle—resistance, friction, that stuff will rob it of energy. So when your swing comes back that first time, you won't make it all the way back to where you started. Then, each subsequent back and forth will be a little less than the one before.

Bukola: So you start pumping and leaning back and stuff to get it to overcome the resistance.

Tom: Which swing would you rather be on, a rusty creaky one, or a slick new oiled one?

Bukola: Less resistance is better.

Tom: True of the vocal folds too. Think of when you've had a cold and it's hard to talk. Vocal fold mass and viscosity can increase … they become more difficult to move. Then you need a stronger breath-stream, (a.k.a. more air pressure or subglottal pressure or breath support, however you wanna say it), to get them to move apart.

Bukola: That would be like having to pump my swing harder.

Tom: It can get so bad that you can't talk normally, or end up with total "aphonia" … can't talk at all. (Titze 1994, 309)

Bukola: But what if you don't have a cold?

Tom: The mass and elasticity of your vocal folds can depend on many things: the anatomical differences of one person to another, time of day, intake of certain foods or medication, body fatigue, hormonal levels, even the emotional state of a person. (Titze, 24) "Clinical wisdom is to drink several large glasses of water a day to keep your tissues hydrated, to humidify the indoor environment, and avoid dehydrating substances" [like caffeine and sugary drinks.] (Titze, 195)

(Bukola slowly slides soda off desk.)

But even with the best practices resistance is still too high and "no net energy will be imparted to the [vocal folds], and oscillation will eventually damp out." (Titze, 82)

Bukola: Net? Like what's left after deductions?

Tom: That's right; I forgot you're a double major in marketing! So even with humidified air, and staying away from cola before a show, resistance is still too high to let that swing just keep swinging.

Bukola: So the Bernoulli Effect makes it possible to talk.

Tom: Well, talking involves many things— like you said before, tip of the tongue and stuff— so we'll keep it simple and concentrate just on the vocal folds. So, let's say "possible to phonate."

Bukola: Really, "phonate?" Talk about technical. Can't we just say, "make sound?"

Tom: How's this: With the Bernoulli Effect "the net energy loss per cycle," while making *vibrated* sound, is reduced … to zero. (Titze, 91) And that's called self-sustained or flow-induced oscillation. (Titze, 80)

Bukola: "Flow." Now that sounds effortless!

Tom: Right. And what a wonderful thing for a young actor to keep in mind. So as we consider sound and why one person sounds different from another, let's also keep in mind this idea of ease.

Bukola: Sounds good …

Tom: Yes it does … literally! 'Cause if you don't sound easy, you sound strained.

Bukola: Yeah, I hear that in different people. And feel it in myself sometimes. Not a good thing.

Tom: That's very true. And that's the reason I'd like to consider your question with this other idea. Ok by you?

Bukola: More for less, good thing.

Tom: Now, we know that oscillation of the vocal folds is possible because tracheal air pressure pushes them apart, and that vocal fold elasticity and the Bernoulli Effect help bring them back together.

Bukola: Right …

Tom: Therefore … anything that diminishes these things is going to make it harder to talk.

Bukola: *Phonate …*

Tom: Uh … right. Well most theatre folks know about the elasticity part. They know the importance of staying hydrated and healthy (Titze, 105). And most actors certainly deal a lot with breath support or, excuse me, "tracheal air pressure."

Bukola: Sure, that's important.

Tom: Especially as your pitch goes up. An increase of pitch is created by increasing the tension of the vocal folds, usually by stretching them a little longer. The tension added to the vocal folds to change pitch makes them stiffer, less pliable. (Titze, 194) So as pitch increases it takes more breath support to move them apart. If you'd like to see, I have a video here, somewhere, of the vocal folds changing pitch—

Bukola: Ah no, that's ok …

Tom: *(Searching computer for video)* You gotta see. It's super …

Bukola: It's fine … (https://www.youtube.com/watch?v=7VD7FAXscmE)

Tom: You'll see them strrrrrreeetch and then …

Bukola: No really … thanks! *(Tom stops and looks at Bukola)* I'm good …

Tom: Oh …… ok. Well, basically, the pitch you hear depends on the tension, mass, and length of the vocal folds. (Titze, 172)

Bukola: Hey! Like a guitar string.

Tom: Right, you turn a peg to add or relax tension, so the pitch goes up or down. The more tension, the higher the frequency of oscillation; the less, the lower. The thickness of the string has an effect too—because the thicker the string, that is to say the more mass, the lower the pitch will be.

Bukola: So longer thicker vocal folds have a lower pitch than thinner shorter ones?

Tom: Given the same amount of tension, yes. And that's why some people speak on lower pitches than others—like an adult compared with a child.

Bukola: But if you stretch them don't they get longer making the pitch go down, like the longer the string the lower the pitch?

Tom: Stretching them makes them longer but pitch is more dependent on tension than length, so the *net* result is that stretching makes the pitch goes up. (Titze, 201)

Bukola: Makes sense, 'cause it feels easier to talk lower than higher.

Tom: Yes, easier because if the vocal folds are "more free to move, [less stiff,] a lower subglottal pressure is needed to get the folds to oscillate." (Scherer 1991, 77)

Bukola: Ok. So releasing tension in the vocal folds lowers the pitch, and that's easier for making sound. So then it's super easy to talk *(taking on a real low pitch)* realllllll lllllooww.

Tom: Well, actually? … not completely. There's a point when relaxing won't get you any lower. After that you'll need muscular effort to get a lower pitch. Though lower pitches may require less subglottal pressure, or aka breath support, to phonate— after a while it can start feeling like you're voice is getting tired.

