Social Intelligence

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Learning Outcomes

- We will take a bottom-up approach to what types of intelligence social living requires.
- We will then look at what social living allows which will give us a chance to look at a bottom-up account of social learning and culture.
- Looking at social robots, we see a difference to other topics. Normally we are mimicking the mechanisms of natural intelligence, But we don’t want robots to be social with each other, we want them to be social with us. So in social interactions with humans, we do the heavy lifting and the robot can ‘fake it’.

Requirements for a social brain

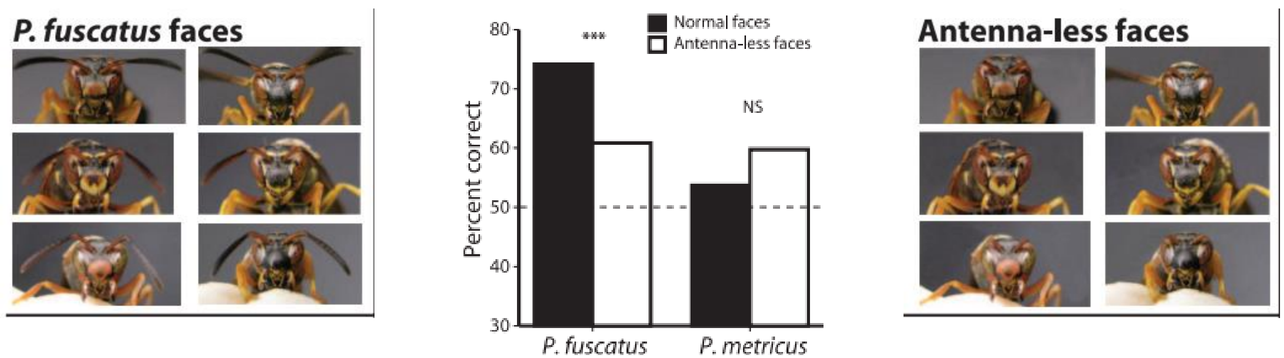
Frith and Frith (2010) The social brain. TiCS
"A bottom-up account of social intelligence"

1. **Is it an agent?**
2. **What is it doing?**
3. **What perspective does it have?**
4. **Can it imitate/understand what I do?**
5. **Does it have a Theory of Mind?**

1. Is it an agent? Species specific recognition is easy

Simple chemical nestmate recognition

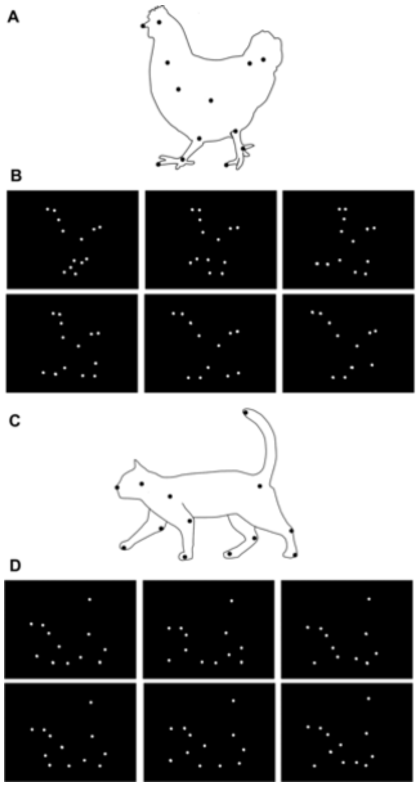
Large vocal recognition networks. McCoomb 2000



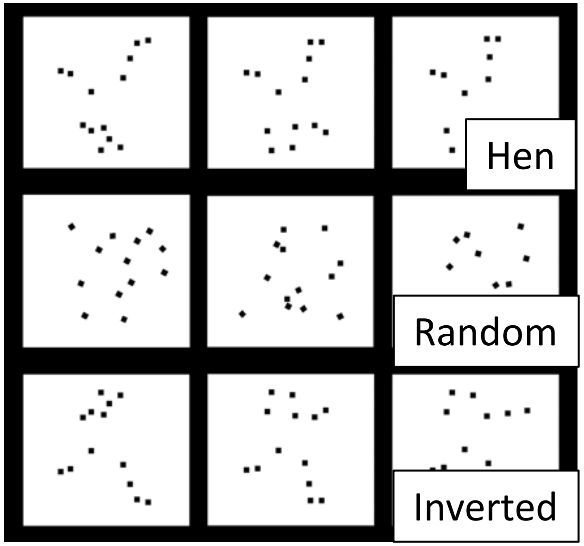
Facial recognition in wasps. Tibbets and Sheehan 2011

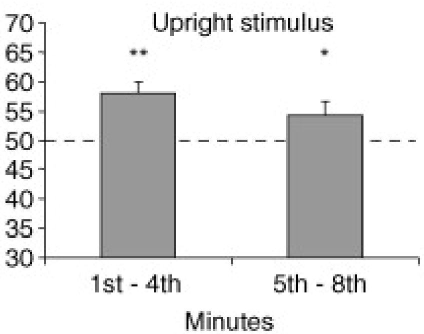
Species can share a dedicated channel for communication and identification

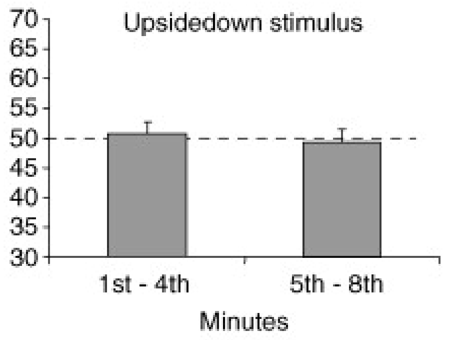
2. Is it an agent? Many species have a general-purpose biological motion detector

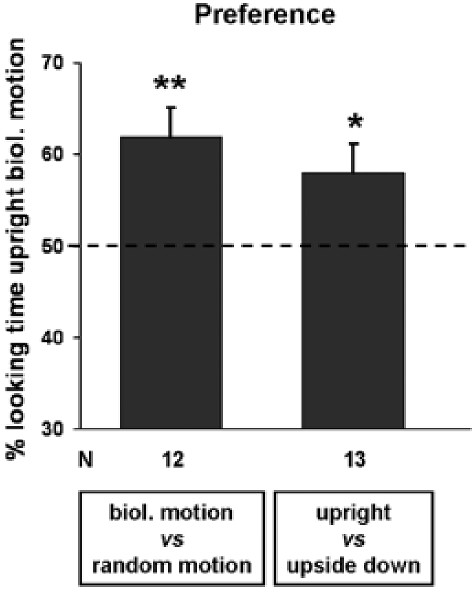


Simion et al., 2008 PNAS



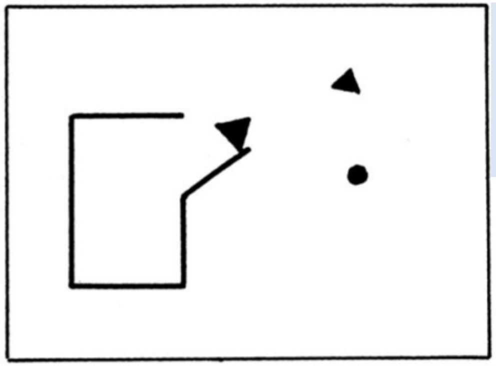






Vallortigara et al., 2005 PLoS BIOL

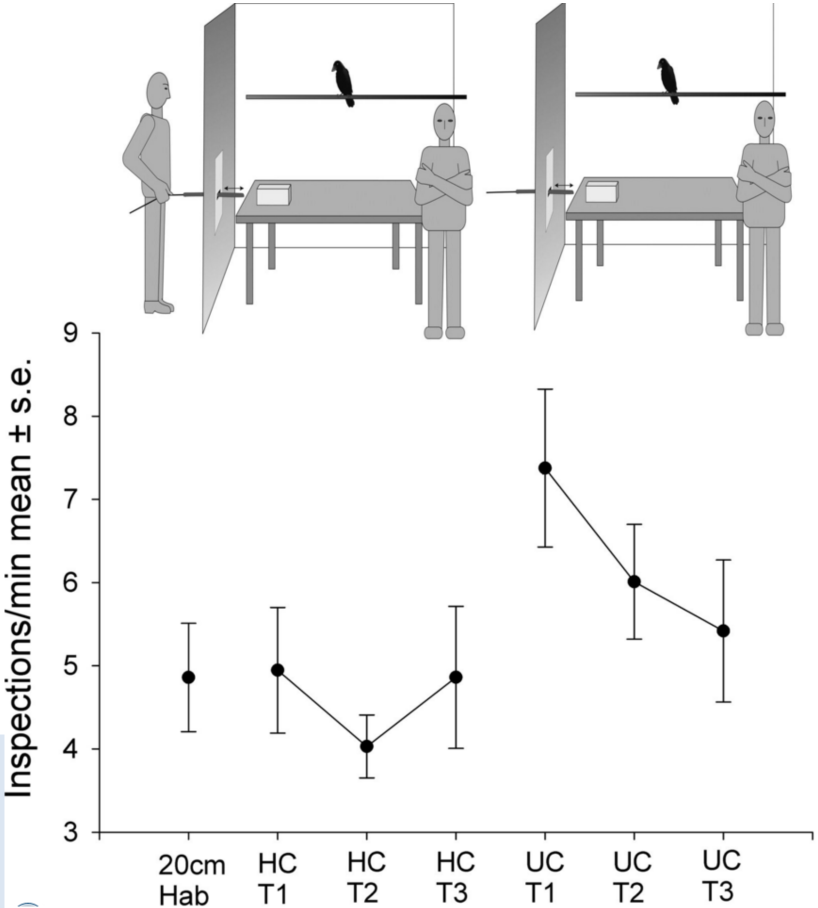
2. What is it doing? Understanding agency/actors allows one to understand actions



