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Accuracy of Thermal Images

Thermal imprint of Flamenco Duende

Effects of Placebo in Abdominal Wall Pain Detected By Thermography

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The influence of colour scale on the accuracy of infrared thermal images

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A common definition of a infrared thermal image is "*a map of temperature distribution on the surface of the object. imaged*". Consequently, thermal images are often regarded as 2-dimensional temperature measurements and evaluation of the accuracy of thermal images are mostly restricted to the accuracy and reproducibility of temperature measurements when *"acccuracy is the closeness of agreement between a measured quantity value and a true value of a measureand* The smaller the measurement error, the better is accuracy. Although accuracy is sometimes understood as closeness of agreement between measured quantity values that are being attributed to the measurand, the term "accuracy" must not used synonymously for the term "measurement trueness" which is defined as *closeness of agreement between the average of an infinite number of replicate measured quantity values and a reference quantity value*[1]. Common limits of measurement errors of infrared thermal imaging devices are ± 2°C [2].

Repeatability is defined as repeating a defined measurement again applying identical equipment, conditions and procedures, while reproducibility is the attempt to achieve the same measurement results using different equipment and/or conditions and/or procedures.

Whenever a thermal image is understood as a map of temperature values, accuracy will always be based the closeness of agreement between the measured temperature and and true value of the temperature. The colour palette irrespective of its composition will not have any influence on the accuracy of the temperature readings as long as the temperature map is the primary output of the recording device of infrared radiation. In case that a copy of a recorded infrared image is used for calibration of software that evaluates the temperature distribution within the image, differences in gray shades and colours compared to the original recorded image will affect the accuracy of temperature readings.

The human eye is the organ that provides vision and images for men. A single eye is generating a 2-dimensional representation of any 2 or 3-dimensional object which reflects or emits light. Possessing 2 eyes, allows us to see the 3-dimensional space, and high level image processing of the central nervous systems perfectly overcomes the rather crude optical system of the eye by transforming poor quality optical images into sharp, colourful and 3-dimensional vision.

An accurate image could be defined by the closeness of agreement between the image and the object imaged. Several physical measures are available [3], to quantify image quality and define in this way the accuracy of an image. Colour, tone (contrast), resolution (details), sharpness (edges) and noise, all contribute to image quality.

In contrast to temperature measurements, image processing procedures such as different colour palettes, isotherms, compression or extension of the temperature window will affect the accuracy of the thermal image.

As we cannot see infrared rays with our vision organ, we can compare the image, generated from infrared emittance of objects, only with the optical image produced by our eyes or other optical systems. The poor resolution of a early thermal imagers compared to photographs (figure 1) was repeatedly mentioned [4,5]. The resolution of infrared for imaging is the better, the closer is the wavelength of infrared to visible light. However, recent developments in infrared detectors design and image processing resulted in high resolution of details in gray shade thermal images recorded in the infrared long wave domain [figure 2).

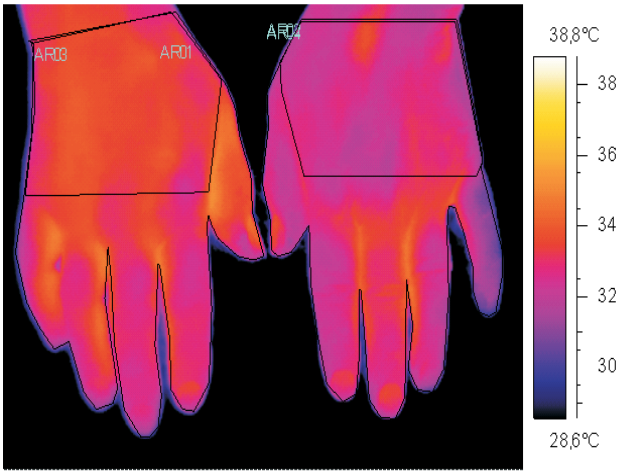
Figure 1
Comparison photographic and thermal image in 1948 [4]

Figure 2
High definition IR mage recorded with a modern detector [6]

Figure 3
Original report

N. I, female, age. 73 years

After acclimatisation to a room temperature of 21°C for 15 minutes with bare forearms, static thermal images of both hands were recorded and the following temperatures were obtained.



The right hand appeared to be warmer than the left hand, the temperature difference of the total hand (AR01 –AR02) is 0,75°C, of the dorsal hand(AR03 –AR04) it is 1.02

Measurement area	Temperature [°C]	Standard deviation	
AR01	right hand, total	33,3	0,7
AR02	left hand, total	32,5	0,8
AR03	right dorsal hand	33,5	0,4
AR04	left dorsal hand	32,5	0,5
fo01	{ar1.avg} - {ar2.avg}	0,75	
fo02	{ar3.avg} - {ar4.avg}	1,02	

CONCLUSION:

Hyperthermia of the right hand, the temperature difference found at the dorsal hands meets the temperature criterium for the diagnosis of CRPS..

The rainbow palette is the preferred colour scale for thermal images in medicine and biology [7]. Variations of the colour palette, especially for use in breast thermography has been proposed and evaluated [8,9]. Vardasca suggested a rainbow based colour scale, which had the highest acceptance in health professionals who were regularly involeved in medical thermography [10].

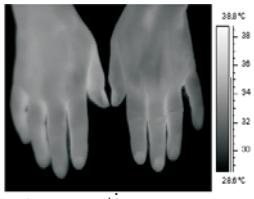
However, none of these papers addressed the closeness of the thermal image to the visional image, although Zahedi et al are aware that pseudo-colouring of gray shade thermograms must not add information to the image and that a specific colour is not assigned to a specific temperature.

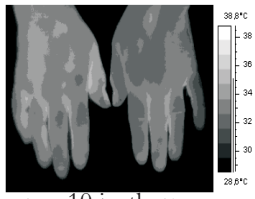
As chromatic colours resemble gray shades, false colour palettes add gray levels to the original gray shade image. Isotherms which are common at ten step increment in false coloured thermal images, add bands of additional gray shades and linear elements on the edges of each isotherm band due to contrast of chromatic colours.

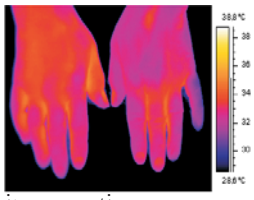
A series of processed thermal images of a patient with suspected CRPS (figure 3)show the effects of different colour scales available in the FLIR software Thermocam Researcher Pro 2.1

At first, the image was displayed in continuous gray shades and 10 gray shade isotherms, followed by the continuous and 10 isotherms iron palette, the continuous rainbow and 10 isotherms rainbow colour scale and finally the 10 isotherms medical scale. (Figure 4). It becomes obvious that the gray shade image is closest to the visual image, although the temperature distribution does only in part enhance the anatomy and acts as a factor of deformation,

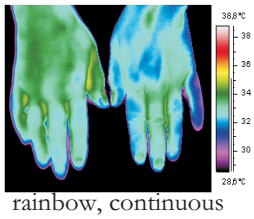
Figure 4. Images were recorded at temperature window of 10° C width

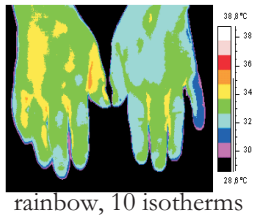

gray, continuous


gray, 10 isotherms


iron, continuous


iron, 10 isotherms


rainbow, continuous


rainbow, 10 isotherms

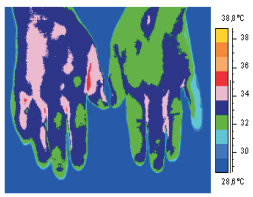
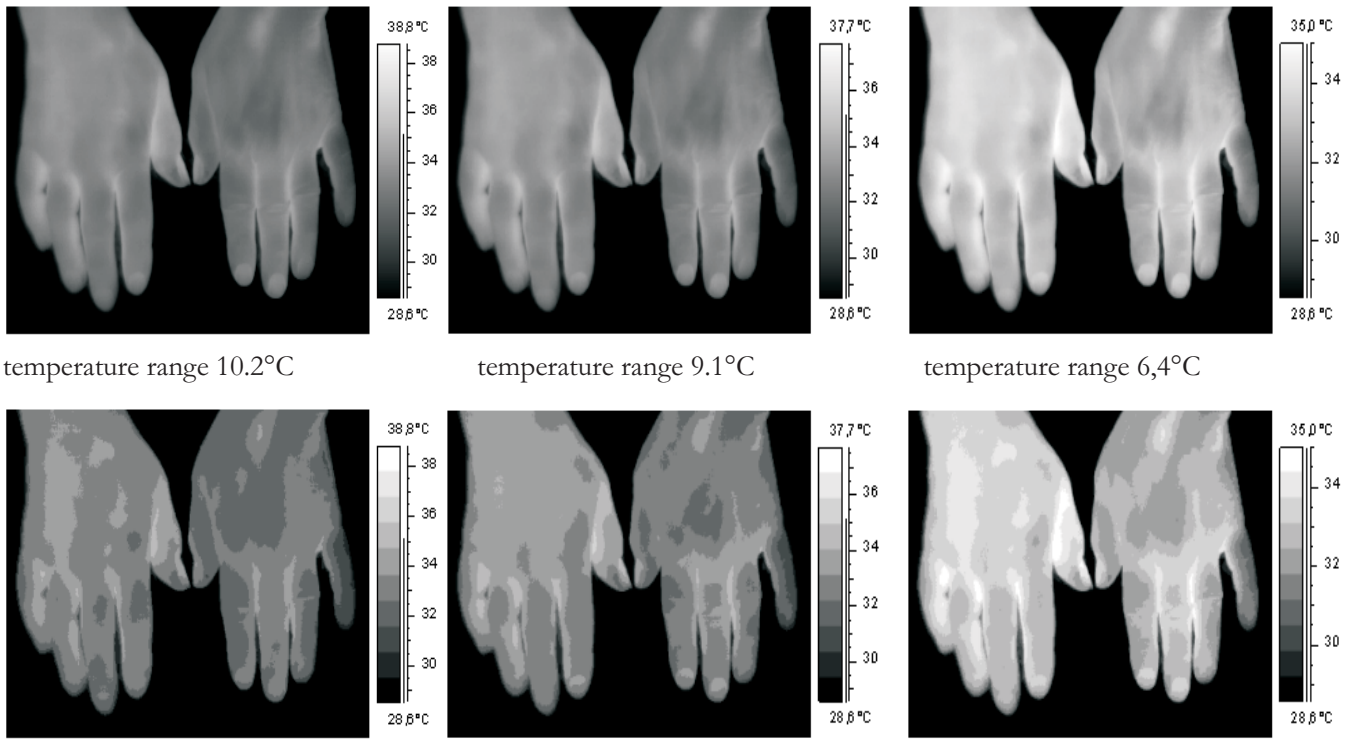
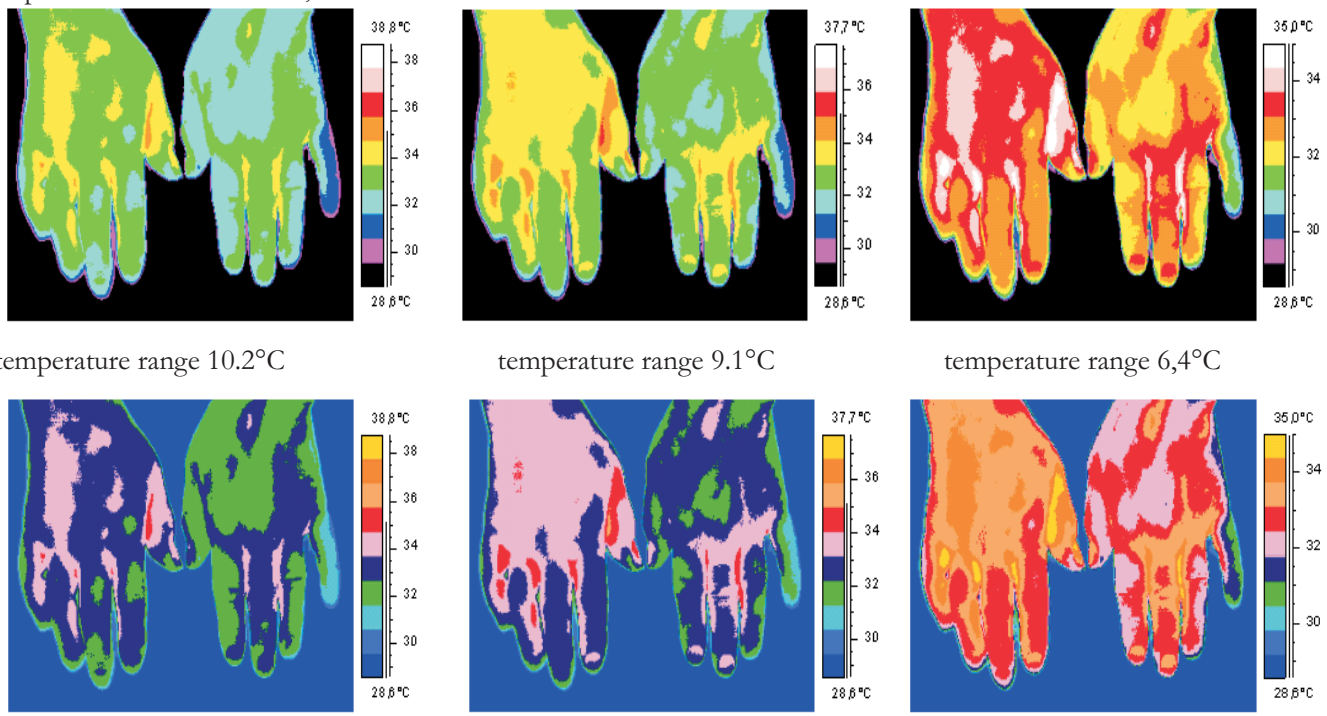

medical, 10 isotherms

Figure 5
Effect of compresssion of the temperature window on resolutionof gray shade thermal images. Top line continuous gray shades, bottom line gray isotherms



temperature range 10.2°C temperature range 9.1°C temperature range 6,4°C

Figure 6
Effect of compresssion of the temperature window on resolution in false coloured thermal images.
Top line rainbow isotherms, medical isotherms



temperature range 10.2°C temperature range 9.1°C temperature range 6,4°C

which becomes more visible in isotherm images. Here are new areas generated that do not correlate with any anatomical structure.

Compression of the temperature windows to a width of 9.1°C and 6.4 °C slightly increased the resolution of continuous gray shade images, but generated new areas and line elements in the gray isotherm image (figure 5).

Narrowing the temperature window in false coloured isotherm thermograms induced a change in colours and induced new shapes of areas not related to anatomy, leading in this way to a distoration of the visual image (figure6).

