Feasibility of Acoustic Analysis to Measure Fricative Speech Characteristics in Jamaican Creole and English-Speaking Bilingual Preschool Children

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Introduction

- While there are many standardized assessments utilized in the Communication Sciences and Disorders field to determine typically developing (TD) speech versus Speech Sound Disorders (SSD), clinicians tend to rely upon American English norms and standards to assess and treat the multilingual population. The combination of a lack of multilingual diagnostic tools and monolingual Speech-Language Pathologists (~92%) providing majority of services, presents increased opportunities for misdiagnosis of SSDs in multilingual children (Guiberson & Ferris, 2019).
- Within the multilingual population, understudied language combinations, such as multilingual preschoolers who speak Jamaican Creole (JC) and English (cf. Washington et al., 2017) require improved evaluations. Fricatives (/s, z, ʃ, f, v, h, θ, ð/) are known to inform developmental profiles and have been studied to examine how acoustic properties of consonants change during typical speech development (e.g., Miccio, 1996). Therefore, **this study investigates** the feasibility of implementation and use of acoustic analysis as a diagnostic tool to investigate English consonant productions in multilingual speakers.

Goals

- *The overall goal of this project* is to conduct a feasibility task to determine clinical adaptability and usability of acoustic analysis to discriminate linguistic and dialectical differences versus Speech Sound Disorder in a multilingual population.
- If found to be feasible, the training and protocols utilized in this study could be adapted to educate and create a training resource for SLPs to utilize acoustic analysis in assessment and treatment of multilingual children.

Participants

- Corpus of bilingual Jamaican Creole and English-speaking preschoolers (ages 3-5) previously diagnosed with TD speech or suspected SSD through the Intelligibility in Context Scale (ICS) and Intelligibility in Context Scale-Jamaican Creole (ICS-JC).

- Participants completed the Diagnostic Evaluation of Articulation and Phonology (DEAP) in English (DEAP; Dodd et al., 2006), administered by SLPs.

Methods

Training and protocols were developed to provide specific instructions on:

1. Phonetic transcription of English productions by bilingual JC and English-speaking children
2. Navigating and using Praat, a free-to-download acoustic analysis software
3. Sanitizing and tagging audio files in Praat
4. Extracting target fricative from whole word productions in Praat

Procedures

Data were extracted using audio files from 30 bilingual JC-English-speaking preschoolers (TD=22, SSD=6)

1. Data were reviewed to identify and classify participants as TD versus suspected SSD using ICS and ICS-JC, with an established cut-off score of 4.12
2. Audio recordings were sanitized, tagged, and de-identified via Praat
3. Target production from the DEAP Articulation and Phonology subtests included:
   - single words (N=17, phonotactics= CVC/CCV/CVCV/CVCVC)
   - fricatives in the initial position
4. Target fricatives were transcribed using broad transcription, with 10% reliability for each language
5. Fricatives were isolated using tagged whole word productions
6. Praat script to calculate spectral center of gravity (CoG) validated
7. Praat CoG script was applied to isolated fricatives to calculate CoG

