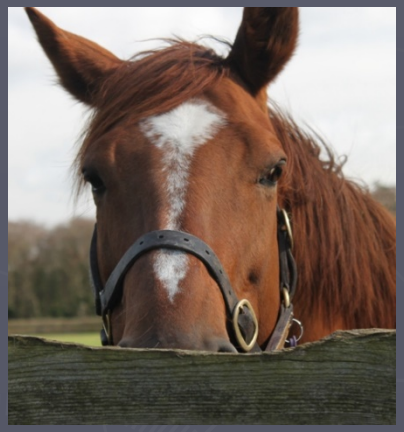
MAXIMUM EYE TEMPERATURE IN THE ASSESSMENT OF STRESS IN RACEHORSES, COMPARING THE RESULTS WITH SALIVARY CORTISOL CONCENTRATION, RECTAL TEMPERATURE AND HEART RATE



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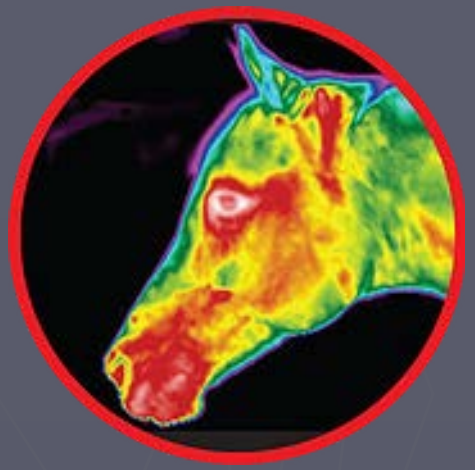
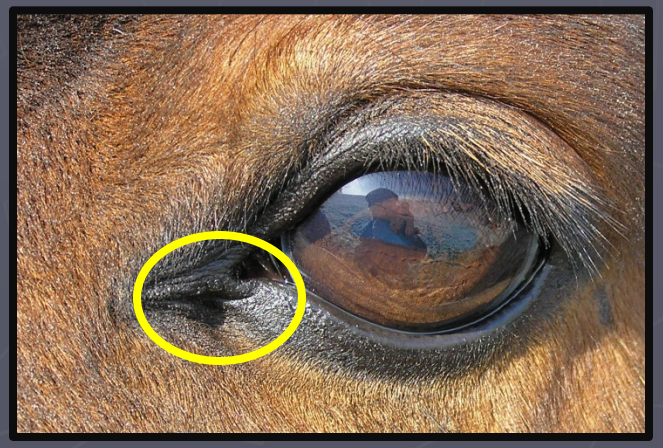
Stress in racehorses

- Detection of stress is important in young racehorses
- Extreme physical demands in early stages of racing careers
- Physiological assessment of stress
  - saliva cortisol concentration
  - heart rate
  - rectal temperature
- All of these methods require physical contact

Stress in racehorses



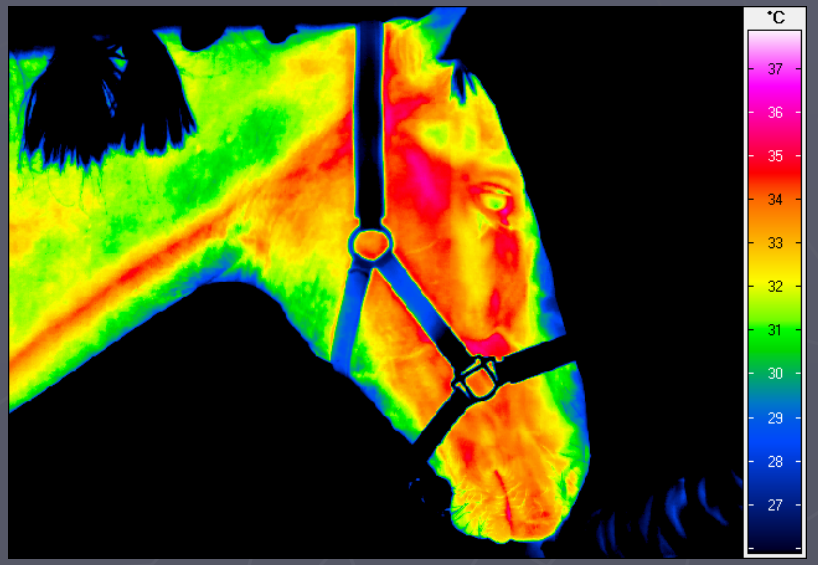
- Infrared thermography (IRT)
  - non-invasive technique for measuring stress in horses