Brightness of imaged is related to the gray levels of an image. One problem of colouring a gray shade thermal image arise from the fact that the grey level of a colour selected

Figure 7
The temperature window was compressed to a width of 6.4°C,thermograms were transformed to gray shade images

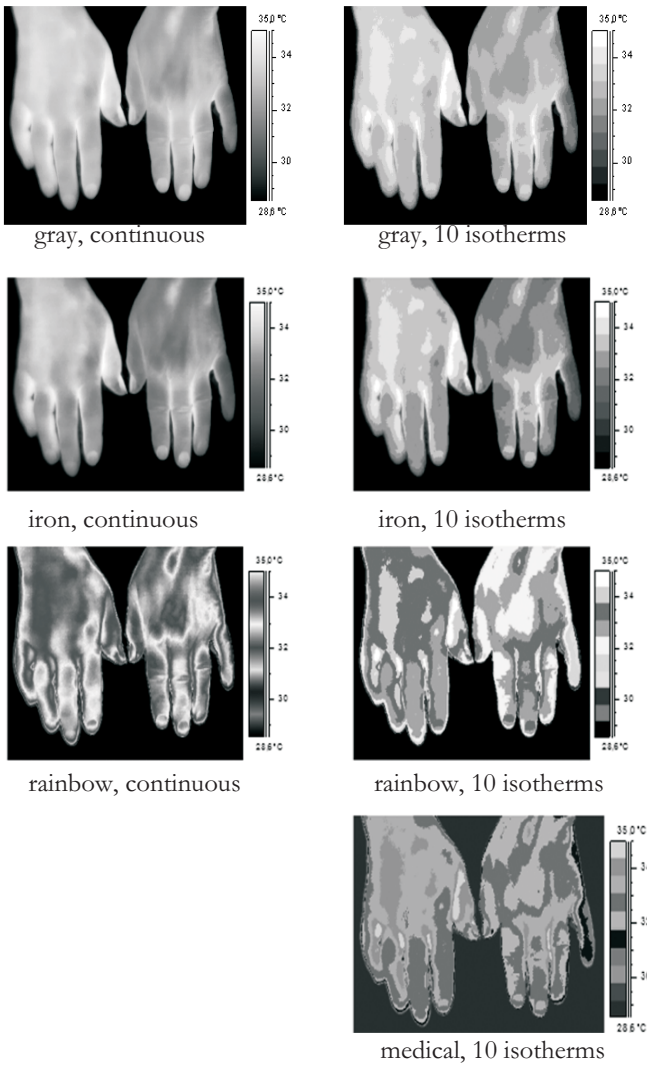
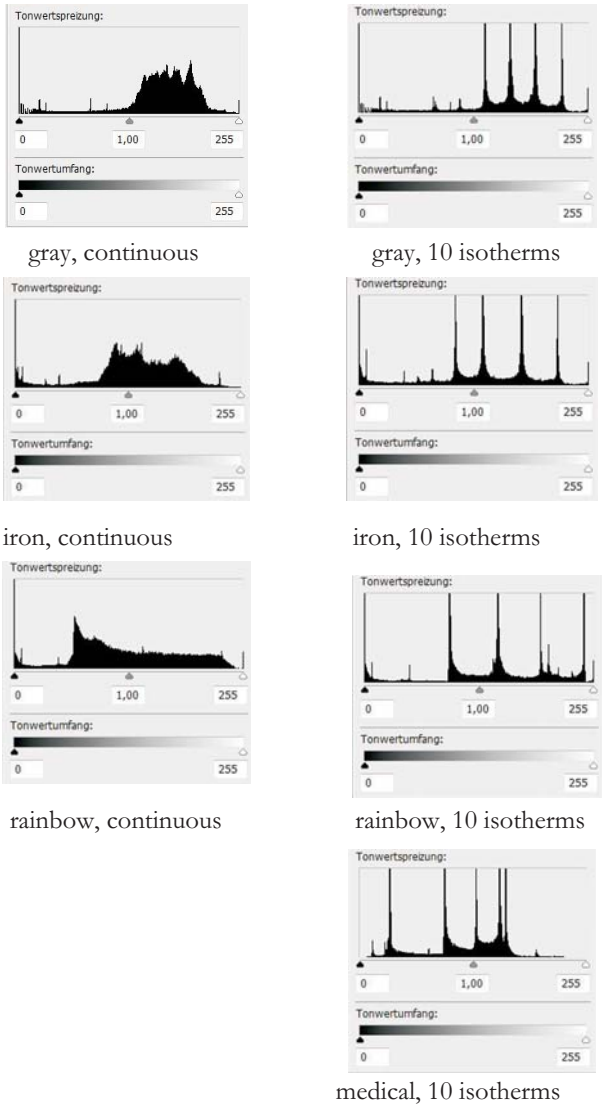


Figure 8
Gray level histograms of the thermal images shown in figure 7



for enhancing a defined temperature band may differ from the gray level that is representing that temperature range already in the original thermogram. In order to see these suspected changes, the thermograms displayed in the gray, iron, rainbow and medical palette were imported into the software programme Adobe Photoshop CS5.1 (64 BIT) and all images were transformed to gray shade images (figure 7) and histogram analysis was applied on these transformed gray images., which is shown in figure 8.

The histograms provide a detailed analysis of the visional impression, that all methods of false colouring affect the gray levels of the original gray image. Separating the continuous colour into 10 isothermal bands resulted in a change of the envelope of the gray level histograms. In continuous scales, the distribution of gray levels occurs over a wide range with similar, but moderate frequencies. In discontinuous scales, the average frequencies of gray levels is much less than in the continuous scale, but four peaks indicate maximum occurrence of these particular gray levels. The distribution of gray levels of the continuous iron palette show a better agreement with the original gray shade thermogram than the rainbow palette.

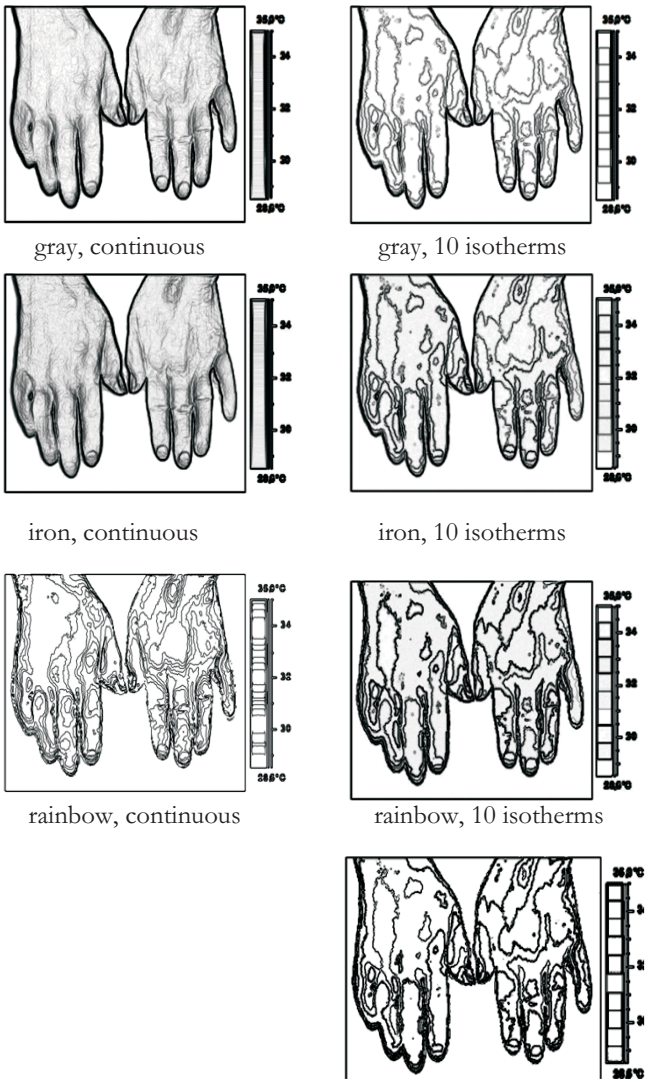
All discontinuous scales have more similarities to each other than to the related continuous palette.

Finally, the question arose, how many linear elements are added to the original thermogram by using different palettes.

Therefore, edge detection was performed in the gray versions of all thermal images displayed with different palettes (figure 9). In order to equalize the gray level of lines,automated level corrections was applied. This image processing resulted in images composed of gray linear elements and light gray areas. These images were also analysed by means of histograms (figure 10.)

Surprisingly the so processed continuous scale images look very like pencil drawings of human hands, with many thin lines, very close to each other. The isotherm images appear like ink drawn landscape maps. The maximum grade of reduction was achieved in the medical palette showing only peaks at gray level 0 and gray level 255. The continuous rainbow palette was next in level of reduction. The continuous iron scale was very similar in gray level distribution as the original gray shade thermogram.

Figure 9
The temperature window was compressed to width of 6.4°C, The thermograms were transformed to gray shade images, automated level corrections was applied and edge detection was performed.



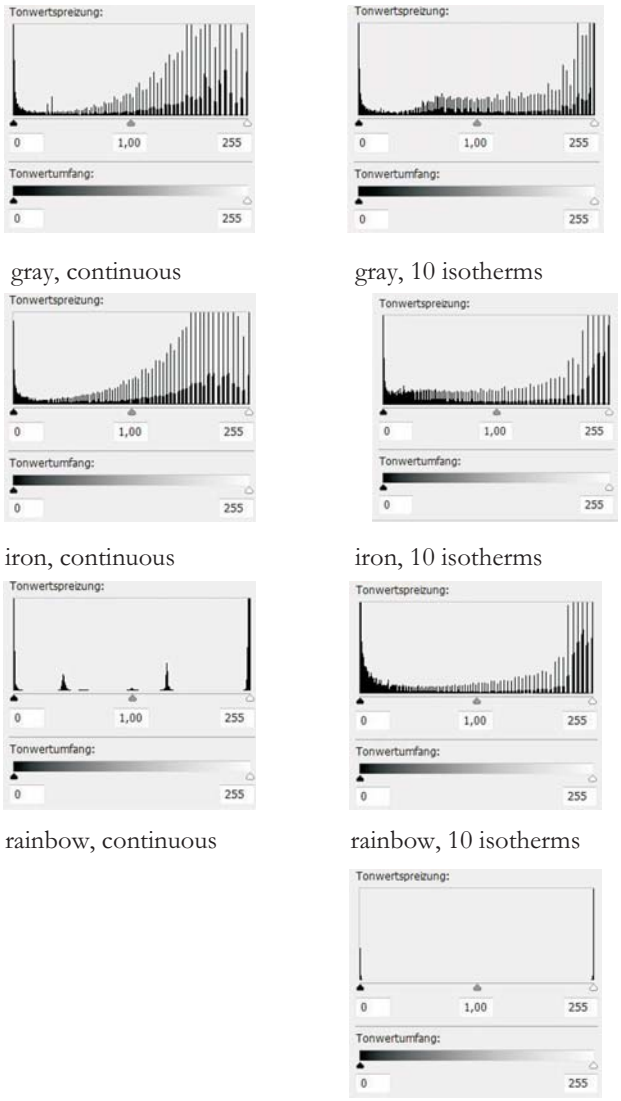
gray, continuous | gray, 10 isotherms

iron, continuous | iron, 10 isotherms

rainbow, continuous | rainbow, 10 isotherms

medical, 10 isotherms

Figure 10
Gray level histograms of the thermal images shown in figure 9



gray, continuous | gray, 10 isotherms

iron, continuous | iron, 10 isotherms

rainbow, continuous | rainbow, 10 isotherms

medical, 10 isotherms

This series of processed and analysed thermograms clearly show that false colouring affects resolution, gray levels and the likeness to the imaged object. Particularly, definition of isotherms, identifying a band of temperatures by a specific colour, adds a lot of distortion to the anatomy imaged. New areas and shaped are generated by isotherm images which are dependent on the temperature increment of isotherm definition.

However, all in this way generated, so-called thermal signatures miss the most important finding in this patient:. A difference in mean temperature > 1° between both dorsal hands is strong support for the suspected diagnosis of complex regional pain syndrome (CRPS). Hughen et al. claimed that the asymmetry factor of temperature distribution has more diagnostic accuracy than mean temperature for the diagnosis of CRPS. [11]. Conwell at al. reported a paradoxical rewarming of the symptomatic CRPS limb when a cold stress was applied to a non affected, asymptomatic extremity [12]. However, a typical thermal signature of CRPS is not yet described and might not be detected, as the pathomechanism of CRPS affects more than on physiological system.

Finally, whenever accuracy of thermal images is reported, the field of accuracy must be clearly stated, either accurate temperature measurements, accurate imaging or diagnostic accuracy of the technique.

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The Thermal Imprint of Flamenco Duende

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SUMMARY

Thermography is a relatively new technique in the study of human behavior, particularly in application to the field of human movement; since it can provide markers about physical changes, it could be considered an appropriate technique to determine whether specific thermal patterns exist for specific physical activities. We present the application of thermography to the set of movements by experts in flamenco dancing, seeking the existence of specific thermal patterns (the thermal imprint) for each type of dance compared to physical exercise. In addition, we relate this thermal imprint to the subject's technical ability, the cerebral areas (in the system of mirror neurons) activated in experts when observing dance movements, and the skin temperature changes observed.

Lastly, we seek a somatic marker of the typical emotion elicited when observing flamenco, the "duende" of flamenco. The lower the temperature of the gluteus and nose, the more empathetic stress and the less emotional comprehension of the dancers. The better the technique, the less empathy. Moreover, the flamenco-duende correlates positively with technical quality and negatively with temperature of the gluteus and nose. When subjects observed flamenco videos, the flamenco-duende score also correlates with the cerebral activation of BA 2, 5, 7, and the insula. At the same time, the activation of the insula correlates with the empathy scores of the dancers.

KEY WORDS: Flamenco-duende, emotion, thermography, cerebral activation

DAS THERMISCHE IMPRESSUM DES FLAMENCO DUENDE

Thermographie ist eine relativ neue Technik in der Untersuchung des menschlichen Verhaltens, insbesondere beim Einsatz im Bereich der menschlichen Bewegung; Da diese Technik Marker physischer Veränderungen bereithält, könnte die Thermographie eine geeignete Methode darstellen, um spezifische thermische Muster bestimmter körperliche Aktivitäten zu entdecken.

