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Report of the XIV EAT Congress, and post-congress survey results

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Contents (INHALTSVERZEICHNIS)

Reliability: What is it, how is it determined and is it necessary for thermal imaging?

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The increasing complexity of measurement devices may potentially contribute to generate erroneous measurements, which in turn, may lead to misguided decision-making if users are unaware of the limitations of the measurement equipment [1, 2]. Measurement quality is a concern in all fields of science. All measurements should be valid and reliable and demonstrating these requisites should be a priority in research and professional practice.

Validity is the extent to which a measurement represents the variable they are proposed to measure. A study is only valid if the implemented measures truly measure what they claim and if there are no flaws in data analysis and interpretation. In research, validity issues may arise from three contexts, threatening the meaningfulness of a measurement: the measure itself, the construct and statistical analysis and research design. The validity of a measurement method, often reported as accuracy, is a measure of proximity between test results and the true value being measured [1, 3].

Reliability of a measurement, often reported as precision, is a measure of scatter between repeated measurements of the same variable [1], a measure of the repeatability and reproducibility of measurements [4, 5]. This editorial will focus on this concept, on how it is determined for continuous variables (e.g. skin temperature) and on its relevance for thermal imaging.

Clinically, measurements are performed as part of an assessment, as an outcome, as part of a decision-making process and/or to provide feedback to patients or other interested parties. However, the utility of such measurements depends on how reliable the measurements are in themselves and on the reliability of the assessor executing them.

As stated before, reliability is linked to the repeatability and the reproducibility of measurements, it is a concept closely related to agreement and uncertainty. Results of reliability studies provide information regarding the amount of error related to a measurement. Repeatability is a measure of the agreement between successive measurements of the same measurand performed under the same conditions, i.e. same measurement procedure, same observer, same measuring instrument under the same conditions, same location and repetition over a short period of time. On the other hand, reproducibility is a measure of the agreement between measurements of the same measurand performed under changed conditions, i.e. different principle of measurement, method of measurement, different observer, different measuring instrument, different location, different conditions of use and different time of assessment [4]. This is very important for clinicians and researchers because good measurement methods, with good repeatability and reproducibility, allow to monitor small but clinically important changes in individual subjects.

The terms "reliability" and "agreement" are used many times as synonyms, but the two are conceptually different. Baumgarter [6] has identified two types of reliability, relative reliability and absolute reliability. The first is related to the degree in which subjects maintain their position (rank) in a sample over repeated measurements and the second is related to the variation of repeated measurements. Absolute reliability is inversely proportional to measurement variation. Relative reliability and absolute reliability are conceptually distinct, with absolute reliability being, conceptually, more related to agreement than relative reliability.

For those working with thermal imaging, reliability testing is important for many reasons:

1.To determine the reliability of the imaging system, comparing it to another imaging system or a reference source.

2.To determine rater reliability, i.e. the reliability of the observer using the imaging system. This can be done comparing measurements from the same observer or comparing measurements from different observers.

3.To determine the stability of skin temperature measurements.

The first point is related to instrumental reliability, the second point is related to rater reliability and the third point is related to response reliability [7].

When dealing with rater reliability two aspects must be considered, one related to the reliability of the process leading to the image capture and one related to the placement of the regions of interest (ROI). In both cases, standardization is the key. In the last two decades there was a growing concern about standardization in protocols, and several publications have highlighted the need for such practice [e.g. 8, 9-12], however, reliability reporting in research is still lacking in the vast majority of thermal imaging publications, and those that report reliability measures often do it inadequately [e.g. 13]. In this issue of Thermology International, a publication review addresses the problems of this specific publication [14].

But how can we measure reliability in thermal imaging studies? Before answering this question, one must ask what the research question behind the analysis is. Do we want to measure the reliability of infrared thermography to measure skin temperature or do we want to measure the reliability of image analysis, i.e. the placement of ROI in a thermogram? The answer to this question will determine the necessary study design. If the reliability of infrared thermography is of interest the research design will require the analysis of different images acquired in different occasions by the same observer (intrarater reliability) or by more than one observer (interrater reliability) [e.g. 15]. If the reliability of image analysis is the question being answered, the same images should be analysed by the same observer (intrarater reliability) or more observers (interrater reliability) in different occasions, preferably blinding the observers [e.g. 16]. Statistically, the data analysis is similar in both cases, and the most used analysis methods will be discussed. For relative reliability, correlation coefficients (CC) are used, such as Pearson's r, Spearman's rho and intraclass correlation coefficients (ICC), which provide information regarding the association between measurements but not, except for the ICC, about their agreement. For absolute reliability, the standard error of measurement (SEM), coefficient of variation (CV) and Bland and Altman's analysis are used. Contrary to relative reliability measures, these measures are expressed in the actual units of measurement, or as a proportion of the measured values [7].

If the reliability of image analysis is being assessed, analysing the reliability of the placement of ROI, the analysis should focus on the temperature values in the ROI but also in the size of the ROI, i.e. the number of pixels in the ROI. There is evidence that significant temperature differences are found if the number of pixels within a ROI varies by 100% or more [17] and there is also evidence that skin temperature differences are associated with differences in the number of pixels in a ROI [16]. This is particularly relevant when small ROI are used, and authors should be aware of the need to control these aspects.

The most common statistical approaches to measure reliability will be described and discussed next:

Correlation coefficient

A CC measures the degree of linear association between sets of measurements [18]. It is a dimensionless measure that will take a value between -1 and 1. A value of 0 indicates no linear association and a value of -1 or 1 indicates a perfect negative or positive linear association, respectively. Consider a scenario where T_{Sk} is measured in several patients in consecutive days. When data is ordered from the highest value to the lowest value, the rank of each patient can be observed in both days. If the rank of each subject remains the same, the CC will be high. However, this kind of analysis does not detect systematic errors, which means that it is possible to have two sets of measurements that are highly correlated but with low repeatability or reproducibility. Let us consider a scenario where we are comparing the measurements of two thermal cameras (TC_1 and TC_2) with measurement T_{Sk1} as the reading of TC_1 and T_{Sk2} as the measurement of TC_2. It is possible to obtain perfect CC ($r = 1$) for a situation where $T_{Sk1} = T_{Sk2}$ and for a situation where $T_{Sk1} = 3xT_{Sk2}$.

The CC is highly dependent on the range of measurement and it is not related to the units of the measurement or to the size of the measurement errors, which may be clinically relevant [19]. CC only provide information on how two sets of measurements vary together, not the extent of agreement between them. In other words, CC may provide a measure of relative reliability but not absolute reliability, therefore they should not be used as the sole indicator of reliability [7].

Intraclass correlation coefficients

The ICC attempts to overcome some shortcomings of the CC. It is defined as a ratio between subject variance and total variance, which includes subject and error variance, in other words, it is an analysis of variance or ANOVA. The ICC is also a dimensionless measure that can assume a value from 0 to 1, with 0 demonstrating no agreement and 1 demonstrating perfect agreement. In contrast with the CC, which quantifies the strength of association between two measurements, the ICC quantifies the agreement between pairs of measurements [20]. Shrout and Fleiss [21] defined 6 different types of ICC that when applied to the same data can give different results, therefore, the correct ICC must be chosen according to the research question. Unfortunately, although the ICC is reported in many research reports, which ICC was used is often not clear [e.g. 13]. The selection of the correct ICC is based on the model (e.g. two-way random-effects), type (e.g. mean of k raters) and definition selection (e.g. consistency) [22]. This reliability measure can be used to evaluate the degree of consistency or the degree of absolute agreement. When assessing consistency of T_{Sk} in a ROI which was repeatedly measured, the repeated measurement is considered a fixed factor, not involving any errors but, when assessing absolute agreement of T_{Sk} in a ROI which was repeatedly measured, errors in the repeated measurements must be accounted for and the repeated measurement is considered a random factor. An ICC value based on absolute agreement is always lower than an ICC based on consistency because a stricter principle is applied [23].

The ICC has a clear advantage over the CC because it evades the problem of linear relationship being erroneously considered agreement, however, similarly to the CC, it is still dependent on the range of measurement and it is also not related to the units of the measurement or to the size of the measurement errors [19]. This is still an important limitation encouraging not to use ICC measures in isolation. If the ICC is calculated from a set of measurements with wide range, the reliability will always appear to be higher than when the ICC is calculated from a set of measurements with a narrow range.

Standard error of measurement

When repeated measurements are applied to the same individual, in the same conditions, we can expect little variation from measurement to measurement. The existing differences may be regarded as measurement error and the mean of these errors may be determined. The more reliable the measurements, the less error variability will be found around the mean. The standard deviation of these errors reflects the reliability of the measurements and is known as SEM. To calculate the SEM a reliability score is needed, often the ICC. The formula is:

SEM=standard deviation (SD)$\times(\sqrt{(1-ICC)}($[24].

Contrary to the CC and ICC, the SEM is expressed in the actual units of measurement, which is easier to interpret, and the smaller the SEM, the greater the reliability. The interpretation of this absolute reliability measure depends on the type of reliability coefficient used in the formula. If a test-retest reliability estimate was used, the SEM indicates the errors that can be expected on retesting. If the ICC used in the computation was an indicator of interrater reliability, the SEM indicates the expected error between raters. If the ICC was an indicator of intrarater reliability, the SEM indicates the expected error between assessments by the same rater [7, 24]. This can be applied to the reliability of T_{Sk} measurements or to the reliability of placement of ROI.

Coefficient of variation

The CV is a measure of variability that can be computed as the SD of the data, divided by the mean and multiplied by 100. It is, therefore, a percentage score expressing SD as a proportion of the mean, and in doing so it accounts for differences in the magnitude of the mean [24]. This measure of reliability may be of interest, for instance, to compare two temperature distributions, two patient groups, or different temperature assessments to determine if some are more stable than others. However, as pointed out by Bland [25], expressing error as a percentage may be a problem because x% of the smallest observation is will be much different from x% of the largest observation.

Bland and Altman agreement measures

Bland and Altman acknowledged several of the limitations of the existing forms of analysis [26] and introduced a simple but effective approach. The article published in the Lancet is one of the most cited papers in statistics [27], with more than 40000 citations as reported by Google Scholar. This is not a surprise since it is the most popular method to test for agreement [28].

In the Bland and Altman approach the difference between a pair of measurements is plotted on the vertical axis of the diagram against the mean of the pair of measurements on the horizontal axis. Afterwards, it is necessary to calculate the mean and standard deviation of the differences between the measurements and to calculate the 95% limits of agreement and add them to the diagram. The 95% limits of agreement are easily calculated as the mean difference plus and minus 1.96 standard deviations of the differences. Sometimes two standard deviations are used instead, as even Bland and Altman have not been entirely consistent about this. Assuming a normal distribution of the differences, approximately 95% of the differences are expected to lie between the limits of agreement [27, 29], if not, the agreement between measurement methods, between repeated measurements or between observers may be questioned.

Before constructing the Bland-Altman plot, a correlation analysis between the mean and the differences of the measures of each pair of assessors should be conducted to verify the association between those variables. The distribution of the differences of the measures should also be checked by histogram analysis and to assess departures from normality, a Z-score test for skewness and kurtosis can be used. If both assumptions (symmetric distribution of the differences and small association between the mean and the differences of the measurements) are met, the Bland-Altman plot can be used to analyse the agreement of temperature measurements. In the case of the existence of an association between the mean and the difference of the measurements being plotted, the appropriate data transformation (e.g. logarithmic or percentage scale) should be undertaken [27].

The Bland and Altman approach has several advantages as data can be visually interpreted easily, and outliers, exaggerated bias, and the relationship between variance in measurements and the mean of the measurements can easily be spotted [7]. Moreover, this agreement assessing approach can be used to analyse the repeatability of an assessment procedure, to compare different measurement methods [7, 27], and has also been used to analyse rater reliability [16]. If the 95% limits of agreement are too wide it means that there are random errors associated with the measurement instrument, or process if reliability of the placement of ROI is being studied. On the other hand, if the 95% limits of agreement are narrow but the average of the differences (bias) is different from 0, it means that systematic errors may be present. This analysis, however, does not have objective criteria and should be interpreted regarding clinical acceptability, i.e. judging if the limits of agreement are too wide or bias is to high must be done according to the clinical needs.

Other methods to assess reliability - Hypothesis testing

Tests based on hypothesis testing, such as the t-test and ANOVA, or non-parametric equivalents, can assess the existence of statistically significant bias between measurements. These tests are commonly mentioned in reliability studies [28] but researchers should be aware that these tests only provide information about systematic errors between the means, or medians, of two or more sets of data and not about individual differences. Moreover, if large amounts of random errors are present, systematic bias is less likely to be detected. Therefore, these tests should be used with caution and not in isolation but should be used with other approaches such as the Bland and Altman approach [7, 27].

Comparing clinical measurements using CC, hypothesis testing and regression analysis has been criticised before [30] but researchers still report them in reliability studies, evidencing the need to understand statistics in clinical research.

The described reliability measures are not all the possible approaches but are the most frequently reported. Reliability is a complex construct and reliability analysis is definitely not a "black or white" scenario with agreed thresholds to help researchers decide if the measurements or methods are reliable. There is no $p<0.05$ rule, the decision that must be made is whether the measurement error is acceptable for clinical use and will be based on specific contexts. Is reliability important in thermal imaging studies? The answer is a strong "yes". Although previous research demonstrates that specific protocols for image analysis are reliable [9], clinicians and/or researchers are free to select their own ROI. However, even when analysing the same body region, the shape, size and placement of the ROI are not defined similarly. This is not a problem, since the definition of the ROI is dependant of the goal of the study, however, the reliability of the adopted methodology should be tested and reported.

Reliability studies in thermal imaging are lacking. The reliability of thermal imaging applications must be clear, or hardly they will be used in practice, especially in clinical practice. Guidelines for reporting reliability and agreement studies have been established [31] and should be used in thermal imaging studies. Thermology International endorses these guidelines, the journal has always paid attention to methodological quality and continues to do so.

It is strongly advised that any thermal imaging study reporting reliability:

(1) provide a rationale for the choice of statistics;

(2) include measures of relative reliability, specifically ICC, with clear description of which ICC was used, with the corresponding 95% confidence intervals; and

(3) include adequate measures of absolute reliability.

References:

1. Stoker MR. Common errors in clinical measurement. Anaesthesia & Intensive Care Medicine. 2008;9(12):553-8.

2. Weisz M, Johnston V. Common errors in clinical measurement. Anaesthesia & Intensive Care Medicine. 2014; 15(11): 533-536.

3. Garson DG. Validity and Reliability: Statistical Associates Publishing; 2013.

4. Joint Committee for Guides in Metrology (JCGM). Evaluation of measurement data - Guide to the expression of uncertainty in measurement: JCGM; 2008. Available from: https://ncc.nesdis.noaa.gov/documents/documentation/JCGM_ 100_2008_E.pdf.

5. Joint Committee for Guides in Metrology (JCGM). The international vocabulary of metrology-basic and general concepts and associated terms: JCGM; 2012; 3rd edition. Available from: https://www.bipm.org/utils/common/documents/ jcgm/JCGM_200_2012.pdf.

6. Baumgarter TA. Norm-referenced measurement: reliability. In: Safrit MJ, Wood TM, editors. Measurement Concepts in Physical Education and Exercise Science. Champaign, Illinois: Human Kinetics; 1989. pp. 45-72.