- Significant correlations between maximum eye temperature and both salivary and plasma cortisol concentration (Cook et al. 2001)
- No studies on the use of IRT as a measure of stress in racehorses in their first year of racing
- No studies reporting the agreement between maximum eye temperature and core temperature

Aims of study

- Investigate agreement between maximum eye temperature (using thermography), and rectal temperature in racehorses



- Comparing the results with:
  - salivary cortisol concentration
  - heart rate
- at rest and after exercise

Data collection

- Partynice racecourse - August 2015 (middle of racing season)
- 19 clinically healthy horses (10 Thoroughbred and 9 Arabian Horses)
- 4 measurement techniques used on the 3 days of intensive training scheduled in the training timetable (Tuesday, Friday and the following Tuesday).

Data collection – thermography

- Infratec Variocam HR
- 640 x 480 pixels
- Uncooled, 7.5 – 14 µm
- ε = 1
- Imaging distance 1m
- Analysis in Infratec IRBIS 3 Professional software

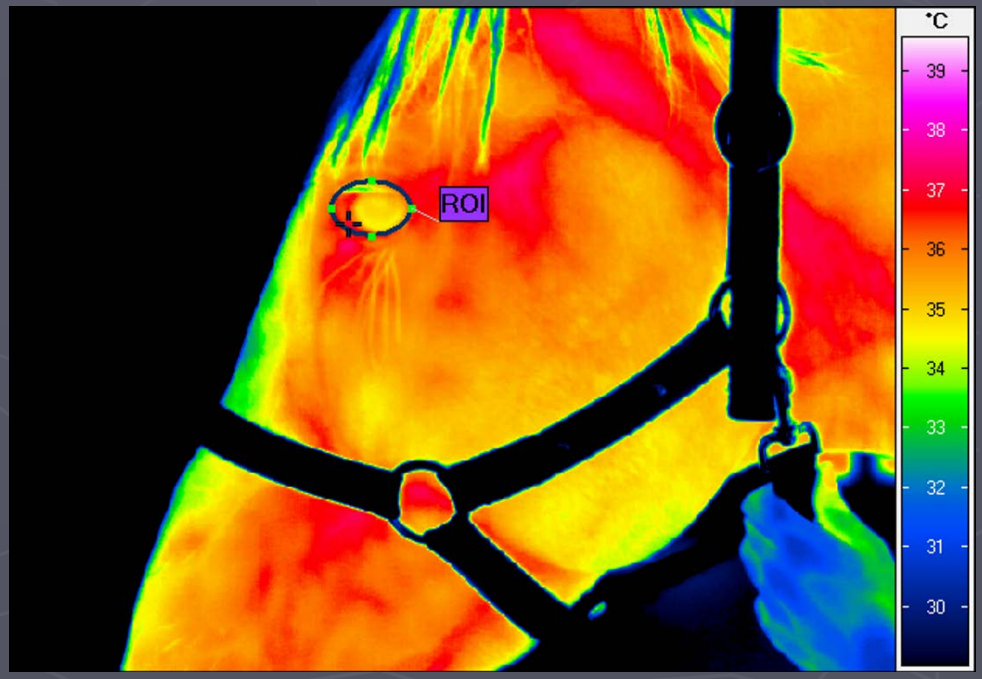
Data collection – thermography

Thermographic images of the left eye were taken:

