



Module 6

Assessing Animal Welfare – Physiological Measures

Student Activities

Questions

1. During the daily life of an animal in a given environment, various stimuli will be encountered and responded to in order to ensure survival. Describe the four-stage sequence depicting how an animal will experience and process an event in the environment. Remember to consider both behavioural and physiological elements of the animal's response in your answer.

(4 marks)

- The event creates sensory input.
- The brain evaluates the input and may generate an emotion based on past experience.
- The emotion gives rise to physiological and behavioural responses.
- The animal adapts to the event and survives.

2. Define stress in a biological context.

(1 mark)

Stress is the biological response elicited when an individual perceives a threat to homeostasis.

3. 'Stressors and stress are internal events'. True or false?

(2 marks)

False. Stress is a response to an eliciting event known as a stressor. Stressors may be internal events or external events.

4. Name the two elements of the stress response, and the main anatomical structures associated with each element. (4 marks)

- Autonomic nervous system (ANS): sympathetic nervous system, adrenal medullar, parasympathetic nervous system (PNS)
- Hypothalamo-adrenal-pituitary (HPA) axis: the brain (hypothalamus and pituitary gland) and the adrenal cortex.

5. Name three physiological effects that sympathetic-adrenal-medullary (SAM) activation has on the body? (4 marks)

- Increased cardiac output by elevating heart rate and increasing cardiac muscle contraction
- Increased blood to the muscles by increasing peripheral vasoconstriction and contraction of the spleen
- Increased air intake by elevating respiratory rate and relaxation of bronchioles in the lungs
- Inhibition of non-essential bodily activities, e.g. salivation, peristalsis

6. Glucocorticoid levels have been used to study the welfare of animals exposed to an acute real-life stressor. Give one example of such a study in a farm setting, specifying the animal, the specific stressor, and which glucocorticoid was measured. Write a short sentence reporting on the conclusion of the study. (4 marks)

Piglets – surgical castration without analgesia – cortisol

- The authors did not find a significant difference in the stress response between the groups: urinary corticosteroids and urinary catecholamines were similar in all groups at the time of castration and over the following days.

Dairy calves – surgical and clamp castration with and without different types of analgesia – cortisol

- When analgesia was not used, all the castrated calves had a marked cortisol response compared to calves in the control groups (sham castration), with clamp castration causing the smallest cortisol response.

Water buffalo – surgical and clamp castration – cortisol

- Surgical castration: cortisol elevated for ~6 hours; pain on palpation at 48 hours.
- Clamp: cortisol elevated for ~9 hours; no pain on palpation at 48 hours.

7. Identify two limitations associated with using blood cortisol levels to assess acute stress in animals. (2 marks)

- Blood cortisol can be increased by positive or negative experiences, making it difficult to interpret results accurately.
- Blood cortisol can be increased by restraint and blood sampling alone, and can therefore confound results.

8. Why are adrenalin and noradrenalin limited in their use as indicators of acute stress in animals under real-life field conditions? (2 marks)

Because the half-life of these substances is very short, and blood levels decrease, rapidly so laboratory measurements would under-estimate the levels that were present at the time of sampling.

9. Give an example of how previous experience may modify the stress response. (1 mark)

One study of dogs who had been put into a shelter indicated that those dogs with previous experience of kennelling had lower urinary cortisol than dogs who had never been kennelled before.

10. What is the main physiological effect of hypothalamic-pituitary-adrenal (HPA) axis activation in the face of an acute stressor? Circle the correct answer. (2 marks)

- a) Mobilising energy stores by increased glycogenolysis in the liver and suppressed insulin secretion.
- b) Increasing blood flow to the gut and stopping peristalsis.
- c) Ending the SAM response and taking over from it.
- d) Providing negative feedback on adrenocorticotrophic hormone (ACTH) release from the pituitary gland so that the adrenal cortex stops releasing cortisol and the adrenal medulla can release more adrenalin.
- e) None of the above.

Answer: a)

11. The immune response enables an animal's body to deal with potentially harmful foreign molecules and organisms. Identify the two main components of the immune response. For each component, give an example of how the stress response may affect it.

(4 marks)

- Innate response – phagocytes and chemicals, e.g. complement. Cortisol can increase numbers of phagocytes (neutrophils) in the blood, improving the response to infection, or decrease phagocytic activity, increasing vulnerability to infection.
- Acquired response – antibodies (B cells) and cellular response (T cells) mediated by chemical messengers such as cytokines. External stressors reduce the antibody response to infection.

12. Stress can create a change in an animal's immune system and therefore indirectly increase an animal's risk of getting an infection. Using this framework, explain how the stress response to parturition may be related to the occurrence of mastitis in dairy cows.