7. Bruton A, Conway JH, Holgate ST. Reliability: what is it, and how is it measured? Physiotherapy. 2000;86(2):94-99.

8. Ring E, Ammer K. The technique of infrared imaging in medicine. Thermology International. 2000;10(1):7-14.

9. Ammer K. The Glamorgan Protocol for recording and evaluation of thermal images of the human body. Thermology International. 2008;18(4):125-44.

10. Ring E, Ammer K. Infrared thermal imaging in medicine. Physiological Measurement. 2012;33(3):R33-R46.

11. Ammer K, Ring E. Standard Procedures for Infrared Imaging in Medicine. In: Diakides N, Bronzino J, editors. Medical Infrared Imaging: Principles and Practices. Boca Raton, FL: CRC Press; 2013. p. 32.1-32.14.

12. Vardasca R, Marques A, Diz J, Seixas A, Mendes J, Ring E. The influence of angle and distance on temperature readings from the inner-canthi of the eye. Thermology International. 2017;27(4):130-135.

13. Silva NCM, Castro HA, Carvalho LC, Chaves ÉCL, Ruela LO, Iunes DH. Reliability of Infrared Thermography Images in the Analysis of the Plantar Surface Temperature in Diabetes Mellitus. Journal of Chiropractic Medicine. 2018;17(1):30-35.

14. Seixas A, Ammer K. Reliability of the analysis of infrared thermography images. Thermology International. 2018; 28(4): 192-193.

15. Zaproudina N, Varmavuo V, Airaksinen O, Närhi M. Reproducibility of infrared thermography measurements in healthy individuals. Physiological measurement. 2008;29(4):515-524.

16. Seixas A, Azevedo J, Pimenta I, Ammer K, Carvalho R, Vilas-Boas JP, et al. Skin temperature of the foot: Reliability of infrared image analysis based in the angiosome concept. Infrared Physics & Technology. 2018;92: 402-408.

17. Ammer K. Temperature readings from thermal images are less dependent on the number of pixels of the measurement area than on variation of room temperature. Thermology International. 2005;15(4):131-133.

18. Sedgwick P. Correlation. BMJ. 2012;345:e5407.

19. Bland J, Altman D. A note on the use of the intraclass correlation coefficient in the evaluation of agreement between two methods of measurement. Computers in Biology and Medicine. 1990;20(5):337-340.

20. Sedgwick P. Intraclass correlation coefficient. BMJ. 2013; 346:f1816.

21. Shrout PE, Fleiss JL. Intraclass correlations: uses in assessing rater reliability. Psychological Bulletin. 1979;86(2):420-428.

22. Koo TK, Li MY. A guideline of selecting and reporting intraclass correlation coefficients for reliability research. Journal of Chiropractic Medicine. 2016;15(2):155-163.

23. Kim H-Y. Statistical notes for clinical researchers: Evaluation of measurement error 1: using intraclass correlation coefficients. Restorative Dentistry & Endodontics. 2013;38(2):98-102.

24. Portney LG, Watkins MP. Foundations of Clinical Research: Applications to Practice. 3rd ed. Philadelphia: F. A. Davis Company; 2015.

25. Bland JM. An Introduction to Medical Statistics. 3rd ed: OUP Oxford; 2000.

26. Altman DG, Bland JM. Measurement in medicine: the analysis of method comparison studies. The Statistician. 1983: 307-317.

27. Bland JM, Altman D. Statistical methods for assessing agreement between two methods of clinical measurement. The Lancet. 1986;327(8476):307-310.

28. Zaki R, Bulgiba A, Ismail R, Ismail NA. Statistical methods used to test for agreement of medical instruments measuring continuous variables in method comparison studies: a systematic review. PloS one. 2012;7(5):e37908.

29. Bland JM, Altman DG. Agreed Statistics: Measurement Method Comparison. The Journal of the American Society of Anesthesiologists. 2012;116(1):182-185.

30. Bland JM, Altman DG. Comparing two methods of clinical measurement: a personal history. International Journal of Epidemiology. 1995;24(Supplement_1):S7-S14.

31. Kottner J, Audigé L, Brorson S, Donner A, Gajewski BJ, Hróbjartsson A, et al. Guidelines for reporting reliability and agreement studies (GRRAS) were proposed. International Journal of Nursing Studies. 2011;48(6):661-671.

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Reliability of the analysis of infrared thermography images

Review of the paper by Natália C.M. Silva, Hirlaine A. Castro,Leonardo C. Carvalho, Érika C.L. Chaves, Ludmila O. Ruela and Denise H. Iunes, "**Reliability of Infrared Thermography Images in the Analysis of the Plantar Surface Temperature in Diabetes Mellitus"**. Journal of Chiropractic Medicine. 2018;17(1):30-5

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Summary

Background

The use of thermal imaging in health care has been reported with good outcomes in musculoskeletal disorders, diabetic neuropathy, vasculopathy, and in other applications. The presence of local lesions may impair thermo-reg ulation, promoting physiological changes in organisms. Patients with diabetes often have damaged peripheral nerves and blood vessels, which has proven to affect skin temperature through the impairment of autonomic control mechanisms. However, few studies have reported reliability measures of foot skin temperature assessment. Therefore, a group of Brazilian researchers has conducted a study aiming to assess the intrarater and interrater reliability of infrared thermography in the analysis of the plantar surface temperature in patients with diabetes.

Methods

The authors conducted a cross-sectional study enrolling 51 patients with diabetes. Plantar foot images were acquired in a room with controlled temperature after an acclimation period of 15 minutes, in a supine position. All images were acquired by the same researcher. To assess intrarater reliability, one observer analysed the images on two different time points, 10 days apart. To assess interrater reliability, images were analysed by two observers, in different locations and computers to avoid information exchange that could interfere with the assessment. The Quick Report software (version 1.1, FLIR Systems) was used in the analysis. Statistical analysis included intraclass correlation coefficients (ICC) with 95% confidence intervals (95% CI), standard error of measurement (SEM) and minimum detectable change (MDC).

Results

The authors reported excellent reliability in all 18 regions of interest (ROI), in both intrarater and interrater reliability (ICC > 0.94; 95% CI > 0.89; p < 0.01). SEM values varied between 0.00ºC and 0.73ºC and MDC varied between 0.00ºC and 2.05ºC.

Conclusions

After presenting and discussing their results, the author concluded that interrater and intrarater reliability for the analysis of infrared thermography images of the plantar surface temperature of patients with diabetes was good.

Commentary

We read with great interest a recently published article in Journal of Chiropractic Medicine focusing on the reliability of infrared thermography image analysis [1]. The idea of the study is relevant and in high demand in the literature. Unfortunately, this is a case where reviewers and journal editor failed to improve the author's submission because incorrect and incomplete information was reported in the manuscript.

We do not agree with the authors when they state that thermal imaging is a new methodology in healthcare. Thermal imaging became available to medicine in 1956 and started to be used in diabetic patients in 1967 [2, 3]. Moreover, contrary to the stated purpose of the study [1], the authors have not assessed the intra-rater and interrater reliability of infrared thermography. To do so, a different study design should have been conducted, with different images acquired by different assessors in different occasions [4] and not the analysis of the same images by different assessors in different occasions. Silva et al. [1] assessed the intrarater and interrater reliability of image analysis, which is still relevant because image analysis is one of the identified sources of bias in thermal imaging [5] and is rarely reported.

Information regarding the raters should have been reported. Were they trained and/or experienced in thermal imaging analysis? Were they blinded regarding repeated measurements? How was that achieved? Blinding of the assessors is important, but hard to achieve.

Detailed information should have been provided concerning the size of the regions of interest [6]. The reasoning behind the choice of the regions of interest and their clinical relevance should also have been explained. After reading the manuscript it is not clear if the authors used 18 areas of pixels (ROI) or 18 single pixel ROI in the analysis. An image with the location of the regions of interest was provided (Fig.1A) but not in the thermal image, as recommended [6]. If 18 areas of pixels were used, the size of the ROI (in pixels) should have been reported. This is of utmost importance, especially because the ROI are very small, and it is easy to use ROI with large pixel variation and previous research has demonstrated that large variations in size lead to differences in skin temperature [7]. Moreover, it is also not clear which temperature value (minimum, maximum, mean) was extracted to be analyzed. Without such information it is impossible to understand and reproduce the study.

Looking into Fig.1A we clearly see that the regions of interest follow three vertical lines - in the lateral, central and medial foot - connecting the dots in the rear and forefoot, which may have been the orientation for placing the small regions of interest. Such a procedure, which should be reported if used, might explain the high agreement of temperature values, as previous research where strategies helping to delineate the ROI were used reported high reliability measures [8, 9].

Another aspect deserving discussion is the insufficiently reported statistical analysis, and the fact that the reported intraclass correlation coefficients (ICC) may be overestimated. Sample size calculation was poorly described and with the available information it can't be replicated. Shrout and Fleiss [10] defined 6 different types of intraclass correlation coefficients (ICC) that when applied to the same data can give different results. The different forms of ICC are based in distinct assumptions and will lead to different interpretations. The selection of the correct intraclass correlation coefficient (ICC) is based on the model (e.g. two-way random-effects), type (e.g. mean of k raters) and definition selection (e.g. consistency). Only one type of ICC is appropriate for each specific situation and when incomplete or confusing information about the type of ICC is provided, the ICC value should be interpreted with caution [11]. Silva et al. [1] were not clear regarding the type if ICC that was used. Based in the description of the statistical analysis, we are led to believe that the definition selected by the authors was "consistency", as described in the statistical analysis. However, the definition "absolute agreement" should always be used in interrater and intrarater reliability studies [11], even if it provides smaller ICC estimates, because if there is no agreement between repeated measurements, measurements are not meaningful. A guideline to select and report ICC values has been published in the Journal of Chiropractic Medicine but neither the authors, the reviewers and the journal editor were able to spot these issues.

The study also reported the MDC (minimum detectable change). Although related to measurement error, the MDC is rather a measure of change. It could be interesting to report the MDC if the reliability of infrared thermography were truly being assessed like in Zaproudina and colleagues' study [4], but that is not the case. Reporting MDC when the reliability of image analysis is being assessed is questionable and the meaning of the reported values are dubious.

Considering the issues regarding the procedures to define the regions of interest and extract temperature values and the analysis of the intra-rater and interrater reliability, the results of this study should be interpreted with caution.

References

1. Silva NCM, Castro HA, Carvalho LC, Chaves ÉCL, Ruela LO, Iunes DH. Reliability of Infrared Thermography Images in the Analysis of the Plantar Surface Temperature in Diabetes Mellitus. Journal of Chiropractic Medicine. 2018;17(1):30-5.

2. Lawson RN. Implications of surface temperatures in the diagnosis of breast cancer. Can. Med. Assoc. J. 1956. 75: 309-310.

3. Brånemark P-I, Fagerberg S-E, Langer L, Säve-Söderbergh J. Infrared thermography in diabetes mellitus a preliminary study. Diabetologia. 1967;3(6):529-32.

4. Zaproudina N, Varmavuo V, Airaksinen O, Närhi M. Reproducibility of infrared thermography measurements in healthy individuals. Physiological measurement. 2008;29(4):515.

5. Ammer K, Ring E. Standard Procedures for Infrared Imaging in Medicine. In: Diakides N, Bronzino J, editors. Medical Infrared Imaging: Principles and Practices. Boca Raton, FL: CRC Press; 2013. p. 32.1-.14.

6. Moreira DG, Costello JT, Brito CJ, Adamczyk JG, Ammer K, Bach AJE, et al. Thermographic imaging in sports and exercise medicine: A Delphi study and consensus statement on the measurement of human skin temperature. Journal of Thermal Biology. 2017;69:155-162.

7. Ammer K. Temperature readings from thermal images are less dependent on the number of pixels of the measurement area than on variation of room temperature. Thermology International. 2005;15(4):131-133.

8. Costa AC, Dibai Filho AV, Packer AC, Rodrigues-Bigaton D. Intra and inter-rater reliability of infrared image analysis of masticatory and upper trapezius muscles in women with and without temporomandibular disorder. Brazilian Journal of Physical Therapy. 2013;17(1):24-31.

9. Dibai-Filho AV, Guirro EC, Ferreira VT, Brandino HE, Vaz MM, Guirro RR. Reliability of different methodologies of infrared image analysis of myofascial trigger points in the upper trapezius muscle. Brazilian Journal of Physical Therapy. 2015; 19(2):122-128.

10. Shrout PE, Fleiss JL. Intraclass correlations: uses in assessing rater reliability. Psychological Bulletin. 1979;86(2):420-8.

11. Koo TK, Li MY. A guideline of selecting and reporting intraclass correlation coefficients for reliability research. Journal of chiropractic Medicine. 2016;15(2):155-63.

Perfusion dynamics in abdominal skin after free abdominal flap breast reconstruction using internal mammary vessels as recipient vessels. A clinical study using Dynamic Infrared Thermography*

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SUMMARY

BACKGROUND: Internal mammary vessels (IMV) are used to provide blood to the free abdominal flap in autologous breast reconstruction. Wound healing problems at the abdominal donor site cause significant morbidity to patients. We hypothesized that harvesting the IMV has a negative effect on abdominal skin perfusion.

METHODS: Examination of skin perfusion of the abdomen and thoracic wall using Dynamic Infrared Thermography in 17 patients scheduled for free abdominal flap breast reconstruction. Qualitative and quantitative analyses of the rate and pattern of recovery in Huger´s vascular zones with modifications were performed.

RESULTS: Large variability in distribution of hot spots between left and right side of the abdomen. The rate of rewarming of the abdominal skin was lower at the side where the IMV was used.

INTERPRETATION: Using IMV in free abdominal flap breast reconstruction had a significant effect on abdominal skin perfusion and may contribute to abdominal wound healing problems.

KEY WORDS: Free abdominal flap, infrared thermography, breast reconstruction

DURCHBLUTUNGSDYNAMIK DER BAUCHHAUT NACH BRUSTREKONSTRUKTION MIT EINEM FREIEN, VON DEN THORACICA INTERNA GEFÄSSEN VERSORGTEN ABDOMINALEN HAUTLAPPEN. EINE KLINISCHE STUDIE MIT DYNAMISCHER INFRAROT THERMOGRAPHIE

HINTERGRUND: Bei der autologen Brustrekonstruktion mit freien Abdominal-Lappen wird die Blutversorgung über die Thoracica interna Gefäße hergestellt. Wundheilungsprobleme an der abdominalen Entnahmestelle führen zu einer erheblichen Belastung der Patienten. Wir vermuten, dass die Entnahme des Transplantats die Durchblutung der Bauchhaut beeinträchtigt.

METHODEN: Bei 17 Patientinnen, bei denen eine Brustrekonstruktion mit freien Abdominal-Lappen vorgesehen war, wurde die Hautdurchblutung der Bauch- und der Thoraxwand mittels dynamischer Infrarot-Thermographie untersucht. Die Geschwindigkeit und die Wiederherstellung der Durchblutung im Sinne modifizierter-Gefäßzonen nach Huger wurden qualitativ und quantitativ analysiert.

ERGEBNISSE: Es fand sich eine große Variabilität in der Verteilung von Hot Spots zwischen der linken und rechten Seite des Bauches. Die Wiedererwärmung der Bauchhaut war an der Seite der Transplantatentnahme verlangsamt.

INTERPRETATION: Die Entnahme von Bauchhautlappen, die von den Thoracica interna Gefäßen versorgt werden, verändern die Durchblutung der Bauchhaut im signifikanten Ausmaß und das kann zu Wundheilungsstörungen beitragen.

