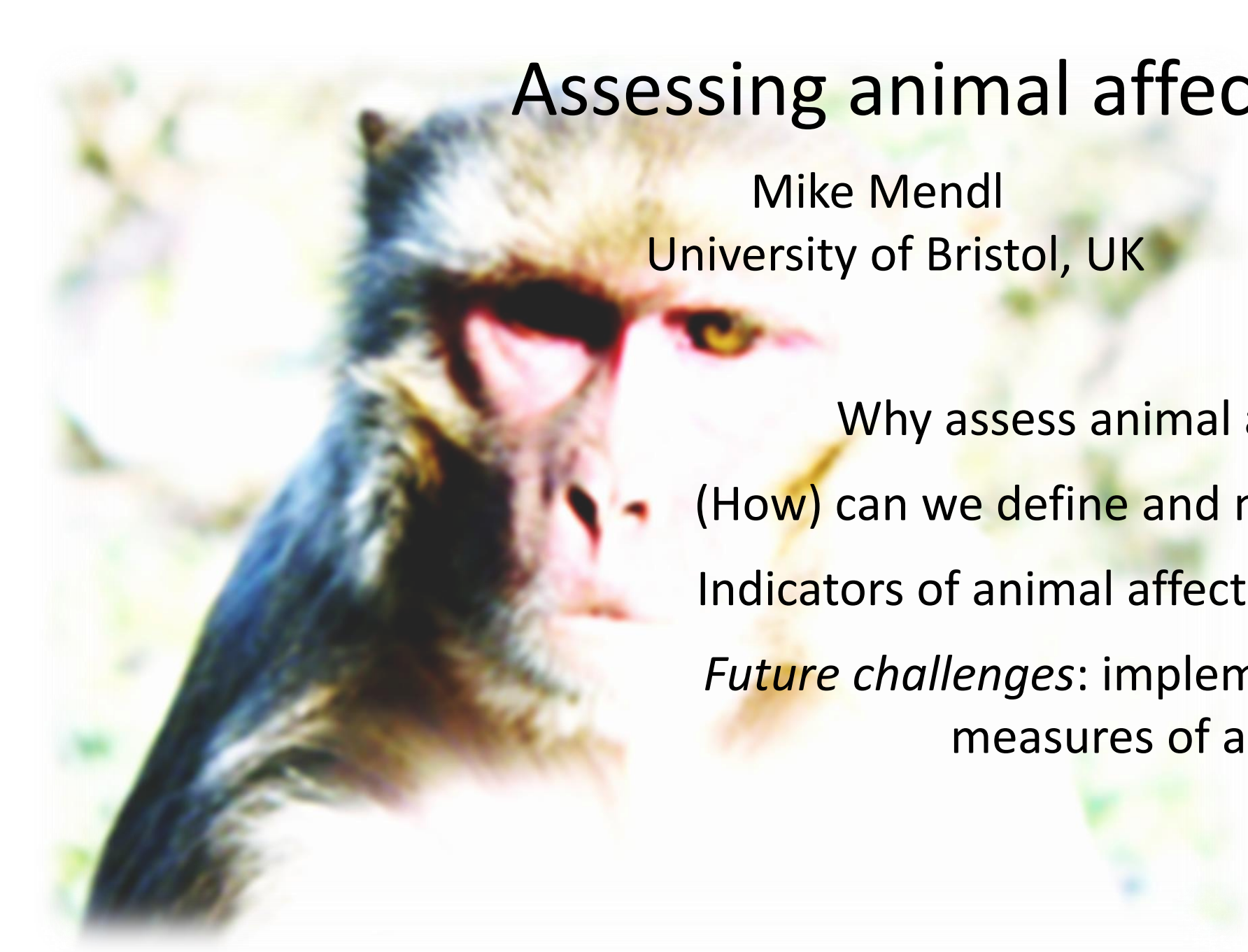


Assessing animal affect

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

Animal Welfare and Behaviour Group, University of Bristol

http://www.bristol.ac.uk/vetscience/research/welfare-behaviour/

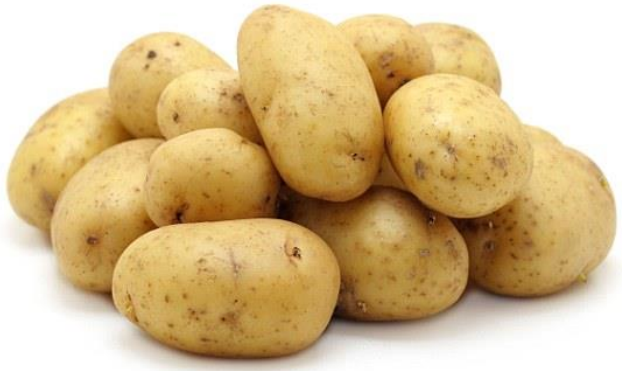
Identifying and tackling animal welfare problems, and implementing solutions

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



Why study animal affect?

There is recognition that animal ‘sentience’ underpins animal welfare obligations

Australian Animal Welfare Strategy (AAWS)

- Sentience is the reason that welfare matters

ACT to introduce laws recognising animal sentience, in Australian first

mandatory to consider animal sentience in all welfare laws

Animals are now legally recognised as 'sentient' beings in New Zealand

The legislation included a ban on the use of animals for cosmetic testing

Sophie McIntyre | Sunday 17 May 2015 11:27 |

Why study animal affect?

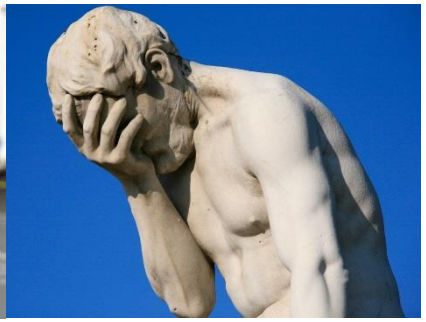
There is recognition that animal 'sentience' underpins animal welfare obligations

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 anim
beings,



Animal Welfare (Sentencing and Recognition of Sentience) Draft Bill

Presented to Parliament
by the Secretary of State for Environment, Food and Rural Affairs
by Command of Her Majesty

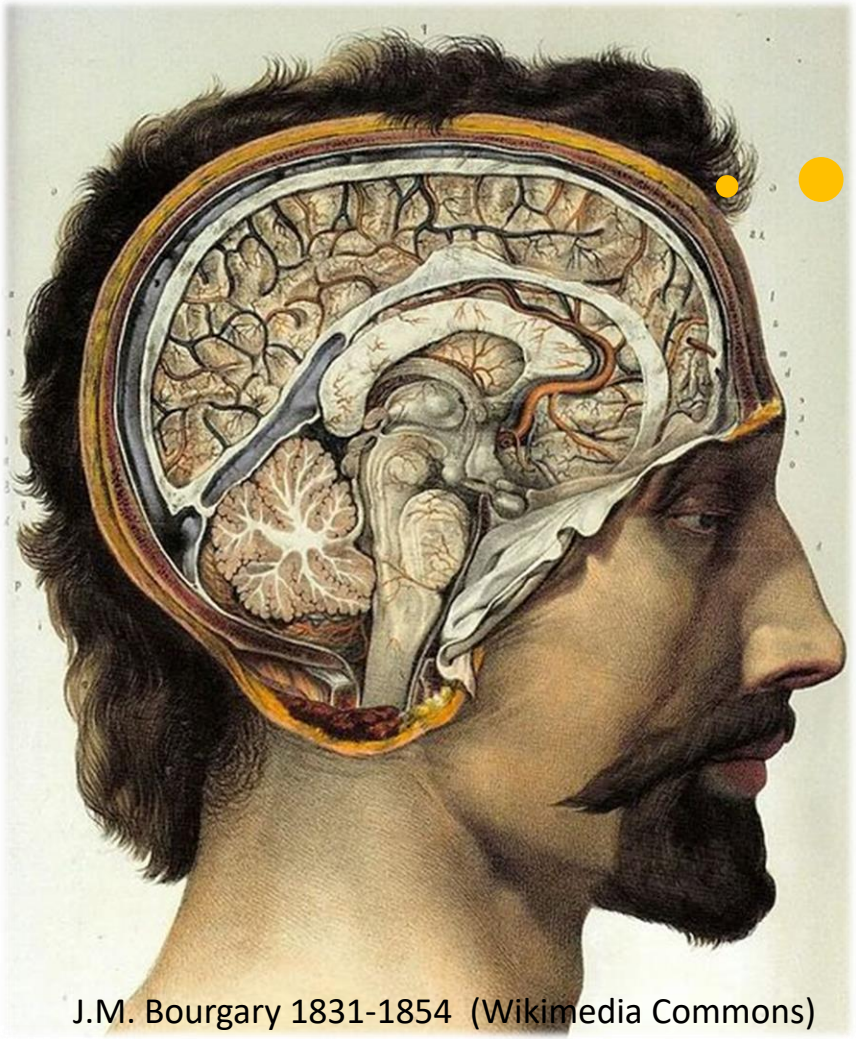
December 2017

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?



J.M. Bourgary 1831-1854 (Wikimedia Commons)

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?

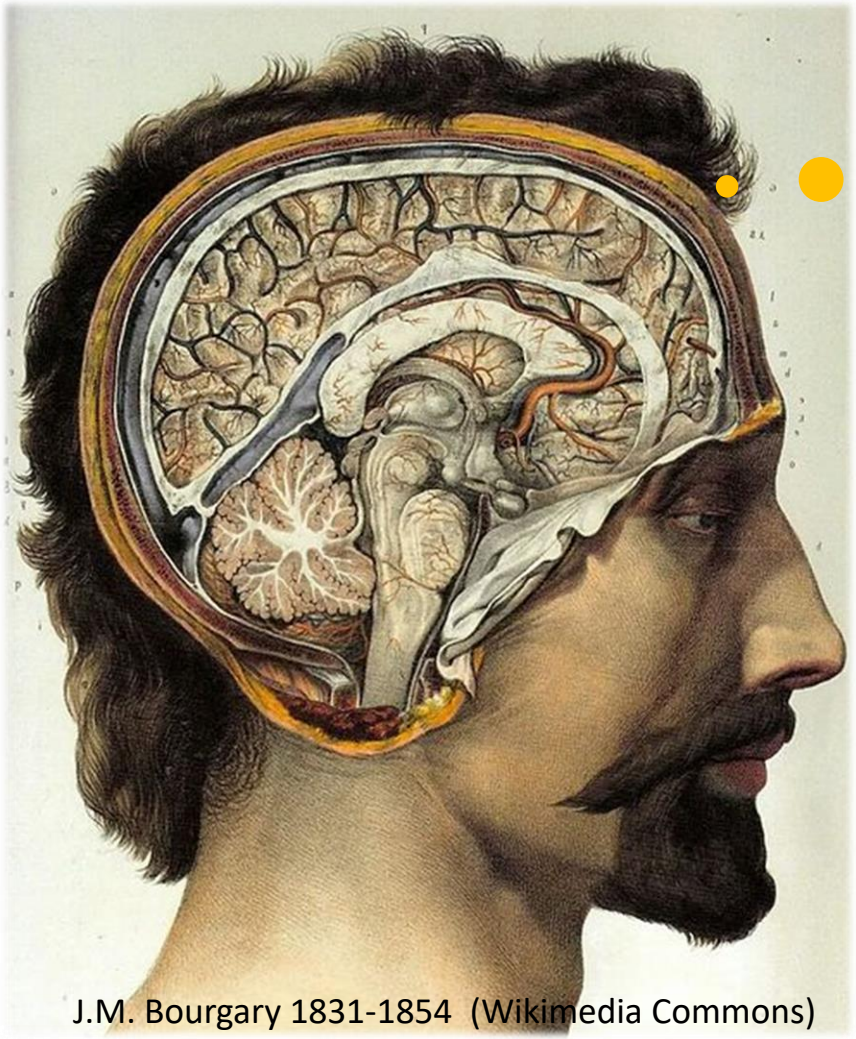
even in humans, emotion words are not universal

age-otori (上げ劣り)

(n.) the state of looking worse after getting a haircut

JAPANESE | wordstuck

What are affective (emotional) states?



J.M. Bourgary 1831-1854 (Wikimedia Commons)

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?

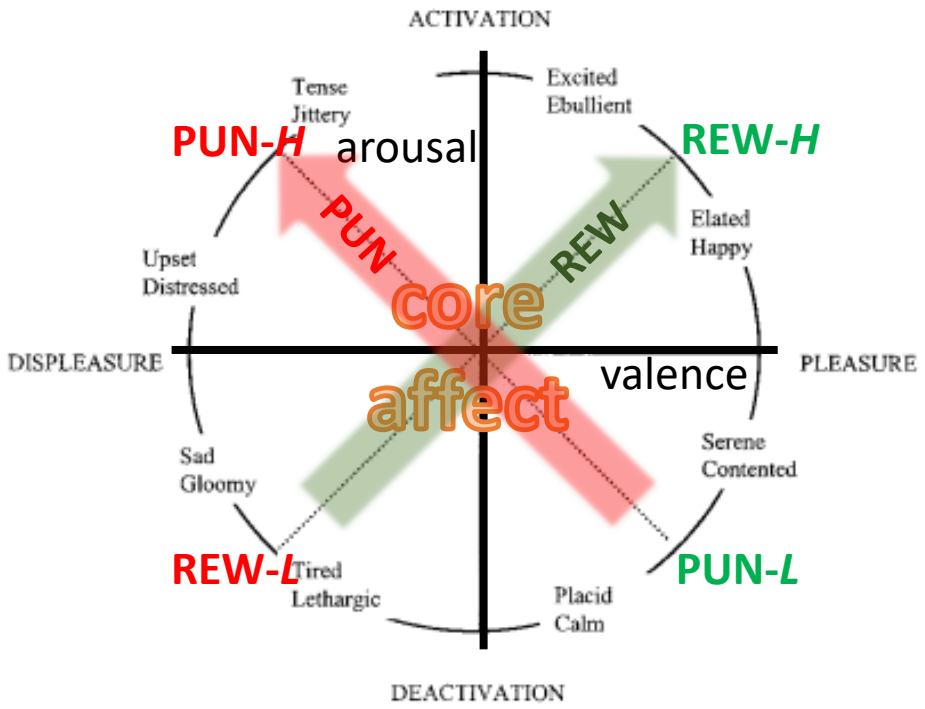
use of emotion words also implies consciousness

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

Russell & Feldman-Barrett 1999; Russell 2003; Feldman-Barrett 2017

What are affective (emotional) states?

