Preliminary Investigation of Tongue Motion and Its Role in Clarinet Multiphonic Production

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Background: Clarinet performance at a high level requires the coordination and control of various fine muscles. While the naked eye can observe the movement of most of these muscles, one very importance muscle is invisible to the naked eye—the tongue. World class performers and pedagogues have long acknowledged that the tongue plays an important role in sound production on the clarinet. However, much of what we learn as clarinetists about how to use the tongue during performance is based on subjective perception of our teachers. It was not until the last decade that clarinetists have utilized technology to objectively examine tongue motion when playing the clarinet (Fritz and Wolfe, 2005; Chen *et al.*, 2009; Gardner, 2010).

The tongue can be manipulated to control frequency of vibration (pitch), quality of the sound spectrum (tone color), and the mode of vibration (harmonics and overtones). This study focuses on a special case of controlling mode of vibration—production of multiphonics. The clarinet is a traditionally single pitched instrument, but in the mid 1900s performers have discovered the possibility of producing multiple pitches at the same time—multiphonics—on the clarinet. Since its discovery, composers have used multiphonics frequently in their works (Rehfeldt, 2003). However, despite the common usage of this technique in modern clarinet works, pedagogues and performers have not been able to accurately describe how this technique is executed, with different people providing contrasting or incomplete information, especially regarding the manipulation of tongue shape (referred to as voicing from here on). The technique to produce multiphonics is further complicated by the fact that each different multiphonic requires a different voicing configuration.

This study uses ultrasound imaging to gather information on the changes in voicing between the production of the multiphonic versus the production of the individual pitches that make up the multiphonic. The goal of the study is to accurately identify the voicing changes necessary for multiphonic production, using the results to create a resource for performers learning this technique, and provide a basis for further exploration and research.

Methods: One professional clarinetist (the author) performed 604 multiphonics and their individual pitches five times each. The perceived voicing adjustments necessary to produce the multiphonic compared to producing the individual pitches were documented. Other factors affecting sound production on the clarinet, such as embouchure force and air intensity, were limited to imperceptible changes. Multiphonics were then grouped based on similarity in perceived voicing adjustments. A representative number of multiphonics from each group, as well as multiphonics with different perceived voicing adjustments during the five repetitions were selected to be played while the tongue is observed using ultrasound imaging.

Ultrasound imaging was performed at the Performance Physiology Research Laboratory at Arizona State University using a Terason T3000 Ultrasound System. The transducer was handheld submentally to examine midsagittal tongue motion at a scan depth of 9 centimeters. The investigative nature at this stage of the research did not require the stabilization of the transducer, as qualitative data is valued over quantitative data, and the transducer angle can be more easily adjusted while handheld to observe different parts of the tongue.

The data collected during the ultrasound investigation was used to evaluate the perceived voicing adjustments documented in the previous stage. The process of performing 604 multiphonics five times each, then using ultrasound to evaluate perceived voicing changes was repeated three more times. At the end of the investigative process, each multiphonic was played a total of 20 times and ultrasound was used to evaluate the perceived voicing changes after every five repetitions.

During the final ultrasound investigation session, images were captured for quantitative analysis as well. In this session, the transducer was stabilized using the Articulate Instrument Probe Stabilization Headset to allow quantitative analysis of the captured images. Still images of the tongue were captured when performing the multiphonic as well as the individual pitches of the multiphonic. The multiphonics were grouped into four groups based on the necessary voicing changes to produce them. Images of the tongue when performing eight multiphonics and their individual pitches were captured, two from each group.

Eight more subjects were selected to perform ten multiphonics to verify the findings. Each subject was fitted to the headset and asked to perform the same ten multiphonics. Still images were once again captured of the tongue when performing the multiphonics and their individual pitches.

Results and discussion: Results from this study confirm the generally accepted idea that each multiphonic is produced with a unique voicing configuration. Furthermore, the same multiphonic when performed by different test subjects can also exhibit different voicing configurations. However, when comparing the voicing configuration of each test subject when playing the high note and the multiphonic, the direction in which the tongue moves is always the same. Depending on the acoustical and physical nature of the multiphonic being produced, the voicing changes in one of four ways to produce these sounds:

A. Retracting the back of the tongue towards the throat.
B. Raising the back of the tongue slightly towards the soft palate.
C. Slowly shifting the voicing configuration from that of the upper note to the lower note until the multiphonic is produced.
D. Raising the root of the tongue (a similar sensation to constricting the throat).

Multiphonics are categorized into groups based on which of the above voicing changes are used to produce them to create a preliminary resource to help performers learn this technique.

The result of this study is largely based on informed perception. But regardless of how informed the perception may be, perception will always be subjective and therefore not 100 percent reliable. Ideally, the study would be repeated using ultrasound to observe all 604 multiphonics played in this study, performed by multiple people in order to produce a definitive result.

References

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