Bukola: Yeah like talking on the phone forever at work …

Tom: *Phonating* on the phone forever! *(Bukola glances upwards, text bubble "smh")* A person's vocal folds might have a length where they're maximally relaxed with the least amount of muscular effort; a possible optimal place to speak. (Titze, 214) But to go down from there you have to get the vocal folds even shorter and thicker; and the only way to do that is to activate muscles. One way is to contract the sternohyoid muscle. That will pull your whole larynx down and add "flabbiness" to the vocal folds. (Berkeley Department of Linguistics, Ohala 1972, 11) I've seen myself do that, as well as squeezing everything together, pulling the tongue down, constricting my throat. *(Excitedly whirls to computer)* I can show you the vid—

Bukola: No no … really … *(He stops, looks back at Bukola)* I'm good.

Tom: Oh … ok. Now there is another muscle that can lower pitch … and amazingly, it can also raise pitch … *and* it can change the quality of your voice …

Bukola: Cool …

Tom: Yeah. It's called the thyroarytenoid muscle …or TA for short. It runs through each vocal fold from back to front …

Bukola: So when you tense it, the vocal folds get a little shorter?

Tom: Yes. There is soft tissue between the muscle and the edge of the vocal fold, which is called the mucosal cover. At a low pitch, if you shorten the vocal folds with the TA and only vibrate the soft cover, then the pitch drops. But if your vibration includes part of the TA, then the added tension may increase the pitch. (Scherer, 83)

Bukola: So if the breath doesn't blow'em … uh, I mean … move'em apart so much …

Tom: … it'll lower the pitch.

Bukola: And if it moves them "moderately" (Behrman 2007, 159) a lot …

Tom: … more of the vocal fold will start vibrating and the pitch goes up.

Bukola: But how does it affect *quality*?

Tom: "It produces a register change …." (Titze, 182) Engaging the TA will not only shorten your vocal folds a bit, but it will make them thicker. (Scherer, 84) So when you engage "more of the entire body of the vocal fold … into vibration … the result is a voice of richer timbre … call[ed] chest … voice" (Titze, 182) This happens to the voices of pubescent males. During that growth spurt, "aside from the increase in vocal fold length, there is also an increase in the bulk of the TA muscle." (Titze, 182)

Bukola: Yeah, like my brother one day just started sounding so different! … Uhm, but, when you go up in pitch the vocal folds stretch and start thinning out, no?

Tom: True, and as they do, the sound gets less rich, or less full, or "light" (Sundberg 1987, 54)—it goes to what singing teachers might call middle voice or mixed voice or head voice which is less chesty than the lower pitches but "fuller than falsetto." (Titze, 272–275) In falsetto the vocal folds are so stretched out that the TA is no longer engaged and only the soft cover vibrates. (Sundberg 1987, 50) There can be an abrupt change in quality as the TA lets go.

Bukola: *(In falsetto voice)* Roma, roma, mah … Gaga, ooh la lah … *(in chest voice)* it's hard to go high in pitch, but staying relaxed so as not to mash'em.

Tom: Good reason why concentrating on breath is so important.

Bukola: Yeahhhhhh …

Tom: Like we said, you're gonna need more breath support as pitch increases cause the vocal folds are more tense. On the flip side, though, the air pressure of the breath stream can change pitch.

Bukola: On the flip side?

Tom: It's an old term from 45's …

Bukola: … 45's?

Tom: Records.

Bukola: *(Quizzical look)*

Tom: … uh … breath stream can change pitch. How do you play louder on your guitar?

Bukola: Well if I pluck the string with more force it's louder.

Tom: You'll increase the amplitude of the stings. The same with the voice.

Bukola: Sure, I can talk loud or soft.

Tom: All things being equal, the greater the air pressure of the breath stream the more amplitude you'll get in your vocal fold vibration; that is to say, the greater the movement of the vocal folds away from each other …

Bukola: … and the less air pressure, the less amplitude. That makes sense.

Tom: But the more your vocal folds separate away from each other in the vibration, the vocal folds naturally stretch more and that will add tension to them …

Bukola: And the pitch goes up a bit.

Tom: Right.

Bukola: Hey, is that like when people shout, their pitch goes up?

Tom: Good observation. "Subglottal pressure plays a significant role in … pitch." (Scherer 2005, 172) Singers have to practice staying on pitch while building to a crescendo.

Bukola: So when getting louder singing you'd have to learn to relax a bit whatever muscle is stretching the vocal folds.

Tom: Exactly.

Bukola: *(Smiling)* O-K! I think I'm down with this elasticity, pliability, resistance, breath support and pitch stuff.

Tom: Great! Now, most acting students are taught to concentrate on breath support and disallow any effort in the throat other than the, to borrow Julia Child, "soupçon" necessary for gently adducting one's vocal folds for oscillation and preparing them for a particular pitch.

Bukola: So you don't strain …

Tom: Right. They seek to find the good effects that the airflow itself provides, to let the flow of the air make the vocal sound, rather than any sense of forcing or squeezing. *However*. This particular recipe for achieving ease and avoiding strain neglects to mention another important ingredient—an ingredient taken for granted by theatre professionals. Something taken for granted as much as we do the air we breathe.

Bukola: The Bernoulli Effect?

Tom: Precisely! And because it's taken for granted, what we discuss now will not only continue informing you about why people sound as they do, but it may make a difference in many people's understanding of the voice, and even rock the foundation of some of the most established speech techniques used in actor training today.

Bukola: Woo-who! … but, uh, even though it's taken for granted, it still always happens, right?

Tom: Yes … but.

Bukola: But.