Another way of looking at it

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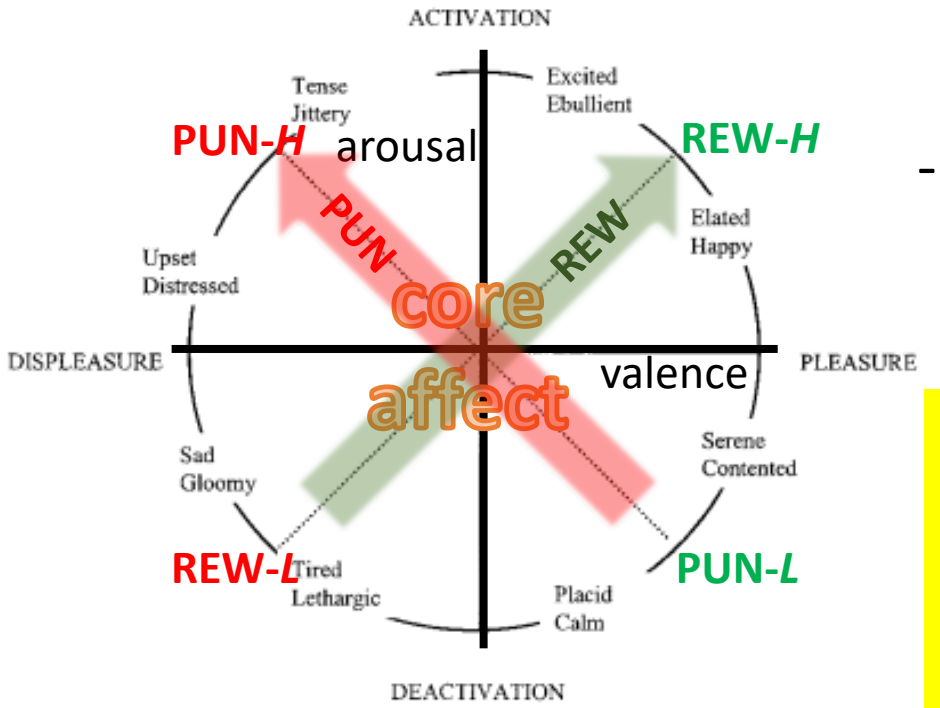


- arguable that animals more likely to share these 'building blocks' of emotion than specific discrete emotions
- the 4 basic states are less dependent on extrapolation from human feelings and emotion words, and dovetail with an *operational definition*:

"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"

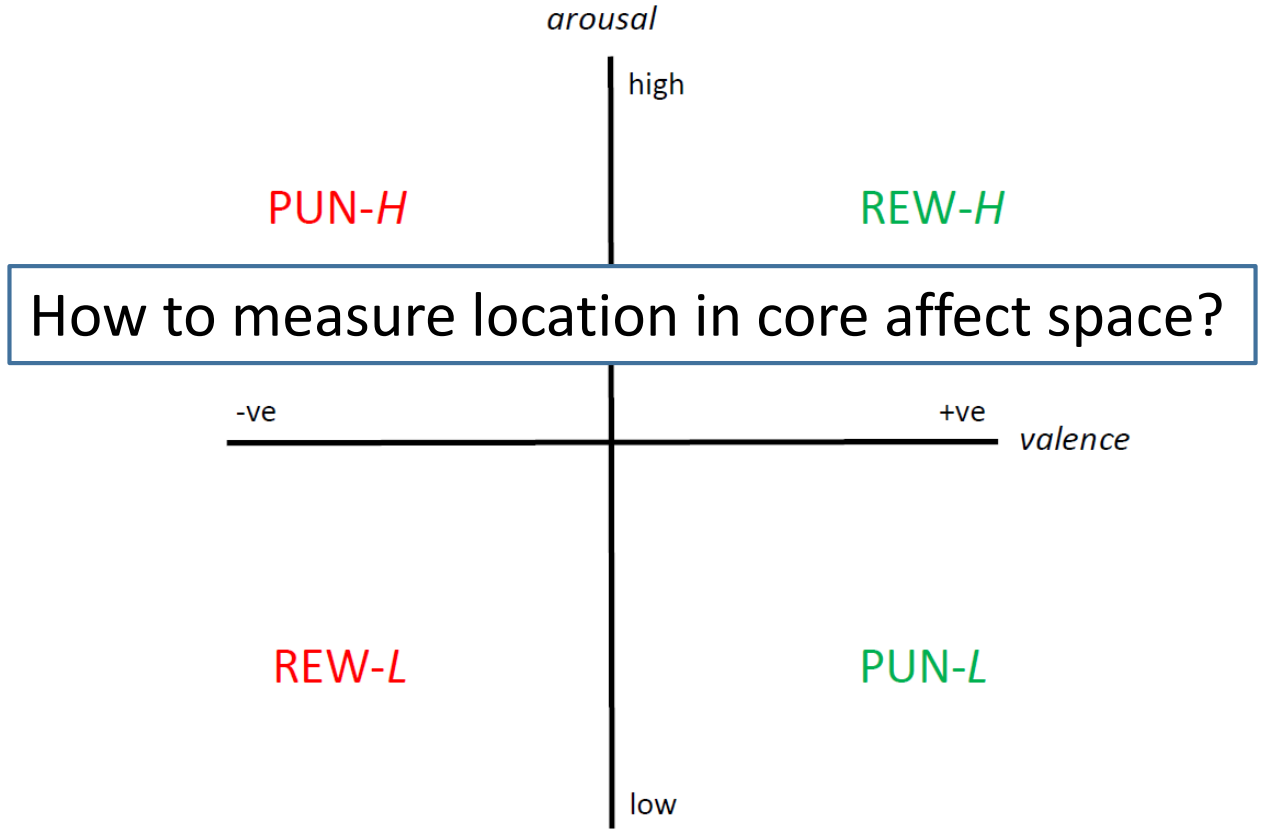
Rolls 2005, 2014; Paul & Mendl 2018

presence of a reward →**REW-*H***, or punisher →**PUN-*H***
absence/omission of a reward →**REW-*L***, or punisher →**PUN-*L***

Russell & Feldman-Barrett 1999; Russell 2003; Feldman-Barrett 2017

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 can we measure animal affect scientifically?

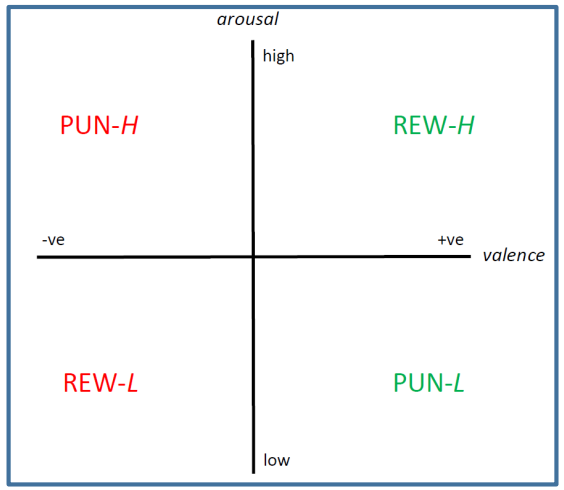
what we (as animal welfare researchers) are ultimately interested in

conscious emotional experience (feelings)?

what we can actually measure

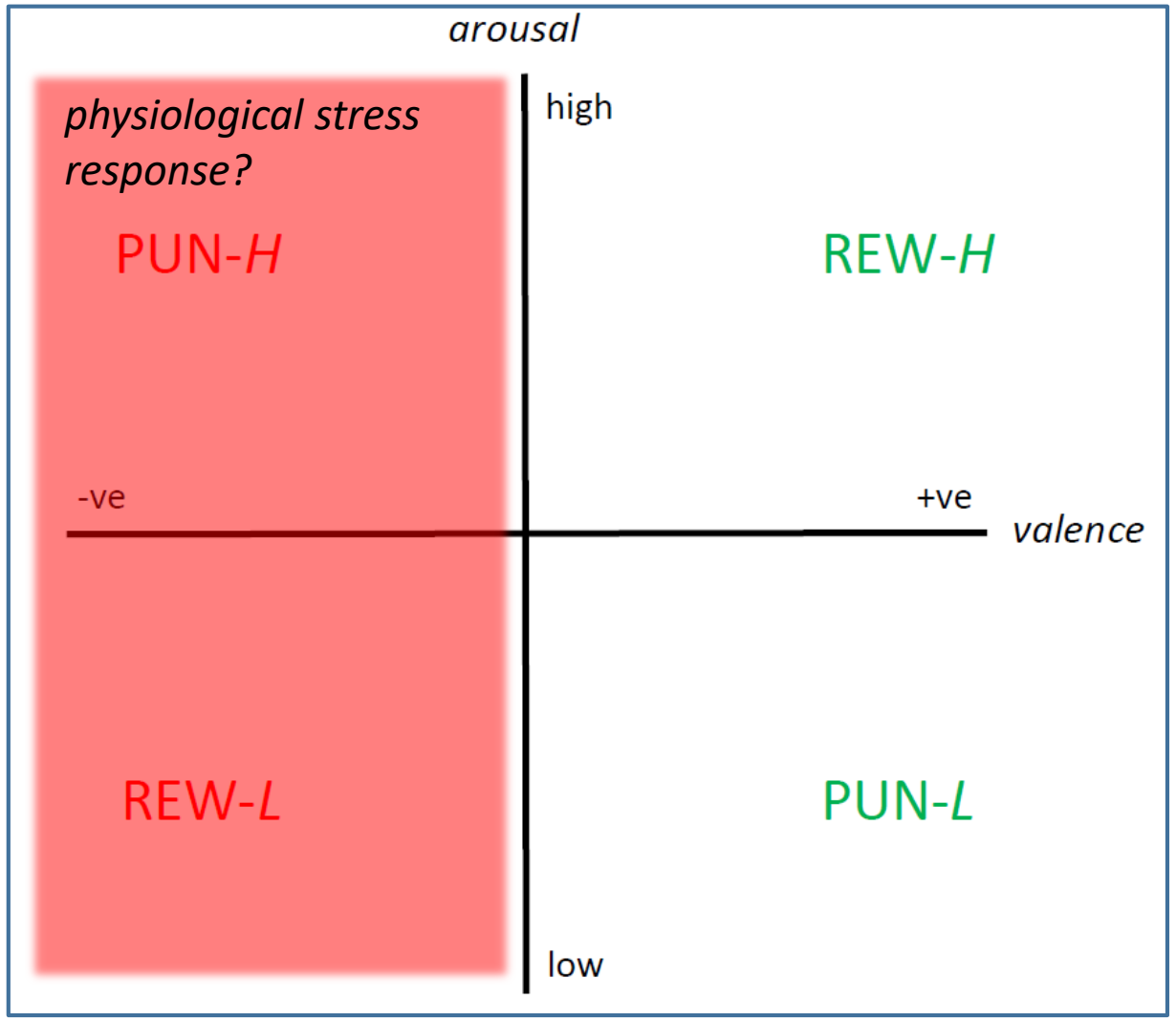
- brain activity
- physiology
- behaviour

affective state

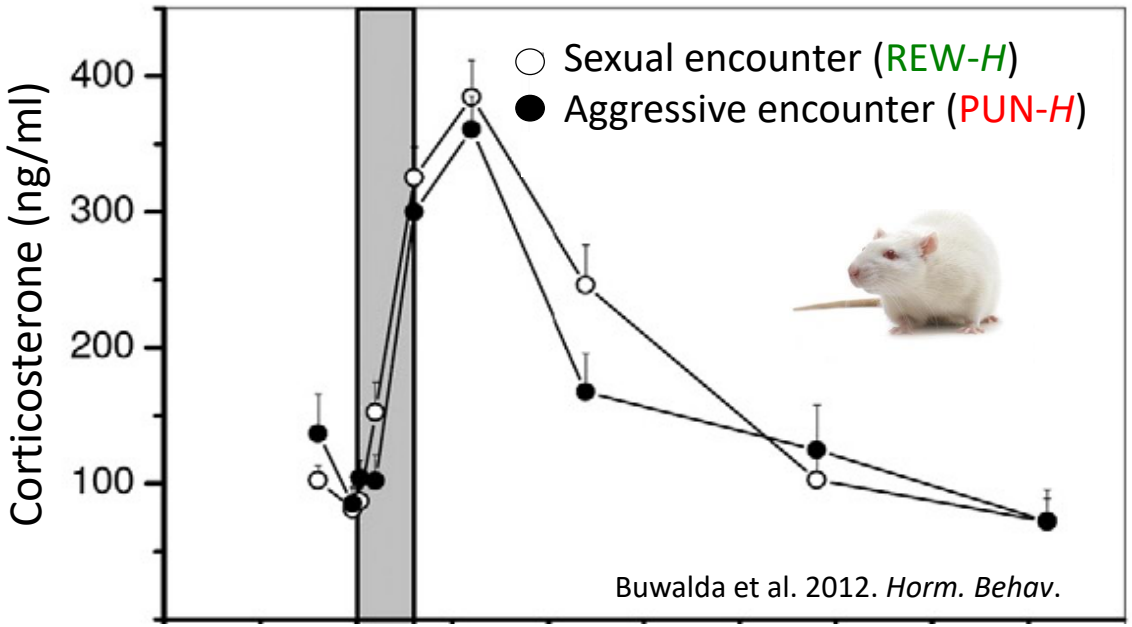


which measures can tell us about location in core affect space?

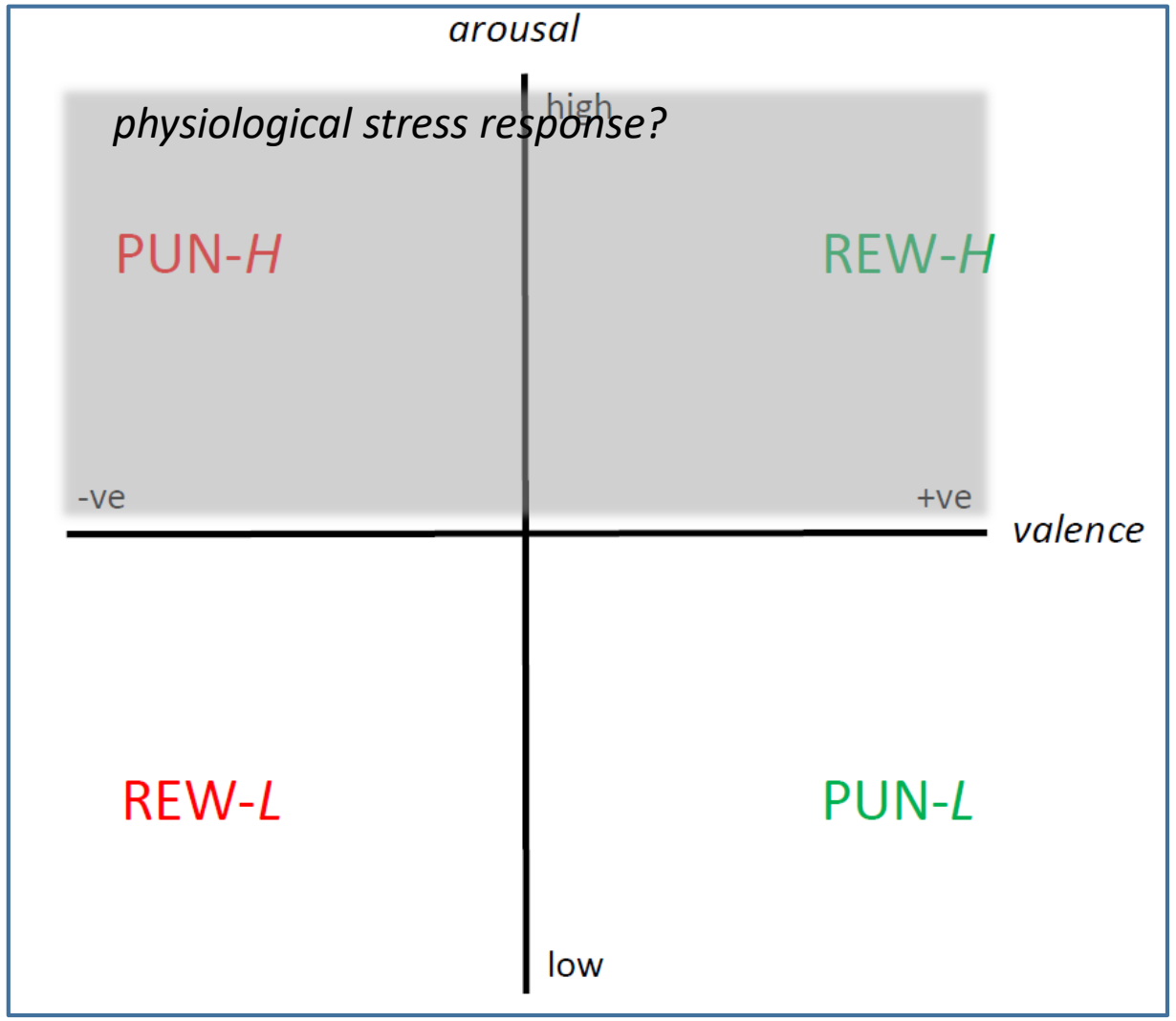
How can we measure animal affect scientifically?