SCHLÜSSELWÖRTER: Freier Bauchhautlappen, Infrarotthermographie, Brustrekonstruktion

Thermology international 2018, 28(4)194-196

Introduction

Breast reconstruction with a free abdominal flap after breast cancer surgery has become increasingly popular. The internal mammary vessels, IMV, are used to provide blood to the free flap after its transfer from the abdomen to the thoracic wall. Wound healing problems at the abdominal donor site in free abdominal flap breast reconstruction cause significant morbidity to patients. No studies have investigated what impact the use of the internal mammary artery in free abdominal flap breast reconstruction has on abdominal skin perfusion.

Method

17 patients scheduled for free abdominal breast reconstruction were included in this study. Skin perfusion on the abdomen and thoracic wall was examined pre-, intra-, and postoperatively with the use of Dynamic Infrared Thermography (DIRT). The abdomen and anterior thorax were after an acclimatization period of 10 minutes exposed to a mild cold challenge. An infrared (IR) camera was positioned ca 1.0 m directly above the exposed anterior thorax and abdomen. This camera can produce sequences of high definition digital IR images with an accuracy of 0.1°C.

* This article is based on a poster presentation at the EAT2018-Conference, at NPL, London Teddington in July 2018

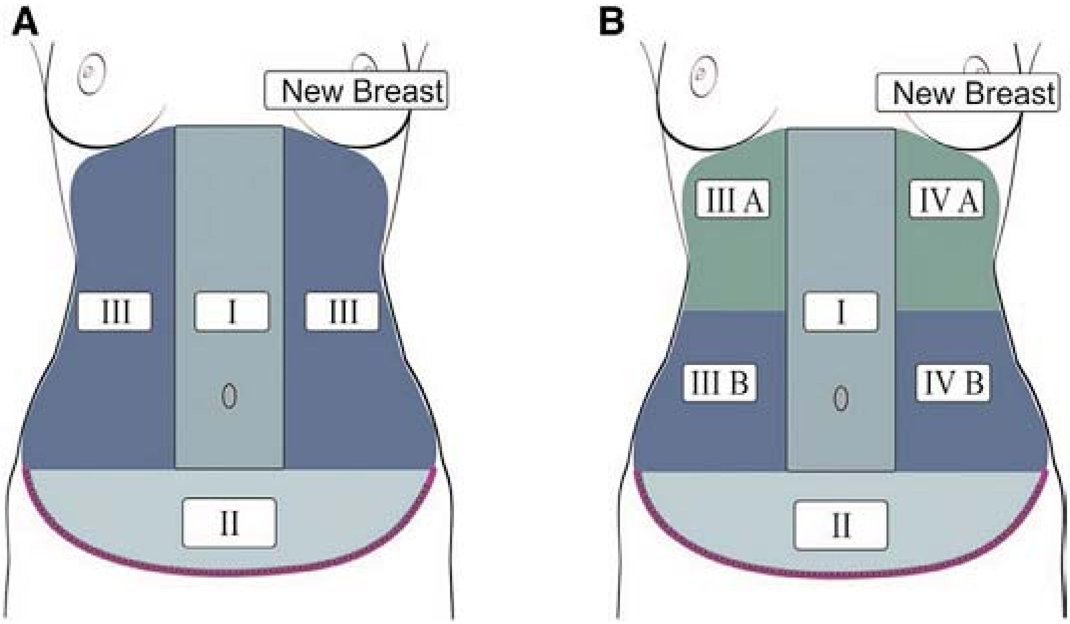

Figure 1
A : Illustration of Huger's vascular zones of the abdominal wall. B: Modification of Huger's vascular zones; zone III on the side where the IMV are harvested is numbered zone IV. Zone III and IV are subdivided into upper halves (subzones IIIA and IVA) and lower halves (subzones IIIB and IVB), respectively. Zone III is the reference zone.

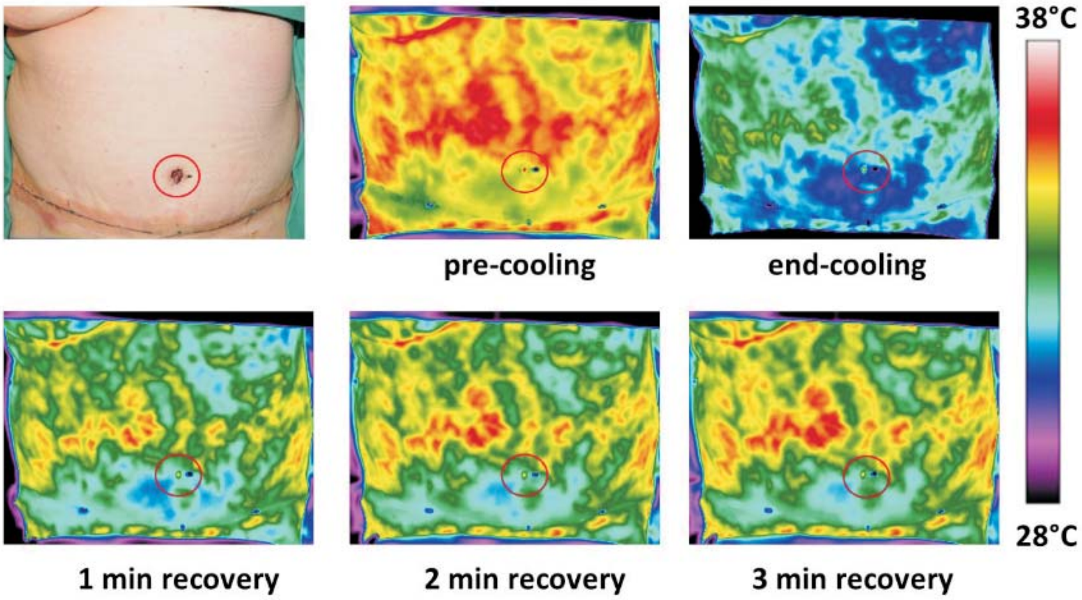

Figure 2
Day 1 post-operative photo and DIRT images of the abdominal wall before and after a cold challenge. The thermal images during the rewarming show the hypo-perfused area in subzone IVA (upper left) caudal to the reconstructed breast as well as in zone II (above the transverse suture line). Skin perfusion is clearly best on the patient's right side (zone III). The red circle indicates the position of the navel.

Thermal emissivity was set to 0.98, and the accuracy of the camera was regularly checked against a black body with a traceable temperature source. IR images were taken at regular intervals to register the rate and pattern of skin rewarming for 3 minutes after a mild cold challenge. The pre- and postoperative images were taken in a dedicated laboratory (room temperature: 21-23°C). The thermal challenge was delivered by blowing air at room temperature over the skin surface for 2 minutes with a desktop fan. The intraoperative examination was performed with the patient in anesthesia just before and at the end of surgery. The intraoperative thermal cold challenge was performed by washing the thorax and abdomen evenly for 1 minute with gauze soaked in saline at room temperature (22-23°C).

The abdomen was divided into vascular zones as defined by Huger with modifications. The lateral zone III on the side where the IMV were harvested was numbered zone IV, and zones III and IV were also subdivided into upper halves and lower halves (Fig. 1). Zone III is not involved in the surgical procedure and therefor selected as the reference zone. Each patient served as its own control. A qualitative analysis of the changes of pattern and rate of rewarming of hot spots within each zone was made and compared with the results from the other zones.

A 1-tailed t test for paired variables was used to see whether the mean temperatures of zones II and IV were lower compared with reference zone III. A 2-tailed t test of paired variables was used to see whether there was a statistically significant difference in mean zone temperatures between zone II and zone III at precooling, at end cooling, and at 1-, 2-, and 3-minute rewarming for postoperative days 1, 3, and 6. This test was also used to see whether there was a statistically significant difference between the mean temperatures of all zones together at 3-minute rewarming after cooling. Statistical significance was defined as $P < 0.05$.

Results

Qualitative analysis of the pre-, intra-, and postoperative DIRT examinations showed a large variability in distribution of hot spots between patients and between the left and right side of the abdomen. In all patients surgery caused a similar effect on abdominal and thoracic wall skin perfusion. At the end of surgery the pattern of hot spots had become less clearly visible or had disappeared in zones I, II and subzone IVA. There was a gradual increase in the number of hot spots in these zones during the postoperative days. During the first postoperative days hot spots in zone III and subzone IVB showed a hyperemic state with a more rapid rate of rewarming at the hot spot. Both the hyperemia and rate of rewarming at the hot spots in zone III and subzone IVB decreased on days 3 and 6.The rate of rewarming of the abdominal skin was lower at the side where the IMV was used, compared to the contralateral side. Postoperative abdominal skin perfusion in zone IV was always significantly reduced compared with zone III. The difference between zones II and III was statistically significant for day 1 and 3, but not for day 6. Hot spots were less visible at the end of the operation on the side where the IMV was used. Skin perfusion in zones II and IV increased during consecutive postoperative days with an increase of hot spots in these areas.

In general, the quantitative results reflected the qualitative findings. A statistical significant difference in mean temperatures was found between zone III (reference zone) and zone II at end cooling and at 1-, 2-, and 3-minute re- warming on days 1 and 3, but not on day 6 with zone II being cooler. The precooling showed no statistically difference between zones III and II. Analyzes for the difference of mean temperatures between zones III and IV showed a statistical significant difference on days 1, 3, and 6 for end cooling and 1, 2, and 3 minutes with zone IV being cooler.

Discussion

Using the IMV in free abdominal flap breast reconstruction had a significant effect on abdominal skin perfusion and may contribute to abdominal wound healing problems. These wound problems occur at the center of the lower incision line. This area corresponded very well with the area with the lower perfusion during the postoperative days. The reperfusion of the abdominal skin was a dynamic process showing an increase in perfusion in the affected areas during the postoperative days. Huger's vascular zones and the angiosome theory can explain these changes in skin perfusion. The IMA has its own angiosome and divides at the sixth intercostal space into the superior epigastric artery (SEA) and musculophrenic artery (MPA). In free abdominal flap breast reconstruction, the IMA is transected at the third or fourth intercostal space. As a result, blood perfusion to the IMA angiosome distal to this level and to the angiosomes of the SEA and MPA becomes drastically reduced. Perforators no longer transport blood to the skin. As a result, hot spots disappear and the affected zones becomes hypo-perfused. Hot spots reappeared in zones I, II and subzone IVA during the postoperative period. Perforators of the angiosomes incorporated in zones I and II are no longer perfused by their source vessels because of undermining of the abdominoplasty flap but depend for their perfusion on the source vessels of adjacent angiosomes. We anticipate that the changes in hyperemia are a result of a redistribution of blood flow after an increase in the diameter of choke vessel lumen in the subcutaneous tissue and skin. This study provides for the first time, scientific information on the impact free abdominal flap breast reconstruction using IMV has on abdominal skin perfusion. DIRT showed in vivo the reperfusion of the abdominoplasty flap over time as a dynamic process.

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References

Mirzabeigi MN, Wilson AJ, Fischer JP, et al. Predicting and managing donor-site wound complications in abdominally based free flap breast reconstruction: improved outcomes with early re-op erative closure. Plast Reconstr Surg. 2015; 135:14-23

Zetterman E, Salmi A, Suominen S, et al. Effect of cooling and warming on thermographic imaging of the perforating vessels of the abdomen. Eur J Plast Surg. 1999;22:58-61

De Weerd L, Mercer JB, Weum S. Dynamic infrared thermography. Toolbox for autologous breast reconstruction. Clin Plast Surg. 2011; 38:277-292

Chubb DP, Taylor GI, Ashton MW. True and 'choke' anastomoses between perforator angiosomes: part II. Dynamic thermo- graphic identification. Plast Reconstr Surg. 2013; 132: 1457-1464

Mayr M, Holm C, Höfter E, et al. Effects of aesthetic abdominoplasty on abdominal wall perfusion: a quantitative evaluation. Plast Reconstr Surg. 2004;114:1586-1594.

Taylor GI, Palmer JH. The vascular territories (angiosomes) of the body: experimental study and clinical applications. Br J Plast Surg. 1987;40:113-141.

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Skin temperature reveals empathy in moral dilemmas: An experimental thermal infrared imaging study

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SUMMARY

The main objective of this research is to investigate the relationship between skin temperature changes, empathy and moral behaviour through the application of thermography. We recorded the skin temperature changes that occur during the presentation of one personal and one impersonal moral dilemma to high and low-empathy participants. The time needed to make this moral judgement was used as an indicator of the cognitive style of the participant: intuitive thinking (emotional) or deliberate thinking (utilitarian or logical). The main results were as follows: Large temperature changes occurred in high-empathy participants (overall in the personal dilemma) that could be understood as a skin representation of emotional judgements. These participants also tended to make non-utilitarian judgements. On the other hand, the low-empathy participants tended to make utilitarian judgements, and this study found that their change in skin temperature was almost always non-significant. The findings are discussed on an emotion-based description of moral dilemmas:

KEYWORDS: thermography, empathy, moral dilemmas, arousal, intuition

DIE HAUTTEMPERATUR WEIST BEI MORALISCHEN DILEMMATA AUF EMPATHIE HIN: EINE EXPERIMENTELLE STUDIE MIT INFRAROT -THERMOGRAPHIE

Hauptziel dieser Forschung ist es, den Zusammenhang zwischen den Temperaturschwankungen der Haut, Empathie und moralisches Verhalten mittels Thermografie zu untersuchen. Es wurden die Veränderungen der Hauttemperatur aufgezeichnet, die bei der Präsentation eines persönlichen und eines unpersönlichen moralischen Dilemmas bei Teilnehmern mit hohen und niedrigen Einfühlungsvermögen auftreten. Die Zeit, die für dieses moralische Urteil benötigt wurde, wurde als Indikator für den kognitiven Stil des Teilnehmers verstanden: Intuitives (emotionales) oder bewusstes Denken (utilitaristisch oder logisch). Die wichtigsten Ergebnisse waren: Große Temperatur- Veränderungen wurden bei hochempathischen Teilnehmern beobachtet, besonders im persönlichen Dilemma). Das könnte als die Repräsentation emotionaler Urteile an der Haut verstanden werden. Diese Teilnehmer neigten auch dazu, nicht-utilitaristische Urteile zu fällen. Auf der anderen Seite tendierten die gering-empathischen Teilnehmer dazu, utilitaristische Urteile zu fällen, und die Studie ergab, dass ihre Hauttemperaturveränderung fast immer unbedeutend war. Die Ergebnisse werden auf einer emotionsbasierten Beschreibung moralischer Dilemmata diskutiert.

SCHLÜSSELWÖRTER: Thermographie, Empathie, moralische Dilemmata, Erregung, Intuition

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Introduction

A vast number of individual interactions with the environment and other people depend on empathy [1-6]. Empathy is the ability to perceive and understand what other people are thinking and feeling, to put ourselves in the place of others and feel as they feel [7-11].

Emotions and empathy are fundamental bases of morality (12-14). In this research, we will measure empathy with the TECA scale (see Method section). In regard to moral conduct, we find ourselves with an emotional component on one hand and a rational component on the other [15-23]. Moral dilemmas are often characterised by the conflict which arises between these two responses: the rational response and the emotional response. Rational or utilitarian judgements think about the possible benefit for the majority, tend to be slow and consider a list of reasons before deciding. Emotional and intuitive judgements appear quickly in consciousness, their underlying reasons are not fully aware, and they are strong enough to act upon [24-28]. These two components are related to the cognitive style of the participants and can be measured with the Preference for Intuition and Deliberation (PID) Scale [29].