Tom: In order for the Bernoulli Effect to occur and allow flow-induced oscillation …

Bukola: Yeah …

Tom: And this is a big "but" …

Bukola: Big but, got it …

Tom: Really big, actually …

Bukola: A really big but …

Tom: And this "but" is critical to our discussion here …

Bukola: A critical big but, ok.

Tom: In order for the Bernoulli forces to occur and allow flow-induced oscillation of the vocal folds, two things must be present. That is to say, if these two things are not present, the Bernoulli forces will not occur. (Titze, 82)

Bukola: Two things …

Tom: First, the vocal folds must vibrate in a special (or “nonuniform” (Titze, 94)) way.

Bukola: Special way, k …

Tom: And, second, (well, this one may sound a little weird …) but secondly, you need to have a vocal tract. (You know the tube that runs from your larynx, where your vocal folds are, up and out of your mouth, your *upper airway*) Oh, and your vocal tract has to be connected to the larynx. (Titze, 82)

Bukola: I’d hate to think if it wasn’t!

Tom: Now we could just take this information as a given and go on with our discussion, but understanding this point will help you better understand how your vocal folds vibrate, and that has a lot to do with why folks sound as they do.

Bukola: All right, I’m ready.

Tom: Ok. Imagine you closely “approximate” (Behrman 2007, 144) your vocal folds (gently or almost touching them together), and the air streaming up from below builds up pressure until the glottis …

Bukola: Glottis?

Tom: The space between the vocal folds …

Bukola: k … continue.

Tom: … until the glottis opens and the air comes through the larynx which then pushes upward on the air that’s already in the vocal tract just above the larynx.

Bukola: Larynx?

Tom: *(Pointing at plastic model)* This thing here that houses the vocal folds …

Bukola: k.

Tom: This raises the air pressure just above the vocal folds. So “when the vocal folds are separating, pressure is positive.” (Scherer 1991, 77)

Bukola: Sure.

Tom: Yeah, only it’s not just that the building pressure *under* the vocal folds moves them apart; it’s also that the positive pressure created “just above the vocal folds communicates into the glottis and helps push the vocal folds [open].” (Scherer)

Bukola: “Communicates,” cool.

Tom: Isn’t it? It’s neat to think of “imparting energy” (Scherer) as communication. And that’s what’s happening here, from one medium to another—from the air to the body.

Bukola: Awesome.

Tom: Now, here’s the question. After the vocal folds open, why in the world don’t they just stay open? I mean, even though they naturally and elastically want to recoil back together, you’d think that all this positive pressure will hinder that.

Bukola: *(With long rising inflection)* But?

Tom: Well, when the vocal folds are open all the way, the airflow going through the glottis is at its maximum.

Bukola: Yeah, ok, makes sense …

Tom: Then, as the vocal folds start recoiling back towards each other, there is less air coming through the glottis because the vocal folds are starting to close, *but* the “momentum of the air column” (Titze, 100) continues up the vocal tract. So because of the “inertia” (Scherer 1991, 79) of the air up the tract the molecules of air just above the vocal folds separate more and more from one another, and the air pressure decreases … and can even become negative. (Scherer 1991, 78) And this decrease of air pressure just above the glottis …

Bukola: … *communicates* to the vocal folds.

Tom: You got it! You could even perhaps say the pressure is "sucking" (Scherer).

Bukola: … suckie communication … been there.

Tom: And this pressure "aids the movement of the vocal folds because the … inward pull has the same direction … as the movement of the vocal folds." (Scherer) Now, here's something interesting to note: Because the air is going up the vocal tract, the peak of airflow out of the glottis "comes later in time than the peak displacement" (Titze, 102)—or you could say, peak separation—of the vocal folds. Did you get that? One more time; because of the vocal tract, the peak airflow out of the glottis is slightly delayed in relation to the peak opening of the glottis. This may therefore be referred to as the delayed response due to vocal tract inertance. (Titze, 94)

Bukola: *(Slight pause)* … catchy.

Tom: Ok, but the neat thing is: The vocal tract "response" (Scherer 1991, 79) to the breath "leads to air pressures that act on the vocal folds, aid[ing] their motion by giving them a push when they're going out … and not hindering (and partly aiding) them when they are coming back together." (Scherer)

Bukola: Need the vocal tract. Got it!

Tom: Now let's relate this to you on the swing. There you are pumping away—maybe a little more, maybe a little less, depending on the resistance—but then a couple of your friends come by. Just as you start to swing forward one friend gives you a push to your back, sending you sailing forward, and just as you start to swing back the other gives you a push at your feet, sending you sailing back.

Bukola: Sweet …

Tom: When a push is "synchronized with natural oscillation. This is called resonance." (Titze, 84)

Bukola: So the delayed response … uh, yada-yada … because of the vocal tract, creates pressures that *resonate* with my oscillation. Like in sync friends!

Tom: Sure. Now let's talk about the second thing that happens so the Bernoulli Effect can assist in making sound.

Bukola: A special vibration, I think you said?

Tom: Yes, do this: Put your hands together like your praying. Now turn them so your fingers are pointing forward. Imagine your fingertips are fastened together, but you can swing the heel of your hands apart. This is like your vocal folds. They are fastened together in front right behind your Adam's Apple.

Bukola: Do women have one?

Tom: Uh-huh, it's just that a guy's is pointier so it sticks out more. (Behrman 2007, 118) Now, when you "abduct" your vocal folds, it's like you swinging the heels of your hands apart; and when "adduct," it's like you swinging them together.

Bukola: Does the breath do that?