- when horses were at rest before training (BT)
- within 5 minutes after the end of training (T+5)
- 2 hours after training (T+120)

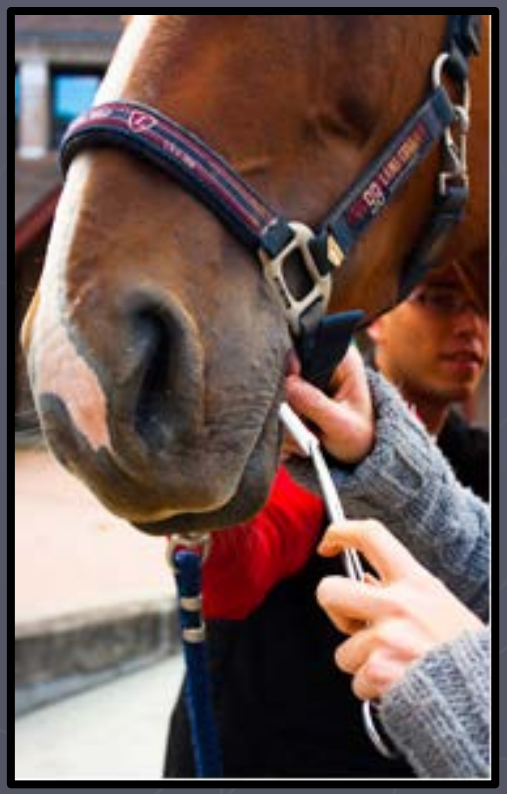
Maximum eye temperature at the lacrimal caruncle was used

T_{max} = maximum eye temperature averaged over the 3 training days



Data collection - cortisol assay

- Saliva collected: BT, T+5; T+120
- Using Salivatte® probes (SARSTEDT, Germany).
- Gathered from the mouth by running a cotton swab between the cheek and teeth
- cortisol assay
- SCC = salivary cortisol concentration averaged over the 3 training days



Data collection – heart rate

- Heart rate measured: BT, T+5; T+120
- Using a stethoscope (Littmann, model Classic II SE)
- HR = heart rate averaged over the 3 training days