Wir präsentieren den Einsatz der Thermografie in der Bewegungsanalyse erfahrener Flamenco-Tänzer mit dem Ziel, spezifische thermischen Muster (thermisches Impressum) für jede Art von Tanz im Vergleich zu körperlichen Bewegungsübungen zu entdecken. Darüber hinaus setzten wir dieses thermische Impressum mit den technischen Fähigkeiten des Tänzers, den Hirnarealen im System von Spiegelneuronen, die bei Tanz-Experten aktiviert werden, wenn sie Tanzbewegungen betrachten, und den beobachteten Hauttemperaturänderungen in Beziehung. Schließlich suchten wir einen somatischen Marker für das spezifische emotionale Erleben, das "Duende" des Flamenco, welches das Betrachten von Flamenco auslöst.

Je niedriger die Temperatur des Gluteus und der Nase, desto größer die empathische Belastung und desto geringer das emotionale Verständnis der Tänzer. Je besser die Technik, desto weniger Empathie. Darüber hinaus korreliert der Flamenco-Duende positiv mit der Qualität der tänzerischen Fähigkeiten und negativ mit der Temperatur des Gluteus und der Nase. Wenn Personen Flamenco Videos betrachten, korreliert der Score des Duende auch mit der zerebrale Aktivierung in den Arealen BA2, 5, 7 und der Insula. Gleichzeitig korreliert die Aktivierung der Insula mit den Empathie-Resultaten der Tänzer

SCHLÜSSELWÖRTER: Flamenco-Duende, Emotion, Thermographie, zerebrale Aktivierung

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Introduction

The application of thermography to different human behaviors has become widespread in the last twenty years. Its application to sport is fairly recent [1,2], mainly in the last decade, and was focussed on sport rehabilitation and on the processes of heat diffusion in the joints [3].

The processes of heat homeostasis in the human body after exercising show a simple pattern: at the start of the motor activity, a vasoconstriction of the blood vessels in the skin is produced, and when the temperature of the limbs involved in the movement rises, a vasodilatory response is generated to disperse the heat produced [4]. Kenny et al. [5] notes that the temperature of body tissue at a particular moment depends on the ratio of heat produced-lost, which in the case of the muscles refers to the metabolic exchange between the surrounding tissue and the blood circulation. The studies on changes of tem- perature in the muscles and also in the skin [6] indicate that the dispersion of heat in the muscles is uniform but that the use of direct sensors in muscles or skin can affect the measurement to a considerable extent [7]. The application of thermography to new sets of movements, therefore, seems the most appropriate technique to determine whether specific thermal patterns exist for specific physical activities. We must take into account some basic findings regarding changes in body temperature. According to Ferreira et al. [4], in normal conditions a thermal symmetry of the body exists before any

kind of sporting activity is carried out and there are no significant differences in the subsequent temperature of the limbs involved. However, there are differences between the side that has performed the exercise (whose temperature rises) and the contralateral (whose temperature drops). This is caused by vasoconstriction in some parts of the body that are not performing the exercise, which allows the accumulation of blood in the muscular mass where it is needed at that moment [8]. Studies of this kind are based on changes of temperature in parts of the body other than those exercised, in which the blood flow, and therefore the temperature, in the hands is reduced in the first few minutes of performing exercise with the legs [9].

The vasoconstriction associated with the particular exercise performed, for example lifting weights, seems to delay the homeostatic recovery of the limbs in older people compared to younger ones [8] In general, considerable difficulty has been detected in older people in re-establishing muscular thermal equilibrium after physical activity [9].

It was shown that muscular temperature increases during continuous performance of physical exercise although less intensively than after anaerobic exercise for a short time [6]. However, according to Zontak, et al. [8] constant performance of an exercise (for example, for twenty minutes) shows a temperature pattern that undergoes an initial descent, a later increase and an almost static stabilization during the remaining time, during which a balance between the hemodynamic and the thermoregulatory processes is sought.

In the current study we relate these investigations to the application of thermography to dance to provide insight into muscle behavior in intense physical exercise and determine whether specific thermal patterns (a thermic imprint) exist for dance compared to mere physical exercise of similar intensity, and whether there are specific thermic imprints for each type of dance. Our investigation is singular in a number of ways: our sample is young (aged between 15 and 26) and for this reason the processes of loss of muscular mass and reduction in metabolism do not intervene [9,10]; we use global movements of all parts of the body (trunk, head and extremities) so we can concentrate solely on the changes of temperature evident in the performance of exercise; we do not use any additional element, neither weights as in the studies with sportspeople nor the accessories appropriate to dance, such as clothing or footwear.

Our objective is to study the thermal pattern of the body in various types of dance, with a special emphasis on flamenco to find a somatic marker [11] of motor, cognitive or subjective processes. Dance has a series of quantitative aspects in common with physical exercise (associated with the intensity and duration of the exercise). However, there are differences: dance is a complex skill which must be learnt, and there are qualitative aspects such as sensuality or "duende" in the case of flamenco dance. In 1780, the Dictionary of the Real Academia Española defined duende as "having a mysterious and ineffable enchantment" [12]. Goethe defined it as a mysterious power felt by everyone that no philosophy can explain, while in Webster´s words "you have it or you don't" [13]. Federico García Lorca defined it as an effective intuition [14]. The concept of duende perfectly matches the definition of quale considering that duende is the feeling unique to flamenco lovers. Thus, we seek a somatic marker (of thermal changes in the body) of a quale [15] or subjective experience, the flamenco duende.

To summarise, this study attempts to determine whether a thermal imprint specific to flamenco exists, and whether it is related to the capacity for performance (capacity for technical execution), the cerebral areas in experts involved in watching dance movements, that means system of mirror neurons [16], the regulation of body temperature due to the involvement of BA1, BA2, BA5,BA7 (BA=Broadman Area) and the insula [17, 18,19], and duende. A practical output of this study is a thermogram of flamenco dancers during different physical activities.

Methodology

The subjects for the experiments described in this paper were ten professional flamenco dancers (all women, mean age 23.3 $\pm$ 6.9 years), students in their final year of flamenco studies at the Conservatorio Profesional de Danza de Granada, who had been dancing in this discipline for at least ten years. All of them were right-handed, without any history of psychiatric or neurological problems and with normal or corrected to normal vision during the execution of the experiment. They were all expert dancers in flamenco, but had received training in contemporary dance (at least 5 years 5.3 $\pm$ 2.5) . They knew each other as dancers and on a personal level. All gave their written consent, signing an "Informed consent to participate in the cerebral study of expert dancers" form provided by the Department of Experimental Psychology. In the case of subjects who were minors, their parents signed the consent form. They did not receive any economic recompense for their participation.

Experiment 1

Methodology

Equipment

The ThermoVision A320G Researcher Infrared Camera, with a sensitivity of 0.07 to 30°C of difference between successive readings was used. The work was carried out between 19°C and 38°C (this level is within the range of the camera). The camera was placed on a tripod 0cm above the floor and 100 to 120cm from the subjects. The height was adjusted to capture the whole body of the subjects. The camera had automatic focus and this was always used. The signal was recorded on a laptop with the program Researcher TermaCAMP 2.9, that allows continuous recording at 8 frames a second. The experiment was carried out in a closed room of about 40 m2 with a changing room door. The thermographic camera, the computer and the experimenter were positioned in the middle of the room. To cap-

ture the image properly, the subject was asked to perform the movements within a defined space of approximately 9 square meters. The temperature of the room, measured with an external thermometer, was found to be between 23° and 25.5°C (Mean 24,02 ± 0,87). No cooling apparatus was needed to maintain the temperature (the room was in a basement which maintains an almost constant temperature throughout the season). The humidity was 50%.

Design

Four different thermal conditions were measured: baseline, with the subject at rest (BL); performing a series of fitness training exercises (D), performing a contemporary dance choreography (C); and dancing a flamenco choreography (F). With the exception of BL, which lasted 10 seconds and was taken after a 15-minute adaptation to the room, the remaining performances had durations between 4 min. 50 sec. and 5 min. 30 sec. according to the time required to dance a complete piece. The sequence of fitness training movements had been sent to the subjects beforehand so that they could practice them. The steps of this condition were simple: running on the spot for two minutes, jumping on two legs, turning their arms in the same direction and similar activities until five minutes had passed.

The contemporary and flamenco dance choreographies were previously decided for all subjects and modelled by an expert. Since the emotional component of the dance was subjective and personal for every participant, we gave the instruction of choose a piece that present feelings similar in both categories, flamenco and contemporary dance. This instruction was followed by the dancers choosing pieces with equivalent emotional sign, mainly sadness (in flamenco is much more common to refer to this negative emotion).

The thermographic shot for each movement condition was carried out during and immediately after each dance, always in the same position. Between each session of movements, a rest time of 15-minutes was interposed.

Procedure

The protocol for measurement with thermographic cameras [20] demands a certain preparation for different aspects of the thermography measurement to be carried out: the part of the skin to be studied must not be covered with fabric as thermography captures the whole temperature; subjects must be at rest for between 10 and 15 minutes before the recording to adapt the skin to the temperature of the room; the temperature of the room must be between 18 and 25°C.

The subject was received on entering the room and asked to stay seated for 10 minutes on a stool in the changing room adjacent to the studio, keeping on only an undergarment that covered the genitals, preferably a thong. The subject then entered the studio and received instructions similar to "we are now going to record your movements performing different exercises; we will first take a static image at rest and then indicate to you the nature of the exercises to be performed. The stance you must adopt for the static image and after each dance is the following (...)" (here the experimenter demonstrates the pose, which consists of remaining still on one leg to expose the inner surface of one of the legs and the front part of the other, upper arms at right angles to the trunk, the arm bent at a right angle at the elbow, and palms towards the observer). The same pose was also adopted with the back turned (see Figure 1).

Images of each subject were first recorded in the baseline position, which shows an initial thermogram of the whole

Figure 1:
Thermogram of a subject in the front and back poses adopted after each experimental condition and in the baseline. The black boxes define the zones studied where significant

Table 1:
Temperature mean and standard deviation for the 10 subjects for the different ROI analysed, X= mean, SD=standard deviation

Part of the body	Baseline		Fitness training		Contemporary		Flamenco	
	X	SD	*X*	SD	X	SD	X	SD
front forearm	33.9	1.3	33.2	1.5	30.9	0.9	32.2	1.0
front arm	33.9	1.3	33.4	1.0	31 .6	1.0	31.5	0.9
face-nose[1]	36.1	0.4	35.6	0.5	34.3	1.0	34.5	0.8
front neck-shoulder	36.2	0.5	35.8	0.5	34.1	1.2	34.7	1.6
front thigh	35.0	1.0	34.5	1.0	32.7	0.9	33.2	1.3
front palm	35.0	1.8	34.5	2.1	32.7	0.7	33.2	0.7
front calf	34.0	0.9	33.5	1.3	32.2	1.1	32.3	0.9
front breast	35.1	0.9	34.5	1.0	32.9	1.4	33.2	1.5
front knee	35.2	1.1	34.7	1.0	33.1	1.3	33.5	1.4
back forearm	33.9	0.9	33.3	0.8	32.1	0.9	33.5	1.2
back arm	33.3	1.2	33.2	0.5	31.8	0.8	32.0	0.9
ankle and heel	31.7	1.2	31.6	1.2	30.5	0.9	30.3	1.2
back waist	32.9	1.1	32.8	1.5	31.2	1.7	31.1	1.8
back knee	33.2	0.9	33.6	1.2	32.4	0.9	31.8	0.9
back hand	33.0	1.6	32.9	1.9	31.6	0.8	31.7	0.9
back shoulder	35.6	1.1	35.2	0.7	33.6	1.0	33.6	1.5
back thigh	32.5	1.2	32.5	1.0	31.2	0.8	30.9	1.0
gluteus muscles	31.4	1.1	31.3	1.1	29.5	0.8	28.6	1.0

[1] The face was divided down into cheeks, orbicular zone, forehead, mouth and nose to be analysed. These data are not offered because no significant differences were found except for the tip of the nose (see in the text). For this reason we referred to this measurement generically as 'nose'

Table 2
Comparison of temperature of those parts of the body analyzed, using Student-t.
Significant results indicated in red.
BL: base line; D: fitness training; C: contemporary dance; F: flamenco dance. * P<.05

ROI	BL-D	BL-C	BL-F	D-C	D-F	C-F
front forearm	0.9	**5.1***	**3.0***	**2.9***	**1.8***	**2.8***
front arm	0.8	**4.0***	**4.2***	**3.8***	**4.0***	0.3
face-nose	2.3*	**5.7***	**4.7***	**3.8***	**3.3***	0.6
front neck-shoulder	**1.8***	**5.5***	**2.4***	**4.0***	**2.0***	0.7
front thigh	0.5	**4.4***	**3.1***	**3.9***	**2.1***	0.4
front palm	0.9	**3.8***	**2.7***	**3.1***	**1.9***	0.7
front calf	1	**3.8***	**3.8***	**2.2***	**2.1***	0.6
front breast	0.6	**3.9***	**3.6***	**2.6***	**2.0***	0.4
front knee	1	**3.7***	**2.8***	**2.8***	**2.0***	0.6
back forearm	1.2	**4.0***	0.4	**2.8***	0.4	**2.6***
back arm	0.3	**3.1***	**2.2***	**4.2***	**3.4***	0.2
ankle and heel	0.2	**2.4***	**2.2***	**2.0***	**2.2***	0.4
back waist	0.1	**2.2***	**2.5***	**2.0***	**2.0***	0
back knee	0.4	**1.9***	**3.3***	**2.2***	**3.0***	0.7
back of hand	0.3	**2.2***	**2.0***	**2.0***	**2.0***	0.4
back shoulder	0.8	**2.9***	**3.1***	**3.1***	**3.0***	0
back thigh	0	**2.3***	**3.5***	**3.0***	**3.1***	0.5
glutei muscles	0.2	4.0*	**5.2***	**6.9***	**8.6***	**2.1***

body, and then after performing each of the sequences D, C and F (fitness training, contemporary and flamenco). In order to have a continuous recording of the changes the whole sequence of each dance was recorded.

Results

The first analysis shows the average temperatures for different zones of the body, analyzed by regions of interest [21], according to the thermogram of each subject in each condition.Examples of some ROIs can be seen in figure 1. The same parts of the body were studied from the front and the back. In Figure 1 we only highlighted those areas that produced statistically significant results. . The temperature mean and standard deviation for the ROIs is shown in Table 1. The statistical analysis can be seen in Table 2.

