

Thermal patterns and health perceptions

John Hart, DC, MHS*
Bernard Omolo, PhD**
W.R. Boone, PhD, DC†

Introduction: Thermal pattern analysis is thought to be an indicator of health. However, the validity of this concept has not been established. To further investigate the relationship between thermal pattern analysis and health perceptions, thermal scans were assessed in conjunction with results from the SF-12 health survey.

Methods: Sixty-eight chiropractic students were recruited to receive two paraspinal thermal scans, 5 minutes apart, on three visits that were 1 week apart. Each scan produces three graphs or channels; one for each of left and right sides of the spine and a delta or difference between left and right. The scans were imported into a thermal pattern calculator (TPC) providing a percent similarity between the two. The TPC percents were compared with to their corresponding SF-12 scores.

Results: There were no significant findings in the left or delta channel. For the right channel, there was a decrease in mental health perception in participants having a TPC percent of 70.8 or higher (32.3% of all visits).

Conclusion: Participants in this study who had right channel TPC percents of 70.8 or higher were associated with lower mental health perception scores. The study is considered a preliminary inquiry only due to the small sample size.

(JCCA 2007; 51(2):106-111)

On est porté à croire que le profil thermique constitue un indicateur de la santé d'une personne. Cependant, la validité de ce concept n'a jamais été établie. Pour pousser plus loin la recherche sur le rapport entre l'analyse du profil thermique et la perception d'une bonne santé, des balayages thermiques ont été réalisés en utilisant parallèlement les résultats d'enquêtes sur la santé SF-12.

Méthodologie : Soixante-huit étudiants en chiropratique ont été recrutés pour recevoir deux balayages thermiques paradorsaux, à cinq minutes d'intervalle, au cours de trois visites espacées d'une semaine. Chaque balayage a produit trois graphiques ou canaux; un pour le côté droit et gauche de la colonne vertébrale et le delta or la différence entre la gauche et la droite. Les balayages ont été importés dans un calculateur de profil thermique (TPC), qui génère un pourcentage de similarité entre les deux. Le pourcentage du TPC a été comparé avec les résultats des SF-12 correspondants.

Résultats : On n'a pas trouvé de résultat significatif dans le canal de gauche et dans le delta. Quant au côté droit, on a observé une baisse dans la perception de la santé mentale chez le participant qui affichait un TPC de 70,8 ou plus élevé (32,3% de tous les participants ; 50% du sous-groupe).

Conclusion : Les participants à cette étude qui ont obtenu du côté droit du canal du pourcentage du TPC de 70,8 ou plus élevé étaient associés avec des résultats de perception de santé mentale moins élevé. L'étude est

* Assistant Director of Research, Sherman College of Straight Chiropractic (Spartanburg, S.C.).

** Department of Math and Computer Science, University of South Carolina – Upstate (Spartanburg, S.C.).

† Director of Research, Sherman College of Straight Chiropractic (Spartanburg, S.C.).

Contact: John Hart, DC, Sherman College of Straight Chiropractic, P.O. Box 1452, Spartanburg, SC 29304.

Email: jhart@sherman.edu Phone: 864-578-8770, ext. 232 Fax: 864-599-4858

© JCCA 2007.

KEY WORDS: Thermography, pattern analysis, SF-12, health perceptions.

Introduction

Skin temperature is primarily under the control of the autonomic nervous system¹ and can be used to assess autonomic function.² The patterning of skin temperatures, or thermal pattern analysis (TPA), is a method that purportedly assesses autonomic integrity.³⁻⁹ TPA has been used by chiropractors since the early 1940s.¹⁰ Thus, TPA is considered one assessment of the autonomic nervous system, accompanied with the concept that high levels of similarity between repeated thermal scans implies a state of poor neurological adaptability.³⁻⁹ These authors refer to this concept as *pattern theory*. Although there is debate regarding the existence and clinical significance of chiropractic subluxation,¹¹ this study does not address those issues. Rather, this is an observational report investigating the relationship between the percent agreement between repeat thermal scans and SF-12 health perceptions.