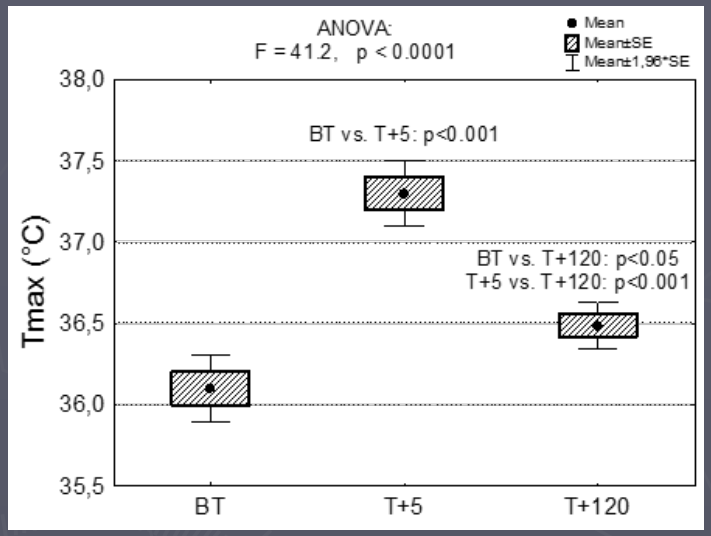
Data collection – rectal temperature

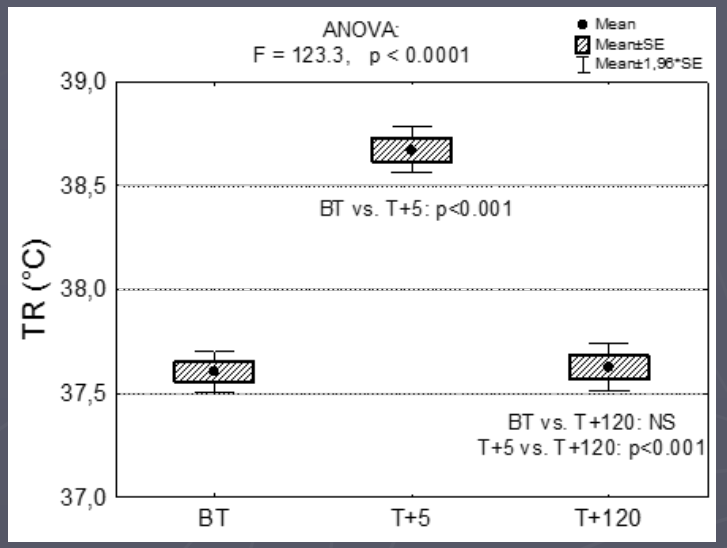
- Rectal temperaure measured: BT, T+5; T+120
- Taken with an electronic veterinary rectal thermometer (KRUUSE Digi-Vet SC 12, Denmark)
- TR = rectal temperature averaged over the 3 training days

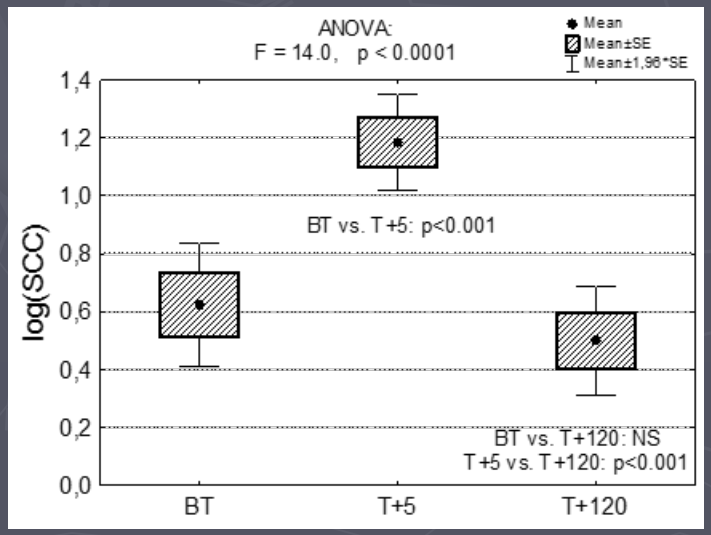
Statistical analysis

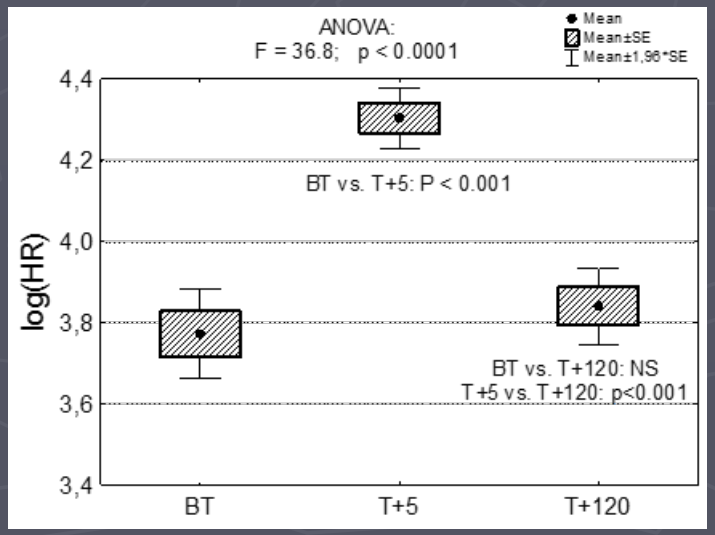
- Different physiological contexts
  - data for BT, T+5; T+120 were analysed separately
- STATISTICA v. 10 (StatSoft, Tulsa, USA)
- Data for saliva cortisol concentration and heart rate were not normally distributed
  - log transformed to facilitate parametric analysis.
- Effect of training assessed by ANOVA and **Tukey** post hoc testing
- Agreement between T_{max} and TR was evaluated using Bland Altman plots.
- Correlations between measured parameters calculated using the Pearson correlation coefficient, r.

