

Goat cognition and emotions – how goats perceive the world



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Talk outline

1. Goat cognition

→ physical cognition

→ social cognition

2. Goat emotions

→ behavioural indicators

→ perception of emotions

INTRODUCTION

Goat cognition: anecdotal evidence

Very curious....



INTRODUCTION

Goat cognition: anecdotal evidence

Very agile...



INTRODUCTION

Goat cognition: anecdotal evidence

Get access to food by any means...



INTRODUCTION

Goat cognition: anecdotal evidence

But... ???



Goat cognition: ecological relevance

- Live in many different, harsh environments (e.g. difficult access to food; food extraction) (Coblentz 1978; Aldezabal & Garin 2000)
- Complex social groups – fission-fusion social systems (Shi et al. 2005; Dunbar & Shi 2008)
- Strong dominance hierarchy (Barroso et al. 2000)
- Form coalitions and alliances and engage in reconciliation after fights (Schino 1998)
- First livestock domesticated by humans ($\approx 10,000$ years ago; Zeder and Hesse, 2000)



Goat cognition: experimental evidence

Process through which animals collect, process, retain and respond to environmental information (e.g. perception, memory, learning and decision-making)

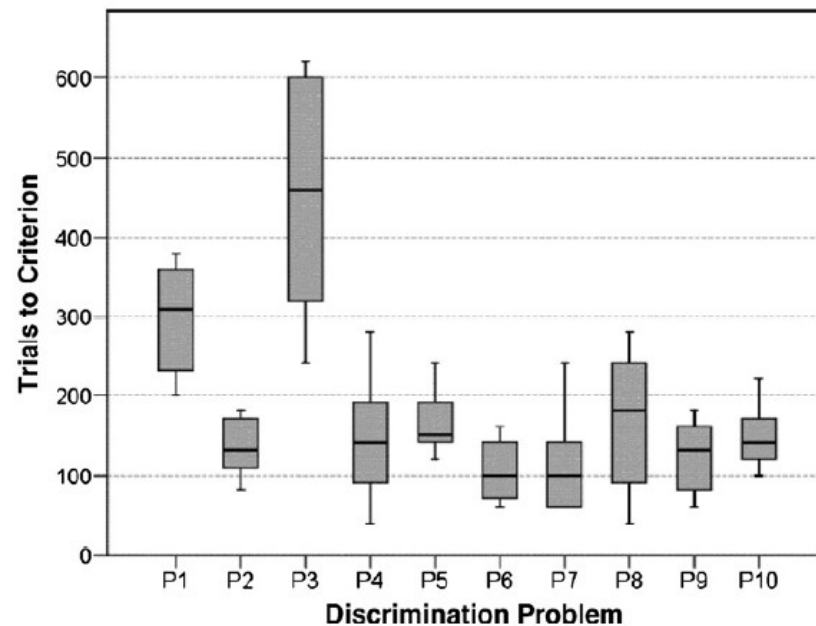
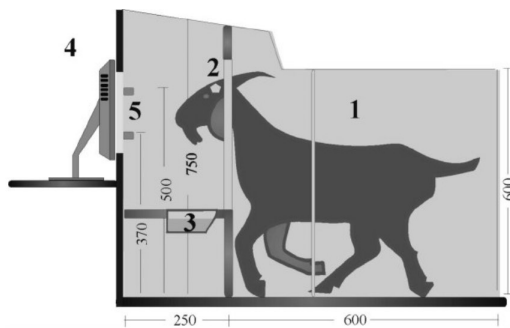
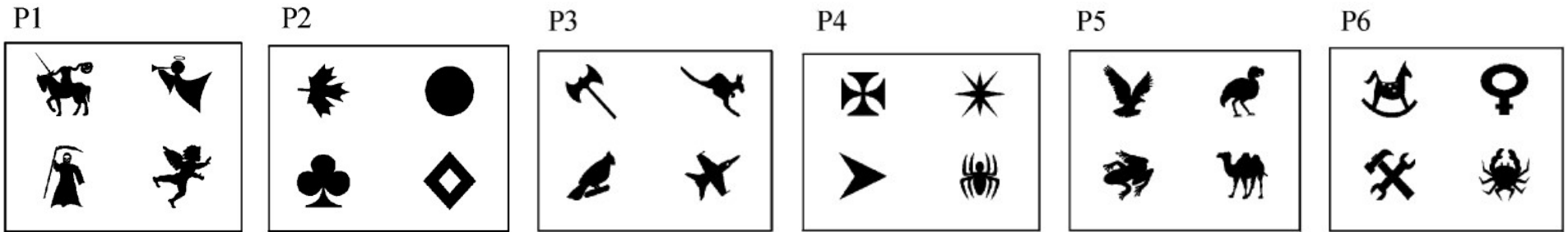
1. Physical Cognition

1. Object Discrimination and Categorization
2. Inferential reasoning
3. Object Permanence
4. Long-term Memory
5. Behavioural Flexibility
6. Contrafreeloading

2. Social Cognition

1. Recognition
2. Attributing Attention
3. Interpretation of Human Gestural Communication
4. Use of Social Cues and Social Learning

Object discrimination and categorization



Goats discriminate complex shapes and 'learn to learn'

Inferential reasoning



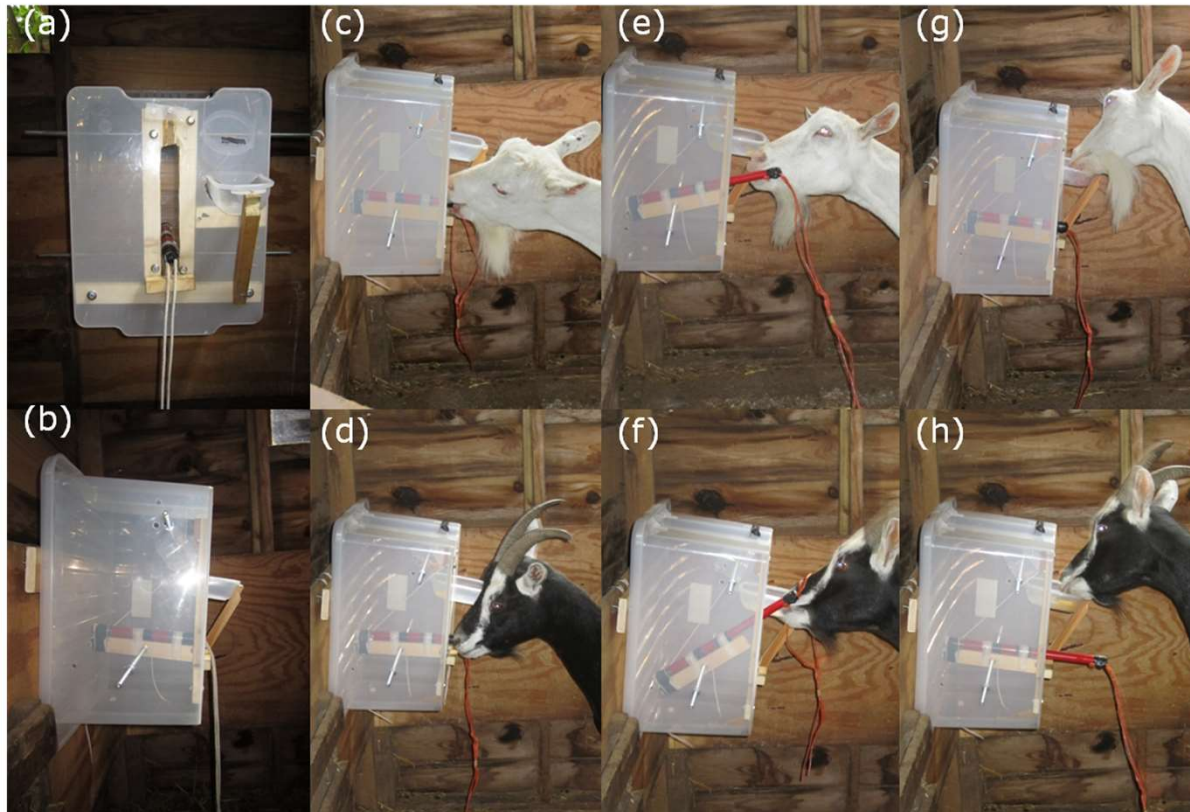
Goats but not sheep are able to use indirect information (i.e., the absence of food) to find a reward

Object Permanence



Goats can track hidden objects

Long-term memory



9/12 goats successfully learned the task within 8-13 ($n=8$ goats) or 22 ($n=1$ goat) trials (mean= 12.0 ± 1.4 ; 4.3 ± 0.6 days of training)
1 goat never learned (after 22 trials)
2 goats removed from the experiment

No evidence for social learning

Long-term memory



Test 1 (26-33 days): **36 s**; $n=9$ goats

Intermediate tests (139 and 168 days): **6 and 4 s**; $n=1$ goats

Test 2 (281-311 days): **39 s**; $n=8$ goats

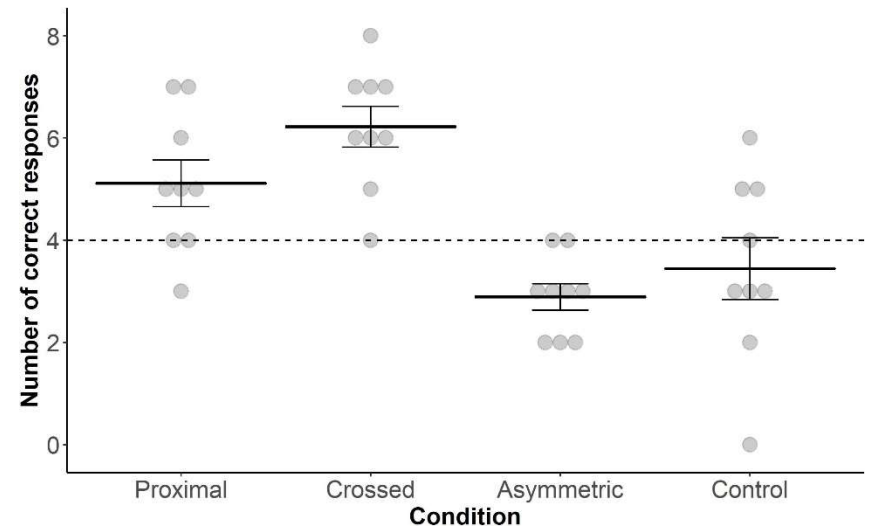
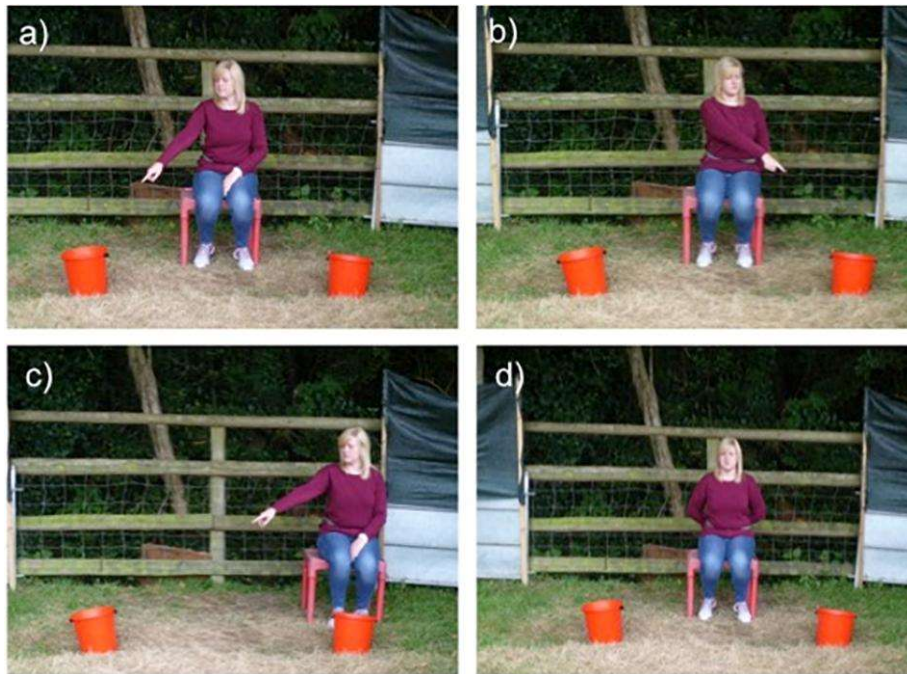
Memory → 10 months (even 2 years)