Greene distinguished two types of moral dilemmas: impersonal and personal [30]. An example of an impersonal moral dilemma is the 'trolley problem'. Imagine a runaway boxcar heading toward five people who cannot escape its path. Now imagine you had the power to reroute the boxcar onto a different track with only one person on that route. About 90% of participants pulled a switch to reroute the boxcar, suggesting people are willing to violate a moral rule if it means minimising harm.

An example of a personal moral dilemma is: imagine that you find yourself living in the Second World War with a group of neighbours. In this scenario, you are hiding in a basement because the enemy soldiers are approaching. Among this group of people, you find a mother and her baby, who starts to cry. The soldiers are going to hear the baby, enter the basement and kill everybody they find. To resolve this dilemma, you are offered two options: strangle the baby to save the rest of the group or let the baby cry and allow the soldiers to enter.

The impersonal dilemma is presented when the action must be performed over an inanimate object; the tendency of the participant is to give a utilitarian response. For those exposed to personal dilemmas, the result of carrying out an action on an animate object (for example, a human being) tends to be non-utilitarian. In general, and given the characteristics already described, we expect that people with low empathy tend to express utilitarian judgements and a rational cognitive style, while those who possess high levels of empathy express non-utilitarian judgements and an intuitive cognitive style [26,31].

It has been observed that changes in temperature on the surface of the human body are correlated with empathy [32]. Infrared thermography measures emitted radiation, which can be used to calculate temperature[33]. This may serve to evaluate emotions and understand the emotional attachment involved. Emotions are frequently perceived in the body and face, where they are associated with physiological changes that are provoked by mental states [34-37].

Valence, defined as the intrinsic attractiveness (positive valence) or aversiveness (negative valence) of an event, object, or situation, and arousal are associated with the temperature response in the face. High face temperature has been observed in study participants who were exposed to positive International Affective Picture System (IAPS) (38) images and low face temperature for negative IAPS images (32). Under high arousal the face temperature increased with positive and negative IAPS images [32, 39-42]. Most of these temperature changes have been measured in the face (nose, forehead) [42]. However, based exclusively on facial regions of interest (ROIs), it is impossible to discriminate fear, stress, lying or guilt [35]. For example, decreases in nose temperature were found with both pleasant (joy) and unpleasant (disgust, fear, anger, sadness) information [35,44,45]. The temperature changes of the nose are nonspecific for negative or positive valences. Other established markers of the balance within the autonomous nerve system must complement the measurement of facial temperature to improve the discrimination of emotions. It is currently unknown, whether skin temperature measurements in other body parts bear information which is equivalent to that derived from heart rate variability or skin conductance. In an unpublished pilot study, a different development of skin temperature of the face and the trunk was observed after exposure to various emotional stimuli.

The lower face temperature has been related to stress and increased sympathetic activity. However, in other studies, high arousal has been associated with increased face temperature in the case of negative emotions, lie detection, mental effort, crying, ostracism or direct gaze [41,42,45,46]. Different authors frequently related this thermal effect (the augmented face temperature) to a complex autonomic interaction between the sympathetic and the parasympathetic nervous systems or to residual effects probably due to a withdrawal of the sympathetic alpha-adrenergic vasoconstriction effect [43,45,47,48].

The experimental hypothesis is that when individuals are exposed to a personal moral dilemma, the skin temperature would change more in people with high empathy compared to people with low empathy. Furthermore, it is supposed that the skin temperature changes would be more pronounced for personal dilemmas than impersonal dilemmas.

In line with that, high-empathy people would respond in an emotional or intuitive way, whereas low-empathy people would respond in a selfish mode following the economic theory [49]. We expected that the participants with high empathy would take less time to respond and choose the option of not killing the baby, different and opposite to low-empathy participants, who usually make their frequent decisions slowly and an anticipated preference for the killing option. For impersonal dilemmas, we expected more utilitarian decisions for both groups of participants and less differences in skin temperature changes.

Method

Participants

The participants consisted of university students, 20 women and 20 men between the ages of 18 and 34 years. All interested participants were instructed to read a brief description of this research project; we obtained written informed consent from each participant. After that, each participant answered a series of medical and biographical items to ensure that they were in good health and not taking medication or drugs that could interfere with the examination results. From a pool of 120 possible participants, 40 subjects were selected in accordance with their score in TECA (Cognitive and Affective Empathy Test) [50]: 20 who scored above the 70th percentile, and 20 who scored below 30th percentile.

Materials

A ThermoVision A320G infrared camera, with a potential sensitivity of 0.07 to 30 ºC between successive readings and adequate high resolution for human research and medical thermography, was used. This camera offers different palettes. We used the medical palette, named for its use in medical thermography, which gives a clearer view of temperature changes. The automatic focus on the camera was used each time.

To capture the signal, a laptop PC with the programme ThermaCAM Researcher 2.9 (by FLIR manufacturer) was used. This software allows for continuous recording during the measurement of each condition, with an interval of 8 frames per second.

Procedures

The measures were performed at the same time of day for all participants [51]. The experiment took place in a tested thermographic laboratory [52,53] in an enclosed room of approximately 40 m² with one designated space for people to change their clothes. The thermographic camera, computer and researcher were situated in the centre of the room in front of the participant.

The protocol for taking measurements using thermographic cameras [52-54] that we followed for this study demands a specific preparation to obtain adequate recordings. The area of the skin that is going to be imaged must not be covered by any material. In this way, thermography can capture images that accurately reflect temperature. Before the recording, the participants should sit or stand still for 10 min for allowing their skin temperature to adapt to the ambient temperature (of 22 ºC in this study).

The camera was placed on a tripod 110 cm above the ground, and 2 m from the participants. The camera angle was adjusted to capture the entire body of the participants, including the face and the upper and lower parts of the body. Each recording was performed on the front portion of the body.

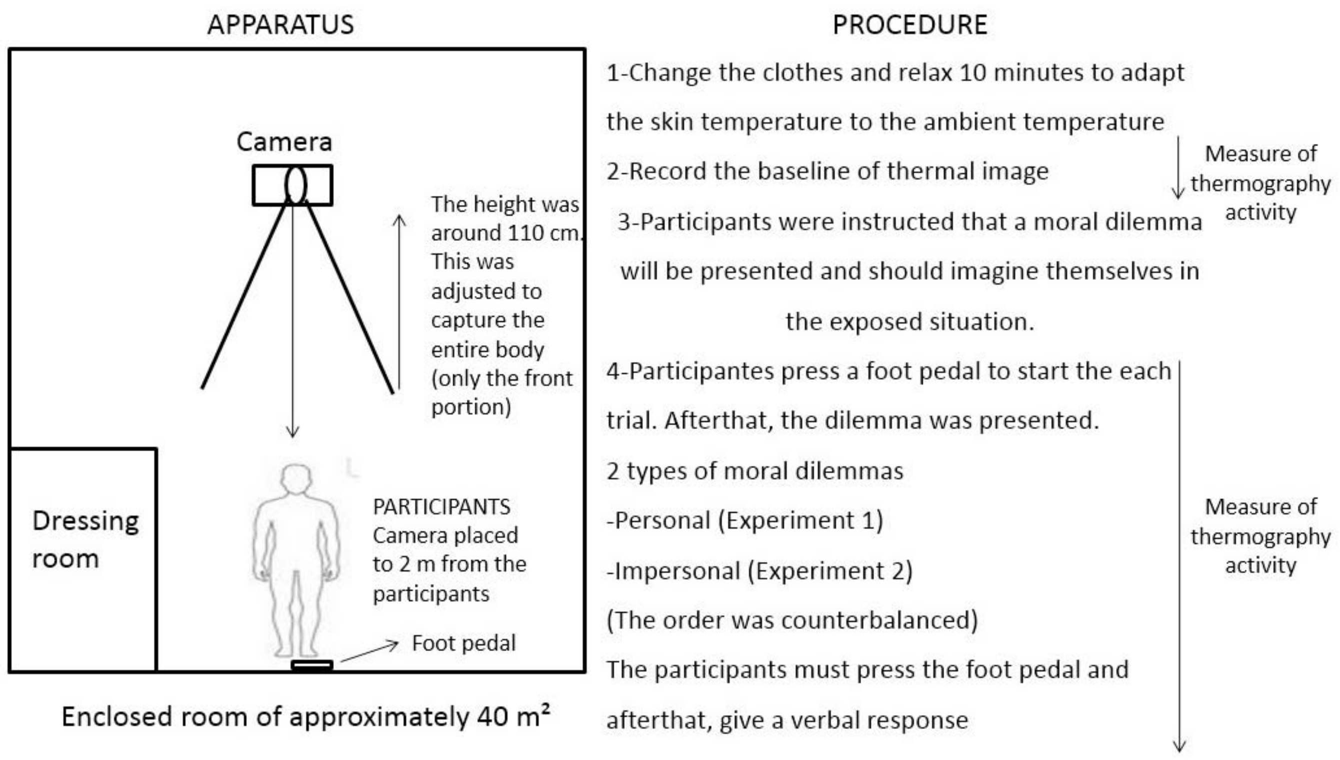
In accordance with the procedure for image recoding (see Figure 1), the participants were asked to put on bathing suits after they entered the dressing room and were instructed to remain seated and relax for 10 min in the prepared room. Next, the experiment was carried out in participants wearing shorts and bras. Then the researcher recorded a baseline thermal image, which showed an initial skin temperature distribution of the total body before the participant knew the dilemma. After this, the participants were told that a moral dilemma would be presented, and they were asked to imagine themselves in the exposed situation. They were also instructed to indicate their readiness to provide their verbal response by pressing a small foot pedal with the right foot. Then the dilemma was presented, and the participants were asked to make their decision on it. The researcher recorded thermal images during the whole test: one image while the participant was listening to the dilemma and thinking about it, followed by an image of the participant pressing the foot pedal with the right foot and a final image when giving a verbal response. The entire test lasted in total for 5 min.

The stimuli were the exposure to two moral dilemmas: a personal (experiment 1) dilemma and an impersonal (experiment 2) dilemma (i.e. the personal dilemma of the baby and the impersonal trolley dilemma, explained previously in the introduction). Both dilemmas were offered to participants in a counterbalanced fashion (i.e. half of the participants received the personal dilemma first, and the other half received the impersonal dilemma first).

Measures

Regarding temperature measurements, to guarantee consistent definition of ROIs, we defined in all thermograms of each participant the same polygonal shape for each region of interest but adapted them to the participant's individual body configuration (see Figure 2). We employed a

Figure 1.
Left panel: experimental setup. Right panel: sequence of events in the procedure.



semi-automated procedure for ROIs location and area size (pixels): A Matlab algorithm designed by us. It draws on the thermogram a square/rectangle ROI of the height and width previously indicated around the pixel selected manually by the analyzer. The ROI location bias was estimated from the distance between the pixels selected by the analyzers for the same ROI and it was computed like percentage of non overlap between the two versions of each ROI. All participants served as their own control for their ROIs (i.e., their ROIs were compared individually). Thus, it was necessary to maintain the same body position across conditions.

The TECA test [50] measures the features empathy in four subcategories: the adoption of perspectives (AP; i.e. the ability to put ourselves in the place of another person); emotional comprehension (EC; i.e. the ability to understand the emotions, intentions and impressions of others); empathetic stress (ES; i.e. the ability to be in tune with the negative emotions of others); and empathetic happiness (EH; i.e. the ability to feel the positive emotions of other people).

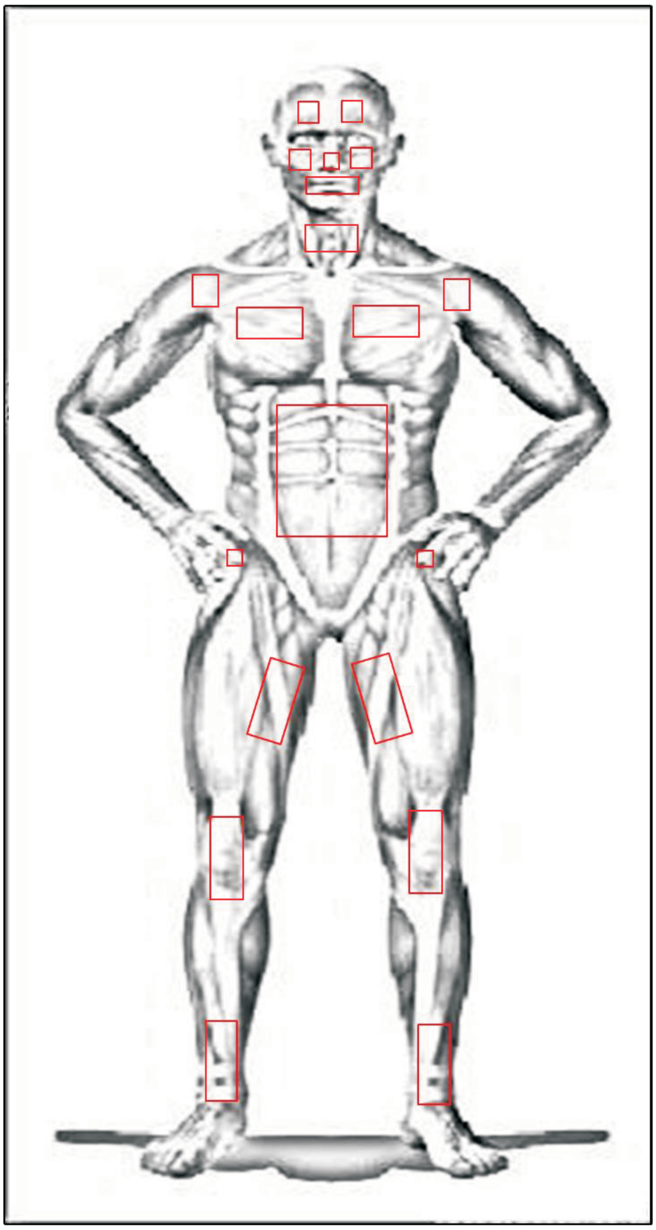


Figure 2
Scheme of ROIs for forehead, tip of the nose, cheeks, mouth, neck, shoulders, chest, abdomen, tips of the middle fingers, inner thighs, knees and calves.

The PID scale [29] consists of two subscales (PID deliberation and PID intuition). Respondents are divided into four groups: deliberative (above the mean in deliberation, below the mean in intuition); intuitive (vice versa), indifferent (both below the mean in deliberation and intuition) and mixed (above the mean in both subscales).

We measured participants' anxiety levels with the State-Trait Anxiety Inventory (STAI) [55] during baseline and after the dilemma.

The PID and TECA scales were administered at the beginning of the session.

Statistical Analysis

The data analyses were performed with the Stata v14.1 statistical software. A univariate analysis was performed to estimate central tendency and dispersion statistics for the quantitative variables. The univariate normality was analysed through the Shapiro-Wilks test. Since most of the variables fulfilled the assumption of normality, parametric tests were used.

Student's t-test was used to compare mean temperatures of ROIs, scores of the PID scale and STAI response time in making the decision between of high and low empathy groups. Deliberative thinking was correlated with empathy, thermal change in the torso and the time of response and time of response and the type of response through Pearson's r. All statistical tests considered a statistical significance of $p < 0.05$; all p values reflect 2-tailed statistical tests.

Two researchers, who were blind to the purpose of the study and independent of each other, gave the instruction about size, shape and position of the ROIs. The segmentation and data collection (mean, standard deviation, maximum and minimum for each ROI) were compared to ensure the repeatability of the ROIs. Statistical analyses were performed independently by two other researchers, each one working with one of the two data files and on the different descriptive statistics, obtaining the same general pattern of results. We analysed and compared congruency of results for maximum, minimum and mean values of each ROI [56]. The interrater reliability of ROIs was estimated with Reliability Coefficient Alpha to assure data consistency.