How to Extract Fricative

Each previously tagged word is located and selected. The fricative is extracted based upon wavelength, spectrogram formants, and determining start and end of phoneme. The fricative sound is saved as an audio file, and factors such as background noise are noted.
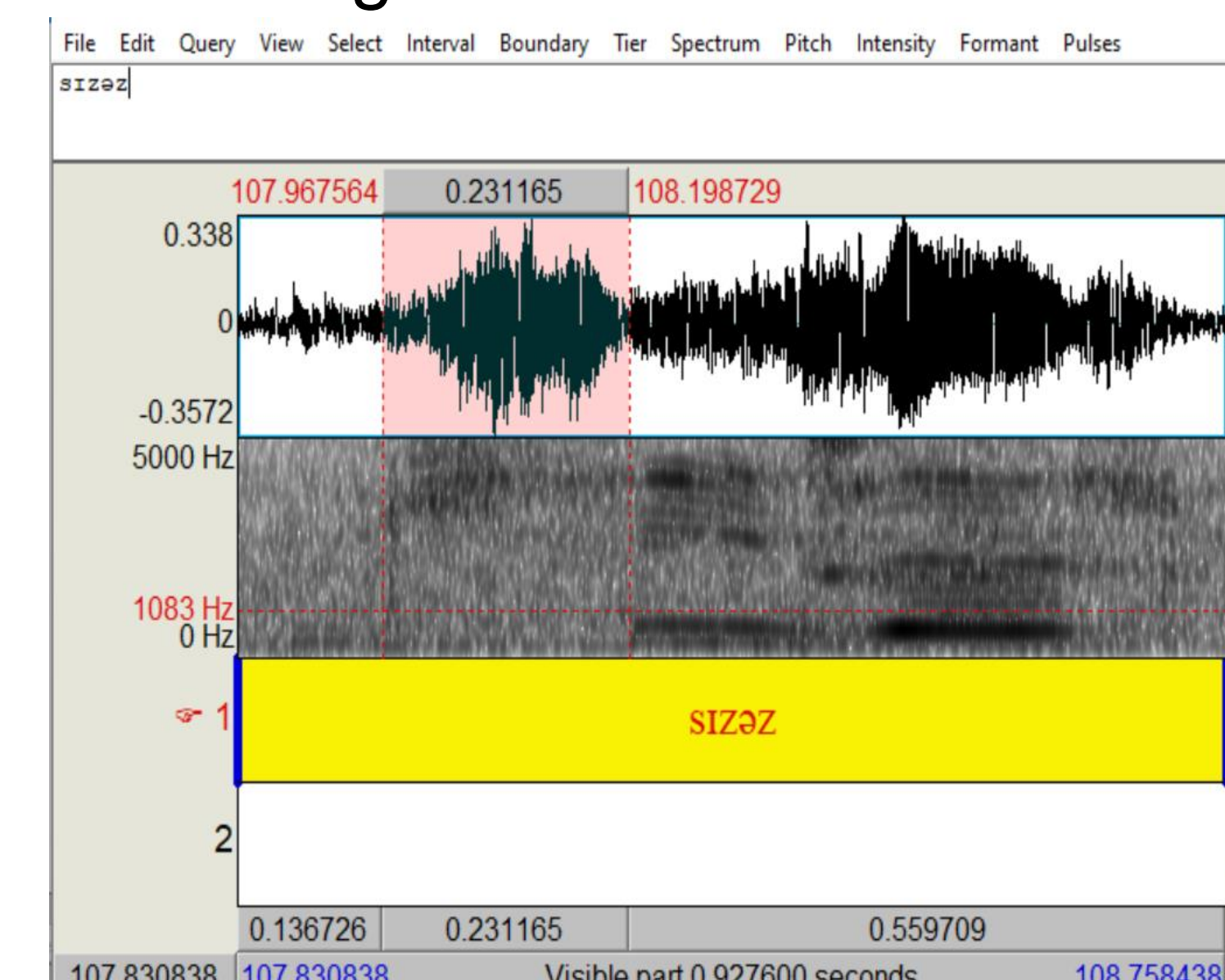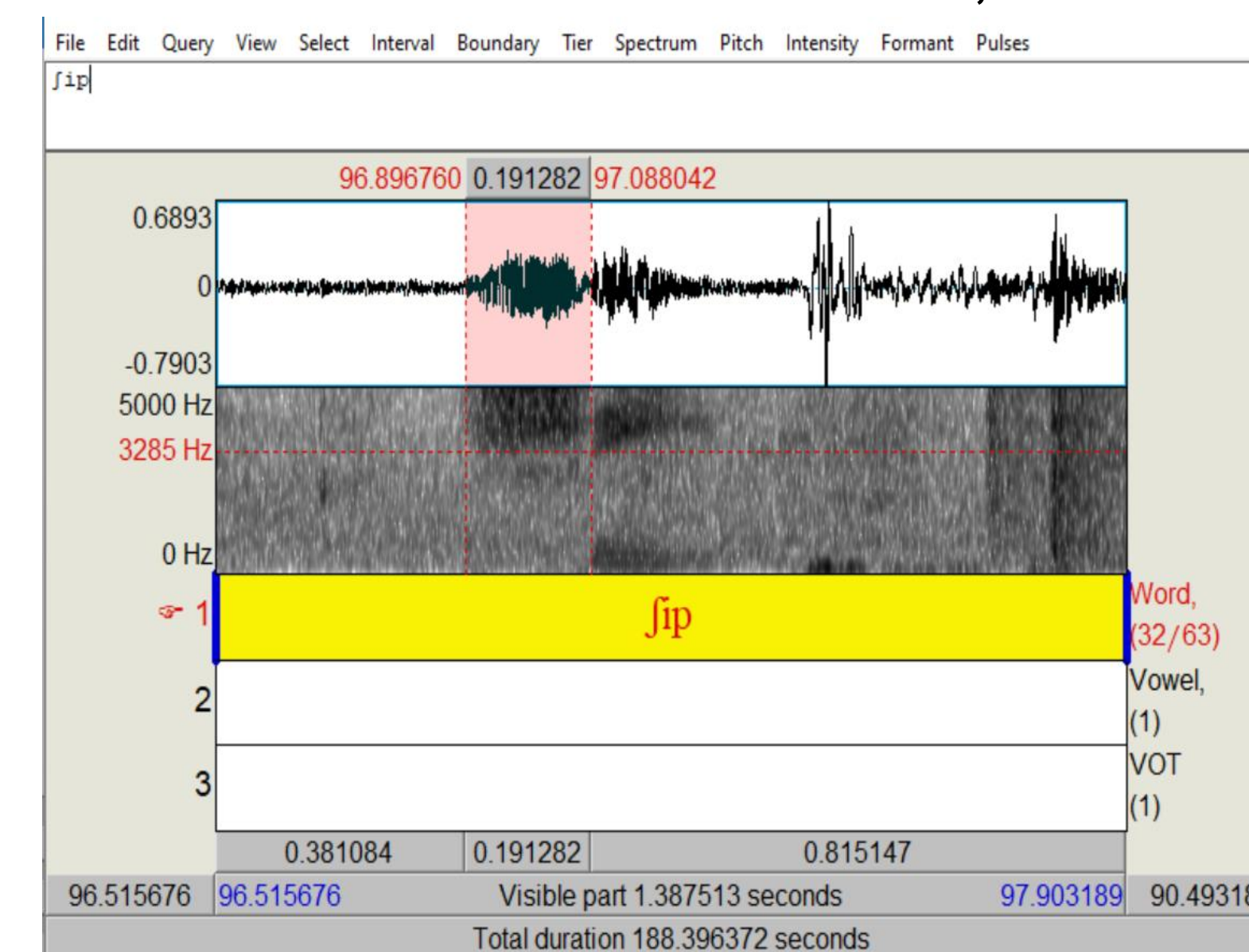
Using a written script, Praat measured spectral CoG to determine the average frequency (Hz) of each fricative produced. Results from spectral CoG measurements will provide an average range of frequency measures and cut-off values for both typical and disordered speech sound productions in the given population.