PHYSICAL COGNITION

Long-term Memory: High motivation to learn

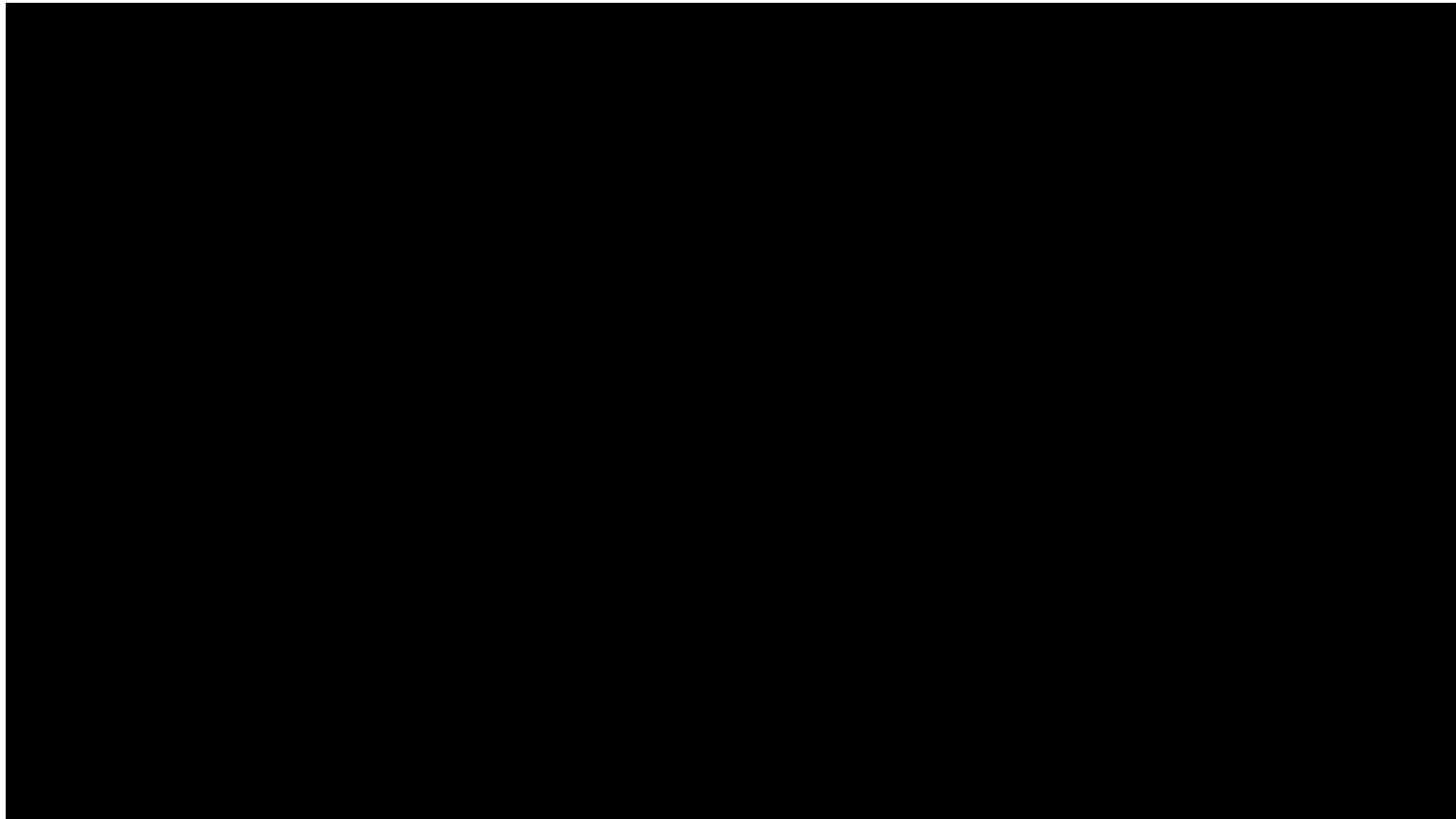


Interpretation of Human Gestural Communication



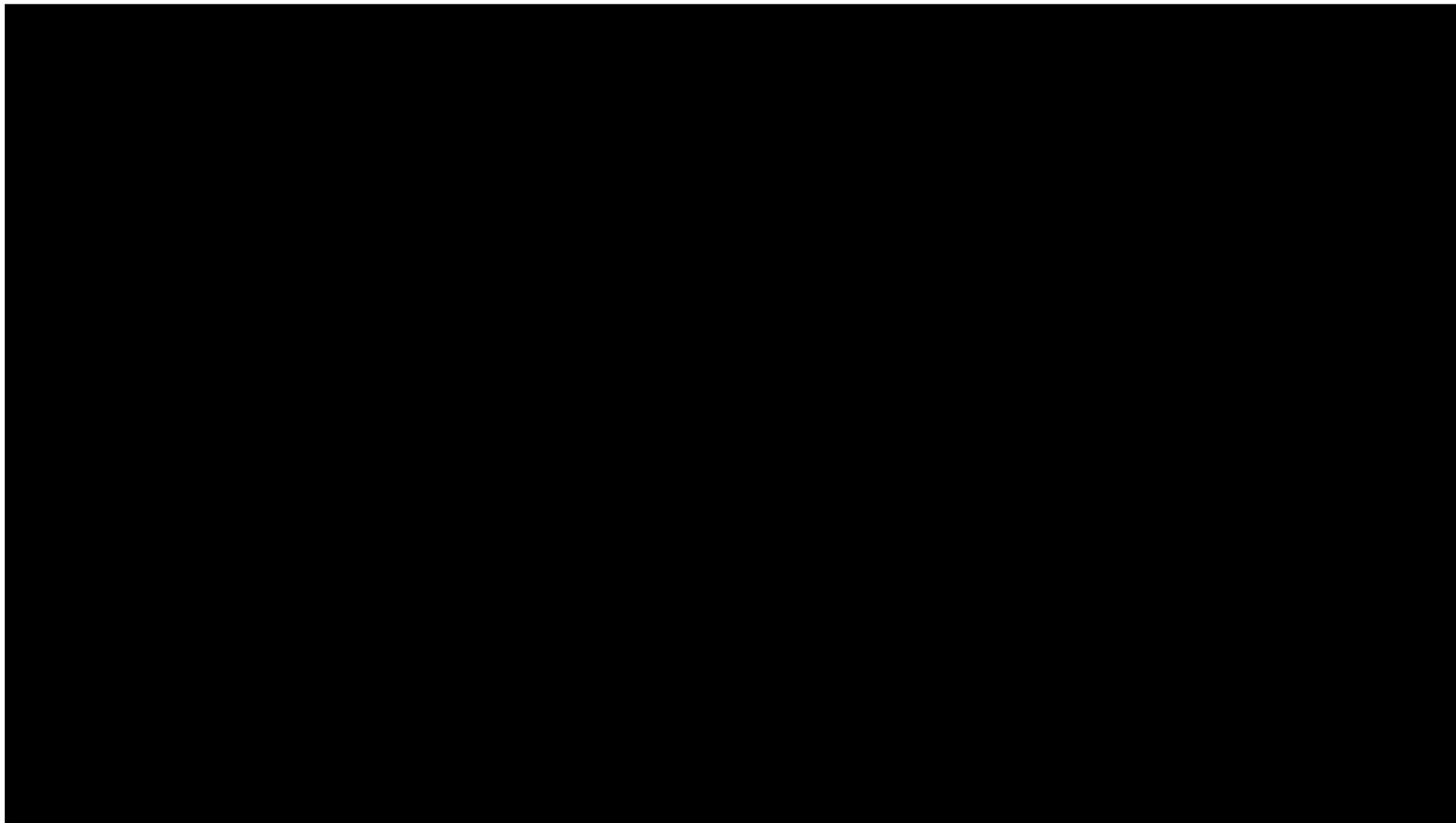
Goats follow human pointing gestures (proximal and crossed)

Attributing attention



Goat gaze for longer a forward-facing experimenter than a back-facing one in an 'unsolvable problem' task

Learning from humans



Goats solved the task faster after seeing a human solving it just once
(better than control group)

Goat cognition: conclusion

- Advanced understanding of physical environment
- Ability to interpret human gestures, attention state and learning from humans
- Scarce evidence for social learning (learning from conspecifics)



Goat emotions: how to read goats?

