

Fréour V.², Bianco T¹., Cossette, I.²

1- Ircam, UPMC

2- Music Reserach Department, Schulich School of Music, McGill University, Canada.

Title:

Coordination of facial muscle activation, intraoral pressure and mouthpiece force during trumpet playing: preliminary findings.

The control of sound production in trumpet performance requires mechanical and physiological expertise. From a basic perspective, this control is achieved through setting of the lip mechanical properties (mass and stiffness) and their aerodynamic excitation provided by the respiratory system. Attacks and coarticulation between notes implies the action of articulators such as the tongue to modify the air stream in the oral cavity. In the literature, studies particularly focus on control parameters such as intraoral pressure and force applied by the lips on the mouthpiece (Barbenel 1988, Fletcher 1998). Moreover, some works (White and Basmajian, 1973) conducted on facial muscles recruitment during playing describe coordination between muscle activation and sound production.

Whereas previous studies describe the magnitude of these control parameters in quasi-static regime of oscillation (sustained tones), the present account focuses particularly on the time domain evolution of the control parameters during note transients, and on the coordination of the parameters between subsequent notes. These observations have been made possible by combining two measurement systems from two different laboratories. Our set up includes: facial surface electromyography, sound (Respiratory mechanics lab-CIRMMT, Schulich School of Music, McGill University), intraoral pressure and force applied on the mouthpiece (Instrumental Acoustics laboratory, IRCAM).

Electrical activity of two facial muscle groups, respectively associated with smiling and depressing the lower lip (zygomaticus and depressor anguli oris-DAO) was measured with surface electromyography (EMG). The force applied by the mouthpiece in its axis was recorded thanks to a force sensor mounted on a specially shaped mouthpiece receiver. Intraoral pressure and radiated sound were recorded using, respectively, a pressure transducer and a microphone mounted to the trumpet at a constant distance from the instrument bell. 6 high level trumpet players performed some equally spaced quarter notes at the dynamics pp, mf and ff with two different accentuations (tenuto, staccato).

Temporal profiles taken into account are: 1-Radiated sound envelope, 2-intraoral pressure, 3- envelope of EMG activity, 4- mouthpiece force.

Preliminary results reveal good consistency in between subjects in terms of intraoral pressure profile. An overshooting of intraoral pressure is observed before the sound production during tenuto notes whereas the increase of pressure occurs monotonously in the case of staccato. Moreover, experimental data confirm that EMG activity distributes asymmetrically to tone production, with a higher activity prior to tone commencement (as in Heuser and McNitt-Gray, 1991). EMG activity also shows complementary behavior to mouthpiece force, suggesting that lips' stiffness setting is regulated by the joined control of their muscular tension and compression.

These first analyses revealed different control parameter patterns following accentuation. Notable differentiations were observed with intraoral pressure. Further analysis must focus on the coordination between all variables, aiming at identifying some specific features relevant to each type of articulation.

Acknowledgements.

This work is partially supported by the Short-Term Scientific Mission funding program of the COST Action IC0601 on Sonic Interaction Design and Canadian Foundation for Innovation.