Results


ANOVA:
F = 41.2, p < 0.0001
Mean
Mean±SE
Mean±1,96*SE
Tmax (°C)
38,0
37,5
37,0
36,5
36,0
35,5
BT vs. T+5: p<0.001
BT vs. T+120: p<0.05
T+5 vs. T+120: p<0.001
BT
T+5
T+120


ANOVA:
F = 123.3, p < 0.0001
Mean
Mean±SE
Mean±1,96*SE
TR (°C)
39,0
38,5
38,0
37,5
37,0
BT vs. T+5: p<0.001
BT vs. T+120: NS
T+5 vs. T+120: p<0.001
BT
T+5
T+120


ANOVA:
F = 14.0, p < 0.0001
Mean
Mean±SE
Mean±1,96*SE
log(SCC)
1,4
1,2
1,0
0,8
0,6
0,4
0,2
0,0
BT vs. T+5: p<0.001
BT vs. T+120: NS
T+5 vs. T+120: p<0.001
BT
T+5
T+120

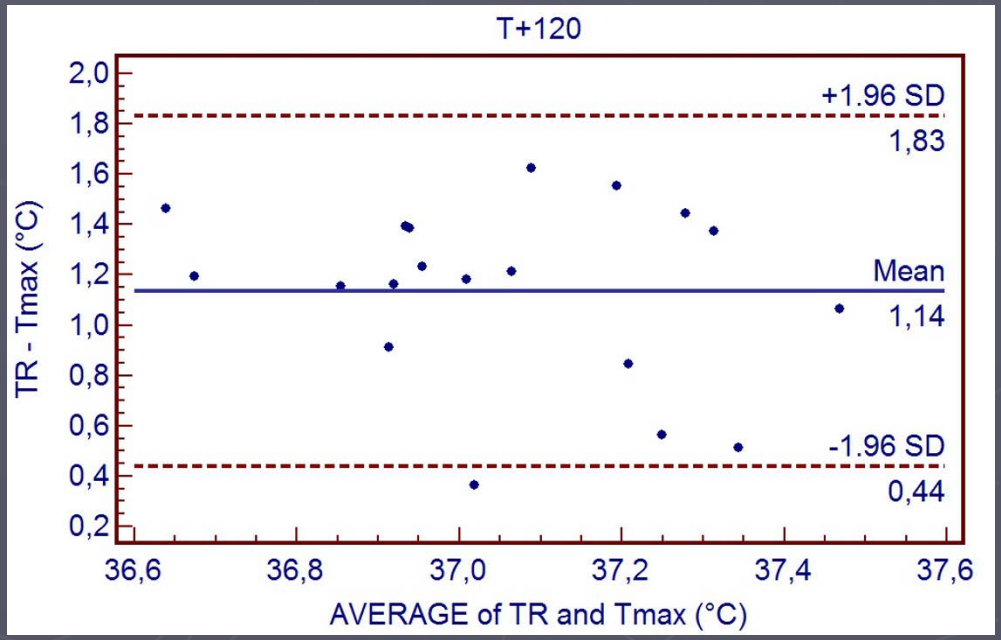

ANOVA:
F = 36.8; p < 0.0001
Mean
Mean±SE
Mean±1,96*SE
log(HR)
4,4
4,2
4,0
3,8
3,6
3,4
BT vs. T+5: P < 0.001
BT vs. T+120: NS
T+5 vs. T+120: p<0.001
BT
T+5
T+120

Results

Agreement between maximum eye temperature and rectal temperature BT, T+5 and T+120.

The best agreement was observed at T+120

The bias between T_{max} and TR was 1.1ºC ($TR>T_{max}$)



BLAND ALTMAN PLOT

Results

- The only significant correlation between measured parameters was between T_{max} and TR before training.