Results

We found a significant difference with respect to the scores of the TECA. The 20 participants with low levels of empathy had always lower scores than those with high levels of empathy in three out of four subcategories, and in the overall score. The scores were equal between groups only in the subcategory of emotional comprehension (see Table 1).

Table 1
Differences Between High-Empathy (HE) Group and Low-Empathy (LE) Group in TECA Scores

TECA	HE	LE	*t*(39)	*p*
AP	40	20	38.37	0.0001
EC	39	38	1.35	0.3637
ES	31	23	16.43	0.0012
EH	36	33	6.32	0.0369
Global	146	124	41.52	0.0001

The Cognitive and Affective Empathy Test (TECA) is from López-Pérez et al. (2008).

Table 2
Correlation Between Cognitive Style (Intuitive Scale) and Empathy (TECA Subscales)

TECA	r_{xy}	p
EC	0.440	0.028
ES	0.602	0.001
EH	0.389	0.054
Global	0.563	0.003

The Preference for Intuition and Deliberation Scale (PID) is from Betsch and Kunz (2008).
The Cognitive and Affective Empathy Test (TECA) is from López-Pérez et al. (2008).
EC = emotional comprehension; ES = empathetic stress; EH = empathetic happiness.

The high-empathy group achieved mean scores (with standard deviations in parentheses) of 36 (5) and 41 (6) points in the both subscales of the PID scale, deliberation and intuition. The results were 40 (6) and 28 (4) for the low-empathy group. Scores in the intuition scale were significantly different between groups, t = 3.85, p < 0.01.

We detected a significant correlation between the score of intuitive thinking and TECA scores (table 2) in the high empathy group. The correlation between deliberative thinking scale and empathy measures was not significant for all TECA scales, with rxy = 0.137, p > 0.05 in the best case. In short, intuitive thinking and emotional empathy was significantly associated in high-empathy participants.

Results for the Personal Dilemma

With respect to the Spielberger Question of Anxiety Characteristic-State (STAI), we did not find significant differences between both groups, t = 1.05, p > 0.01. At the end of the session, the state anxiety score was 27 (4) in the high-empathy group, and 23 (5) in the low-empathy group.

Regarding the time it took the participants to decision, we found that the difference between the two groups was significant, t = 3.05, p < 0.01. The average decision time taken by the participants with low empathy was less than those with high empathy: 32 (8) s versus 46 (9) s.

The notice that participants decided to sacrifice the baby to divert harm from the group was defined as utilitarian response. With respect to the type of response, 16 participants of the low-empathy group said they would sacrifice the baby, but only five people selected the utilitarian response in the high-empathy group.

In relation to the affirmative response of killing the baby, we found that those with high empathy needed much more time than the low-empathy participants in making the decision: 70 (12) s versus 32 (13) s, t = 8.15, p < 0.01. In case the responded not to sacrifice the baby, the time to decision was almost the same in the high- and the low-empathy group: 35 s versus 33 s, t = 5.03, p >0.01.

In summary, we proposed that in general, the participants with high empathy would be faster or more intuitive in selecting the not-utilitarian response. Contrary to this, they would be slower and more deliberate in selecting the utilitarian response. When we compared their answers of yes or no, they were faster in deciding not to kill the baby, t = 2.63, p < 0.01, which was the main response. For those who selected the utilitarian response, after inhibiting their intuitive tendency to say no, this occurred after a long period of rationalisation. Those with low empathy took the same amount of time to respond yes or no, and in the end tend to select the utilitarian response.

With respect to thermography, the interrater reliability of ROIs (Cronbach's alpha coefficient for each ROI) was between 0.94 (lower value) and 0.99 (higher value). The congruency between the results of the standard deviation and mean temperature for each ROI was high between the two analyzers, with Cohen´s delta (57) between 0.1 and 0.3 what means an overlapping from 79% to 93%.

Baseline temperature readings of all ROIs were not significantly different between high and low-empathy participants (Table 3) except for cheeks and mouth (higher temperature for the Low Empathy group), and for chest and knees (lower temperature for the Low Empathy group). However, the difference between groups was significant for all ROIs (except for knees) after exposing them to the dilemma (just after the response of the participants), see Table 3.

Regarding the face, the observed thermal changes were as follows: in high empathy participants the temperature increased with respect to baseline in all analysed areas of the face by 1.7°C (t = 6.03, p <0.001); by 2.1°C (t = 5.99, p <0 .001) at the tip of the nose; by 2.0°C (t = 3.12, p <0.005) at cheeks and by 2.0°C (t = 4.05, p <0.001) around the mouth. At the trunk, the temperature decreased in the region neck by 0.6°C (t = 1.15, p = 0.153), by 1.1°C (t = 3.28, p <0.005) at the shoulder, by -1.2°C (t = 3.76, p <0.001) at the chest

Table 3
Thermal Differences between Groups in base line Condition and 'After Personal Dilemma' Condition

Region of Interest			baseline		HE/LE comparison	After dilemma		Change (baseline minus dilemma)		Comparison changeHE/ changeLE
Region	Area size (pixels): height x width	Bias of area location (pixel):percentage of non overlap	HE	LE	p	HE	LE	HE	LE	p
Forehead	5x5 (each side)	20%	34.7 (0.8)	34.9 (0.8)	0.40	35.4 (0.8)	35.0 (0.5)	+0.7	+0.1	0.04
Tip of the nose	3x3	1%	32.5 (0.5)	32.4 (0.9)	0.60	34.6 (1.0)	31.5 (1.6)	+2,1	-0.9	0.00001
Cheeks	5x5 (each side)	4%	32.5 (1.1)	33.1 (0.7)	0.04	34.5 (0.6)	34.0 (0.5)	+2.0	+0.9	0.001
Mouth	3x10	5%	33.5 (0.5)	34.1 (0.9)	0.04	35.5 (0.9)	34.4 (0.8)	+2.0	+0.3	0.0002
Neck	5x10	0%	35.7 (1.2)	35.3 (1.0)	0.30	35.1 (1.5)	34.4 (0.8)	-0.6	+0.3	0.005
Shoulder	5x5 (each side)	10%	35.2 (0.8)	34.9 (1.2)	0.30	34.1 (0.6)	34.8 (0.4)	-1.1	-0.1	0.0001
Upper Chest	5x15 (each side)	20%	34.6 (0.9)	33.4 (1.0)	0.002	33.4 (0.7)	32.9 (0.4)	-1.2	-0.5	0.001
Abdomen	30x25	10%	33.6 (0.9)	33.8 (0.8)	0.66	32.3 (1.0)	33.8 (0.5)	-1.3	0.0	0.0002
Middle finger	3x3 (each side)	0%	30.7 (1.3)	30.5 (2.6)	0.70	33.5 (1.2)	29.9 (2.1)	+2.8	-0.6	0.00001
Inner thighs	10x5 (each side)	2%	32.5 (1.1)	32.1 (0.7)	0.35	31.6 (1.1)	32.4 (0.9)	-0.9	+0.3	0.0003
Knees	10x5 (each side)	10%	30.9 (1.0)	30.1 (0.7)	0.0002	30.4 (0.8)	30.0 (0.7)	-0.5	-0.1	0.30
Calves	10x5 (each side)	26%	33.3 (1.3)	32.9 (1.3)	0.30	32.7 (0.7)	33.1 (1.0)	-0.6	+0.2	0.02

Participants with high empathy (HE) and low empathy (LE) for different body parts. 'After dilemma' is the thermal measure just after the response of the participants to the personal moral dilemma. For paired ROIs, left-right sides like for cheeks, the mean value of these regions in table 3 represents the average of the bilateral measurement areas

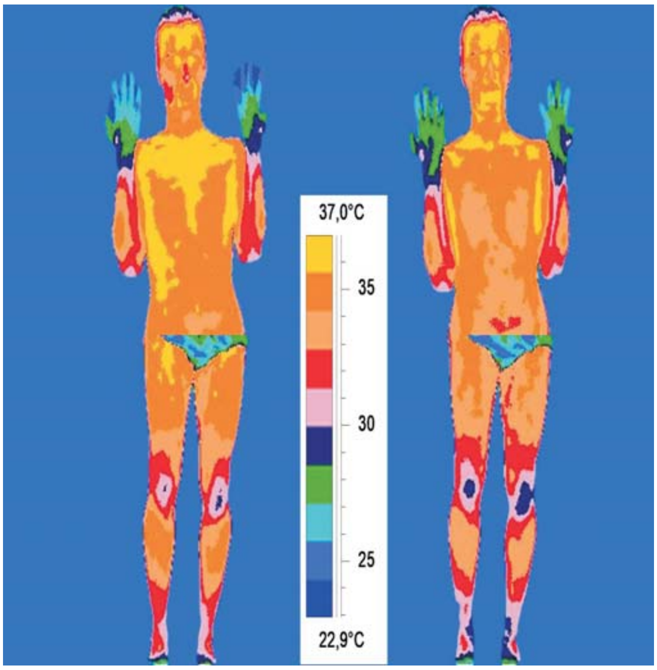


Figure 3 Thermogramsof a high empathy participant with intuitive thinking recorded at baseline (left side) and after an emotional, non-utilitarian response to a personal dilemma (right side).

and by 1.3° ($t = 8.23$, $p < 0.001$) at the abdomen. We observed those changes only in participants with high empathy (figure 3).

We obtained the following results for the hands, where the temperature increased by 2.8°C ($t = 4.57$, $p < 0.001$) for those with high empathy. The temperature changes in the legs was like those obtained at the trunk. We observed a significant decrease of 0.7°C in mean leg temperatures of high empathy participants, but non-significant changes in the legs of those with low empathy.

After hearing the dilemma, the temperature of low empathy participants decreased at the tip of the nose by 0.9°C ($t = 3.23$, $p <0.005$) and marginally in the fingers by 0.6°C ($t = 2.34$, $p <0.066$), but was slightly increased by0.3°C at the mouth. The pattern of temperature changes in the low-empathy group was similar to that observed in physical stress.

We also found significant correlations between the magnitude of the temperature decrease at the trunk and the time of response (Decision Time), $r_{xy} = -0.536$, $p < 0.001$ and

Table 4
Thermal Differences between Groups in base line Condition and 'After Impersonal Dilemma' Condition

Region of interest			baseline		HE/LE comparison	After dilemma		Change (baseline minus dilemma)		Comparison changeHE/ changeLE
Region	Area size (pixels): height x width	Bias of area location (pixel): percentage of non overlap	HE	LE	P	HE	LE	HE	LE	p
Tip of the Nose	3x3	0%	32.5 (1.0)	32.2 (0.9)	0.30	33.4 (1.1)	32.1 (1.2)	+0.9	-0.1	0.001
Mouth	3x10	10%	34.3 (1.2)	33.3 (0.8)	0.004	35.2 (1.9)	33.1 (1.0)	+0.9	-0.2	0.02
Tip of the middle finger	3x3 (each side)	0%	29.6 (0.7)	28.5 (0.5)	0.00001	32.5 (0.8)	28.8 (1.1)	+2.9	+0.3	0.00001

Participants with high empathy (HE) and low empathy (LE) for different body parts. 'After dilemma' is the thermal measure just after the response of the participants to the impersonal moral dilemma. For paired ROIs, like left-right cheeks, the mean value of these regions in table 4 represents the average of the bilateral measurement areas.

between time of response and the type of response (utilitarian or not), $r_{xy} = -0.402$, $p < 0.005$.

Results for the Impersonal Dilemma

With respect to state anxiety, the scores were 23.5 (5.5) and 25.8 (7.5) for the high and low-empathy participants at the end of the session, resulting in the differences being non-significant. The average time it took the participants to make a decision was 23 (10) s and 18 (11) s, respectively; again, the differences were not significant. In both groups, almost all participants decided to kill the innocent to save the other five persons (90% and 90%, respectively, for high and low-empathy participants).

With respect to thermography, the interrater reliability of ROIs (Cronbach's alpha coefficient for each ROI) was between 0.95 (lower value) and 0.99 (higher value). The congruency between the results of the standard deviation and mean temperature for each ROI was high between the two analyzers, with Cohen´s delta [57] between 0.0 and 0.4 what means an overlapping from 72% to 100%.

We found that chest and abdominal temperatures remained unchanged in high and low-empathy participants during the impersonal dilemma.

However, there were some significant differences between the groups. The changes occurred in baseline and 'after dilemma response' and were limited to the ROIs mouth and hands (see table 4) and also in the tip of the nose but only in the "after dilemma" condition.

In high-empathy participants, we found an increase in nose temperature (+0.9°C, $t = 4.45$, $p < 0.001$) and mouth temperature (+0.9°C, $t = 3.64$, $p < 0.001$] compared to baseline. They also exhibited higher hand temperature (+2.8°C, $t = 5.96$, $p < 0.001$) than at baseline after hearing the impersonal dilemma involving the trolley. In low-empathy participants, the mouth and fingers-hand temperature was lower at baseline but it remained equal "after dilemma" condition. We observed no other significant temperature changes in any body region of participants with low or high-empathy after they have been exposed to the impersonal dilemma.

To summarise, most participants thought it was permissible to divert a train so that it would kill one innocent person instead of five, based on simple utilitarian calculus. However, only in highly empathetic persons this decision was associated with an attenuated temperature map, which according to Salazar-López et al. [32] may be explained as arousal or valence effect.

Discussion

People with high levels of empathy presented with larger changes of temperature when exposed to a moral dilemma than people with a low level of empathy. These changes were more pronounced for personal dilemmas than for impersonal dilemmas and became obvious in the face and other body regions. Since ROIs of the face are not clearly discriminative between personal and impersonal dilemmas, temperature measurements in other body regions may improve the discrimination of physiological responses associated with decisions in moral dilemmas. In the personal dilemma, high-empathy people presented with signs of emotional or intuitive thinking, while low-empathy people showed a rational cognitive response. The participants with high empathy took less time to respond, deciding to not kill the baby, different to low-empathy participants in their slower achieved, predominant decision to kill the baby. For impersonal dilemmas, as expected, more utilitarian decisions for both groups of participants (low and high-empathy groups) and less differences in changes of skin temperature occurred.

We found two patterns of temperature changes in the personal dilemma: an increase in facial and finger temperature and a decrease in the temperature at the trunk in 80% of the high-empathy participants, and in 20% of the low-empathy participants. The other pattern can be described as increased temperature of cheeks, temperature fall at the nose and fingertip and unchanged temperatures at all other measurement sites. We interpret the increase in facial and finger temperature as an arousal or valence effect. If and how the temperature reduction at the trunk is associated with arousal or valence effects remains unclear. We named this pattern of decreased trunk temperature "visceral response", but do not claim that this observation is related to physiological function of the inner organs. For the impersonal moral dilemma, we found the assumed arousal-valence effect in 90% of the high-empathy participants (we also found a visceral response in four of these participants), and in 30% of the low-empathy participants.

In summary, we obtained a temperature map associated with an intuitive moral judgement during the solution of a personal dilemma. Temperature increase in hands and face might be the result of an arousal or valence effect similar to that obtained by Salazar-López et al. [32] with the IAPS [38]. The map also consisted of low temperature at the torso, observed only in high-empathy participants. Figure 3 shows the thermograms of a high empathy participant with intuitive thinking recorded at baseline and after an emotional, non-utilitarian response to a personal dilemma.