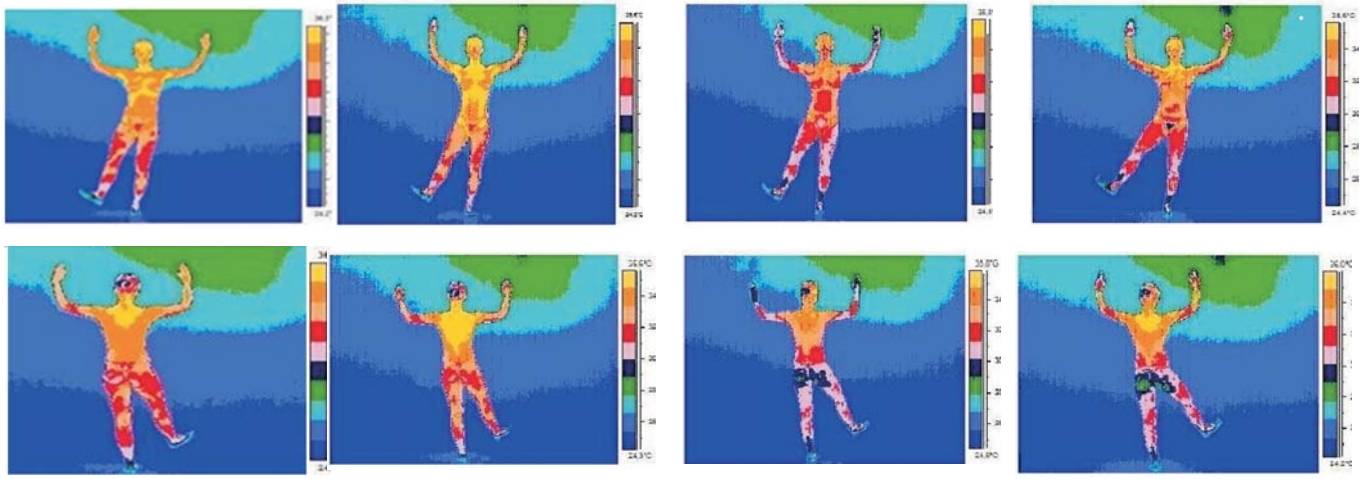
The results show a general change in the temperature of the participants when comparing all activities. We outline the significant difference in the temperature of the nose and neck in all comparisons (except for contemporary vs flamenco), finding more than 1.8 °C of change between conditions. The forearm, the nose and the neck represent the biggest change in temperature when comparing baseline with contemporary dance. The glutei are the ROI that changes more, presenting a big difference when comparing fitness training and contemporary dance, and especially when comparing fitness training and flamenco. This ROI and the forearm (back and front) are the ones that are different in the comparison between contemporary and flamenco dance.

Discussion

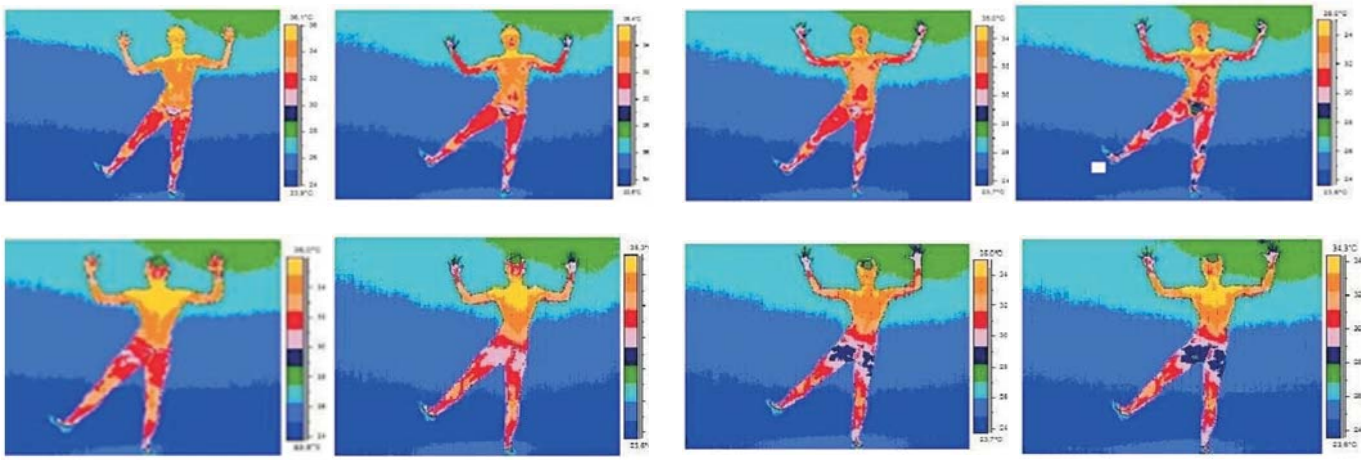
The first notable difference is that body temperature after performing 5 minutes of aerobic fitness training did not vary significantly from the baseline, except for the face and the back of neck-shoulders. For both dance forms in comparison to the baseline after five minutes, all of the measured zones of the body showed statistically significant thermal changes, with the exception of the back of the forearm for flamenco.

All the values compared for different parts of the body showed a significant difference in temperature when physical exercise was performed as opposed to dancing, whether

Figure 2:
Complete thermogram of two of the subjects,06 in the two upper rows and 09 in the two lower rows, front and back view in each of the fourconditions (BL, D,C, F).



Series of thermogram from participant 06



Series of thermogram from participant 09

it was contemporary or flamenco. The only zone that did not show this tendency was the back of the forearm for flamenco (as in the comparison between baseline and flamenco).

The comparison between the types of dance, contemporary and flamenco, showed significant values in three body zones: the front and back of forearm (which showed a higher temperature in flamenco) and the gluteus (which showed a lower temperature in flamenco).

In conclusion, this led us to examine the forearms and the gluteus in flamenco in more depth, bearing in mind that a general thermal difference exists (including the face and nose) between performing any kind of dance or practising fitness training. The thermal imprint of flamenco could consist of the lower temperature of the gluteus muscles in relation to the baseline, fitness training and contemporary dance together with the higher temperature of the forearms in relation to contemporary (see Figure 2). A later comparison between ballet and flamenco with the subjects from our study produced similar differences: flamenco had lower temperature in the gluteus muscles and nose and higher temperature in the forearms.

Experiment 2

In this experiment we investigated the relationship between skin temperature and the cerebral image of flamenco. The work of Gómez-Milán et al. [22] served as a foundation. In this study, the cerebral image of our ten expert flamenco dancers when viewing flamenco was compared to those obtained when viewing fitness training. The subjects watched other subjects performing flamenco or fitness training movements while submitting themselves to fMRI. The results indicate an activation of the human mirror neuron system while viewing flamenco. This is similar to the results found by Calvo-Merino et al [16] for ballet, specifically: an activation of the mirror neuron system, that is to say, the bilateral premotor cortex (including the precentral gyrus) and the upper temporal sulcus and left parietal cortex, when the subjects see specifically flamenco stimuli as opposed to other dances. This has been termed the expert effect [23].

Many of the areas that were activated differently in flamenco, such as BA2, BA5 and BA7 and the insula [21] play a role in the detection and/or regulation of body temperature [24]. In this second experiment we analyze the correlations between the thermal imprint of Flamenco obtained in Experiment 1 (temperature of specific body areas like nose or gluteus) and the cerebral areas activated differently in Flamenco and related to control of temperature, such as BA1, 2 and 3 associated with the localization of temperature [25], BA5 and BA7 associated with the localization of touch and the perception of pain [19], and BA13 (the insula) associated with the processing of temperature directly [18].

The mirror neuron system has also been widely studied in relation to empathy [26], specifically to investigate to what extent the experience of empathy is mediated by shared neural circuits [27, 28, 29. The expert effect in dancers is related to the human mirror system activation as well as to practice, which was called acquisition of expert performance by Ericcson [30] and popularized by Gladwell [31] which enables mastery of technique. However, even more strongly, the expert effect is related to practice plus top-down attention or intelligent practice[32] . In some sense, empathy and expert effect appear to be two sides of the same coin (mirror neurons activation), but the correlation between them is negative, as can be seen not only in some of our pilot study for dancers, but also in, for example, Decety et al. [26] - in an ERP study they found that physicians down-regulate their pain-empathy response; Lamm and Singer [27,28] defend a common role of the insula in feelings, social emotions, empathy and uncertainty. Salazar-Lopez et al [33] found a positive relationship between empathic emotion scores and nose thermal decrement in normal population viewing videos of pain and happiness. For these reasons, we decided to study the correlations between empathy scores, brain expert effect and thermal imprint in our flamenco dancers. Duende, as described in the introduction, is a special type of emotional or empathic response of experts while performing or viewing flamenco and is considered something more than technique, which could be measured through expert judgments as we demonstrate in this study.

Methodology

We used the TECA test [33] to measure empathy, which produces general values on four subscales: Perspective Adoption (AP) which relates to one's capacity to place oneself in the shoes of another (as though it was in the third person perspective); Emotional Understanding (CE) which demonstrates our capacity to understand other people's emotions, intentions and impressions (as though it was in the first person perspective); Empathic Stress (EE), or the ability to be in tune with others' negative emotions; and the Empathetic Happiness scale (AE), which shows the ability to feel others' positive emotions.

Given that the subjects were students in their final year of flamenco at the Conservatory of Dance, we had their grades from the previous years in the following subjects: dance techniques, Spanish dance, flamenco, song accompaniment, guitar accompaniment, workshops in choreography, interpretation and music. The metric for individual technical ability (hereafter "technique" or "technical quality") was an average of each individual's grades in these subjects.

To measure the duende, we asked the subjects to evaluate their fellow subjects by awarding 1 point if they felt that their fellow subject had duende, and 0 points if they did not, following an interjudge criteria. The points awarded were accumulated, so that, given that there were 10 subjects, the maximum duende achievable by any one subject was 9 points.

The brain image data of expert effect in flameco, for the areas related to body temperature regulation and differentially acti-

vated in Flamenco, was taken from Salazar- López [34] and Salazar et al. [32]. This FMRI study was performed in our laboratories with the same ten expert flamenco dancers. In order to define, if possible, the relation between these variables, we conducted a correlation analyses ($p<0.05$) of the results of these tests with the results of brain images.

Results

As mentioned, we obtained the cerebral activation pattern for each subject when observing each of the cases flamenco and fitness training. Table 3 shows the activation of cortical regions where BOLD signal is higher for each subject in the comparison flamenco vs fitness training.

The results of empathy, technique and duende (see Table 4) are according to Salazar- López [34], since we were working with the same subjects. The analysis of correlation of these data with the differential activation of the cerebral areas presented in Table 3 allowed us to establish the following significant correlations ($p<0.05$): between BA3 and BA4 and technique, 0.84 and 0.87 respectively; BA1, 2, 5, 7 and 13 correlate with the duende, 0.84, 0.87, 0.90, 0.81 and 0.82 respectively. The above areas show a high correlation among themselves, between 0.86 and 0.92. The empathy subscale Empathic Happiness (AE) correlates negatively with BA4 (-0.83).

In the comparison of the thermal changes between flamenco and fitness set out in Experiment 1, we obtained the following correlation coefficients for global empathy in direct score and percentile score and thermal changes: (back of) shoulders, 0.82; arms, 0.94; gluteus, 0.87; thigh, 0.91; forearm, 0.88; nose, 0.78 and palm, 0.87. The correlation coefficient of the Empathic Stress subscale (EE) with thermal changes in the gluteus was 0.94; the Adoption of Perspectives subscale (AP) correlation coefficient with the zone of the arm was 0.84. The direct temperature of the forearm in the flamenco condition (without comparing it with the thermal value in fitness training) correlates negatively with Empathic Happiness (AE), -0.86. The Emotional Understanding subscale (CE) in the flamenco con- dition correlates with the direct temperature of the gluteus, 0.94. Duende correlates negatively with the direct temperature of the gluteus and nose in the flamenco condition, -0.88

Table 3
MNI coordinates of peaks of Relative Activation in the Cortical Regions where BOLD signals were higher in the Brodman areas (BA) indicated for each subject when observing stimuli of flamenco compared to fitness training.

Dancer\BA	BA1	BA2	BA3	BA4	BA5	BA7	BA13
1	-1.0974	-0.379	-0.3704	-0.2463	0.2798	0.6764	-0.4447
2	-0.4469	0.0347	0.3636	0.4 5	0.0629	-0.6365	-0.3033
3	0.8649	0.5374	0. 08	0.4035	0.4756	-0. 16	0.2305
4	-0.2944	-0. 77	0.0598	-0.0374	0.3 5	0.5272	-0.2
5	-0.1552	0. 95	0.8846	1.0	1. 04	1.	0.3924
6	-0.8679	-0.1855	-0.1007	-0.1488	-0.3449	0.1366	-0.4327
7	-1. 72	-1.8384	-1.4404	-1.5 2	-1.6583	-1.2904	-1. 52
8	-0.2 3	0.3253	0.7966	0.8999	0.9745	1.245	0.4948
9	0.4256	0.568	0.1294	-0.0 2	0.6923	1.4075	-0.1007
10	0.6746	0.8644	0.7639	0.6965	1.15	1.5043	-0.00

Table 4
Results of the empathy tests (TECA scale), technique (academic grades) and duende (judgments of fellow subjects).

Subject	Empathy (TECA Scale						Technique (0-10)	Duende 0-9)
	AP	CE	EE	AE	PD Total	PC		
1	27	25	18	29	99	10	6.95	5
2	22	28	21	30	101	15	7.10	7
3	23	25	19	28	95	4	7.40	6
4	27	28	20	32	107	20	6.00	2
5	28	32	22	26	108	25	7.40	6
6	24	28	25	26	103	15	7.10	3
7	34	26	23	34	117	40	5.62	2
8	27	30	19	30	106	20	6.20	4
9	28	28	16	31	103	15	6.30	7
10	26	24	20	30	100	10	7.90	8

and -0.66 respectively, while the technique correlates, also negatively, with the AP and AE TECA subscales, -0.84 and -0.82 respectively. The correlation between duende and technical quality is 0.54. The correlation between gluteus temperature and nose temperature is 0.81. The correlation between the temperature in the gluteus and nose and insula activation is -0.71 and -0.56.

Discussion

Given that the subjects have low empathy (the majority below 20%), technique shows a trade-off effect with the empathy component (the more empathy, the less technical quality). In cerebral terms, the sensory-motor activations correlate positively with technical quality (meaning BA3 and 4 involvement) and negatively with empathy. With regard to duende, this correlates positively with the cerebral activations of the insula and the sensory-motor areas BA2, 5 and 7.

With respect to the thermal imprint of flamenco, the temperature difference in several parts of the body (lower temperature in flamenco than in fitness training) correlate positively with empathy: the bigger the difference, the greater the empathy. Empathic understanding correlates positively with the direct temperature of the gluteus in flamenco (the higher the temperature, the more CE) as does the adoption of perspectives with the direct temperature of the forearm. Therefore, the gluteus and the forearm form two thermal markers of flamenco. However, the direct temperature of the gluteus in flamenco is associated negatively with duende. The technique, in turn, correlates negatively with adoption of perspectives and empathic happiness.

