VISUALIZATION OF TRUMPET PLAYERS' WARM UP BY INFRARED THERMOGRAPHY

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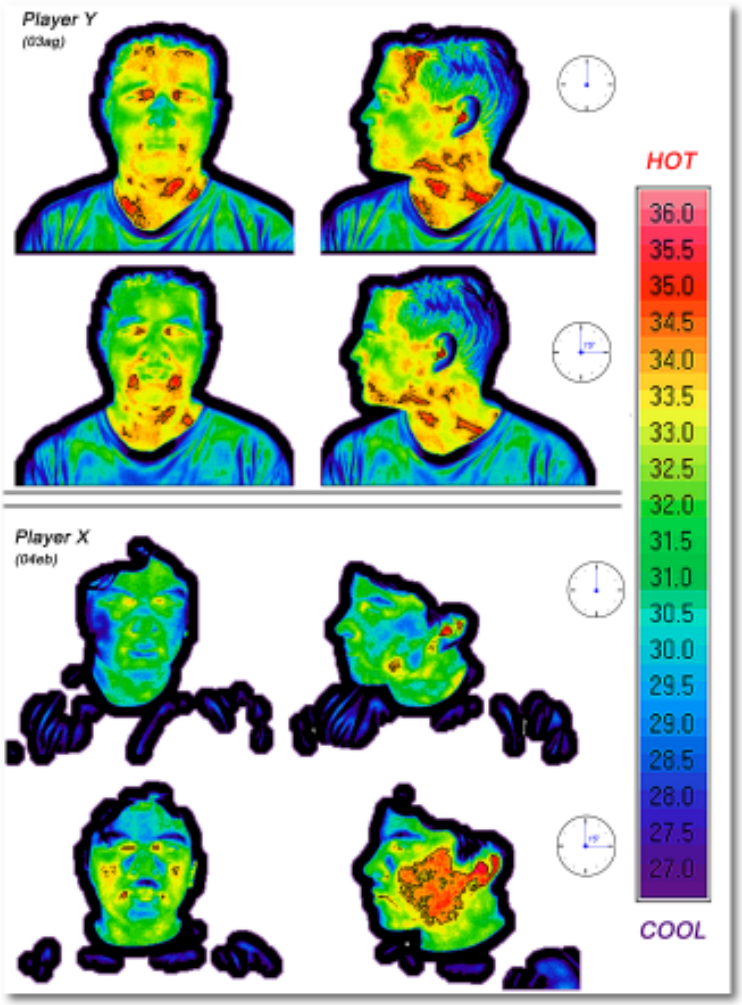

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Visualization of Trumpet Players' Warm up by Infrared Thermography

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Abstract

During the warm up of trumpet players, face muscle contractions with increased blood flow result in a higher temperature of the overlying skin. This effect can be visualized and quantified by infrared-thermography. The analysis demonstrates that the main facial muscle activity during warm up is restricted to only a few muscle groups (M.orbicularis oris, M.depressor anguli oris). The "trumpeter's muscle" (M.buccinator) proved to be of minor importance. Less trained players expressed a more inhomogenous thermographic pattern compared to well-trained musicians. Infrared thermography could become a useful tool for documentation of musicians playing technique.

Introduction

Just as in athletics, trumpet playing induces activation of certain muscle groups which are optimised after a warm up phase. For that reason this warming up is the first part of a brass player's daily routine to enhance muscle coordination of the complex setup of the embouchure. The warm up includes body and brain work; it "refreshes" the trained lip and muscle control mechanism. During the warm up, muscle contractions and increased blood flow result in a higher temperature of the overlying skin due to generation of heat. This effect can be visualized and quantified by infrared-thermography.

Aims

This study is a new approach to reflect physiological aspects of musicians' playing-technique by means of infrared thermography. The purpose of this study is to observe the individual reactions of different facial muscle groups during warm up and to compare playing patterns of professional trumpet players (n=5) with students (n=5) and beginners (n=6).

Method

16 Trumpet players were invited to the Vienna General Hospital (AKH). Five professional trumpet players (with an average 22 years of routine, standard deviation [SD] ±8 years), five students (13 years routine, SD ±4 years) and six beginners (4 years of routine, SD ±2 years). In order to meet the international standards for thermography they were instructed not to eat or smoke four hours before the test and to acclimate for 30 minutes in the lab (where they completed a questionnaire form). The time schedule is sketched in figure 1.

