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Analysis of reed vibration and mouthpiece pressure in contemporary bass clarinet playing techniques

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Abstract

While articulation on the B♭-clarinet has already been a subject in various studies, articulation on the bass clarinet has gotten less attention. Because of the increasing interest for using the bass clarinet, especially in contemporary music, this instrument is emerging from the shadow of the B♭-clarinet. In order to investigate articulation on the bass clarinet an experiment was carried out in an anechoic chamber at the University of Music and Performing Arts Vienna. A professional clarinetist was recorded performing different articulation techniques on a German bass clarinet under controlled performance conditions. Results show that the attack transients on the bass clarinet were about 0.085 s long in staccato articulation. In comparison, attack transients on the B♭-clarinet are 2 to 3 times shorter. This study especially focuses on the slap tonguing technique. Of particular interest is the reed bending signal, which shows the movement of the reed. It has been observed that tones articulated with slap tonguing have a significantly shorter attack transient and are immediately entering the decay phase. Such measurements allow an in-depth analysis of player-instrument interactions with contemporary playing techniques and may support the refinement of physical model parameters but may also support music education.

Keywords : Bass clarinet, articulation, woodwinds, contemporary music, player-instrument interaction

1 INTRODUCTION

Articulation techniques on the bass clarinet require precise control over the blowing pressure, the tongue and the embouchure as well as simultaneous fingering actions. There have been studies on how professional players use their vocal tract [5, 6] and tonguing technique for articulation on single reed instruments [7]. Furthermore, measurements of finger forces during clarinet playing were investigated [1]. However, these studies have primarily been focussing on classical performances on the B♭-clarinet and did neither investigate the playing techniques on the bass clarinet nor contemporary playing techniques like slap tonguing.

Recently, the bass clarinet gets more attention not only in orchestral or chamber music, but especially in contemporary music [2]. Reasons therefore are for example the large pitch range (4 octaves), the possibility of extreme dynamics and the potential of being able to producing a variety of contemporary sound effects. For the production of such sound effects, unique playing techniques are required and some techniques are still under development, usually in a collaboration between clarinetists and composers. Classical articulation techniques, like staccato, legato or portato, mostly require an interaction between the tip of the tongue and the tip of the reed [4].

In contrast, the so called slap tongue requires the player to use a larger area of the tongue to act on a large reed area [3]. During slap tongue, the top side of the tongue is used to create a vacuum between tongue and reed so that it is possible to pull the reed away from the mouthpiece, working against its restoring force. When the tongue is reshaped, it releases the reed, so it snaps back against the mouthpiece. There are three different kinds of slap tonguing: the non-pitched slap, where the player releases the reed without blowing into the instrument, the pitched slap, where the tone actually sounds after the snap of the reed, and the open slap, which is played

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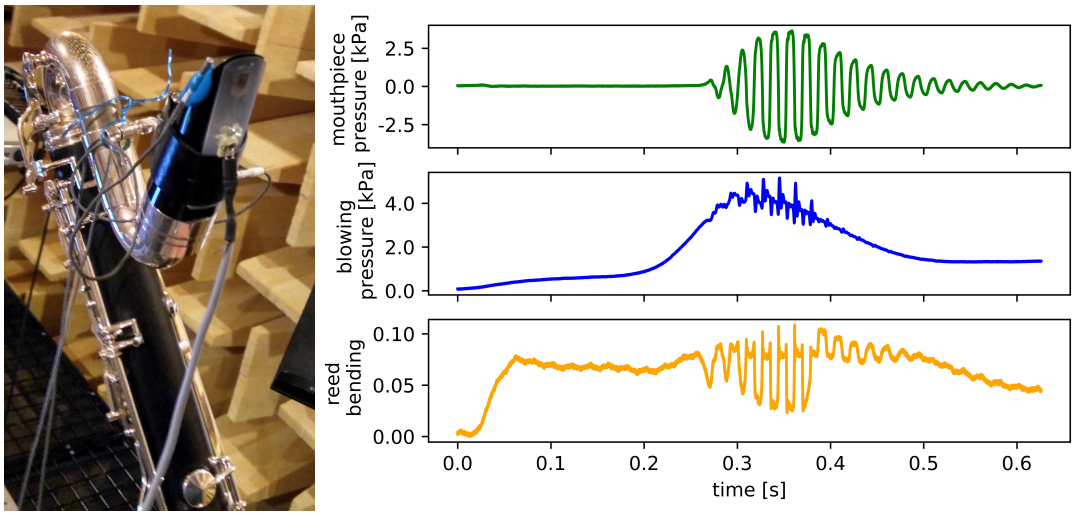

Figure 1. Left: Bass clarinet mouthpiece with two piezo-resistive pressure tranducers to measure blowing pressure (left side of the mouthpiece) and mouthpiece pressure (right side of the mouthpiece). Synthetic reed with strain gauge measures the reed bending. Right: Captured signals during classical staccato articulation of the tone C2 (notated), showing mouthpiece pressure (green), blowing pressure (blue) and reed bending (orange).

by releasing the reed and simultaneously opening the lower jaw.