Heider and Simmel 1944

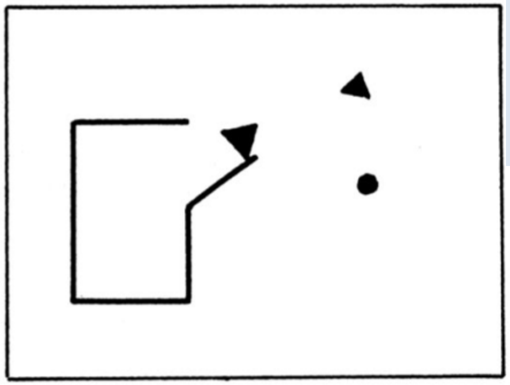
Humans attribute intentions to objects that move non-randomly

Taylor et al., 2012 PNAS



Crows expect agents to be responsible for the movement of objects

2. What is it doing? A sense of agency/actors



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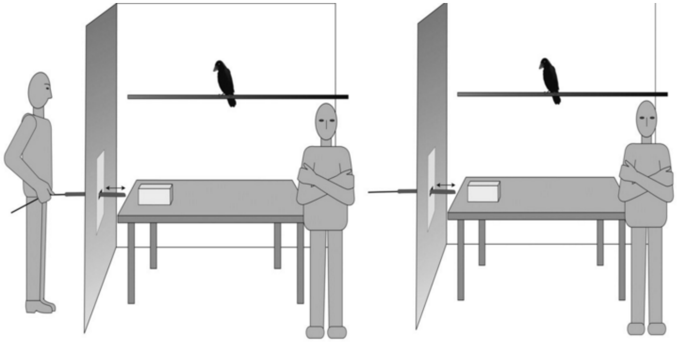
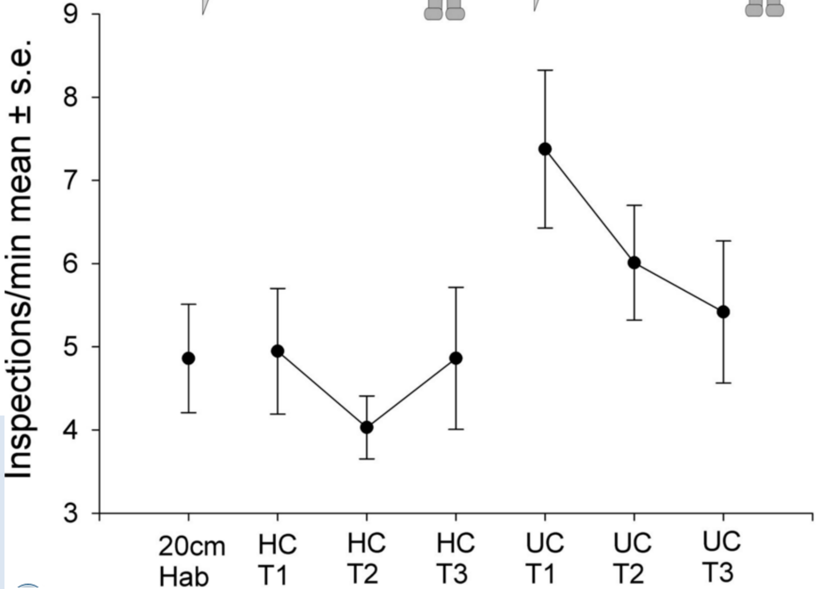


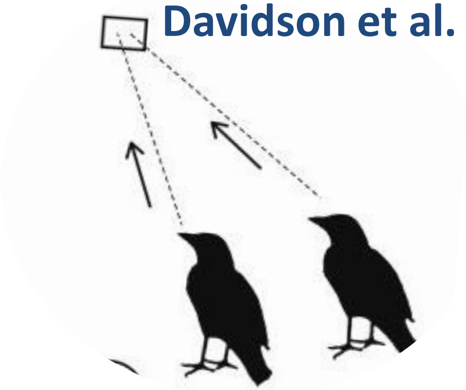


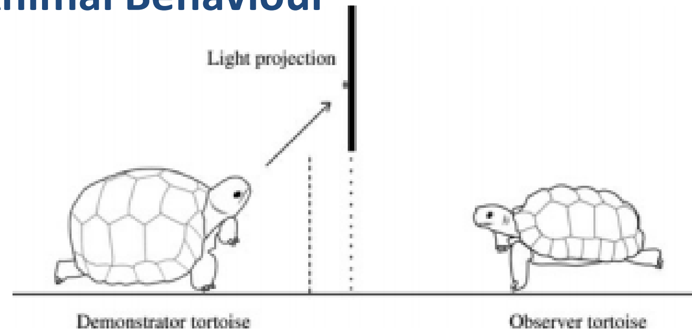
Taylor et al., 2012 PNAS

Crows expect agents to be responsible for the movement of objects

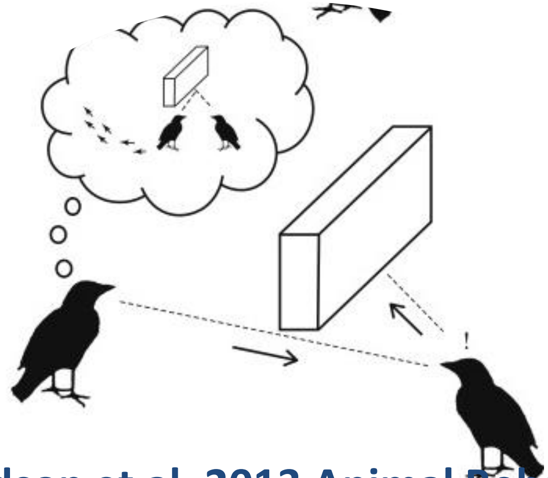
3. Perspective taking

Davidson et al. 2013 Animal Behaviour



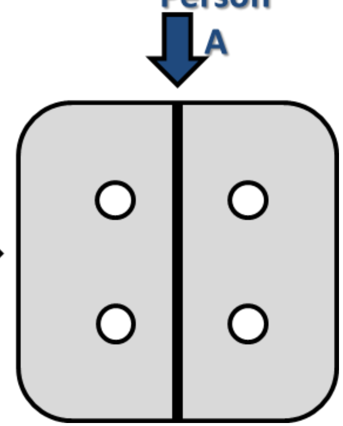


Automatic imitation allows social sharing of information

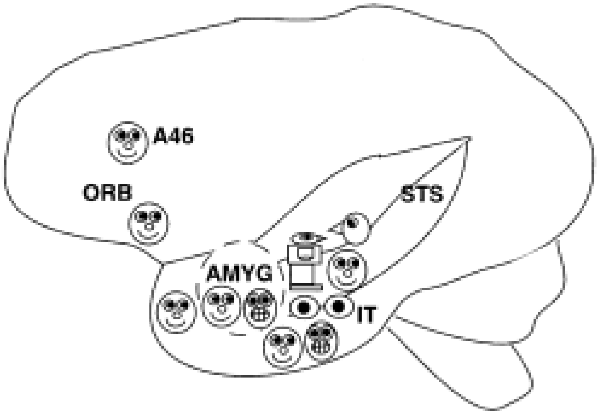


Davidson et al. 2013 Animal Behaviour

Samson et al., 2010



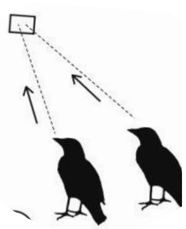
Emery 2000

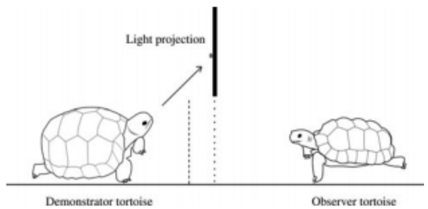


True perspective taking shows an understanding of 'other'

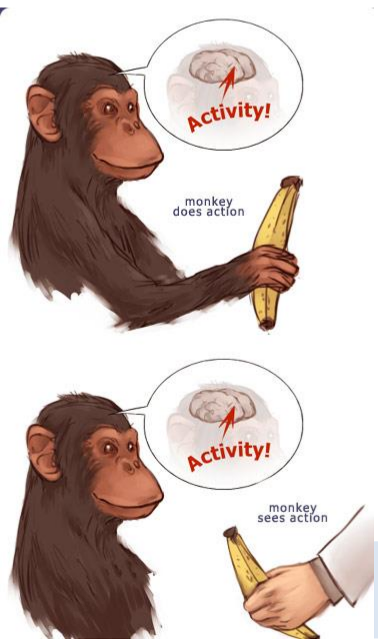
Requirements for a social brain (Frith and Frith)