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



How can we measure animal affect scientifically?



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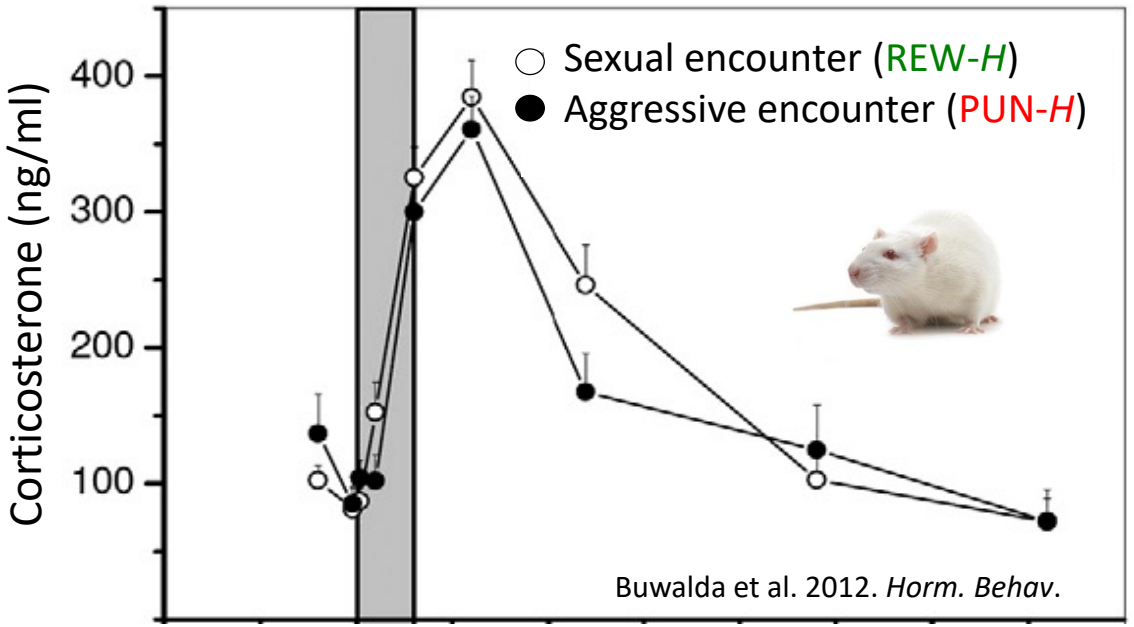
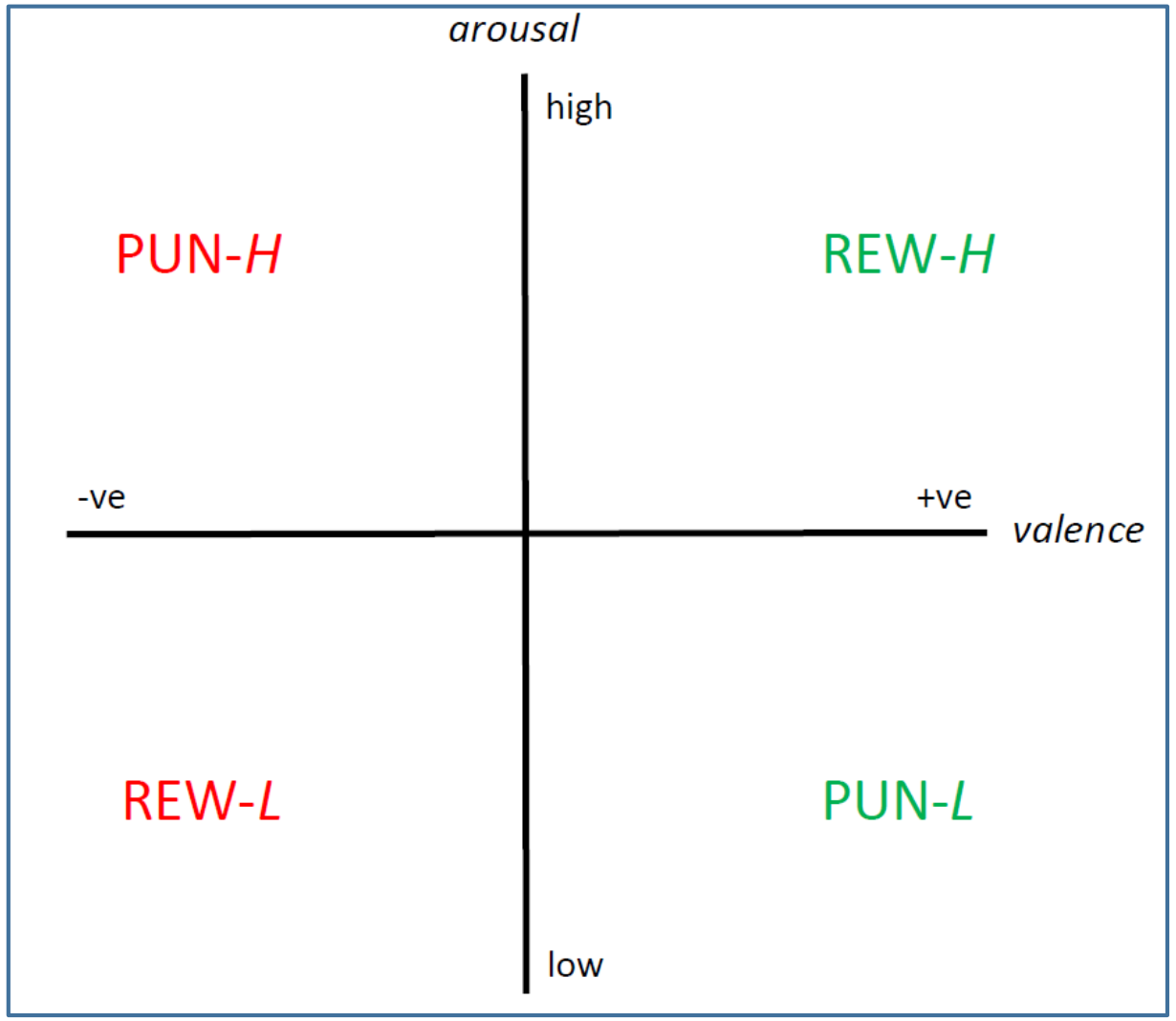


Measures arousal but not valence

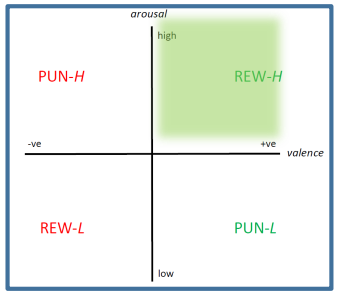
How can we measure animal affect scientifically?



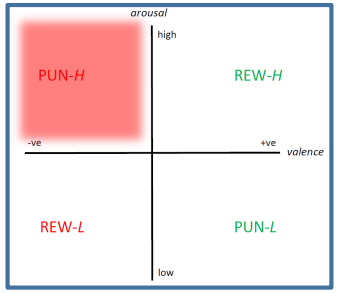
Vocalizations

Calls recorded in different social contexts

during approaches for affiliative interactions

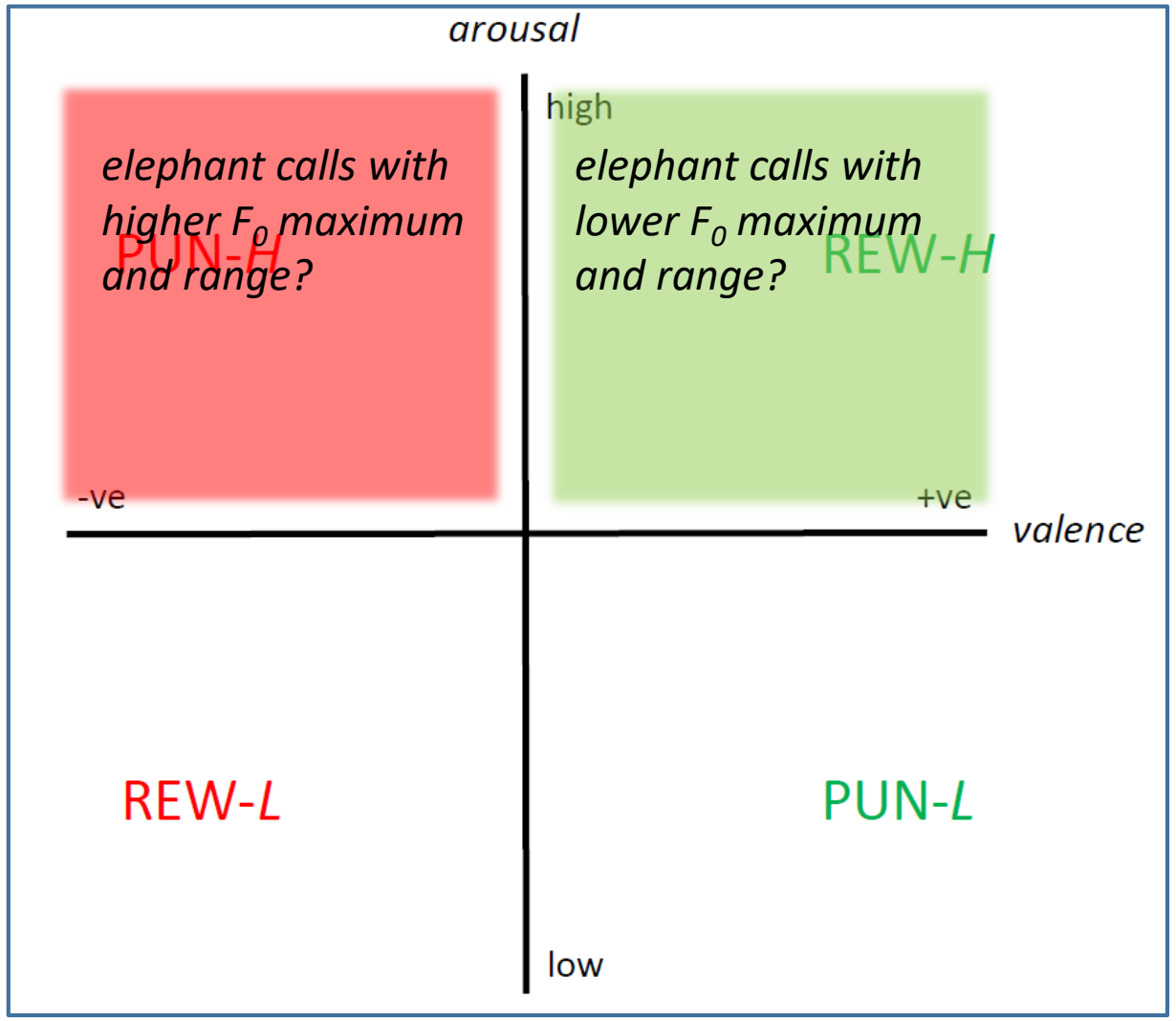


during conflict interactions

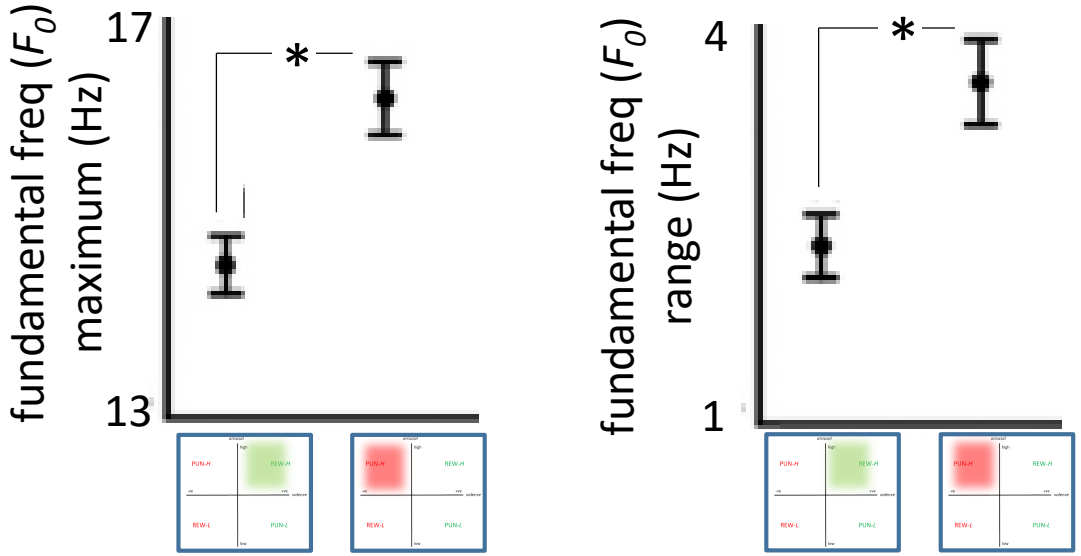


Soltis et al. 2011. *J. Acoustic Soc. Amer.*

How can we measure animal affect scientifically?



Vocalizations



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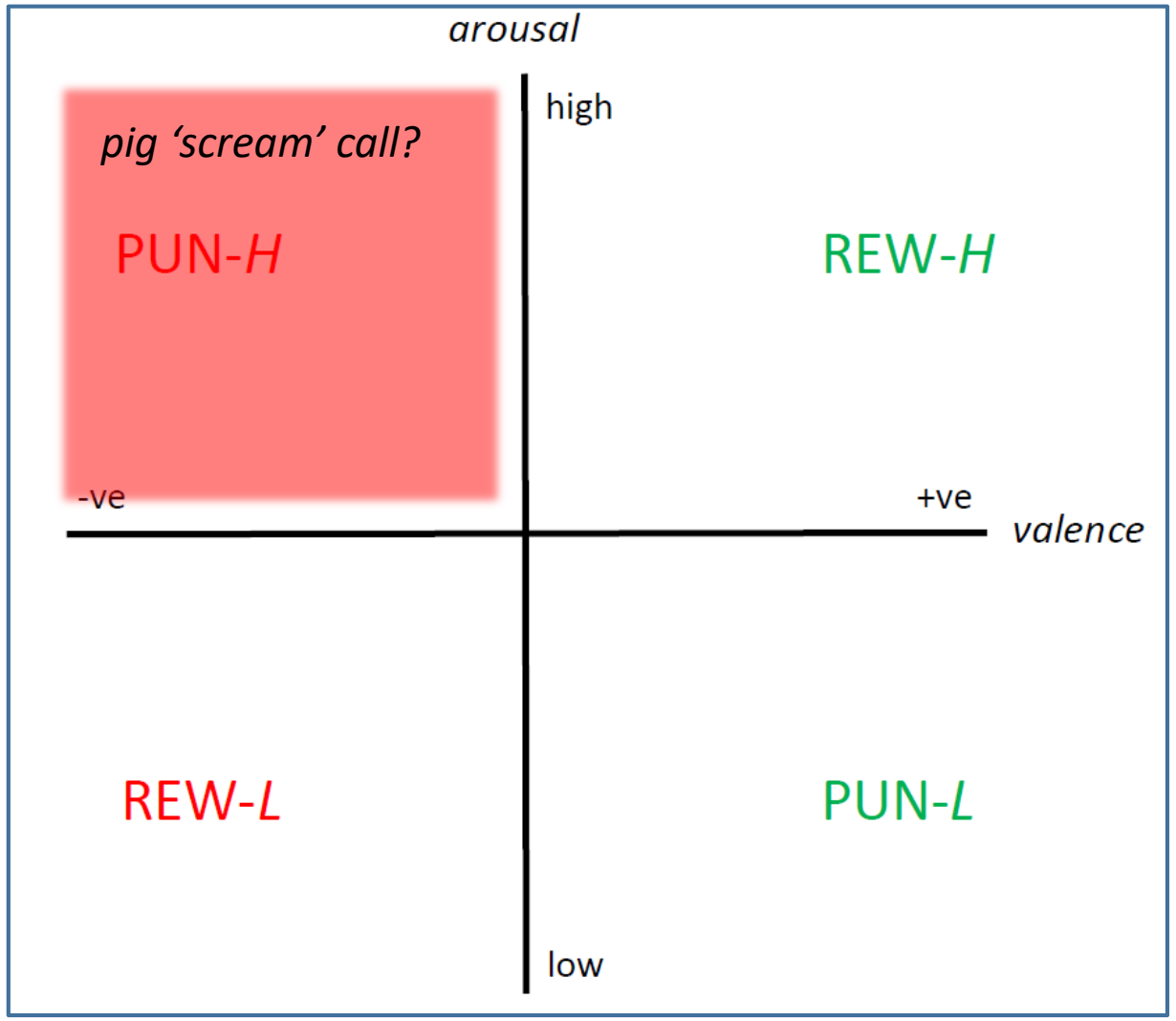
How can we measure animal affect scientifically?



