A TOOLBOX FOR TEACHING PHONETICS

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Phonetics is my favourite topic to teach. I think this is because it has such a high ‘wow’ factor — the scope for fun and impressive demonstrations is vast. This makes the students particularly easy to engage.

In developing my introductory phonetics teaching, a lot of effort has gone towards collecting fun but useful demonstrations which can be done in the classroom. I have encountered many of them as, I’m sure has anyone else who has attempted to teach in this field. And I have settled on my own personal favourites. This paper describes my own ‘phonetician’s toolbox’ — the ingredients which are packed into my phonetics teaching drawer, and which do dutiful service each year. I write this in the hope that itemising the objects may provide a useful service for people who are new to the teaching of phonetics, or for more experienced people looking for a toolbox refresher.

My contribution here is solely one of compilation and documentation. None of the demonstrations I describe in this article are of my own invention, but I am afraid the chain of inheritance is so long and so lost, that it is impossible to credit anyone appropriately. I’ve observed some of these tricks in other people’s lectures, I’ve read about some of them on the web or in books, and many of them have been related to me by fellow phoneticians. Hopefully readers will forgive the paucity of citations.

When teaching phonetics, a lot of the best learning happens in the lab, and there is a sense in which excellent lab exercises are the very best arsenal you can have. Luckily these days no special equipment is required, at least at introductory level. In fact, one doesn't even need a lab, as there is excellent free available software such as Praat, which students can download onto their own machines. Students enjoy being asked to work with unknown languages — even from very early in the phonetics course, and they also very much enjoy working with their own voices. In my introductory course, a successful assignment involves recording all of the students, and then asking them to analyse their own voice: produce a vowel plot, measure their Voice Onset Times, assess the length difference between their 'short' and 'long' vowels. From a teaching perspective, this is much more engaging and successful than having all the students measure a single voice. It does, however, present its own challenges in terms of the increased grading burden.

As students become increasingly advanced, it is my preference to make my phonetics teaching increasingly lab-based. However at the beginning, there is basic content to be covered, and lecturing to be done, and this is where the box of tricks is invaluable.

Our introductory course at Canterbury covers both articulatory and acoustic phonetics. Students inevitably find the acoustic phonetics material more difficult, and often slightly overwhelming. I have found an approach which weaves together the two approaches throughout the course more successful than one which has a strictly separate 'acoustics' component. This way they have had several weeks to digest — for example — what a waveform is, before we get on to complex wave forms and resonant frequencies.

Now, onto the contents of the toolbox:

1. Two empty beer cans and a straw

Sometime early in an introductory phonetics class, I teach about the voicing mechanism, and attempt to convey how the passage of air through the vocal folds causes them to vibrate. This — I relate to the students — consists of several phases. First, the air builds up below the closed vocal folds until the pressure is high enough to push the vocal folds apart. As the air rushes through the vocal folds, the increasing velocity of air eventually causes the vocal folds to spring back together. On this last point, I invariably lose the students, whose foreheads wrinkle in eery unison. Out come the trusty beer cans for a demonstration of the Bernoulli Effect.

To do this, position two empty cans quite close together on a desk — with about 5 mm or so between them. My cans are battered 'Canterbury Draught' cans, which I like to think endows me with extra street-credibility amongst my students. I then wave a straw at the students, and ask what will happen if I use the straw to blow air between the cans. New Zealand students are very consistent in their response: The air will force the cans to move away from one another. When asked for a show of hands, the majority of the class seems to agree on this point. But — low and behold — when I blow through the straw, the exact opposite happens. The cans snap together in a pleasing demonstration of the Bernoulli Effect. Moving air creates low air pressure. Objects move from areas of higher air pressure to areas of lower air pressure. This makes planes fly, and vocal folds vibrate. I also remind students of the demonstration later in the course, when we discuss the mechanisms of trills. It is always satisfying to demonstrate something that seems to run completely counter to students' intuitions. And precisely because it is counter to their intuitions, the demonstration is important. The element of surprise seems to make the principle memorable.

Of course, the same point can be made by holding a piece of paper vertically below one's mouth, and blowing (causing the paper to rise up to horizontal position). But this doesn't involve beer cans, and so is inherently less interesting.

The presence of the straw in your inventory can come in handy for other means, as well. For example, in combination with a glass of water, it can be used to demonstrate different degrees of airflow produced by different types of sound.