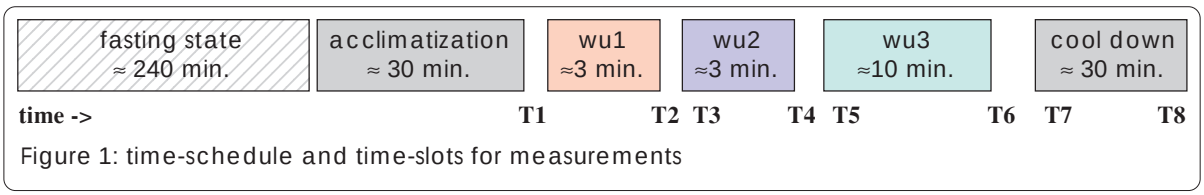


Figure 1: time-schedule and time-slots for measurements

Then, all trumpet players were instructed to play easy exercises for three minutes (given music tasks "wu1") then an exercise of medium difficulty (given music tasks "wu2") and, finally, about 10 minutes of playing whatever they play usually for warming up (individual music "wu3"). Frontal and lateral infrared images were taken before the very first warm up (T1) and after each part of the warm up (T2, T4, T6). This was realized with a Thermo Tracer TH1100 System (San-ei Inc.), and processed, using IRIS-software (nbn-Elektronik Inc.). The temperature resolution is 0,1°C; the frame time for one image is 1s and was taken about 30 seconds after each task. Additionally, axillary and finger temperatures were measured together with blood pressure and pulse rate before and after they finished playing (T1, T6).

Regions of interest

For determing the temperature at the selected points, the following 13 square sections with an area of 1cm x 1 cm have been used. Besides the forehead, which is measured in one point in the center only, all other locations have been measured on the left side *{sinistrer, s}* and on the right side *{dextrer, d}:*

1 • corner of the mouth *{anguli oris inferior}*
2 • inner corner of the eye *{anguli oculi}*
3 • forehead *{frontal}*
4 • side of nose *{perinasal}*
5 • inner cheek *{buccal rostral}*
6 • center of the cheek *{buccal central}*
7 • outer cheek *{buccal auriculaer}*

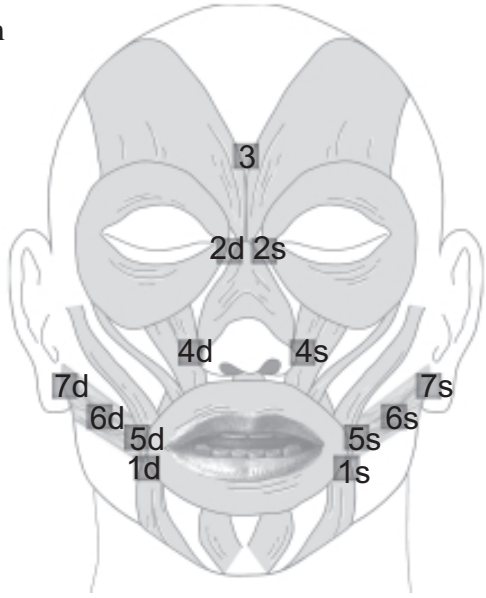


Figure 2: Areas of measured temperature

Questionnaire

The question "how long do you warm up daily and how long before a concert" has been answered in a rather wide range of 0 minutes (not at all) to 90 minutes. Regarding duration of warm up and the playing level there was no significant correlation. The duration seems to depend on the individual type only and not on level of skill. The mean duration of all groups was 30 minutes. Professionals are used to warm up for about 50 minutes before concerts, which is much higher than average.

The responses to the questionnaires showed the importance of the warm up for trumpet players. Since "to crack a note" is the result of a missing control of the complex interaction musician - instrument, the player have been asked to estimate how often they can play a sounding b2 in "pia-no" in a perfect manner - before or after a warm up.