Tom: No, you do. Try this: Keep your hands in the same position, but now stick your thumbs up in the air. We'll pretend that your thumbs are the arytenoid cartilage that connects to the back of each of the vocal folds. Small laryngeal muscles move the cartilage which then adducts or abducts the folds. It's important to realize that *you* set the adduction level, but it is the *breath-flow* that creates oscillation, by pushing and pulling on the vocal folds, like we said before.

Bukola: Gottchya … So now, how do they *vibrate*?

Tom: Well, in all sorts of ways. The more flexible they are, the more freedom the tissue has to move in different ways—"and the greater potential for achieving conditions under which self-oscillation may occur." (Titze, 97) The most observable movements …

(Tom swings chair toward computer with enthusiasm and goes into files.)

I mean I have video of my vocal folds vibrating in slow motion if you'd …

Bukola: *(Putting up hand to stop him)* No, no! *(Tom looks at her.)* I mean … 'nother time …

Tom: *(Sighs)* … k. Place your hands together again—prayer position, fingers pointing front; so thumbs are flat on top and pinkies below. We'll forget about the arytenoid cartridge now, and pretend that your entire hands are your vocal folds, ok?

Bukola: k.

Tom: Now, you're going to imitate the special vibration.

Bukola: Cool.

Tom: Begin by moving the bottom of your hands away from one another till they form the shape of a house roof, or upside down V. This shape is called *convergent*.

Bukola: Alright ….

Tom: Notice the top parts of the vocal folds haven't come apart yet. This is the first phase of the move.

Bukola: So the *glottis* is still technically closed.

Tom: That's right, the folds are separating but the glottis is not actually opened yet —air is still prevented from moving from below the glottis through the glottis. But now, let's do phase two, that's when the glottis actually opens. Phase two: Let your hands almost flatten out, palms down. Then, separate them a couple of inches from one another as you move your palms to face one another a couple of inches apart. Now the glottis is open.

Bukola: Ok.

Tom: Now for the closing phase: Begin by letting the bottom of your hands come together, the whole length of the pinky and the fleshy muscle underneath. This will create a V shape; it's called divergent. That's the third phase.

Bukola: Got it.

Tom: Now roll your hands together till they're flat against one another, back in the prayer position with your fingers pointing in front of you. Now your vocal folds are completely closed; the fourth and final stage.

Bukola: *(Doing entire motion over and over very fluidly)* … it's like bubbles dancing …

Tom: Remember, the fleshy part near the surface of the vocal fold is called the mucosa? So this is sometimes referred to as the mucosal wave, partly because of the traveling wave of mucosa from the bottom margin of the vocal fold to the top margin. Note how both the opening and closing phases of the vibration start first with the lower margins of the vocal folds. (Behrman 2007, 148)

Bukola: And this allows for the Bernoulli Effect?

Tom: Yeah, along with the "delayed action in the vocal tract" (Scherer 1991, 77), the diverging shape of the closing glottis "results in the Bernoulli Effect causing a lowering of [pressures in the glottis], and an inward pull on the lower margin of the vocal fold." (Behrman 2007, 146) Thus, there are positive air pressures pushing on the vocal folds to separate them during glottal opening, and negative pressures pulling on the vocal folds during glottal closing. "This process allows energy transfer to the vocal folds and opposes the frictional energy losses of the tissue to maintain oscillation." (Scherer 1991, 82)

Bukola: Ok, so the mucosal wave and vocal track air momentum … two important things that go great together.

Tom: Like peanut butter and bananas.

Bukola: Nice!!

Tom: And this goes along with another idea: If the vocal folds have a taller medial surface, this will tend to decrease how much breath support (that is, the subglottal air pressure) you need to get the folds vibrating. One reason may be there is more vertical surface along which the driving pressures can develop. (Scherer 1991, 83)

Bukola: So thick, pliable, vocal folds plus a vocal tract equals *easier to talk*.

Bukola & Tom: *(Looking askance at each other) Phonate*!

Tom: Now, since you know some important things about vocal fold oscillation, let's consider how that can affect vocal quality.

Bukola: Rock on.

Tom: Ok, a bit ago you said you didn't wanna mash your throat.

Bukola: Right.

Tom: Well what's wrong with mashing?

Bukola: Hm, not sure … but sounds painful.

Tom: Yeah, it could be. What do you think the quality would be … that is to say, whadaya think it'd *sound* like?

Bukola: Uhhh … hard?

Tom: Yes, the official term is called "pressed phonation." (Sundberg 1987, 80) The quality will tend to be "brassy." (Titze, 115) It's got an edge to it.

Bukola: Like a brass instrument?

Tom: Compare a trumpet playing the same note as a flute.

Bukola: Gotchya.

Tom: "Pressed phonation is characterized by a high subglottal pressure combined with a strong adduction force." (Sundberg 1987)

Bukola: Uhm, but *why* does it sound brassy, and not some other way?

Tom: Because of the relationship of its harmonics.

Bukola: Harmonics?

Tom: Well, to discuss that we'd first need to talk about sound waves … you up for that?

Bukola: Carpe diem!

Tom: Ok, what is a frequency of sound?

Bukola: Uh, how fast some sound is vibrating?

Tom: Yes, per second. The higher the frequency …

Bukola: … the faster the vibration, and the lower the frequency the lower the pitch. Just like one of my guitar strings.

Tom: Yeah. Here, I have a tuning fork in my drawer. *(Finds tuning fork after much searching.)* When I smack it against my hand … *(Smacks it)* you hear that?

Bukola: Sounds like the electric thing I use to tune my guitar.