Current technologies allow temperature differentials obtained through infra-red scanning to be quantified with the use of the thermal pattern calculator (TPC) software.⁸⁻⁹ The TPC software permits scanned temperatures to be compared for percent similarity.⁹ The concept of TPA has been referred to in case reports⁴⁻⁶ and the TPC software has been used in a study on thermal equilibration.⁷

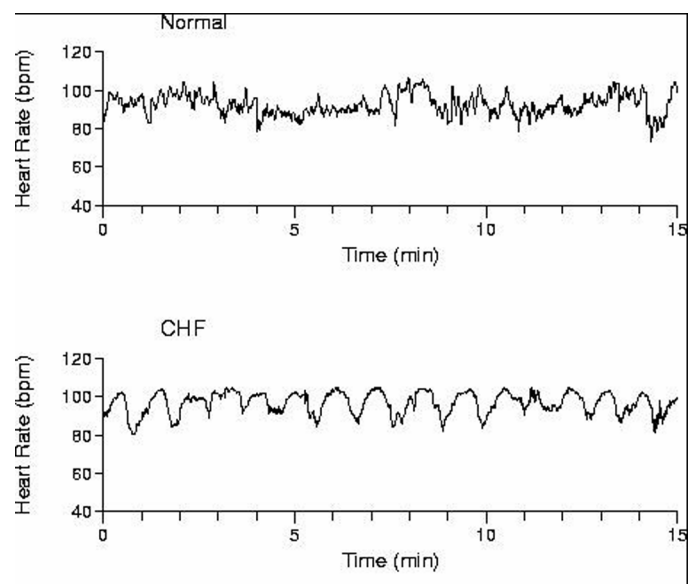
Pattern theory

The non-variability of physiological findings, particularly those under autonomic influence, has been recognized as a sign of loss of the dynamic nature of autonomic regulation. Goldberger et al. state, in regard to function of the heart, that “the healthy heartbeat displays highly complex, apparently unpredictable fluctuations even under steady-state conditions.” (Figure 1)¹² Goldberger et al. also believe that when physiological systems lose their variability, becoming more repetitive, they also become less adaptive to environmental challenges. Varela et al.¹³ note that less variation in temperature findings have “dismal prognostic implications.” Thus, the significance of a

considérée comme une recherche préliminaire seulement en raison du faible échantillon.
(JACC 2007; 51(2):106–111)

MOTS CLÉS : thermographie, analyse de modèle, SF-12, perception de la santé.

Figure 1 Normal heart rate versus pathological heart rate.¹ From Goldberger¹²



1 Note the variability with the normal heart rate versus the repeating cycles, or *pattern* shown with the person with congestive heart failure (CHF).

loss of dynamic response, substituted by repetitive patterns is consistent with the concepts of Goldberg et al.¹² and Varela et al.¹³ Thus, the non-dynamic nature of thermal readings is an indicator that the nervous system is less than optimally adaptive. It is proposed that this may have an effect on mental health, as evidenced in the present study by the decrease in mental health perceptions. Further research will be required to identify mechanisms involved when a person displays persistent neurological patterns, which appear linked adversely to the person's health perceptions. Stability of paraspinal thermal patterns depends upon a) acclimation time and b) adaptability of the person undergoing the acclimation time.⁷ The different acclimation times used in this study

(1 minute, 6 minutes, and 11 minutes) allowed for an exploration of how these times might relate to the health outcome of health perception.

Methods

The study was approved by the Sherman College Institutional Review Board (IRB). Participating students were invited from the classroom, representing a *convenience sampling method*.¹⁴ A total of 68 students volunteered to receive thermal scans on three separate visits. Participants were scanned twice on each visit. The visits were scheduled 1 week apart, within the same hour of the day, to maintain consistency with regard to circadian rhythms. Typical pattern analysis may be done with one or two days between visits but since the SF-12 asks questions about the previous one week, the scan visits were scheduled 1 week apart. The initial scan was taken approximately 1 minute after the participant's back was exposed to an ambient room temperature, between 70–75 degrees F and the second scan was obtained 5 minutes later. The initial scans are used in the present study while the second scans will be addressed in a subsequent paper. Visits 1 and 2 resulted in 68 TPC percents (from 68 participants) as did Visits 2 and 3. The total n of 136 TPC percents was statistically analyzed.

Each participant was positioned in a posture constant chair for the scanning procedure and scanned with a Tytron C-3000 digital thermographic instrument (Titronics R & D, Oxford, Iowa). Details of the scanning procedure are provided elsewhere.⁷ The scanning procedure has been found to be reliable (ICC of 0.75 and higher).¹⁵ The reliability is based on two examiners each performing two scans on 30 student volunteers.¹⁵ Each scan began at the L5 vertebral level, and ended at the occipital shelf, producing three lines, or channels. The left channel representing the left side of the spine, the right channel representing the right side of the spine, and a third center channel representing the difference (delta) between the left and right channels. The thermography scans were imported to the TPC to determine percent similarity of slope between scans. Details of the development and implementation of the TPC software have been described elsewhere⁹ (Figure 3). The procedures for TPC operations have been found to be reliable (ICC of 0.75 or higher).¹⁶ The reliability is based on three examiners assessing 30 pairs of thermal scans (from 30 student volunteers).