In the case of moral (impersonal or personal) dilemmas, the arousal-valence effect occurred in most of the high-empathy and some low-empathy participants. This means that the arousal-valence effect is not related to the type of moral dilemma or the type of response, as it occurred in both types of dilemmas and for utilitarian and non-utilitarian responses. However, the visceral response occurred almost exclusively in high-empathy participants in the personal dilemma. This could be associated with non-utilitarian responses.

This combined temperature pattern (arousal-valence effect and visceral response), shows that unlike the general adaptation response to fight or flight there is not a uniform response of the autonomic nervous system to different situations. Simultaneous occurrence of arousal-valence effect and visceral response may be called 'thermal love map' or 'empathy thermal map' which have been reported in different circumstances [31,42,44,49] and that looks like the negative image of the stress thermal map.

The results showed that participants who possessed a high level of empathy were influenced to a large extent by emotional components when they selected one of the two options provided to them in combination with the dilemma. They showed a tendency not to risk harm of other human beings. Participants with low empathy preferred rational decisions. Thereby, they opted to cause damage to another person if this meant they could save a greater number of people or if they could save themselves. Greene, Sommerville, Nystrom, Darley and Cohen [58, p. 2107] proposed that the responses to the baby dilemma are generated by the fact that these actions are 'personal', and such actions generate greater emotional engagement than 'impersonal' actions. Our results confirm that such an emotional response is associated with autonomically driven skin responses, at least in high-empathy participants. Greene et al. [57] also maintained that a crucial feature of personal acts is that they elicit strong emotions. In fact, personal dilemmas elicited an arousal-valence effect in combination with a "visceral response" in high-empathy participants, as our results showed. The activation of this specific temperature map is related to a short response time (intuitive response) and a non-utilitarian type of response.

In short, our experiment showed that thermography is a non-invasive tool to study physiological reactions associated with moral dilemmas. Further studies should compare the thermographic effects of the personal and impersonal moral dilemmas on the skin of subjects with extreme forms of personality disorders: a case of zero empathy [59]- we expect no thermal changes for both types of dilemmas; and mirror-touch synesthetes: a case of extra high empathy [60]- we expect the arousal effect plus the visceral effect even for impersonal moral dilemmas.

Conflict of interest

This manuscript is based on data also used in the doctoral dissertation of Alejandro Moliné. The authors declare no conflict of interest. This research did not receive any specific grant from funding agencies in the public, commercial or not-for-profit sectors.

Compliance with ethical standards:

All procedures performed in this research, which involve human participants, were in accordance with the ethical standards of the local institutional research committee and with the 1964 Helsinki declaration and its later amendments. This article does not contain any studies with animals performed by any of the authors. Informed consent was obtained from all individual participants included in the study.

References

1. Decety J. Dissecting the Neural Mechanisms Mediating Empathy. Emot 2011, 3(1):92-108.

2. Decety J, Svetlova M. Putting together phylogenetic and ontogenetic perspectives on empathy. Dev Cogn 2012; 2(1): 1-24.

3. Eisenberg N, Eggum ND. Empathic responding: Sympathy and personal distress. In: Decety J, Ickes W, editors. The social neuroscience of empathy. Massachusetts Institute of Technology Press; 2009. pp. 71-83.

4. Hodges SD, Klein KJK. Regulating the costs of empathy: the price of being human. J Socio Econ 2001; 30(5):437-452.

5. Rizzolatti G, Sinigaglia C. Mirrors in the Brain: How Our Minds Share Actions, Emotions, and Experience. Oxford, United Kingdom: Oxford University Press; 2008.

6. Shamay-Tsoory SG. Empathic Processing: Its Cognitive and Affective Dimensions and Neuroanatomical Basis. In: Decety J, Ickes W, editors. The Social Neuroscience of Empathy, Massachusetts Institute of Technology Press; 2009. pp. 215-232.

7. Fernández-Pinto I, López-Pérez B, Márquez M. Empatía: Medidas, teorías y aplicaciones en revisión. An Psicol 2008; 24(2):284-98.

8. Frazzetto G. Joy, Guilt, Anger, Love What Neuroscience Can-and Can't-Tell Us About How We Feel. New York, NY, US: Penguin Books; 2014.

9. Ickes W, Stinson L, Bissonnette V, Garcia S. Naturalistic social cognition: Empathic accuracy in mixed-sex dyads. J Pers Soc Psychol 1990;59(4):730-742.

10. Levenson RW, Ruef AM. Empathy: A physiological substrate. J Pers Soc Psychol, 1992;63(2):234-246.

11. Mason P, Bartal IB-A. How the social brain experiences empathy: Summary of a gathering. Soc Neurosci 2010; 5(2): 252-256.

12. Churchland PS. Braintrust: What neuroscience tells us about morality. Princeton, NJ: Princeton University Press; 2012.

13. Greene J, Haidt J. How (and where) does moral judgment work? Trends Cogn Sci 2002; 6(12):517-523.

14. Iacoboni M. Mirroring People: The New Science of How We Connect with Others. New York, NY, US: Macmillan; 2008.

15. Choe SY, Min KH. Who makes utilitarian judgments? The influences of emotions on utilitarian judgments. Judgm Decis Mak. 2011;6(7):580-592.

16. Everett JAC, Pizarro DA, Crockett MJ. Inference of trustworthiness from intuitive moral judgments. J Exp Psychol Gen 2016; 145(6):772-787.

17. Gleichgerrcht E, Young L. Low Levels of Empathic Concern Predict Utilitarian Moral Judgment. PLoS One 2013; 8(4):e60418.

18. Greene JD, Morelli SA, Lowenberg K, Nystrom LE, Cohen JD. Cognitive load selectively interferes with utilitarian moral judgment. Cognition 2008; 107(3):1144-1154.

19. Navarrete CD, McDonald MM, Mott ML, Asher B. Virtual morality: Emotion and action in a simulated three-dimensional "trolley problem". Emotion 2012;12(2):364-370.

20. Nichols S, Mallon R. Moral dilemmas and moral rules. Cognition 2006; 100(3):530-542.

21. Patil I, Cogoni C, Zangrando N, Chittaro L, Silani G. Affective basis of judgment-behavior discrepancy in virtual experiences of moral dilemmas. Soc Neurosci 2014; 9(1):94-107.

22. Robinson JS, Joel S, Plaks JE. Empathy for the group versus indifference toward the victim: Effects of anxious and avoidant attachment on moral judgment. J Exp Soc Psychol 2015; 56:139-152.

23. Wiech K, Kahane G, Shackel N, Farias M, Savulescu J, Tracey I. Cold or calculating? Reduced activity in the subgenual cingulate cortex reflects decreased emotional aversion to harming in counterintuitive utilitarian judgment. Cognition 2013; 126(3):364-372.

24. Gigerenzer G. Gut feelings: the intelligence of the unconscious. Penguin Group 2007, New York

25. Christensen JF, Gomila A. Moral dilemmas in cognitive neuroscience of moral decision-making: A principled review. Neurosci Biobehav Rev 2012; 36(4):1249-1264.

26. Kahneman D. Thinking, fast and slow. New York, NY, US: Macmillan; 2011.

27. Nichols S, Knobe J. Moral Responsibility and Determinism: The Cognitive Science of Folk Intuitions. Nous 2007; 41(4): 663-685.

28. Patil I, Melsbach J, Hennig-Fast K, Silani G. Divergent roles of autistic and alexithymic traits in utilitarian moral judgments in adults with autism. Sci Rep 2016; 6(1):23637.

29. Betsch C, Kunz JJ. Individual strategy preferences and decisional fit. J Behav Decis Mak 2008; 21(5):532-555.

30. Greene J. Moral Tribes: Emotion, Reason, and the Gap Between Us and Them. London, United Kingdom, Atlantic Books; 2014.

31. Greene JD, Nystrom LE, Engell AD, Darley JM, Cohen JD. The Neural Bases of Cognitive Conflict and Control in Moral Judgment. Neuron 2004; 44(2):389-400.

32. Salazar-López E, Domínguez E, Juárez Ramos V, de la Fuente J, Meins A, Iborra O, et al. The mental and subjective skin: Emotion, empathy, feelings and thermography. Conscious Cogn 2015; 34:149-162.

33. Clay-Warner J, Robinson DT. Infrared Thermography as a Measure of Emotion Response. Emot Rev 2015 ,25;7(2):157-62.

34. Ioannou S, Ebisch S, Aureli T, Bafunno D, Ioannides HA, Cardone D, et al. The Autonomic Signature of Guilt in Children: A Thermal Infrared Imaging Study. PLoS One 2013;8(11): e79440.

35. Ioannou S, Gallese V, Merla A. Thermal infrared imaging in psychophysiology: Potentialities and limits. Psychophysiology 2014; 51(10):951-963.

36. Nhan BR, Chau T. Classifying Affective States Using Thermal Infrared Imaging of the Human Face. IEEE Trans Biomed Eng 2010;57(4):979-987.

37. Shastri D, Merla A, Tsiamyrtzis P, Pavlidis I. Imaging Facial Signs of Neurophysiological Responses. IEEE Trans Biomed Eng 2009; 56(2):477-484.

38. Moltó J, Segarra P, López R, Esteller À, Fonfría A, Pastor MC, et al. Adaptación eapañola del "International Affective Picture System" (IAPS). Tercera parte. An Psicol 2013;29(3)153591

39. Cushman F, Gray K, Gaffey A, Mendes WB. Simulating murder: The aversion to harmful action. Emotion 2012;12(1):2-7.

40. Hahn AC, Whitehead RD, Albrecht M, Lefevre CE, Perrett DI. Hot or not? Thermal reactions to social contact. Biol Lett 2012; 8(5):864-867.

41. Ioannou S, Morris P, Mercer H, Baker M, Gallese V, Reddy V. Proximity and gaze influences facial temperature: a thermal infrared imaging study. Front Psychol 2014; 5:845

42. Panasiti MS, Cardone D, Pavone EF, Mancini A, Merla A, Aglioti SM. Thermal signatures of voluntary deception in ecological conditions. Sci Rep 2016; 6(1):35174.

43. Moliné A, Gálvez-García G, Fernández-Gómez J, De la Fuente J, Iborra O, Tornay F, et al. The Pinocchio effect and the Cold Stress Test: Lies and thermography. Psychophysiology 2017 Nov;54(11):1621-1631.

44. Kosonogov V, De Zorzi L, Honoré J, Martínez-Velázquez ES, Nandrino J-L, Martinez-Selva JM, et al. Facial thermal variations: A new marker of emotional arousal. PLoS One 2017; 12(9): e0183592

45.Ioannou S, Morris P, Terry S, Baker M, Gallese V, Reddy V. Sympathy Crying: Insights from Infrared Thermal Imaging on a Female Sample. PLoS One 2016; 11(10):e0162749.

46. Paolini D, Alparone FR, Cardone D, van Beest I, Merla A. "The face of ostracism": The impact of the social categorization on the thermal facial responses of the target and the observer. Acta Psychol (Amst) 2016; 163:65-73.

47. Ebisch SJ, Aureli T, Bafunno D, Cardone D, Romani GL, Merla A. Mother and child in synchrony: Thermal facial imprints of autonomic contagion. Biol Psychol 2012; 89(1):123-129.

48. Tyler WJ, Boasso AM, Mortimore HM, Silva RS, Charlesworth JD, Marlin MA, et al. Transdermal neuromodulation of noradrenergic activity suppresses psychophysiological and biochemical stress responses in humans. Sci Rep 2015; 5(1):13865.

49.Knight S. Using the ultimatum game to teach economic theories of relationship maintenance to A-level students. Psychol Teach Rev 2011;17(1):46-49.

50. López-Pérez B, Fernández-Pinto I, Abad FJ. TECA: Test de empatía cognitiva y afectiva [TECA: Cognitive and affective empathy test]. Madrid, Spain: TEA; 2008.

51. Marins JCB, Formenti D, Costa CMA, de Andrade Fernandes A, Sillero-Quintana M. Circadian and gender differences in skin temperature in militaries by thermography. Infrared Phys Technol 2015; 71:322-328.

52. Fernández-Cuevas I, Bouzas Marins JC, Arnáiz Lastras J, Gómez Carmona PM, Piñonosa Cano S, García-Concepción MÁ, et al. Classification of factors influencing the use of infrared thermography in humans: A review. Infrared Phys Technol 2015; 71:28-55.

53. Moreira DG, Costello JT, Brito CJ, Adamczyk JG, Ammer K, Bach AJE, et al. Thermographic imaging in sports and exercise medicine: A Delphi study and consensus statement on the measurement of human skin temperature. J Therm Biol 2017; 69:155-162.

54. Ring EFJ, Ammer K. The technique of infrared imaging in medicine. In: Ring EF, Jung A, Zuber J, eds, Infrared Imaging. A casebook in clinical medicin. IOP Publishing; 2015. p. 1.1-1.10.

55. Spielberger C, Gorsuch R, Lushene R. STAI: Cuestionario de ansiedad estado-rasgo [STAI: State-Trait Anxiety Inventory]. Madrid, Spain.: TEA; 1982.

56. Ammer K, Formenti D. Does the type of skin temperature distribution matter? (editorial). Thermol Int. 2016; 26(2):51-54.

57. Cohen, T., & Lin, M. T. (1984). Two-flask preparation of. alpha.-lithio cyclic ethers from. gamma.-and. delta.-lactones. Reductive lithiation as a route, via radical intermediates, to axial 2-lithiotetrahydropyrans and their equilibration to the equatorial isomers. Journal of the American Chemical Society, 106(4), 1130-1131.

58. Greene JD, Sommerville RB, Nystrom LE, Darley JM, Cohen JD. An fMRI Investigation of Emotional Engagement in Moral Judgment. Science 2001 293(5537):2105-2108.

59. Baron-Cohen S. Empatía cero: Nueva teoría de la crueldad [Zero degrees of empathy: A new theory of human cruelty]. Alianza, editor. Madrid, Spain; 2012.

60. Banissy MJ, Ward J. Mirror-touch synesthesia is linked with empathy. Nat Neurosci 2007; 10(7):815-816.

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Figure 1:
The National Physical Laboratory provided advanced audio-visual facilities for delegates, including Irene Diez Artigao

XIV European Association of Thermology Congress, National Physical Laboratory, Teddington, UK. 4th - 7th July 2018: Report of the meeting and post-congress survey results

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Introduction

Although summer in England does not always bring a guarantee of pleasant weather, the 84 delegates attending the XIV Congress of the European Association of Thermology (EAT) at the National Physical Laboratory in Teddington were treated to warm sunshine throughout the conference.

Figure 2
EAT President Kevin Howell opens the Congress

EAT congresses are organised every three years, and this meeting followed on from recent successes in Porto (2012) and Madrid (2015). The National Physical Laboratory (figure 1) has been the venue for a number of UK-focused clinical temperature meetings in recent years. The NPL Temperature Standards team, headed by Prof. Graham Machin, has made significant contributions to better quality assurance of clinical radiometric temperature measurements (e.g. medical thermography, tympanic ear thermometry). NPL, with its state-of-the-art conference facilities, was therefore the ideal venue to host the largest gathering of biomedical temperature scientists in the UK for some twenty years.

Scientific sessions

EAT President Kevin Howell (Royal Free Hospital, UK) welcomed delegates to the opening evening session by comparing the EAT Congress to a large sporting event such as the World Cup (figure 2). Twenty nations were represented at the Congress, with attendees from as far afield as the United States, Japan, South Korea, India and Brazil.

