EFFECTS OF EXERCISES INTENSITY ON FACIAL HEAT DISTRIBUTION IN MALE SUBJECTS AND RELATIONSHIP WITH FEELING SCALE

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The purpose of this study is to identify the effects of exercises intensity on facial thermoregulation and to evaluate the relationships between changes in men's facial temperature and changes in affect that occur during muscular exercise. Moreover, a special attention has been paid on the possible relationship between the skin facial temperature and the heart rate of subjects. Fifty-four male performed a 12 min long session of aerobic exercise at moderate-to-high intensity. IR cartographies were performed using an IR camera. Pleasure and displeasure levels were assessed repeatedly over the exercise session.

KEY WORDS: Thermography, facial temperature, intensity exercise, pleasure and displeasure levels.

INTRODUCTION: Thermography represents a non-invasive method that provides information about the skin's thermal aspect in a complex thermoregulatory process. Moreover, infrared thermography gives a possibility to evaluate the effect of the sporting activity and to analyse the impact of physiological and morphological factors on the dynamics of temperature changes (Chudecka & Lubkowska 2010). Even rapid walks as short as 10 minutes have appeared to be of sufficient duration to increase energy and/or decrease tension levels for about half an hour following the walk. As a result, the purpose of the present study is twofold: (1) examine how exercise-induced thermal symptoms are related to pleasure-displeasure feelings during high-intensity exercise. (2) examine a possible relationship between the facial skin temperature and the heart rate of subjects.

METHODS: ***Subjects:*** Fifty-four young males (age = 20.1 years, SD = 1.4) were volunteers to participate to this study. They were moderately active. All of them were free of known cardiovascular and respiratory diseases at the time of the study.
Institutional Review Board approval was obtained for this study and the Ethical committee of the University of Reims approved of this study and the protocol used which was conducted in accordance with the ethical guidelines (Harriss & Atkinson 2014). Measures have been made in the same experimental conditions the room temperature was maintained constant at 20 °C ± 0.5 °C.
Materials: The experiment was conducted in an Exercise Physiology Laboratory with exercise sessions carried out individually on a SRM indoortrainer. Before the start of each test, each participant has adjusted his position.
- Heart rate beat by beat (RR interval) was recorded during all experimental sessions using the Polar S810 heart rate monitor.
- Facial skin temperature was measured using an infrared thermal camera (Cedip Titanium HD560M).
- The Rating of Perceived Exertion scale (RPE) is used. This scale consists of 15 assessments between 6 and 20 (from « very, very light » to « very, very hard »)
- The Feeling Scale (FS) which is an 11-point single item scale (from -5 « very bad » to +5 « very good », with 0 as a neutral midpoint) designed to assess the pleasure/displeasure core of emotions.

Protocol Participants had to perform an exercise during 12 minutes at an intensity that felt somewhat strenuous but not incredibly difficult (a perceived exertion of 13-15 on the Borg's RPE scale). The initial workload was set at 100 Watts during the first two minutes of exercise (warm-up). After that, participants had to continuously adjust exercise intensity by telling the researcher if changes in the rear wheel resistance were needed to keep them at an RPE of 13-15. Throughout the exercise, pleasure-displeasure feelings and IR thermograms of face were taken before the effort and during exercise (at 1min, 6min and 11min).

Statistical analyses All data were analyzed using descriptive statistics (percentages, means, standard deviations, correlations), repeated-measures ANOVAs.

RESULTS: The figure 1 presents the mean cutaneous temperature of the each cheek and the forehead at rest and during test (1, 6 and 11 min) for the fifty-four young males with the error bars representing standard deviation. It appeared that temperature sampled from the right and left cheeks significantly increased from Min-1:00 ($T_{right\ cheek}$ = 32.54°C, SD = 1.29; $T_{left\ cheek}$ = 32.82°C, SD = 1.23) to Min6:00 ($T_{right\ cheek}$ = 33.45°C, SD = 1.64; $T_{left\ cheek}$ = 33.55°C, SD = 1.63) and from Min6:00 to Min11:00 ($T_{right\ cheek}$ = 34.15°C, SD = 1.30; $T_{left\ cheek}$ = 34.23°C, SD = 1.32).

In figure 2 are represented the evolutions of facial skin temperatures (in left cheek, right cheek and in forehead areas). (*) represent: Significant difference p<0.001. One may observe a similarity between both evolutions of temperatures on the left and right cheek. On the other hand, left cheek measures significantly increased only between the first and the eleventh minute. However, the variation of the average temperature of the forehead skin is not significant (p > 0.001).

