Infrared Thermography as a Evaluation Metod an Athlete's Emotional Readiness

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Abstract

Purpose - to study the informative evaluation of an athlete's emotional readiness for competitions using infrared thermography. Materials and methods: the study involved 25 people aged 19 to 30 years. To take thermal images, an NEC TH9100 infrared camera was used, with a sensitivity of 0.03 ° C and a spectral range of 8-14mkm. Images were used from the standard database of realistic images of the IAPS (International Affective Picture System) to evoke an emotional response. 180 images of various emotional valence were selected adapted from the Russian sample: neutral, negative (causing negative emotions) and positive (causing positive emotions). Each study participant was presented with a sequence of images: 60 frames that evoke positive emotions, 60 frames that evoke neutral emotions, and 60 frames that evoke negative emotions. Each slide show time is 5 seconds. Black screen were presented for 3 seconds between the slides for participants. Thermal images were manually selected to create the analyzed database of thermal images. General indicators were calculated for each type of emotional response based on the analysis of a series of thermal images.

Statistical data analysis was carried out using specially developed software written in the C# programming language, the characteristics of adjacency matrices and some characteristics of the central trend were calculated. Statistical processing of the obtained data was carried out using SPSS–20 for Windows. Results. Significant differences were revealed in the parameters of textural features of the image under positive and negative emotional loads.

Conclusion. Infrared thermography can be used as a highly accurate evaluation metod an athlete's emotional readiness for competitive tests in real time, which will help optimize training activities and increase success at competitions.

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Introduction

The emotional response of a person remains an urgent issue to this day. Despite the many works evaluating emotional manifestations at various levels, to describe the fullness of this mental phenomenon with the help of one instrumental technique at the moment it is not possible. Various physiological reactions are used to describe human emotional responses: an increase in blood pressure is associated with anger and general arousal[1], heart rate is associated with the valence of emotion, and a decrease in pulse rate is associated with fear[2]. Techniques for detecting emotions on the face, for example, a system for coding facial movements and electromyography, can determine the strength of activation of muscles on the face and can be used to study suppressed emotional responses, but are not applicable for distinguish the sign of emotions[3].

Infrared thermography (ICT) registers only the own thermal radiation of objects in the infrared range, therefore it is absolutely safe for humans. The parameters of infrared cameras have significantly improved in recent years. The sensitivity of modern matrix systems reaches 0.0007-0.01°C, with a spatial resolution of 640*480 and a registration rate of about 50-100 frames per second, which gives a very detailed temperature portrait. The ability to transfer to a PC and analyze the received data arrays using

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BigData opens up new possibilities of the method[4].

Sports load requires maximum physical and mental mobilization from an individual, assessment of the psycho-emotional state of an athlete with the help of ICT can be successfully used in the field of sports and find practical application, both in psychology and in the physiology of sports, at the stage of preparing an athlete for competitions and, directly, in competitive activity.

However, a review of the available material shows its disunity, since researchers approach the issue of studying emotions from the point of view of different sciences, use a variety research methods and different terminological language. Thus, the connection between deception and an increase in the temperature around the eyes has been experimentally confirmed[5]. It has been shown that frustration leads to warming of the forehead area[6]. It was found that the temperature in the nasal region was an indicator of arousal in people in a situation with a high level of arousal[7]. The general temperature of the facial area increases with social contact with the opposite sex[8]. The temperature in the eye area increases during sexual arousal[5]. Researchers of emotional reactions in children have recorded a decrease in nasal temperature in a state of excitement[9, 10, 11]. In a study by a group of scientists led by Robinson D. T., it was shown that the areas of the forehead and cheeks are temperature-negatively associated with positive emotions, and the temperature in the eye area, on the contrary, is positively associated[12].

The use of ICT in the assessing the emotional reactions of athletes is promising and informative both from a practical and theoretical point of view. And it could be relevant both within the training and in the conditions of the competitive process. All of the above has predetermined the conduct of our research.

The aim is to study the information content and simplicity of assessing the emotional readiness of an athlete to compete using infrared thermography.

Materials and methods

The study involved 25 people (16 boys and 9 girls) aged from 19 to 30 years, (average age 20.32). The permission of the ethics committee and the consent of each person to participate in the experiment was obtained. The experiment took place in a room with an area of 24 m^2. The room was kept at a constant level of humidity and temperature of 24-26° C, the level of illumination also remained unchanged. To exclude extraneous emotional stimuli in the room and outside its immediate limits, silence was maintained. In the experiment area, there were: an infrared camera, a laptop, a table and a chair for the subjects. Participant was separated from the experimenter by two screens to make he feel more free in expressing his emotions. The infrared camera was located at a height of 1.5 meters from the floor and at a distance of 0.85 meters from the study participant. The equipment was calibrated before filming each individual.

To shoot thermal videos with a frame rate (thermal images) of 5 per second, an NEC TH9100 infrared camera was used. The minimum distinguishable temperature difference (sensitivity) of the NEC TH9100 infrared camera is 0.03 ° C, the spectral range is 8-14mkm.

To evoke an emotional response, images were used from the standard database of realistic images of the IAPS (International Affective Picture System)[13,14], adapted on the Russian sample[15,16] 180 images of different emotional valence were selected: neutral, negative (causing negative emotions) and positive (evoking positive emotions). For example, as images of a neutral plan, photos of kitchen utensils, interior items, etc. were presented, as images of a negative plan – photos of accidents, catastrophes, etc., as images of a positive plan – specific images of landscapes and natural landscapes, babies, lovers, etc. The IAPS Incentive Material Agreement does not imply its publication by researchers.