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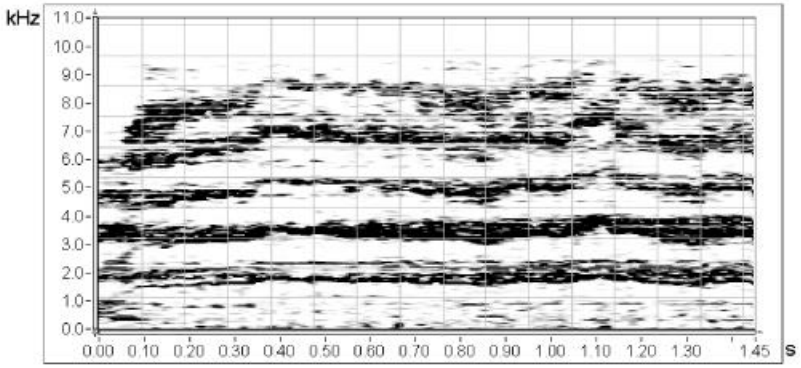


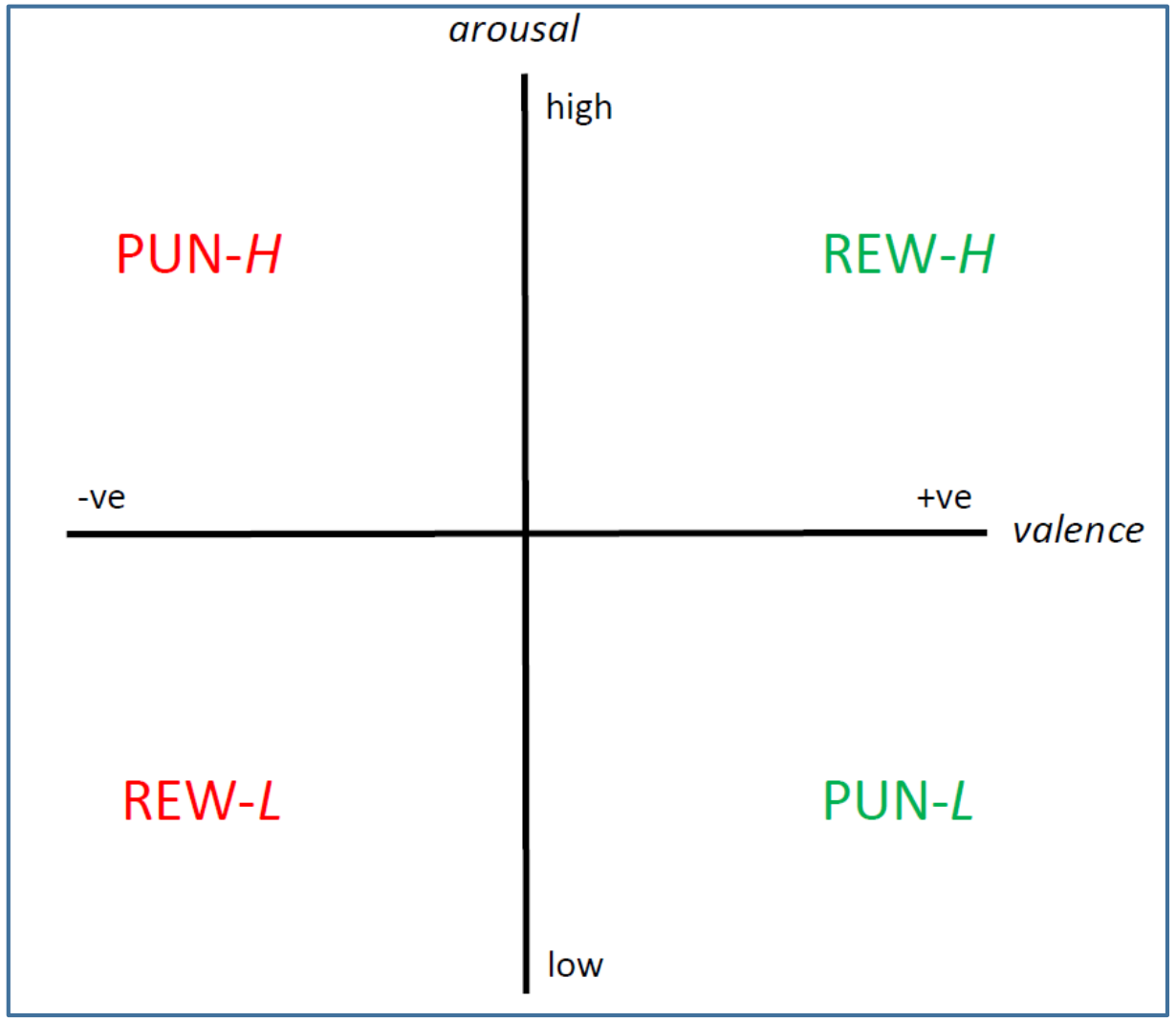
Vocalization emitted in apparently stressful contexts

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

Schön et al. 2004. *Anim. Welfare*

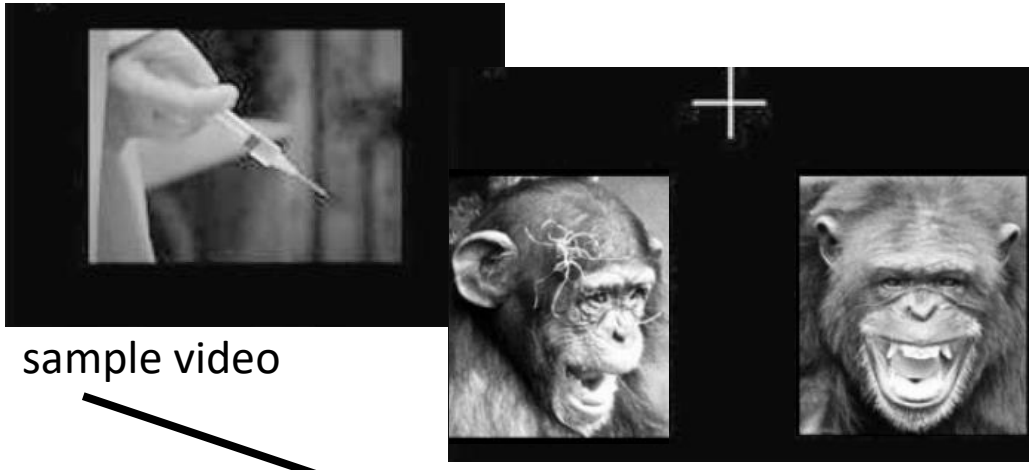
How can we measure animal affect scientifically?



Facial expressions

'play-face' scream

How do chimps perceive these?

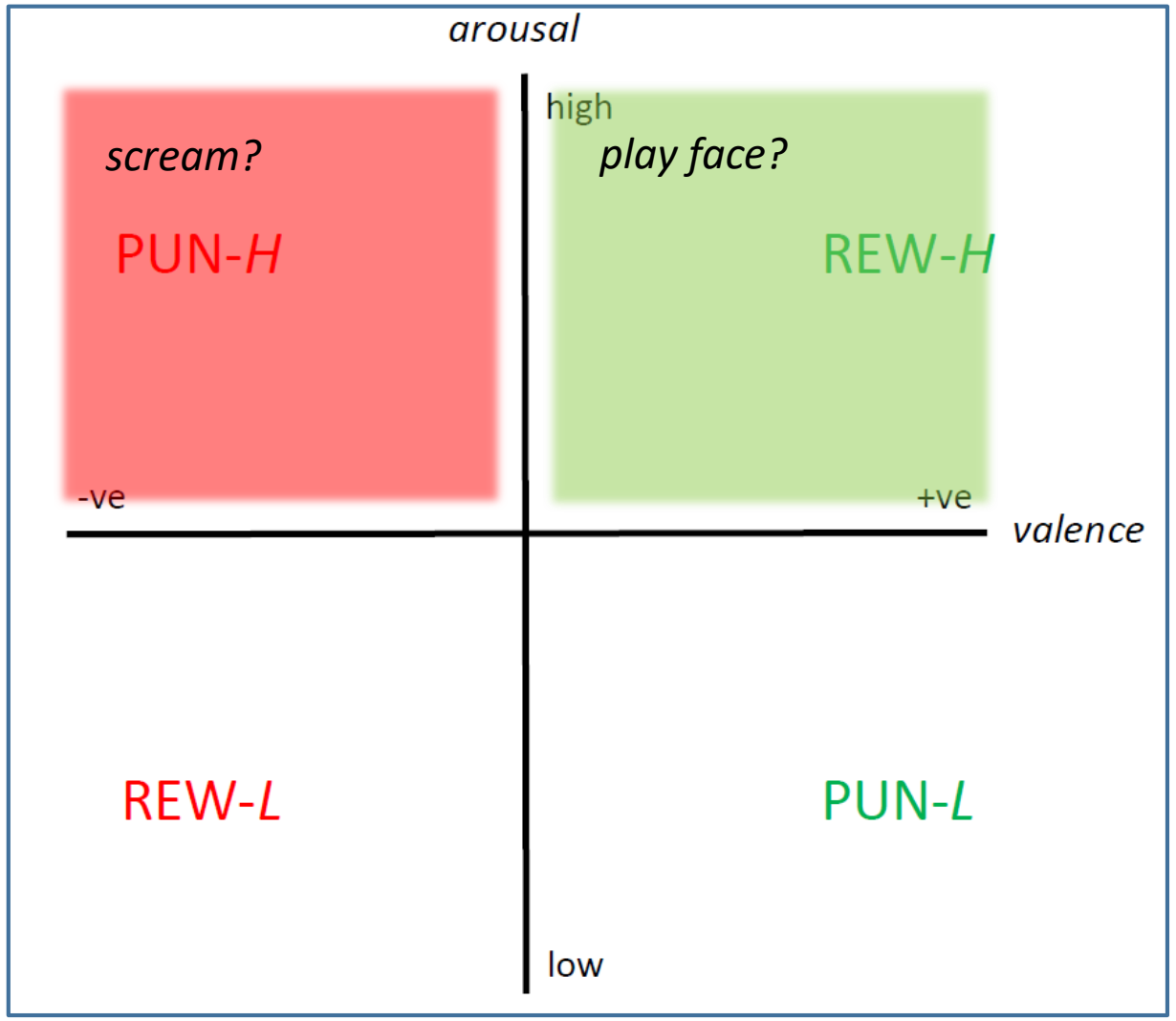


sample video

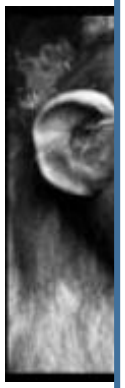
pick expression with similar valence

Parr et al. 2001. *Anim Cogn*

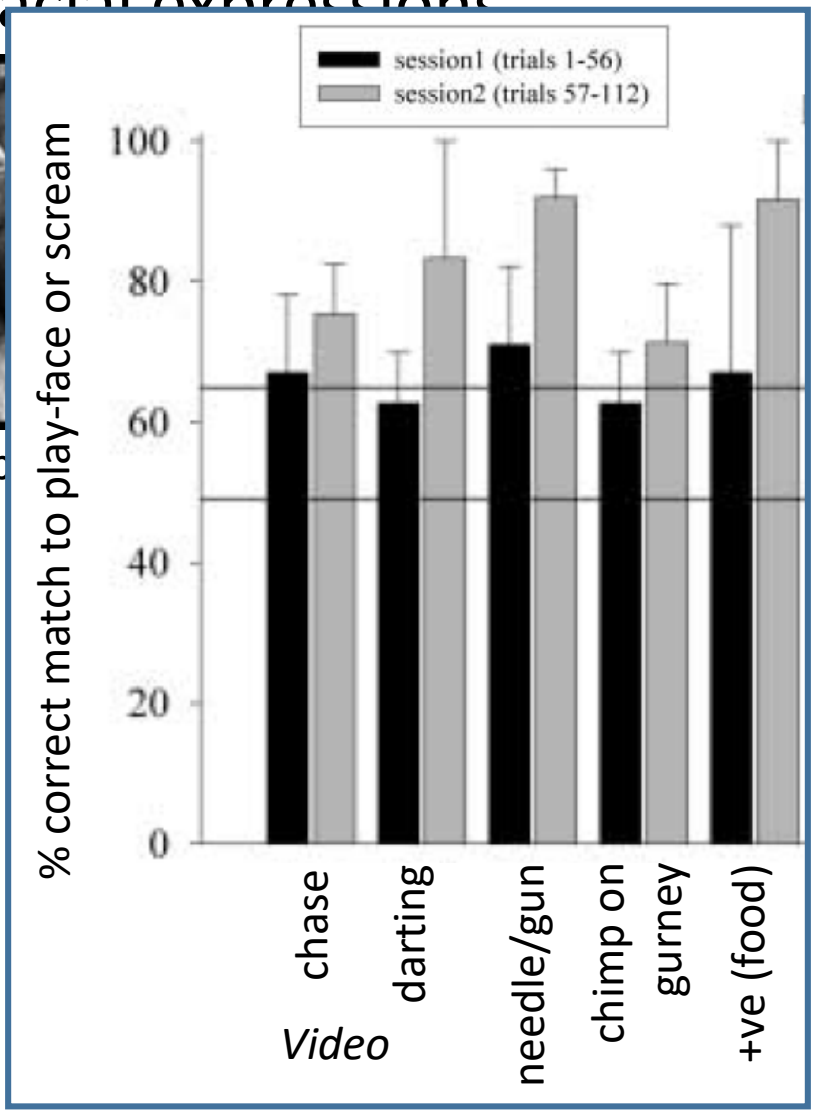
How can we measure animal affect scientifically?