1. Emotional Indicators

1.1. Physiological Indicators

1.1.1. Hormonal profiles

1.1.2. Cardiac Parameters

1.1.2. Thermal Imaging

1.2. Behavioural Indicators

1.2.1. Body Posture and parts

1.2.2. Facial Expressions

1.2.3. Vocal Expressions

1.3. Cognitive Indicators

2. Social Dimension of Emotion

2.1. Perception of emotion information in conspecifics

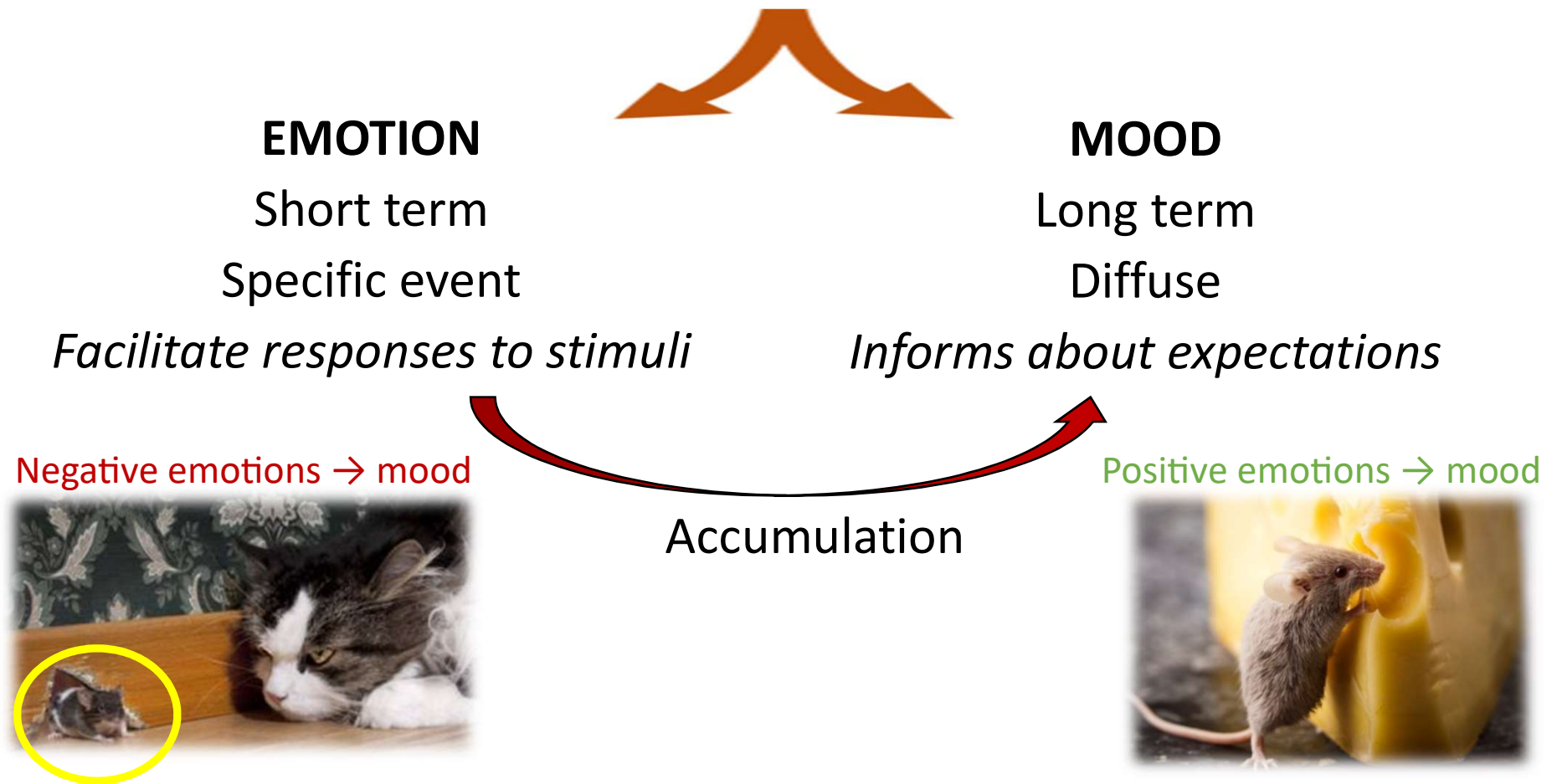
2.2. Perception of emotions information in humans

2.3. Empathy and prosocial behaviours

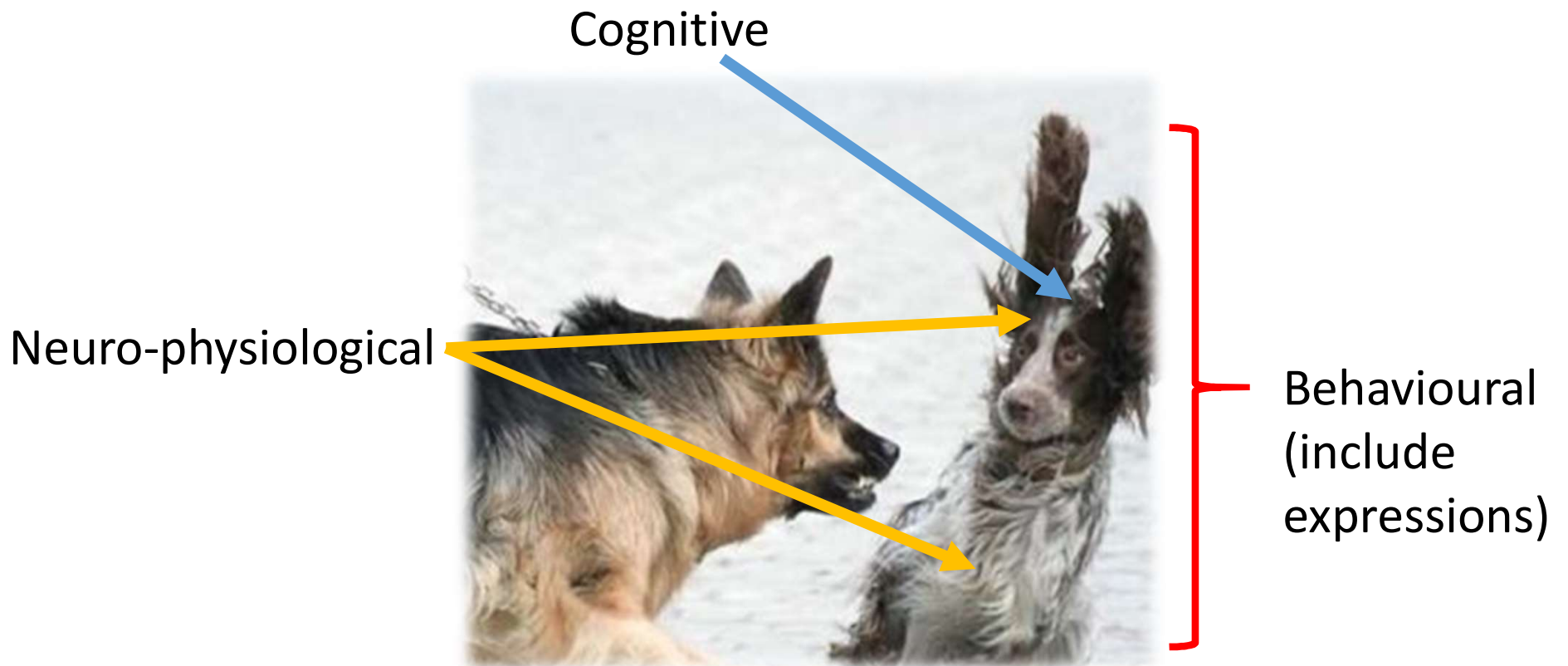
What are affective states?

Multicomponent response (behaviour, neurophysiology, cognition & feeling)

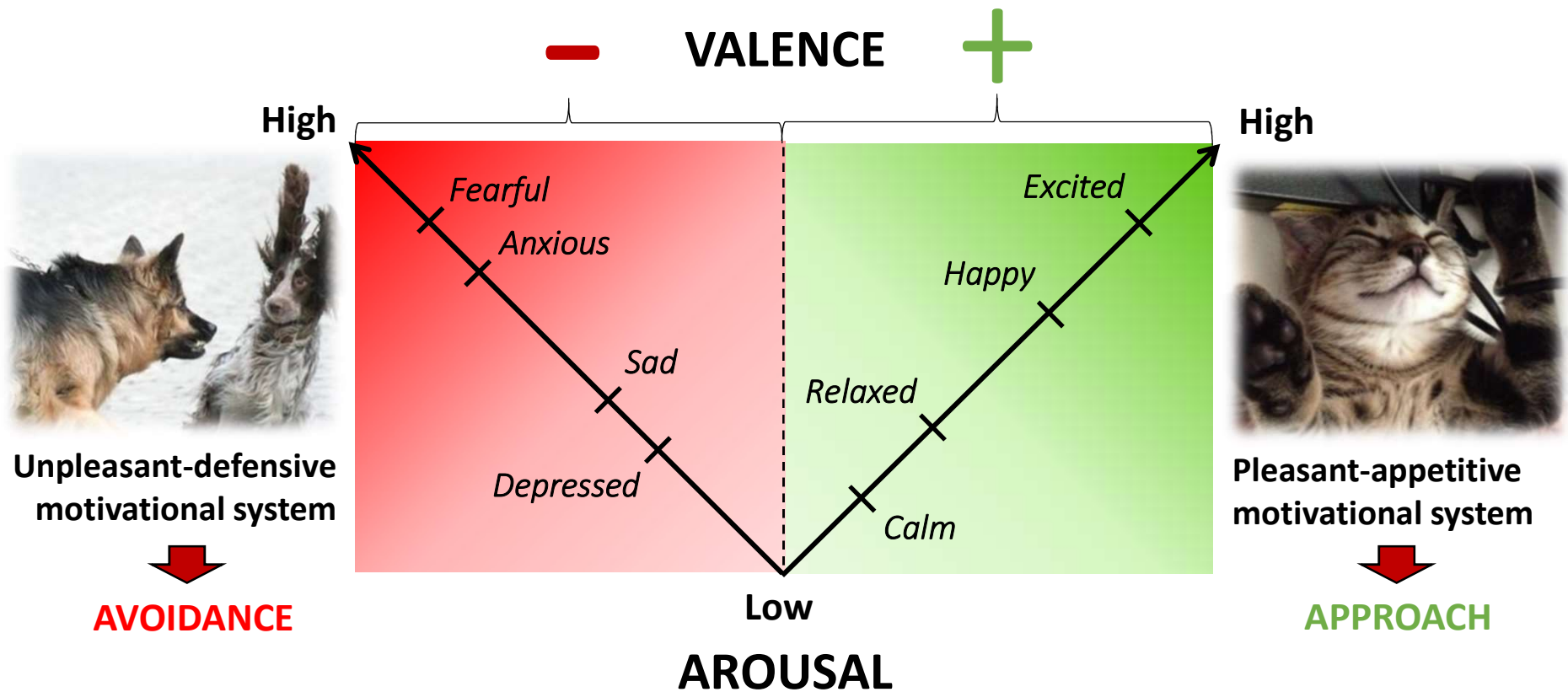
Valenced states (positive and/or negative)



