International Symposium on Performance Science
ISBN tbc

Tonguing on brass instruments: tempo and endurance

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Daily, there are zillions of notes performed on brass instruments by beginners and virtuosi. Articulation on brass instruments has been a subject of many method books for centuries, and subsequently qualitative research on their performances have been studied by different visualisation techniques. Maximal tempo and endurance for ' single tonguing ' and 'double tonguing' is musically relevant and quantitative figures are empirically evaluated in this study for 121 brass players for the first time. Maximal tempi show high inter-individual variability. The average value for 'single tonguing ' over two seconds is about 121 bpm and slows down to 103 bpm within 30 seconds of playing. The fastest player performed 167 bpm (eleven notes per second). With 'double-single' the mean values are 173 bpm at the beginning and 136 bpm after 30 seconds. Fastest player performed 238 bpm (sixteen notes per second). The level of experience is more relevant than the instrument. For conclusions regarding gender and mother tongue, more participants are necessary.

Keywords: Brass instruments; Tonguing; Articulation; Tempo; Evaluation

A trombone student told me his story, that he had a stroke 6 years ago, and lost his tongue control. After relearning to swallow and to speak, he started to play trombone again, and continued his trombone studies 4 years later. He wondered how fast he would have to train his tongue for a professional career, but no information about maximum tonguing tempi, neither in research papers, nor in study books could be found. Instruction books from Altenburg (1795) to Arban (1879, 2007) hardly explain techniques, let alone tempi, except the fact to always start practising slowly in order to achieve a better regularity.

Budde documented in 2011 a good collection of literature and method books on wind instrument articulation. He found very little common facts for brass instrument tonguing beside general principles: " The tongue should create a

seal when articulating on brass instruments; as such, the exact amount of tongue contact changes as the jaw is lowered or raised to accommodate the various pitch ranges within a specific instrument"

Hall (1954) and Meidt (1967) have been pioneers in the investigation of wind instrument performance through the use of technology for research and it can been seen, that specific vowel formations do not correspond to particular pitches or registers, as stated in different method books since Altenburg 1795. After Hall, the most common oral shape utilized during trumpet performance approximated the position of the tongue and jaw when saying the vowel /ɒ/ as in pod, but players tend to assume individualistic positions of the tongue and jaw. Since descriptions of motions and sounds are limited, modern teaching methods include audio-visual material that can be found at YouTube, or from specific DVD as e.g. the "Brass Master-Class" by Burba (2006).

More questions rose through discussions with colleagues about the ability and when to use different playing techniques. While some professionals say, they have a slow 'SINGLE TONGUING' but a good control to use 'DOUBLE TONGUING', others explain that they are not good in 'DOUBLE', but they have a very fast 'SINGLE'. This variability is relevant in the performing within a brass section, where similar attacks and articulations are required. This depends on how fast the player is able to produce each playing technique. This study aims to find the critical tempi, where individual preferences and abilities influence the interpretation of the brass section.

The evaluation of maximal tempi by brass players of various expertise levels is the objective of this paper and the first part of a larger project on the articulation on brass instruments. Follow up studies will focus on the physiological aspects, optimal training techniques and qualitative sound properties. In a third step, the acoustical properties of the instruments will be correlated with articulation characteristics.

METHOD

Participants

The presented results are based on 121 participants. Recordings were made in 2012 with professional brass quintets, amateur and professional participants of a brass players' summer camp in 2012 in Samedan (CH), in Linz (A), in Ghent (BE) , Beijing (China) and at the University of Music in Vienna (A). Mean age is 26,1 years old (SD 11,9) and the average years of playing experience is 15,2 years (SD 10,8). The grouping of the brass players is: Female (N=14), Male (N=107), Amateurs (N=59), Professionals (N=20),

Students (N=42), Trombone (N=27), Horn (N=7), Other (N=6), Trumpet (N=72), Tuba (N=9).