José González-Alonso (Brunel University, UK) then delivered the first keynote address of the meeting on the topic of "Cardiovascular and thermoregulatory responses to heat therapy" (figure 3).

Day two of the Congress began with a keynote from Graham Machin (NPL, UK) entitled "The Kelvin redefined", describing the major international effort now under way to redefine the SI unit of temperature so that uncertainties meet the needs of modern research and industry (figure 4).The ensuing session on metrology included a notable contribution from Igor Pusnik (University of Ljubljana, Slovenia) on "Size of source effect in thermal imagers."

This was a timely reminder that thermal imaging systems are limited by the quality of their optical pathways, which has implications on the minimum number of pixels that should be included in measurements if an acceptable uncertainty is to be attained (figure 5).

The meeting then turned to a session on fever and body temperature, in which Francis Ring (University of South Wales, UK) described the revision to the ISO standard for thermographs employed for human febrile screening (figure 6)

The first of two poster sessions then followed. The Kurt Ammer Prize, awarded for the best Congress poster, went this year to Erik Staffa (Masaryk University, Czech Republic)

Figure 3:
José González-Alonso

Figure 4:
Graham Machin

Figure 5:
Igor Pusnik

Figure 6:
Francis Ring

Figure 7:
Erik Staffa presents his poster

Figure 8:
Animal session chair Maria Soroko

Figure 9:
Kurt Ammer

Figure 10:
Marina Gil-Calvo

Figure 11:
Former EAT President James Mercer collects the award for best oral presentation, on behalf of Arne Johan Norheim, from current President Kevin Howell, Francis Ring, and Ismael Fernández Cuevas from ThermoHuman

Figure 12:
Mike Tompsett

Figure 13:
Dilan Dabare

for his work utilising thermography for imaging ischaemia during bowel surgery (figure 7).

After lunch, the Congress reconvened with a session on animal thermography, including a contribution from Maria Soroko (Wroclaw University of Environmental and Life Sciences, Poland) on equine veterinary applications of thermal imaging (figure 8). This was one of the larger animal sessions at an EAT Congress in recent years, and there was a real sense that interest is growing in the application of thermography in veterinary research.

The final session of the day focussed on temperature measurement in exercise and sports research. Kurt Ammer (EAT, Vienna, Austria) discussed how the recently-published "Thermal Imaging in Sports and Exercise Medicine (TISEM)" checklist could be used to improve consistency in reporting thermographic studies (figure 9). Marina Gil-Calvo (University of Valencia, Spain) discussed the effect of different foot orthoses on plantar foot temperature after a treadmill exercise (figure 10).

The second full day of the Congress began with an extensive session on thermography in the peripheral limbs. Ben Kluwe (University of South Wales, UK), Adérito Seixas (Fernando Pessoa University, Portugal), and Audrey MacDonald (Freeman Hospital, UK) all presented work on various aspects of thermal imaging to predict ulceration in the diabetic foot. This is a topic receiving growing research attention, with the possibility of home monitoring using low-cost thermal imaging devices. Arne Johan Norheim (University of Tromsø, Norway) presented data on variability in hand rewarming rates after cold challenge in Norwegian army conscripts. This was the winner of the Francis Ring award for the best Congress oral communication (figure 11).

The third and final keynote address was delivered by Mike Tompsett (formerly e2V, Bell Labs, and US Army Labs). Among his many contributions to digital imaging, Mike developed the first uncooled pyroelectric vidicon detector for thermal imaging, and he gave a fascinating overview of uncooled technology, from the early innovations to the portable and reliable devices we depend upon for thermography today (figure 12).

Dilan Dabare (University of Birmingham, UK) contributed to a session on surgical applications with a fascinating presentation discussing the possibility that thermographic measurement could be a good predictor of delayed graft function in kidney transplantation (figure 13). James Mercer (University of Tromsø, Norway) discussed how dynamic thermography could help to evaluate perfusion in lower abdomen perforator vessels, and Hisashi Usuki (Kagawa University, Japan) addressed the challenge of ensuring operating theatres are regulated at comfortable temperatures for both the patients and medical staff.

Figure 14:
Congress delegates outside the NPL building

Figure 15:
Gala Dinner at The King's Head, Teddington

Figure 16:
University of South Wales thermographic research group

Social programme

Delegates enjoyed a relaxed evening at the EAT Gala Dinner, staged at The King's Head in Teddington, just a short walk from NPL (figure 15). Over dessert, Kevin Howell paid tribute to the efforts of Francis Ring and Peter Plassmann in developing the UK's leading centre for academic thermographic research at the University of South Wales. This unit was now due to close on the retirement of Francis. Kevin, Kurt Ammer, Ricardo Vardasca (University of Porto, Portugal), Rob Simpson (NPL, UK) and Ben Kluwe (University of South Wales, UK) had all received higher degrees arising from study at this centre, and all were present for this celebration (figure 16).

The Congress closed on the morning of Saturday 7th July with a guided tour in beautfiful sunshine of historic Hampton Court Palace Palace, home of King Henry VIII, which is situated across Royal Bushy Park from the NPL building (figure 17).

Figure 17: Delegates enjoy the historic surroundings of Hampton Court Palace

EAT Short Course on Medical Thermography

Prior to the XIV Congress, on 4th July 2018, a Short Course on Medical Thermography was staged at the NPL Postgraduate Centre. The course was fully-subscribed with 12 students (figure 18), who received a full day of instruction on topics such as the principles of heat transfer, basic thermal physiology, quality assurance of thermal imaging systems, image capture and analysis, and educational resources. The teaching faculty consisted of Kurt Ammer, Ricardo Vardasca, Adérito Seixas, Manuel Sillero- Quintana, James Mercer and Rob Simpson from NPL.

An evaluation form was sent to all course participants, aiming to receive feedback that would allow the improvement of future courses. On the basis of the feedback received it is possible to state that regarding the course objectives 50% agreed, and a further 50% strongly agreed that the objectives were met. All respondents strongly agreed that the tutors were engaging, well prepared, and able to answer any questions. Regarding the presentation material 25% agreed and 75% strongly agreed that the material was relevant. When questioned about the course contents 25% agreed and 75% strongly agreed that the contents were organized and easy to follow. Concerning the pace and length of the course 25% agreed and 75% strongly agreed that the pace and length was appropriate to the content and attendees. All respondents strongly agreed that the practical session was helpful and relevant, and that the course venue was appropriate for the event. All respondents would recommend the course to colleagues.

The respondents were also asked what they considered to be most and least useful parts of the course. The balance between the theoretical and practical contents, and the talks about thermal physiology, producing a thermographic report and educational resources were all mentioned as most useful. One respondent identified the talk about physical principles of heat transfer to be the least useful.

The syllabus was also assessed by two respondents, who felt that it met their requirements.

Regarding other relevant comments, one participant said that he would like to attend a course with more advanced topics after a period of practice, and another stated that it would be good if a course could be offered covering more aspects of thermology than just infrared thermography. Another participant mentioned that it would be good to receive better course materials or a detailed transcript, since the recommended and shared literature "is good but, too extensive to dive faster into the topic". The same respondent also felt that more attention to pedagogy could have been paid to some presentations, that had slides with a lot of text, and commented on some discussions that happened between the tutors.

Summary

Both the Congress, and the associated Short Course in Medical Thermography, were accredited for CPD points from the London Royal College of Physicians. This was important recognition of the quality of the Congress scientific programme and the EAT's teaching.

Figure 18
Students and faculty of the 2018 EAT Short Course on Medical Thermography

The EAT extends its thanks to Graham Machin and Rob Simpson at the NPL Temperature Standards group for all their hard work in bringing the XIV Congress to the UK's "Home of Measurement." Thanks are also due to Roger Hughes, Veronica Luttman, and all at the NPL Events team who ensured the needs of delegates were met during the Congress.

Overall, the meeting was considered a great success, with 40 quality papers presented and 12 posters displayed at an exceptional conference venue. Key papers from the programme will now be published in a special edition of the journal Physiological Measurement, and we now look forward to the XV Congress in 2021, at a venue to be finalised next year.

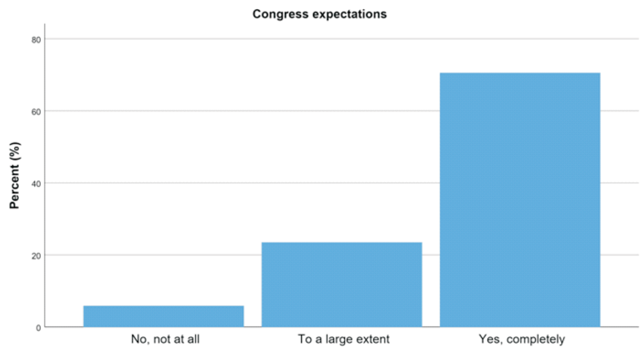

Figure 19:
Meeting the expectations of the congress delegates

Post-congress survey

To fulfil the requirements related to the CPD accreditation of the Congress, and because the EAT Board is always trying to improve the experience of Association members, a post-congress survey was conducted online.

The survey aimed to assess the views of all participants of the XIV Congress, plus EAT members that hat not attended, towards the EAT Congress, the Association in general, the content of the EAT website, and the Association journal "Thermology International."

We received 21 answers, 17 (80.9%) from congress participants and 4 (19.1%) from EAT members that had not attended the congress.

European Association of Thermology Congress

Regarding the delegates' expectations, 1 (5.9%) considered that the congress had not fulfilled his expectations at all, 4 (23.5%) considered that their expectations were met to a large extent, and 12 (70.6%) considered that their expectations were completely fulfilled (figure 19).

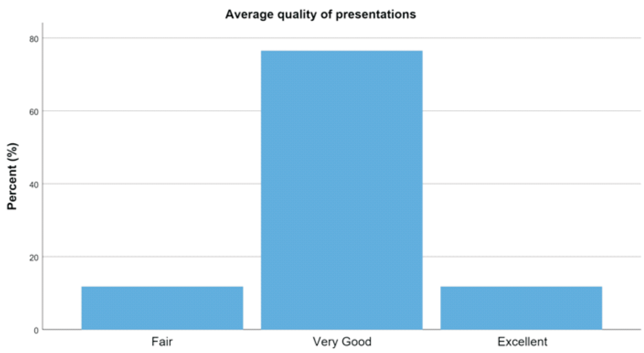

Figure 20:
Average quality of the congress presentations

Regarding the average quality of the congress presentations, 2 (11.8%) perceived the average quality as fair, 13 (76.5%) considered the average quality to be very good, and 2 (11.8%) considered the average presentation quality to be excellent (figure 20).

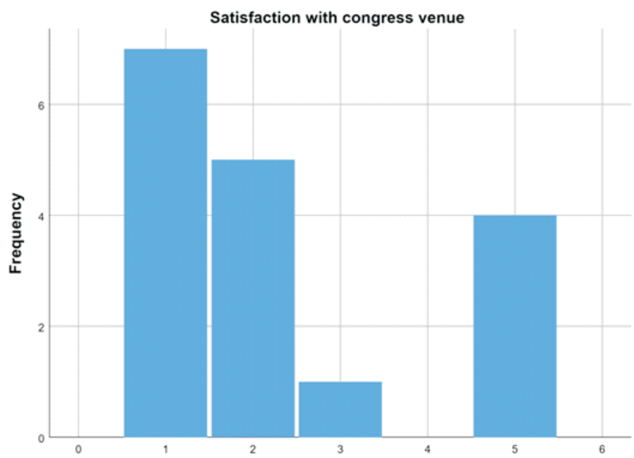

Figure 21:
Congress delegates' satisfaction of the congress venue

The satisfaction with the congress venue was also assessed, using a linear scale ranging from 1 (very satisfied) to 5 (very dissatisfied). The median value for the satisfaction with the congress venue was 2 and the mode was 1. Seven participants (41.2%) were very satisfied with the congress venue, 5 (29.4%) were somewhat satisfied, 1 (5.9%) was neither satisfied nor dissatisfied, and 4 (23.5%) were very dissatisfied (figure 21). The answers to this question deserve some reflection, since the EAT Board considered the facilities provided by the National Physical Laboratory to be exemplary. The conference centre at NPL is used to host international meetings, providing state of the art technology that allowed, for instance, electronic poster presentations for the first time in the history of the EAT Congress. The facil-

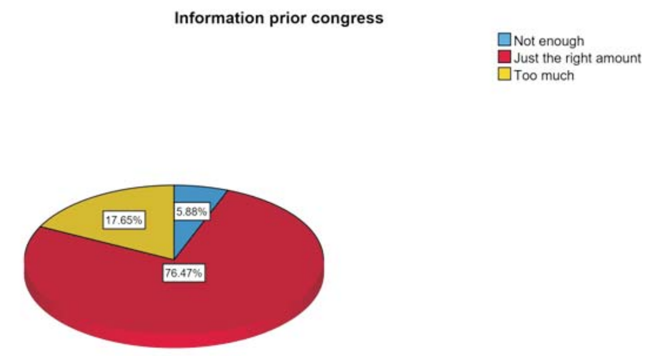

Figure 22
Amount of information received prior the congress

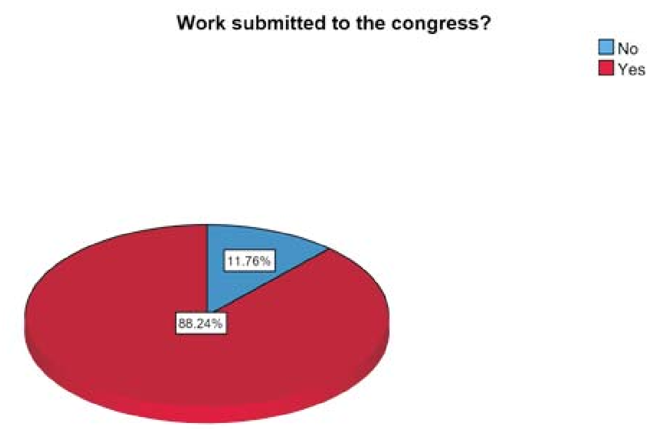

Figure 23
Work submission to the congress

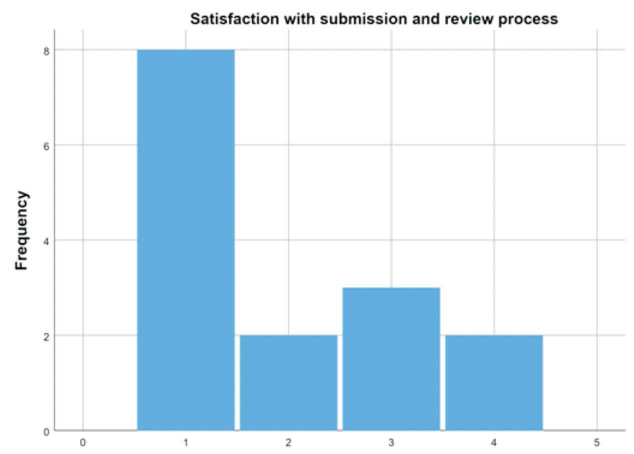

Figure 24
Overall satisfaction with the abstract submission and review process

ities are well located, easy to reach for national and international delegates and have a wide variety of hotels within walking distance.

Information was sent regularly to Congress delegates regarding the meeting programme, the venue and its location, local accommodation and other relevant aspects. One participant in the congress (5.9%) considered that the amount of information was not enough, 13 (76.5%) felt they received the right amount of information, and 3 (17.6%) considered that too much information was sent prior the congress (figure 22).

