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Sound quality of the 16” french bagpipe: wood influence

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The most played among the bagpipes from the centre of France is the 16-inch musette, called in this way because of the length of the melodic pipe (oboe). Though these instruments are less known than the biniou from Brittany or the Great Highland Bagpipe, the number of players and makers is, nowadays, in increase because of their easy play and quasi-chromatic scale. Whereas the Breton and Scottish bagpipes are always made of very hard woods, some 16'' musettes are fabricated with softer woods. In this study, we first recorded some short musical sequences played on 16'' musettes made of 5 different woods (African Ebony, Santos Rosewood, Boxwood, African Blackwood and Service Tree), then some listeners (specialist and naïve) were asked to give their feedback about the quality of the recorded sounds.

1 Introduction

Opinions about the contribution to musical quality by the walls of woodwind instruments are many and various.

There are several origins for the impact upon sound quality by the wall, and more precisely by the wall material.

- The main physical process at the origin of the sounds produced by woodwinds is the radiation of the open end(s) of the waveguide. The mechanical vibrations of the instrument wall may contribute to sound production by: i) structure/internal fluid interaction, ii) structure/external fluid interaction and iii) inter-modal coupling due to the radiation of the open end of the waveguide. It is, however, worth noting that all of these contributions seem to be quite negligible in pipe with no circularity default [1].

- The vibration of the air column can be altered by some oval-shaping of the wall and/or state of the internal surface [2].

- The porosity of the pipe material may generate losses, and thus modify the instrument tuning and scale.

From a perceptive point of view, no clear-cut evidence of the influence by the material is available. Flutists submitted by Coltman to blindfold tests were unable to distinguish between several instruments of similar internal shape, but made of various materials [3]. In a study by Smith about trombone bells, none of the trombone players successfully distinguished thick from thin materials [4]. On the other hand, most of the musicians and woodwind instrument makers are convinced that the quality of a sound depends on the material used to make the instrument and that this effect is of key importance.

The sound of a reed instrument is strongly dependent upon the player's lips position. If the pipe material has an effect, the player should be able to compensate for it by his lips. Bagpipes are worth being used for experiments about pipe perception because the player has no direct influence on the reed since the reeds of oboe and drones are enclosed in stocks. The 16'' musette is a traditional instrument from the centre of France. It consists of a bag, usually a blowpipe used to blow the bag, two drones equipped with single reeds, and a quasi-chromatic oboe; the small drone plays a G3, whereas the big one plays a G2. The oboe is equipped with a double reed. These instruments are exclusively homemade, and the most used wood species are Boxwood, African Blackwood, and Service Tree. Traditionally, the oboe double reeds have been made of cane, but nowadays more and more players use synthetic ones. Plastic is interesting to make reeds because they are less dependent on moisture levels, high temperatures and ageing.

According to the unique study (from Bernard Blanc) available about the perception of sounds produced by a bagpipe close to the 16'' French musette [5], the sounds by oboes made of various wood species seem to be different. This perceptive observation was confirmed by the finding of some differences in measured spectra. However, there was no relationship between the differences between oboes and some physical property of the wood (e.g. density,…). One should note that this study was limited because it relied on i) the assessment of oboe sounds by only one listener and ii) the use of only one reed and one oboe per wood species.

In this study some short musical sequences played on 16''-musettes with oboes made of 5 different woods were recorded and presented through two tests to "piper-listeners" and "non piper" listeners to assess the recorded sounds. One should note that here it means not only "assessment of the quality of sound" (first test), but also quantitative feedback about the "brightness", "aggressiveness", "warmth", "volume" and "detached quality" (second test).

2 Materiel and methods

2.1 Recordings

The oboes under test were made in duplicate from different species of wood: African Ebony, Santos Rosewood, Boxwood, African Blackwood and Service Tree.