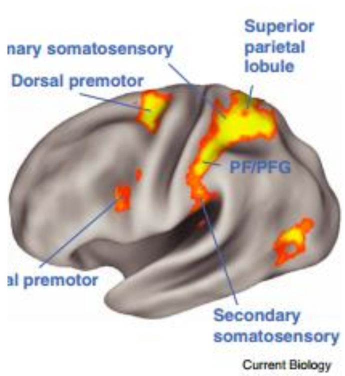
4. Imitation/understanding





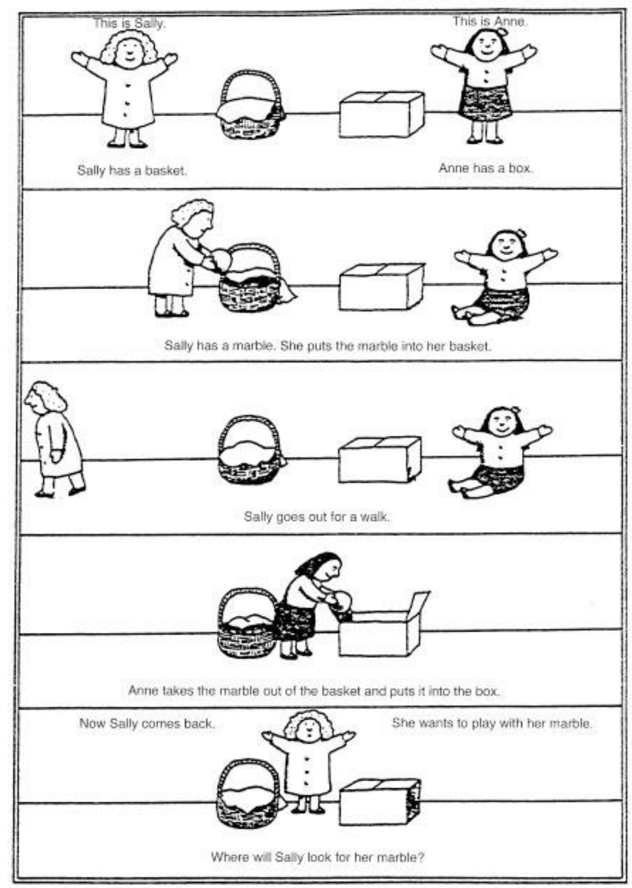
Automatic imitation, but also see …





Mirror neurons

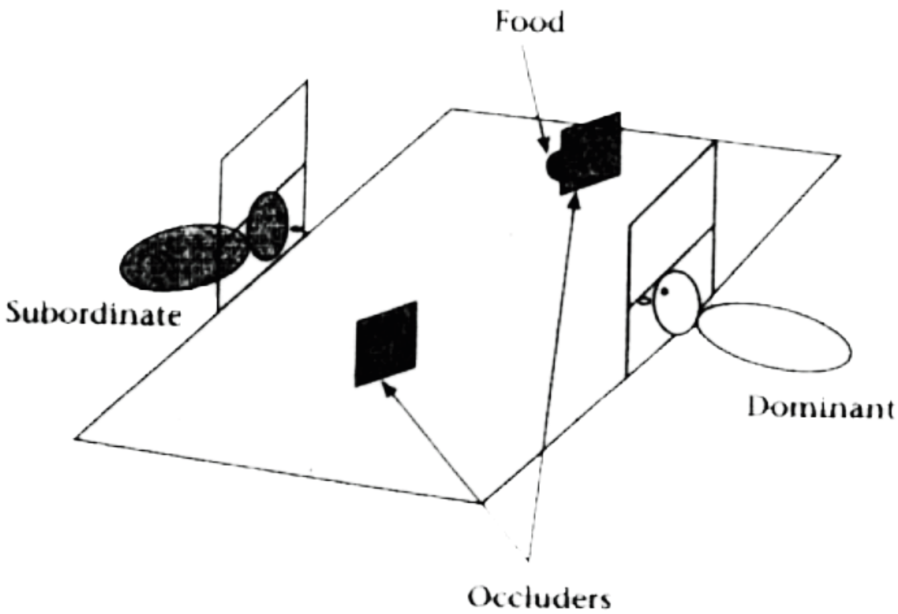
5. Theory of mind



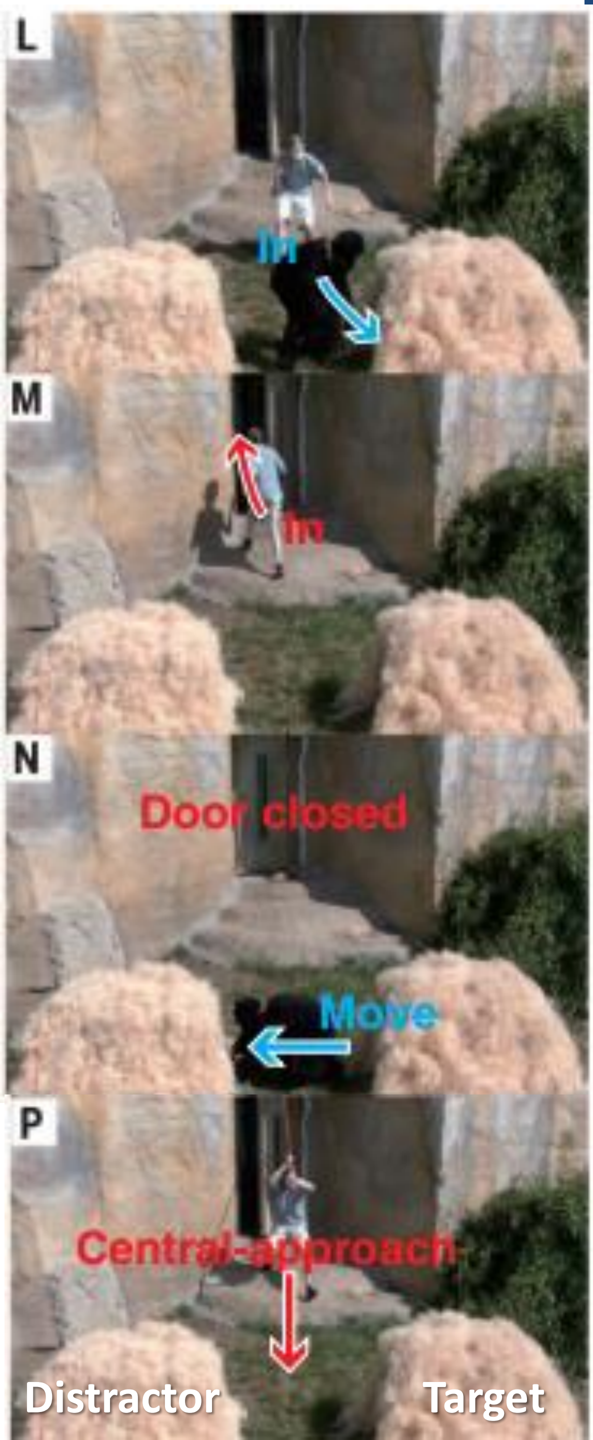
False belief. I.e. belief not driven by reality

5. Theory of mind

Here we are looking for evidence that one animal knows what another is thinking.



Subordinate chimp only goes for food when he knows dominant couldn't see it
Hare (2000,2001)



5. Theory of mind

Krupenye et al., 2016 Science

- **The logic of the classic false-belief task can be recreated with an action sequence.**
- **Eye-movements show predictions of where the action will be.**
- **So you can measure understanding/expectation based on where the subjects look.**
- **In their looking patterns, chimps, bonobos and orang-utans all show understanding of false belief.**

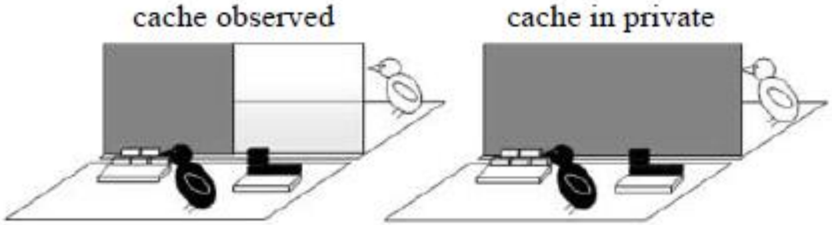
5. Theory of mind in corvids?