That is to say, the flamenco 'duende' is linked to technical quality but does not fully explain it (about 26% of common variance); in addition, it is linked to the cerebral activation of areas BA2, 5 and 7 (that is, with the somato-topic representation of the body in movement) and the insula (linked to autonomous self-awareness). We propose that this suggests a union of the body ego in movement and the visceral ego [35]. These areas, in turn, play a part in thermal detection and regulation, which means that a somatic marker of duende is the temperature of the gluteus and nose (the lower the temperature of the gluteus and nose, the more duende) and a behavioral marker of the temperature of the gluteus and nose is empathy, especially emotional understanding (the greater the CE, the greater the temperature) and empathic stress (the greater the EE, the lower the temperature). Therefore, duende is indirectly positively associated with the contagion of stress or negative emotions (flamenco is considered a dramatic dance) and negatively with empathic understanding or a third person point of view. In short, duende is related to empathy and insula activation.

Experiment 3

The aim of this experiment was to record the thermogram of these subjects while they danced (first person condition) or while they watched flamenco stimuli, that is, videos of flamenco dance (third person condition). Our attention is

Figure 3:
Thermogram of a subject where the temperature of forearms, gluteus palms and nose are compared to the base line, after dancing and after observing videos of flamenco, respectively.

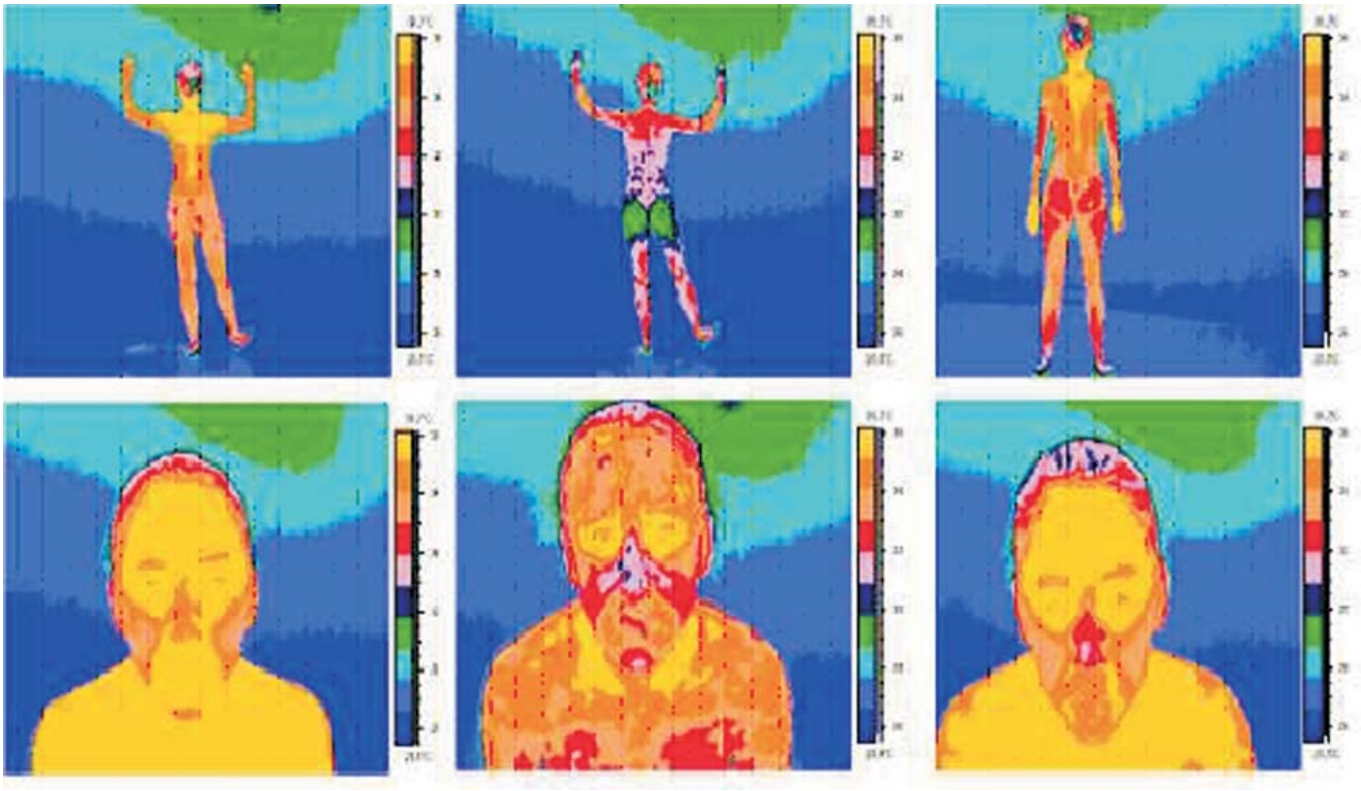


Table 5
Mean temperature of gluteus and nose after dancing and observation conditions.

Dancer	Nose thermal decrease. Action	Nose thermal decrease. Observation	Glutei thermal decrease. Action	Glutei thermal decrease. Observation
1	2.2	0.9	3.1	1.6
2	2.3	1.0	4.8	1.9
3	1.3	0.9	1.2	1.0
4	1.5	1.1	1.8	0.7
5	2.3	0.8	2.9	1.5
6	3.1	1.0	3.7	2.1
7	2.7	0.7	3.5	2.2
8	1.4	1.4	2.1	1.9
9	2.7	0.8	2.3	1.5
10	1.8	1.2	2.1	0.9

focused on studying the areas that are the thermic markers of flamenco, specifically the nose and the gluteus, to test whether significant variations in temperature exist when observing and/or performing flamenco, with a similar logic to that of touch-mirror synesthesia [36], which has been linked to the mirror system.

Methodology

Apparatus

The same thermographic camera was used as in Experiment 1 in the same room. A laptop with DVD player was added for the stimulus presentation; it was placed on a table, at about 1.5m from the subject and at an angle of 45° to her head to avoid the heat given off by the laptop affecting the registration of the camera, which was opposite the subject, in the same conditions as in Experiment 1.

Design

The outfit of the subjects was similar to that of Experiment 1. In this case, the experimental conditions were: Baseline (BL), Dancing (D) and Video of Flamenco (V). In the D condition, the dancers were to dance the flamenco choreography of experiment 1. In the V condition, two videos were shown to each subject, one to watch during the thermal recording of the front of the body and the other during the thermal registration of the back of the body. Each video lasted an average of 5 minutes.

Procedure

The subjects entered the room and prepared for the registration in a similar way to that described in Experiment 1. The baseline was measured in all cases. In the V condition, after the baseline measurement the subjects stood opposite the camera and received the following instruction: "you are going to see some images; your task consists of keeping as still as possible while they last". The subjects remained standing on both feet while both videos were played and the front and back parts of their bodies were recorded. In the D condition, after the baseline measurement the subjects were asked to dance the flamenco choreography of experiment 1.

Results

We observed a significant reduction of nasal and gluteus temperature amongst expert flamenco dancers of 2.1 (±0.8) °C while dancing and of 1.0 (±0.4) °C during observation of the videos, $t=8.83$, $p<0.01$ and $t=8.20$, $p<0.01$ respectively with respect to the base line. This drop in nasal temperature correlates with the gluteus temperature decrement, $rxy=0.52$, see Table 5 and Figure 3.

Discussion

When expert dancers observe flamenco dance, a drop in temperature of the gluteus and nose and a rise in temperature of the palms takes place. We suggest that when observing movements of a dance at which they are expert, there is a tendency to prepare for action, which occurs at the cerebral level with the activation of areas BA2, 5 and 7. However, in this case we would expect a correlation between thermal changes when observing flamenco and the activation of sensory-motor areas or the primary or supplementary motor area, but this correlation only occurs when they perform flamenco (Experiment 2), not when they observe it (Experiment 3).

General Discussion

We obtained a thermal imprint specific to flamenco, different to that of physical exercise and contemporary dance: lower temperature in the gluteus and nose and higher temperature in the forearms. This thermal imprint correlates with somatosensory and visceral cerebral activations, technical ability, empathy and flamenco duende of the subjects. The better the technique, the less empathy. The more duende, the lower the temperature in the gluteus and nose. The lower the temperature in the gluteus and nose, the less emotional understanding and more empathic stress. The higher the duende, the greater the cerebral activation in areas BA2, 5 and 7 and the insula. As an overall conclusion, we obtained a somatic marker (thermal imprint) of a quale (the flamenco duende) related to brain action-self and visceral-self.

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Abdominal Wall Pain: Effects of Placebo Measured by Infrared Thermography

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SUMMARY

BACKGROUND: This study was conducted from 1982 to 1983 in a general practice and has not been previously published because of time constraints. The study is based on a number of not yet explained observations: abdominal pain that frequently appeared in the abdominal skin and persisted for longer than three months, is lacking any explainable substrate. Such pain disappeared with an intra-cutaneous or subcutaneous injection of a local anaesthesia and generally responded moderately to NSAIDs, and better to pharmaceuticals containing metamizole. Local anaesthetics were prescribed as prostaglandin agonists-antagonists and NSAIDs were prescribed to inhibit their synthesis. It is known that prostaglandins play a role in vascular circulation, but NSAIDs do not. The objective of the study was to investigate if local inhibition of prostaglandins with NSAIDs could affect the thermal image of patients with abdominal wall pain.
NULL HYPOTHESIS: The null hypothesis: infrared thermography does not detect changes in abdominal wall temperature during an intervention with prostaglandin synthesis inhibitors for abdominal wall pain.
METHODS: Infrared thermography was chosen as the effect measurement because of the relationship between prostaglandins and vascular circulation, and because of the expectation that abdominal wall pain is sensed in the skin. The intervention was conducted with two types of pharmaceuticals, of which one (indomethacin) affects prostaglandins synthesis, and the other (metamizole) is regarding as similar in biochemical action. Avicel® was used as the placebo. A double-blind, placebo-controlled cross-over study with pharmaceuticals in low dosages was conducted.
RESULTS: 57 patients were included in the study. The pain site was cooler than the surroundings in 44 of these patients; The pain site was warmer in 13 (p=0.01). The pain site was significantly cooler than the reference area after use of indomethacin (p<0.01). The pain site was also cooler after use of the placebo (p=0.03). The pain sites were cooler compared with the baseline with every intervention (p<=0.01). The population was split in "cool" and "warm" pain, and then with each intervention the cool places became warmer and the warm places became colder.
CONCLUSIONS: The null hypothesis was rejected. There was a measurable effect of pharmaceuticals in low dosages. All substances used showed a significant change of temperature compared with the baseline. They led to significant temperature increases on cool pain sites and temperature decreases on warm pain sites. In addition, the placebo is measurably not always as inert as it is believed to be.
KEYWORDS: Chronic pain, placebo, prostaglandins, infrared thermography, abdominal pain.

BAUCHWANDSCHMERZEN: MIT INFRAROTHERMOGRAPHIE NACHGEWIESENE WIRKUNGEN VON PLACEBO

HINTERGRUND: Diese Studie wurde von 1982 bis 1983 in eine Allgemeinpraxis durchgeführt und aufgrund von Zeitmangel noch nie veröffentlicht. Die Studie basiert auf einer Reihe von noch nicht erklärten Beobachtungen: Bauchschmerzen, die häufig in die Bauchhaut erscheinen und länger als drei Monate bestehen, fehlt jedes erklärbare Substrat. Derartige Schmerzen verschwanden nach einer intrakutanen oder subkutanen Injektion von Lokalanästhetika. Im Allgemeinen verminderten sie sich nur mäßig nach NSAR-Gaben und wurden deutlicher durch Medikamente reduziert, die Metamizol enthalten. Lokalanästhetika wurden als Prostaglandin-Agonisten-Antagonisten verschrieben und NSAR verschrieben wurden, um deren Synthese zu hemmen. Es ist bekannt, dass Prostaglandine eine Rolle in der gefäßbedingten Durchblutung spielen, NSAR jedoch nicht. Ziel der Studie war zu untersuchen, ob eine lokale Hemmung von Prostaglandinen mit NSAIDs das Wärmebild von Patienten mit Bauchwandschmerzen verändern kann.
NULL-HYPOTHESE: Die Null-Hypothese war, dass mit Infrarot-Thermografie während einer Intervention mit Prostaglandin-Synthese-Inhibitoren für die Bauchwandschmerzen keine Änderungen der Temperatur an der Bauchdecke entdeckt werden.
METHODE: Wegen der Beziehung zwischen Prostaglandinen und vaskulärer Durchblutung und der Erwartung, dass die Bauchdeckenschmerzen in der Haut empfunden werden, wurde die Infrarot Thermografie wurde als Ergebnismessung gewählt. Die Intervention wurde mit zwei Arten von Arzneimitteln, durchgeführt, von denen eines, Indomethazin, die Prostaglandinsynthese beeinflusst, und das andere, Metamizol, ähnliche biochemische Wirkungen zeigt. Avicel ® wurde als Placebo eingesetzt. Es wurde eine doppelblinde, Placebo-kontrollierte Cross-over-Studie mit Pharmazeutika in geringen Dosierungen durchgeführt.
ERGEBNISSE: 57 Patienten wurden in die Studie aufgenommen. Bei 44 dieser Patienten waren die schmerzhaften Stellen der Bauchwand kälter als die Umgebung, bei 13 Personen erschien die Schmerzlokalisationen wärmer (p = 0,01). Nach Verwendung von Indomethazin waren die schmerzhaften Stellen deutlich kühler als der Referenzbereich (p < 0,01). Auch nach der Verwendung von Placebo reduzierte sich die Temperatur an den Schmerzstellen (p = 0,03). Im Vergleich zu den Ausgangswerte wurden die Schmerzlokalisation nach jeder Intervention kälter (p < = 0,01). Nach Aufteilung der Patientengruppe in "kalte" und "warme" Schmerzen, zeigte sich, dass nach jeder Intervention kalte Stellen wärmer und warme Stellen kälter geworden waren.
SCHLUSSFOLGERUNG: Die null-Hypothese wurde abgelehnt. Es gab eine messbare Wirkung von Arzneimitteln in geringer Dosierung. Alle Substanzen zeigten eine signifikante Temperaturänderung verglichen mit den Ausgangswerten. Sie führten zu deutlichen Temperaturanstiegen an kalten Schmerzstellen und zur Temperaturabsenkung an warmen Schmerzstellen. Darüber hinaus ist messbar ein Placebo nicht immer so unwirksam, wie es erwartet wird.
SCHLÜSSELWÖRTER: Chronischer Schmerz, Placebo, Prostaglandine, Infrarot-Thermographie, Bauchschmerz.