The oboe reeds were either synthetic or made from cane. Since they were brand-new, they had to be used for a few hours before starting recordings. It is worth underlining that our aim was not to observe the effects attributable to the reeds, but rather to extend the conditions of playing to make the experiments more realistic. Moreover, according to literature data [6,7] with some bagpipes, the pre-eminence of the input impedance of the pipe and the secondary role of the reed are not obvious.

Then these oboes were successively mounted on a unique bagpipe in order the recordings be made with the same drones, the same bag…

In most bagpipes the musician has to blow in the bag. As the air from the lungs is moist, the working of reeds (especially cane reeds) is liable to be affected by the progressive increase of humidity. In order to free from this problem, we used a 16'' « Bechonnet » bagpipe for it allows the player to send some dry air in the bag by moving a swell.

The two drones were made of African Blackwood and were equipped with synthetic single reeds as usual for this instrument

All of the oboes and the whole of the bagpipe components were made by a professional maker.

For each oboe, we recorded a traditional tune from France played on the oboe with the two drones. After removal of the attack and release from the recording, 20-s sequences were kept for the test.

A total of 20 sequences (5 woods x 2 items/wood x 2 reeds) was recorded.

The tuning pitch was controlled with an electronic tuner.

The recordings were made in a recording studio where a single DPA 4006 microphone was placed at 1.20 m from the piper and at 1.60 m above the floor. The PC was equipped with a Presonus Firestudio soundcard; the sampling frequency and quantization were 48 kHz and 16 bits, respectively. The test interface was developed with the Matlab software

2.2 Test protocol

To carry out the tests planned to assess i) the global quality of sound, and ii) the five criteria, the listener equipped with Sony CDR2000 headphones was always placed in front of a computer screen. He could hear the sequence followed with the display on the PC screen of the words "global quality of sound" (test 1), or of the five criteria "brightness", "aggressiveness", "warmth", "volume" (refers to the volume of the sound by the oboe with respect to the sound by the drones), and "detached precision" (test 2). These terms had been chosen further to a pre-study during which pipers and non-pipers had been asked to express at best how they qualified and differentiated the sounds from bagpipes. For each criterion the listener had to choose among five boxes from "1" (low) to "5" (high). At the end of a sequence, the listener under test was requested to tick the box that matched at best his feeling about the global quality of sound (test 1) or the five criteria (test 2); then he had to do the same thing after a new sound sequence. Each listener was successively given the two tests. The first one lasted each for about 15 minutes, whereas the other one took 25 minutes. Each test was preceded by a pre-test of about 5 minutes to enable the listener to get used to the proposed range of sounds and become more familiar with the different criteria. The listeners had been informed that the test was aimed at assessing the sound produced by the oboe played under normal conditions, i.e. with drones; the drones were never the subject of the assessment.

The sound volume of the sequences played in the headphones was about 85dB SPL to correspond to the true volume of a 16'' musette (at 1meter).

Among the 14 listeners involved in the study, 7 were non-piper musicians. The other ones were all trained pipers with a high practice level. This diversity in the populations under test was made on purpose to determine whether both populations of listeners had similar quality criteria to assess oboe sounds.

3 Results

3.1 Global quality of sound

Wood species effect

According to the listeners, the species of wood used to make the oboes had no direct effect on the sound produced by the oboe: indeed, their opinions were very similar whatever the wood (Fig. 1).