Facial expressions



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



Parr et al. 2001. *Anim Cogn*

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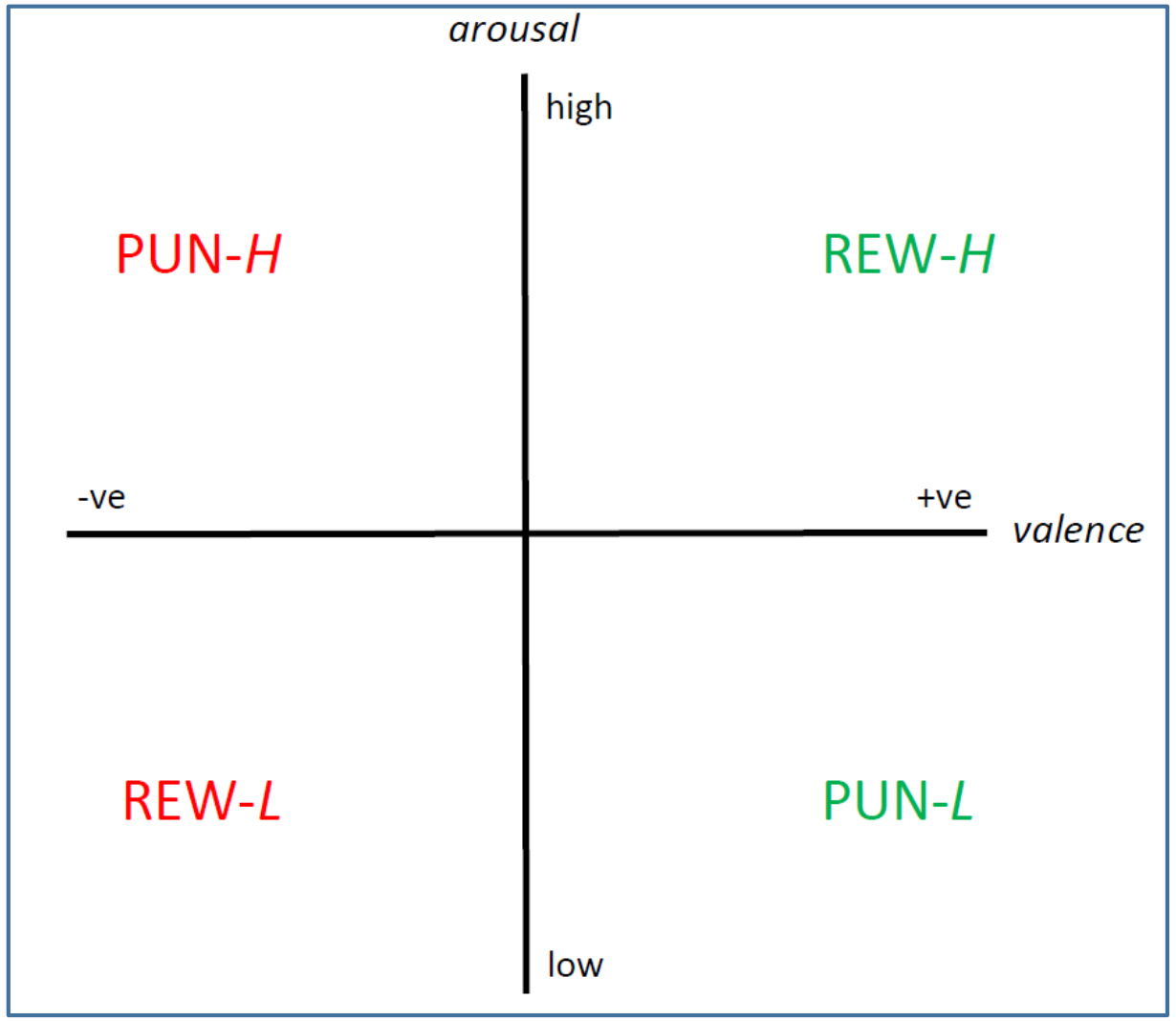


Valuable measures of animal affect exist and are being developed

But we still need measures that:

- 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)

Cognitive bias as an indicator of animal affect

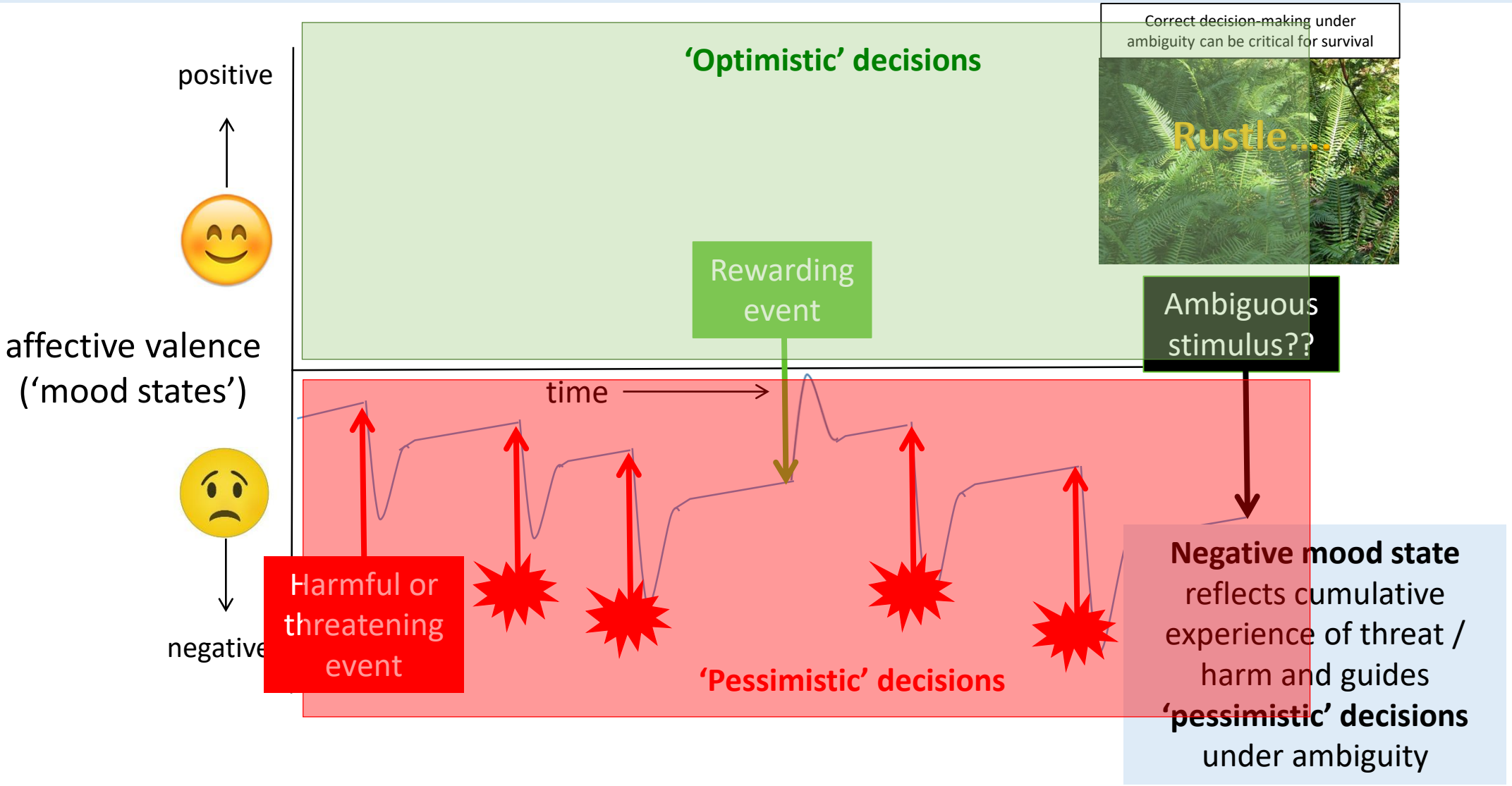
Empirical: in humans, affect reliably influences cognition (e.g. decision-making)

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*



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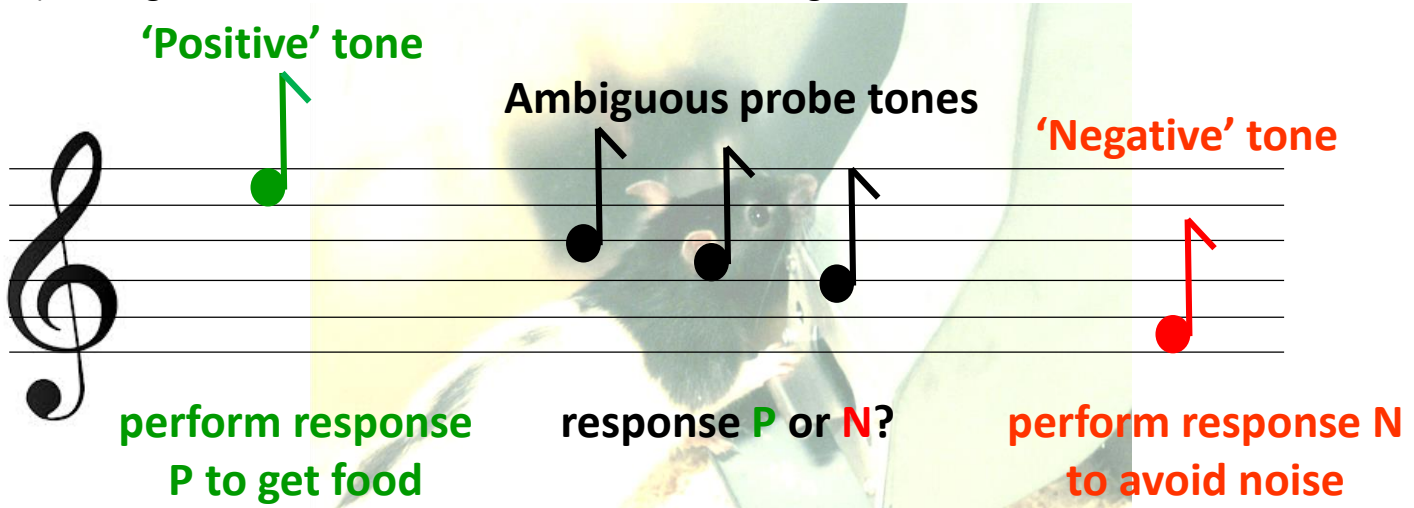
Such cognitive biases are likely to occur across species if they have ***adaptive value***

Need *non-linguistic* measures to explore whether cognitive biases do reflect emotional state in animals

A test of decision-making under ambiguity in animals

(Harding, Paul & Mendl. 2004. *Nature*; Paul, Harding & Mendl. 2005. *Neurosci. Biobehav. Rev.*)



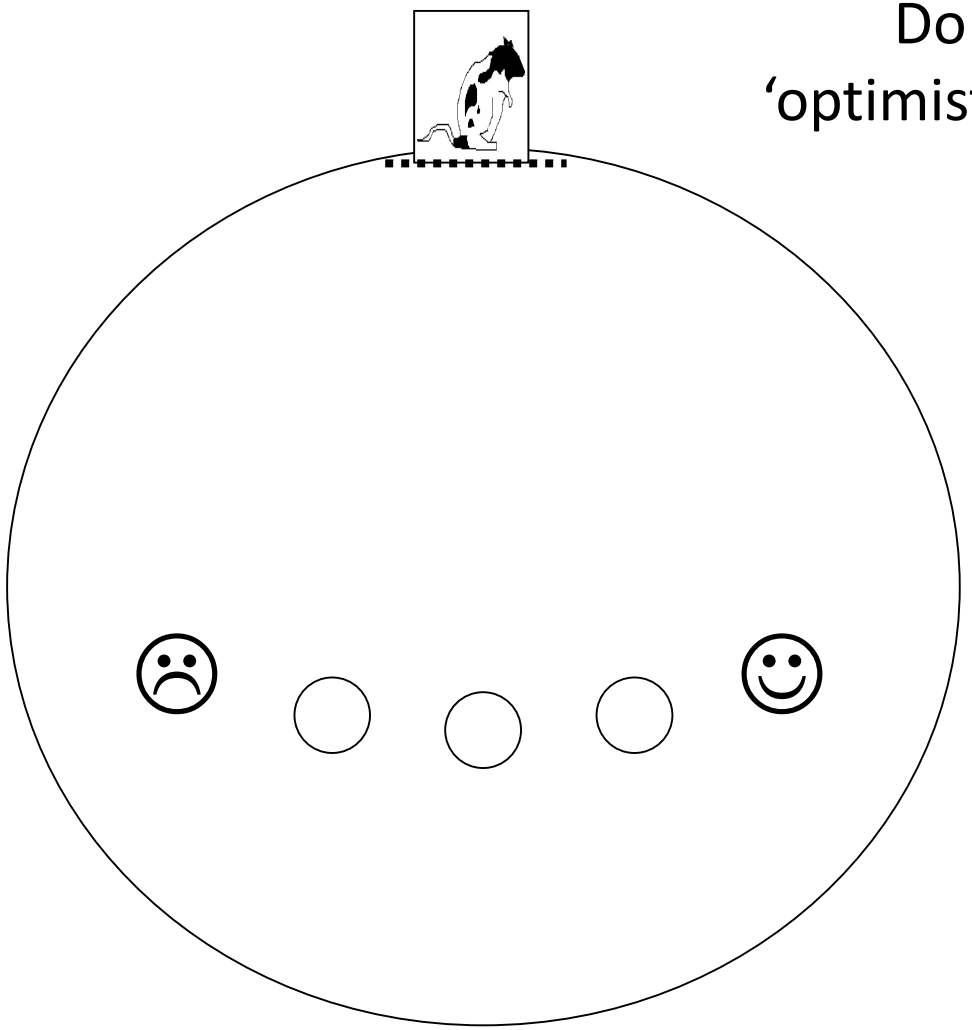
Performing response P indicates anticipation of a positive event
Performing response N indicates anticipation of a negative event

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

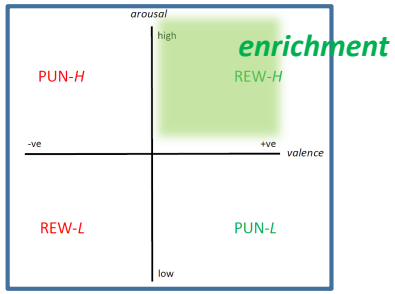
Test: Rats housed in unpredictable (mildly stressful), or stable and predictable conditions

Results: Rats in unpredictable housing conditions were more likely to treat probe tones as predicting a negative event (a 'pessimistic' response bias)

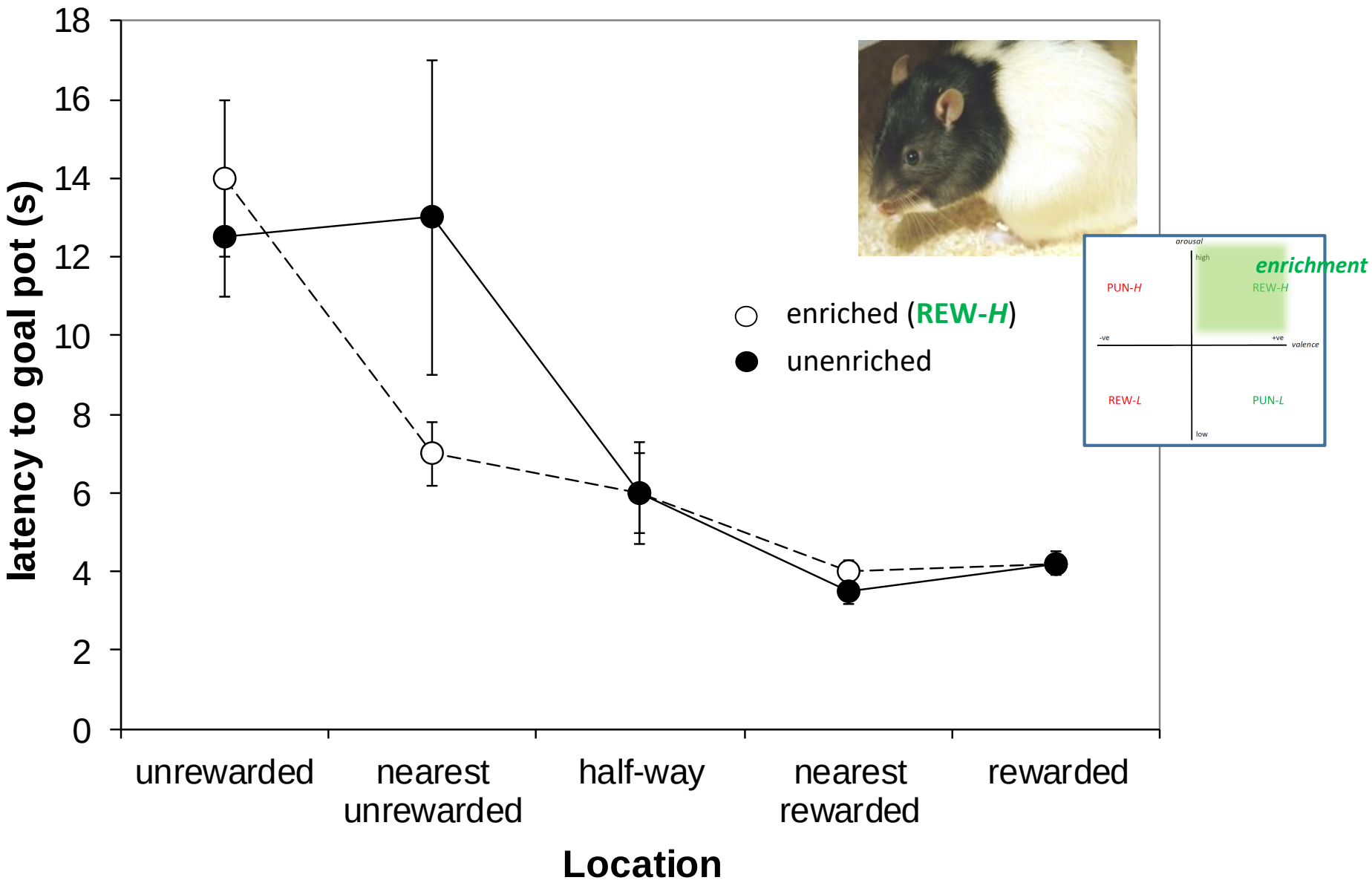
A spatial test of '*judgement bias*' in response to ambiguity



Do **REW-*H*** rats show more 'optimistic' judgement of ambiguity?

