

Intuitive Education in Acoustic Phonetics and Speech Science

Takayuki Arai¹

¹Dept. of Information and Communication Sciences, Sophia University, Japan

¹arai@sophia.ac.jp

Abstract

When we teach acoustic phonetics or speech science, we might face some problems in teaching certain topics. The source-filter theory is one of them, for example. We have been developing several types of physical models of the human vocal tract and showed that they are useful because it is extremely intuitive to show people how we make speech sounds by using them.

The Acoustic-Phonetics Demonstrations (APD) is an online version of demonstrations in acoustic phonetics and speech science. It helps teachers and learners for education in such areas because the materials are mainly in the form of sounds, images, videos, and explanations. The APD website shows several video clips demonstrating vowel production using vocal-tract models.

Using a physical device is often effective for children as well. Therefore, an English TV program for children is now focusing on the pronunciation of English sounds. In this TV program, the author supervises an experiment segment in each episode. Using familiar words, the experimental tools used in these segments enable viewers to enjoy learning English with all five senses.

Keywords: intuitive education, vocal-tract models, acoustic phonetics, speech science, acoustic-phonetics demonstrations

1. Introduction

For the last two decades, I have been teaching acoustic phonetics to technical students and humanities students in such disciplines as psychology, linguistics, and speech & language pathology. Instead of using mathematical notations of acoustic theory, I have established methods for teaching the subject in an intuitive way. For example, I developed different types of vocal-tract models, which are now used for education in science research and foreign pronunciation for all types of people, including children. The following is a description of the various educational applications we have been exploring. The targets are all of us,

including students, children, language learners, and patients.

2. Vocal-tract models

About twenty years ago, I started teaching acoustic phonetics. My classes are often a mix of science & engineering and humanities students. In 2001, we celebrated the 60th anniversary of the publication of *The Vowel* by Chiba and Kajiyama [1]. Because my first vocal-tract models were based on Chiba and Kajiyama's 3D measurements of the human vocal tract, we developed precise reproductions of their models for this anniversary celebration [2] (please see VTM-N20 in Fig. 4).

Since then, I have developed many types of vocal-tract models, which are summarized in several articles [3, 4, 5, 6]. Some sets of our vocal-tract models are even on display at museums around the world (Figs. 1 and 2).



Figure 1: Vocal-tract models exhibited at the Händel-Haus in Halle, Germany.



Figure 2: Vocal-tract models exhibited at the National Estonian Museum in Tartu, Estonia.

The sets of our vocal-tract models were originally designed and are still used to give an intuitive education in acoustic phonetics and speech science. It soon became obvious that they are useful for science research and pronunciation training. One example of the models being used in foreign pronunciation training is described in [7].

While early sets of the vocal-tract models were originally designed for vowels, we now have consonant models as well. For example, there are models which produce English /r/ and /l/ that are useful in pronunciation training. Even consonant clusters, such as /br/, are evaluated with one of the models as shown in Fig. 3 [8]. We have started to use a head-shaped model to evaluate different types of articulations of vowels and consonants.

3. Acoustic-Phonetics Demonstrations

Because not everyone has access to our vocal-tract models, there was a demand among acoustic phonetics and speech science learners for an e-learning environment. Therefore, we developed the website “Acoustic-Phonetics Demonstrations (APD)” (<http://www.splab.net/APD/>). On this website you will find an introduction to acoustic phonetics and speech science using text, figures, sounds, and videos. Some of the video clips are available on YouTube, where the vocal tract models are used to explain several topics. On this website, files for 3D printing of vocal-tract models (Fig. 4) are provided.

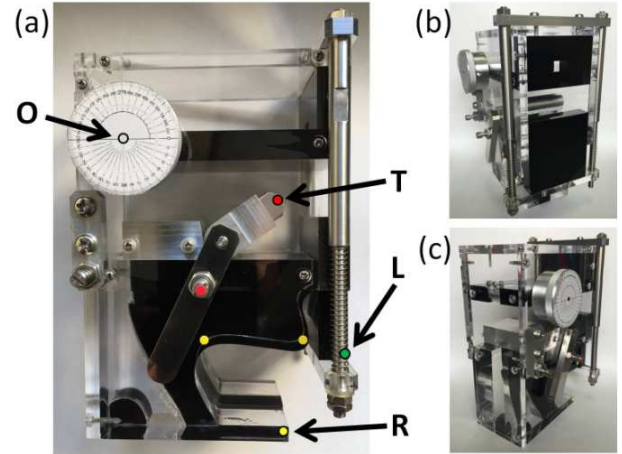


Figure 3: A bent vocal-tract model with a nasal cavity. This model can produce consonants /b/, /m/, /w/, /r/, and /l/ besides vowel /a/.