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Introduction

This study was conducted from 1982 to 1983 in a general practice and has not been previously published because of time constraints. The outcomes are still relevant and current. Publication after 30 years provides the opportunity to critical analysis in light of current literature.

The study is based on a number of unexplained observations: pain, including abdominal pain, lacking any explainable substrate that have persisted for longer than three months and frequently appeared in the abdominal skin. They disappeared with an intracutaneous or subcutaneous injection of a local anaesthesia and generally responded poorly to antiphlogistic medication and responded good to pharmaceuticals containing metamizole. The last dosage could be drastically lowered, even to a one-hundredth of the indicated minimum dosage, with the effect achieved. The dosage of the NSAID had to be frequently increased multiple times. Vitamin preparations such as nicotinamide also had an effect on this pain. Inflammations, to the contrary, seemed to respond poorly to metamizole and well to the antiphlogistic NSAIDs.

In 1982 inflammations and pain were also associated with prostaglandins (1,2,3,4), which was a fairly recently discovered group of substances at the time. Prostaglandins are ubiquitous in the body and intermediate all biochemical processes. The NSAIDs should inhibit their synthesis. Local anaesthetics are described as prostaglandin agonists-antagonists (5).

A problem developed through the fact that it was not clear if the pain manifested itself as a solitary conditions of the skin instead of "referred pain" from visceral conditions. Viscerocutaneous reflexes in the skin expressed with pain were extensively described in 1982 as Head's areas (6). Evidence was, however, mainly indirect evidence. Viscero-cu taneous reflexes in vivo were shown in worms (7). Statistically substantiated studies on the existence of viscero-cu taneous reflexes in people in vivo were only found in the literature in 2008 (8). Two statistically substantiated studies on the existence of reflex pathways in vivo in humans that were conducted from 1981 to 1982 were published in 2013 (9,10).

The possibility of H+ and OH- ions in the Head's areas was already reported in 1937 (11), though it was not clear what was happening in the skin to cause the pain sensation. Local processes or influences from visceral activity through the central nervous system: It might be that the hyperalgesia could have been a result of sensation at the spinal cord that resulted from the visceral process. It also might be that the biochemical reactions on the skin take place as a result of viscerocutaneous reflex activity that could result in local sensation. Sensation has been included in the literature only in recent years (12). Viscerocutaneous reactions without sensation are a possibility. No one had yet heard of Cox1, Cox2 and Pox inhibitors in 1937.

It may be that these inhibitors would have an "active" status with diseases of the viscera. Warm skin sites as segmental representatives could be expected more so than cool sites. However, it is already known that most of the Head's areas (75%) have a lower temperature than their surroundings (13,14), and only 25% of them have a higher temperature than their surroundings.

There were a multitude of unclear parameters at the start of this study. Regardless if pain process was local, transmitted, or reflected, all Head's areas have a shared core question: do processes take place in the skin that are affected by prostaglandins? A study on the effect of prostaglandins in the Head's areas using infrared thermography was apparently necessary in view of the relation of warmth, pain and inflammations in the Head's areas with prostaglandins, and the ability to measure warmth with infrared thermography. If these prostaglandins are partially responsible for pain in the abdominal wall, synthesis inhibitors should change the pain, and probably also the circulation, of the pain site. And if the functional situation at the pain sites change, prostaglandins may play a role.

Aim of the study

The aim of the study was to investigate if skin pain could have something to do with the generation or modulation of prostaglandins in the skin. The research questions is: Do NSAIDs change the pain and temperature at the abdominal wall pain sites, and is this measurable with infrared thermography? Nothing was known about the effect NSAIDs have on circulation in 1982.

Null hypothesis

The null hypothesis: infrared thermography does not detect changes in abdominal wall temperature during an intervention with prostaglandin synthesis inhibitors for abdominal wall pain.

Methods and materials

Choice of the intervention drugs

Pharmacology

Two analgesics were sought that should have opposite effects on the circulation at the pain sites because, in accordance with earlier separate observations, cooler and warmer pain sites do not respond to the same NSAID. A problem developed from the fact that there were no analgesics in 1982 that affected vascular circulation.

The effects that prostaglandins have on the circulation of their "targets" were known in 1982 (Figure 1). Depending on their concentrations, PGE is a vasodilator and PGF is a vasoconstrictor. The structures of PGE and PGF are slightly different: The difference between them is one

Figure 1
Chemical formulas of prostaglandine (PGE) and prostaglandin F (PGF)

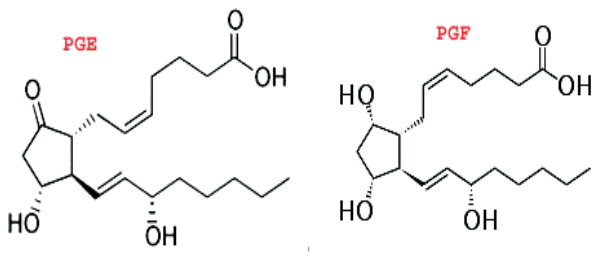
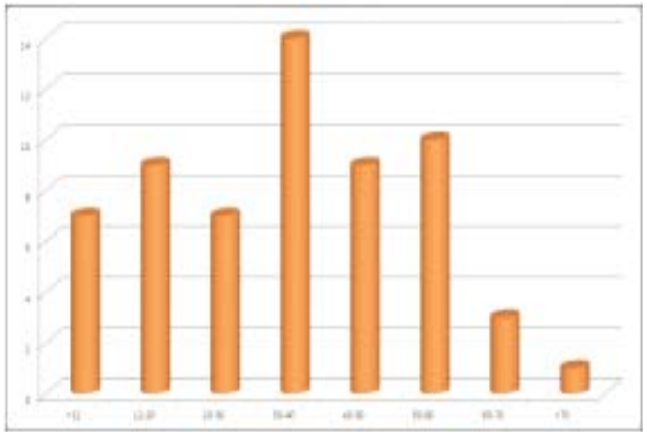


Figure 2
number and age of patients, vertical axis: number of patients, horizontal axis: age range in years



hydrogen ion. PGE is clinically used for inflammations. PGE can be formed if 9-hydroxyprogesterone dehydrogenase releases one of PGF's H+ ions.

Indomethacin and novaminsulfon were the intervention drugs used. Novaminsulfon, also called metamizole, is a sodium salt of metamizole. The inhibitory effect indomethazine has on prostaglandins was known, and the effect of metamizole was presumed.

The dosage of metamizole and indomethacin in this study were set to 0.1 mg per dosage three times a day. These dosages were more suitable for a biologically active level of prostaglandins (nanograms and picograms per millilitre). This could strongly decrease the risk of agranulocytosis resulting from dosage toxicity from metamizole. The risk that a change in pain would be insufficiently observable because of the low dosage is acceptable.

The design of the study was a double-blind, cross-over and placebo-controlled. The placebo was Avicel®, an inert cellulose preparation that is not absorbed in the intestines. The pharmaceuticals were prepared by a local chemist, and the composition and purity were controlled by the Laboratory of the Dutch Pharmacists. They were administered in white capsules using the code names: "X", "Y" and "Z". The actual composition remained confidential until the completion of the study. Every week the medication was administered to patients who were randomly assigned to receive one of the three capsules. After one week of receiving the medication, the patients took no medication during the next week.

Patient population

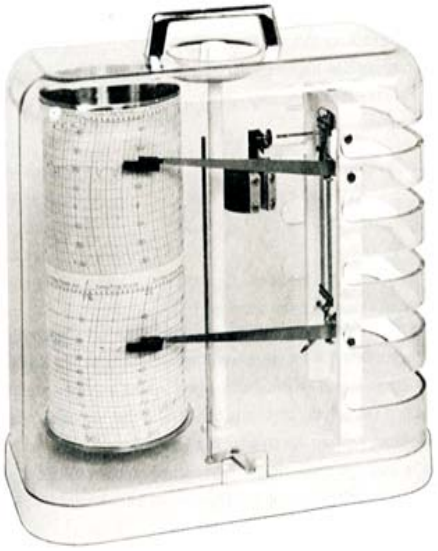
The target group was patients with abdominal pain who showed no anatomical substrate. Age and sex were not taken into consideration. The duration of the pain was a minimum of three months. The patients were extensively informed, orally and in writing, about the study, the mechanism of action and the known risks of the drugs used.

The "Declaration of Helsinki" of 1973 was followed. Registration with a Medical Ethics Committee was not possible because they did not exist at the time. Written "informed consents" were not used, and the "Declaration of Helsinki" did not require them either. Sixty patients participated. Three patients did not arrive at the agreed upon control appointments, and were therefore not included in the evaluation.

Technique

The measurements were made with a Phillips infrared thermograph, model 1980. The technique was conducted in accordance with standard procedures as described above (10, page 89). Measurement took place under standard conditions: prone, 30 seconds active cooling with a wall ventilator two metres away and three minutes of adaptation time. Ambient temperature was 21 degrees Celsius, controlled with a Thies Hygro Thermograph (15).

Figure 3
Thies Hygro Thermograph (registered brand of Thies Clima)



3. Technische Daten

Feuchte		
Meßbereich	:	0...100 % rel. F.
Meßgenauigkeit	:	± 3 % rel. F.
Schreibbreite	:	82 mm
Teilung	:	5 % rel. F.
Meßelement	:	H, K
Temperatur		
Meßbereich	:	-35°C...+45°C oder 0°C...+40°C
Meßgenauigkeit	:	± 0,5°C
Schreibbreite	:	82 mm
Teilung	:	1° C
Meßelement	:	Bimetall, gealtert
Registrierzeit	:	7 Tage oder umschaltbar 1 bzw. 7 Tage
Trommeluhrwerk	:	nach DIN 58658
Ganggenauigkeit	:	nach DIN 8300
Gewicht	:	2,6 kg
Meßelement "K"	:	geeignet für normale bis trockene Luft im Temperaturbereich 0°C...+110°C
Meßelement "H"	:	geeignet für normale bis sehr feuchte Luft im Temperaturbereich -60°C...+70°C

The measurements were taken on the pain site and two reference areas following a standardised pattern. Because digital processing was not performed in those days, a Phillips "Character generator" a raster was projected on to a screen with the numbers 1 to 22 horizontally and the numbers 1 to 17 vertically. The pain sites were marked with the letter X (Figure 4). The reference areas are the segment areas from Th10 and Th 12 (Figures 7 and 8), which are also used with the study on the existence of viscerocutaneous reflex pathways in people in vivo (9,10). Figures 5 and 6 are sections of the reference areas that are used for the part of the viscerocutaneous reflex reactions. The coordination of the pain site and the navel were documented in writing. The average of the reference areas were noted. The screen was photographed with an analogue camera and recorded on 18 DIN diapositive film. A null measurement was taken before starting. Measurement was taken again after the first week of administration of the medication and after the second week during which no medication was administered. Then after every cycle of two weeks (one week with medication and the second without).

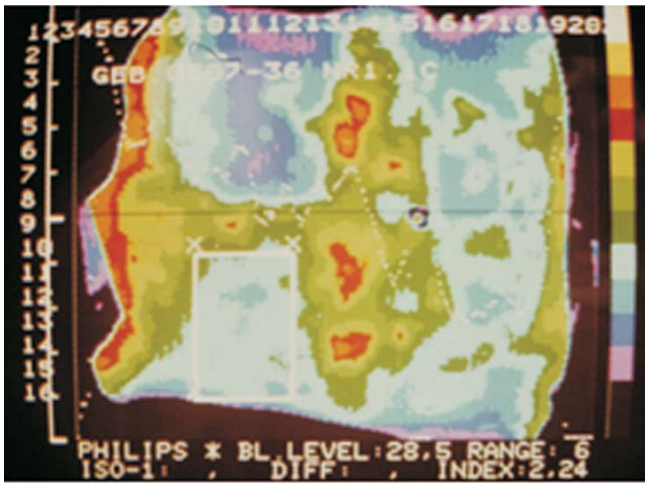


Figure 4

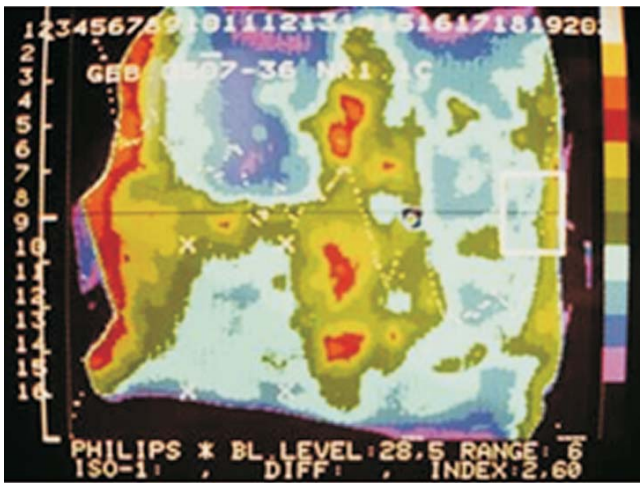


Figure 5

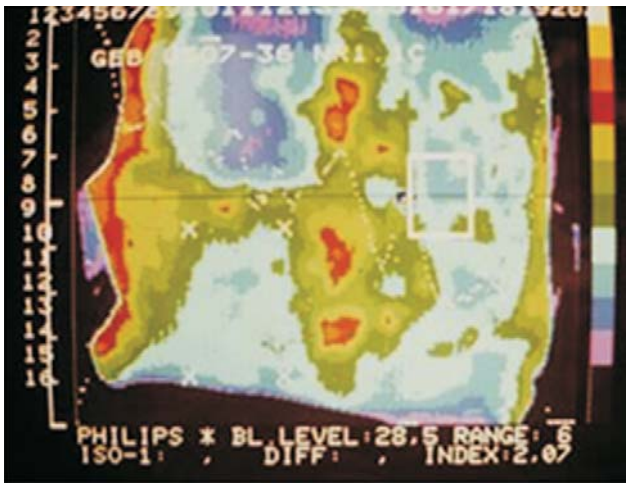


Figure 6

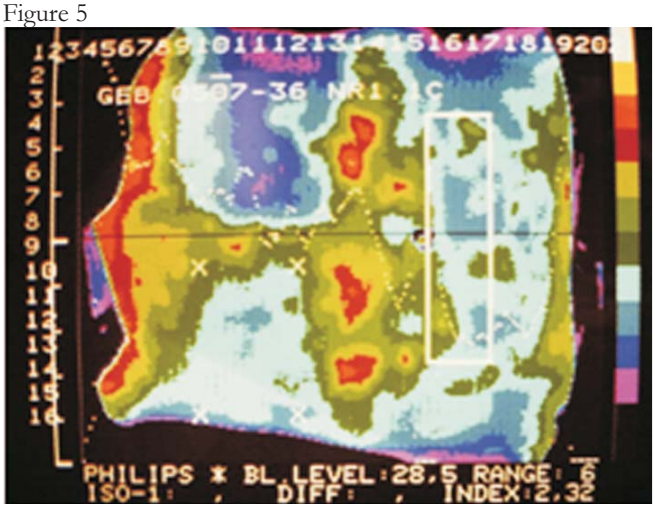


Figure 7

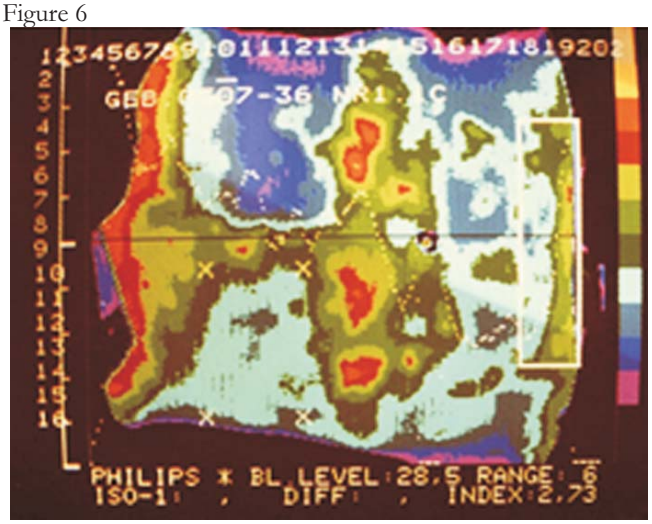


Figure 8

Figures 2 to 8

Pain site. The horizontal as well as the vertical coordinates were determined with the first measurement.