Analysis

Pearson Correlation was utilized to establish Praat script validity by determining the relationship (i.e., correlation) between experimenter and script extracted CoG for 10% of the sample.

Results

- Following data preparation, some CoG data were excluded from analysis for the following reasons: (1) low signal amplitude, (2) CoG measurements below 3Hz, and (3) background noise.
- **Descriptive Statistics**: Male, N=16 and Female, N=11, 3-year-olds, N=3, 4-year-olds, N=14, and 5-year-olds, N=10. Typically developing fricative CoG, Mean= 7926 Hz and SD= 2673.069 Hz. Suspected SSD fricative CoG, Mean= 7788 Hz and SD= 2299.429 Hz.
- Pearson Correlation revealed r=1, p=.01 showing a strong positive relationship between CoG measures gathered manually and automatically in Praat. This shows validity of the protocol developed to extract accurate fricative CoG measures automatically in Praat.
- Time to Calculate Measures (per child): Sanitizing and Tagging 1-2 hours, Isolating Fricatives 30 minutes, Calculating CoG 5 minutes

Conclusions

- These findings demonstrate the feasibility and utility of acoustic methods in informing typical and atypical speech sound production. Feasibility strengths acoustic analysis include providing objective acoustic measures to compliment perceptual and parent report data and providing a culturally appropriate diagnostic method for the multilingual population.
- Limitations for clinical application include the total time required for analysis in addition to considering a clinicians typical diagnostic and treatment hours.
- Application of clinically feasible tools that permit cross-language analyses are needed to ensure accurate diagnosis of production competence in multilingual contexts, particularly for understudied language combinations.

References

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