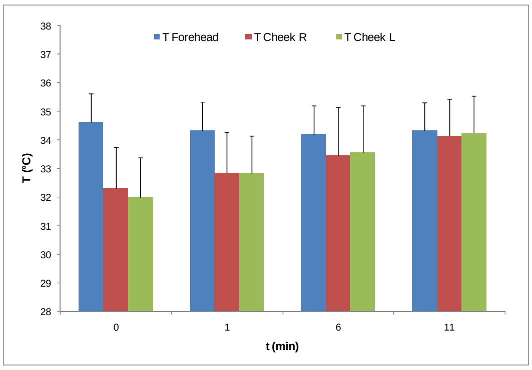


Figure1: Skin temperature of cheeks and forehead before and during test (1, 6 and 11 min).

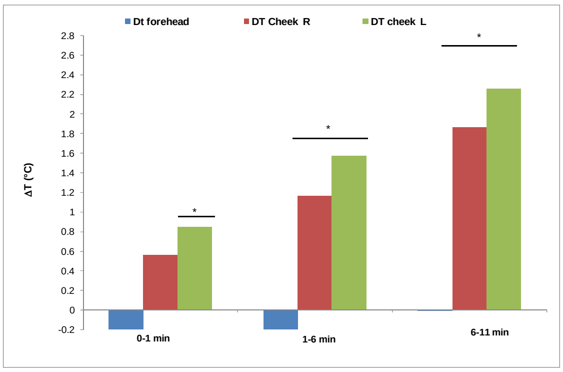


Figure2: Evolutions of facial skin temperatures (left cheek, right cheek and forehead areas).

Figure 3(a) shows the temporal evolution of Heart Rate (HR) and skin temperature during the exercise. We note that HR significantly increased from Min-1:00 (HR = 119.3 bpm, SD = 8.2) to Min6:00 (HR = 159.1 bpm, SD = 5.0 and again from Min6:00 to Min12:00 (HR = 170.8 bpm, SD = 3.4). Taken together, these values reflect the relationship between heart rate and the facial temperature during exercise of moderate-to-hard intensity. The heart rate values increase significantly (p<0.001) according to the exercise intensity. In figure 3(b) we represent a significant relationship between the heart rate and the skin temperature of cheeks with high coefficient (r = 0.9; 0.99).
The function is a polynomial evolution and is written: $Fc = -23.24\ T^2 + 1594\ T - 27.17\ 10^3$

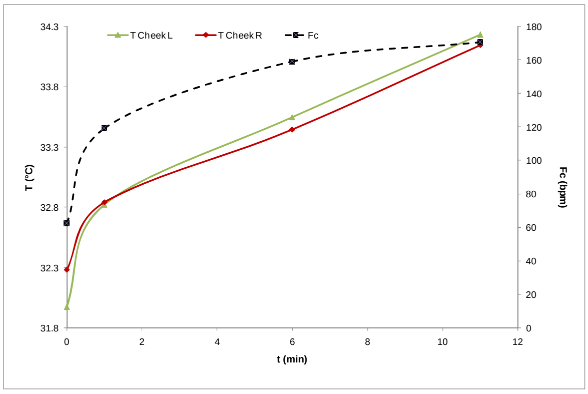


Figure 3(a): Distribution in time of Heart rate and skin average temperature gradient

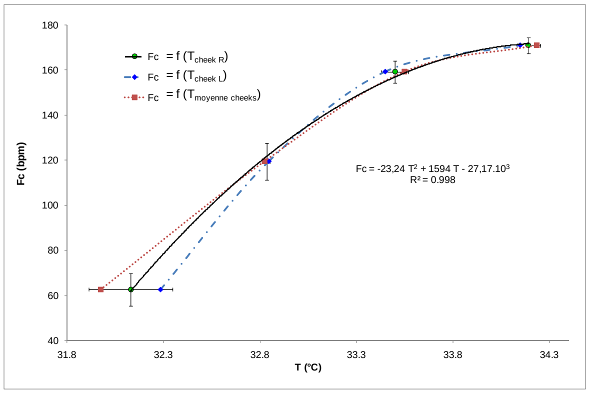


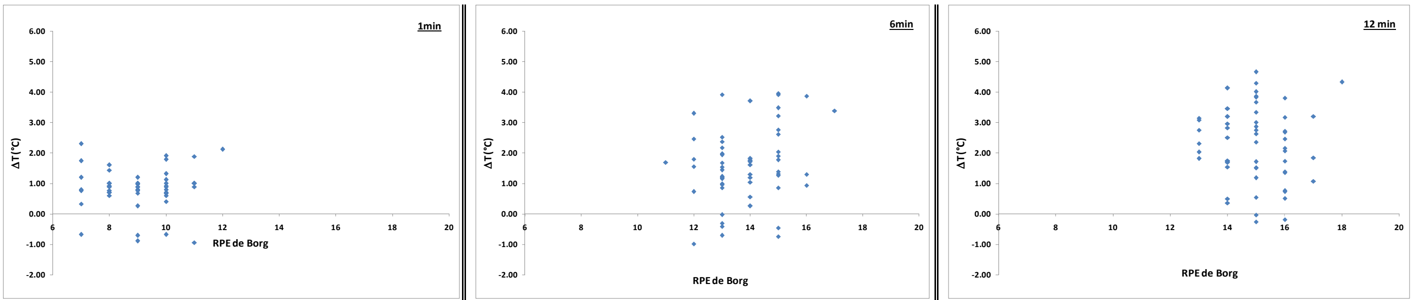
Figure 3(b): Correlation between Heart rate and cheeks skin temperature.

