

SPECTROGRAMS FOR SPEECH: THE CLINICAL APPLICATION OF SPECTROGRAPHIC DISPLAYS

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INTRODUCTION

It is estimated that 5% of first graders and roughly 8—9% of children in general have some type of speech sound disorder (National Institute on Deafness and Other Communication Disorders, 2010). 80% of these children require formal therapy; in fact, 92% of speech-language pathologists who work in schools provide services to remediate articulation (Castrogiovanna, 2006, as cited in Ruscello, 2008). While many children are likely to demonstrate accurate phoneme production after traditional speech therapy, some children do not respond as positively to treatment; their errors may extend into the teenage years and even adulthood (Ruscello, 1995; Shriberg, Gruber, & Kwiatkowski, 1994). Unfortunately, a proportion of these children are often characterized as “lacking motivation” and may be eventually dismissed from treatment for lack of progress (Ruscello, 1995). Certainly, the social-emotional and interpersonal effects experienced by individuals with speech sound disorders, especially by those whose disorders are never fully remediated (Gordon-Brannan & Weiss, 2007), warrant creative and alternative treatment approaches.

Biofeedback, one alternative treatment approach for speech sound disorders, is becoming an increasingly useful tool in wider health circles. Spectrographic displays (SDs), a form of biofeedback, have been shown to be effective in treating a variety of speech sound disorders (Adler-Bock, Bernhardt, Gick, & Bacsfalvi, 2007; Ertmer & Maki, 2000; Ertmer & Stark, 1995; Ertmer, Stark, & Karlan, 1996; Massaro & Light, 2004; Ruscello, Shuster, & Sandwisch, 1991; Shuster, Ruscello, & Toth, 1995; Stark, 1971, 1972). Various obstacles, however, including cost and accessibility (Houle, 1988; Ruscello, 1995), have kept many clinicians from trying alternative therapy approaches to help their clients remediate errors that are particularly stubborn and unresponsive to traditional treatment approaches. The following project offers a solution to the problem of accessibility and cost of SDs. Moreover, making the technology available to clinicians is only part of the solution. It is equally important that clinicians know how to use SDs appropriately for their various clients. This project also will demonstrate *how* SDs may be used as an additional feedback tool to remediate specific speech sound disorders.

PURPOSE

SDs have been shown to be effective and affordable for treating speech in various populations, even for children who lack auditory feedback. Nevertheless, many clinicians still refrain from using SDs in day-to-day practice. The tools, it seems, are all available, but the *process* of putting all the pieces together for a clinical purpose may be a daunting one, especially if many clinicians have not considered speech sciences since their undergraduate careers.

The purpose of this project is to consolidate the research, tools, and process of using SDs in a clinical setting so that clinicians can efficiently and affordably do the following:

- 1.) Consider the appropriateness of using SDs with various clients
- 2.) Acquire the appropriate software and hardware needed to start an SD intervention program
- 3.) Learn how to operate the SD software and hardware for clinical use, including troubleshooting and customization for their clients' individual needs
- 4.) Learn instructional techniques and methods when using SDs with children
- 5.) Obtain instructional materials, such as worksheets and data collection forms to use in accordance with the principles of evidence-based practice.

METHOD

- Selection criteria for spectrogram software were developed. Priority was given to real-time analysis, PC/Mac compatibility, and affordability. Secondary criteria included modifiability of settings and availability of dual display.
- 19 spectrogram software programs were reviewed and trialed.

- One software program, WaveSurfer, was selected as the most suitable tool for clinical use based on the above criteria.
- Project author was oriented to WaveSurfer and developed step-by-step protocols for various tasks (e.g., set up basic spectrogram, save settings, modify settings, etc.).
- Screenshots of software procedures were prepared for tutorials. Screenshots of spectrogram images created with WaveSurfer were prepared.
- Activities and data collection sheets were developed to support use of spectrograms in the clinic.
- Domain name and hosting for website was purchased and developed.
- Website with a total of 41 subpages was created to deliver information how to download WaveSurfer, modify WaveSurfer's settings for basic spectrographic displays, and use WaveSurfer with students.

RESULTS

- www.spectrogramsforspeech.com, includes the following information:
 - Homepage with images of spectrogram therapy and basic instructions for getting started
 - Background information of spectrograms
 - History of the development spectrograms
 - Detailed history of the clinical use of spectrograms
 - Review of instrumentation research
 - Theoretical foundation for the use of spectrograms to treat articulation
 - Early theory of phonology acquisition
 - Directions Into Velocities of Articulators (DIVA) model
 - Learning/motivation theory
 - Process of creating website
 - Author's own personal and clinical background with spectrograms
 - Software selection flowchart
 - Tutorials
 - Overview of WaveSurfer (i.e., developer information, features)
 - Computer requirements (i.e., platform, hard disk space, memory)
 - Microphone recommendations and microphone setup tutorial
 - How to download and install WaveSurfer
 - How to use WaveSurfer in the clinic (i.e., set up basic spectrogram, modify settings, apply target line)
 - SLP Resources
 - Candidate selection
 - Target selection
 - Spectrogram bank (i.e., screenshot images of vocalic and consonantal /ɹ/ spectrograms)
 - Instruction tools (i.e., directions, analogies, feedback)
 - Activities (i.e., worksheets to accompany therapy with spectrograms)
 - Data collection sheets for clinicians and students
 - Web resources
 - Credits
 - Acknowledgements
 - Extensive bibliography
 - Contact
 - E-mail information for author
 - "Leave a Reply" form

CONCLUSIONS

Speech acoustics tools are not just useful in university research labs. Spectrograms provide valuable biofeedback information that clinicians can use to remediate tough speech errors such as vocalic and consonantal /ɹ/. www.spectrogramsforspeech.com is a new website that provides access to free spectrogram software as well as education on how to use spectrograms for clinical purposes.

