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Surface temperature changes in response to handling in domestic chickens

J.L. Edgar [a,*], C.J. Nicol [a], C.A. Pugh [b], E.S. Paul [a]

[a] School of Veterinary Sciences, University of Bristol, Langford House, Langford BS40 5DU, UK
[b] The Roslin Institute, University of Edinburgh, Roslin EH25 9RG, UK

HIGHLIGHTS

- We subjected hens to handling followed by 20min in a holding box.
- Head, eye and comb surface temperatures were monitored using non-invasive thermography.
- Comb temperature decreased significantly, showing a rapid 2°C drop following handling.
- Head and eye temperature showed characteristic patterns of change during the test.
- Surface temperature changes are a potentially useful welfare assessment method in hens.

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ABSTRACT

Stress-induced hyperthermia (SIH) occurs in numerous species and is characterised by an increase in core body temperature, and a decrease in surface temperature, of between 0.5 and 1.5 °C within 10 to 15 min of the onset of "emotional stress". The aim of the current study was to ascertain whether the husbandry-relevant procedure of handling resulted in measurable changes in surface body temperature in chickens, as measured using infrared thermography. Baseline temperatures for 19 domestic hens were compared to temperatures immediately, and up to 20 min following handling (catching and brief restraint by a human). Surface head, eye and comb temperatures were plotted to investigate the pattern of temperature change. In response to handling, comb temperature decreased significantly, showing a rapid 2 °C drop. Eye temperature showed an initial decrease then rose to levels significantly higher than handling. Head temperature increased over the 20 min post-handling period, to reach levels significantly higher than baseline. It can be concluded that surface temperature changes assessed using infrared thermography, in particular of the hen's comb, are sensitive to husbandry procedures such as handling and represent a potentially useful method for assessing stress-induced hyperthermia in chickens.

1. Introduction

The phenomenon of stress-induced hyperthermia (SIH), or "psychogenic fever" [1] occurs in numerous species and is characterised by an increase in core body temperature of between 0.5 and 1.5 °C within 10 to 15 min of the onset of an "emotional stressor", such as anticipation of an aversive event, startling and restraint [2]. As core body temperature rises during SIH, decreased surface body temperature is also observed [3]. This is likely to be an indicator of peripheral vasoconstriction, a mechanism to redistribute blood to more important areas (e.g. the muscles and brain) and to prevent blood loss due to potential injuries in the peripheries [3]. Being thought of as primarily a response to "emotional stress" [4–6], SIH should occur irrespective of any physical activity, although increased activity may also give rise to core temperature increases [7], especially when a stimulus results in both an SIH response and a physical response, complicating the accurate measurement of SIH. SIH is mediated by prostaglandins [8] and is closely associated with an activation of the hypothalamic–pituitary–adrenal (HPA) axis and the sympathetic–adrenal–medullary (SAM) system [2]. In humans, SIH occurs prior to academic examinations [4,5] and sporting competitions [10]. In mice, SIH has been proposed as a potential model for the understanding and treatment of anticipatory anxiety in humans. Borsini et al. [10] found that when group-housed mice were removed one-by-one from their home cage, the mice that were removed last had significantly higher core body temperatures. This effect was exacerbated when there were fewer mice in the cage to begin with, and was prevented by the anxiolytics, diazepam and nitrazepam.

The strong link between self-reported emotional states and SIH in humans [4,5,9] means that, with further research, this physiological response may become a potentially useful tool to make inferences about subjective states in non-human animals. SIH has been studied

* Corresponding author. Tel.: +44 117 928 9320.
E-mail address: j.edgar@bristol.ac.uk (J.L. Edgar).

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in the context of animal welfare research in laboratory mice [11], sheep [12] and farmed foxes [13,14], where it was found that SIH correlates with other commonly used welfare indicators, including increases in glucocorticoids [12], heart rate [11] and behavioural "fearfulness" scores (time taken to catch animal [13] and behaviour during a human approach [14]). Kramer et al. [11] found a significant increase in core body temperature and heart rate when an animal technician entered the room in which the mice were housed, but no additional increase in response to handling. In farmed foxes, SIH may be indicative of fear towards humans [13], being less pronounced during a human approach test in foxes selectively bred for tameness [14].

Traditionally, core body temperature in animals has been recorded using internally implanted or rectal dataloggers. Although such methods can be useful for making long-term recordings, they are invasive and thus have the potential to influence animal behaviour and physiology and/or involve surgery. Thermal imaging cameras detect infrared radiation and translate this into readable surface body temperatures. Recent advances in thermal imaging technology mean that this method of non-invasive body temperature measurement is now affordable and widely accessible; a significant potential advantage for animal welfare research.

Although SIH has traditionally been characterised by an increase in core body temperature, decreased surface body temperature (as a result of peripheral vasoconstriction) is also part of the broader process of stress-induced hyperthermia [3]. Decreased peripheral temperature has been found in response to a number of events and stimuli in cattle (startling, shouting, and use of electric prod [15]) and rats (restraint [3]). Although decreased surface body temperature has generally been associated with apparently negative events, Moe et al. [16] found a 1.5 °C drop in comb temperature in chickens during anticipation and consumption of a food reward, i.e. a putatively positive event.

