

**Title: Measuring Musical Sound: Exploring The Efficacy Of Spectral Analysis To Identify Trombone Tone Quality**

**Author: Richard D. Edwards, Doctoral Candidate in Music Education**

**Affiliation: Music Research Institute**

**School of Music**

**P.O. Box 26170**

**UNC Greensboro**

**Greensboro, NC 27402-6170**

**Phone: (336) 202-1455**

**Introduction**

Traditionally, music teachers have used verbal descriptions and aural modeling to help their students develop good tone quality. For students who learn best in a visual context, image feedback of student tone quality via real-time spectrogram may augment traditional methods of music instruction. A spectrogram (i.e., spectral analysis) is a computer display of the harmonic characteristics of a sound over time. At present, spectrograms are occasionally used as a pedagogical tool in vocal studios to assist students learning how to identify and improve the harmonic characteristics of proper diction, tongue placement and tone quality (Miller, 1996; Miller & Franco, 1991).

Little research however, has been conducted to explore the efficacy of spectroanalysis with instrumental tones. Conducted in two phases, the purpose of this study was to observe whether (a) spectroanalysis would serve as a means for significantly differentiating between the tones from beginning and advanced trombonists (phase 1), and (b) whether spectroanalysis data would significantly differentiate between 'good' and 'poor' tone samples as determined by Likert ratings of tone quality by music judges (phase 2).

**Procedures**

All subjects for both phases of the study were college music majors. In phase 1, the Beginning Trombonist (BT) group consisted of 7 non-brass majors, who had been learning to play the trombone for 4 weeks. The Advanced Trombonists (AT) group were 7 trombone majors selected from the UNCG School of Music trombone studio with an average of 9 years experience playing the trombone. All subjects were instructed to play with their warmest tone quality as a sample was collected using Kay Elemetrics' CSL 4400 spectral analysis equipment. Each subject played the same pitch (F3, 172 Hz), for the same duration (5 sec.), and monitored by a sound pressure level meter with the same approximate intensity (90dB, +/- 3dB).

In phase 2, four judges (graduate students in music) listened to 14 samples of trombone tones (f3) for a duration of 4 seconds. After each tone was heard, each judge rated the tone using a Likert scale where 1 represented the best possible tone quality and 5 represented the worst possible tone quality. The pool of Likert-rated sample tones was divided into two groups where group 1 (n = 9) contained all tones that were rated less

than 3 (good tone quality), and group 2 (n= 5) contained all tones that were rated greater than or equal to 3 (poor tone quality). A 2-Way ANOVA was used to determine if any significant difference exists between the dependent variable (mean bandwidth) of 5 possible formants within each tone sample (independent variable 1) from tones between groups 1 and 2 (independent variable 2).

### **Results**

During phase 1, a significant difference ( $p < .035$ ) was observed among the mean harmonic characteristics (formant bandwidth) of tone samples based on subject performance experience (i.e., beginner vs. advanced). In phase 2, there was no significant difference ( $p = .444$ ) among the mean formant bandwidths of trombonist tones that were separated into two groups based on ratings of good or poor tone quality. Interrater reliability showed moderately strong consistency (Cronbach's Alpha = .7031).

### **Conclusions**

Based on the significant difference that was identified between BT's and AT's formant bandwidths during phase 1, the lack of significant difference between formant bandwidths of Likert-rated tones was an unexpected result. However, early results indicate that real-time spectrograms might yet serve as a valid and effective pedagogical tool for helping beginning trombonists to develop their tone quality by directing their focus both aurally and visually to the sound and spectrogram of their tone. Three potential factors that may have contributed to the lack of significance among formant bandwidths in phase 2 are (1) formant bandwidth is not the best determining factor to differentiate between spectral analysis data of tones, (2) the sound quality of the playback system used by the music experts was not of high quality and may have prevented them from identifying tone quality accurately, and (3) the current method of measuring the significant difference between spectral analysis data from separate groups may not be the best method of statistical analysis. Given these remaining unknowns about the measurement of musical tone via spectral analysis, further research is warranted.

### **References**

Miller, R. (1996). Energy and freedom in singing. *Journal of singing*, 53(2), 27.

Miller, R., & Franco, J. C. (1991). Spectrographic analysis of the singing voice. *NATS journal*, 48(1), 4.