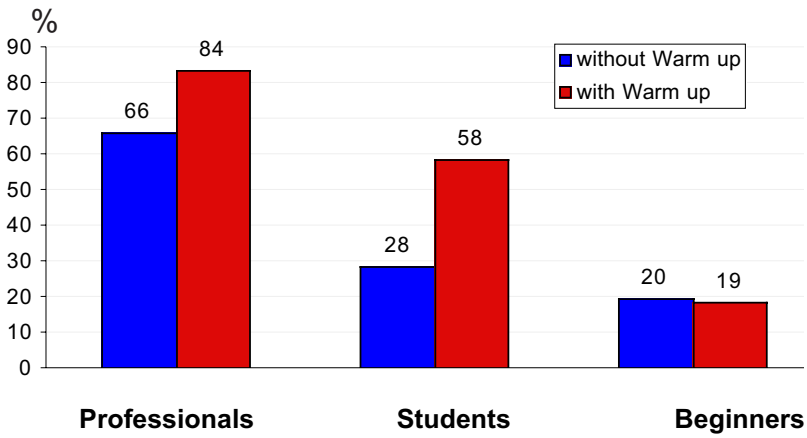


Figure 3: Estimated „rate of accuracy" for a difficult high note *(„high c" piano attack)* with and without „Warm up"

The estimated effect of the warm up is shown in figure 3. Professionals present an increase of 18 % in the "rate of accuracy" due to the warm up, whereas students have a 30 % increase on average. Since beginners usually are not able to play this note at all, the warm up shows no influence.

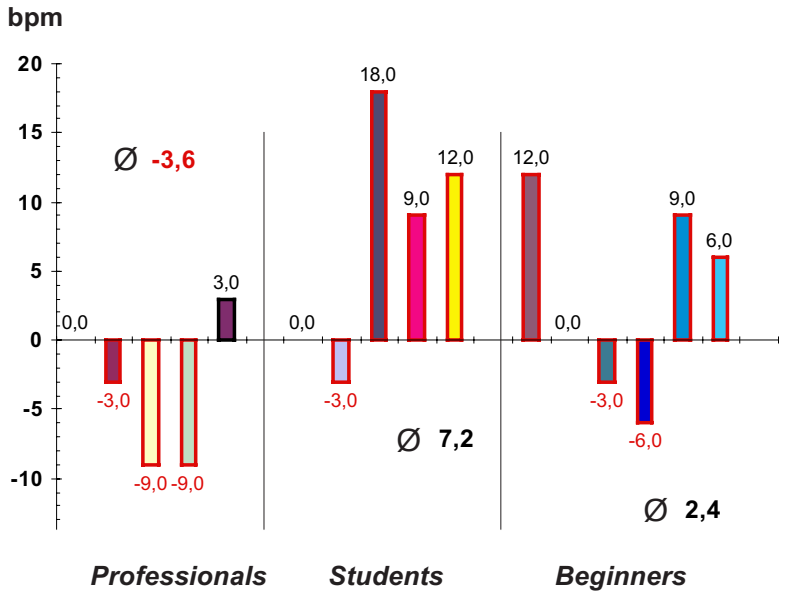


Figure 4: changes in the pulse rate after warming up

Pulse Rate

From the additionally measured values (axillary and finger temperatures, blood pressure and pulse rate) very individual variation was found. Pulse rate was the only sign that professional players may be more relaxed after the warm up, even in the strange surrounding of the hospital. The professionals stayed "cool"; their mean pulse rate dropped 3,6 bpm while the rate of the students and the beginners rose (+7,2, +2,4 bpm) respectivly. The individual changes can be seen in figure 4.

Results

Figure 5 shows typical thermo-patterns of 3 trumpet players before and after warm up, with images before the very first warm up on the left and images taken after the third warm up on the right. Warm colors (from yellow to red) correspond to warm areas. Whereas cool regions range from dark blue to green.

By Infrared Thermography the main changes can be seen in the embouchure region with increased temperatures during brass playing The blood supply seems to be redistributed from lateral to central parts. Therefore, the main facial muscle activity seems to be restricted to only a few muscle groups in this area (M.orbicularis oris, M.depressor anguli oris, M.levator anguli oris).

Variation between the three groups of players can be observed in Figure 5 . The first player, a professional musician, shows a very symmetric and compact warm region in the embouchure area. In comparison, player two, a beginner, shows a more asymmetric warm up, while player three, a trumpet student, demonstrates a much greater area of warming. For all players, the inner corner of the eyes seems to be a hot spot before and after playing.