2. A balloon for each student

This demonstration has some slight educational value, but I mainly like it because it makes the students laugh. It is very loud and is guaranteed to break down any preconceptions students may have about the lecture theatre being a non-interactive environment. I use it early — directly after teaching about voicing, when I am teaching about pitch. The puzzle: how do we use our articulators to increase or decrease the pitch of our voices?

I give every student a balloon, and ask them to blow it up and then slowly let out the air such that the balloon emits a rather annoying squeaky noise. They seem to have to do this at least once or twice to get over the apparent humour involved in the chorus of a classroom of 40 students emptying balloons simultaneously.

In collaboration with their neighbours they are then asked to figure out the various ways in which they can change the pitch of their deflating balloon. With luck, there are two families of response. One involves changing the tautness with which the mouth of the balloon is held. This can be directly related to the tightness of the vocal folds. The second involves the velocity of air through the balloon — manifest in two ways. One is simply the observation that as there is progressively less air in the balloon, the pitch of the balloon decreases. The second is that a sudden squeezing of the balloon results in a corresponding rise in pitch. From the resulting discussion the students are usually able to infer that a change in the pitch of an individual's voice relates to a change in the speed of vibration of the vocal folds. The speed of vibration can be controlled in two ways — (1) by manipulating how tightly the vocal folds are stretched, and (2) by manipulating the speed of airflow through the vocal folds. I usually suggest to the students that they can test this latter point at home by attempting to voice a constant pitch while having their flatmate or sibling punch them in the stomach. I'm not sure whether any of them have actually conducted this experiment.

3. A lollipop for each student

The tongue is not as sensitive as one might think, and students seem to have surprising difficulty knowing what position their tongue is in when they produce various sounds. And instructing them to put their tongue in a particular position to create a new sound is more or less doomed to failure. A tried and true method for connecting the tongue with the brain is the use of the lollipop. I first came across this technique while visiting Ohio State as a graduate student. It is crucial for its success that it is a classic, round, flat lollipop with a nice long stick. The modern spherical lollipops of the chuppa-chups generation are no good at all.

I distribute lollipops when I am teaching vowels. They can be placed flat on the body of the tongue, and then the movement of the stick reveals relative differences of position of the tongue. For example, if you can get the students producing a high front /i/, then you can issue instructions such as: attempt to slowly lower your tongue without moving it backwards. The lollipop stick should lower, but not retract (or, at least, retract as little as possible). This gives them the concept of moving from high to low front vowels. Once they are producing a low front vowel, they can be asked to keep the lollipop stick as low as it is, but retract their tongue so the stick moves back as far as possible. This enables them to 'feel' the difference between front and back low vowels. Producing various vowels while holding the lollipop stick gives relatively concrete feedback about the position of the tongue. Of course, and rather unfortunately, the presence of the lollipop in the mouth rather distorts the acoustics of the vowel, and also the ability of the tongue to get into the highest positions. This activity, of course, needs to be optional, as there are occasionally students who have dietary restrictions prohibiting lollipop consumption. For such students, it is useful to note that the activity works just as well with the lollipop 'backwards' — so that the stick is in the mouth and the plastic-covered lolly is held outside the mouth. The degree to which this approach provides a hygiene hazard may depend on the initial packaging of the lollipop.

4. Slinkies

Slinkies are invaluable for the demonstration of various properties of waves. I have two — a large one and a small one. One useful demonstration involves the difference between transverse and longitudinal waves. This works best with a relatively large slinky, so students can quite clearly see the movement of the individual coils for the longitudinal wave. I also often use members of the class for this demonstration, setting up a transverse (Mexican) wave along one row of the classroom, and a longitudinal wave along another (where a student starts the wave by rocking left to right, and bumping into their neighbour).

When questioned about what kind of wave sound is, many students believe it is transverse. This no doubt comes from the standard method of diagramming sound waves, which looks very similar to a transverse wave. So I find it is very important to drum home the fact that the sound waves are longitudinal, and to carefully explain how a diagrammed waveform relates to differing air pressure during the wave.

The slinky also comes in handy for various other demonstrations. By holding it fixed at each end, it is useful to demonstrate different modes of vibration, in discussions of harmonics. Once one gets to the third mode of vibration, one needs to be quite practised, unless in possession of a relatively small slinky. I keep two different sizes on hand for different demonstrations.