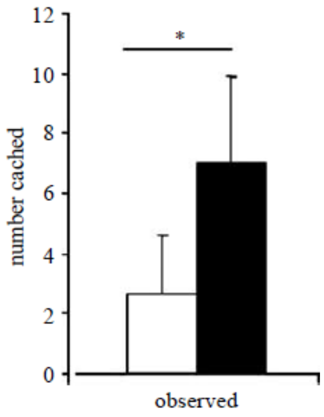
- It is not a surprise if we see ToM in close relatives of humans, but other animal groups might also be predisposed to social skills, such as **corvids**:
  - Complex social groups
  - Long development with lots of social interaction
  - Large nidopallium (avian PFC)
  - General intelligence is evident in tool-use
  - **Lab experiments have ecological validity**

Experimental evidence: caching heuristics

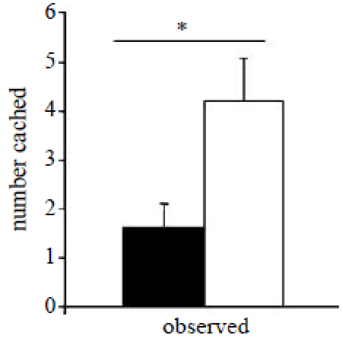
Scrub jays cache differently if a conspecific is watching.
Dally et al. (2005)

Clayton et al 2007

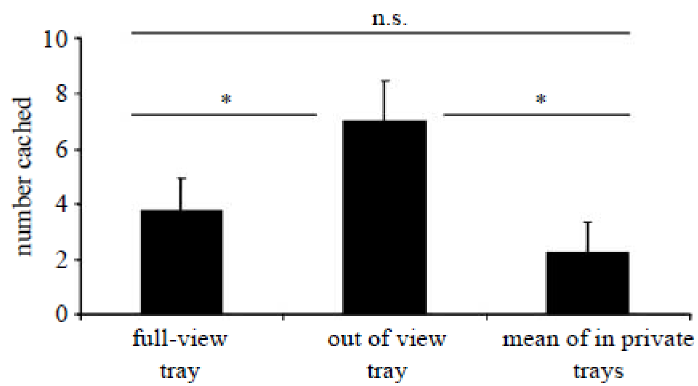




Lit v Shade



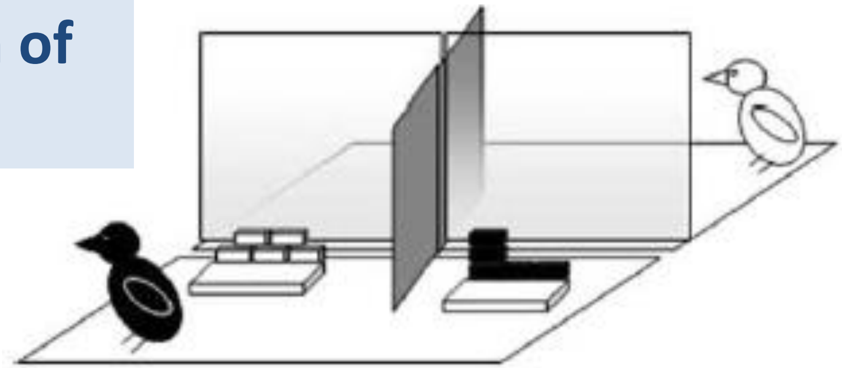
Near v Far

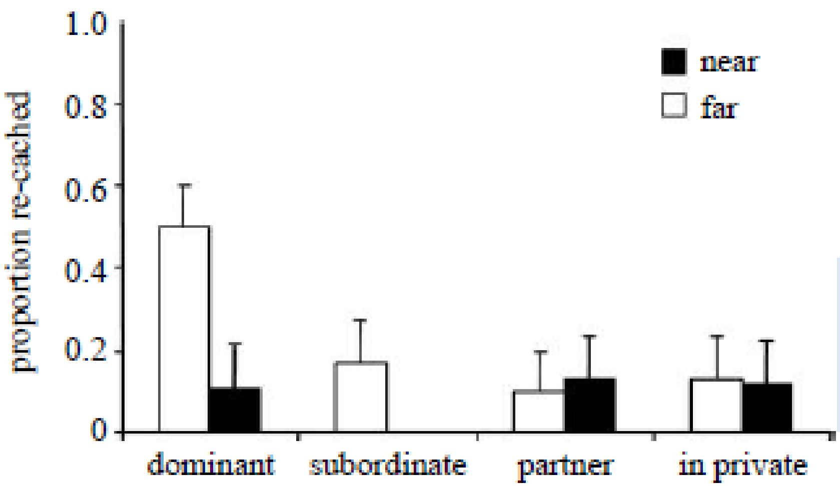


In view v Hidden

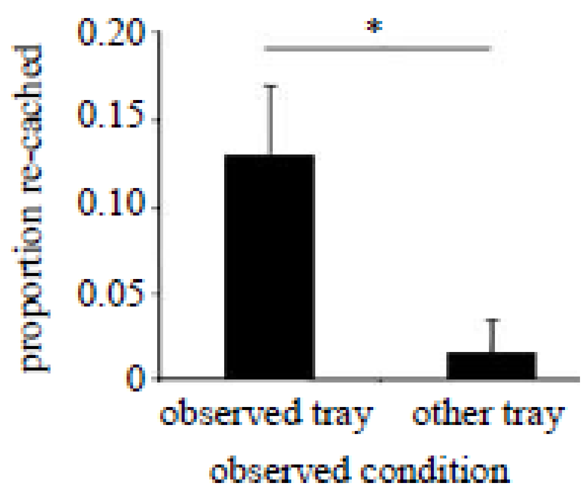
Moving caches as a function of social cues

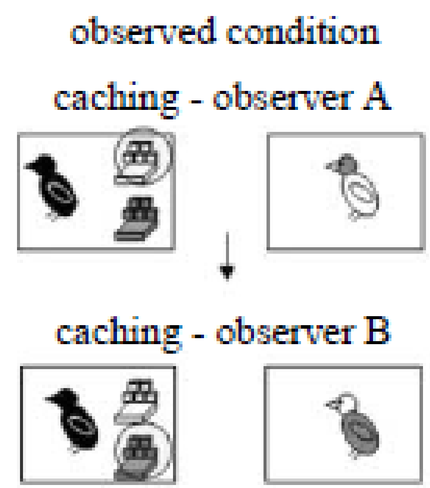
Birds re-cache as a function of being observed





Cache moving depends on who was watching





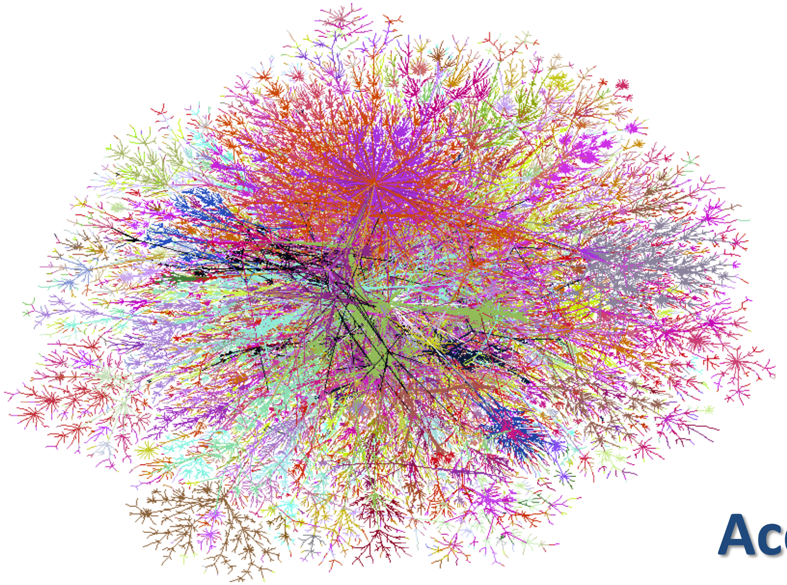
Suggests an understanding of which observer knows what. ToM?

Clayton et al 2007

Mini-break

Retention of expertise

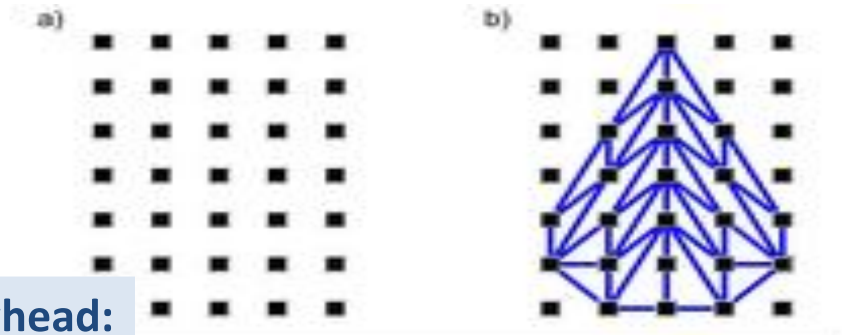
What social living allows



Accumulation of information

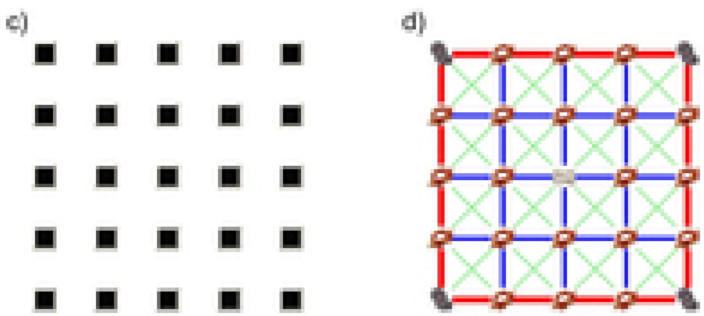
A simple foraging game: Derex et al. (2013)

1. Individuals playing a game where at each step they have to build a object to collect food.
2. Characteristics of the object lead to different food scores (and £)
3. They are assigned to a group and between rounds they can view another group member's solution.
4. At the start they are shown a demo of the arrowhead and the fishing net.