Tom: Look at it closely; you can see the blur of it oscillating back and forth. Tuning forks pretty much produce simple sound waves. (Bachus 1969, 67) By simple I mean you hear only the frequency of it vibrating back and forth. Here, I have another one. *(Locates another and strikes it.)* This one is lower.

Bukola: It sounds lower. So it's vibrating fewer times per second.

Tom: Right, but now to understand qualities we have to consider a *complex* wave.

Bukola: All right, with ya.

Tom: Let's get into this a bit, and then we'll apply what we learn to why the quality of a pressed voice *sounds* pressed … and then we'll take it from there.

Bukola: Cool.

Tom: Suppose you tuned one of your guitar strings somewhere near middle C. When you pluck it you will produce a pitch vibrating at, let's say, 250 times per second. But you will also create another pitch sounding at 500 times a second, and another at 750 a second, and on and on continuing on at intervals of 250.

Bukola: Are those overtones?

Tom: You could say that, yes. And some say partials, or harmonics.

Bukola: Like when I play a harmonic on my guitar?

Tom: What do you mean?

Bukola: Uhh, if I pluck a string and then touch it lightly in the right place it suddenly sounds higher. I have to touch it lightly. If I touch it too hard to just stops vibrating.

Tom: Yeah! You hear a harmonic. Let's try to visualize why that happens.

Bukola: k.

Tom: Suppose you grabbed a jump rope and whipped it up and down once. You'd see a wave travel down the length of the line.

Bukola: Ok, I know what you mean …

Tom: That would be a simple wave.

Bukola: If I kept whipping it I'd see one wave after another travel down the line.

Tom: Yes. So that's like the tuning fork- one simple wave after another. Instead of whipping your hand up and down, you could connect the rope to the tuning fork, and it would whip the rope up and down.

Bukola: A big tuning fork.

Tom: But now, suppose you hook up another tuning fork to the other end. Then every wave that comes down the line will hit the other tuning fork, and *that* tuning fork will vibrate and send waves back the other way.

Bukola: Like an echo?

Tom: Right. So now you have waves going both ways on the rope.

Bukola: They're going to intersect.

Tom: Yes, they will *interfere* with one another. And that interference will cause standing waves. (Backus 1969, 55–58)

Bukola: Standing waves?

Tom: Waves that look like they're standing still. To imagine this let's keep the image of a tuning fork on both sides of a rope, sending down waves from both sides.

Bukola: Yup.

Tom: If we get the right frequency of vibration, the rope will look like one big loop going up and down.

Bukola: Like a jump-rope, only it's going up and down instead of a circle.

Tom: Sure.

Bukola: But how do you know how fast the vibration has to be?

Tom: That depends on the length and thickness (that is to say mass or density) and tension of the rope.

Bukola: Ok, so depending on the thickness, length, and tension of the line, a certain frequency will make it go up and down in a big loop.

Tom: And that big loop is called a standing wave; because the wave doesn't appear to be travelling one way or the other. It just looks like it's going up and down. Also, on the ends of the loop, the rope doesn't appear to be moving at all.

Bukola: Like on my guitar; one end stops at the bridge and the other at the capo I use. And when I pluck it, I hear a certain pitch and it looks like it's going up and down.

Tom: Let's imagine our rope with the tuning forks again. If we get tuning forks that vibrate twice as fast as the other ones. And send vibrations down both ways using the same length of rope—same mass and tension too—a really cool thing happens.

Bukola: Yeah?

Tom: The line would develop two smaller loops on it, instead of big one. Each would be half the length of the line. Also, each loop would be going up and down less high then the first big loop.

Bukola: Instead of one big standing wave, we'd get two shorter and less high ones. I'd like to see that.

Tom: If you google youtube, "standing wave", there are lots of demonstrations. Let's look. (University of Colorado at Boulder)

(They go online and watch a demo.)

Now, if you send vibrations up and down the line *three* times as fast as the first time, we would get *three* loops.

Bukola: And the height of the up and downs would be even less then when there were two loops.

Tom: Right. The height it vibrates is called the *amplitude* of the vibration.

Bukola: I think I get it. Each time you increase the frequency by the same amount you get another loop going up and down, and a smaller amplitude. (Backus 1969, 60)

Tom: Right. Now, the first big loop has the largest amplitude, but the lowest frequency. That one is called the fundamental frequency. The other higher frequencies …

Bukola: Are called harmonics.

Tom: Yes. And they and the fundamental are all partials, because as components of the whole they all partially make up the entire complex wave. Now, if you think of amplitude as sound energy, or let's say vocal power …

Bukola: Then, the fundamental is loudest.

Tom: You got it. Now here's a neat thing: Most mediums, like a guitar string, or air in a tube, can carry many waves simultaneously. (Backus 1969, 60)

Bukola: So when I touch my guitar string that's going up and down, just a little bit, and in the right place …

Tom: You stop the fundamental vibration …

Bukola: But not the other vibrations.

Tom: So then you hear the next "loudest" partial.

Bukola: Cool. But, how is all this like my voice?

Tom: Well, we were imagining a tuning fork vibrating back and forth at 250 times per second. When attached to a string, waves were created that interfered with one another and became a complex waveform with a fundamental frequency and harmonics. Now, if you're singing a note just below a middle C, at a frequency of 250, then your vocal folds are oscillating 250 times per second, and pressure waves are created in the airstream which interfere with each other to become a complex waveform. The sound has a fundamental of 250 and harmonics.

Bukola: And just like the loops, the fundamental has the lowest frequency; and there is a harmonic at each frequency *above* the fundamental, in multiples *of* the fundamental.

Tom: Right, 500, 750 …

Bukola: 1000 …

Tom: … and so on.