From the pool of respondents, 15 had submitted an abstract to the congress (figure 23), and from those, 8 (47.1%) were very satisfied with the abstract submission and review process, 2 (11.8%) were somewhat satisfied, 3 (17.6%) were neither satisfied nor dissatisfied and 2 (11.8%) were somewhat dissatisfied (figure 24). The median value for the satisfaction with the abstract submission and review process was 1 and the mode was 1 (very satisfied).

When asked for ideas to be implemented at the next EAT congress, 6 participants (35.3%) provided some ideas that will be analysed by the EAT Board in order to assess their viability. Some of the suggestions were: the implementation of different types of platform presentations, the implementation of a mentoring programme for abstract submissions, more clinical topics, traditional poster presentations, the implementation of a young researcher award, editing a special journal issue with all the papers presented in the congress, and the creation of an easy-to-find home page of the congress.

European Association of Thermology

From the 21 respondents, 12 (57.1%) were members of the EAT and 9 (42.9%) were not. When asked for the reasons why they had never joined the EAT, none reported the membership fee as a factor but 3 (33.3%) said that they had never been invited to join, 2 (22.2%) referred to not knowing what was available for members, 1 (11.1%) commented that he didn't know the EAT and 3 (33.3%) reported other motives for not joining the Association. One member saw no advantage in joining the EAT because accessing Thermology International and having a discount at the Congress was not important for him, another member reported that his institution was not paying for his membership and, finally, another respondent cited his non-European origin to justify not joining the EAT. These responses are important, as they suggest ways in which the EAT may be able to increase its number of members. Apparently, the membership fee is not a problem and at least some people may be waiting for an invitation to join the Association. Clearly evidencing the benefits of joining and increasing the visibility the EAT in Europe and abroad may bring new members.

When the EAT members that completed the survey were asked what they expected from the Association, all felt that the peer-reviewed journal was important, 6 (50%) identified continuous education and training opportunities as

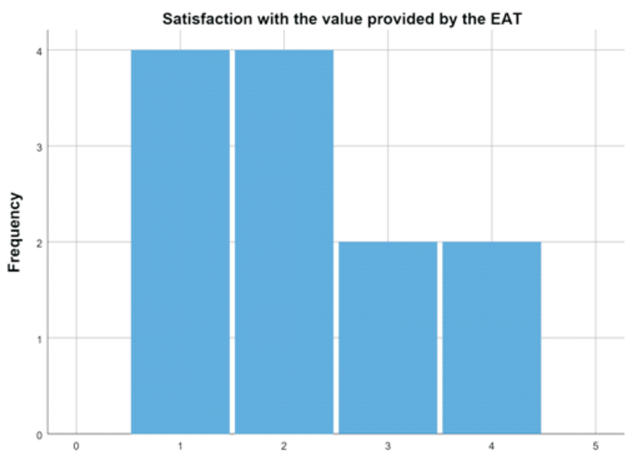

Figure 25:
Member satisfaction of the value provided by the EAT

something that should be offered, 8 (66.7%) expected publications about the latest trends and techniques in thermology, 5 (41.7%) wanted the EAT to create practice guidelines, 6 (50%) were looking for expert advice, 6 (50%) considered the website to be a key feature of the Association and 4 (33.3%) cited other requirements such as providing guidelines and/or tutorials on thermology applications, more frequent congresses, the creation of a clinical case presentation library and publishing thermology events on the website.

When asked about the satisfaction with the value provided by the EAT, 4 (33.3%) reported being very satisfied, 4 (33.3%) were somewhat satisfied, 2 (16.7%) were neither satisfied nor dissatisfied and 2 (16.7%) were somewhat dissatisfied with the value currently being provided by the EAT (figure 25).

Whilst the number of respondents who were dissatisfied with the value provided by the Association was low in absolute terms, the EAT Board will nonetheless consider all the suggestions about how we can continue to increase value to members.

When asked about suggestions to dynamize the EAT, 6 member respondents (50%) provided some ideas that will be analysed by the Board. Among these suggestions were to improve, in the short-term, the communication strategy with members and with "the outside world", to have a fully-functional and improved website with contents like guidelines and tutorials for thermal imaging applications, to organize and encourage more frequent meetings (even if in the form of online congresses, a very popular format nowadays), granting scientific sponsoring and assistance, to increase the number of publications in Thermology International, improving the journal in terms of sharing knowledge not only to members, to provide mentoring to clinicians for imaging interpretation, and to expand the scope of scientific research using infrared thermography.

European Association of Thermology Website

Regarding the EAT website(http://www.eurothermology.org), 1 member (8.3%) had not visited the new version of the website. From those who had visited (11 members; 91.7%), 4 members (44.4%) reported issues in the process. Two members reported that the website had been down, 1 member reported that the website was identified as insecure content, and another member said he could not remember the issue, but he considered the website to be uninteresting.

The members were asked to identify the web content that, in their view, would add value to EAT membership. Only 6 members (50%) identified content they were keen to see added. The suggested contents were meeting reports and photos, guidelines and tutorials for applications, a member directory (for members that approve sharing their information) which would facilitate research interaction, a list of recent publications in the field of thermography, announcements of job opportunities, a member area for information exchange, sale of cameras or software, other exclusive content review, and a nice-looking website with photos which would make people proud to be a member of the EAT.

Thermology International

The EAT members were asked if they were willing to support Thermology International becoming an open access journal, and were encouraged to present their arguments. There was no consensus on this topic: 5 members (41.7%) disagreed with the idea, whereas 7 members were in favour of Thermology International becoming an open access journal with publication costs being supported by EAT membership fees.

The arguments presented by those that disagreed with the idea were: (1) fear that it would put up fees too much, (2) the destruction of the business model of the journal, removing all possible income from past and future publications of the journal, (3) the endangering of the ongoing indexing process of the Journal by EBSCO, (4) the fact that there is already free access to the abstracts of articles and to the meeting calendar, (5) the fact that free items are often understood as items without value, (6) the fact that the journal should not be devalued by removing the already moderate subscription fee, (7) the fact that the statutes say that the publication of a scientific journal is a means of promoting thermology, but also that publications should generate income and in that sense, a free access journal reduces the financial security of the EAT, (8) misrepresentation, (9) similarly to other journals, it should only provide freely the abstracts of the articles and, finally (10) the fact that if the reader appreciates the information, he will not mind paying for access to it.

The arguments presented by those that are in favour of the idea were: (1) the fact that members already pay the journal publication fees, which means that becoming open access will just facilitate its dissemination and increase its visibility, (2) higher chance to improve impact factor, (3) the fact that science should be available to everybody, not only to members of the EAT, (4) the fact that valuable information in the journal is too limited in the publication's present form, (5) the fact that in order to make the research available to the non-thermography community, open access is imperative. Two members that agreed with the journal becoming open access presented suggestions that were not considered arguments for their answers, but nonetheless may be important contributions to the discussion: (1) the journal should apply to be indexed in more services and (2) open access journals have publication fees, and these fees could be waived only for EAT members, and should be charged to non-EAT members.

Some interesting points on both sides were provided and will be analysed by the Board.

Conclusion

In conclusion, the survey was very important in collecting feedback from members and non-members regarding the EAT's activity. This feedback will be analysed and discussed by the Board members, aiming to meet the expectations of those involved in the activity of the Association

2019

12th-14th April 2019

23th Conference of the Polish Association of Thermology Combined with the European Association of Thermology in Zakopane

Conference venue:
HYRNI Hotel, Pilsudskiego str 20, Zakopane

Abstract deadline March 15th 2019
Please send your abstract to
a.jung@spencer.com.pl or
armand.cholewka@gmail.com

Accepted abstracts will be published in Thermology International.

Accommodation (2 nights) / meals, welcome dinner 130 E per person (participant, accompanying person) will be paid in cash/credit card on arrival in hotel reception

EARLY RESERVATION FOR ACCOMMODATION before March 15th to ensure hotel reservation by email to a.jung@spencer.com.pl

Organising Committee

Prof.Armand Cholewka Ph.D, Eng

Prof.Anna Jung MD, Ph.D

Dr.Janusz Zuber MD,Ph,D

Mgr. inz. Teresa Kasprzyk MSc,Eng

Dr.Anna Kowalczyk MD,Ph.D

Scientific Committee

Dr.Kevin Howell Ph.D (UK)

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Prof.Sillero-Quintana Manuel Ph.D (SPA)

Mgr.Aderito Seixas MSc,DPT, (POR)

Dr.Ricardo Vardasca Ph.D (POR)

Prof.Armand Cholewka Ph.D,Eng (Poland)

Prof.Francis Ring Dsc (UK)

Prof.Anna Jung MD,Ph.D (Poland)

Prof.Antoni Nowakowski Ph.D, Eng (Poland)

Dr.Janusz Zuber MD,Ph.D (Poland)

Prof.Boguslaw Wiecek Ph.D, Eng (Poland)

PROGRAMME AT A GLANCE.

12th April, Friday - 7 p.m.
Welcome Dinner (HYRNY Hotel)

13th April, Saturday

9.00 - 11.00 Session I

11.00 - 11.20 Coffee break

11.20 -13.00 Session II

13.00 - 14.15 Lunch

14.30 - 16.00 Session III

16.00 - 16.15 Coffee break

16.15 - 18.00 EAT board meeting

22th - 24th July 2019

HEFAT 2019
14th International Conference on Heat Transfer, Fluid Mechanics and Thermodynamics in Wicklow, Ireland

Venue: POWERSCOURT HOTEL RESORT & SPA, Wicklow, Ireland

The conference is broad in scope and provides a forum for specialists in heat transfer, fluid mechanics and thermodynamics from all corners of the globe to present the latest progress and developments in the field. The broad scope brings together a wide range of research areas from narrow fundamental work in nanofluids to import applications such as in the broad fields of energy, manufacturing, biomedical processes, production, education, instrumentation and control, and MEMS. This will not only allow the dissemination of the state of the art, but it will serve as a catalyst for discussions on future directions and priorities in these areas. The additional purpose of this conference is to initiate collaboration in research.

PAPER ABSTRACT SUBMISSIONS
Closes: 24h00 (GMT +2) on Friday, 01 February 2019

Submission via abstract submission information at
https://www.eiseverywhere.com/eSites/349879/Homepage

Prospective authors are invited to submit an abstract online (200 to 1000 words without any figures, equations, tables, photos, references, etc.). After review and acceptance, successful authors will be informed by email and invited to submit full text papers, including tables, figures and references.

All submitted abstracts must report original, previously unpublished, research results - either experimental and/or theoretical. Articles submitted to the conference must meet these criteria and must not be under consideration for publication elsewhere.

FULL-LENGTH MANUSCRIPT SUBMISSIONS

Opens: 00h00 (GMT +2) on Thursday, 28 March 2019

Full text papers (in PDF format only) will only be considered if submitted via the online submission system. In addition, manuscripts must follow the style of the con- ference and are subject to both peer review and editing.

The full-length manuscript must be submitted as a PDF file and should be limited to a maximum length of six pages. Keynote papers are limited to a maximum length of 15 pages.

Registration Information

Registration on the website via
https://www.eiseverywhere.com/ehome/349879/752623 /?&t=37e84e64acfd67aa345e8e3046e4d5ab

The online registration portal for 14th International Conference on Heat Transfer, Fluid Mechanics and Thermodynamics is open!

Once you have completed the step-by-step online registration, you will have the option of paying immediately online using a credit card, or alternatively, to download a copy of your invoice for payment via EFT / Wire Transfer.

Please don't hesitate to contact Angus Morton should you need any assistance.

Maximum number of papers

The maximum number of papers a paying author may submit is two. Between two paying authors, four papers may be submitted. One author may submit more than two papers, but must then pay an additional 50% of the registration fee for every paper more than two.

Who must pay the registration fee?

Every delegate attending the conference must pay the conference fee (a student must pay the student fee, a retired academic must pay the retired academic fee and all other delegates must pay the fee for delegates). For every paper that is accepted and published in the conference proceedings, at least one of the authors must pay the fee. One of the authors must present the paper in person at the conference.

Payment of Conference Fees

Early payment (before or on 1 April 2019)

Delegate:€700
Student:€650
Retired academic:€650
Accompanying person:€140
(partner/friend or child to also attend the Welcome and Banquet; but not the conference)

Registration (after 1 April 2019 and not later than 22 May 2019)

Delegate:€800
Student:€750
Retired academic:€750
Accompanying person:€150
(partner or child to also attend the Welcome and Banquet; but not the conference)

Registration fee includes:

Welcome pack (delegate badge and accreditation, programme, and conference proceedings on a USB flash drive). Take note that the proceedings will be available only electronically. Only a programme booklet will be made available on paper.

Tea/Coffee breaks
Light lunch
Welcome
Awards ceremony and conference banquet.

Registration fee for accompanying persons includes:
Welcome function
Awards ceremony and conference banquet.

Welcome function (Sunday, 22 July 2019, 18:00-19:00)

Awards ceremony and conference banquet (Wednesday, 24 July 2019, 20:30-23:30)

Certificate awards will be given to the best paper of every session.

CANCELLATION POLICY

Registration Fees & Accommodation

Any cancellation received will be subject to the following refund policy:

75% of the amount paid if written cancellation is received prior to 15 May 2019

No refund if written cancellation is received on, or after 15 May 2019

TERMS, CONDITIONS AND RATES

All terms, conditions, dates and rates are subject to change (with changes to be made on the website only and without any other notifications).

Contact Information

SCHOLARLY MATTERS

For all queries pertaining to abstracts, manuscripts and the conference programme:

CONFERENCE CHAIR
Prof. Josua Meyer
University of Pretoria, South Africa
Josua.meyer@up.ac.za

ADMINISTRATIVE MATTERS
For all queries pertaining to payment of registration fees, travel, visas, accommodation and all other logistical issues:

Conference Co-ordinator
Mr. Angus Morton
africaMASSIVE; South Africa
angus@africamassive.co.za
+2782 770 3855

16th -18th October 2019

International Conference VipIMAGE 2019 - VII ECCOMAS THEMATIC CONFERENCE ON COMPUTATIONAL VISION AND MEDICAL IMAGE PROCESSING in Porto, Portugal.

Chairs: João Manuel R. S. Tavares & Renato Natal Jorge, Universidade do Porto

Venue: Axis Vermar Conference & Beach Hotel, Porto, Portugal.

Possible Topics (not limited to)

- Signal and Image Processing
- Computational Vision
- Medical Imaging
- Physics of Medical Imaging
- Tracking and Analysis of Movement
- Simulation and Modeling
- Image Acquisition
- Industrial Applications
- Shape Reconstruction
- Segmentation, Matching, Simulation
- Data Interpolation, Registration, Acquisition and Compression
- 3D Vision
- Machine Learning, Deep Learning and Big Data
- Virtual Reality
- Visual Inspection
- Software Development for Image Processing and Analysis
- Computer Aided Diagnosis, Surgery, Therapy, and Treatment
- Computational Bioimaging and Visualization
- Telemedicine Systems and Applications

Thematic Sessions

Proposals to organize Thematic Sessions under the auspicious of VipIMAGE 2019 are welcome.

Proposals for Thematic Sessions should be submitted by email to the conference co-chairs (tavares@fe.up.pt, rnatal@fe.up.pt).

Important Dates

- Deadline for Thematic Session Proposals: January 31, 2019
- Deadline for Extended Abstracts: March 31, 2019
- Authors Notification: April 30, 2019
- Deadline for Papers: June 15, 2019

Furter information at the conference website: www.fe.up.pt/vipimage