Assessing animal affect

Mike Mendl
University of Bristol, UK

Why assess animal affect (emotion)?
(How) can we define and measure it scientifically?
Indicators of animal affect including cognitive bias

*Future challenges*: implementing and automating measures of animal affect
Identifying and tackling animal welfare problems, and implementing solutions

Defining and conceptualising *animal welfare* and developing new measures
Why study animal affect?

“Let us not mince words: animal welfare involves the subjective feelings of animals.”

Dawkins 1990
There is recognition that animal ‘sentience’ underpins animal welfare obligations.

Why study animal affect?

Australian Animal Welfare Strategy (AAWS)

- Sentience is the reason that welfare matters.
There is recognition that animal ‘sentience’ underpins animal welfare obligations.

**Why study animal affect?**

TREATY OF AMSTERDAM (1997)
AMENDING THE TREATY ON EUROPEAN UNION,
THE TREATIES ESTABLISHING THE EUROPEAN COMMUNITIES
AND CERTAIN RELATED ACTS

Protocol on protection and welfare of animals

THE HIGH CONTRACTING PARTIES,

DESIRING to ensure improved protection and respect for the welfare of animal beings,
Why study animal affect?

If accurate measurement of animal welfare requires us to assess animal affect, a solid theoretical foundation is essential

But what exactly are affective states?
What are affective (emotional) states?

emotions are a category of conscious experience (‘subjective feelings’) that humans can report linguistically and label as ‘happy’, ‘sad’, ‘depressed’ etc.

Might animals have similar ‘discrete’ emotions? assumed (implicitly) in many studies (e.g. ‘fear’, ‘anxiety’) but how valid is it to generalise human discrete emotions to other taxa, especially if they are phylogenetically distant? even in humans, emotion words are not universal
What are affective (emotional) states?

Emotions are a category of conscious experience ('subjective feelings') that humans can report linguistically and label as 'happy', 'sad', 'depressed' etc.

Might animals have similar 'discrete' emotions? Use of emotion words also implies consciousness.

To avoid anthropomorphism, we need to be clear about why a particular discrete emotion is likely in a species, and that we cannot be sure about whether it is consciously experienced.
What are affective (emotional) states?
Another way of looking at it

All emotions are constructed through the action of a small number of underlying systems

- **core affect** reflects the action of bodily systems (e.g. REWard acquisition, PUNishment avoidance systems)
- 4 basic states can be identified
- discrete emotions are ‘constructed’ from a combination of core affect, and stimulus and context appraisal
What are affective (emotional) states?

Another way of looking at it

All emotions are constructed through the action of a small number of underlying systems

- arguably that animals more likely to share these ‘building blocks’ of emotion than specific discrete emotions
- the 4 basic states are less dependent on extrapolation from human feelings and emotion words, and dovetail with an operational definition:

> “Animal affective states are elicited by rewards and punishers where a reward is anything for which an animal will work and a punisher is anything that it will work to avoid”

**Rolls 2005, 2014; Paul & Mendl 2018**

presence of a reward →REW-H, or punisher →PUN-H

absence/omission of a reward →REW-L, or punisher →PUN-L
What are affective (emotional) states?

A *core affect* view of animal affective states has advantages:

- Readily translatable across taxa;
- Can be operationally defined;
- Less anthropomorphic;
- Valence is directly relevant to welfare;
- Integrative view of how different states are related.

How to measure location in core affect space?
How can we measure animal affect scientifically?

what we (as animal welfare researchers) are ultimately interested in

what we can actually measure

conscious emotional experience (feelings)?

brain activity
physiology
behaviour

affective state

which measures can tell us about location in core affect space?
How can we measure animal affect scientifically?

Stress physiology measures (e.g. cortisol, heart rate)

- Corticosterone
- Sexual encounter (REW-H)
- Aggressive encounter (PUN-H)

How can we measure animal affect scientifically?

Stress physiology measures (e.g. cortisol, heart rate)

Corticosterone (ng/ml)

- Sexual encounter (REW-H)
- Aggressive encounter (PUN-H)

Measures arousal but not valence

How can we measure animal affect scientifically?

Vocalizations

Calls recorded in different social contexts during approaches for affiliative interactions during conflict interactions

How can we measure animal affect scientifically?

Vocalizations

- elephant calls with higher $F_0$ maximum and range?
- elephant calls with lower $F_0$ maximum and range?


<table>
<thead>
<tr>
<th>Arousal</th>
<th>Valence</th>
</tr>
</thead>
<tbody>
<tr>
<td>high</td>
<td>+ve</td>
</tr>
<tr>
<td>low</td>
<td>-ve</td>
</tr>
</tbody>
</table>

fundamental freq ($F_0$) maximum (Hz)

- 17
- 13

fundamental freq ($F_0$) range (Hz)

- 4
- 1

* denotes significance.
How can we measure animal affect scientifically?

Vocalizations are species-specific, and likely measure short-term state only. Species-general indicators of high arousal may exist (high fundamental and peak frequency, vocalization rate), but less clear for valence.

How can we measure animal affect scientifically?

Facial expressions

- 'play-face'
- scream

sample video

pick expression with similar valence

Parr et al. 2001. *Anim Cogn*
How can we measure animal affect scientifically?

Facial expressions

Species-specific and taxon-limited (cf. birds, fish); short-term affect; specific to particular states

Parr et al. 2001. Anim Cogn
How can we measure animal affect scientifically?

Valuable measures of animal affect exist and are being developed.

- Indicate general affective valence.
- Have cross-species translatability.
- Can measure longer-term states.
- Are grounded in theory as well as empirically (allows predictions of how indicator reflects affective state).