Bukola: Suppose I was singing higher, like at 300 vibrations per second …

Tom: Then the second harmonic would be at 600.

Bukola: Then the next at 900, then …

Tom: 12 hundred …

Bukola: … and so on.

Tom: And just like the loops, the fundamental has the largest amplitude.

Bukola: … or you could say, *vocal energy*.

Tom: Right, and each succeeding partial …

Bukola: … will have a lower amplitude, or less vocal energy.

Tom: That's it. Now, if you will, picture a *graphic display* of all the component frequencies and their respective energy levels. Imagine the fundamental (the first harmonic) is represented as a vertical line. Then picture the second harmonic represented as another vertical line, just to the right of the fundamental, but drawn shorter in height.

Bukola: Because it has less energy.

Tom: Excellent. Keep picturing … the second harmonic would be drawn as …

Bukola: … another vertical line, to the right of the first harmonic, and it would be even shorter.

Tom: Right, and then each harmonic down the line to the right would get shorter and shorter still.

Bukola: Yeah, I can picture it.

Tom: Great! This graphic is called a vocal "spectrum"—a rainbow of sound, if you will!

Bukola: Looks more like the side of a roof …

Tom: Ah, yes! And notice how the roof slopes down to the right.

Bukola: Yeah …

Tom: Well, the *pitch* you hear will be the frequency that separates each of the partials …

Bukola: The fundamental frequency …

Tom: Right. But the *quality* of the sound depends on what that spectrum looks like. (Backus, 100)

Bukola: You mean, the quality of the sound differs depending on how much energy the harmonics have?

Tom: Absolutely. "In general, the quality of sound sources is embodied in the frequency spectrum." (Titze, 117) Now, I hate to throw you a curve ball here, but, we've been talking about vibration as if it's perfectly periodic.

Bukola: Periodic?

Tom: If the amount of time each cycle takes to complete is equal. So if you, like, have a frequency of 250 vibrations per second and if each cycle takes 1/250 of a second to complete, then that vibration would be perfectly periodic.

Bukola: What if it's not?

Tom: Inharmonic frequencies can start coming into the complex wave. (Backus, 104) Some cycles can take a bit longer than 1/250 of a second and some a bit less, but after a second it can still total 250 vibrations. So you'll hear the fundamental frequency of 250; but the more aperiodic it is, the more nonharmonics, the more "rough" (Titze 1993, 167) the sound. The amplitude of the fundamental can vary from cycle to cycle too. That can be perceived as a "crackling or buzzing." (Titze 1994, 282)

Bukola: But that's normal …?

Tom: Irregularity is natural. "Vocal folds are made up of pliable tissue with an exterior layer of mucus, they do not repeat their patterns of vibration exactly from cycle to cycle; [there can be differences in the shape and mass of one vocal fold from the other too] … and irregularity can come [also] from the pulsatile nature of … [your]

heartbeat cycle, [and] from the unsteadiness in the respiratory system …" (Titze, 286) If it gets too rough though, it could be a health issue. (Titze, 309–322)

Bukola: What if you *wanna* sound extra rough.

Tom: Sometimes you need to. "When a baby cries, the sound isn't pretty … the vibration isn't regular"—and that's a pretty good sound for catching a parent's attention. (University of Utah News Center) People can do it just playing around too; sometimes it's referred to as "*creaky* voice." (Titze 1994, 259)

Bukola: Like the sound of a creaky door … *(Demonstrating)* e-e-e-e-e-e-e-k …

Tom: Yup. If it's on a real low pitch some call it vocal fry—cause it sounds like bacon frying, I think. But even a periodic vibration can sound like fry on a real low pitch if a person can perceive individual vibrations instead of collectively as one tone. (Titze, 257) Sometimes you can hear it at the end of people's sentences. It's kinda a fad now—talk low and fry. (Wolk, Abdelli-Beruh, and Slavin 2011, e111–e116)

Bukola: *(Demonstrating)* You mean like thi-i-i-i-i-i-s?

Tom: Yeah … it can be done with very little breath support.

Bukola: Hey, why breathe when you can sound cool and apathethi-i-i-i-i-i-c.

Tom: It takes very little subglottal pressure—remember, oscillation threshold, like we were say'n before?

Bukola: Ok this is all cool. But now, what makes the harmonics change their levels? I mean why will one sound be different from another …. uhhh, *harmonically*? What about pressed voice?

Tom: Right! Back to pressed voice. Thanks for staying focused!

Bukola: No problem …

Tom: Picture your vocal spectrum again, the roof sloping down to the right? "Spectral slope is the measure of how the amplitudes of successive components decrease with increasing harmonic number." (Titze, 120)

Bukola: Right.

Tom: Well, the less decrease of amplitude, which is to say *vocal power*, of each successive harmonic, the more brassy the sound will be. (Titze, 115)

Bukola: So if you're pressed, the spectral slope will be flatter. (Scherer 1991, 89–91)

Tom: Consider one cycle of vocal fold vibration of a pressed voice vs. a voice that's not pressed. Imagine they both have the same fundamental pitch, so the amount of time each cycle takes to complete is the same. In the pressed voice, because there is so much "adduction activity" (Sundberg), the vocal folds close faster and stay closed longer then a voice less pressed. In the voice less pressed, the amount of time of the cycle would be the same, but the vocal folds wouldn't close so fast or stay closed as long, all other things being equal.

Bukola: But why's pressed more *brassy*?

Tom: Because the upper partials get more power. "The quicker the flow [of breath] is … stopped, the [greater the vocal power of] the frequency components of the sound will be." (Titze, 113) If I clap my hands together fast … *(He does so.)* Now when I slap against my pants leg … *(Slapping his leg)*

Bukola: It's a duller sound.

