INTERSPEECH 2023
20-24 August 2023, Dublin, Ireland

Teaching Non-native Sound Contrasts using Visual Biofeedback

Shawn Nissen

Department of Communication Disorders, Brigham Young University, Provo, Utah, USA
Shawn_nissen@byu.edu

Abstract

This demonstration will explain how non-native sound contrasts can be taught to second language (L2) learners using real-time visual biofeedback through an electropalatographic (EPG) sensor. How the EPG sensor is created from a dental mold and is subsequently produced will be shown during the presentation. An explanation of how a student can visualize the contact patterns of their speech and how a tutor might use the various features of the associated software to customize the instruction to an individual speaker will be illustrated during the presentation. Possible limitations, costs, and drawbacks to using the technology will also be discussed.

Index Terms: second language instruction, electropalatography, pronunciation training, ESL

1. Introduction

EPG is a system designed to provide real-time visual bio-feedback on a computer monitor of how a speaker's tongue contacts the hard palate during speech production [1, 2]. Historically, visual biofeedback from an EPG device has been more commonly used to evaluate and treat developmental and acquired speech disorders [3]. Similar to the difficulty that native speakers may encounter when learning to distinguish and accurately produce a native fricative or liquid contrast, second language (L2) learners may also encounter difficulty acquiring the motor speech patterns to produce sounds in a native-like manner. Traditional approaches to L2 instruction have often relied heavily on auditory modeling of correct sound productions. However, L2 students who have difficulty perceptually distinguishing a sound contrast may need an alternative form of feedback. A limited number of studies have reported positive results when EPG is used in L2 instruction [4, 5, 6]. In particular, EPG may be useful to facilitate the acquisition of sound contrasts that require differing patterns of lingua-palatal contact, such as the English /l/ and /r/ distinction for native Japanese speakers or the allophonic variations of the German voiceless palatal [ç] and velar fricatives [x] for native English speakers (ich-laut/ach-laut).

This presentation will examine an EPG system originally developed by Fletcher [2], of which the sensor and associated software has been recently updated and produced by SmartPalate International©. As shown in Figure 1, the pseudopalate sensor is similar to an orthodontic retainer (approximately 2 millimeters thin). This EPG sensor is designed to fit the contours of a speaker's upper teeth and hard palate, extending from the central incisors to the back molars. The sensor contains 124 gold-plated electrodes arranged in a grid pattern across the surface of the pseudopalate.

Figure 1: *EPG pseudopalate*

Considering that the monetary cost and time of production is practical, this EPG system may be an effective tool for improving the pronunciation of an individual's L2 or possibly for use in a small classroom environment. In addition, the size of the artificial pseudopalate and the nature of the visual display of the speaker's contact patterns may indicate the system is a more effective tool for adult speakers learning an L2, compared to the more traditional application, the remediation of speech sound disorders in children, as shown in Figure 2.

Figure 2: *EPG pseudopalate*

2. Demonstration Procedures

This Show and Tell demonstration will give a brief history of the EPG device, both older and current models, followed by an explanation of the process by which the pseudopalate in the recent system is created from a dental impression and subsequent stone model, as shown in Figure 3.

Figure 3: *Stone Model*

The presentation will also explain how a small microprocessor or data link, worn around the user's neck, is used to transfer the electrode contact pattern data from the pseudopalate sensor to a computer display through a USB connection. The linguapalatal contact pattern is overlayed on an anatomical drawing of a model of the hard palate and upper teeth, as shown in Figure 4. A simulated electrode is highlighted when the speaker makes contact between their tongue and hard palate at that location.

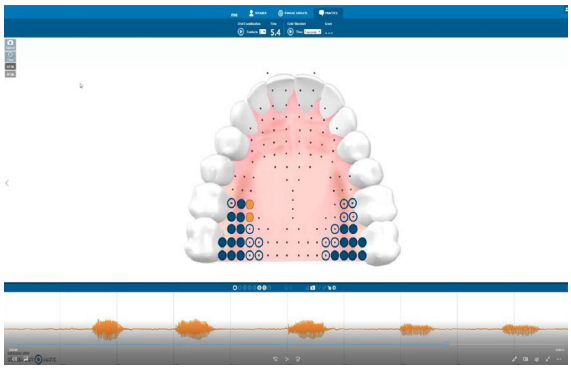

Figure 4: *EPG software*

The different features of the instructional software will then be demonstrated. The software allows a user or instructor to set patterned targets for individual speech sound contrast. A demonstration will be given describing how the software can be customized to have an instructor model a sound contrast on a split screen view. Several drawbacks and limitations of the system will also be discussed, including but not limited to possible interference of the speech acoustics, time needed to adapt to the pseudopalate device, and possible confusions when interpreting the software display in real time.

3. Conclusion

The aim of this demonstration is to explain the history, production, and the possible benefits and limitations of using EPG visual biofeedback to facilitate the acquisition of L2 sound contrasts.

4. Acknowledgements

This research was made possible through funding by the Fletcher Endowment for Biocommunication. I have no conflict of interest, financial or otherwise, regarding the company that produces the EPG device demonstrated in this presentation.

5. References

[1] S. Fletcher, *Articulation: A physiological approach.* San Diego: Singular Publishing Group, 1992.

[2] S. Fletcher, M. McCutcheon, and M. Wolf, "Dynamic palatometry," *J. Speech Hear. Res.,* vol. 18, pp. 812-819, 1975.

[3] A. Lee, M. Liker, Y. Fujiwara, I. Yamamoto, Y. Takei, and F. Gibbon, "EPG research and therapy: Further Developments," Clin. Lingist. Phonet., June 2022. [Online]. Available: http://doi.org/10.1080/02699206.2022.2080588

[4] A. Bright, "The palatometer as an instrument for accent reduction therapy with three native ESL Spanish speakers," M.S. Thesis, Dept. Communication Disorders, Brigham Young University, Provo, UT, 1999.

[5] J. Hacking, B. Smith, S. Nissen, and H. Allen, "Russian Palatalized and Unpalatalized Consonants: An Electropalatographic and Acoustic Analysis of Native Speaker and Learner Productions," *J. Phonetics,* vol. 54, pp. 98-108, 2016.

[6] A. Schmidt, "Electropalatography treatment for training Thai speakers of English," *Clin. Linquist. Phonet.*, vol. 12, pp. 389-403, 1998.