Indicators accessible in animals

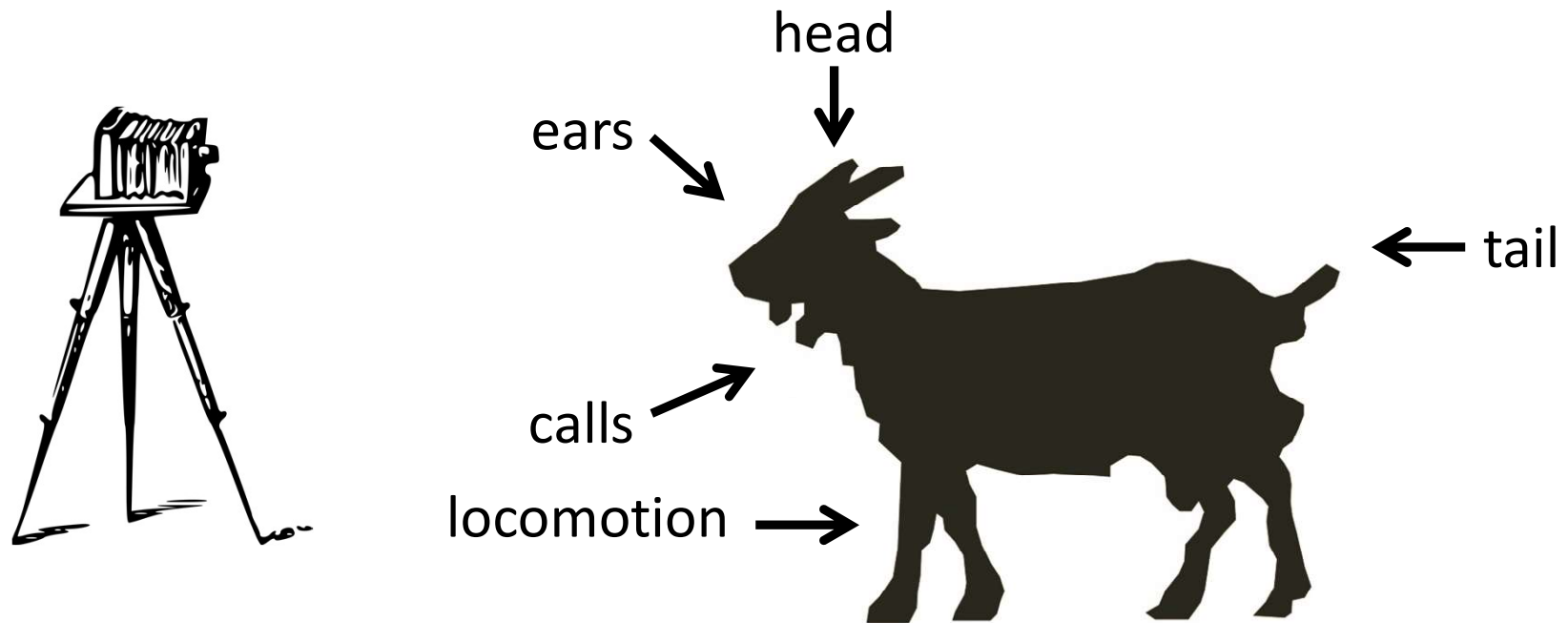


Dimensional approach



- ➔ **Valence** = Negative vs Positive
- ➔ **Arousal** = Bodily activation

Behavioural Indicators: Body posture & parts



- Isolation (negative, low arousal - HR)
- Food frustration (negative, high arousal – HR)
- Food reward anticipation (positive, high arousal – HR)
- Control (neutral, low arousal – HR)

BEHAVIOURAL INDICATORS



Food anticipation (positive)

BEHAVIOURAL INDICATORS



Food frustration (negative)

BEHAVIOURAL INDICATORS



Social isolation (negative)

Behavioural Indicators: Body posture & parts



VALENCE = Ears back (>), Tail up (<)

AROUSAL (HR) = Head mvt (<), Locomotion (<),
Ears forw (<), Ears horz (>) & Calls (<)

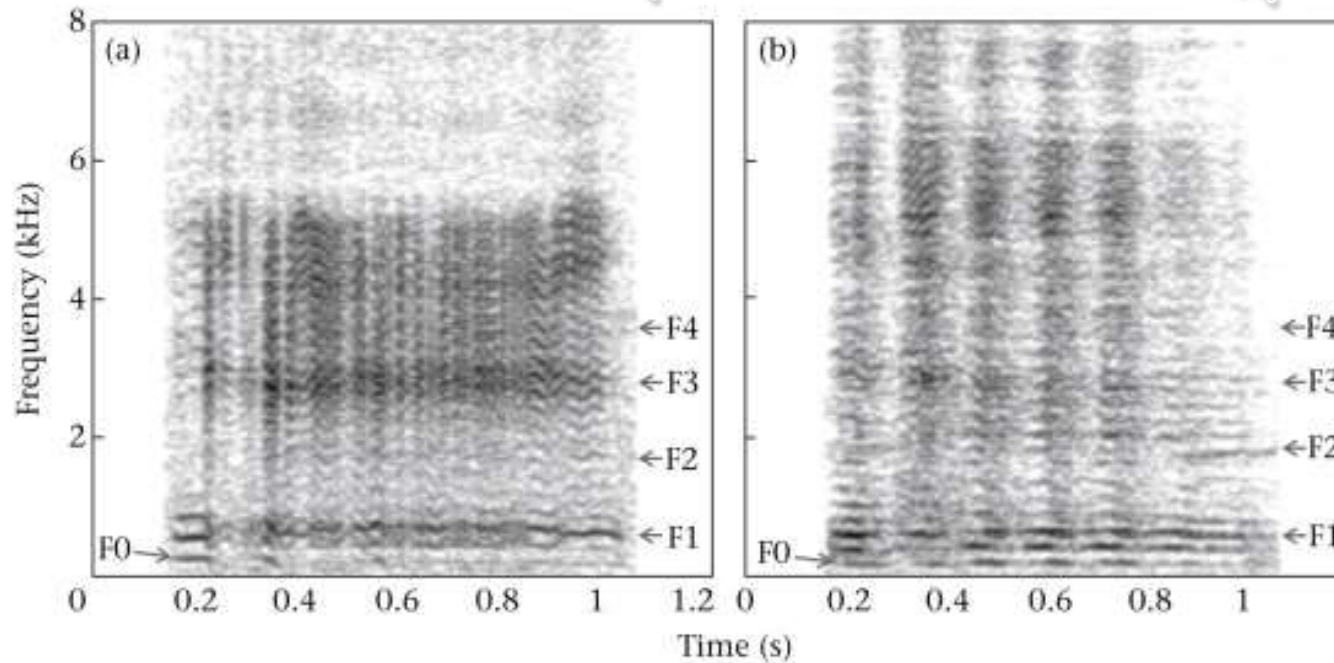
Behavioural Indicators: Vocal expressions



Negative



Positive



→ More stable pitch during positive situations

Goat emotions: indicators

- Locomotion, head movement, ears forwards and call rate → arousal, attention, expectation
- Ears back → negative emotion, uncertainty
- Tail up, calls with more stable pitch → positive emotion of high arousal (excitement)



SOCIAL DIMENSION OF EMOTIONS

Do goats perceive these emotional changes in other goats?

Facial expressions



(c) Negative

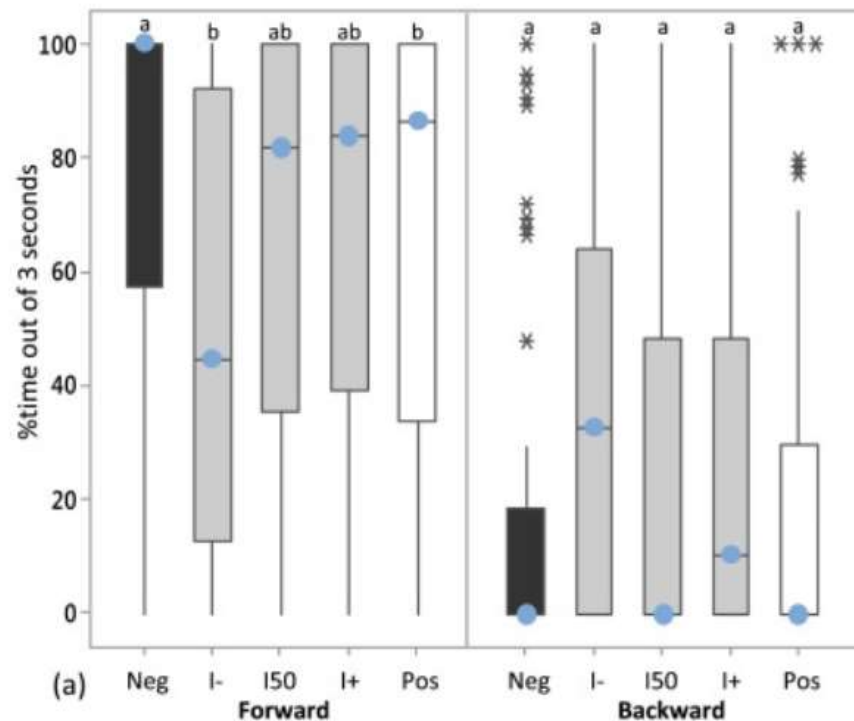
I-

I50

I+

Positive

Icepack on udder



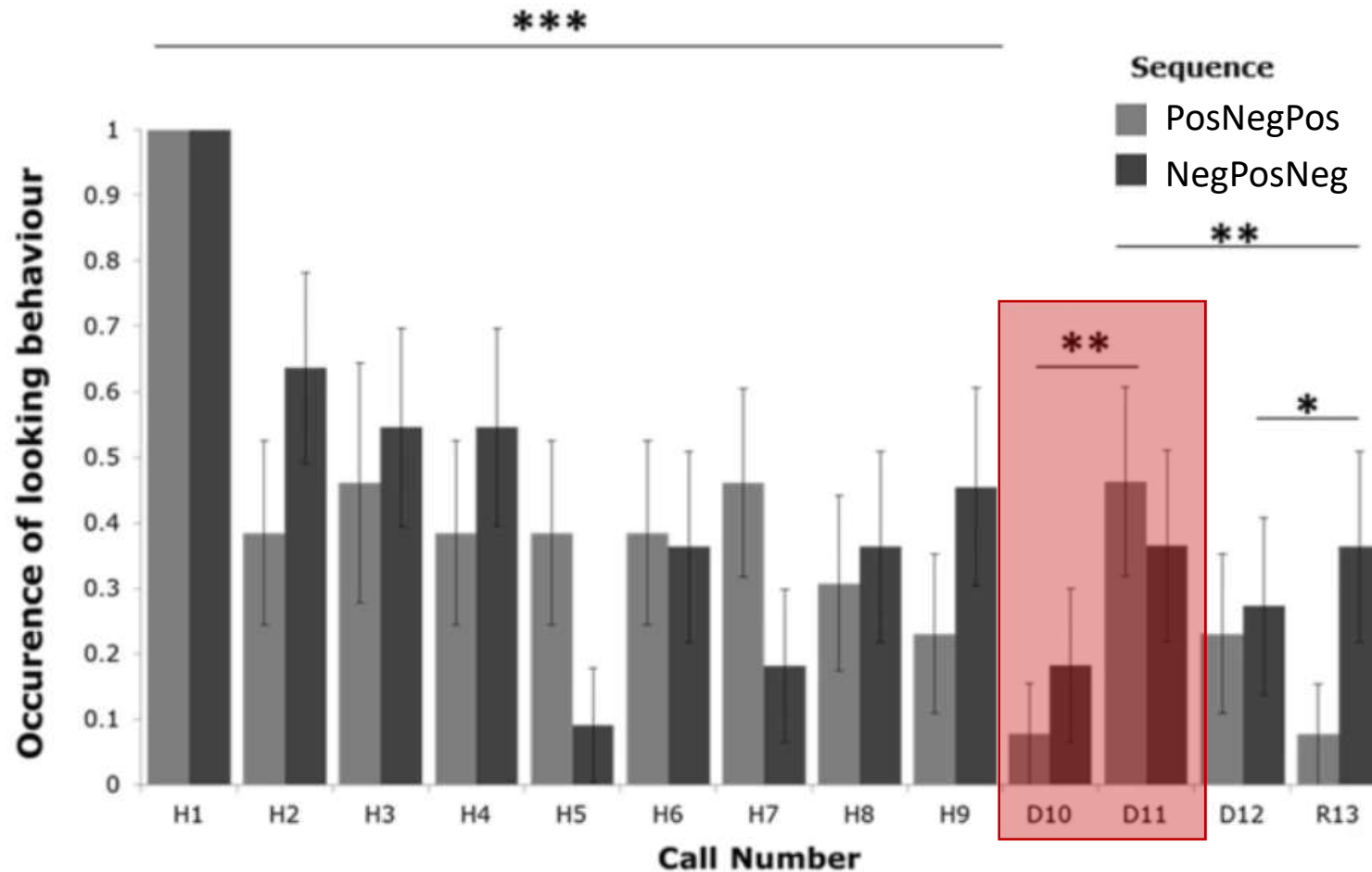
Grooming

More ears forward towards negative (more attention)