Tom: My hands against each other created a sharper cut off … more brassy, more "brilliant." (Scherer 1991, 90)

Bukola: That means the vocal folds hit into each other each cycle?

Tom: Yes, if you're pressed they're coming into contact with each other quite sharply, and the airflow through the glottis is shutting off very fast. So just imagine if you shout when pressed …!

Bukola: Like clapping hard … can get painful.

Tom: Yeah, including possible pain, or maybe the creation of a vocal polyp or contact ulcer. (Titze, 311–312)

Bukola: Yikes.

Tom: Yeah, and that ain't all. There's another not so great aspect with pressed voice … the amount of time the glottis is open is less.

Bukola: So, because fundamental frequency is the same amount of cycles per second as the voice we're comparing it to, if the folds in pressed voice stay closed longer, then they must stay open less.

Tom: Very good! *And*, because the open phase of the glottal cycle is less, there will be, therefore, less airflow going through the glottis. And that means the vocal power of the fundamental will be less, and will end up with less power in the lower, or "woofer," part of the spectrum. (Scherer)

Bukola: Ok. Now, I understand why if the upper partials get more energy the sound'll be brassier; but how does a decrease of energy of the fundamental affect the sound?

Tom: Less woofer, less warmth. In my experience I've heard it described as a "tinny" or, like you said, a "hard" sound. In pressed voice the overall acoustic energy doesn't increase, because what you gain in stronger upper partials you lose with a weaker fundamental. (Sundberg 1987, 81) If the fundamental were stronger the overall sound would be more "full" or "richer" or "warmer," some people would say. There are all sorts of terms to describe timbre. Like if you're pressing on a high pitch it is often called "strident;" and if you're pressing on a low pitch people may say you have a "harsh" sound. (Rubin 2003, 50)

Bukola: It's kind of ironic that a person will press to get more intense if the result ends up they get less out of it.

Tom: Yes indeed! And interestingly enough, even if you're not squeezing your vocal folds together too tightly, if you get louder by increasing subglottal pressure, the more the closing rate also increases and the longer the closed phase of the oscillation becomes. (Sundberg 1987, 83) As loudness increases the more your vocal folds will displace away from each other during oscillation (or the greater the amplitude.) So then they're gonna come springing back with more zip … (https://www.youtube.com/watch?v=C18aL166O_I)

Bukola: … myo-elastic …

Tom: Yeah, the more they separate away from each other the faster they will come into contact again …

Bukola: That's why just being loud can hurt …

Tom: Yes, right—especially if you're pressed. But even the best trained singers who are careful to be vocally efficient, avoiding any excessive laryngeal effort … they still won't wanna sing full out two shows a day every day …

Bukola: Ouch …

Tom: Yeah … so when you're loud and the vocal folds come fast together, what does that do for your sound …

Bukola: Uh, the faster closing rate and longer closed time you said?

Tom: Yeah … what will happen to the quality?

Bukola: Umm …

Tom: Will you be more brassy or fluty?

Bukola: Brassy. It'll give a boost to the upper partials. (Sundberg, 78) Right, that makes sense. Like when most people, or me, get loud it can sound annoying …

Tom: It can have a "hard" edge, like pressing.

Bukola: Right. I think most people press when they shout.

Tom: So what's something actors might do to take that edge off, and consequently maybe not hurt themselves; I mean if they have to be really loud, or shout in a scene?

Bukola: Use lots of breath support.

Tom: True. But knowing what we've just been talking about what—

Bukola: Uh, not press so much …

Tom: Yes, you would do well not to …

Bukola: …to …adduct …

Tom: Not adduct so much.

Bukola: Right, gotchya! So now … like, what would be the opposite of being pressed?

Tom: The complete opposite?

Bukola: Sure.

Tom: That's called breathy voice.

Bukola: That sounds healthy.

Tom: Yes, breathy voice "is less likely to be injurious than pressed voice" (Titze, 249) because vocal fold adduction is reduced to the point where the glottis is "no longer completely closed but only nearly so …" (Sundberg 1987, 80) But like the pressed voice there are efficiency issues.

Bukola: Efficiency?

Tom: Yeah, ratio of effort to vocal power. The most bang for your buck. That's one reason I like talkin' about qualities with you—because it gets into appreciating what's happening for someone to achieve what they want in the most effortless manner.

Bukola: Not a lot of sound in breathy.

Tom: "It is characterized by a harmonic spectrum that is mixed with a constant, hissing, high frequency noise emanating from the leaking air." (Sundberg 1987, 63)

Bukola: Noise?

Tom: That is the technical name of aperiodic sound. (Backus 1969, 104)

Bukola: Like a whisper?

Tom: Yes that's made purely by aperiodic sound waves from air turbulence. People most often whisper by squeezing their vocal folds together so tensely that they can't vibrate (https://www.youtube.com/watch?v=2BsMasSdekE); the very ends in the back are separated where the airstream creates noise as it goes through. (Sundberg 1987, 63) It's possible to whisper with the vocal folds completely open, but it takes a lot more airstream to generate sound. (Behrman 2007, 206)

Bukola: It's still not very loud.

Tom: Even breathy voice, with the vocal folds vibrating, there's little overall power. The spectral slope is steep—after the fundamental the sound level of each successive partial drops off a lot more than in pressed voice.

Bukola: Because it's like clapping your hand but never actually getting to the clap!

