Oral dynamics in clarinet playing: Developing a new, evidence-based teaching method

Clarinet playing technique consists of two main aspects: the finger-technique and the embouchure (a relation of mouth, tongue, and jaw to the mouthpiece). (McKinney, 2015) The former provides fluency of execution of different sounds and the latter is responsible for sound timbre and articulation. The way in which the tone is being controlled on the clarinet directly impacts the response of the instrument across registers, tone quality, intonation and its dynamic range. It is safe to say that the quality of the embouchure will determine expressivity and player’s personal musicianship. It is much more difficult and time consuming to develop a proper embouchure (on average 4 years or more) than to acquire fluency of finger-technique (a student can play sequences of notes in pieces studied for a year or less). Teaching the embouchure presents all instructors with a very unique problem. As opposed to the finger-technique, embouchure’s crucial components (the oral articulators) remain invisible inside payer’s mouth. The tongue, jaws and lips are all supported by muscles that need to provide ‘a dynamic balance’ throughout any performance because embouchure is subject to frequent changes in back pressure from the instrument requiring constantly making necessary adjustments. Therefore, it is crucial to understand how a proper, dynamic embouchure works in order to teach it effectively.

For the last 200 years, clarinet teaching method books show very little change in the approach to develop clarinet embouchure. Both old and newer methods (Lefèvre, 1802; Galper, 1999) concentrate on developing a fluent technique through long tones, scales, arpeggios and more complex etudes. Comments referring strictly to embouchure actions are either taught verbally using demonstrations from an instructor or self-taught. However, there are no method books that would consist of both comprehensive, up-to-date explanation of what the embouchure “should be doing” and corresponding musical exercises helping with practical applications of it. One of the reasons for this omission is that almost all existing method books have been written without the support of evidence from research on the matter depending largely on personal experience and intuition. This professional culture resulted in very different ‘schools’ of teaching trying to approach the technique related issues in their own unique way. (Friedland, 2015)

In the professional clarinet literature available in English the intuitive approach to the embouchure is probably best summarized by the work of William Stubbins in his book on acoustical mechanics of the clarinet. (Stubbins, 1965) Stubbins’ is the first most serious and descriptive account presented in a book on the clarinet. However, Stubbins’ explanations leave out answers to important questions on for example double-tonguing, frullato, rapid register changes in legato playing and other contemporary techniques as well as issues related directly to the sound quality. The 1950s mark the beginning of a more scientific approach on acoustics and physics of woodwind instruments; most notably in the works by A. Benade. (Benade, 1958) This type of research has found its incorporation in clarinet design and production. Even though Benade’s work in general greatly contributes to the knowledge of the instrument’s acoustics, it has very little significance to clarinet instruction.
With technological advancement scientists and clarinetists alike expressed interest in observing the behavior of the oral articulators while playing (in real time). In the early 70s, Ray Wheeler pioneered with the first X-Ray video of himself playing the clarinet. This video recording of the working embouchure showed, for the first time, that embouchure mechanics work in contrary to common believes of that time. (Wheeler, 2010) Prior to Wheeler’s experiment it was accepted knowledge that the tongue should stay in a low position in the low register and vice versa. However, his observations unfortunately, have never been published nor included in any teaching method. More substantial information on the role of oral articulators in playing the clarinet comes from a 1982 scientific paper published by Australian researchers. (Fig. 1 and 2)

![Fig. 1 Tongue position for 3 lowest notes](image1)

1. 155.56 Hz,
2. 233 Hz
3. 392 Hz

![Fig. 2 Tongue position for 3 high-register notes](image2)

1. 920 Hz,
2. 1244 Hz,
3. 1611 Hz.

By using X-ray fluoroscopy as well as collecting sound spectra from inside the mouth and close to the bell, it was concluded that the shape of the vocal tract impacts not only the tone production in all registers but also tone quality, therefore they concluded that, “(…) the vocal tract resonant frequencies must match the frequency of the required notes in clarinet and saxophone performance”. (Clinch, Troup, Harris, 1982)

Most recently, Prof. R. Spring and Dr. J. Gardner at the Arizona State University presented a real-time video ultrasound of the tongue for an individual playing a clarinet. (Spring, 2011) This can only provide a demonstration of tongue actions with various articulation and register changes without the ability to quantify relevant information related to lip control, tongue dynamics etc. Neither ‘national schools’ nor the data presented above provide a detailed and more or less complete ‘look inside’ the clarinetist’s mouth to explain relevant theoretical issues or to aid in understanding how to prevent common issues for clarinet players such as occurrences of tendonitis, temporal-mandibular joint (TMJ) problems, the so-called “biting effect” or other painful conditions developed by improper use and positioning of the oral motor structures, in particular lips, jaw and tongue often leading to so-called embouchure dystonia. (Dystonia Medical Research Foundation, 2015) Over more than a decade, technologies that offer reliable assessment of oral structures such as lips, tongue and jaw have been in existence and are widely used in the realm of speech research. Although producing speech and playing the clarinet require different oral activities, there are common principles related to motor control in general. (McKinney, 2015) In a generic way of speaking, clarinetists use their embouchure in order to create and articulate sounds on the clarinet while speakers use the same structures to articulate sounds for speech. Both areas of research have yet another
unique similarity, which is the role of auditory perception of the articulators’ output that may serve as a feedback source for self-correction and problem solving during playing or generating speech.