SOCIAL DIMENSION OF EMOTIONS

Do goats perceive these emotional changes in other goats?

Vocal expressions



→ (Delayed) discrimination in deshabituation phase

SOCIAL DIMENSION OF EMOTIONS

Do goats perceive emotional changes in humans?

Facial expressions



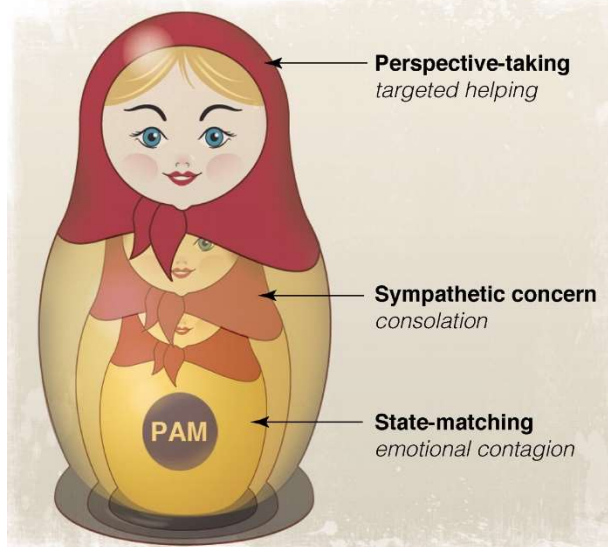
Goats interacted first more often with the positive image

SOCIAL DIMENSION OF EMOTIONS

Could emotion perception lead to empathy and prosocial behaviour?

Empathy

Russian doll model



Prosocial behaviour: (or “helping behaviour” or “free behaviour”): behaviour or action performed by an individual to benefit another individual, without necessarily incurring costs to do so. **Can be empathy-motivated or not.**

Investigating prosocial behaviour in goats: a preliminary study



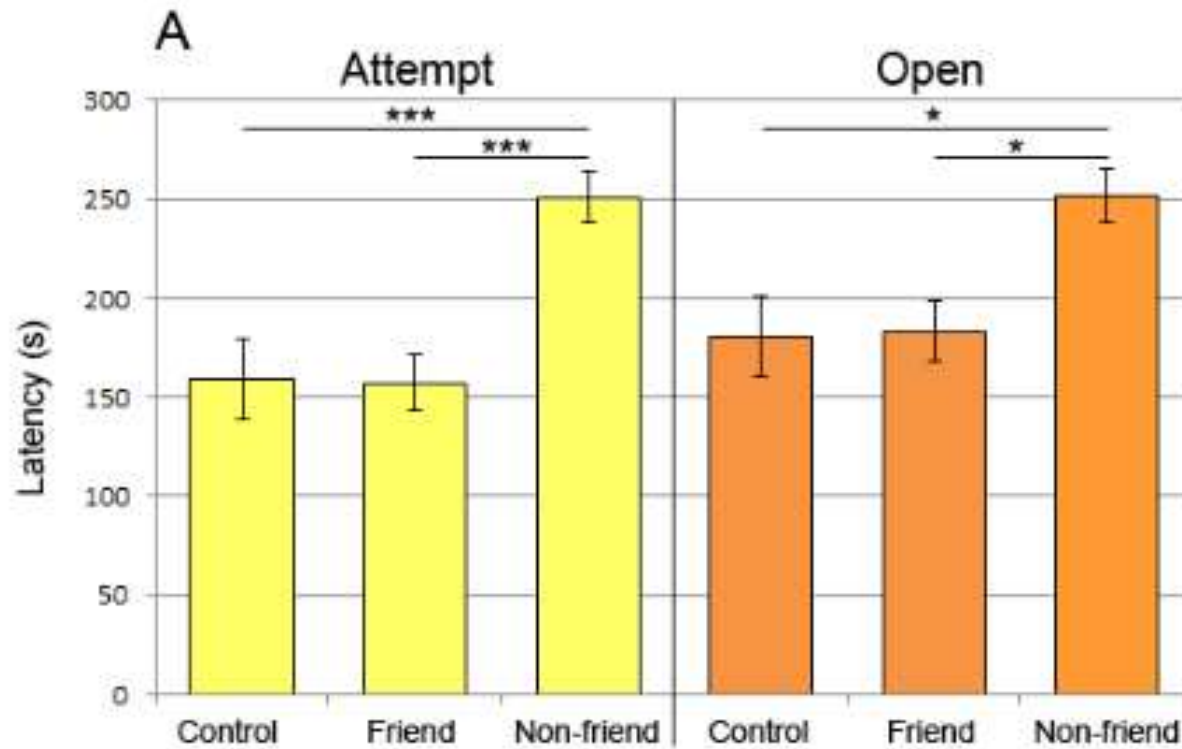
SOCIAL DIMENSION OF EMOTIONS

First attempt: releasing friend by opening door lock (trained with food)



Buttercups Sanctuary for goats
(<http://www.buttercups.org.uk/>)

First attempt: releasing friend by opening door lock (trained with food)



Open as much during control → food?

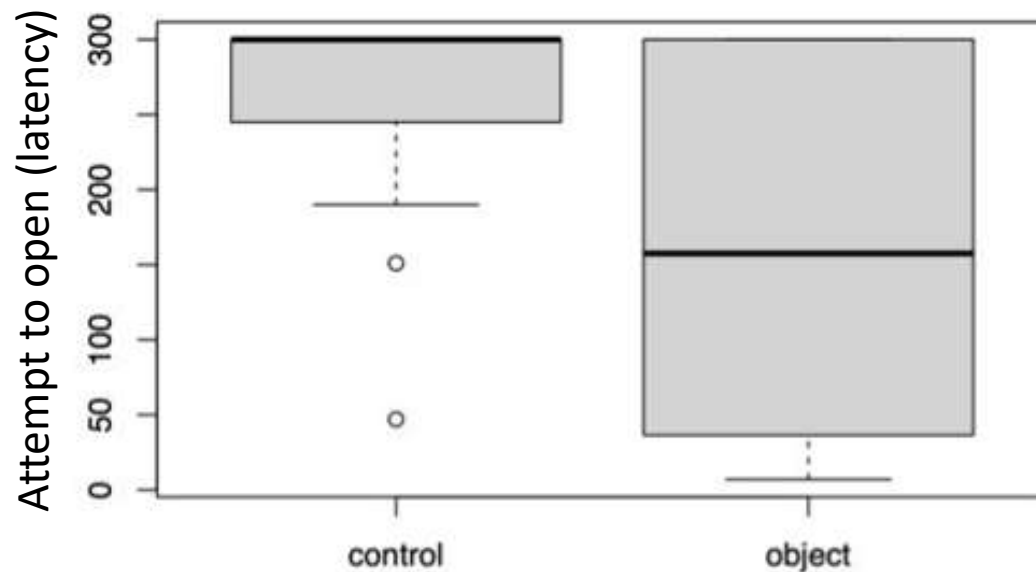
Refrain to open for non-friend?

Second attempt: releasing friend by pushing door (no food involved)

Videos



Second attempt: releasing friend by pushing door (no food involved)



- Open more when goat inside than control
- No effect of friendship

Conclusion

- Natural life in harsh environment
→ Advanced understanding of their physical environment & long-term memory
- Early domestication
→ Good ability to 'read' and learn from humans (but not other goats)
- Experience, express and perceive emotions of other goats & humans
→ Prosocial behaviour?



Tak for opmærksomheden!



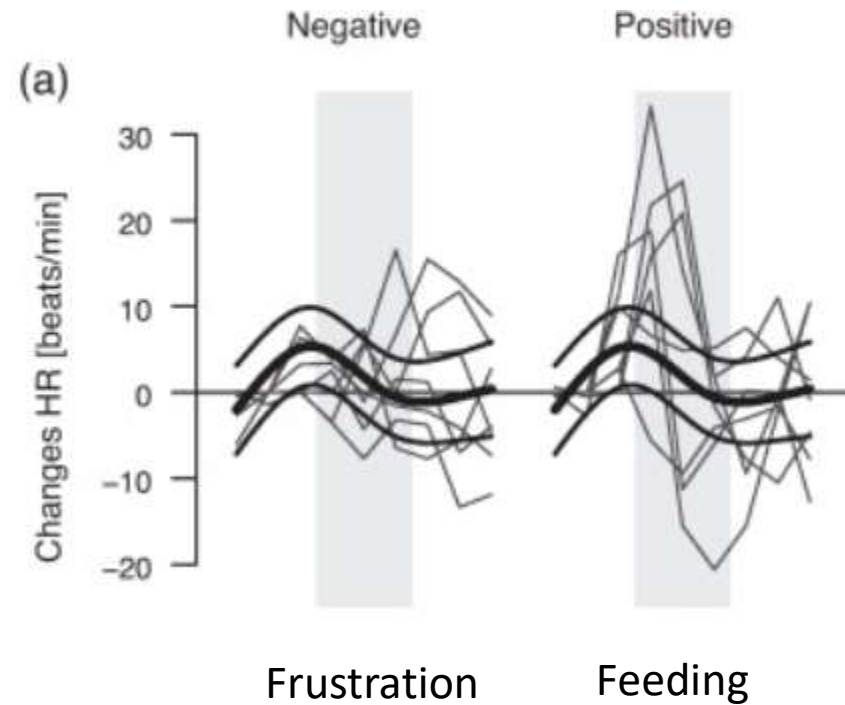
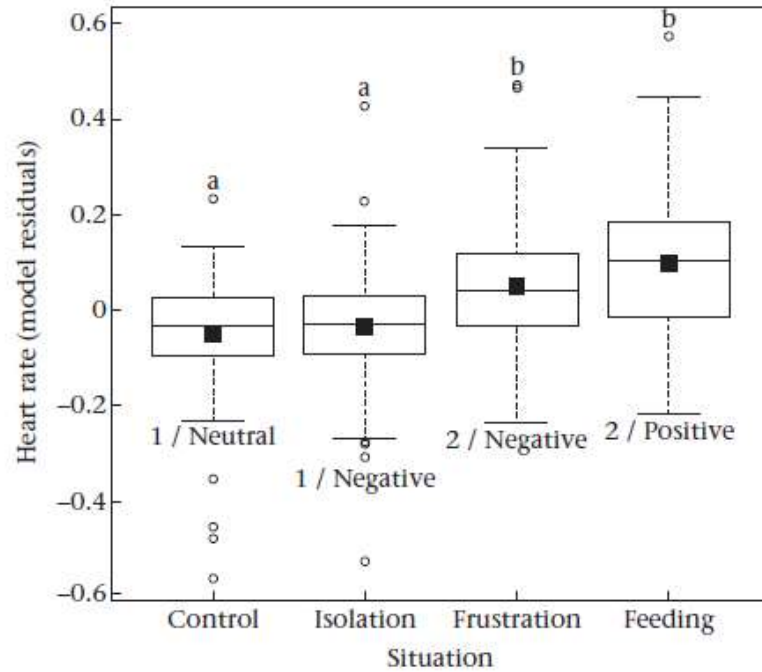
Annex