For almost all players the "Trumpeter's muscle" (M.buccinator) proved to be of minor importance since the area of the cheeks are not warming up.

One exemption can be found in example 4. Figure 6 shows the hot cheeks of a trumpet student on the lateral infrared images. This is obviously caused by a buccal playing technique (like Dizzy Gilespie or the baroque angels who gave the "trumpeter's muscle it´s name).

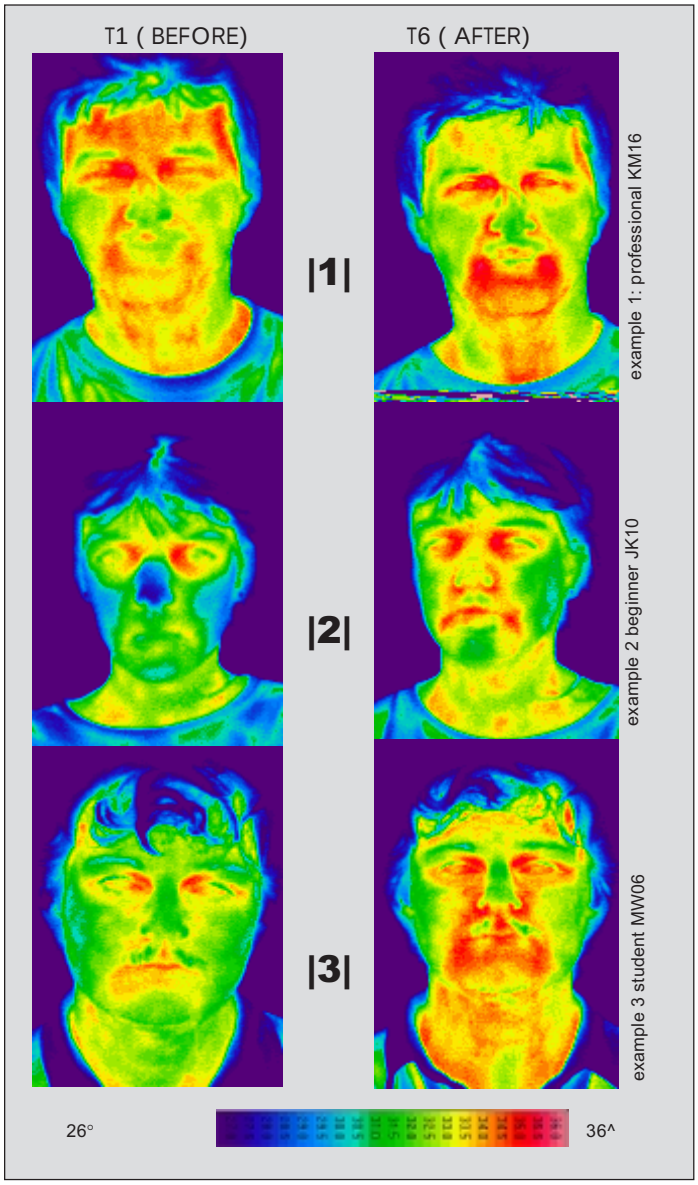
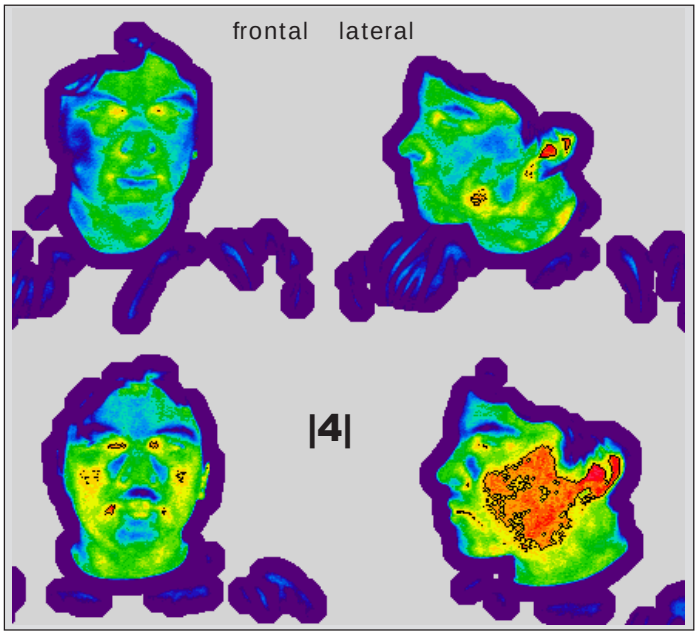