The SF-12 version 2, one-week recall survey (SF-12), was used to assess participants' self reported health perceptions.¹⁷ The survey instrument contains 12 questions resulting in a *Physical Composite Summary* (PCS) and *Mental Composite Summary* (MCS). Only the composite scores (PCS and MCS) were assessed in the present study, as they represented a synopsis of those items dealing with perceptions of physical and mental events. The SF-12, version 2 was selected as the survey of choice due to its short form, ease of application, and reliability. The SF-36 has been shown to capture 85% of the reliable variance in health profile. The 12-item SF-12, version 2 captures 90% of the variance of the 36-item SF-36.¹⁸ After the second scan on each visit, participants completed the SF-12 health survey. The higher the SF-12 score, the better the health perception is.

Stata/SE 8.2 was used to estimate required sample size to demonstrate a significant difference between groups (StataCorp LP, 4905 Lakeway Drive, College Station, Texas, 77845USA). It was estimated that there would be a difference of 3-points between the mean SF-12 scores, and that the standard deviation of the two groups (high TPC percent group vs the low TPC percent group) would be approximately equal. Alpha was set as two-sided 0.50 and power at 0.80. Estimated required sample size to demonstrate significance was 130 in each of the two groups. As the actual sample size in this study was considerably lower, the research project was considered to be preliminary in nature.

The Kolmogorov-Smirnov and Shapiro-Wilk statistics¹⁹ revealed that the data (TPC and SF-12) were not normally distributed ($p < 0.05$). Therefore, the data were assessed with the non-parametric tests Wilcoxon²⁰ and Spearman as these tests do not presume normal distribution. These tests were performed with the Statistical Package for the Social Sciences (SPSS v. 14, Chicago, IL) with a two-tailed significance and an alpha level of 0.05. The data were analyzed for correlation (via Spearman, of the raw data between TPC percents and SF-12 scores) and differences (via Wilcoxon). Differences were assessed by dividing the group in half and comparing SF-12 scores corresponding to higher TPC percents with SF-12 scores corresponding to lower TPC percents. If a significant correlation (with Spearman) was found, but no significant difference (with Wilcoxon) found (by dividing the group in half or into two sub-groups), further analysis involved in-

Figure 2 Highest 44 right channel TPC% rankings and corresponding mental health perception scores¹

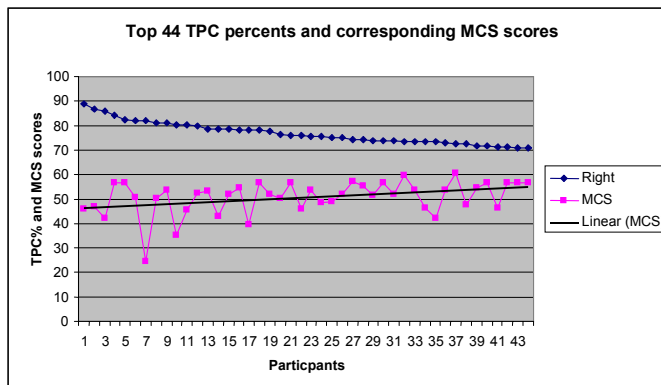


Figure 2. Raw scores for TPC% and MCS. Computer-generated trend line shows an increase (improvement) of mental health perception scores as TPC% decreases (improves). Spearman = -0.356 , $p = 0.01$. TPC% range = 70.8–89.0.

crementally assessing the data. That is, five participants were subtracted from the low end of the higher TPC percent half and five from the upper end of the lower TPC percent half until a) there was a significant difference or b) there was only 20 participants in each of the high and low TPC percent groups. In this way, more extreme ends of the TPC percent list, along with corresponding SF-12 scores, could be assessed. If a significant difference was found in incremental analysis, i.e., SF-12 scores corresponding to the highest 40 TPC percents being significantly different than SF-12 scores corresponding to the lowest 40 TPC percents, then two other procedures were followed as a method of further investigation: a) one participant was added back into the high and low ends of the TPC percent list (along with corresponding SF-12 scores) until significant differences disappeared (i.e., 41 in the high group, 41 in the low group and so on). This was done in an attempt to determine if there was a threshold or “cut-off” point where the TPC percents no longer showed differences in corresponding SF-12 scores. Once the maximum number of participants showing a significant difference was found, a correlation was performed for this sub-set.