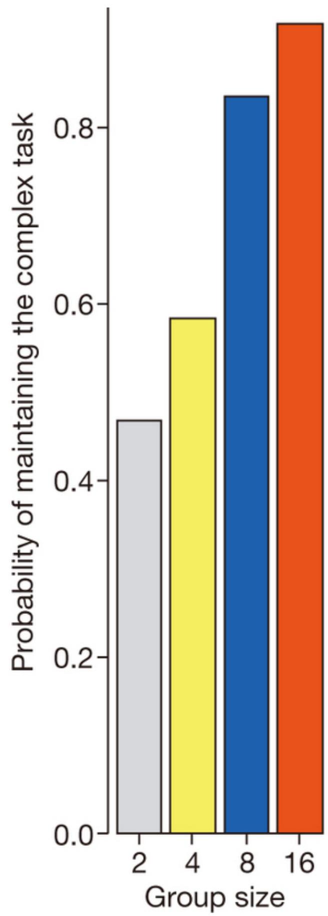
Arrowhead:
Symmetry
Shape
Weight

Fishing net:
Strength
Mesh size
Visibility
Weight

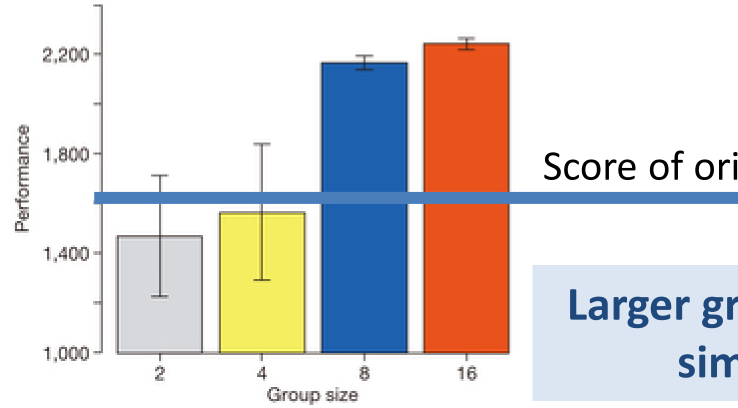


How does group size influence skill retention?

Looking at performance after 15 rounds

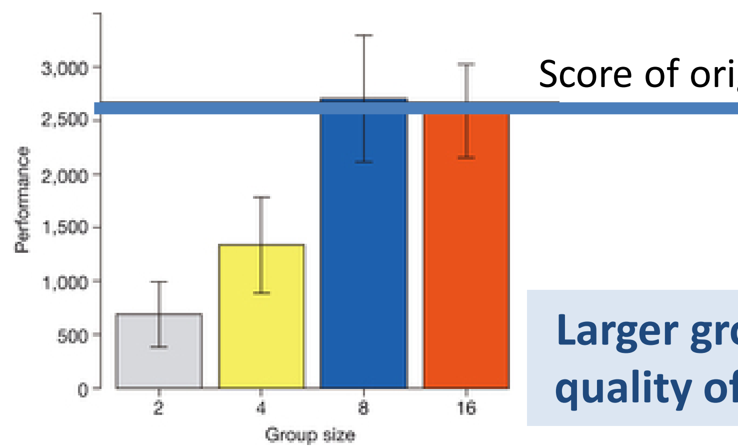


Larger groups maintain the complex task



Score of original arrowhead demo

Larger groups improve simple task

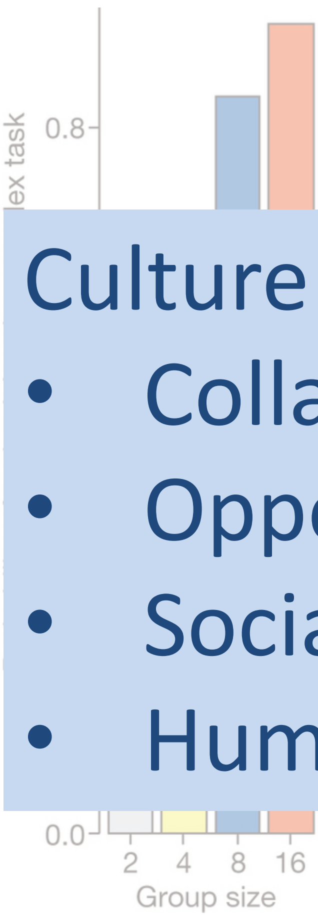


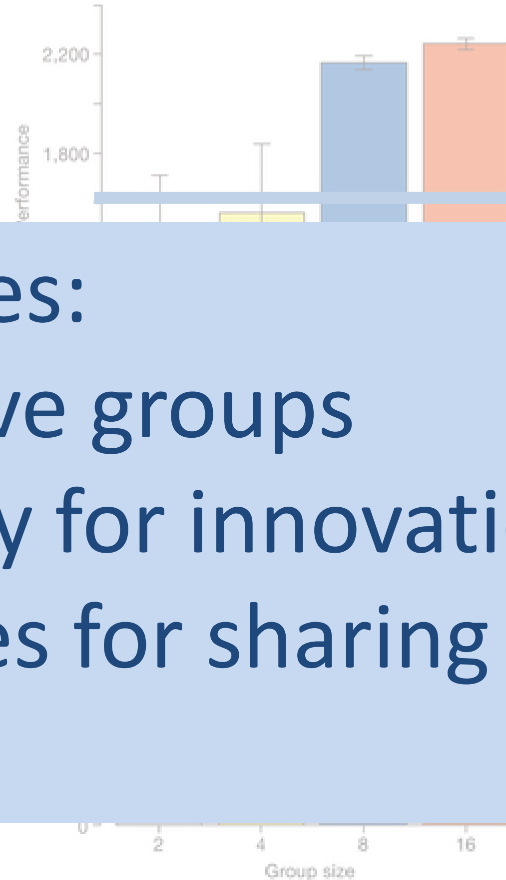
Score of original fishing net demo

Larger groups maintain quality of complex task

How does group size influence skill retention?

Looking at performance after 15 rounds





Score of original arrowhead demo

Culture requires:

- Collaborative groups
- Opportunity for innovation
- Social routes for sharing information
- Humility

emo

quality of complex task

Larger groups maintain the complex task

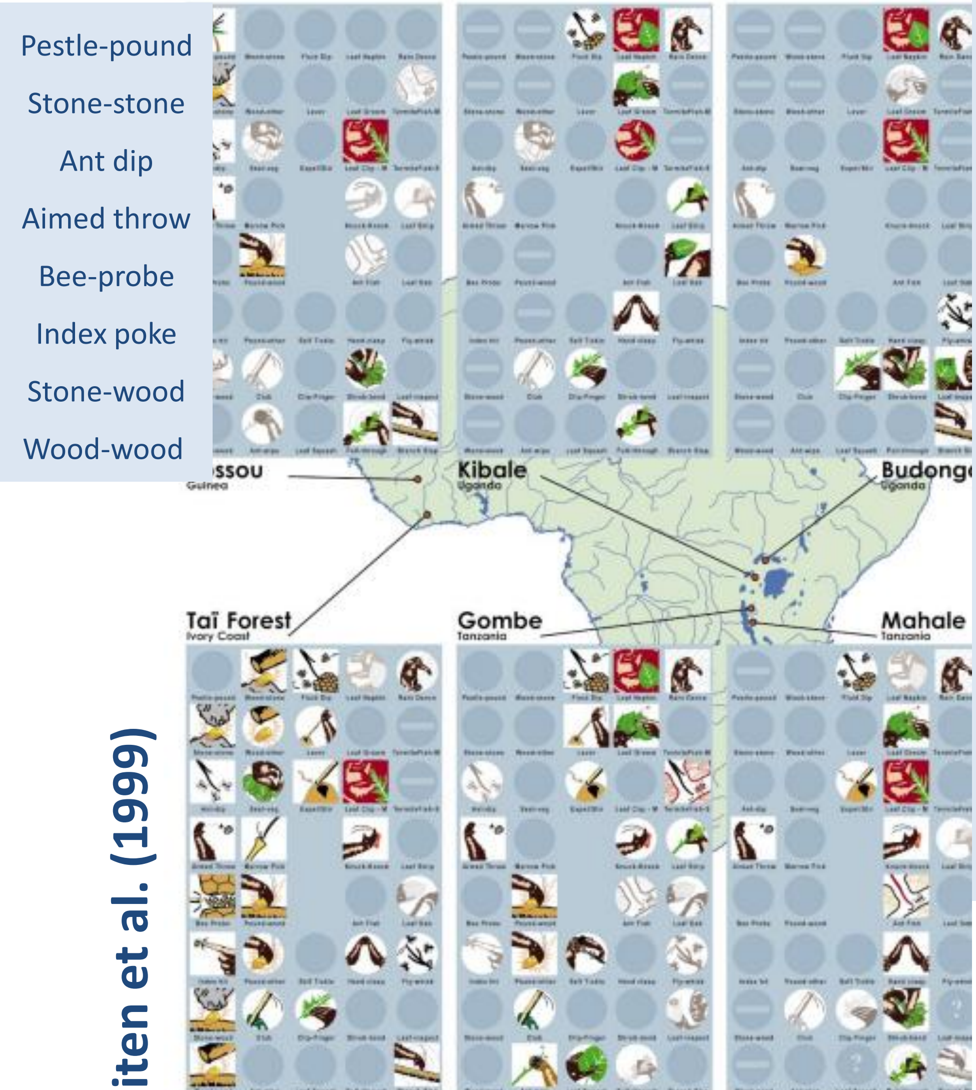
Introduction of culture in the wild

- Two wild populations of *Parus major*
  - Group A - Demonstrators taught to push door to left
  - Group B - … push door to right
- Apparatus and demonstrators introduced to the wild
- Sub –populations rapidly adopt the demonstrated strategy
- Behaviour persists and rapidly remerges if apparatus reintroduced 2 years later