Procedure

All Brass players had to perform two tasks, recorded by any kind of equipment (e.g. Laptop with external microphone or cell-phone video documentation.) The procedure has been documented through a YouTube video for the research partner. Each musician has been recorded twice for 30 seconds, playing his or her maximum tempo with 'SINGLE TONGUING' and 'DOUBLE TONGUING'. With the exception of the fastest players, all participants have been assured to remain anonymous. They could choose their preferred natural open note in the middle register. The sound quality and the playing style have not been taken into account. They could perform soft or hard attacks therefore only the onset numbers have been measured, when the tongue opens the lip-valve.
The recordings are analysed semi-automatically with the "Audio Beat Tracking System BeatRoot 0.5.8" of Simon Dixon. The accuracy of discrimination for IOI intervals is about 5-10 milliseconds. Data are analysed and visualized by self-made Gnu-R statistic scripts. As intuitive tempo description, the timing is displayed in typical players' specifications units, that is to say in quarter metronome numbers (BPM) playing semiquaver notes. Additionally, the numbers of notes played in 30 seconds; the mean (median) values and standard variations for fifteen two-second sections have been calculated.

RESULTS

Preliminary results (n=121) show a large difference between amateur players and students or professional players and within these groups.
'SINGLE TONGUING': Within 30 seconds female musicians played with 'SINGLE' on average 205 notes (236 maximum); male players on average 207 notes (maximum 262); amateurs 200, students 219 and professionals 225 notes. A professional trombone player *(Gerhard Füssl of Mnozil Brass on his Schagerl Model 'Prototype Jubilee 2012' Instrument)* played 262 notes. Fastest Players at the start – that is the first two seconds of the task - were a 19 year old trumpet student *(Paolo on his Schagerl, Model 'Vienna')* with tempo MM=167, followed with tempo 150 by a professional trumpet player tempo *(Ludwig Wilhalm of Bozen Brass on his customized 'Spada-Bach' Instrument)* and a beginner (!) *(Norbert Amon, a clarinet player on Lechner*

trumpet), who could only play a few notes on the trumpet, but indeed very fast.

'DOUBLE TONGUING': Within 30 seconds female musicians played with 'DOUBLE' on average 250 notes (304 maximum); male players on average 287 notes (maximum 415); amateurs 257, students 288 and professionals 303 notes. Utmost notes in 30 Seconds (415 notes) have been played by a professional trumpet player (Ludwig Wilhalm of Bozen Brass on his Spada-Bach Instrument).

Fastest Players at the start were a trumpet student *(Thomas Liesinger on his Yamaha YTR 6310ZS)* with tempo MM=238, followed by a professional player *(Herbert Zimmermann, Munich Philharmonic, on his Schagerl Heavy Hörsdorf trumpet)* with tempo MM=231.

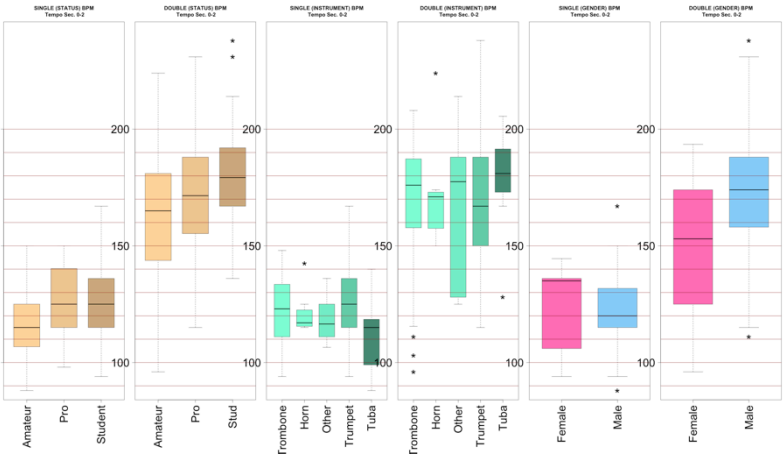

Figure 1 Boxplot comparisons of the maximal tempi played during the first two seconds. The 1st, 3rd and 5th graphic correspond to 'SINGLE', the 2nd, 4th and 6th graphic to the corresponding results of 'DOUBLE'. The 1st and 2nd plot compare the values by status (amateur, professionals, students), the 3rd and 4th by instrument (trombone, horn, other, trumpet, tuba) and 5th and 6th by gender (female, male).

DISCUSSION

Noticeable is the fact that most more experienced players tend to start with tempi that they think they can maintain for longer periods, and do not start with absolute maximum tempi. Many advanced players distinguish themself with more regularity. The tempo variation is shown in Figure 1.