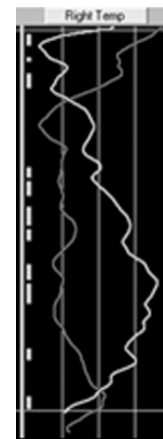
The Bonferroni adjustment of the data was a consideration in this study.²¹ However, there is opposition to the use of the Bonferroni adjustment as it imposes a greater

Figure 3 Example of high right channel TPC percent¹



1 Right channel TPC here = 89.3.

Figure 4 Example of low TPC percent¹



1 Right channel TPC here = 36.4.

probability of committing a type II error (which is a false negative, or the rejection of the research hypothesis – finding no significance difference – when the research hypothesis should be accepted),^{21–22} and as Nakagawa points out, formal consensus is lacking as to when the Bonferroni adjustment is appropriate.²² This has led to the suggestion that when the use of a Bonferroni adjustment is questionable, significant findings are best confirmed through separate studies.²³ Thus, in this study, the jury is out in terms of whether it is best to have erred in committing a type I versus a type II error. Consequently,

Table 1 Significant Correlations¹

Group	Channel / TPC percent range	Corresponding SF-12	Correlation coefficient / P-value
All visits combined (n = 136)	Right / 33.1–89.0	MCS	–0.188 / 0.02
All visits combine, highest 44 TPC%	Right / 70.8–89.0	MCS	–0.356 / 0.01

¹ TPC percents from scans taken 1 week apart and then compared to corresponding SF-12. MCS = mental composite summary. There is a slight correlation when all TPC percents are compared to the MCS and a small correlation when the highest 44 TPC percents are compared to MCS.

Table 2 Significant Differences¹

Group	Channel	# in each upper / lower TPC% group	Upper TPC% range	Lower TPC % range	Corresponding SF-12	P-value
All visits combined	Right	44	70.8–89.0	33.1–62.7	MCS	0.03

¹ TPC percents from scans taken 1 week apart and then compared to corresponding SF-12. MCS = mental composite summary. There is significant decrease in mental health perception (MCS) in the upper TPC% range (70.8–90.0) compared to the lower TPC% range (33.1–62.7), $p = 0.03$.

it is the opinion of these authors that further study will be required to confirm or refute the present findings, rather than defaulting to a statistical calculation to correct for multiple testing. Nonetheless, the present data sets were compared with and without the adjustment. The Bonferroni adjusted alpha was derived by dividing the alpha level of 0.05 by the number of tests for significance. There were 17 tests for significance, resulting in a Bonferroni-adjusted alpha of 0.002.

Results

There was a slight, significant, and inverse correlation between right channel TPC percents and mental health perception (-0.188 , $p = 0.02$, Table 1). Subsequent incremental analyses showed a significant decrease in mental health perception (corresponding mean MCS score of 50.69) in participants having the highest 44 right channel TPC percents compared to mental health perception in participants having the lowest 44 right channel TPC percents (corresponding mean MCS score of 52.97) ($p = 0.03$, Table 2). A small, significant, and inverse correlation was seen in the highest 44 right channel TPC percents and corresponding mental health perception scores ($r = -0.356$, $p = 0.01$, Table 1 and Figure 2). There were no significant findings observed for the left or the delta

channels. Figures 3 and 4 are offered as examples of TPC high and low percents.

Discussion

Limitations of the study

The most important limitation of this study is the small sample size. As mentioned in the methods section, this limitation means that the study is a preliminary inquiry only. The convenience method of recruiting these participants was not a random sample from the general population and students may not be considered as “real patients.” However, students are real people who have: a) real and varied health perceptions (as evidenced by the range of SF-12 scores) and b) real and varied skin temperature patterns (as evidenced by the range of TPC percents). Future studies however should include patients from the general population. Furthermore, the use of healthy volunteers is not unusual in clinical studies. The National Institutes of Health for example recruit approximately 3,500 healthy volunteers for clinical studies each year.²⁴

Implications

This study showed significant findings only in the right

thermal channel. It is unknown as to why the left and delta channel did not display significant findings. Nonetheless, when using 1 minute acclimated readings taken 1 week apart, decreased mental health perception can be expected to accompany right channel TPC percents of 70.8 or greater (32.3% of total visits).

Conclusion

When comparing the highest and lowest 44 TPC percents, there was a significant decrease in physical health perception seen in participants having a right channel TPC percent of 70.8 or greater. These results are preliminary but could serve as a springboard for the development of standards in the area of thermal pattern analysis. Further research is warranted, using greater sample sizes in different populations, to verify these findings.

