Judgement bias:

A cognitive measure of affective state in sheep

PhD thesis

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Declaration

I hereby declare that this thesis is an original body of work produced as a part of a Doctorate in Philosophy. This thesis has not been submitted for any other degree. Contributions to the research made by my co-authors have been indicated in each chapter. I have made the largest contribution to this thesis by planning and conducting the research and writing the associated chapters.

Rebecca E. Doyle

Ethical statement

As outlined in each chapter of research, all experimental procedures were approved by ethics committees and performed in accordance with either the Australian Code of Practice for the Care and Use of Animals for Scientific Purposes, or the European Communities Council Directive of 24 November 1986 (86/609/EEC). Additionally, all of these experiments were aimed at gaining knowledge, which would ultimately improve the welfare of sheep.

Abstract

Sheep welfare is predominately measured by identifying behavioural and physiological changes. While informative, they can often be difficult to interpret, identifying the arousal of a sheep in a particular situation but not the valence (positivity or negativity) of the affective state being experienced. Judgement bias has been proposed as a cognitive measure of affective state valence in animals. The aim of this thesis was to adapt a method of assessing judgement bias for use in sheep to identify cognitive changes influenced by affective states. In all studies, sheep were trained to a go/no-go operant task where they learnt to approach (go response) a bucket when placed in one corner of the testing facility to receive a positive reinforcer (feed reward), and not approach it when in the alternate corner (no-go response) to avoid a negative reinforcer (exposure to a dog or fan forced blower). Judgement bias testing involved exposing the sheep to ambiguous bucket locations between the two learnt ones. The sheep had to judge which way to respond to these ambiguous locations (go/no-go), which would give insight into their affective states. In the first study a restraint and isolation stressor (RIS) for 6 h/day on 3 consecutive days generated a significantly more positive judgement in sheep compared to controls. Two further studies, using a chronic, intermittent treatment and a pharmacological treatment using a serotonin antagonist respectively, generated more pessimistic-like judgement biases in the sheep compared to that of the controls. These studies suggest that judgement bias can identify affective state changes in sheep and that the response differs depending on the nature of the stress. Furthermore, the unexpected result generated from the RIS treatment suggests that judgement bias can be used to measure differently valenced affective states in sheep. Another study conducted into

the method itself showed that the sheep learn not to approach the unreinforced ambiguous locations when repeatedly exposed to them and this affects their judgement of the bucket locations. This means that there are a limited number of times that the sheep can be exposed to the testing situations. Despite this and other methodological concerns discussed, these results strongly suggest that judgement bias can be used as a measure of affective state in sheep. The use of this method could help to improve the welfare assessment of sheep in the future, especially if used in conjunction with other measures of affective state.

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Thesis structure

This thesis presents a series of experiments designed to adapt current measures of judgement bias to sheep. Chapter 1 provides an introduction and background information on why a method for measuring judgement bias in sheep should be developed. Chapters 2, 3, 4 and 5 are presented as peer reviewed publications with Chapters 2 and 5 having already been published, and Chapters 3 and 4 have been submitted to the respective journals. Because these chapters are presented as papers formatting may differ and the explanation of some experimental techniques have been repeated. Chapter 6 presents integrative conclusions from all of the experimental work of this thesis, and relates back to the issues discussed in the introduction. Appendix 1 is a paper that has been co-written by the thesis author based on some of the unrelated issues identified in the development of this thesis. Appendix 2 is a short report of a study conducted to address an issue raised by an anonymous reviewer of one of the papers. Reference lists are provided at the end of each chapter.

Chapter 2 is the first experiment measuring judgement bias in sheep. It uses a previously validated stressor model in sheep where the animals are restrained and isolated (RIS) for 6 hr per day for 3 consecutive days. Following each day of RIS sheep were tested for judgement bias. This stressor was significantly different to those used in judgement bias studies performed in other species, being more intense but shorter in duration. This treatment produced a more positive judgement bias in the RIS treated sheep. Examples of more positive judgement biases following a negative treatment had not been published before in animals.

Chapter 3 tested judgement bias using a long-term treatment similar to a previous judgement bias study in rats in an effort to generate a more negative judgement bias. The hypothesised difference in judgement bias was seen, but only on the third day of testing.

Chapter 4 used a serotonin antagonist to start investigating which neural pathways may be involved in the formulation of judgement bias. After administration of serotonin inhibitor pChlorophenylalanine (pCPA) for 5 consecutive days, a difference in judgement bias was identified with those pCPA treated sheep being more negative in their judgement than the controls. This difference is thought to reflect the involvement of serotonin in the formulation of judgement biases in animals, as it is in humans.

Chapter 5 is an investigation into the effects of repeated testing on judgement bias. It was noted in previous studies in this thesis, and in other judgement bias studies, that the repeatability of the test might be limited. It was shown that over time sheep learnt that the ambiguous cues were not reinforced, and so stopped responding to them.

Judgement bias seems to reflect the welfare of sheep and may be a measure of their affective states. Chapter 6 is a general discussion and summarises the findings of this thesis and discusses issues that were identified in the studies.