Figure 5 (above): Frontal infrared images from three different trumpet players before (left) and after the third warm up (right). Figure 6 (below): Frontal and lateral images of a players as example for a buccal type (hot cheeks).



The increase in temperature at the corner of the mouth was found for all players. Figure 7 demonstrates the values for the right side (anguli oris inferior, dextrum). The graphic shows the changes for all players from "before playing" (T1) to "after the first warm up" (ΔT2) and to "after the third warm up" (ΔT6). Values corresponding to professional player are plotted with a red line, those of students in blue and for beginners in green. The black line refers to the mean value.

The average temperature increase "after the third warm up" (T6) is one degree Celsius at the corner of the mouth. Some players even are 2 degrees warmer at the mouthcorner.

Figure 8 and 9 represent the same type of graph. In figure 8 you can see that the temperature at the eyecorner (point 2d; anguli oculi) remains very similar before and after both warm up rounds.

Figure 9 corresponds to the measured temperature at the outer cheeks (point 7d; buccal auriculaer). The average change is very small except for one beginner. The reason for this exemption could be explained by his different playing technique, whose thermo- pattern is shown in figure 5.

These three examples for temperature changes on the right hand side of the face are similar but not identical for the left side.

In figure 10, where the temperature changes after third warm up have been compared at all points of measurements between the

Figure 7: temperature changes at the right mouthcorner (Point 1d: anguli oris inferior)

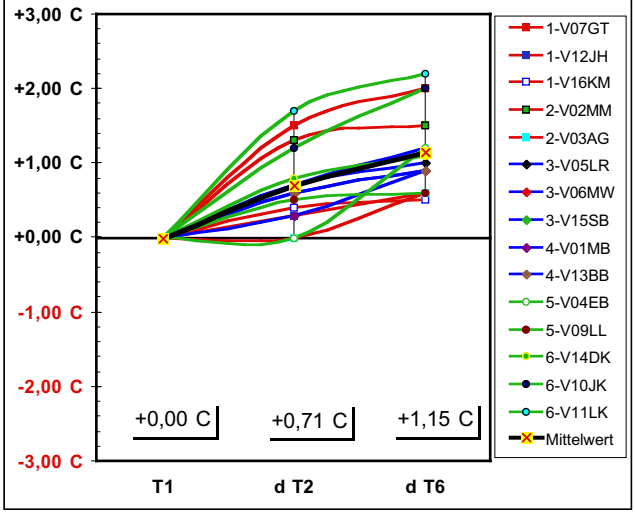


Figure 8: temperature changes at the right eyecorner (Point 2d: anguli oculi)

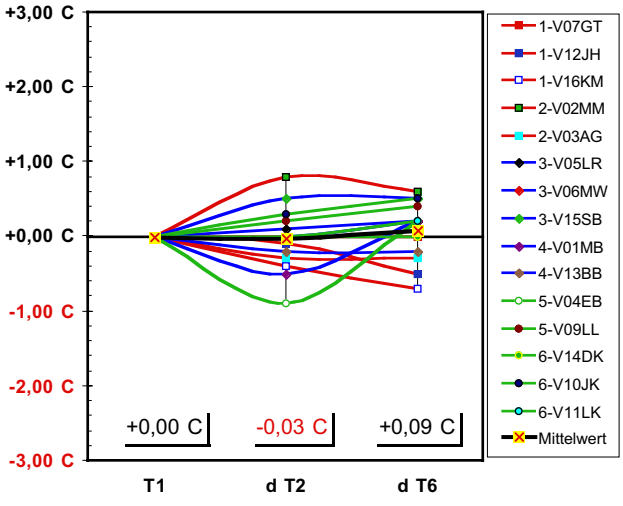
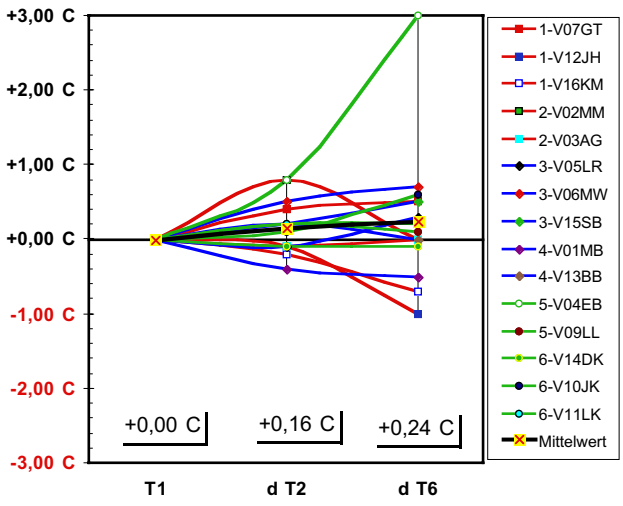