Catching and handling are highly relevant events for prey species such as domestic fowl. They are also applicable to the commercial setting; at the end of their production period, the process of transport and slaughter involves catching, handling and placement in a crate for both broilers and laying hens. Catching, handling and restraint by humans has been found to produce SIH in numerous species, including impala [17] silver foxes [18], rats [3], pekin ducks [19] great tits [20] and eider ducks [21]. There is a preliminary suggestion that SIH might also occur in chickens in response to handling. Cabanac and Aizawa [22] found that two of a total of three chickens observed showed an increase in core (45 mm cloacal) body temperature and a concurrent decrease in surface (foot and comb) temperature. However, temperature measurement using a cloacal thermometer may have contributed to the process of SIH and confounded the temperature changes. Importantly, the small sample size and coarse temporal resolution (readings were taken every 3 min) limit the conclusions that can be drawn about the acute effects of handling on body temperature in chickens.

The aim of the current study was to examine the distribution of surface body temperature changes that occur in response to handling and non-physical restraint within a holding box in domestic hens, using the entirely non-invasive method of thermal imaging. By placing hens in a holding box following handling, we were able to measure the duration of the thermal responses over a 20-minute period, at a finer temporal resolution than has previously been investigated. We focused on three body areas where feather cover is sparse or absent: head, eye and comb. To determine whether factors other than handling might also influence surface temperature in chickens, we additionally assessed, during baseline temperature measurements, whether behaviour in the home pen was associated with surface body temperature.

2. Methods

2.1. Animals and husbandry

19 female chickens (Hubbard JA57, aged 72 weeks) were obtained from a commercial broiler breeder farm. The hens were in good physical condition, had no plumage damage and had been exposed to minimal handling during their period of production. On the day of the hens' arrival (day one), they were leg tagged for identification. The hens were housed together in a floor pen (4 m × 4 m) which was bedded with 4 cm of wood shavings and contained a metal nest box unit. The hens were provided with ad libitum layers mash from two free-standing poultry feeders and water from two suspended poultry drinkers. Temperature in the floor pen was maintained at 23 °C and the lighting schedule was 12L:12D. The birds were allowed to acclimatise to the floor pen until day 8, during which time they were not handled.

2.2. Procedure

2.2.1. Habituation

Following the 7-day acclimatisation period, on days 8 and 9, the hens were gradually habituated to the presence of a human with a thermal camera (FLIR ThermaCAM E4) sitting on a chair for 4 h each day in their floor pen.

2.2.2. Order of testing

Following the two habituation days, days 10 and 11 were testing days. Ten of the hens were tested on day 10 and nine on day 11. To counteract the effects of possible variation in temperature due to circadian rhythms, hens were randomly assigned to either i) have their baseline temperature measured in the morning and their handling and holding box temperature measured in the afternoon ($n = 10$) of the same day or ii) vice versa ($n = 9$). For handling, the order in which the hens were caught was determined using a random number generator.

2.2.3. Baseline

A thermal imaging camera (ThermaCam E4, FLIR) was used to capture a thermal image of either side of each hen's head whilst they were exhibiting each of three naturally occurring behaviour patterns within their floor pen: 1) standing with head up, 2) eating from the feeder and 3) pecking at the ground. The camera was set up at a distance of 1 m from one of the feeders and the thermal images were taken whilst the hens performed the different behaviours whilst adjacent to the feeder. The thermal camera set to an emissivity of 0.96 and the ambient temperature of the room was maintained at 23 °C.

A period of approximately 3 h was sufficient to obtain one clear image per hen per each of the three behaviours.

2.2.4. Handling and subsequent 20 min period in the holding box

An experimenter entered the floor pen and caught each hen individually by placing their hands over and around the hen's wings and body and lifting slowly. The hen was then gently held over the holding box for 5 s. An initial thermal image was taken (referred to as measurement point "handling") before the hen was lowered into the holding box. The holding box measured 0.5 m × 0.5 m × 0.6 m (L × W × H), had one wire mesh side and was positioned in a corner of the floor pen so that the wire mesh side faced into the room. The holding box allowed the hen to be kept within the range of the thermal camera at a set distance of 1 m without physically restraining her. The wire mesh along the side of the box allowed the subject hen visual and auditory contact with the rest of the flock and enabled effective use of the thermal camera. Thermal images were taken of each hen's head at 1 min intervals for 20 min. A time window of 10 s either side of the 1 min mark was allowed to ensure that an accurate image of the side of each hen's head was obtained.

2.2.5. Thermal image analysis

Temperatures were obtained from the thermal images using the software package Thermacam Reporter Professional 2000. The measurement regions are shown in Fig. 1. In chickens, the head and comb regions generally vary in temperature over their surface and so