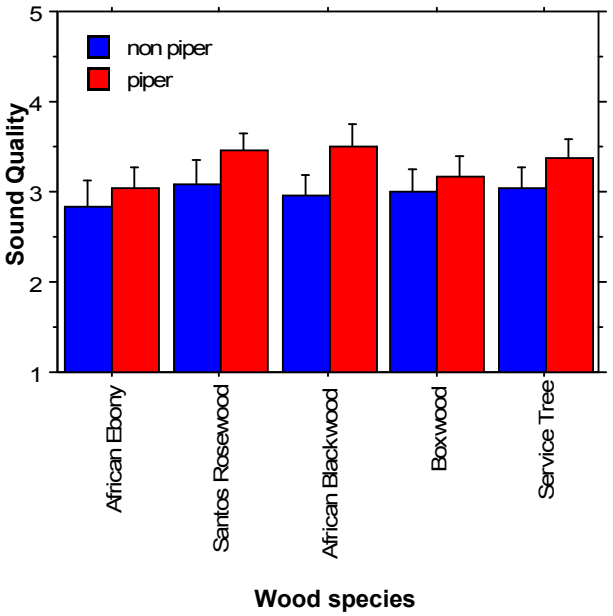


Fig.1: Sound quality of oboes as a function of wood species and listeners.

Reed effect

The listeners gave significantly higher marks to the sounds produced by oboes equipped with synthetic reed than to those with cane reed ($F(1,278) = 13.677$; $p = 0.0003$ – Fig. 2).

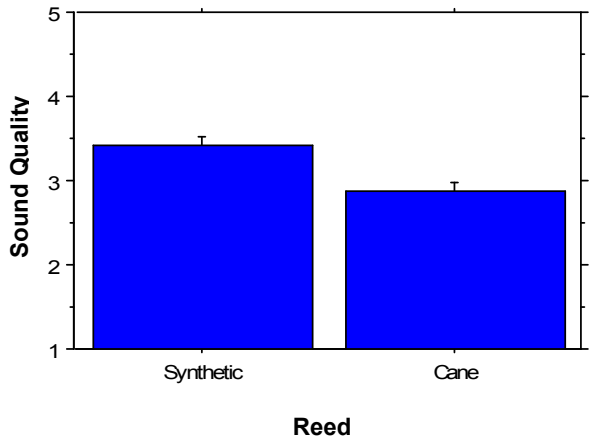
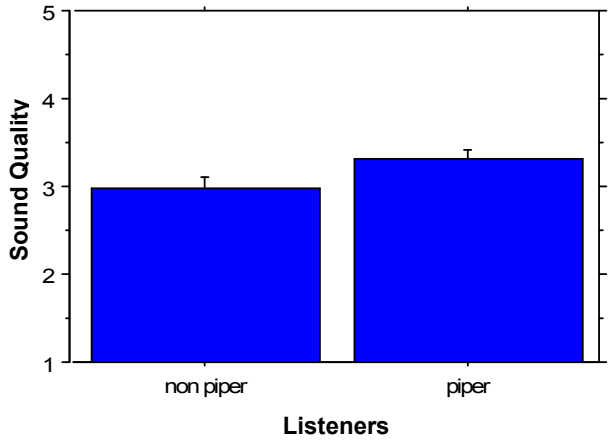


Fig.2: Sound quality of oboes as a function of the reed

Listener's background effect

The ratings of the set of heard sounds by piper listeners were significantly higher than those by the "non piper" listeners ($F(1,278) = 5.241$; $p = 0.0231$ – Fig. 3).



.Fig.3: Sound quality of oboes as a function of listeners

Effect by oboe items :

Despite the lack of direct effect by wood species on the assessment of sound quality, listeners showed some significant preferences for certain oboes (independently of their wood). Globally, these preferences were significant between two oboes made from different woods, but in the case of African Ebony, there was a significant difference in the assessment by listeners of the two theoretically similar oboes played with the same synthetic reed ($p = 0.0107$ Fisher post-hoc test).

3.2 Other criteria

Concerning the criteria, "brightness", "aggressiveness", "warmth", "volume", and "detached precision", no effect by wood species was found.

- "Brightness" criterion: the reed and the listeners background were found to have some significant effects ($F(1,278)=13.553$; $p = 0.0003$ and $F(1,278)=11.388$; $p = 0.0009$, respectively): indeed, the oboes with the cane reed were judged as brighter than those with the synthetic reed, and the "non piper" listeners gave higher brightness marks than the "piper" listeners to the whole set of sounds. Moreover, "non piper" listeners considered that the cane reed produced brighter sounds than the synthetic reed, but the "piper" listeners noticed no difference between both types of reeds (significant <reed/listener background> interaction: $F(1,1,278)=11.388$; $p = 0.0009$).