Table 1. Pearson product-moment correlation coefficients at BT, T+5 and T+120

BT	T_{max}	TR	log(SCC)	log(HR)
TR	**r = 0.554 p = 0.014**	×		
log(SCC)	r = 0.248 p = 0.307	r = 0.001 p = 0.998	×	
log(HR)	r = -0.128 p = 0.602	r = -0.220 p = 0.366	r = 0.405 p = 0.085	×

T+5	T_{max}	TR	log(SCC)	log(HR)
TR	r = 0.401 p = 0.089	×		
log(SCC)	r = 0.130 p = 0.597	r = 0.399 p = 0.091	×	
log(HR)	r = -0.143 p = 0.560	r = 0.172 p = 0.482	r = 0.152 p = 0.536	×

T+120	T_{max}	TR	log(SCC)	log(HR)
TR	r = 0.228 p = 0.347	×		
log(SCC)	r = -0.069 p = 0.778	r = 0.145 p = 0.554	×	
log(HR)	r = -0.277 p = 0.250	r = -0.254 p = 0.294	r = 0.332 p = 0.165	×

Conclusion

- Maximum eye temperature, rectal temperature, salivary cortisol concentration and heart rate were all elevated by exercise in racehorses.
- The only significant correlation between these parameters was between eye and rectal temperature before exercise.
- Agreement between eye and rectal temperatures was limited at all time points.

Discussion

- Doubt on maximum eye temperature as a valid estimate of rectal temperature, and may limit the ability of IRT to identify individual febrile horses.

- Teunissen and Daanen (2011) found that eye temperature at rest in humans was, on average, around 1.4ºC lower than oesophageal temperature.

- The findings question the validity of eye temperature for the detection of fever or the evaluation of stress in racehorses undergoing training.

Thank you!

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Original Research

Maximum Eye Temperature in the Assessment of Training in Racehorses: Correlations With Salivary Cortisol Concentration, Rectal Temperature, and Heart Rate

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ABSTRACT

We investigated agreement between eye maximum pixel temperature (using thermography) and rectal temperature (RT) in racehorses, comparing the results with salivary cortisol concentration and heart rate (HR), both at rest and after exercise. Nineteen horses, undergoing training for racing in their first racing season, were studied. Eye maximum pixel temperature, RT, salivary cortisol concentration, and HR were measured before training (BT), within 5 minutes of the end of the training session (T+5), and 2 hours after training (T+120). Eye maximum pixel temperature, RT, salivary cortisol concentration, and HR were all significantly elevated at T+5 compared to BT (all $P < .001$). At T+120, only eye maximum pixel temperature remained significantly elevated compared to BT ($P < .05$). Bland-Altman analysis indicated a poor agreement between eye maximum pixel temperature and RT. We noted no significant correlations among any of the measurements at any time point, with the exception of eye maximum pixel temperature and RT at BT ($r = 0.55$, $P = .01$). In racehorses, eye maximum pixel temperature is a poor estimate of core temperature due to limited agreement with RT. Furthermore, eye maximum pixel temperature is not correlated with accepted measures of stress such as salivary cortisol concentration and HR.

1. Introduction

The reliable measurement of stress in sport horses is important both for animal welfare and optimal sport performance. Both biological factors (e.g., sex, age, breed) and environmental issues influence the physiological stress response in horses [1–4]. A variety of situations to which sport horses are regularly exposed have been classified as potential stressors. These include training [5,6], mounting by a rider [7], veterinary examination [8], or changes of daily routine [9]. The detection of stress is particularly important for young racehorses, which are put under extreme physical demands in the early stages of their racing careers as their training progresses.

The physiological assessment of stress is typically determined by the invasive measurement of cortisol concentration in plasma. This measurement, however, is a stressor in itself and can lead to confusing results [10]. For this reason, research interest has expanded to identify and

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