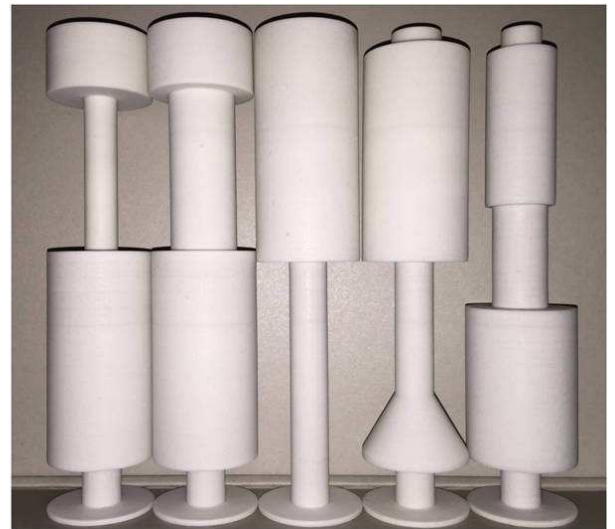


Figure 4: Vocal-tract models produced by a 3D printer. Top: VTM-N20. Bottom: VTM-T20.

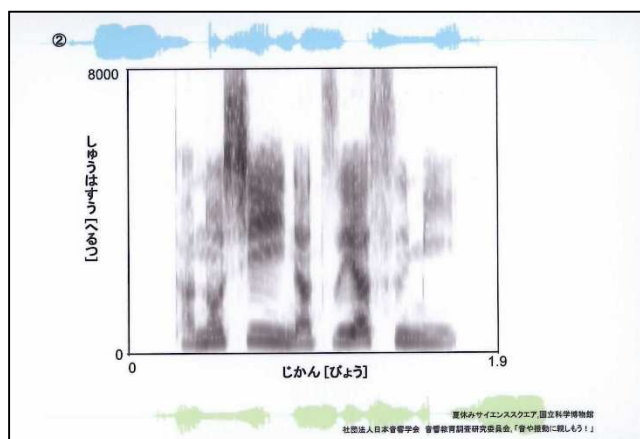


Figure 5: A card with a spectrogram for an activity using the Digital Pattern Playback at the National Museum of Nature and Science.



Figure 5: An experimental tool in the NHK English TV program for children.

Digital Pattern Playback, or DPP, is another tool for education in acoustic phonetics and speech science. The DPP technology is based on the original “Pattern Playback,” and it is used to demonstrate the importance of formant transitions, among other things. DPP application software is now used for a science event for children at the National Museum of Nature and Science in Tokyo (Fig. 5).

4. English TV program for children

Since April 2017, NHK has been broadcasting an English TV program for children called “Eigo de Asobo with Orton” (Let’s Enjoy English with Orton). This TV program focuses on English sounds, and every weekday children learn a new English vowel or consonant. Currently, I am supervising the sound experiments for this program where the children can practice English sounds using tools like those shown in Fig. 6.

English /r/ and /l/ are the typical sounds that Japanese children face difficulty in acquiring. For /l/, a tool called “Lion Mask” was introduced in this TV program. This tool consists of a frame and a thin stick running horizontally as shown in Fig. 6. As a girl is doing in the right panel of Fig. 6, one can place the thin stick on the surface of the tongue with the tongue tip reaching against the alveolar ridge. In this case, she can experience a lateral approximant and pronounce a proper English /l/ with this tool.

The program also introduces how to make simple experimental tools for the viewers. They can make their own tools with everyday products available at home as shown in Fig. 6.



Figure 6: A tool called “Lion Mask” for English /l/.

We hope all children nationwide are enjoying learning English while becoming interested in the world of sound.

5. Conclusions

Several types of educational tools were introduced. Even though the vocal-tract models were originally designed for education in acoustics and speech science, some of the models can be applied for science and application purposes. The vocal-tract models have the potential to contribute to many applications, and we can combine them with PC-based tools.

6. Acknowledgments

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