And when teaching the acoustics of consonants I often return to the slinky in an attempt to demonstrate a non-periodic wave. I do this by attempting to introduce chaos into the slinky. Having broken two slinkies during such demonstrations (by getting them irreparably tangled), my non-periodic slinky waves are now produced in a relatively restrained manner.

5. Pendulums and tubes

Pendulums are invaluable for illustrating the notion of a resonant frequency. They don't need to be fancy — but there does need to be more than one. Mine are simply pieces of string with dog-clips on the end. Simple pendulums have a simple resonant frequency — a frequency at which they like to swing. For each pendulum, you can demonstrate that, no matter how much or little energy you put into it, it likes to swing at the same rate. Showing two pendulums of different lengths side by side shows that this rate is different for different pendulums — changing the length of the string changes the resonant frequency of the pendulum. It is impossible to get the two different length pendulums swinging in parallel, (though it is easy to amuse the students while trying).

What is important is that in order to keep each pendulum swinging nicely, you have to inject energy into it at its own resonant frequency. As long as you do this, the swings will get bigger and bigger. However if you try and inject energy at a different frequency, this energy will be damped out, and the pendulum won't swing nicely, but rather will wobble in a chaotic, non-pendulum-like manner. This is very useful for talking about resonant frequencies and sound. Sound components near the vocal cavity's resonant frequencies will be amplified, and others will be damped.

In order to demonstrate that different shaped cavities have different resonant frequencies it is handy to have at least two different lengths of tube on hand. Mine are simply cardboard tubes which have been cut to different lengths from the inner tube of a roll of paper towels. Hum, whistle or speak through each tube to show that the tube changes the perceived quality of the voice. The input to each tube is the same, but the sounds are filtered by the different tubes, each of which has their own resonant frequencies.

6. A teaspoon

I do happen to know the original source of this particular trick. Peter Ladefoged, in *A Course in Phonetics* (1982: 174-175), suggests various ways of learning to 'hear' the resonant frequencies of the vocal tract (i.e the formants). A good way to hear the second formant is to whisper the vowels. A good way to hear the first formant is to produce the vowels in creaky voice. Another way of hearing the first formant, suggests Ladefoged, is to create a glottal closure, and then flick the side of the neck with your fingernail. If you silently create different vowels, the sound created by the flick has remarkably different acoustics.

This last demonstration can make quite an impression on students, and so is worth putting some effort into perfecting it. One tool which I find indispensible in this respect is a metal teaspoon. I've found that hitting the side of your neck with the back of a spoon provides a much louder, more satisfying and uniform tone than the mere flick of a fingernail.

This skill can be useful in other respects as well. I was once required to attend a farewell party for a friend which took the form of an 'everyone participates' talent quest. As I am completely talentless, this presented rather a challenge. I ended up studying the 'glottis and spoon' technique sufficiently that I could approximately assign each of my vowels to musical notes, enabling me to perform 'Auld Lang Syne' and other classics at the party. I was an unexpected hit. If you are dedicated enough to perfect the glottis and spoon as an instrument, such performances also go down a treat in the classroom. However I recommend that you confine your practice sessions to the comfort of your home, where an unusually scarlet neck is unlikely to raise any eyebrows.

7. A lighter

A common way of teaching about allophones and phonemes is to discuss the different phonetic variants of voiceless plosives. Beginning phonetics students are unaware, for example, that /t/s in different positions contain different degrees of aspiration. One way to convince them of this is to have them hold the palm of their hand in front of their mouth, and produce paired words such as 'tan' and 'stan'. But, as with many demonstrations, this demonstration is made more dramatic if it involves fire.

I use a long gas lighter, which has a nice big flame. If you practice ahead of time, you'll be able to figure out the optimal distance from your mouth to hold the lighter. This is the distance at which all 'tan's, no matter how subdued, extinguish the flame. On the other hand, no matter how much effort is put into giving the /t/ in 'stan' some legs, the /t/ cannot extinguish the flame. Hold the flame at this distance for your demonstration. It appears to be strangely entertaining for students to watch someone try in vain to put out a flame with their post-fricative /t/s.

8. IPA bingo

From http://www.cascadilla.com/ipabingo.html you can download and print IPA bingo. I keep this on call as a reliable standby, if the students need some revision, or perhaps a break from the onslaught of new information. Sometimes I sneak it into a tutorial. I like to have it on hand in my toolkit, because of my recurring paranoia that one day my lecture will finish prematurely early, and I will be left gaping with nothing to say. In practice, I tend to suffer from the opposite problem, and am constantly running slightly behind schedule. For this reason, while I keep it on hand throughout the course, we often don't have time for it at all.