This study has two aims: a) to compare classical articulations on the bass clarinet with measurements available for the B♭-clarinet and b) to gain more insight into the slap tonguing playing technique.

2 METHODS

2.1 Experimental Setup

For this study a bass clarinet with German system (F. Arthur Uebel B-740) was used. For the measurements, the mouthpiece (MAXTON-KW) and a synthetic reed were equipped with sensors. Because there are no synthetic reeds for bass clarinet with German system, a reed for alto saxophone was used, as it is common practice among professional bass clarinetists. Two piezo-resistive pressure transducers (Endevco 8507C-2) were mounted in a way that they recorded the acoustic pressures in the player's mouth and also inside the mouthpiece. Therefore one transducer was inserted into the mouthpiece via a side hole. The other one was attached to the side of the mouthpiece so that it remains inside the player's mouth while playing. The synthetic reed was equipped with a strain-gauge sensor to measure the bending of the reed. This measurement setup is similar to the one used in [7]. Using the same equipment allows to compare the data of this study with the measured values of the previous study carried out on a B♭-clarinet with German system in the same lab [7].

2.2 Procedure

The experimental aim is to capture data that allows a comparison with articulation techniques on the B♭-clarinet as well as to gain new insights into the slap tonguing techniques on the bass clarinet. To this cause a systematic recording protocol was prepared in the form of a musical score. This score was comprised of a C-major scale and combinations of different intervals (some with slap tonguing sound effects). Instructions were given on the articulation techniques (legato, portato, staccato with and without tonguing), tempi and dynamics on how the score has to be played by a performer.

Pitch (notated)	Articulation	Dynamic	Attack time	Mouthpiece pressure [kPa]	Blowing pressure [kPa]
C2 (58,27 Hz)	staccato	forte	0,085s	3,67	5,19
C2	staccato	piano	0,102s	2,27	3,43
C2	portato	forte	0,102s	2,11	3,45
C2	portato	piano	0,17s	1,25	1,96
C2	without tongue	forte	0,102s	3,42	4,92
C2	without tongue	piano	0,136s	1,87	2,88
Bb3 (207,7 Hz)	staccato	forte	0,024s	2,76	4,38
Bb3	without tongue	forte	0,029s	3,00	4,76

Table 1. Overview of measurements with different articulation techniques and dynamics on a German bass clarinet. Giving details of Attack time, maximum Mouthpiece pressure and maximum Blowing pressure for each analyzed tone.

A professional clarinetist (first author) played the given score on the sensor-equipped bass clarinet. A recording was made in the anechoic chamber of the Department of Music Acoustics at the University of Music and Performing Arts Vienna. The entire recording session lasted approximately 45 minutes, including a 10-minute warm-up phase.

3 RESULTS

3.1 Classical Articulation measurements

Figure 1 (right) shows an exemplary signal of the measurements (captured data was converted into SI units for better comparison). The top panel shows the mouthpiece pressure (green), the middle panel the blowing pressure (blue) and below is the bending signal of the reed (orange). In Figure 1 the lowest tone in the range of the bass clarinet is shown, played with staccato articulation. It was observed that the blowing pressure (blue) increased (0.2-0.28 s) before the tongue released the reed (0.28 s). A tongue release indicates the starting point of the actual tone. After a tongue-release, the observed attack time was about 0.085 s until the maximum amplitude of the oscillations was reached. At the end of the tone when the tongue stops the reed (0.38 s), small vibrations can still be observed in both the mouthpiece pressure (green) and the reed signal (orange). The tone decay time of 0.22 s is the duration of the remaining energy of the standing wave in the tube that gets slowly radiated through the bell of the instrument or lost due to thermal and viscous effects [8].

Table 1 summarizes the results of the measurements of classical articulation techniques. A comparison between the different articulation techniques shows that a tone played on the bass clarinet has the shortest attack time when played with staccato articulation in forte dynamics, because of the higher blowing pressure. Furthermore, a possible influence may be that in staccato-forte playing, the tension of the respiratory system including the tongue may also be higher, compared to other playing techniques like portato or legato.