CLINICAL SIGNIFICANCE

An important key to successful speech therapy is feedback and how it is utilized to shape a new behavior. Sometimes, traditional feedback is not enough to teach and maintain a new speech sound, especially if the sound does not have very obvious tactile cues. Visual feedback is an appropriate form of feedback, particularly for vocalic targets like /ɪ/. When clinicians use visual feedback, such as a spectrogram, to remediate speech errors the following clinical benefits can occur:

- **FEEDBACK:** The student has immediate and specific feedback about his/her productions; he/she does not have to wait for the clinician to tell him/her what he/she is doing wrong and how to fix it.
- **MOTIVATION:** Students take an active role in their learning, which generates intrinsic motivation. If students demonstrate appropriate self-evaluation skills, they may work independently.
- **PRACTICE-BASED EVIDENCE:** Clinicians can track objective data about their students' progress.
- **COST:** Because www.spectrogramsforspeech.com provides access to WaveSurfer to download free of cost, clinicians with limited budgets do not have to spend resources on a more expensive program.
- **TIME:** Clinicians do not have to spend time learning how to operate a new and unfamiliar program. www.spectrogramsforspeech.com provides easy and quick tutorials for busy clinicians to get started with spectrograms.
- **EVIDENCE-BASED PRACTICE:** Clinicians can rest assured that the use of spectrograms for the remediation of speech is grounded in empirical research and a solid theoretical foundation.

REFERENCES

Please see www.spectrogramsforspeech.com/credits for full list of references.

- Adler-Bock, M., Bernhardt, B.M., Gick, B., & Bacsfalvi, P. (2007). The use of ultrasound in remediation of North American English /r/ in 2 adolescents. *American Journal of Speech-Language Pathology*, 16(2), 128-139.
- Castrogiovanna, A. (2006). Communication facts: Incidence and prevalence of communication disorders and hearing loss in children. Retrieved November 7, 2010, from www.asha.org/members/research/reports/children.
- Ertmer, D.J., & Maki, J.E. (2000). A comparison of speech training methods with deaf adolescents: Spectrographic versus noninstrumental instruction. *Journal of Speech, Language, and Hearing Research*, 43(6), 1509-1523.
- Ertmer, D.J., & Stark, R.E. (1995). Eliciting prespeech vocalizations in a young child with profound hearing loss: Usefulness of real-time spectrographic speech displays. *American Journal of Speech-Language Pathology*, 4(1), 33-38.
- Ertmer, D.J., Stark, R.E., & Karlan, G.R. (1996). Real-time spectrographic displays in vowel production training with children who have profound hearing loss. *American Journal of Speech-Language Pathology*, 5(4), 4-16.
- Gordon-Brannan, M.E., & Weiss, C.E. (2007). *Articulatory and Phonological Disorders* (3rd ed.). Baltimore: Lippincott Williams & Wilkins.
- Houle, G.R. (1988). Computer usage by speech-language pathologists in public schools. *Language, Speech, and Hearing Services in Schools*, 19(4), 423-427.
- Massaro, D.W., & Light, J. (2004). Using visible speech to train perception and production of speech for individuals with hearing loss. *Journal of Speech, Language, and Hearing Research*, 47(2), 304-320. doi:10.1044/1092-4388(2004/025)
- National Institute on Deafness and Other Communication Disorders. (2010). Statistics on Voice, Speech, & Language. (November 7, 2010). Retrieved from <http://www.nidcd.nih.gov/health/statistics/vsl.html>
- Ruscello, D.M. (1995). Visual feedback in treatment of residual phonological disorders. *Journal of Communication Disorders*, 28(4), 279-302.
- Ruscello, D.M., Shuster, L.I., & Sandwisch, A. (1991). Modification of context-specific nasal emission. *Journal of Speech-Language-Hearing Research*, 34(1), 27-32.
- Shriberg, L., Gruber, F.A., & Kwiatkowski, J. (1994). Developmental phonological disorders III: Longer-term speech-sound normalization. *Journal of Speech and Hearing Research*, 37, 1151-1177.
- Shuster, L.I., Ruscello, D.M., & Toth, A.R. (1995). The use of visual feedback to elicit correct /r/. *American Journal of Speech-Language Pathology*, 4(2), 37-44.
- Stark, R.E. (1971). The use of real-time visual displays of speech in the training of a profoundly deaf, nonspeaking child: A case report. *Journal of Speech & Hearing Disorders*, 36(3), 397-409.
- Stark, R.E. (1972). Teaching /ba/ and /pa/ to deaf children using real-time spectrographic displays. *Language and Speech*, 15, 14-29.