It seems to require some panache to pull off in style. It was most successful the year I was able to exploit the skills of Andrea Sudbury, a seasoned caller from the bingo-halls of the Northern Hemisphere. She put impressive effort into devising 'bingo'-type embellished descriptions for various IPA categories, and called the cards with spookily professional intonation.

9. Computer tricks

It is very handy to be able to spontaneously record people, and then immediately examine their speech. I take a head-mounted mic to class, so that I can record onto my laptop and open the recording directly in Praat. This is particularly interesting if you have students from different language backgrounds in your class. For example when I am teaching about pitch, I usually ask a speaker of a tonal language to record a few phrases, and then open this in Praat to show students how to read a pitch tracker. I usually also record myself or a student saying /t/ both initially and post-fricative, as part of the demonstration following the flame. Students can see or feel the difference in aspiration, but it is nonetheless very difficult for them to hear it. If you can play 'stan' without the /s/, they instantly realise how very /d/-like the sound is.

There are a number of good interactive IPA charts available. I keep them bookmarked, and access them over the net when necessary. Peter Ladefoged's chart is at http://www.phonetics.ucla.edu/course/chapter1/chapter1.html. York University also has one at http://www.yorku.ca/earmstro/ipa/. You could also use the CD provided by Ladefoged (2004) in 'Vowels and Consonants". I find this comforting to have on hand for times when my production confidence is shaken, and I am unsure of the accuracy with which I may be producing a certain obscure sound. If you play them the sound from the interactive IPA, it provides a nice, authoritative source. Having the sound files available also means you can demonstrate what any sound happens to look like in a spectrogram, should this become relevant in the discussion.

Students seem to best develop an understanding of the component parts of speech when they are actually able to hear them separately. Using speech synthesis to demonstrate the component parts that contribute to natural sounding speech is a handy teaching device. For this purpose, I tend to lift and use Peter Ladefoged's nice 'A bird in the hand is worth two in the bush' demonstration. This is available here: http://hctv.humnet.ucla.edu/departments/linguistics/VowelsandConsonants/vowels/chapter7/abirdinthehand.html.

It provides 9 versions of the sentence — formants 1, 2 and 3 separately, the first three formants all together, the first three formants+higher formants, the non-periodic sounds, all of the above together, and all of the above together with pitch movement. The latter file is a reasonably convincing synthesis of a male voice producing the sentence. If you play each of formants 1, 2 and 3 separately first, students can't make out the content. But if you play them together, they usually can. Playing them separately after students have heard them together enables the listener to tune in to the separate sounds of the different formants. And the non-periodic sounds have a funky beat-box-type effect that never fails to amuse.

A quick search of the web also turns up many other useful demonstrations. Video demos of vocal fold vibration are indispensable, as are X-ray videos of tongue movement. There are also a variety of online demonstrations of the McGurk effect, and of Categorical Perception tasks, which are nice and handy.

10. Conclusion

Obviously 'a bag of tricks' is just that, and is no substitute for good teaching. The majority of my classes are in fact much less vaudevillian than the above might suggest. But I have taken the easy way out here, as the contents of the bag of tricks is infinitely simpler to articulate than the characteristics that make for good phonetics teaching. However I do believe that students learn better when they are able to experience a phenomenon first hand, rather than when it is explained to them in relatively abstract terms. I also believe that the degree to which one can engage the students and keep the classroom lively and interesting has a direct effect on the students' learning, and interesting demonstrations certainly help with this. I have also found that such demonstrations are effective in breaking down barriers, both between the students, and between them and me, and positively influence students' willingness to stick with me during the material that is inherently somewhat drier. These demonstrations are regularly mentioned in the positive comments on my phonetics teaching evaluations, with balloons and lollipops being particular favourites. The most negative comments usually relate to my bad handwriting, and the sometimes illegible nature of my whiteboard technique. As with all things, one can only do one's best. While I have done my best to respond to this criticism, I am assured there is still room for considerable improvement.

References

Ladefoged, Peter. 1982. *A Course in Phonetics*. 2nd Ed. NY: Harcourt Brace Jovanovic.

Ladefoged, Peter. 2004. *Vowels and Consonants*. Malden: MA: Blackwell Publishing. (audio files available from: http://www.phonetics.ucla.edu/vowels/contents.html)