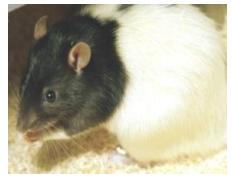


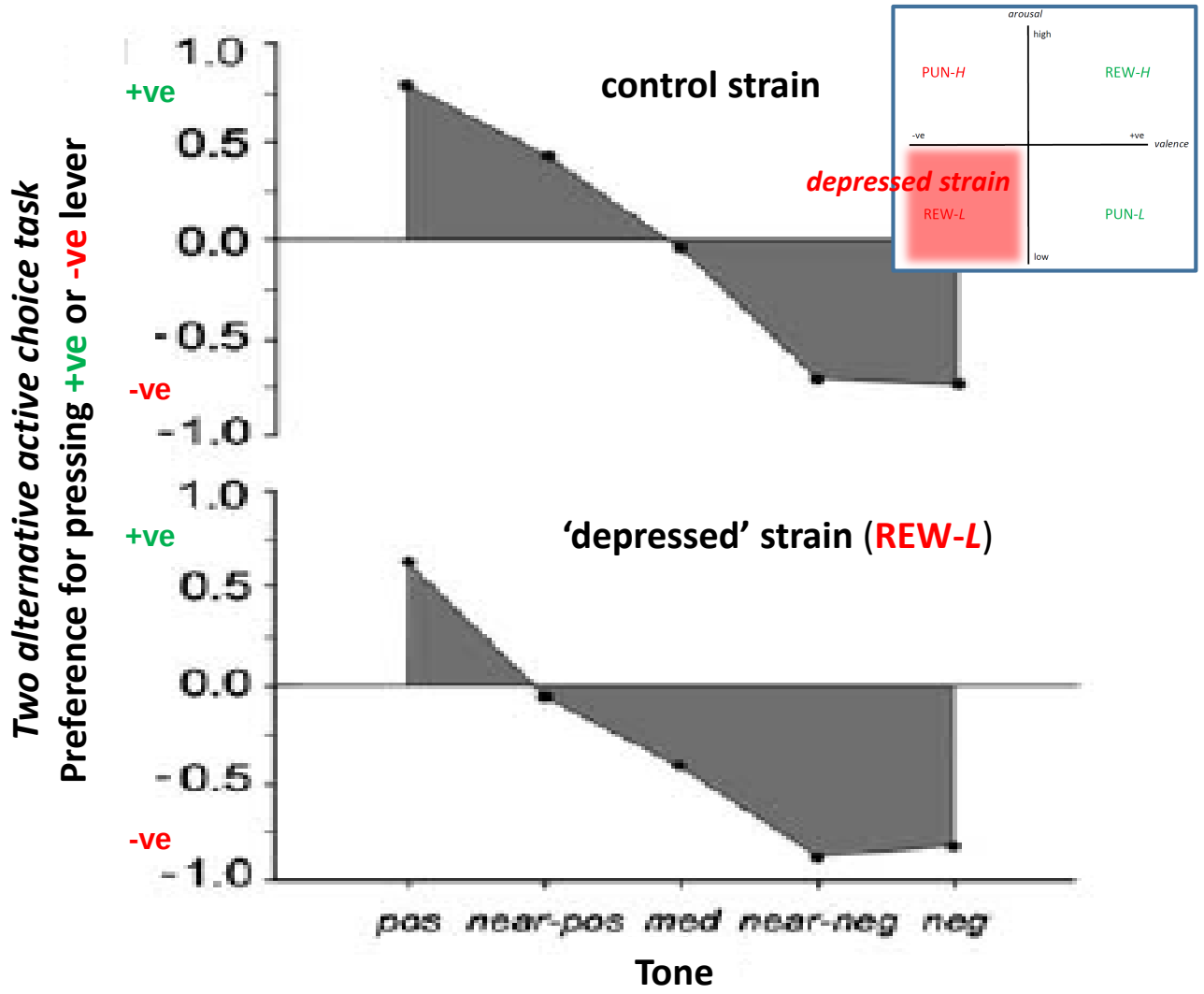
Burman et al. 2008. *Anim. Behav.*



Burman et al. 2008. *Anim. Behav.*

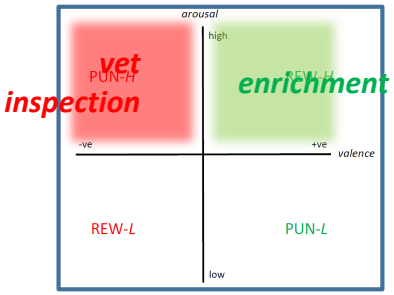
Do REW-*L* rats show more 'pessimistic' judgement of ambiguity?

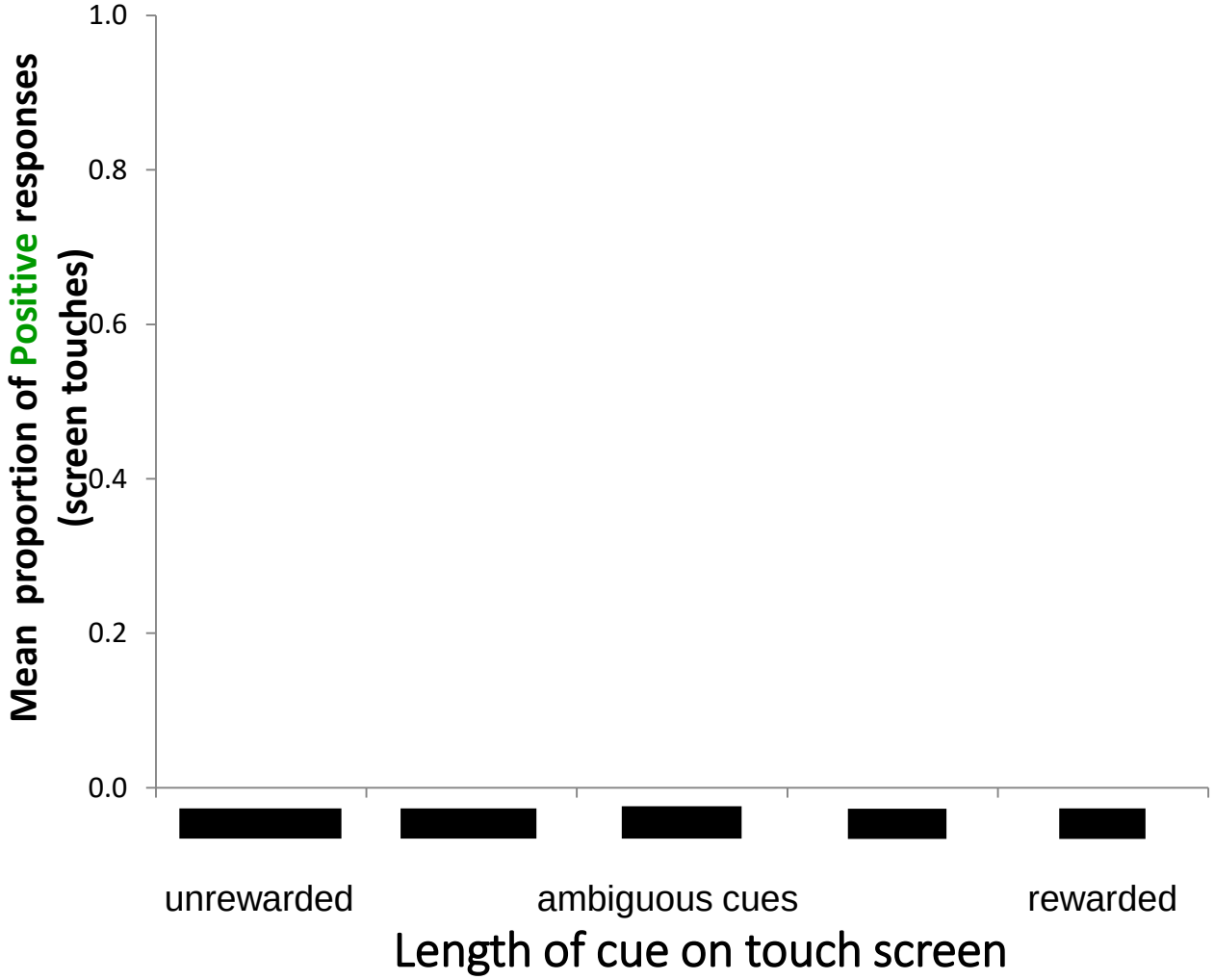




Enkel et al. 2010. *Neuropsychopharmacology*

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






Jakub Halun (Wikimedia Commons)

Bethell et al. 2012. *Anim. Welfare*

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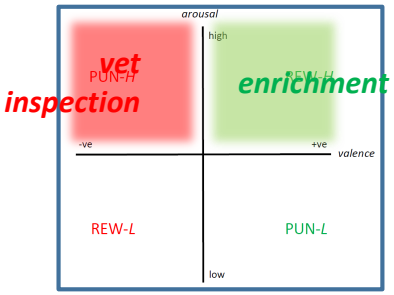
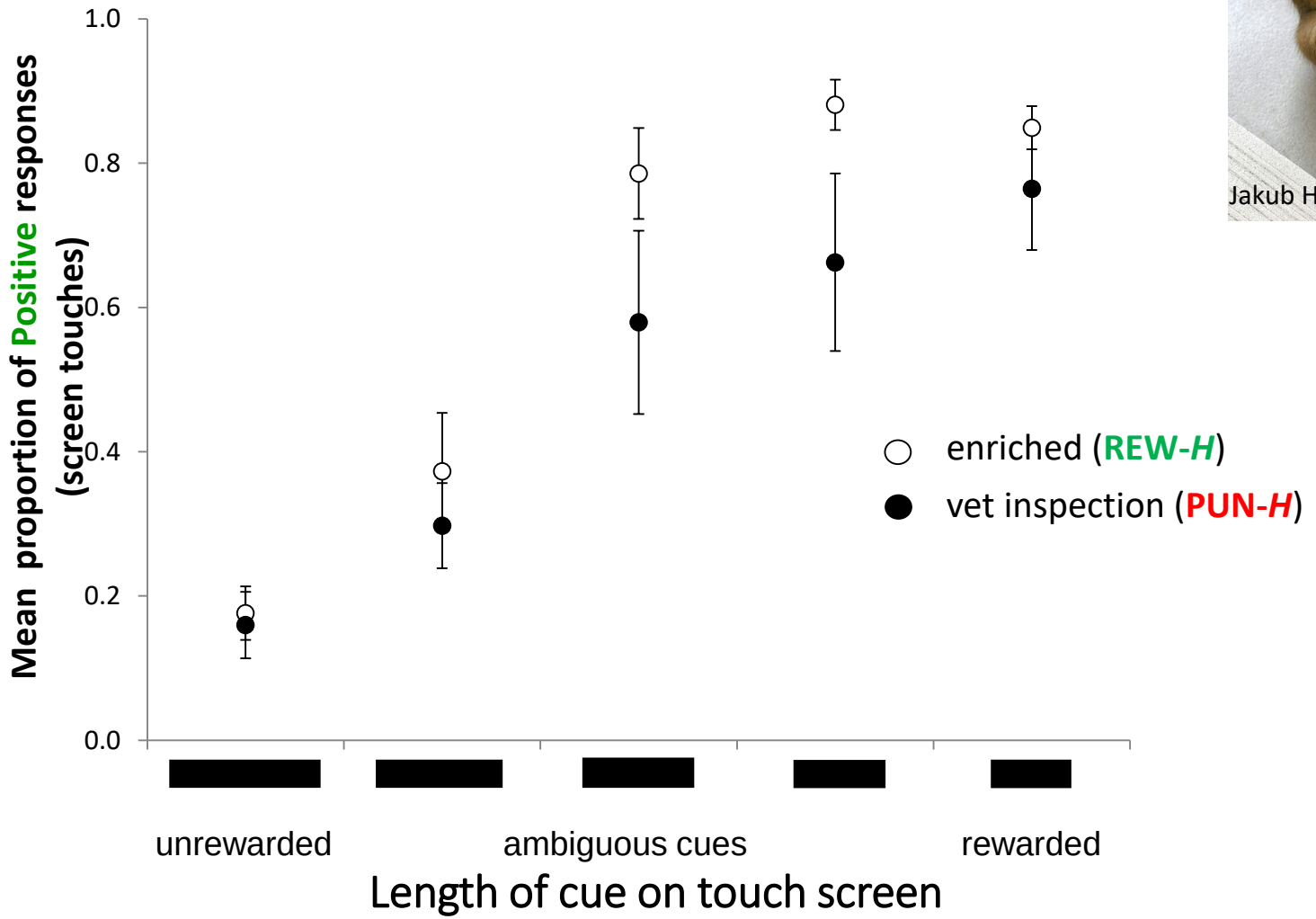



Jakub Halun (Wikimedia Commons)



Bethell et al. 2012. *Anim. Welfare*

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

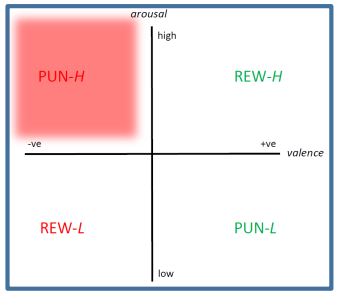
Majority of studies demonstrate that putative **REW-*H* / PUN-*L*** manipulations generate 'optimistic' responses and **PUN-*H* / REW-*L*** generate 'pessimistic' responses, but there are also null and opposite results – meta-analyses ongoing

Different types of manipulation yield similar effects: a general measure of affective valence?