References

- Guyton AC, Hall JE. Textbook of Medical Physiology. 9th Edition. 1996, p. 912.
- AMA Council Report. Thermography in neurological and musculoskeletal conditions. *Thermology* 1987; 2:600–607.
- Owens EF, Pennacchio VS. Operational Definitions of Vertebral Subluxation: A Case Study. *Topics in Clinical Chiropr* 2001; 8(1):40–48.
- Kessinger RC, Boneva DV. Vertigo, tinnitus, and hearing loss in the geriatric patient. *J Manipulative Physiol Ther* 2000; 23(5):359–360.
- Hart J. Skin Temperature patterns of the posterior neck used in chiropractic analysis. *Chiropractic: The Journal of Chiropractic Research and Clinical Investigation* 1991; 7(2):46–48.
- Hart JF, Boone WR. Pattern analysis of paraspinal temperatures: a descriptive report. *J Vertebral Subluxation Research* 1999–2000; 3(4):1–8.
- Hart JF, Owens EF. Stability of paraspinal thermal patterns during acclimation. *J Manipulative and Physiol Ther* 2004; 27(2):109–117.
- Stewart MS, Riffle DW, Boone WR. Computer-aided pattern analysis of temperature differentials. *J Manipulative Physiol Ther* 1989; 12(5):345–352.
- Owens EF, Stein T. Computer-aided analysis of paraspinal thermographic patterns: a technical report. *Chiropr Res J* 2000; 7(2):65–69.
- Palmer BJ. Chiropractic Clinical Controlled Research. Hammond, IN; W.B. Conkey; 1951, pp. 361–476.
- Keating JC, Charlton KH, Grod JP, Perle SM, Sikorski D, Winterstein JF. Subluxation: dogma or science? *Chiropr Osteopat* 2005; 13:17.
- Goldberger AL, Amaral LAN, Glass L, Hausdorff JM, Ivanov PCh, Mark RG, Mietus JE, Moody GB, Peng CK, Stanley HE. PhysioBank, PhysioToolkit, and PhysioNet: Components of a New Research Resource for Complex Physiologic Signals. *Circulation* 101(23):e215–e220 [Circulation Electronic Pages; <http://circ.ahajournals.org/cgi/content/full/101/23/e215>]; 2000 (June 13). Retrieved March 23, 2006 at: <http://www.physionet.org/tutorials/ndc/>
- Varela M, Calvo M, Chana M, Gomez-Mestre I, Asensio R, Galdos P. Clinical implications of temperature curve complexity in critically ill patients. *Crit Care Med* 2005; 33(12):2764–2771.
- Baumgartner TA, Strong CH, Hensley LD. Conducting and Reading Research in Health and Human Performance. New York, NY: McGraw-Hill; 2002, p. 133.
- Owens EF, Hart J, Donofrio J, Mierzejewski E, Haralambous J. Paraspinal skin temperature patterns: An interexaminer and intraexaminer reliability study. *J Manipulative Physiol Ther* 2004; 27:155–159.
- Hart J, Omolo B, Boone WR, Brown C, Ashton A. Intra- and Inter-Examiner Reliability and Comparison of Computer-Aided Methods of Thermal Pattern Analysis. *JCCA*. In press.
- Qualitymetric Health Outcomes Solutions. <http://www.qualitymetric.com/products/SFSurveys.shtml>
- Ware JE, Kosinski M, Keller S. A 12 item short form health survey: construction of scales and preliminary tests of reliability and validity. *Med Care* 1996; 34(3):220–233.
- Becker LA. Testing for Differences Between Two Groups: *t* test. Retrieved 9-7-06 at: <http://web.uccs.edu/lbecker/SPSS/ttest.htm>
- Part VI: NonParametric Analogues Overview of Non-Parametric Tests. Retrieved 9–13–06 at: <http://www.uwsp.edu/psych/cw/statmanual/npoverview.html>
- Perneger TV. What's wrong with Bonferroni adjustments. *BMJ* 1998; 316:1236–1238. Retrieved 8–2–06 at: <http://bmj.bmjournals.com/cgi/content/full/316/7139/1236?view=full&p mid=9553006>
- Nakagawa S. A farewell to Bonferroni: the problem of low statistical power and publication bias. *Behav Ecol* 2004; 15(6):1044–1045.
- Owens EF, Knutson GA. Leg length alignment asymmetry in a non-clinical population and its correlation to a decrease in general health as measured by the SF-12: A pilot study. *J Vert Sublux Res* 2004; 1–5. Retrieved 8–2–06 at: <http://www.jvsr.com/abstracts/index.asp?id=231>
- Program for healthy volunteers. National Institutes of Health. Retrieved 12–12–06 at: http://clinicalcenter.nih.gov/participate/studies/healthy_vol_prg.shtml