- But, innovators switch if their strategy differs from group… …

Aplin et al., 2015

Traditions in natural social groups



Whiten et al. (1999)

- **Cultural phenomena should manifest in geographic variation.**
- **Spatial patterns of tool-use in chimp communities suggests culture.**
- **But it could be due to genetic or ecological factors which also very spatially.**

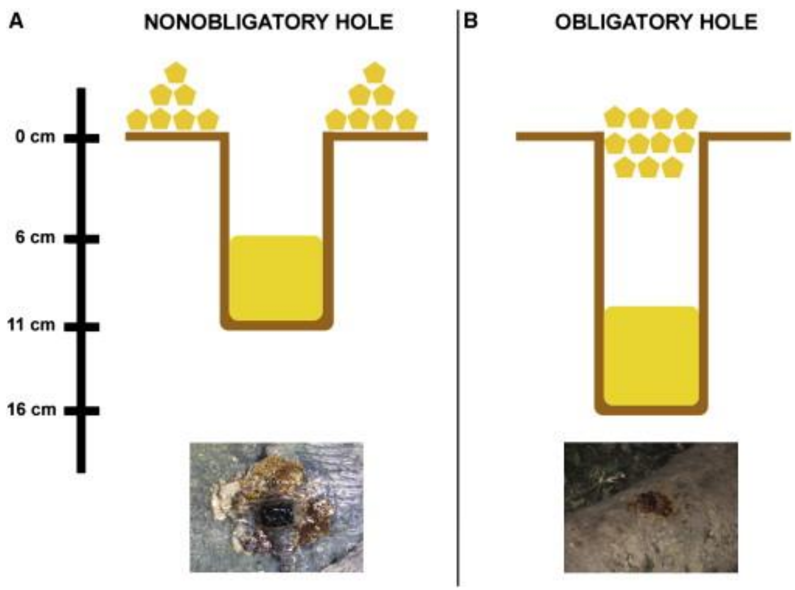
Genetics, ecology or culture?

Two Ugandan communities of chimps solving the same task

New Task

Leaf sponging

Stick probing



Spontaneous variation based on previous group knowledge

Gruber et al., 2009

Towards culture by social learning (another bottom-up account)

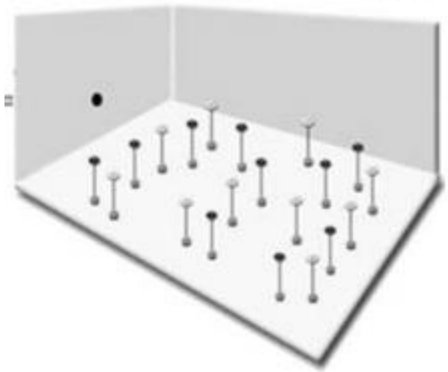
Tapping the knowledge of others is a shortcut to acquiring information :

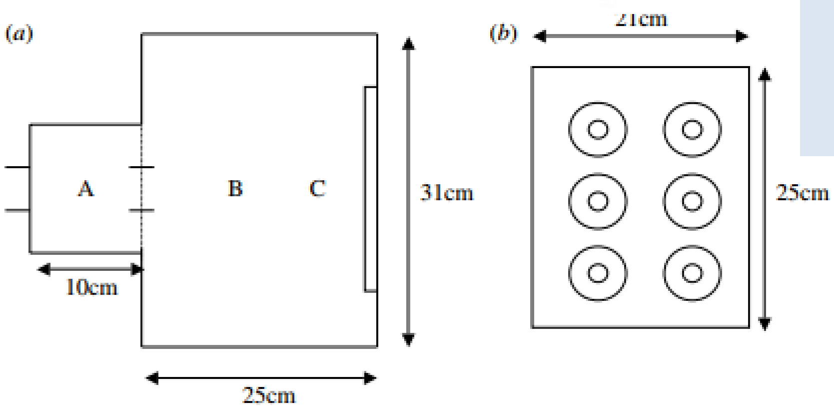
1. Stimulus enhancement: an observer's attention is drawn.
2. Response enhancement: an observer is readier to perform a particular action.
3. Affordance learning: Observer learns what can be done.
4. Imitation: Observer learns a specific sequence of actions.

Local enhancement and simple observational learning

- Local enhancement is an attentional attraction to visit a part of the world.
- Stimulus enhancement is more flexible and can lead to learning that can be applied more generally

Stimulus enhancement in bumblebees



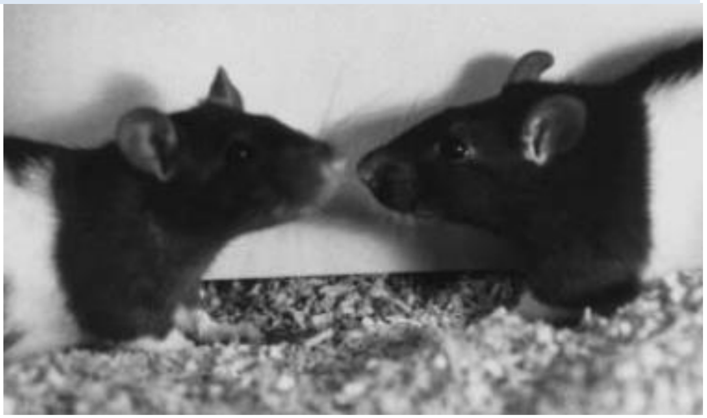


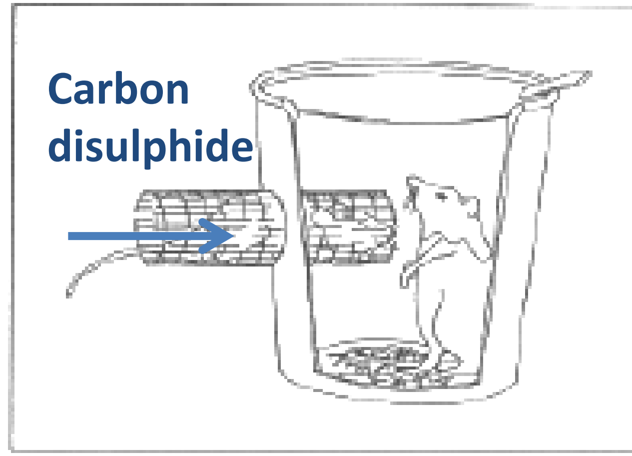
Worden and Papaj (2005)

Leadbetter and Chittka (2007)

Simple associative observational learning

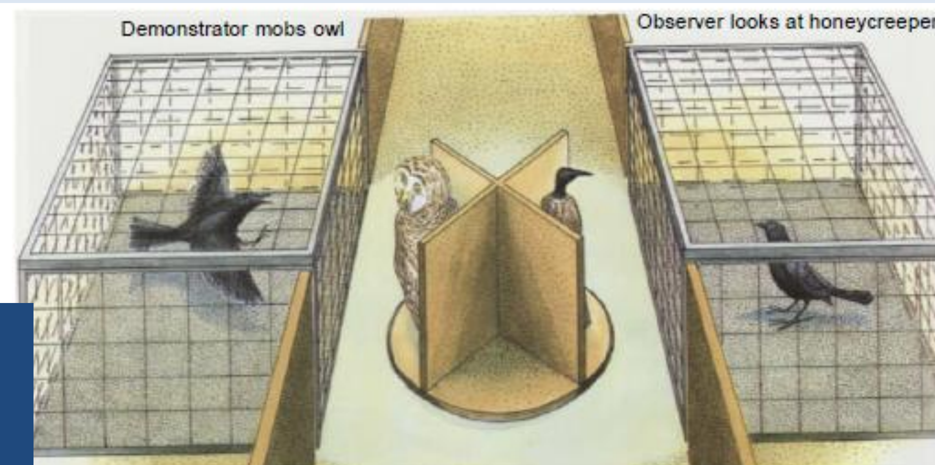
Rats learning about food





Galef et al 1988

Blackbirds learning about predators

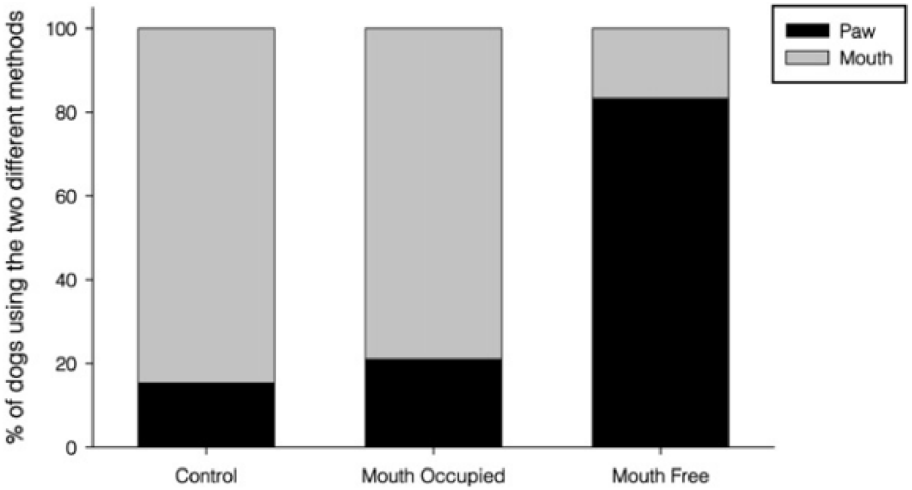


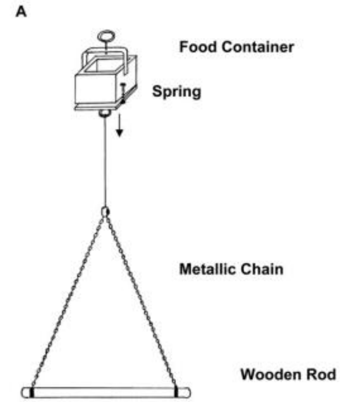
- Observational learning can be based on simple species-specific heuristics.
- Remember ‘killjoy’ explanations.