But we still need measures that:
Cognitive bias as an indicator of animal affect

Empirical: in humans, affect reliably influences cognition (e.g. decision-making)

- Happy people judge ambiguous stimuli positively compared to unhappy people

- If emotion-induced **cognitive biases** (‘optimistic’ or ‘pessimistic’ decision-making in ambiguous situations) exist in other species, they could provide a valuable new indicator of animal emotion

- Such cognitive biases are likely to occur across species if they have **adaptive value**
Moods *integrate past experience* and guide adaptive decision-making, particularly in *ambiguous situations*.

- **Affective valence** ('mood states')
  - Positive
  - Negative

- **Decision-making under ambiguity** can be critical for survival.

- Harmful or threatening event
  - **‘Pessimistic’ decisions**
  - Negative mood state reflects cumulative experience of threat / harm and guides ‘pessimistic’ decisions under ambiguity

- Rewarding event
  - **‘Optimistic’ decisions**

- Cognitive bias as an indicator of animal affect
  - Moods integrate past experience and guide adaptive decision-making, particularly in ambiguous situations.
Happy people judge ambiguous stimuli positively compared to unhappy people. If emotion-induced cognitive biases (‘optimistic’ or ‘pessimistic’ decision-making in ambiguous situations) exist in other species, they could provide a valuable new indicator of animal emotion. Such cognitive biases are likely to occur across species if they have adaptive value. Need non-linguistic measures to explore whether cognitive biases do reflect emotional state in animals.
A test of decision-making under ambiguity in animals

Perform response $P$ to get food
Perform response $N$ to avoid noise

Performing response $P$ indicates anticipation of a positive event
Performing response $N$ indicates anticipation of a negative event

Affect and decision-making hypothesis: **PUN-H** rats more likely to respond to probes by performing response $N$ (‘pessimistic’ judgement of ambiguous stimuli as negative)

Test: Rats housed in unpredictable (mildly stressful), or stable and predictable conditions

Results: Rats in unpredictable housing conditions were more likely to treat probe tones as predicting a negative event (a ‘pessimistic’ response bias)
A spatial test of ‘judgement bias’ in response to ambiguity

Do REW-H rats show more ‘optimistic’ judgement of ambiguity?

latency to goal pot (s)

Location

unrewarded nearest unrewarded half-way nearest rewarded

enriched (REW-H)
unenriched

probe location*treatment F[2,4] = 7.16, P<0.05

Do **REW-L** rats show more ‘pessimistic’ judgement of ambiguity?

Two alternative active choice task

Preference for pressing +ve or -ve lever

**control strain**

**‘depressed’ strain (REW-L)**

Enkel et al. 2010. *Neuropsychopharmacology*
Do **PUN-H** rhesus macaques show more ‘pessimistic’ judgement of ambiguity than **REW-H** ones?

Do PUN-H rhesus macaques show more ‘pessimistic’ judgement of ambiguity than REW-H ones?

Mean proportion of Positive responses (screen touches)

- enriched (REW-H)
- vet inspection (PUN-H)

Length of cue on touch screen

unrewarded ambiguous cues rewarded

Generic judgement bias task has been used in over 100 published studies across species.

Majority of studies demonstrate that putative REW-H / PUN-L manipulations generate ‘optimistic’ responses and PUN-H / REW-L generate ‘pessimistic’ responses, but there are also null and opposite results – meta-analyses ongoing.

Different types of manipulation yield similar effects: a general measure of affective valence? Mammal, bird, insect studies, and fish soon too?

Task may provide a new and translational measure of affective valence in animals.
Future challenges: implementing and automating measures of animal affect

Screaming pigs...
Future challenges: implementing and automating measures of animal affect
Future challenges: implementing and automating measures of animal affect.
Future challenges: implementing and automating measures of animal affect

Aggression, sickness, and postsurgical pain impair nest-building and integration of new material into nests.

Possible false positives when temperature is high.
Future challenges: implementing and automating measures of animal affect

Individual affect monitoring requires automated individual identification

RFID; deep learning of individual ids?
Individual affect monitoring requires automated individual identification

Future challenges: implementing and automating measures of animal affect

RFID; deep learning of individual ids?
Future challenges: implementing and automating measures of animal affect. Individual affect monitoring requires automated individual identification.
Future challenges: implementing and automating measures of animal affect

Using AI and deep learning to develop new welfare and health indicators

Bristol researchers win EPSRC fellowship to develop AI for early disease diagnosis in calves

healthy calf

early-stage bovine respiratory disease

late-stage bovine respiratory disease

Dr John Fennell
PhD(Bristol), BSc(Bristol)
EPSRC Innovation Fellow

Dr Laszlo Talas
EPSRC Innovation Fellow
Area of research
Machine learning
Measurement of animal welfare requires accurate assessment of *animal affect*. A clear theoretical / operational perspective on animal affect is essential. A variety of animal affect measures have been / are being developed and validated. Implementation and automation of new methods is an essential and expanding area of research.
Thanks to: Liz Paul, Melissa Bateson, Emily Blackwell, Bill Browne, Oliver Burman, Gina Caplen, Rachel Casey, Alastair Cockburn, Innes Cuthill, Peter Dayan, Amanda Deakin, Carole Fureix, Iain Gilchrist, Emma Harding, Suzanne Held, Laura Higgs, James Hodge, Alasdair Houston, Kyo Iigaya, Wittawat Jitkrittum, Aurelie Jolivald, Sam Jones, Georgia Mason, John McNamara, Jo Murrell, Justyna Papciak, Vikki Neville, Christine Nicol, Richard Parker, Emma Robinson, Melissa Smith, Helena Tallack, Helena Telkanranta, Ralph Thompson, Anna Trevarthen, Pete Trimmer and many others.