PHYSIOLOGICAL INDICATORS



Heart rate

Experimental situations

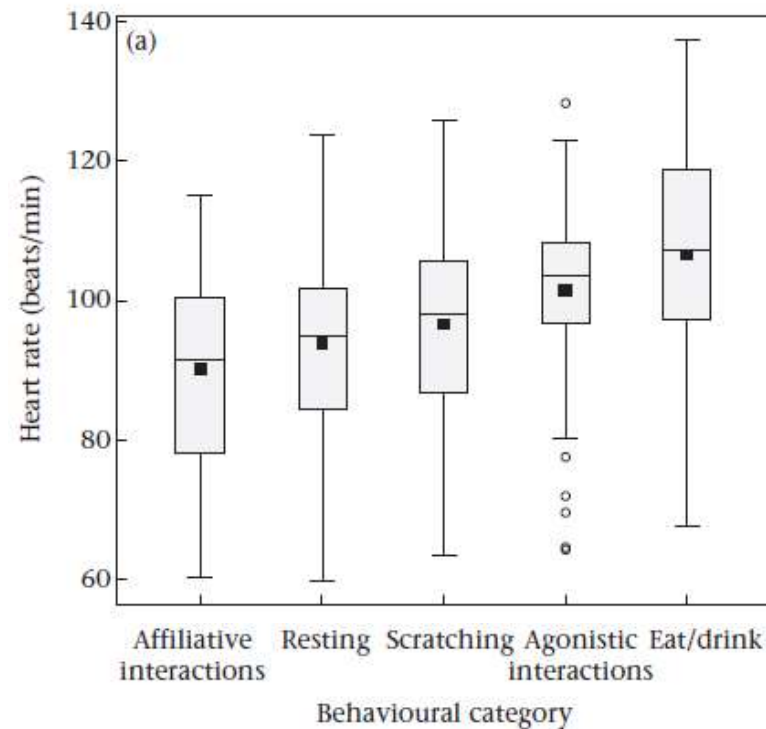


PHYSIOLOGICAL INDICATORS



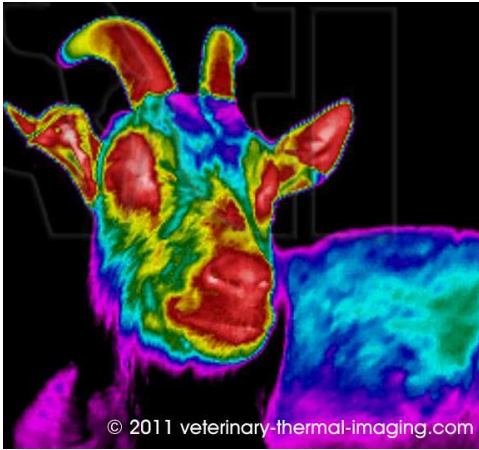
Heart rate

Natural situations

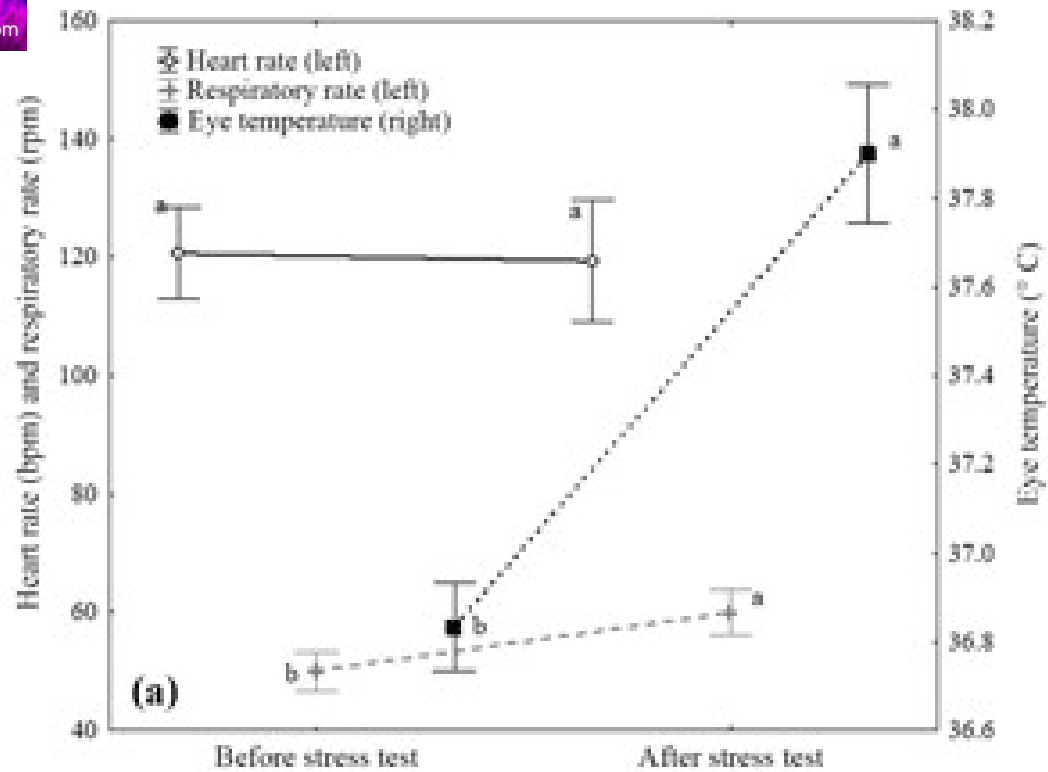
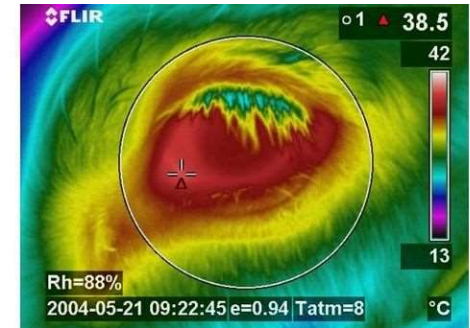


HR reflects 'bodily activation' = arousal (not valence)

PHYSIOLOGICAL INDICATORS



Infra-red thermography



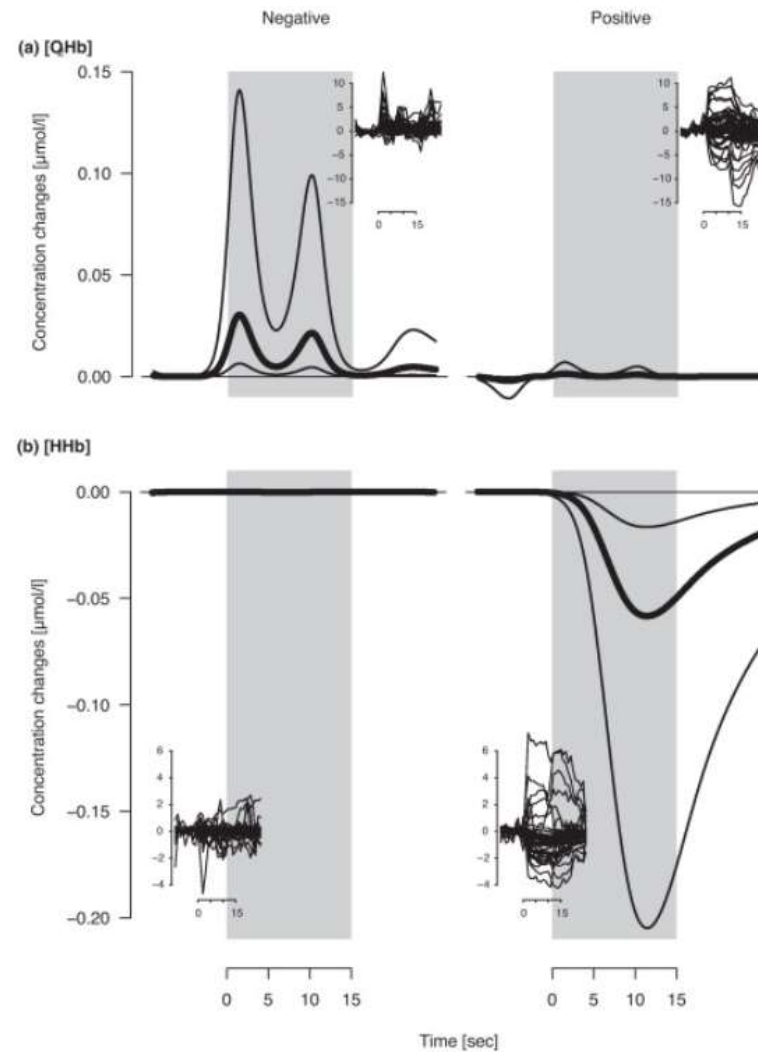
Eye temperature increases after stress

PHYSIOLOGICAL INDICATORS



Increase in prefrontal cortical activity in negative situation

Brain activity oxy- [O₂Hb] and deoxy- [HHb] haemoglobin concentrations



Decrease in [HHb] in the positive situation

Cognitive indicators: methods

Mood → cognitive processes: attention, learning, memory & decision-making = **Cognitive bias**

Half empty or half full?



