

Temperature and Frequency of Percussion Instruments

César Díez Factor

*IES Lancia
s/n Ejido Quintín Road
León, 24006, Spain
Email: cesardiez19@gmail.com*

Abstract

The frequency produced by a wooden xylophone, a metallophone and a drum at temperatures ranging from -18°C to 50°C was studied. It was found that the frequency of the first two increases, while the drum's frequency decreases with increasing temperature. Temperature had the greatest effect on the frequency of the xylophone.

Keywords: percussion instruments, temperature, frequency

I. INTRODUCTION

Instruments are tuned to each other when playing in a band or an orchestra so that a given note played on each of the instruments has the same pitch. Instruments must be re-tuned before every rehearsal and concert, as changes in the temperature affect the frequency of the instruments.

But what about instruments that cannot be tuned, as is the case for most percussion instruments? Does temperature have a significant effect on percussion instruments? Here the effect of temperature on the frequency of a xylophone, a metallophone and a drum (Figure 1) will be studied. While research has been published by Seavoy and Klement on the effect of temperature on a native Ghanaian xylophone¹, no research has been found investigating the instruments tested here.

Knowing the effect of temperature on the frequency of percussion instruments is important for any musical group that performs in a range of temperatures, as it will affect the overall sound of the group. If the frequency of these percussion



Figure 1. The xylophone, metallophone, and drum tested.

instruments is affected by temperature, this will affect the sound of a band playing outside on a summer day or during winter. A way of treating or tuning the instruments might be considered in order to avoid having these instruments being out of tune with the rest of the group in these conditions.

II. METHODS

The sound emitted by the three different instruments was recorded using a mobile phone microphone at temperatures ranging from -18°C to 50°C . The temperature was measured with an infrared thermometer. The A5 bar (nominally 880 Hz) of the xylophone and the metallophone was chosen for testing. The range of temperatures was selected as representative of the most extreme conditions of outside temperatures which might be encountered by a musician playing outside. The sound of each instrument was recorded several times at each temperature.

The recorded sounds were analysed with the computer sound analysis program *Audacity* to determine the fundamental frequency and the frequencies of the harmonics, as shown in figure 2. The mean of the frequencies for the several trials at each temperature was determined.

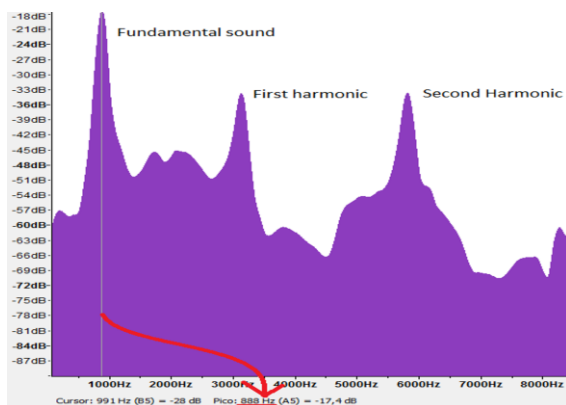


Figure 2. Spectrum analysis of the A5 bar of the xylophone.

III. RESULTS AND DISCUSSION

As shown in Figure 3, the fundamental frequency of the A5 (880 Hz) bar used for the xylophone (green) and the metallophone (blue) both decreased with increasing temperature, which is in line with Seavoy and Klement's results.

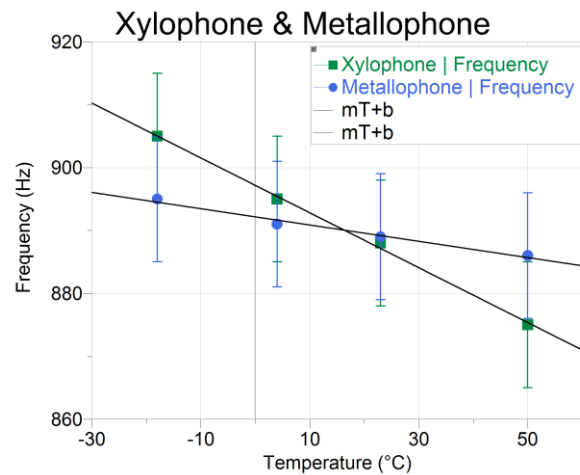


Figure 3. The relationship between temperature and frequency for the xylophone and the metallophone.

As can be seen, the frequency of the xylophone decreased significantly more than the metallophone. The metallophone decreased approximately 10 Hz, while the xylophone decreased approximately 30 Hz over the range of temperatures tested. However, both would be noticeably out of tune with other instruments in an orchestra, as a trained musician can detect frequency differences of just a few Hertz². It is clear that the tuning of the xylophone and the metallophone at different temperatures must be considered to keep them in tune with the rest of the orchestra.

Interestingly, the drum showed the opposite effect, with the frequency increasing with temperature, as shown in figure 4. As can be seen, the frequency of the drum increased approximately 10 Hz over the range of temperatures tested.

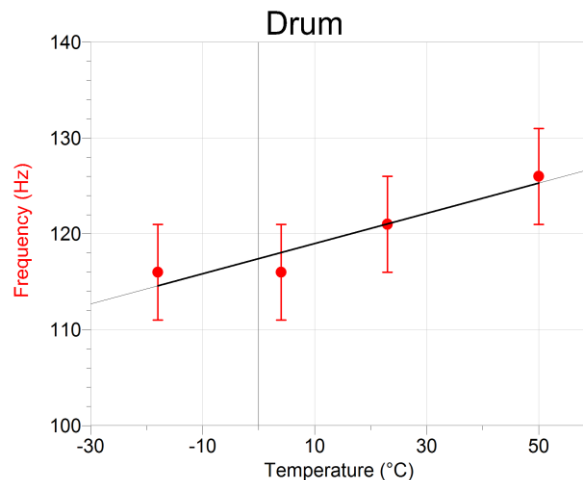


Figure 4. The relationship between temperature and frequency for the drum.

This is a relatively greater change in frequency (10%) when compared to the relative frequency changes of the xylophone (1%) and the metallophone (3%). However, the increase in frequency of the drum with increasing temperature is unlikely to have a noticeable effect on the sound of an orchestra. The drum plays a single sound with a wide mix of frequencies, and is not designed to be in tune with the rest of the orchestra.

This research is a first attempt to understand the role of temperature in the performance of a selection of western percussion instruments. Further research is suggested using improved temperature control methods. It is also suggested that the effect of temperature on all the notes of the xylophone and metallophone be investigated. The effect of temperature on a variety of drums and other percussion instruments should also be studied. Finally, methods to adjust the frequency of the slices of the xylophone and metallophone to account for temperature changes should be investigated.

IV. CONCLUSION

The frequency of both the xylophone and the metallophone decreased significantly with increasing temperature over the temperature range tested. The change in frequency of the xylophone was approximately three times greater than the frequency change in the metallophone. These changes would be noticeable when playing in an orchestra at extreme temperatures. Methods for accommodating these changes should be considered. The frequency of the drum, on the other hand, increased with increasing temperature. However, no accommodation need be considered for the drum.

REFERENCES

1. Seavoy, M., & Klement, W. (1980). Key design, material properties, and temperature factors in frequency variation of Sisaala *jengsi* (xylophone) keys. *J. Acoust. Soc. Am.* 67 (S85). <http://dx.doi.org/10.1121/1.2018442>
2. Cucciardi, F. (2000) *La Batería Acústica*. Valencia: Rivera Editores.