The patient pointed to the site.

The thermograph was unable to create a matrix.

This was improvised by using the superposition of a character generator. The black line in the area of 9 vertical ran from the manubrium sterni above the navel. The position of the navel was also determined.

Figures 7 and 8 are the reference areas.

Statistics

The statistics were calculated with SPSS version 21, and conducted with paired t tests.

Results

Four of the 62 patients were excluded because they did not show up for appointments. One patient was excluded because of aspirin use. Four of the pain registrations were excluded because the VAS score lists were incomplete. There were 14 complaints of side effects, of which nine were headaches, these were equally divided over all groups. One patient in the indomethacin group had stomach acid, and one patient in the metamizole group had dry mouth and a "rash". Two patients had a worsening of complaints. None of the complaints necessitated any further intervention of exclusion from the study.

In agreement with earlier publications, the temperature of the pain sites were substantially lower than the surroundings in this series of measurements (44 of the 57, 77%, p=0.01) Infrared thermography detected no significant difference between with Avicel®, indomethacin and metamizole. A significant difference was found between the measurements of Avicel®, indomethacin and metamizole compared with the baseline. Three paired t tests were conducted to verify if the use of medication changes the temperature between the pain site and the reference area, broken down in cool and warm pain sites: Table 3.

The warm pain sites (n=13) averaged cooler compared with the reference area after medication, and the cooler pain sites (n=44) averaged warmer. Therefore: the difference between the cool as well as the warm pain sites and their respective reference areas are smaller after medication (Table 3).

After treatment with metamizole on cool pain sites the temperature difference between the pain site and the reference area decreases by 0.29 C° (p=0,001, 95% CI: 0.13; 0.45).

Discussion

The risk and usefulness of metamizole was already known in 1982. The general opinion in 1986 was: "Pharmaco-therapy rarely has room for the usual set combinations mainly because, along with having a dubious effect of colic pain, the analgesic has a substantial risk of causing agranulocytosis". That agranulocytosis can have a toxic effect manifesting as an allergic reaction. The incident was estimated between 8 per 1000 users (16) and 1:30000 (17, 18,19) up to even 1:106 (20). Its use was not forbidden in 1982 (16,21), but there were warnings about cautious use of pyrazolones (16,21).

Table 1:
The differences in temperature between pain sites and reference areas for baseline and the three medicines used.

Period	Pain site	Reference area	95% CI lower	95% CI upper	t	p
Baseline	32.60	32.98	-0.66	-0.10	-2.70	0.01
indomethacin	31.96	32.30	-0.55	-1.4	-3.34	<0.01
Avicel®	32.00	32.27	-0.51	-0.02	-2.19	0.03
Metamizole	32.12	32.34	-0.44	-0.01	-1.93	0.06

Table 2:
Temperature differences in the same area and different medication.

Indom./metam.	31.96-32.12		-0.43	0.11	-1.20	0.24
Indom./metam.		32.30-32.34	-.029	0.22	-0.27	0.79
Indom./baseline	31.96-32.60		-0.98	-0.31	-3.84	<0.01
Avicel®//baseline	32.00-32.60		-0.99	-0.22	-3.13	<0.01
Metam./baseline	32.12-32.60		-0.82	-0.14	-2.83	0.01

Table 3:
Temperature differences between pain sites and reference areas for the three medications and baseline, separately for warm and cool pain sites, whereby the reference area is always (Th12 + Th10)/2

	Pain site-reference area	mean	95% CI lower	95% CI upper	t	df	p
Warm pain site	indomethacin-Baseline	-0.515	-0.902	-0.130	-2.911	0.12	0.013
	Avicel® - Baseline	-0.426	-0.762	-0.089	-2.755	0.12	0.017
	Metamizole-Baseline	-0.252	-0.575	0.071	-1.698	0.12	0.115
Cool pain site	indomethacin-Baseline	0.200	0.085	0.316	3.506	0.43	0.001
	Avicel® - Baseline	0.269	0.034	0.505	2.309	0.43	0.026
	Metamizole-Baseline	0.288	0.128	0.449	3.620	0.43	0.001

Data on how frequent the allergic agranulocytosis can be avoided could not be found even with the possibilities afforded us in 2013. PubMed provided 25 hits with the search term "frequency allergic agranulocytosis", six of which involved pyrazolones and none of them provided incidence figures for allergic agranulocytosis. A recent Dutch publication reported on "An anaphylactic reaction to metamizole is very rare" (22).

The daily recommended dosage of metamizole is between one and two grams per day. For the metamizole dosage, that means approximately 25-50 micrograms/ml of body fluid with an equal distribution throughout the body. That is a thousand to a million times the biological concentration of prostaglandin. Prostaglandins are reported as effective in concentrations expressed in picograms and nanograms per millilitre. All in all, it also seemed that the toxic risk was the highest in 1982. That conclusion also seems justified in view of the recent information on the rarity of anaphylactic agranulocytosis.

Recent publications confirm the choice of indomethacin and metamizole as vascular-active substances with opposite effects. The risk mainly concerns metamizole's toxic mechanism of action, which can be reduced by lowering the dosage.

PUBCHEM reported the following on metamizole: "They act by blocking the synthesis of prostaglandins by inhibiting cyclooxygenase". The mechanism of action had already been published in 1999 (23). The choice of indomethacin and metamizole as intervention drugs (NSAIDs) is still correct in 2013.

In order to have infrared thermography as a measurement method of pain processes, it is necessary that the intervention drugs have an effect on the circulation of the subcutaneous arteriovenous system. indomethacin and metamizole both have via different pathways: via cyclooxygenase for the formation of prostaglandins (23,24,25,26), via prostaglandins on the smooth muscle tissue of the vessels (27), via phosphodiesterases, directly or via cAMP (28,29), and via Nitric Oxygen Synthetase (30,31). The mechanism of action of both pharmaceuticals is not always identical and they are sometimes opposite. Even though the NSAIDs have a considerable anti-inflammatory mechanism of action, that is not always the case with phenazone derivatives. indomethacin belongs to the group of "acidic-antipyretic drugs" and phenazone derivatives do not (24,32).

The estimated concentration of 25-50 μg/ml of body fluid for a therapeutic dosage of metamizole is in agreement with found blood concentrations of 30μg/ml (23,33). A 50% (IC50) inhibition factor using 3.5-12 μg/ml metamizole on cyclooxygenase 2 for intact cells (with lipopolysaccharide-induced macrophages) was found (34).

The curve of the cyclooxygenase inhibition is some- what steep in the low concentrations of metamizole: 10% inhibition of COX-2 activity with 10 μg/ml and 80% with 35 μg/ml in human leukocyte suspension (35). Toxicity of this is expected at 35 μg/ml, and there would be no toxicity, or scarcely any, at 10 μg/ml. The concentration of 35 μg/ml is reached with a therapeutic dosage of metamizole, although not all authors agree with this (36). The theoretically safe dosage range could be much lower (10-500 mg per dosage instead of 500-1000 mg per dosage) than has been thought up to this point (33).

In this study 0.3 mg per day was administered. That is 0.0006 × 500 mg, which makes the daily peak dosage 0.0006 × the mean serum value of 34 μg/ml = 0.02 μg/ml. Assuming the IC50 value of metamizole of 3.5-12 μg (34) to 12-1730 μg/ml (35), this dosage contributes to a 0.2 to 0.6 per cent inhibition in the best case. This assumes a linear relationship between serum concentration and inhibition.

Metamizole is used as a painkiller in various large countries. A recent publication states "Inexpensive metamizole is used in many countries as a supplement to paracetamol to counteract visceral pain, colic pain, and postoperatively" (22). Compared with paracetamol, the risk of anaphylaxis with metamizole is as great as was suspected in 1982 (37). The risk of mortality resulting from severe side effects is comparable with that of paracetamol (32). Its point of application is the same as paracetamol: the peroxidase family of COX inhibitors (26,38). It is therefore no surprise that the side effects and mortality with are the same as those with paracetamol. Another recent study showed that the risk of agranulocytosis (0.56 per 1 million people/year) was less with the reduction of the dosage to 1-2 grams/day (39). That means that a higher incidence of agranulocytosis could indeed be attributed to the dosage. That was also the fundamental assumption for the choice of dosage for this study. In retrospect, the results with the placebo indicate that the dosage administered in this study could have been higher.

Indomethacin

The concentration of indomethacin was estimated 0.006 μg/ml. This seems to validate the reduction of the test dosage in 1981, even though it could have been increased 10 to 100 times more.

The serum level at the time of administration was 25 mg 1.5 μg/ml (40). The daily dosage of 0.3 mg therefore provides 0.3 X 1.5/25 μg/ml = 0.018 μg/ml. The contribution to the synthesis inhibition is therefore the best case: 0.018/IC50 =0.018/0.23 (35). That is 7.8 per cent. This too assumes a linear relationship between serum concentration and inhibition.

Placebo effect

The finding that the placebo has a significant effect at the pain site after treatment ($p=0.03$) compared with the surrounding area is noticeably unexpected. There was an indisputably significant effect ($p<0.01$) with respect to the pain site even before starting the study.

Even more noticeable is that the placebo caused a temperature increase at the cool pain site and had an opposite effect at the warm pain site. This is difficult to explain, even with a mental mechanism.

Placebo studies are current and relevant in 2014. The search term "pain and placebo" returns 35,000 hits on PubMed, of which almost 20,000 are dated from 2010 on-

wards. The existence of placebo effectiveness is now incontrovertible. The mechanism is complex. Expectations of the mechanism of action play a role (42,43). Centralised influences through endogenous modulators such as opioids, cholecystokinin, cannabinoids, and dopamine may also play a role (44). Pharmacological conditioning may also be involved (42,45) (PubMed 185 hits). However, almost all of these cases involve reduction of pain as a subjective perception. The aspect of pain reduction was not quantified in this study, which dealt with an objectively quantifiable phenomenon: the measurement of a painful skin area that at the utmost can reach a physiological blood level through pharmaceuticals, with the exception of a placebo that cannot affect the blood level. But still in all, the skin temperature of a specific cool pain site increased, and decreased at a warm pain site. Patients only knew that there was one week when they were not taking a drug with an active agent, that the other drugs were being administered in accordance with traditional methods in non-active dosages, and that the risk of the complaints worsening were not ruled out. They did not know if their pain sites were warmer or cooler than the reference areas. This was also completely unknown to the researcher. The effect could not be explained through the expectations nor from pharmacological conditioning. The dosages of the other pharma- ceuticals were too small for that. The measured effect was too small for the unreported use of other painkillers. A possible hypothesis is a change of the sensation conditions of the central ner- vous system through one or more of the active substances, which can continue for a minimum of two weeks after dis- continuation of the medication. Testing the data for this does not support this hypothesis. The placebo effect re- mains unexplained.

The relatively long duration of the study (six weeks) required the patients to exercise a bit of self-discipline with regard to completing the VAS score on a daily basis, and to avoid taking any other medication. This was problematic in some cases. Patients who used other analgesics such as aspirin were excluded from the study. Patients who did not complete or fully complete the VAS were included in the thermographic test, but not in the pain perception examination. It turned out that a number of pa-tients had VAS scores of 0 or 1, which is no pain or hardly any pain.

The pain site for intervention is 0.36°C cooler than the average of the reference areas, which corresponds with other studies on chronic pain and skin temperature. This area remained cooler than the average after intervention. Coincidentally, the value of the pain sited after intervention with placebo [-0.26°C] was between the values of the interventions with indomethacin [-0.31°C] and metamizole [-0.21 °C]. The maximum difference between indomethacin and meta- mizole was, however, not significant (p=0.06). Even though the literature reports that infrared thermography appears to have the potential to objectify pain (41), the dosage of the NSAIDs used were too low to quantify that. Further re- search - using animal experimentation if needed - with higher dosages may provide more clarification on this. Recent data from the literature reports that an increase of the metamizole dosage is not more risky than the use of paracetamol, and is therefore not unethical.

Taking the above-mentioned considerations of inclusion criteria, dosage, and pain sensation notations into account, the study could be reproduced with current devices without a problem. The expectation is that the placebo effect would then no longer play a role. No improved method for quantifying pain changes than the VAS score has been found since 1982.

The results cannot be explained from the idea that the placebo, indomethacin and metamizole are inert and as such are not active substances. It also cannot be explained with the postulate that the results reflect a natural progression of the body temperature nor that it is the result of chance.

Admittedly, indomethacin and metamizole in the dosage do not contribute very much to the inhibition of prostaglandin synthesis, 8% and 0.6% respectively. A significant effect difference was also not found with the placebo. That does not mean that they, per definition, have the same inertia as the placebo.

Some prostaglandins have a parabolic dosage-effect curve. Very minor changes in concentration could achieve major effect changes in that situation. Infrared thermography not only measure concentrations, but also the resulting effects. In this study indomethacin and metamizole have a clearly significant effect on cold sites (Table 3).