Each participant of the study was presented with a sequence of images from the IAPS database: 60 frames for positive emotions, 60 frames for neutral emotions, and 60 frames for negative emotions. Time for showing each slide is 5 seconds. The subjects were presented with a black screen for 3 seconds between the slides.

Since the emotional response to thermal images was stable for several seconds, thermograms were manually selected and analyzed, obtained in the course of a positive and negative emotional response.

Statistical data analysis was carried out

using specially developed software written in the C# programming language, the characteristics of images (characteristics of adjacency matrices and some characteristics of the central tendency) were calculated. For further statistical processing of the obtained data and identification of statistically significant differences in the compared groups, the statistical package SPSS–20 for Windows was used. The distribution was checked for normality by the Kolmogorov-Smirnov test, the analysis of the results obtained was carried out by nonparametric methods. The nonparametric Mann-Whitney criterion was used to compare the groups. The results of data processing were presented as a median, the first and third quartiles (Me (Q1;Q3)). For all the results presented, the differences were considered significant at the $p<0.05$ level.

Organization of the study. There was only one participant and one researcher in the room, during the study. The subject was sitting at a table in front of a monitor and looking at the images. All subjects gave their voluntary consent to participate in the experiment. If the participant refused to view images that were unpleasant for him, the experiment was stopped. At the start of the experiment, the mood background of all the subjects was assessed as equal. Among the subjects, there were no individuals with mental and neurological disorders. All subjects were students of a higher educational institution, the student's overall score was assessed within the framework of the norm.

Results

During the study of thermographic images obtained upon presentation of emotionally significant information in 25 people actively involved in sports activities, the following results were obtained (table 1).

Discussion

The revealed significant differences in the parameters of the textural features of the image indicate different temperature patterns on the face of a person under emotional loads with positive and negative emotional coloration, and also reflect the regularities of changes in the temperature of the nasal region in the subjects relative to their positively or negatively colored emotional state.

Thus, an increase in the temperature in the area of the nose on a thermal image may indicate the presence of a negatively colored emotional state in an athlete, which, in turn, may negatively affect the forthcoming sports activity.

Parameter	Positive emotional state Me (Q1-Q2), n=25	negative emotional state Me (Q1-Q2), n=25	p
Average color intensity	133,16 (118,37-144,94)	144,10(123,70-150,72)	0,001
Standard deviation	10,12 (6,27- 18,04)	7,77 (4,14- 18,25)	0,067
Asymmetry	0,17 (-0,06-0,35)	-0,41 (-0,45- 0,25)	0,001
Excess	2,39 (2,18- 3,32)	2,56 (2,00-3,28)	0,153
Direction 0°			
Energy	0,088 (0,004-0,011)	0,009 (0,004-0,018)	0,016
Entropy	5,41 (4,91-5,91)	5,16 (4,37-5,94)	0,005
Contrast	8,13 (5,60-21,05)	5,45 (4,11-25,98)	0,220
Homogeneit	0,42 (0,35-0,48)	0,47 (0,33-0,55)	0,001
Correlstion×10^8	1,38 (1,00-1,37)	1,01 (0,47-1,56)	0,833
Direction 45°			
Energy	0,006 (0,003-0,008)	0,007 (0,003-0,015)	0,018
Entropy	5,59 (5,15-6,01)	5,37 (4,58-6,09)	0,008
Contrast	15,15 (10,56-36,97)	9,97 (6,87-43,67)	0,321
Homogeneit	0,27 (0,30-0,39)	0,38 (0,26-0,43)	0,004
Correlstion×10^8	0,88 (0,67-1,33)	0,99 (0,46-1,50)	0,788
Direction 90°			
Energy	0,008 (0,005-0,011)	0,009 (0,004-0,017)	0,022
Entropy	5,44 (4,95-5,81)	5,16 (4,42-5,91)	0,006
Contrast	7,69 (5,73-16,61)	5,40 (4,11-17,06)	0,421
Homogeneit	0,41 (0,34-0,47)	0,47 (0,35-0,51)	0,003
Correlstion×10^8	0,92 (0,67-1,37)	1,01 (0,48-1,54)	0,856
Direction 135°			
Energy	0,007 (0,004-0,009)	0,007 (0,003-0,016)	0,025
Entropy	5,59 (5,08-5,99)	5,38 (4,53-6,02)	0,007
Contrast	15,28 (10,11-38,09)	9,38 (7,22-39,22)	0,204
Homogeneit	0,35 (0,29-0,39)	0,39 (0,26-0,46)	0,002
Correlstion×10^8	0,88 (0,67-1,33)	0,99 (0,46-1,50)	0,788

Table 1. Comparative characteristics of the image at the positive and negative emotional state of the investigated.
Note: correlations in all directions are divided into 108.

Conclusion

ICT, as an inert and atraumatic way of assessing an athlete's emotional readiness for competitive tests, has significant prospects. And although there are a number of disadvantages that limit the use of the technique (hair, clothing, human movements), these problems can be solved with the help of appropriate software. ICT does not require interruption of interaction and complex coding protocols, which is important in the conditions of preparation for competitive activities. Psychological factors play a significant role in the realization of an athlete's potential. High-precision objective determination of the athlete's psycho-emotional state in real time using digital infrared thermography will help optimize training activities and increase success in competitions.

Declaration of Interest

The authors report no conflict of interest.

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