Figure 9: temperature changes at the right outer cheek (Point 7d: buccal auriculaer)



Professionals
Students
Beginners
Mean

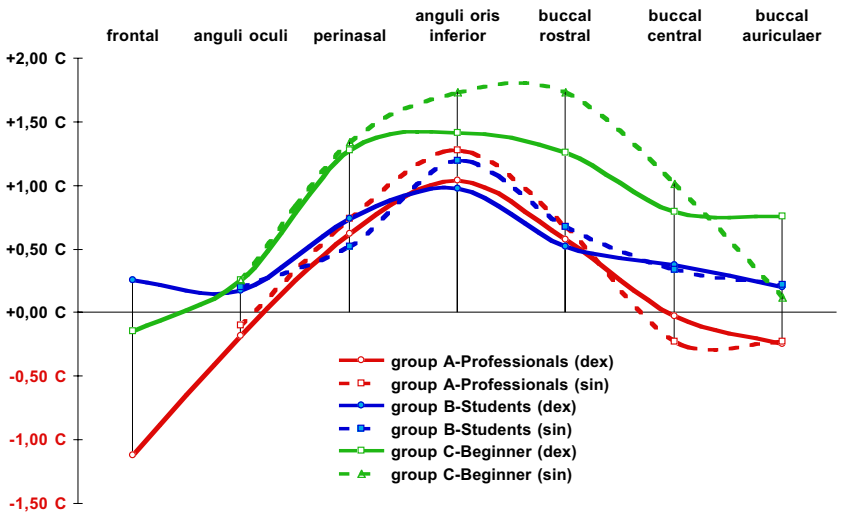


Figure 10: Changes of skin temperature in the face of trumpet players after the third warm up (ΔC t6-t1)
symmetry comparison by level of skill.

solid line: right side; dotted: left side.

three groups, significant differences may be seen: Professionals warm up much more symmetrically than beginners. Not only the symmetry, but also the intensity of the warm up is much more focused towards the embouchure area when the players are more experienced. Players with less experience expressed an inhomogeneous thermographic pattern compared to well-trained musicians. Professional trumpet players show a more compact, economic and homogenous embouchure.

Summary

The main facial muscle activity during warm up seems to be restricted to only a few muscle groups (M.orbicularis oris, M.depressor anguli oris,) while the "Trumpeter's muscle" (M.buccinator) proved to be of minor importance. Less experienced players expressed an inhomogeneous thermographic facial pattern compared to well-trained musicians. Professional trumpet players (with more experience) seemed to be mentally "cooler" after warm up. Their pulse rate tends to decrease probably due to their well-trained condition. Thermography shows a more economic, compact and symmetrical warm up of the embouchure in these players.

This first study gives reason to suppose that infrared thermography could become a useful tool for documentation of brass players playing technique. The technique could for example be used to test the effect of embouchure trainers, or could be expanded to physiological studies of different instrument playing. Perhaps this method could be used to identify areas of unnecessary muscle tensions in string players, either.

Reference

Bertsch Matthias. "Studien zur Tonerzeugung auf der Trompete". Dissertation at the University of Vienna 1998.