(3 marks)

High levels of cortisol are part of the endocrine mechanism that allows parturition to occur. However, high levels of cortisol also induce an imbalance in populations of T cells and result in immune suppression, which could predispose the cow to mastitis. If husbandry is poor (e.g. poor nutrition, dirty bedding), and if the cow has other stressors such as pain due to lameness, these factors, in combination with the stress of parturition, increase the risk of the cow developing mastitis in the days just before and after calving.

13. Consider the following sentence "The brain modulates the immune response, but it is one-way communication, and the immune response does not affect how the brain processes information". Is the sentence true or false? Explain your answer.

(2 marks)

False. The brain has receptors for cytokines which are chemical messengers that are produced as part of the immune response. Therefore, the immune response does affect the brain.

14. Various neurobiological measures can be used to determine an animal's welfare status. As invasive techniques may be required, these measures are typically conducted when the animal is no longer alive or as part of ethically approved research involving living animals. Identify three neurobiological measures that may be used to assess the welfare of an animal in a research setting.

(3 marks)

- Opioids and their receptor number
- Dopamine
- Prolactin
- Brain activity
- Animal's ability to learn and to remember

15. Various physiological parameters can be used to indirectly measure an animal's welfare status. Identify three physiological substances that can be measured in the blood and may be used as metabolic measures of animal welfare. For each one, state how it relates to activation of the hypothalamic-pituitary-adrenal (HPA) or sympathetic-adrenal-medullary (SAM) systems.

(6 marks)

- Glucose – cortisol from HPA activation increases blood glucose by glycogenolysis.
- Lactic acid – results from anaerobic muscle metabolism when animals run away from a threat under the influence of SAM activation.
- Beta-hydroxy-butyrate – results from the metabolism of fat, when blood glucose has been utilised quickly following increased heart rate and running away, under activation of the SAM response.
- Haematocrit – results when the spleen contracts in response to SAM activation.
- Metabolic hormones (e.g. insulin) – insulin release is suppressed by cortisol following acute activation of the HPA axis.
- Muscle enzymes – released into the blood following sustained or extreme exertion, e.g. running away from a threat, under the influence of the SAM response.

In-class activity

Discussion

Allow 45 minutes for this activity,

This discussion will focus on identifying which physiological measures to use, and why, when monitoring the welfare of a species of animal which may be kept for at least two of the following four purposes:

- companionship
- food
- laboratory research
- entertainment/sport

For example:

- horses kept for the sport of racing, and horses used for meat, and
- rabbits kept as pets, rabbits kept as research animals in a laboratory developing drugs for use on both human and veterinary medicine, and rabbits farmed for food.

Separate students into small groups. Tell them that they will be discussing how best to monitor the welfare of the animal species using physiological measures, identifying which are most appropriate for the species kept and used in the two (or more) different scenarios. Allocate an equal number of groups to focus on each scenario.

Notes to students:

Discuss each physiological measure and how it can be used to assess the welfare of the animal kept in the scenario you have been given. Identify the advantages and limitations of each of the physiological measures when used in this context.

Students should report their main discussion points and conclusions to the rest of the class, and compare and contrast the similarities and differences where applicable.

Key points to consider:

How reliable are different physiological measures as welfare indicators for the species in these scenarios? What research is there?; How easy would it be to set up a system for measuring certain physiological substances? Think about the extent to which the species are used to certain handling, equipment and procedures; the animals' value to the owner and the feasibility or acceptability of repeated sampling and possible post-mortem procedures; the availability of appropriate equipment; necessity and availability of analgesics for certain sampling procedures.

Further points for discussion:

Would you do anything differently if you had been allocated a different species, e.g. dogs kept as companions, dogs kept as research animals, dogs kept for food?

Welfare presentation

In groups, prepare a welfare presentation to give an overview of research where the welfare of a specific species in a specific scenario of your choice (companionship, research laboratory, food, and entertainment/sport) has been measured using physiological parameters. Students should consider how the measures may relate to welfare, whether the welfare of animals was affected through the process of taking physiological measures, how reliable the physiological measures used are, and how this may affect the conclusions that are made.

Length of presentations will vary according to which area is chosen, the size of the class and the amount of time available. Where possible, students should be encouraged to present using PowerPoint or another similar presentation tool.

Lecturers are advised to use their discretion in the awarding of marks and in the feedback given to students regarding their presentation skills. A good presentation contains typical sections such as:

- Introduction (describing the purpose of the research or task)
- Main content (the outputs from the options listed below)
- Summary/conclusion (rounding up all the findings and making concluding statements, linking back to the purpose outlined in the introduction).

A good presenter speaks clearly and slowly, and doesn't engage in distracting habits such as clicking a pen while speaking, or jangling change in his or her pockets. They should remain relatively still and not move about too much which can also be distracting to the audience.

PowerPoint slides should also contain a minimum amount of text and the presenter should know the subject well enough (or read from additional notes) so that the slide works as a prompt rather than the presenter simply reading the entire slide to the audience and adding nothing extra.