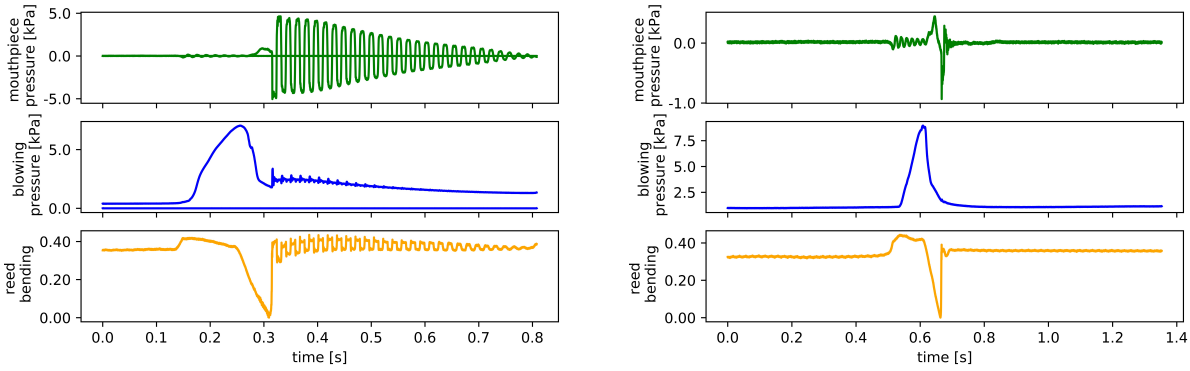

Figure 2. Mouthpiece pressure, blowing pressure and reed bending of a slap tongue tone (notated C2). Left: Slap tongue with giving blowing pressure after the release of the reed. Right: No blowing pressure is applied to the instrument after the reed has been released.

3.2 Contemporary Playing Techniques

Contemporary playing techniques on wind instruments are often created through a new way of player-instrument interactions. Hence, an extraordinary use of the embouchure or unusual tonguing actions are required for these playing techniques. The slap tongue is a prime example for this. Figure 2 shows two slap tonguing tones with a starting transient that has zero attack time. The left panel shows a slap tone with the player giving a blowing pressure to the instrument after the tongue released the reed, whereas in the right panel the reed is released without blowing into the instrument.

In the toned-slap (left), the first period of the tone already reaches the maximum amplitude and then fades out. Specific attention should be given to the reed signal (orange), which depicts how the reed was pulled away from the mouthpiece (0.25–0.3 s) before it suddenly snaps back to the mouthpiece (0.3 s). Compared to classical articulation techniques, the reed bends away from the mouthpiece about four times larger than the equilibrium position. In this case the slap was played in combination of giving a blowing pressure (blue, 0.2–0.3) so that the fingered pitch actually sounded and faded out after the snap. The duration of the fade out is related to the characteristics of the bore resonator.

In the case of mute-slap (Figure 2, right), no such decay was observed, showing that no standing wave was built up in the resonator. The mouthpiece pressure shows an impulse created at reed release (0.68 s). This results in a percussive sound effect.

4 DISCUSSION

Various contemporary playing techniques exist for both the B♭-clarinet and especially for the bass clarinet. This study is a starting point in precisely measuring the player-instrument interactions taking place in such. As this study only scratches the surface of the topic, there is a lot of potential for further studies involving comparisons of similar experiments on different single-reed instruments or even capturing data from different performers.

Moreover, a comparison with a similar procedure carried out on a bass clarinet with french system would be suited to better understand the differences in player-instrument interactions on the two types of popular clarinet systems. Future studies may also involve computer simulations of the captured signals, to gain insight into hidden playing parameters controlled by the player.

REFERENCES

[1] Hofmann, A., Goebl, W. Finger forces in Clarinet playing. *Frontiers in Psychology. Performance Science,* 7(1140), 2016.

[2] Iles, J.B. *The Changing Role of the Bass Clarinet: Support for Its Integration into the Modern Clarinet Studio*, PhD thesis, University of Nevada, Las Vegas, 2015.

[3] Krassnitzer, G. *Multiphonics und andere zeitgenössische Spieltechniken auf der Wiener Klarinette*, Master thesis, University of Music and Performing Arts Vienna, 2000.

[4] Krautgartner, K. *Untersuchungen zur Artikulation bei Klarinetteninstrumenten im Jazz*, PhD thesis, University of Cologne, 1982.

[5] Li, W., Almeida A., Smith J., Wolfe J. How clarinettists articulate: The effect of blowing pressure and tonguing on initial and final transients. *The Journal of the Acoustical Society of America 139 (2)*, 2016, pp 825-838.

[6] Pàmies-Vilà, M., Scavone, G., Hofmann, A., Chatziioannou, V. Investigating vocal tract modifications during saxophone performance. In *Proc. 174th Meeting of the Acoustical Society of America*, New Orleans, Louisiana, (Proceedings of Meetings on Acoustics Vol. 31), 2018.

[7] Pàmies-Vilà, M., Hofmann, A., Chatziioannou, V. Analysis of Tonguing and Blowing Actions During Clarinet Performance. *Frontiers in psychology 9: 617*, 2018.

[8] Schmutzhard, S., Chatziioannou, V., Hofmann, A. Parameter Optimisation of a Viscothermal Time-Domain Model for Wind Instruments. In *Proceedings of the 2017 International Symposium on Musical Acoustics (pp. 27–30)*, Montreal, CA: McGill University, 2017.