Tom: Even if they do make contact a bit, the speed of glottal closing and the speed the flow is shut off are much slower than in pressed voice, so the upper partials never get that "boost." (Scherer 1991, 89) However, there is plenty of airflow going through the glottis during the cycle, so the sound level of the fundamental frequency is strong compared with the successive partials. Without strong higher frequency overtones the sound is not brassy, but more "fluty." (Titze, 120) A breathy voice might be described as warm, but not very brilliant.

(Tom gets an exciting idea.)

Allow me to imitate Marilyn Monroe singing *Happy Birthday Mr. President … (He sighs in a big breath.)*

Bukola: Ahhh, n'other time …

Tom: *(He holds his breath in his throat, looks at Bukola. Then sighing out meekly)* ... k. *(Changing subject)* You know, it's also possible to be pressed and breathy *at the same time*. Say your vocal folds are pressed but you push "excessive" (Titze, 77) breath through an opening in the back of the glottis.

Bukola: What does that sound like?

Tom: Have you seen *Dark Knight Rises*?

Bukola: *"I will find you!"*

Tom: That's it!

Bukola: So breathy and pressed are both not so efficient; and pressed and breathy at the same time—definitely not efficient. There has to be something else?

Tom: Basically, breathy voice to pressed voice is a range (https://www.youtube.com/watch?v=DMs_e_rshno). "Between them are an infinite number of gradations." (Sundberg 1987, 81) If you stop being really pressed, for instance, you won't suddenly become breathy; you'll just be less pressed. So between the two extremes, just like Goldilocks, you wanna find something … in the middle … that's juuuuuust right. And when you do, something really cool happens.

Bukola: The bears come home.

Tom: Maybe … the place that's just right is referred to as *flow phonation* (Sundberg).

Bukola: *Flow* again … what a great word.

Tom: Flow phonation is recognized as having plenty of airflow through the glottis during the open phase, so it'll have a substantial increase in the sound level of the fundamental over being pressed (Sundberg), *plus* it has a fast shut off and gives a boost to the upper partials.

Bukola: So you'll sound *both* warm *and* brilliant … and as powerful as a bear!

Tom: Precisely. And *you* know why you get that fast shut-off, don't you?

Bukola: I do?

Tom: Yes. If you're not pressing, and the vocal folds aren't snapping closed from effortful squeezing. What's working to close them?

Bukola: Uhhh …

Tom: You know …

Bukola: Oh! I remember.

Tom: What …

Bukola: Bernoulli's big but …!

Tom: … um … right. The delayed actions of the mucosal wave and vocal tract inertance. The delayed inward movement of the top part of the vocal folds helps creates driving pressures that suck the vocal folds closed—and the more pliable the wave …

Bukola: … the more it sucks …

Tom: … rrrr-right … and the momentum of the air going up the vocal tract also contributes; the later the vocal folds are open the faster they must shut to be closed for the next cycle—given a particular fundamental frequency. So the delay allows for more airflow through the glottis, which makes for a strong fundamental frequency, and the fast shut off gives a boost of acoustic power to the upper partials. "A combination of vocal fold motion and acoustic interaction with the vocal tract can produce perceptually important differences in the resulting sound." (Scherer 1991, 91)

Bukola: And it's efficient.

Tom: Right! The amount of breath support you'll need to sustain phonation will be less. "A prevailing topic of interest in voice science has been the efficiency of conversion of aerodynamic power into acoustic power radiated from the mouth; [called 'glottal efficiency,' it is traditionally defined as the ratio of radiated acoustic power to aerodynamic power.]" (Titze, 243) Now, in my experience, there are effortful and less effortful and even *non*-effortful ways to create a breath stream with lots of power. And every voice technique I know of spends a lot of time working with students to maximize breath potential. However, that said, the less pressure (breath support) needed for vocal onset and sustained oscillation the better, no matter how effortless you may be at supporting. I mean, why make something more forceful than it needs to be, right? So it's good to consider.

Bukola: And it's good not to squeeze, uh, *adduct* your vocal folds together more than necessary so you don't need the extra breath support to move them apart.

Tom: Yeah. For the performer, glottal efficiency must take into consideration the "cost-benefit ratio for vocal health and longevity … [and any laryngeal effort making] the entire phonation process more effortful." (Titze, 245)

Bukola: *(With a sigh, sitting back in chair and finishing Coke)* I'm all about effortlessness.

Tom: Hey, I think your hour's up. Don'tcha have to be somewhere?

Bukola: Oh yeah … bother! *(Checking phone, getting bag, guitar case, empty soda can, and indicating half-eating Pop-Tart on desk)* You want that …?

Tom: I'll save it for you.

Bukola: Oh yeah, we didn't finish. Like we never got to how this affects speech.

Tom: And, how speech affects this.

Bukola: Huh?

Tom: Yes, there's more to discuss. Today we talked about sound engendered in the larynx by the changing airflow created by the interaction of the vibrating vocal folds and the transglottal pressure. This is generally called the "*voice source*." (Sundberg 1987, 3) But we can still talk more about what happens to the sound as it travels up the vocal tract and influences things.

Bukola: Cool. Same time tomorrow?

Tom: I'll be here.

(Bukola hurries down hallway; Tom wraps up Pop-Tart.)

Bukola: Oh. *(Calling the down hall) Professor!*

(Tom stick head out of doorway)

Tom: Yes?

Bukola: Who's *Julia Child*?

Tom: Tomorrow …

(Bukola nods and continues off; Tom sits down at desk and goes back to his salad. He picks up a carrot stick and stares at it forlornly. After a moment, he takes a bite and continues munching as lights fade. BLACKOUT.)

Supplemental data

Supplemental data for this article can be accessed here: http://dx.doi.org/10.1080/23268263.2014.887241

Notes on contributor

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