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Assessment of anxiety: a matter of temperature?

Anxiety is an emotional response occurring when individuals are facing challenging situations or threats. This affective state promotes adaptive coping strategies and is associated with changes involving a variety of different, cross-species conserved, behavioral and physiological responses such as increased vigilance, careful exploratory behavior, and cardiovascular and endocrine changes.

The study of affective states has historically used animals as models, especially laboratory rodents, to understand and to develop treatments for psychological disorders such as pathological anxiety. Most popular tests involved in the assessment of anxiety use rodents' innate aversion to open, bright and elevated spaces to induce fear. The time spent in the most aversive areas of the apparatuses and/or the expression of defensive behaviors such as freezing are often used as proxy measures of fear and referred to as anxiety-related behaviors. These "unconditioned fear tests" have been extensively used in drug screening studies where the occurrence of anxiety related behaviors have been shown to decrease with the use of anti-anxiety agents.

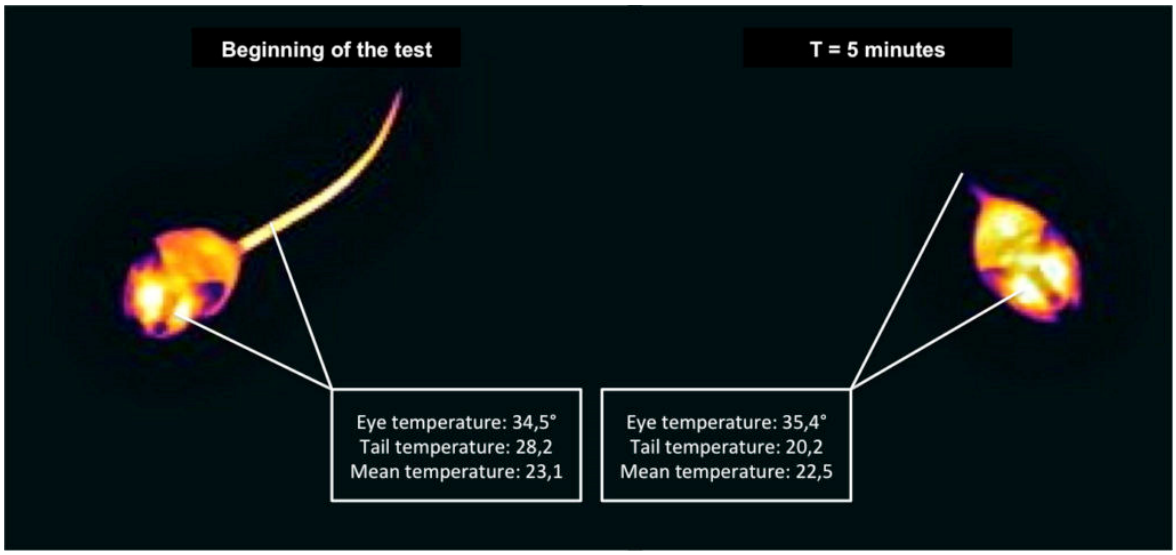

Illustration of changes in temperature during an unconditioned fear test.

Due to their direct inaccessibility, animals' affective states are classically assessed by gathering concomitant physiological and behavioral measures. Although such a dual approach to assess emotional states is frequently used in different species including humans, the invasiveness of the procedures, especially physiological recordings in smaller-sized animals, strongly restricts their application. Indeed these procedures often require handling (e.g. blood sample) that could compromise the accuracy of the results, or even surgery (e.g. of telemetric probes) that could impair animal welfare.

In this study, we used infrared video thermography, a non-invasive method, to assess physiological arousal during unconditioned fear tests in mice. This method allows accurate assessment of the peripheral temperature of the animals, a direct measure of the cardio-vascular changes (i.e. vasoconstrictions / vasodilatations) associated with emotional experience. Generally speaking, fear is believed to increase vasoconstriction in peripheral organs (such as the skin), as it might help to adaptively avoid excessive bleeding caused by potential injuries and to increase blood flow directed to vital organs (e.g., to brain and muscles). For instance in rodents, fear triggers a vasoconstriction of the tail (i.e. an easily harmed area) that consequently leads to a decrease in tail temperature. By using changes in peripheral temperature as a proxy for animals' emotional response, we aimed to improve the inherently limited and still controversial information provided by behavioral measures.

Our results showed that unconditioned fear tests trigger significant and similar thermal responses (i.e. decrease in tail temperature and increase in eye temperature), changes that are in accordance with classical thermal responses occurring in fearful situations.

We also found positive associations between the thermal response of the individuals and the occurrence of anxiety-related behaviors. That is, the more anxiety-related behaviors the animals expressed, the higher the changes in their peripheral temperature. Furthermore, initial temperatures measured at the start of each experimental procedure, which can be interpreted as a measure of the animals' initial emotional state, predicted key behaviors the animals displayed during the tests. Animals with higher initial tail and eye temperatures showed reduced expression of anxiety-related behaviors during the tests. Our results therefore highlight that anxiety has probably started before the tests themselves. Furthermore, it appears that individuals have reacted differently to the pre-experiment handling and the intensity of this response is a good predictor of the behaviors displayed during the rest of the test. Thus infrared thermography emerges as a good tool to assess emotions in small mammals. Additionally, our results stress the strong link between physiological changes and behaviors expressed during anxiety tests, and highlight the great importance of considering the initial emotional state of the animals.

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