Astonishing is the fact, that individual professionals can reach the same speed

on trumpets or tubas, playing 11-13 notes per second (max 240 bpm). Comparisons for different groups are shown in Figure 2. Finally Figure 3 shows the individual ability for maximum tempo of both articulations and the critical tempo for 'SINGLE TONGUING' with about MM=120.

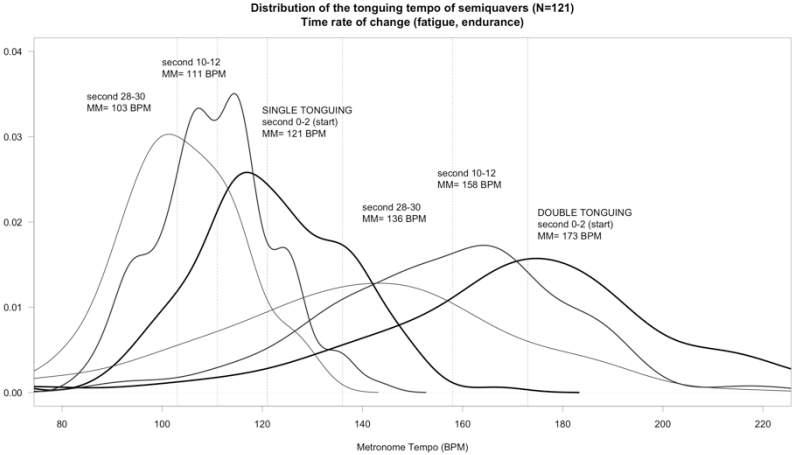

Figure 2 The mean values of the tempo at the beginning (seconds 0-2), after some playing (seconds 10-12) and at he the end of the task (seconds 28-30) are shown as density plot over the metronome tempo. The peak values for 'DOUBLE' slows down from 173 bpm to 136 bpm, and for 'SINGLE' from 121 bpm to 103 bpm. The graph indicates the huge variability for each playing technique.

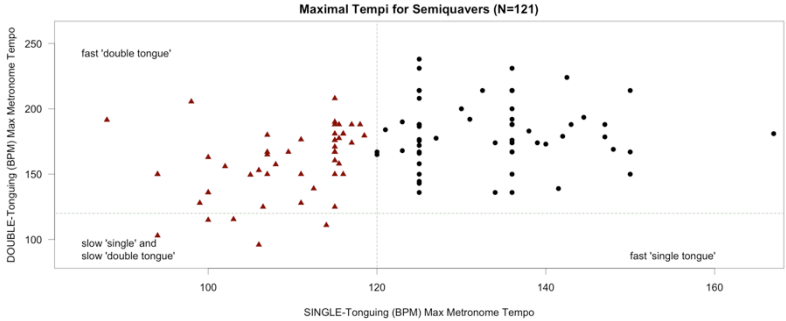

Figure 3 The maximal tempi played during the first two seconds is plotted for each 121 participants in a coordinate system, where the maximal 'SINGLE' corresponds to the x-axis and the values for the 'DOUBLE' to the y-axis. Many brass players (N=58, ▲symbols) are not able to play 'SINGLE' faster than 120 bpm, that is they have ~to play faster tempi by 'DOUBLE'. Other musicans (●-symbols) can choose the type of articulation up to 140 bpm and more.

The study is continued internationally for evaluations of the influence of more parameters, such as gender, mother tongue and more. Furthermore, acoustical, physiological and pedagogical related parameters will be correlated. Qualitative research is necessary to understand the large inter-individual differences as well as the intra-individual differences including the influence of training effects, the instrument acoustics and the preferred sound quality, since a hundred variables create zillions of different notes for many musical purposes. Project Website: www.drtrumpet.eu/tonguing

Acknowledgments

Thanks to all participants of this study, especially Mnozil Brass, Bozen Brass and the Samedan summer workshop musicians. Special thanks to my students Mario Zsaitsits and Philipp Aglas who were engaged in collecting data, as well as to the international partners Yang Chen (Central Conservatory of Music, Beijing, China) and Edith van Dyck (Ghent University, Belgium).

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