Affordance learning and understanding intention

Range et al 2007

Observer behaviour





Mouth occupied

Demonstrator

Mouth free

Observational learning can also take into account expectation, intent and understanding of folk physics.

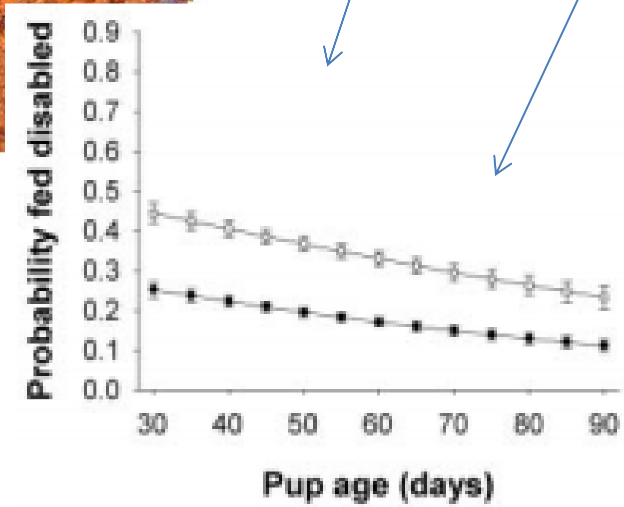
Teaching

Teaching involves modification of demonstrator behaviour to show understanding of the learning process

Adults give disabled scorpions to young meerkats

Non-scorpions

Scorpions



Lots of anecdotes of chimp teaching e.g. Boesch 1991

Hoppit et al., 2007 TREE

Summary

Social Intelligence is a huge and complex research area
But we can see plausible bottom-up 'routes' to understanding it

Social Learning

1. Stimulus enhancement
2. Response enhancement
3. Affordance learning
4. Imitation

Understanding of 'other'

1. Is it an agent?
2. What is it doing?
3. What perspective does it have?
4. Can it understand what I do?
5. Does it have a Theory of Mind? (Do I?)

Social cognition in robots

Two reasons for studying social interactions/intelligence in robotics:

1. Robots are being used in health and education: better human-robot interaction leads to better results
2. Modelling the factors that lead to effective social interaction can help us understand it better: e.g. which of the bottom-up factors are important?

For 1, definitely need a robot

For 2, might not (but only because problem is so hard)

Paro: interaction leads to increased companionship

https://www.youtube.com/watch?v=oJq5PQZHU-I

- Pets can engender good mental health
- When this is impractical, a robotic companion works and can also be a remote monitor
- Key is the companion reacts to you so triggers natural social response

Ethics is a key area

bioethics

SPECIAL ISSUE | Full Access

Dementia care, robot pets, and aliefs

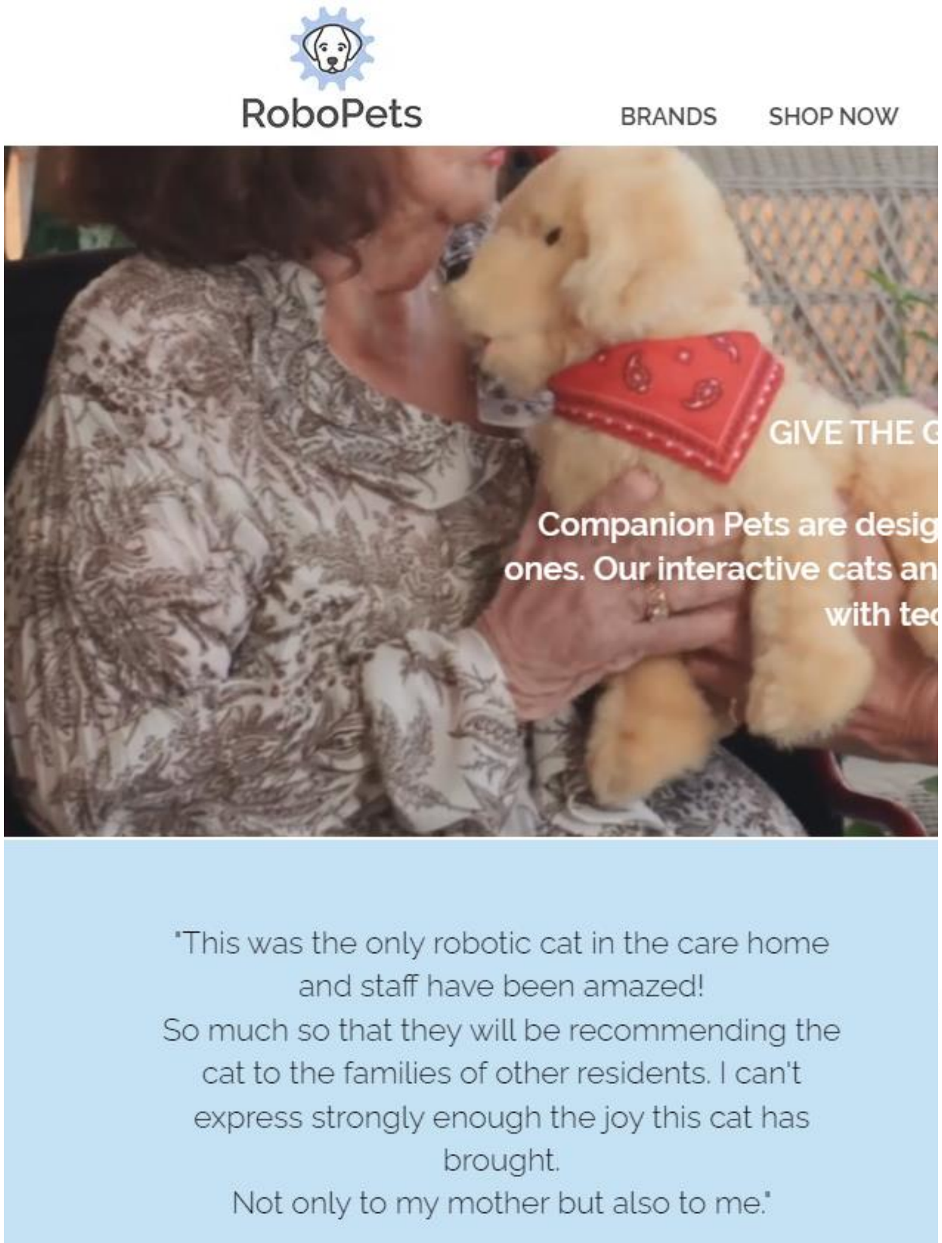
Rhonda Martens, Christine Hildebrand

Abstract: Studies have shown that using robot pets in dementia care contributes to a reduction in loneliness and anxiety, and other benefits. [...] even when people know they are dealing with robots, they often treat the robot as though it is a real pet with genuine emotions. This disconnect between beliefs and behavior occurs not just for people living with dementia, but with cognitively healthy adults, including those who are knowledgeable about how robots work. One possible explanation is that robot pets prompt contradictory beliefs, [... so] encourages self-deception. Sparrow argues that this makes the use of robot pets in dementia care morally objectionable. We disagree. We argue that Gendler's concept of *alief* offers a better explanation of the belief-behavior disconnect observed [...]. An alief is a mental state composed of an automatic, arational, emotional, and behavioral response to representational input.

As is precisely what is needed to elicit benefits

Robopets

“Companion Pets are designed to bring comfort, companionship, and fun to aging loved ones. Our interactive cats and pup are all about an ease-of-care and convenience that pairs with technology for the best possible experience.”