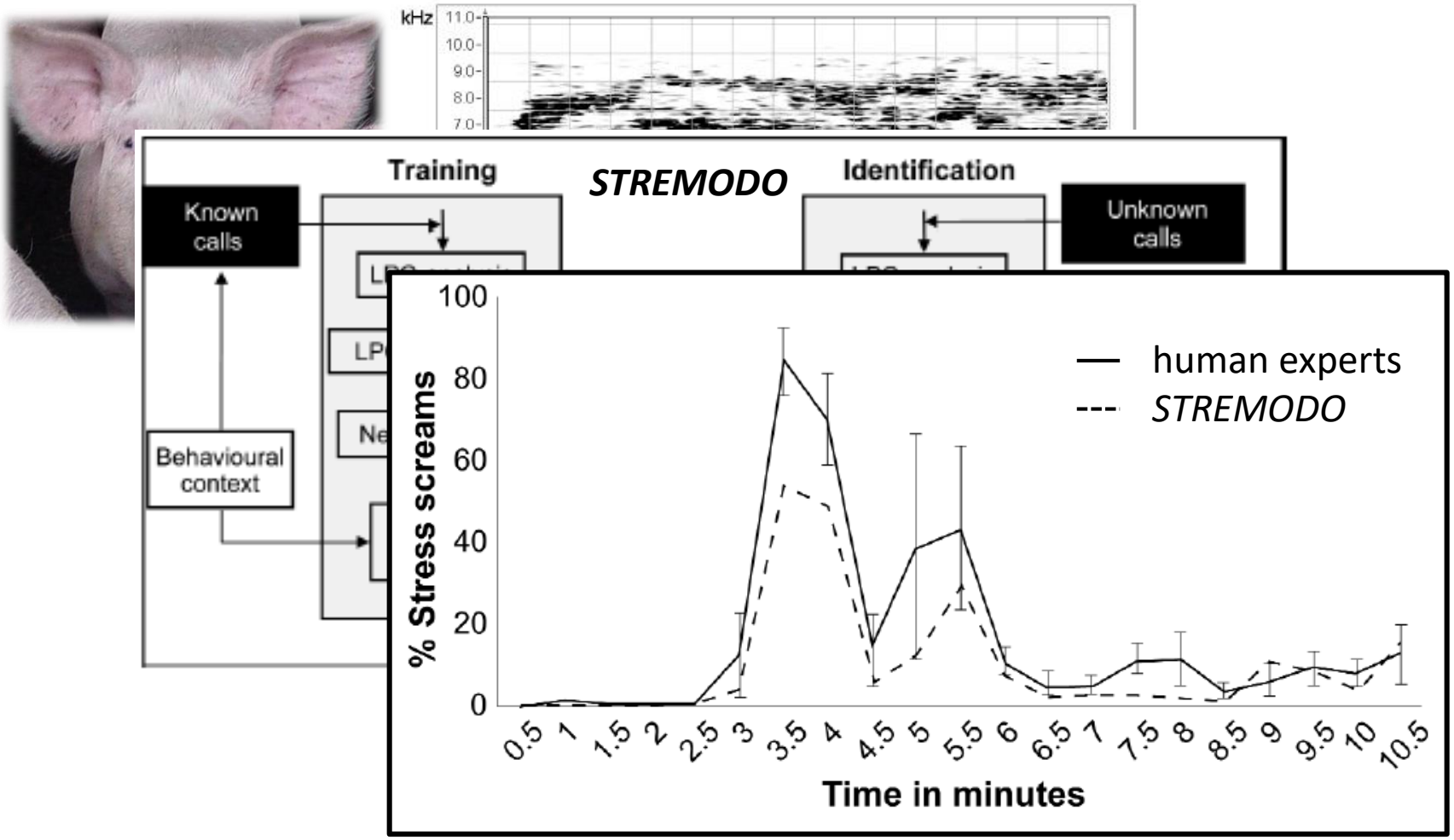
Mammal, bird, insect studies, and fish soon too?

Task may provide a new and translational measure of affective valence in animals

Future challenges: implementing and automating measures of animal affect

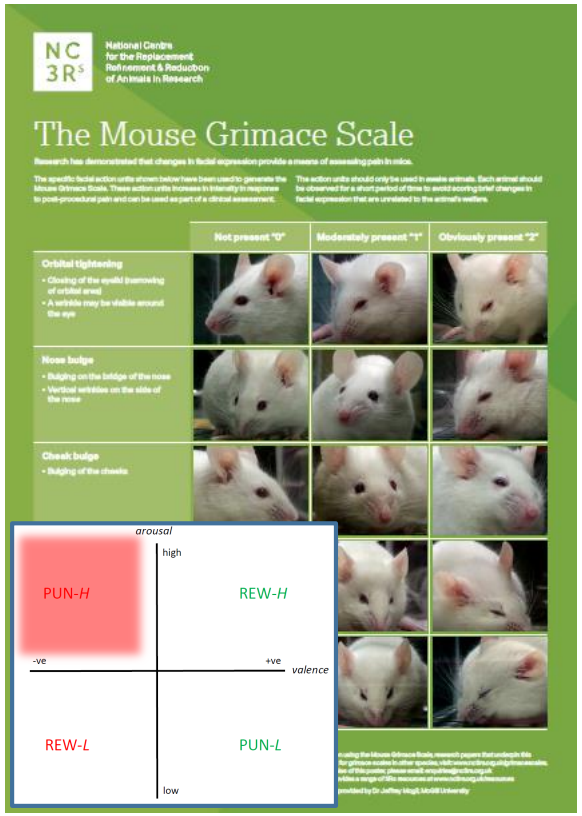


Screaming pigs…



Schön et al. 2004. *Anim. Welfare*

Future challenges: implementing and automating measures of animal affect



in-cage video

Research Article

MOLECULAR PAIN

A deep neural network to assess spontaneous pain from mouse facial expressions

Molecular Pain
Volume 14: 1–9
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DOI: 10.1177/1744806918763658
journals.sagepub.com/home/mpx
SAGE

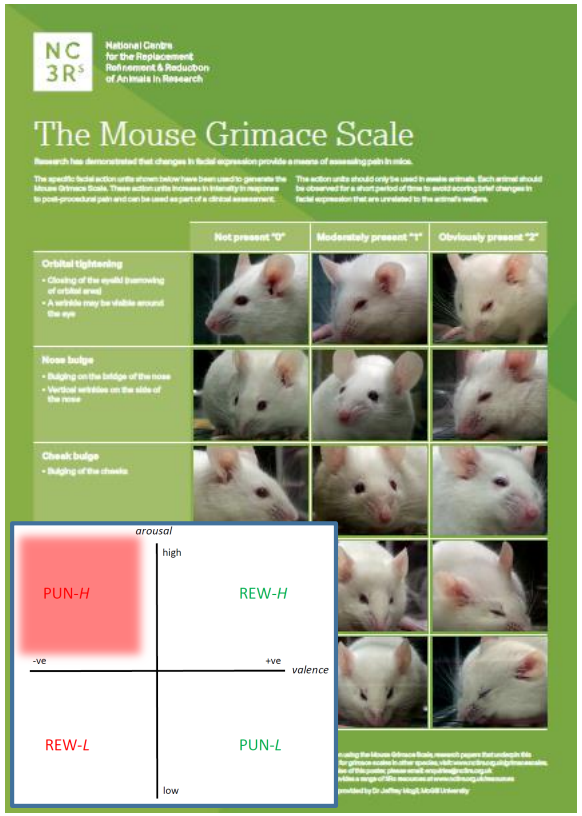
Alexander H Tuttle[1], Mark J Molinaro[1], Jasmine F Jethwa[1], Susana G Sotocinal[2], Juan C Prieto[3], Martin A Styner[3], Jeffrey S Mog

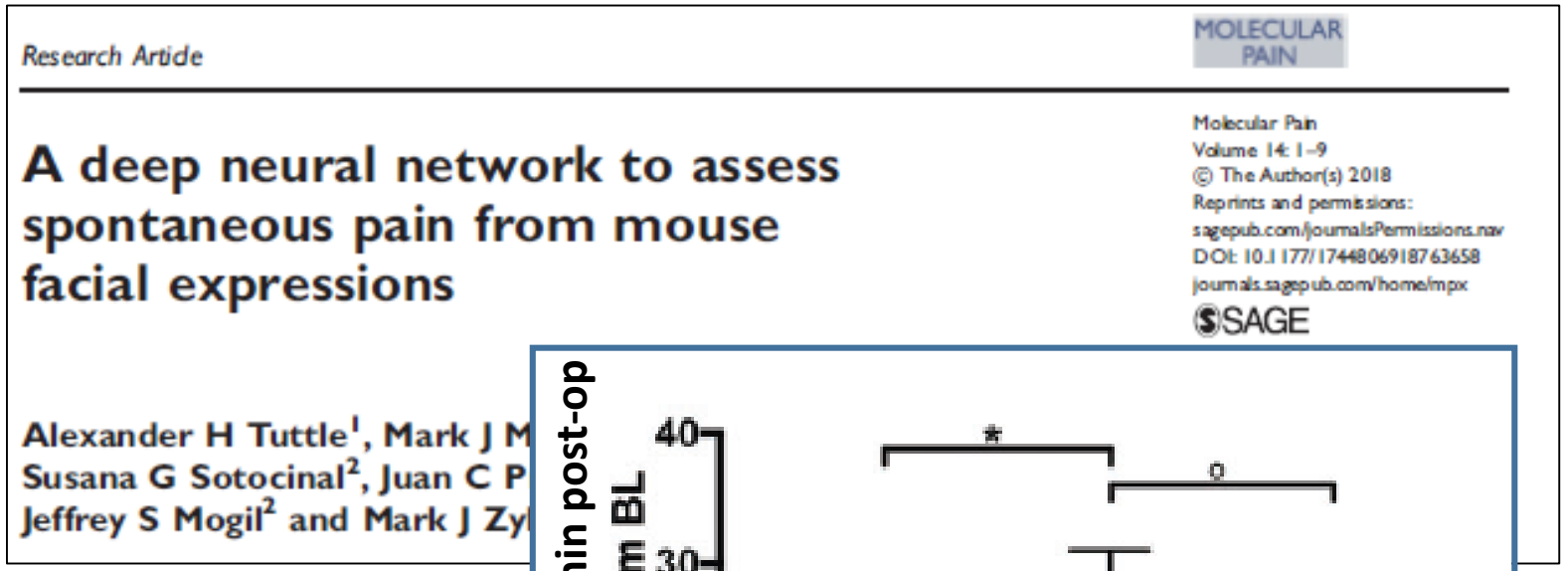
Machine Prediction	Human Prediction (Truth): Pain (images)	No pain	*Total*
Pain	2,159	85	*2,224*
No pain	226	2,107	*2,333*
Total	*2,385*	*2,192*	*4,577*

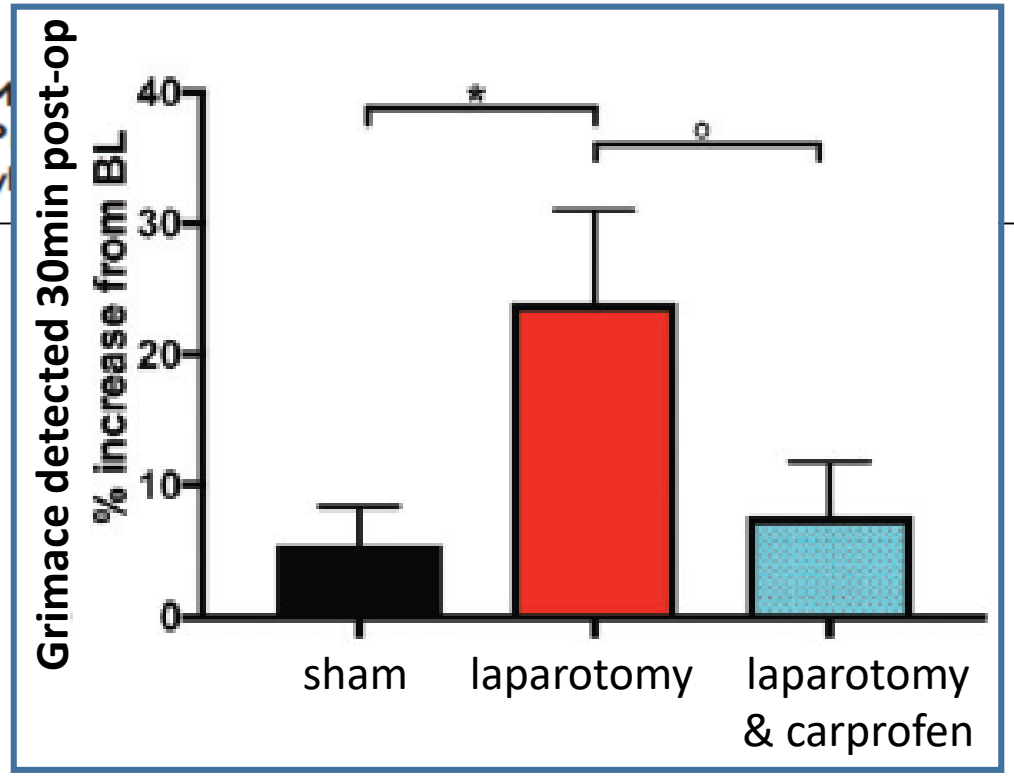
Sensitivity-90.5%

Specificity-96.1%

Future challenges: implementing and automating measures of animal affect







in-cage video

Future challenges: implementing and automating measures of animal affect

jove Journal of Visualized Experiments

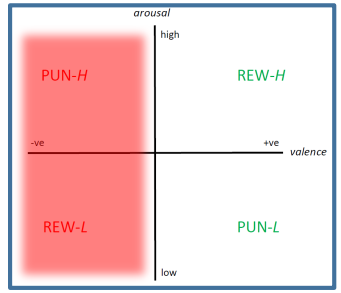
Video Article

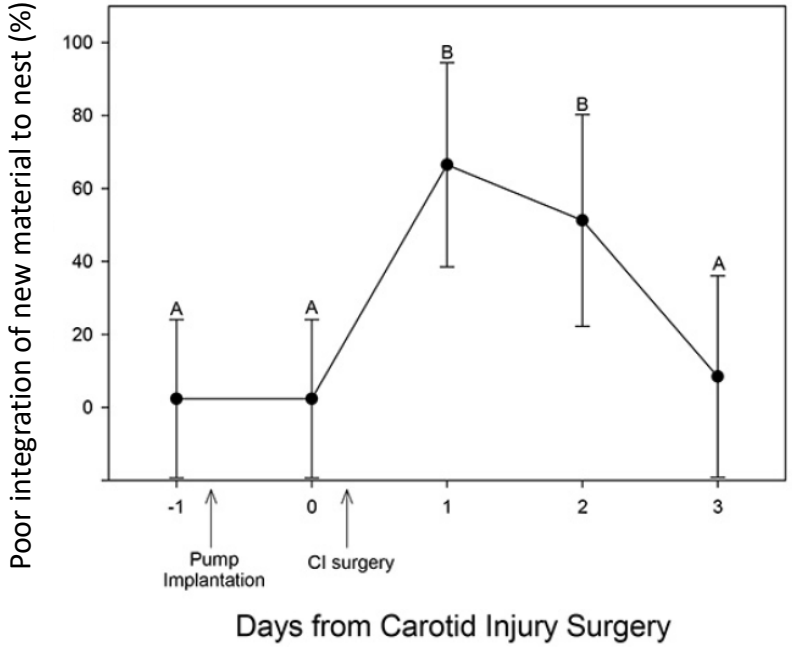
Nest Building as an Indicator of Health and Welfare in Laboratory Mice

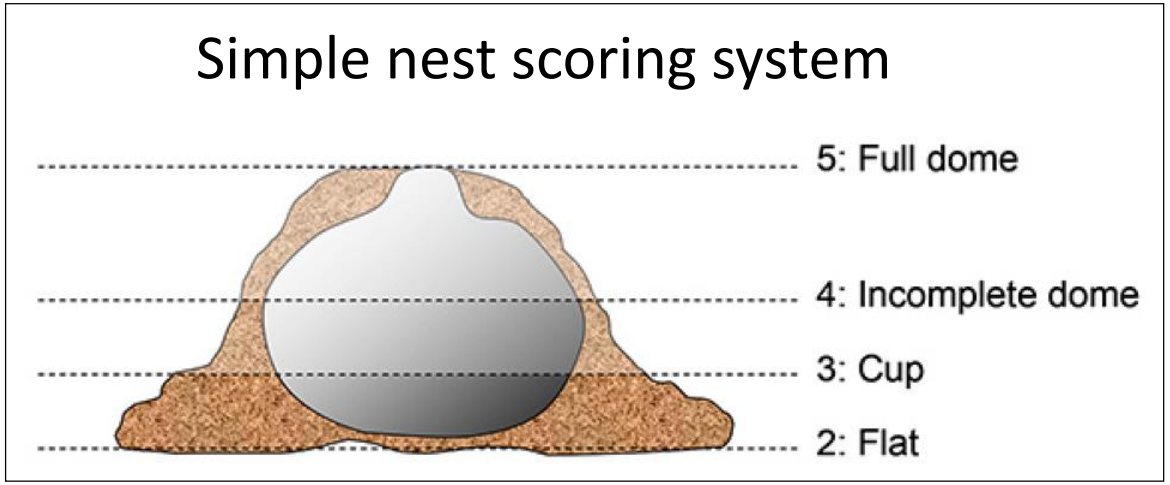
Brianna N. Gaskill[1], Alicia Z. Karas[2], Joseph P. Garner[3,4], Kathleen R. Pritchett-Corning[1]

[1]Research Models and Services, Charles River
[2]Department of Clinical Sciences, Tufts University
[3]Department of Comparative Medicine, Stanford University
[4]Department of Psychiatry and Behavioral Sciences, Stanford University

Aggression, sickness, and post-surgical pain impair nest-building and integration of new material into nests





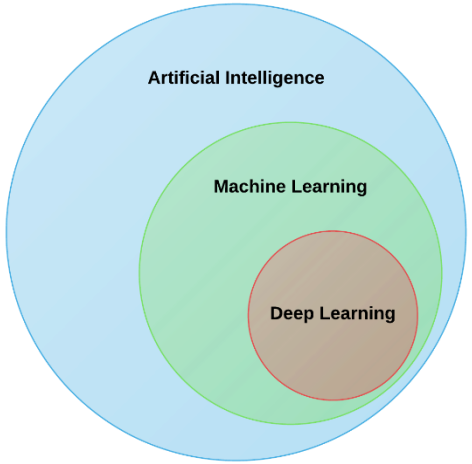


Possible false positives when temperature is high

Future challenges: implementing and automating measures of animal affect

Individual affect monitoring requires automated individual identification

RFID; deep learning of individual ids?