- "Aggressiveness" criterion: the reed and the listeners background were found to have some significant effects ($F(1,278) = 25.541$; $p < 0.0001$ and $F(1,278) = 44.331$; $p < 0.0001$, respectively): indeed, the oboes with the cane reed were considered as more aggressive than those with the synthetic reed, and for all of the sounds the "aggressiveness" marks given by the "non piper" listeners were always higher than those by the "piper" listeners.

- "Warmth" criterion: no significant effect was observed.

- "Volume" criterion: once again the reed and the listeners background were found to have some significant effects ($F(1,278) = 18.138$; $p < 0.0001$ and $F(1,278) = 25.948$; $p < 0.0001$, respectively): the oboes with the cane reed were considered as louder than those with the synthetic reed; Moreover, with respect to the "piper" population, the "non piper" one assessed all of the oboes as louder.

- "Detached precision" criterion: the difference in listeners background had a significant impact on the assessment of this criterion ($F(1,278)=10.419$; $p = 0.0015$): indeed, for all of the instruments, the degree of detached precision found by the "non piper" population was higher than by the "piper" population. Moreover, concerning the cane reed, the former population had also a better appraisal of its detached than the one by the piper population. On the other hand, no difference between listeners was found when the oboes were equipped with the synthetic reed (significant <reed/listener background> interaction: $F(1,1,278)=9.323$; $p = 0.0026$).

4 Discussion

The main result of this study is that the species of wood used to make the oboe seem to have no effect on the global sound quality. A thorough examination of the individual results showed that this lack of impact did not result from a compensation process between the preferences by the different subjects: individual ratings by each listener were unaffected by the species of wood. After the tests, some subjects reported that they had felt the sounds to be very alike conversely to others, who said to have been very embarrassed to accurately rate the big differences they had noticed between the sounds.

The quality of sounds seems to be strongly dependent on the reed material: in this study, the synthetic reed was preferred by most of the subjects. This preference can be related to the results of the second test where the sounds produced by the cane reed were felt to be brighter, more aggressive and louder than those by the synthetic one. Moreover, this preference (at least for "piper" listeners) may be due to the fact that nowadays most of pipers plays with synthetic reeds, and may be more familiar with their sound.

The listener background had a significant effect on the test results: the ratings of the sound quality by the "non piper" listeners were globally worse than those by the "piper" population; the former also considered all of the sounds as brighter, more aggressive and louder. Moreover, the detached precision on the whole set of oboe sounds was assessed by the "non piper" listeners as more precise than by the "piper" listeners. It is worth noting that the former reported to have felt the assessment of this criterion difficult for non-player listeners.

The criteria, "brightness", "aggressiveness", and "volume" (of the sound by the oboe with respect to the sound by the drones) seemed to be inversely correlated with the global sound quality… Nevertheless the difficulty of sound rating reported by some listeners should incite us to be careful in the analysis of results.

Overall these tests seemed difficult: some thin variations between the different recorded sequences could bias the

results; indeed listeners reported they can't disregard the musical content.

Moreover the features used to assess the sound of oboes seemed to be different between subjects (especially between "non piper" listeners). A preliminary experiment about the dissemblance between the oboes -rather than the sound quality- would have been useful.

At last, paired-comparisons of shorter sequences may be an easier and more reliable way to estimate the sound quality of oboes.

5 Conclusion

In this absolute rating experiment, the species of wood seemed to have no effect on the overall sound quality of oboes of 16'' musettes. Nevertheless synthetic reed was preferred to cane one.

The absolute rating of oboe sounds asked in this study was a hard task, and listeners said to have been very embarrassed to assess the heard sounds. Paired-comparisons of shorter sequences may be a more reliable task.

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