A positive or negative dispersion of the measurement results around the focal areas - that is comparable to the reference areas - can be expected by a natural temperature shift. It turns out that this is not the case. Over the course of time the temperature increases in the cold area and decreases in the warm area. Hence the difference in relation to the reference area decreases. The effect can possibly be explained by spontaneous healing, providing the presupposition is that the temperature on the abdominal wall has a relationship with the pain or the cause of the pain. Consequently, chronic pain without an anatomical substrate can progress spontaneously without being a static (psychological) phenomenon, which as often been the notion. Chronic pain is more a disease than an invalidity, and its progress can be monitored with in frared thermography.

Chance can never be ruled out in research. Chance as a potential explanation can be ruled out as much as possible by establishing a hypothesis stating that the temperature does not change, by testing that hypothesis with proper scientific methods, and by estimating the probability that the null hypothesis is true. This is what has happened here, as can be seen in Table 3, which shows that there is merely a slight chance that the outcomes could have come about if the null hypothesis (no temperature changes) was true. Statistically, this rules out the possibility of chance being the explanation for the results in this study.

Conclusions

The null hypothesis was rejected. There was a measurable effect of pharmaceuticals in physiological dosages and placebo peripheral on the pain site itself. All substances used show a significant effect compared with the baseline. They also led to a significant temperature increase at cool pain sites and a decrease at warm pain sites. The placebo effect

was unexpected and is unexplainable beyond to say that a placebo may not always be as inert as is usually thought.

No statistical evidence was found for the opposite effect of indomethacin and metamizole in very low dosages at the warm and cool pain sites. No explanation was found for the significant placebo effect of Avicel®, and in particular the opposite effect on the skin temperature in the warm and cool pain sites. Further research is needed to gain clarification of this.

A possible explanation could be natural recovery, provided it can be assumed that the temperature on the ab-dominal wall has a relationship with the pain or the cause of the pain.

No relation was found between pain sensation and thermographic image, nor between prostaglandin effects and chronic skin pain. Further research with higher dosages (10 mg per dosage) is needed for this. Recent literature reports no ethical obstacles.

Recording pain sensation should be conducted frequently and under supervision.

Funding

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Disclosure

There is no conflict of interest what so ever.

Medical Ethics Review Committee

No medical ethics review committees (METC) existed in 1982. A METC number is not necessary for publication. METC declaration is present.

The declaration of Helsinki has been followed.

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2015

21st -23rd March 2015

XIX National Congress of the Polish Association of Thermology in Zakopane, Poland

Conference Venue:Hotel Hryny, Pilsudsjiego str 20

Information: Prof Dr Anna Jung
email:a.jung@spencer.com.pl

20th–24th April 2015

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IMPORTANT DATES
Abstracts Due:6 OCTOBER 2014
Author Notification:15 DECEMBER 2014
Manuscript Due Date:23 MARCH 2015

PLEASE NOTE: Submissions imply the intent of at least one author to register, attend the conference, present the paper as scheduled, and submit a full-length manuscript for publication in the conference proceedings.

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6th-10th July 2015

QIRT – ASIA 2015 in Mahabalipuram, Chennai, India

Venue Hotel Radisson Blu Resort Temple Bay,
Mahabalipuram (50 kms from Chennai City),

IMPORTANT DATES
Abstract submission deadline: November 20, 2014
Acceptance notification: January 31, 2015
Paper submission deadline: April 30, 2015

SCOPE OF THE CONFERENCE

QIRT-Asia 2015 will cover, but will not be limited to, the following topics:

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XIII European Association of Thermology Congress

XIII EAT CONGRESS
madrid
3rd-5th September 2015

Thermology in Medicine: Clinical Thermometry and Thermal imaging

The EAT and the Faculty of Physical Activity and Sports Sciences (INEF) are has the pleasure of inviting you to participate in the XIII EAT Congress in Madrid between the 3rd and 5th of September, 2015.

The target of this Congress is integrating professionals and researchers from different fields who are working daily with medical thermography, introducing the latest advances in infrared technology and the new applications arising from them

The Congress will appeal not only to end users of medical thermography but also to researchers and developers. The congress will focus on free communications and posters in the areas of Human Applications, Animal Applications, and Engineering.

We look forward to seeing you in Madrid in September 2015.

Prof. Manuel Sillero Quintana
EAT2015 Chairman

Prof. James B. Mercer
EAT President

CALL FOR ABSTRACTS

The scientific committee will receive submission for abstracts for free communications and posters in the areas of "Biomedical Applications", "Animal Applications" and "Technical Applications".

Abstracts submission will be on-line,
for submitting your abstract please click here !

NOTE: Prizes will be awarded for the best oral communications, best poster (Kurt Ammer Prize) and best student oral presentation (Francis Ring prize). The authors of best communications will be invited to submit an extended version of their abstracts for publication in Thermology International.

The congress will take place at the Physical Activity and Sport Sciences Faculty (INEF Madrid) which belongs to the Technical University of Madrid (UPM) located in the University City of Madrid. It has an auditorium with 600 places and two conference rooms with seating for 140 and 120 persons and are fully equipped with modern audio-visual equipments.

IMPORANT DATES

10th October 2014 - Opening of abstract submission and registration.

30th January 2015 - Abstract submission deadline.

27th March 2015 - Acceptance notification to authors.

27th March 2015 - Opening of Early Bird registration.

17th April 2015 - End of Early bird registration.

31st August 2015 - End of Late registration.

3rd September 2015 - End of Last minute registration.

3rd September 2015 - Start of the event

Madrid Metro website:
http://www.metromadrid.es/en/index.html

Spanish train services website:
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TRAVEL INFORMATION

There is a train service directly from Madrid Barajas airport (Terminal 4) to Príncipie Pío Station (35 minutes, about 2.50 €; one train each 30 minutes), where the official hotel is located.

There are also metro and buses from the Airport to the city center (40-50 minutes, about 5-6 Euros). A taxi from the Airport could be another option but a little bit more expensive. In 2014 the fixed fee for a taxi from the Airport to any place in the centre of Madrid is 30€.

The radial structure high-speed (AVE) and regional trains and buses allow travel to Madrid from the most important cities of Spain. Furthermore, Madrid has an excellent underground system, a frequent bus network and many reasonably priced taxis for local transportation.

We encourage our attendees to use the public transport. A 10 ticket bonus will be provided to all the attendants with a 3-days registration at the Reception Desk of the Hotel FLORIDA NORTE.

ACCOMMODATION

Hotels in Madrid are quite full in early September. For this reason, the organizers of the EAT Congress have reserved 100 rooms for participants at the Hotel Florida Norte****, which will be the official hotel of the congress. The special fees for the attendants are:

- 35.35 € (incl. 10% VAT) per person in double bed room including breakfast (buffet).
- 59.35 € (incl. 10% VAT) single room including breakfast (buffet).

The Florida Norte Hotel is about a 25 minutes walk or a 5-10 minute bus ride to the venue. The city centre is a 10 minute walk from the hotel.

VERY IMPORTANT. In the registration form the participants have to indicate whether or not they will stay in the Hotel Florida Norte (organizers will inform to the Hotel). If they choose to use the Hotel Florida Norte, they have to reserve the hotel themselves writing and email to reservas.florida@celuisma.com. Alternatively the hotel can be booked on-line at http://www.celuisma.com/en.

NOTE:
If you indicate in the booking form that you are an attendant of the EAT Congress you will be charged the special congress rate and NOT the fee indicated on their website.

PROGRAMME OF THE EAT CONGRESS 2015 (by 15th of July 2014)

	Tuesday, 1-9-15	Wednesday, 2-9-15	Thursday, 3-9-15	Friday, 4-9-15	Saturday, 5-9-15
8:30		PRE-CONGRESS COURSE Program of the course will be published soon at www.eat2015.info	Late Registrations (INEF)	Late Registrations (INEF)	Late Registrations (INEF)
9:00			Morning Session 1-1 Technical Apps.	Morning Session 2-1 Biomedical Apps. (Sports)	Morning Session 3-1 Biomedical Apps.
9:30					
10:00					
10:30			Coffee Break	Coffee Break	Coffee Break
11:00			Morning Session 1-2 Technical Apps.	Morning Session 2-2 Biomedical Apps.	Morning Session 3-2 Biomedical Apps.
11:30					
12:00					
12:30					
13:00					
13:30			Lunch (INEF)	Lunch (INEF)	Lunch (INEF)
14:00					
14:30	PRE-CONGRESS COURSE Program of the course will be published soon at www.eat2015.info		Evening Session 1-1 Technical Apps.		Closing Ceremony and EAT Awards
15:00					
15:30				VISIT TO A PINTURESQUE CITY AROUND MADRID AND GALA DINNER (*)	
16:00			Coffee Break		
16:30			Evening Session 1-2 Animal Apps.		
17:00					
17:30					
18:00			EAT MEETING		
18:30		Late Registration and Accreditation at the Hotel Florida Norte			
19:00					
19:30					
20:00					
20:30					
21:00					
21:30					
22:00					
22:30					
23:00					

(*) Note.- The bus will depart from the Florida Norte Hotel. The visit will be from 16:30 or 17:00 to 20:00 and the dinner from 20:00 to 22:00 arriving 23:00 to the hotel.

REGISTRATION

	Early Registration (Until 17-4-15)	Late Registration (Until 31-7-15)	Last-minute Registration
EAT MEMBER [1]	300 €	360 €	400 €
Non EAT member [1,2]	350 €	410 €	450 €
1-day registration [3]	125 €	150 €	170 €
Student [4]	150 €	200 €	240 €
Accompanying person [5]	200 €	260 €	300 €

(1) Full inscriptions include registration pack, coffee breaks, lunches, Gala Dinner, and 10 tickets for public transports (metro and bus).
(2) Annual EAT fee = 50 € (including one year subscription to the journal Thermology International). To get information about how to apply to the EAT as ordinary or extraordinary member, visit http://www.europeanthermology.com (membership).
(3) 1-day registration will include registration pack and coffee breaks and lunch of the day. Gala Dinner not included.
(4) A certificate with ECTS credits will be provided by U.P.M. Gala Dinner not included.
(5) Accompanying person registration will include 2 one-day excursions (9:00 - 16:00) with lunch (3rd and 5th of September) and Gala Dinner.

IMPORTANT: To Register click here!

The payments will be trough bank transfer or paypal

Contact

For any question regarding the event do not hesitate in contacting:

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AITA 2015 - Advanced Infrared Technology and Applications

http://ronchi.isti.cnr.it/AITA2015

First Call for Papers

The 13th International Workshop on Advanced Infrared Technology and Applications (AITA 2015) will take place in Pisa, Italy from 29 September to 2 October 2015 and will be hosted by the *Istituto di Scienza e Tecnologie dell'Informazione "Alessandro Faedo" (CNR-ISTI)* in cooperation with the *Fondazione "Giorgio Ronchi"*, the *Istituto di Fisica Applicata "Nello Carrara" (CNR-IFAC)* and the *Istituto per le Tecnologie delle Costruzioni (CNR-ITC).*

Areas of Interest

In the 13th AITA edition, special emphasis will be given to the following topics:

- Advanced technology and materials
- Smart and fiber-optic sensors
- Thermo-fluid dynamics
- Non-destructive tests and evaluation
- Environmental monitoring
- Aerospace and industrial applications
- IR and Nanophotonics
- Astronomy and Earth observation
- Systems and applications for the cultural heritage
- Biomedical applications
- Image processing and data analysis
- Near-, mid-, and far infrared systems

2nd Under 35 Paper Award

A best paper award (reserved to < 35-year old main authors) will be assigned in honour of Ermanno Grinzato, AITA cochair for a long time and known scientist in the thermography community.

Technical Seminar on IR Techniques for Cultural Heritage

Considering the importance of cultural heritage in Italy and the excellence achieved by Italian researchers and operators in this domain, a technical seminar entitled "*Techniques for infrared diagnostics and documentation in the field of cultural heritage*" will be organized.

Submission

All paper submission will be handled electronically.
A dedicated page will be set-up on the conference website.

Important Dates

April 30, 2015 Extended abstract submission

May 31, 2015 Notification of acceptance

June 30, 2015 Revised extended abstract submission

General Chair

Laura Ronchi
«Giorgio Ronchi» Foundation, IT

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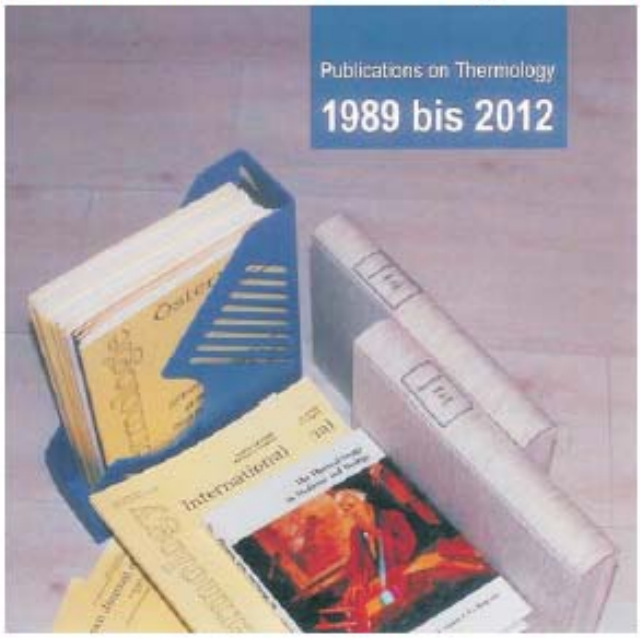
Publications on Thermology 1989 to 2012 - An electronic archive DVD



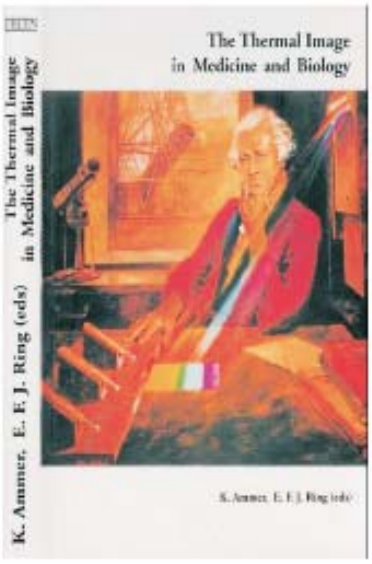
This data compilation contains all issues of

Thermologie Österreich
May 1991 to April 1997
European Journal of Thermology
July 1997to October 1998
Thermology international
January 1998 to October 2012

Plus

The Thermal Image in Medicine and Biology

edited by K.Ammer and E.FJ Ring
Uhlen Verlag, Wien (1995)



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Published Papers on Thermology and Temperature Measurement

Volume 1: 1989 to 2004

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Volume 3: 2007 to 2011

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Proceedings of the First Thermological Symposium of the Austrian Society of Thermology

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