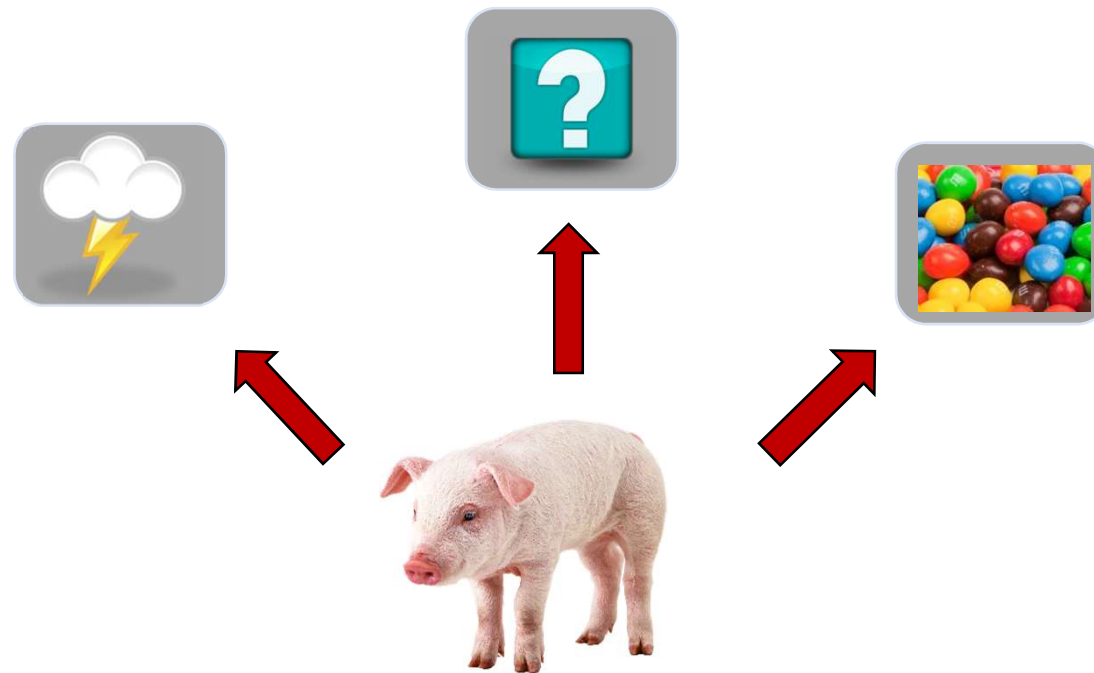
Pessimistic bias
→ **Negative mood**



Optimistic bias
→ **Positive mood**

Cognitive indicators: methods

- 1) Learning reference cues
- 2) Treatment (e.g. unpredictable housing; restrain; pharmacological treatment)
- 3) Test with ambiguous location(s)



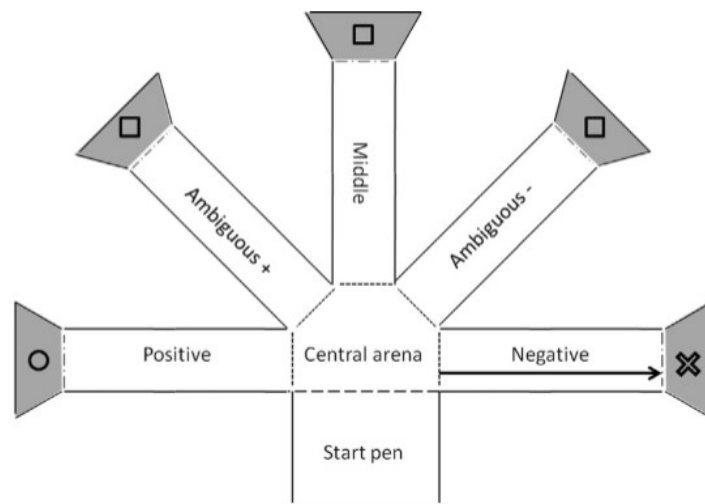
Cognitive indicators: Judgement bias test



9 Poor welfare (PW)
9 Controls (C)

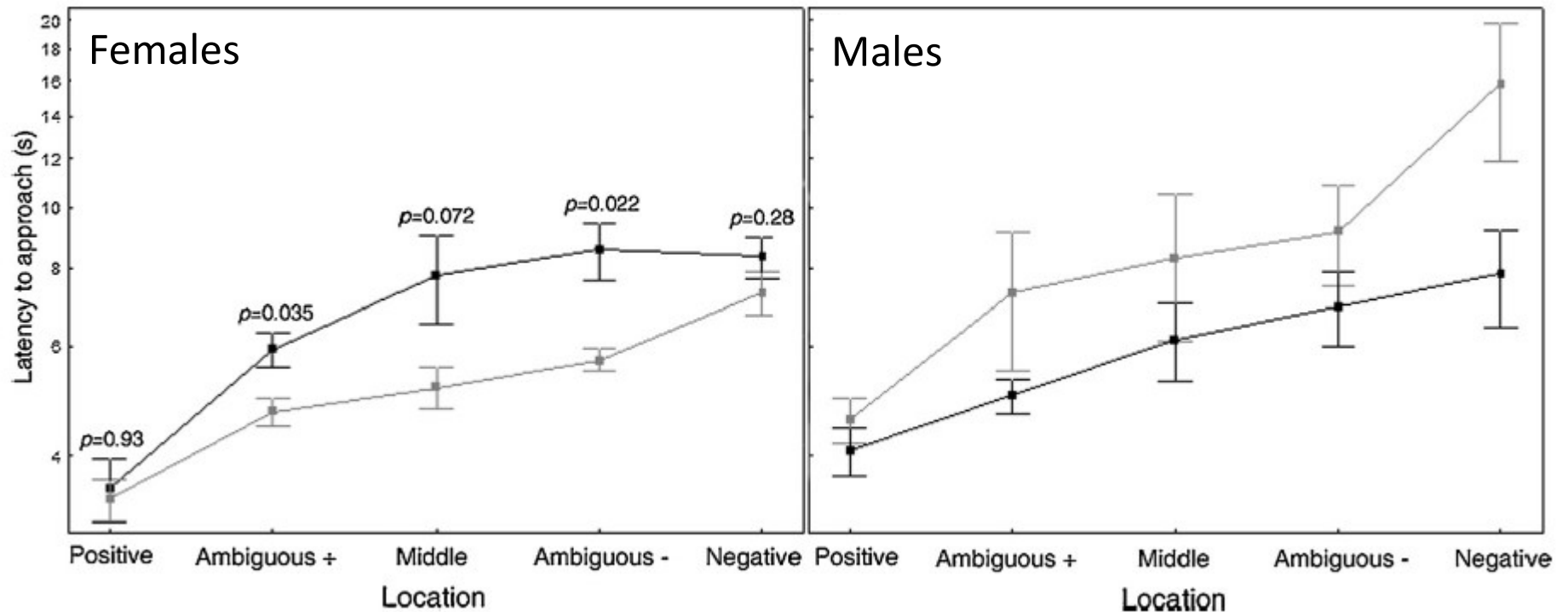
Long-term effects (> 2 years) of previous poor husbandry on moods in goats

- Poor welfare = Rescued (> 2 years) after violations of DEFRA Codes of Recommendation for the Welfare of Goat
- Control = no previous known violations



Cognitive indicators: Judgement bias test

PW
C



➔ PW females more optimistic!