Affective changes and relationships with facial skin temperature changes:

Post analyses showed that RPE significantly increased from Min-1:00 (RPE = 9.02, SD= 1.25) to Min6:00 (RPE = 13.33, SD = 1.46) and again from Min6:00 to Min11:00 (RPE = 14.59, SD = 1.23).

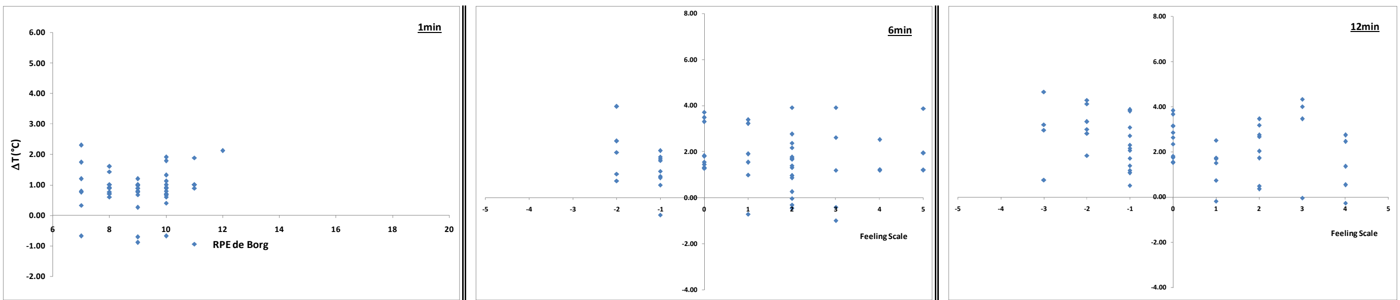
Figure 4 shows the relationships between cheeks skin temperature and Borg RPE during exercise. One may note that the increase of cheek skin temperature and the increase of RPE reflect exercise of moderate-to-hard intensity according to Pollock et al. (1998). Indeed, the examination of changes over time for the mean score of the Feeling Scale revealed a significant decrease in self-reported pleasure across time, $p < 0.001$.

The relationships between cheek skin temperature and pleasure-displeasure values were explored using correlation analyses and represented in figure 5. We observe changes in self-reported pleasure while exercising were negatively and significantly correlated with skin temperature changes sampled from the right and left.



(a) (b) (c)

Figure 4: Distribution of variation temperatures in cheek areas during exercise depending on Borg RPE.



(a) (b) (c)

Figure 5: Distribution of variation temperatures in cheek areas during exercise depending on feeling scale.

DISCUSSION: Increases in skin temperature of both cheeks during exercise period were significantly associated with changes in affect. The direction of this relationship was confirmed by Amanda-Da-Silva et al. (2004) who were first to show an impact of face temperature on perceived exertion and thermal comfort (albeit not affect directly) during high-intensity exercise. The Feeling Scale has previously been demonstrated to be a reliable and valid measure of affect in the exercise domain and has been used extensively in recent studies examining affect during acute exercise bouts (e.g., Ekkekakis & Lind, 2006).Analysis of individual responses on the Feeling Scale revealed that about 77.3 % of our male participants declined in affect over the course of exercise. At first glance, this is in accordance with the conclusions from the recent exercise psychology literature review proposed by Ekkekakis et al. who note an inverse relationship between exercise intensity and affective responses. One may note that 9.1% of participants reported changes of pleasure-displeasure feelings contrary to predictions (i.e., increased pleasure). This finding emphasizes that even if interoceptive cues certainly play a powerful role in the elicitation of positive-negative feelings during strenuous exercise. The affective states and changes experienced by these subjects during exercise may have largely depended on the extent to which they perceived these goals as being achieved as the exercise session progressed. Salience of cognitive factors during high intensity exercise was already noted in previous studies (e.g. Bozoian et al., 1994).

CONCLUSION: In this study, we present the effects of exercises intensity on facial thermoregulation and we evaluate the relationships between changes in facial temperature and changes in affect that occur during muscular exercise. Post analyses revealed that temperature of the right and left cheeks increased continuously throughout the exercise workout and were negatively correlated to changes in affect and one may observe a similarity between both evolutions of temperatures on the left and right cheeks. Therefore, the possible influence of cognitive factors on pleasure displeasure feelings should not be disregarded and is an issue that deserves consideration in future research.

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