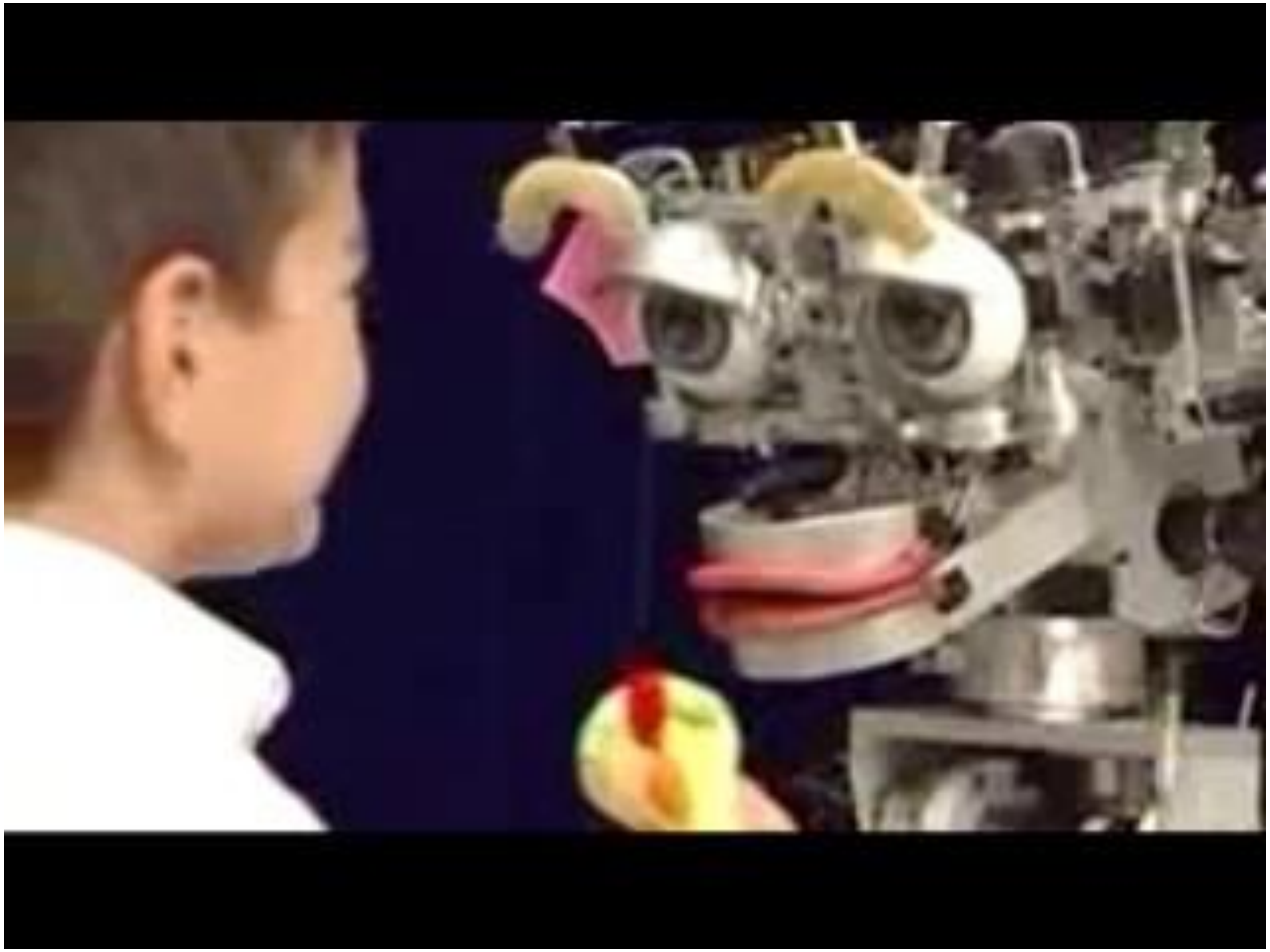


Increasing meaningful social interaction

"What are the common social mechanisms of communication and understanding that produce efficient, enjoyable, natural and meaningful interactions between humans and robots" Handbook of robotics

- Being 'cute' is not the only way to get a good reaction
- Much work from psychology on eliciting emotional empathy
- **Kismet** examines mirroring and its role in social interaction
- Maps affective state to [A,V,S] space (arousal, valence, stance) and to facial and postural expressions and vocal quality
- Learns (via AI) how features map to [A,V,S] space and affective state
- Extract state from vocal input, generate own and start a 'dance' between human and robot

Kismet: Interaction through mirroring



[Video 557: Overview of Kismet's expressive behavior (http://handbookofrobotics.org/view-chapter/videodetails/72)](http://handbookofrobotics.org/view-chapter/videodetails/72)

https://vimeo.com/117196742

My killjoy take

The paper said: *"To participate in emotion-based interaction, robots must be able to recognize and interpret affective signals from humans, they must possess their own internal models of emotions (often inspired by psychological theories), and they must be able to communicate this affective state to others"*

My take: To participate in emotion-based interaction, robots must be able to recognize [...] affective signals from humans, [...] and communicate this affective state to others

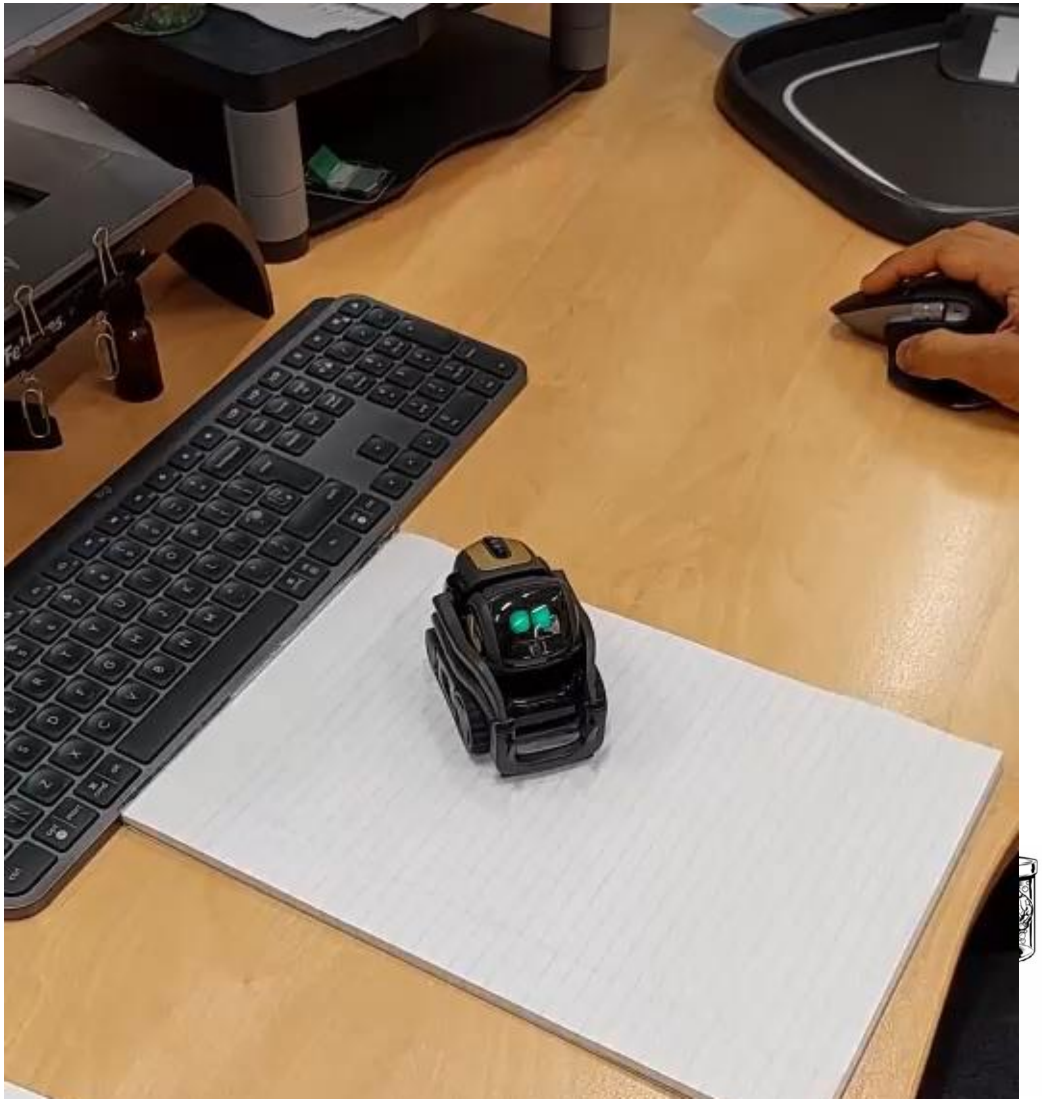
Or even: To participate in emotion-based interaction, robots must be able to [...] communicate this affective state to others

The later statements move from a psychology problem to machine learning problem (could this be the same for us?)

Human-robot interaction (HRI)

- Much research into human robot interaction and ethics
- Especially what engenders interaction, trust (and allows behavioural nudges)
- RoboPets: Embodied Cognition for Human-Robot Interactions at Bristol Robotics Lab: *Research on natural and socially acceptable human-robot interaction*

(https://www.bristolroboticslab.com/ECHOS)



Learning from others' perspectives

- Social referencing behaviour "how nonverbal and verbal communication, emotive behavior, and social learning integrate to support social referencing"

- Highlights two aspects

1. Leonardo Associates emotional valence (from face, tone, words) with the *referent*
2. *Referent* ie whst is attended to is calculated from gaze and fixation time (note inference of others perspective)

Video 556: Social referencing behavior
http://handbookofrobotics.org/view-chapter/videodetails/72
https://vimeo.com/117196840

Summary revisited

- Even ignoring 'companion' robots, HRI is a huge and growing topic
- Clearly important to get better reactions if robots are to interact with humans
- Ethics is becoming vital (especially for agents!)
- HRI allows testing of plausible bottom-up 'routes' to understanding requirements for social learning that Paul highlighted

Social Learning

1. Stimulus enhancement
2. Response enhancement
3. Affordance learning
4. Imitation

Understanding of 'other'

1. Is it an agent?
2. What is it doing?
3. What perspective does it have?
4. Can it understand what I do?
5. Does it have a Theory of Mind? (Do I?)

Reading

- Frith and Frith (2010) The social brain: allowing humans to boldly go where no other species has been. Phil Trans Roy Soc B
- Hoppitt et al. (2008) Lessons from animal teaching. Trends Ecol & Evol
- Siciliano, B., & Khatib, O. (2016). *Springer Handbook of Robotics* (2nd Edition). Cham: Springer International Publishing AG.