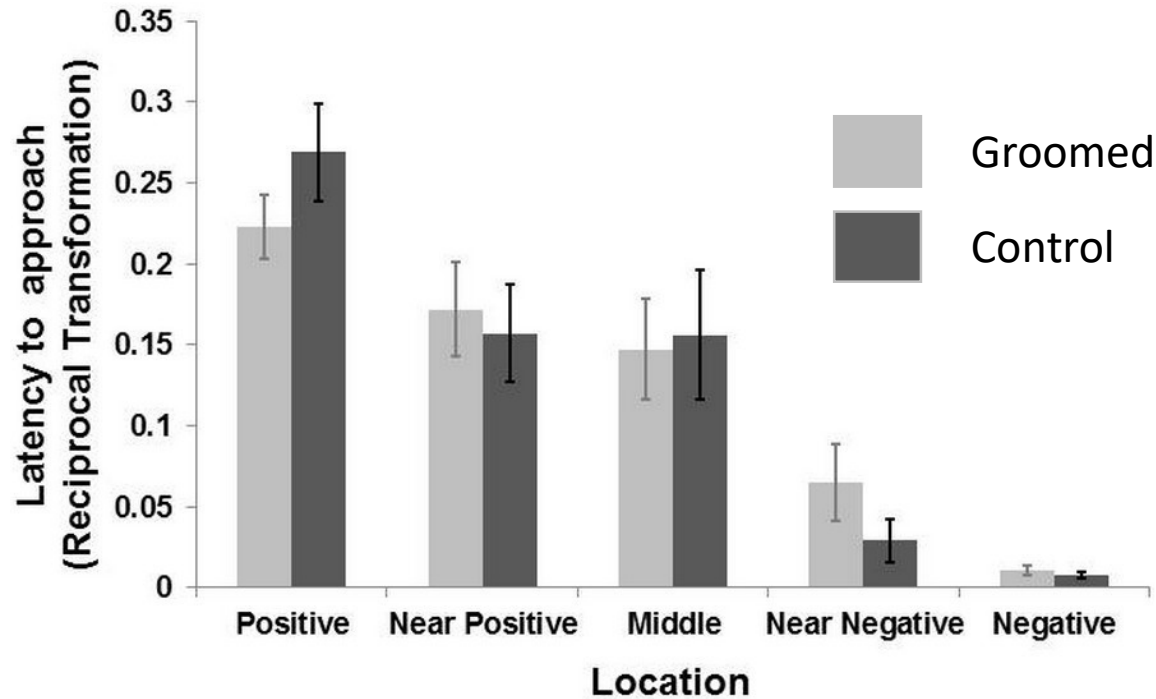
CASE STUDY

Cognitive indicators: Judgement bias test



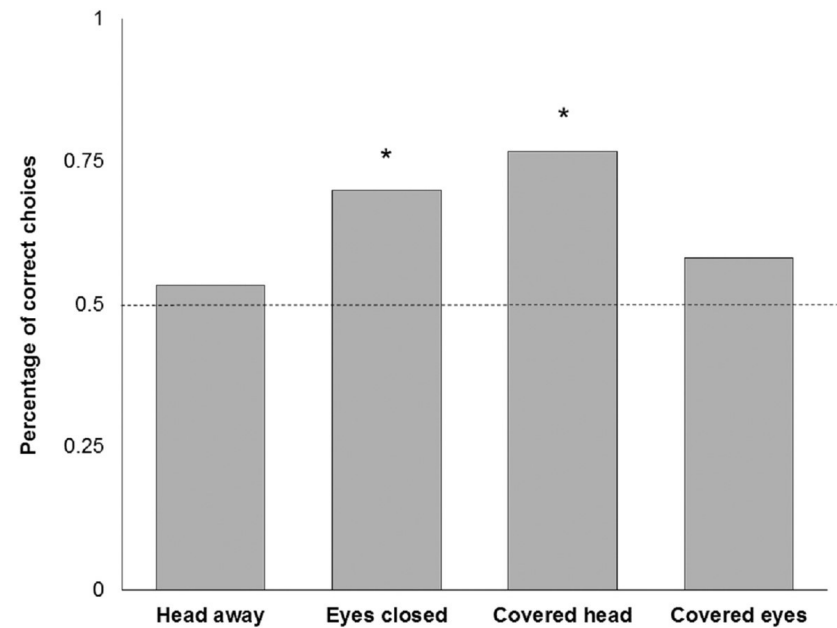
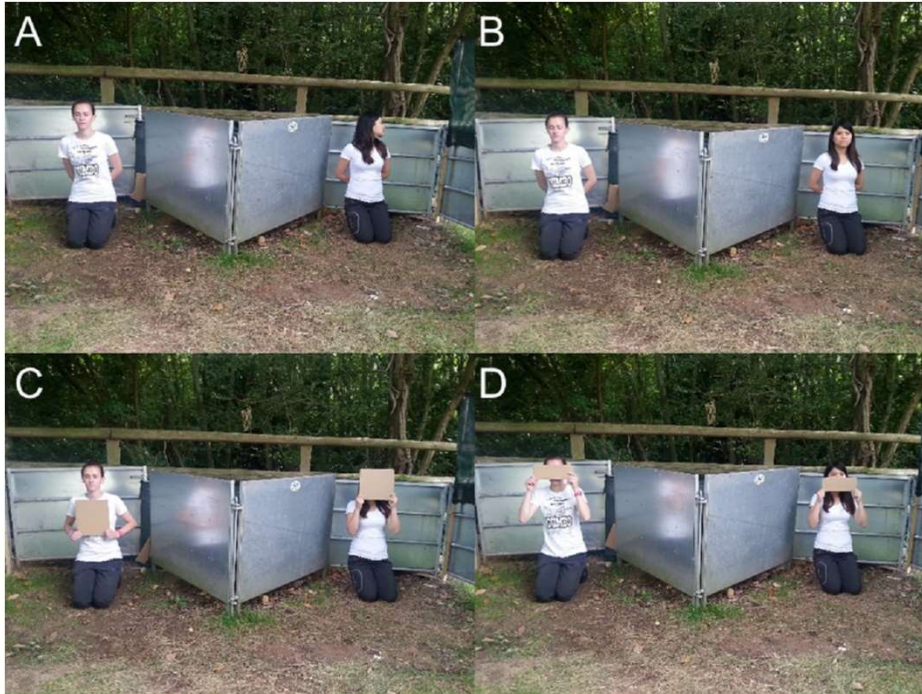
**Control female, rewarded
location**

Cognitive indicators: Judgement bias test



➡ No treatment effect

Attributing attention



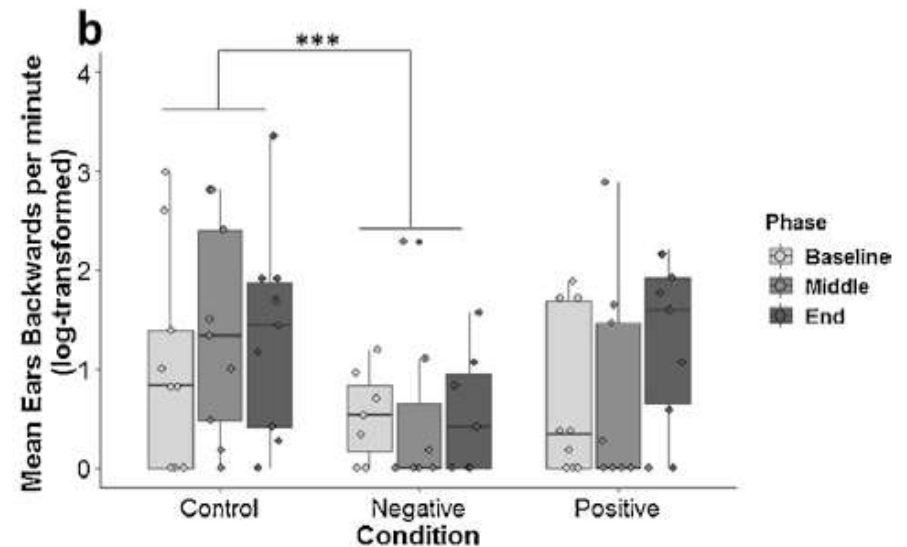
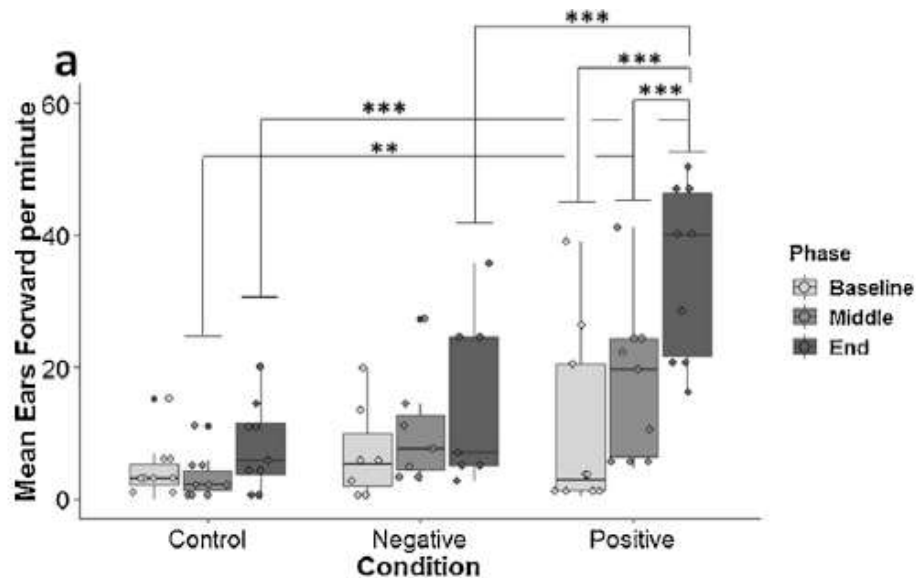
Goats preferred to approach the attentive person more than a person who closed their eyes or covered the whole face with a blind

BEHAVIOURAL INDICATORS

Behavioural Indicators: Body posture & parts



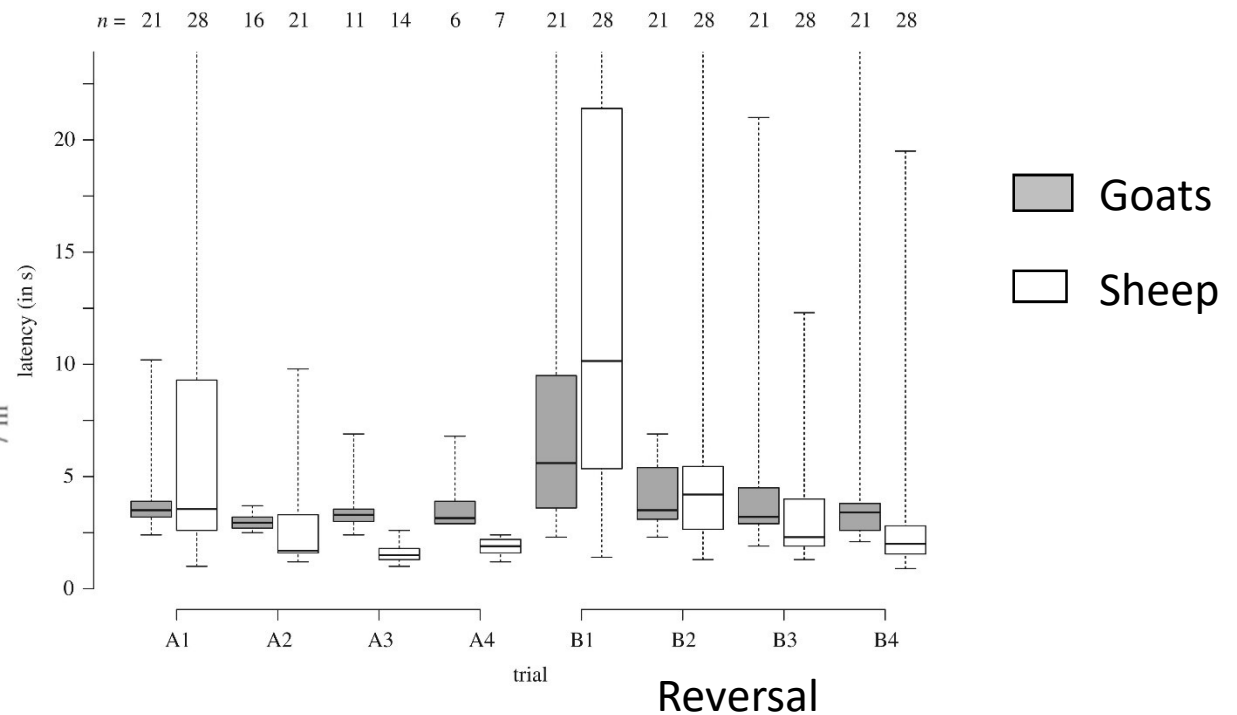
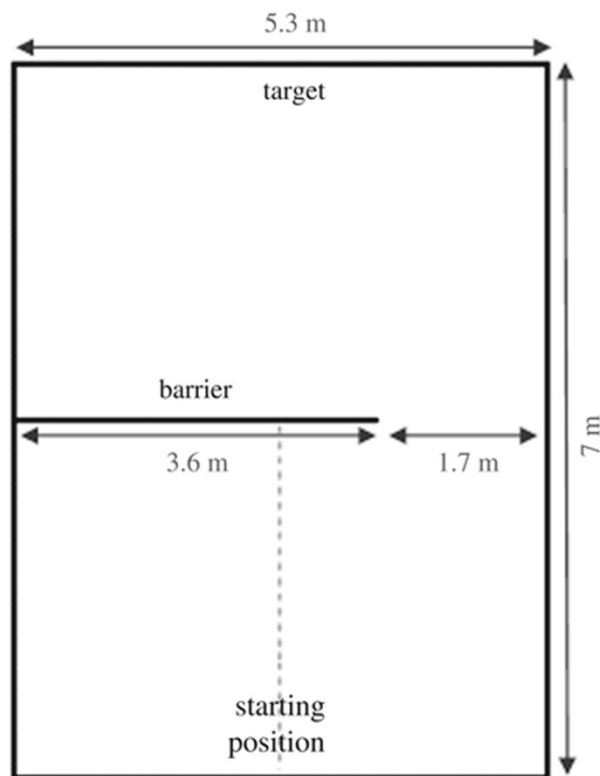
Control = clicker sound
Negative = inaccessible food
Positive = food anticipation



Ears forward = expectation (activity)

Ears back = uncertainty?

Behavioural Flexibility



Goats show higher behavioural flexibility than sheep in a spatial detour task