**Research goals**

The ultimate goal of my post-doctorate fellowship proposal is to conduct a systematic investigation on the oral motor control mechanisms involved in clarinet playing to provide clarinet teachers with evidence based information on properly working, healthy embouchure techniques. However, for pedagogues to better diagnose and solve problems in their teaching studios and classrooms outside a laboratory, this will also require a unique, hi-tech teaching aid that needs to be designed and built based on the outcomes of this investigation in future projects.

In order to test the feasibility of the suggested approach, my collaborators and I performed preliminary studies at the Oral-Dynamics Laboratory (ODL) at the University of Toronto, using the latest generation of the Electro-Magnetic Articulograph (EMA; AG501, Carstens Medizinelektronik GmbH, Germany). Our results already demonstrate discrepancies between what is commonly believed to occur during clarinet playing and what actually happens as well as some very clear differences between motor control strategies for playing certain techniques on a clarinet and how we use the tongue for speech. This preliminary work not only demonstrates the feasibility and great potential of the selected measurement technique but also the ability to use these data in a systematic way to quantify the movement sequences and their coordination over time for generating specific tonal sequences.

**Methods**

Over two years, a total of 10 clarinetists (5 high level professionals and 5 students) will be recruited to investigate the role of oral structures like jaw, lips and tongue in defining proper embouchure for playing the clarinet. Each subject will be given a set of previously prepared exercises that are most suitable to execute specific clarinet idioms. The embouchure behaviour corresponding to each task will be quantified in terms of movement characteristics (duration, velocity, amplitude range, stability, and coordination) for each group. The aim of performing these tasks is to provide a very specific environment for measuring the contributions of different parts of the tongue (front, mid, back), formation and involvement of the lips as well as the resulting changes under challenging assignments. While these tasks will be performed by each participant, we will employ an array of non-invasive, real-time physiological and physical data acquisition methods such as 3D articulography, surface electromyography (sEMG), Respitrace (to study breathing and volume changes) and acoustic recordings. Together, these recordings will allow us to quantify the oral motor events that are directly related to playing the clarinet in terms of dynamic kinematic characteristics and the resulting sound features. To this end, we will use advanced software available in the ODL (EGUANA; Henriques & Van Lieshout, 2013) to process all movement data for further interpretation.
**Research benefits**

At the end of the two-year period, we will have sufficient data collected to understand how a well-balanced embouchure works, therefore, will be able to incorporate it into a new method book helping players to gain more control over their mouth articulators while playing. Our preliminary data indicates that the research goals presented here can be accomplished in due course. The findings will add to the knowledgebase for clarinet playing in the form of papers submitted for peer-review publication. We also aim to translate the research findings into practical applications to support progress and quality of teaching and learning on all levels of clarinet performance: from beginners to high-end professionals.

**Expertise**

The Oral Dynamics Laboratory (ODL) is a research laboratory in the Department of Speech-Language Pathology at the University of Toronto. Founded by Pascal van Lieshout, the ODL conducts groundbreaking research in speech science and oral motor control. The lab is equipped with state-of-the-art technology to record and process physiological and physical aspects of speech and other oral motor functions.

The intended supervisor of this proposal, Dr. Pascal van Lieshout, is a professor in the Department of Speech-Language Pathology and an internationally renowned expert in the field of Speech Science with over 150 peer-reviewed publications (journal articles, book chapters, proceedings), and more than 25 years of experience in research on oral motor control, supervising PhD and research master students in his own department and other departments. His extensive work in areas such as dynamical aspects of speech motor control, stuttering, apraxia and other speech disorders makes him a world authority on those matters. He was a Canada Research Chair in Oral Motor Function across the Lifespan from 2004-2014 as has been funded by CIHR, NSERC and SSHRC. In 2011, Dr. van Lieshout received the Richard H. Barrett Award from the International Association of Orofacial Myology (IAOM) for his research contributions to the field. Currently, he is the chair of the Department of Speech-Language Pathology and Director of the ODL.

**Aravind Namasivayam, PhD**

Dr. Aravind Namasivayam is a consultant research scientist with the PROMPT Institute, Santa Fe, NM. He also holds an adjunct faculty status at the University of Toronto. Dr. Namasivayam’s current clinical and research interests include developmental speech sound disorders, stuttering, sensory-motor integration, and motor skill learning.

**Dr Kornel Wolak** is a performing clarinetist and teacher. He received a number of awards including The Presser Foundation Award for Highest Academic Achievement, L. Berstein Scholarship, A. Galper Scholarship and Polish Ministry of Culture Scholarship and Poland Arts Council Award. Mr. Wolak is frequently invited as a key speaker, clinician and clarinet instructor to lecture on topics such as clarinet technique and acoustics, reed making and design, contemporary techniques, performance practice and