01.17.19 | WORLD CHANGING IDEAS

Facial recognition for chimps searches the internet for stolen baby apes

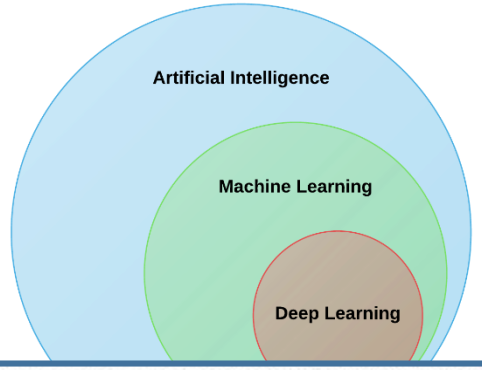
Algorithms can be trained to recognize ape faces as well as human faces. Now ChimpFace is being deployed to help track down poachers who put the animals up for sale online.

[Photo: Francesco Ungaro/Unsplash]

Future challenges: implementing and automating measures of animal affect

Individual affect monitoring requires automated individual identification

RFID; deep learning of individual ids?



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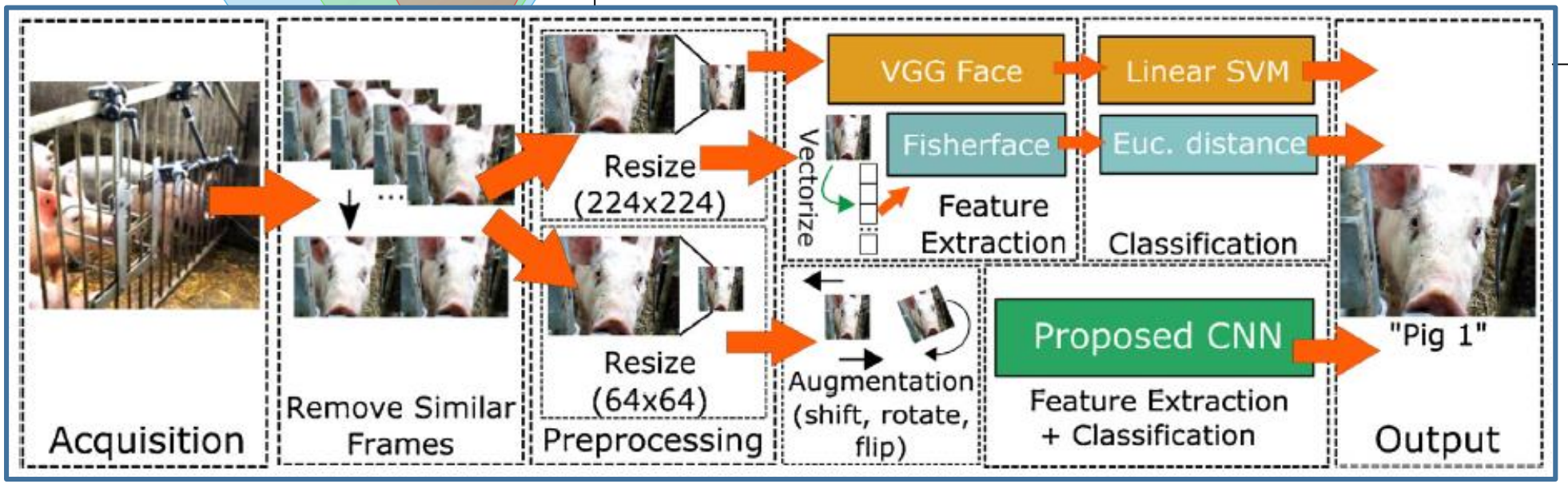
Computers in Industry

journal homepage: www.elsevier.com/locate/compind

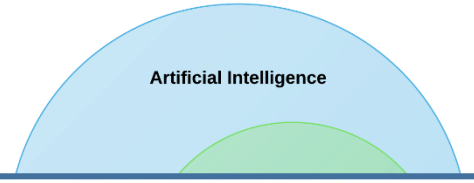
Towards on-farm pig face recognition using convolutional neural networks



Future challenges: implementing and automating measures of animal affect

Individual affect monitoring requires automated individual identification

RFID; deep



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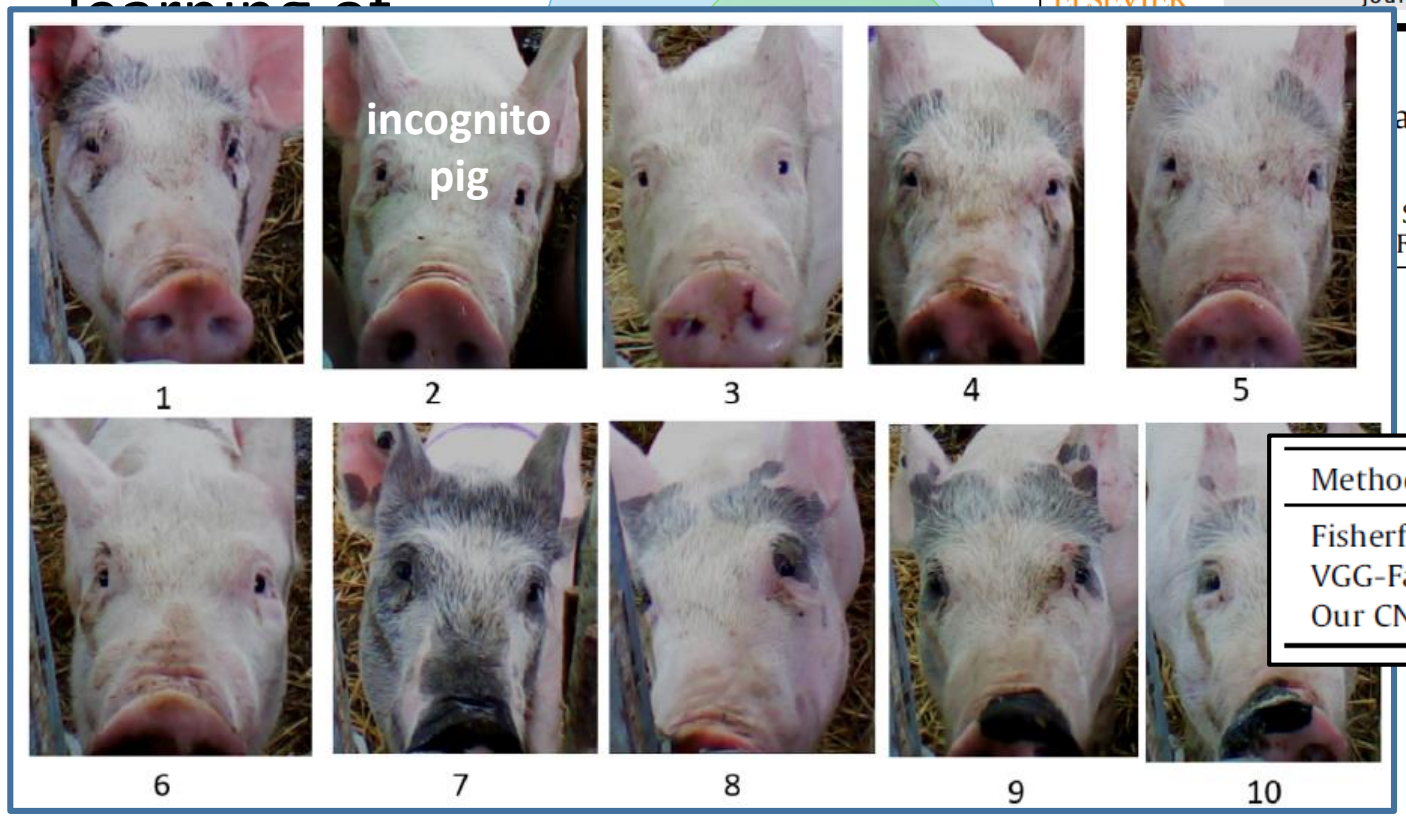
ace recognition using convolutional neural

Smith[a], Lyndon N. Smith[a], Michael G. Salter[b],
Farish[c], Bruce Grieve[d]



Method	Accuracy (%)	False positive (%)	False negative (%)
Fisherface	78.4	26.3	29.7
VGG-Face + SVM	91.0	10.3	13.9
Our CNN	96.7	5.8	5.7

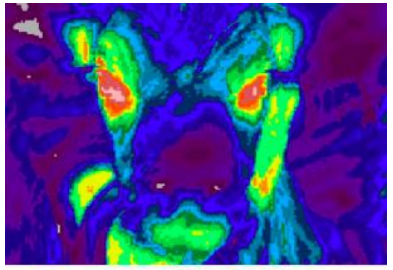
Future challenges: implementing and automating measures of animal affect

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

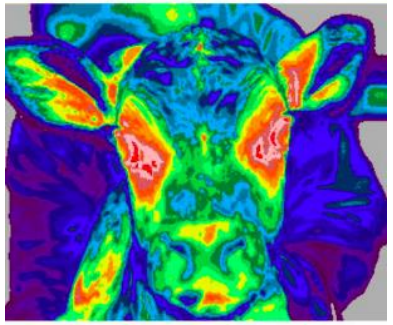
Bristol researchers win EPSRC fellowship to develop AI for early disease diagnosis in calves

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

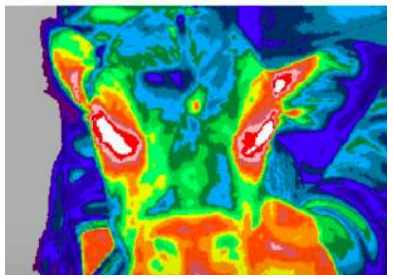
Dr Laszlo Talas
EPSRC Innovation Fellow
Area of research
Machine learning



healthy calf

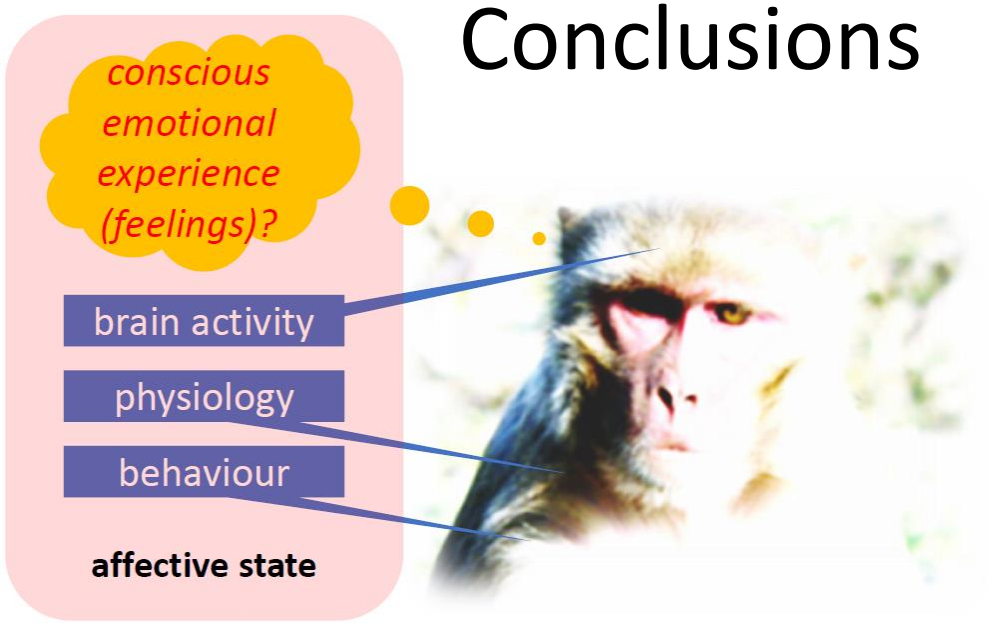


early-stage bovine respiratory disease



late-stage bovine respiratory disease

Conclusions

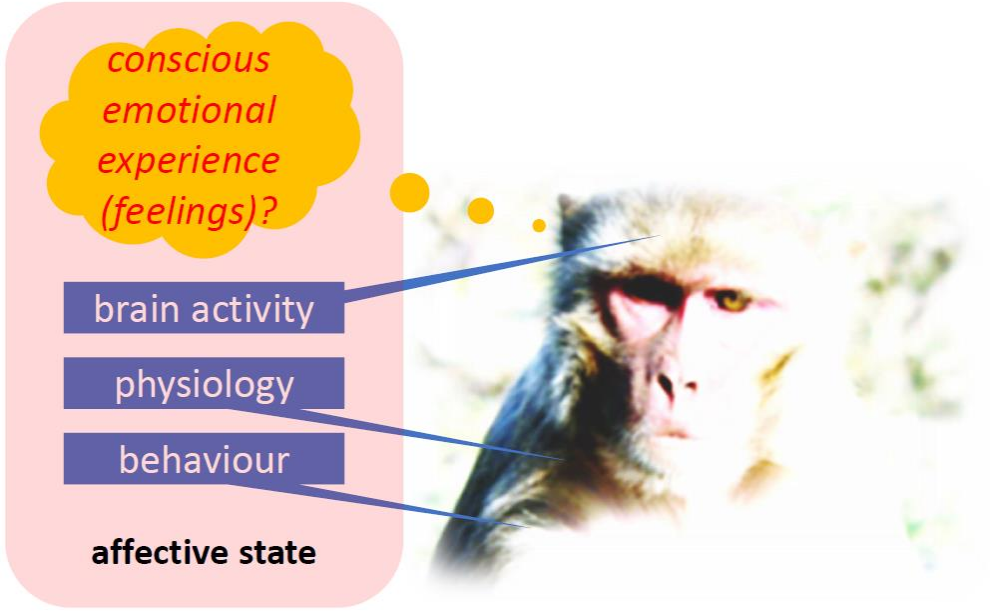


Measurement of animal welfare requires accurate assessment of *animal affect*

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

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