The evolution of human cognition.
Findings from comparative approaches in Psychology and Biological Anthropology

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Lecture 2

Lecture 2

- Social Learning
- Theory of Mind
- Mental Time Travel
- Consciousness

Social learning

Social learning

- Mechanisms underlying social learning
- Specialised mechanism x Part of general learning process
- Function of social learning
- Costs and benefits of different learning strategies
- Possible evidence for cultural differences between populations

What is Social learning?

- Learning that is influenced by observing or interacting with another social agent or its product (Galef, 1988)
- Terkel (1975) – black rats and pine cones

Mechanisms of social learning

- Often different terminology across studies
- Some propose (Heyes, 1994) that demonstrator's behaviour must influence observer's behaviour at later time

Local enhancement and stimulus enhancement

- Local enhancement (Thorpe, 1956) – observer's attention to stimulus is drawn through the exposure to the demonstrator or its products
- Stimulus enhancement (Spence, 1937) – observer is exposed to a stimulus through observing a demonstrator and will thus in the future act on all stimuli of the same type

Hinde & Fisher (1951)

- Blue tit opening a milk bottle

Observational conditioning

- Demonstrator's actions lead to a subsequent change in the observer's affective state or behaviour towards a stimulus
- Cook et al. (1985) – fear responses in rhesus monkeys

Cook & Mineka (1990)

Cook, M., & Mineka, S. (1990). Selective Associations in the Observational Conditioning of Fear in Rhesus Monkeys. *Journal of Experimental Psychology: Animal Behavior Processes*, *16*(4), 372–389. https://doi.org/10.1037/0097-7403.16.4.372

Curio et al. (1978)

Curio, E., Ernst, U., & Vieth, W. (1978). The Adaptive Significance of Avian Mobbing. *Z. Tierpsychol.*, *48*, 184–202. https://doi.org/10.1111/j.1439-0310.1981.tb01262.x

Emulation

- Achieving the same goal as demonstrator but using different actions (Wood, 1989)

a) Goal-emulation

b) Affordance learning

c) Object movement reenactement

Imitation

- Observer learns a form of action from a demonstrator (Shettleworth, 2009)
- Copying a novel behaviour (Thorpe,1963) – must involve a behaviour not previously shown as part of observer's repertoire

How to distinguish imitation from other social learning mechanisms?

- Two-action task – an apparatus can be manipulated in two different ways
- Akins & Zentall (1999) – Japanese quails

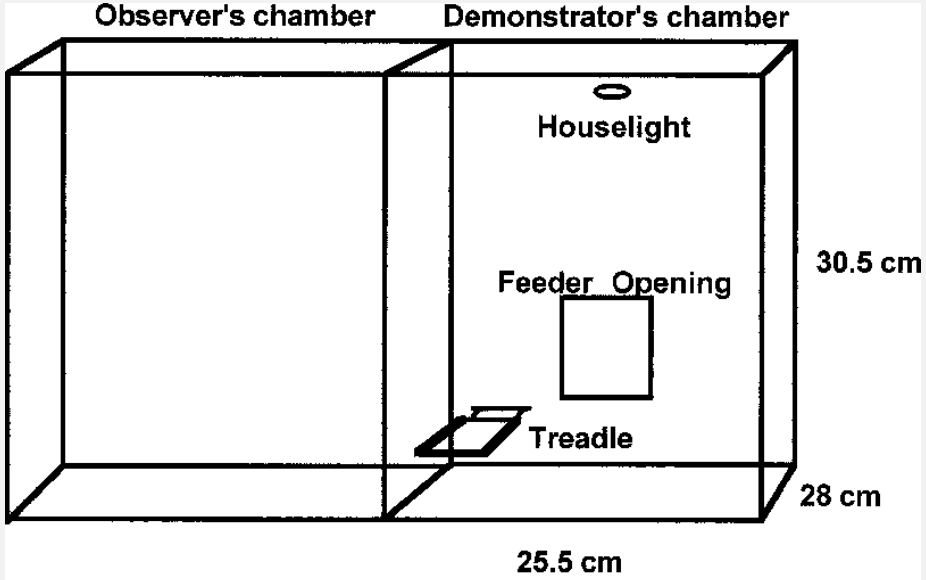
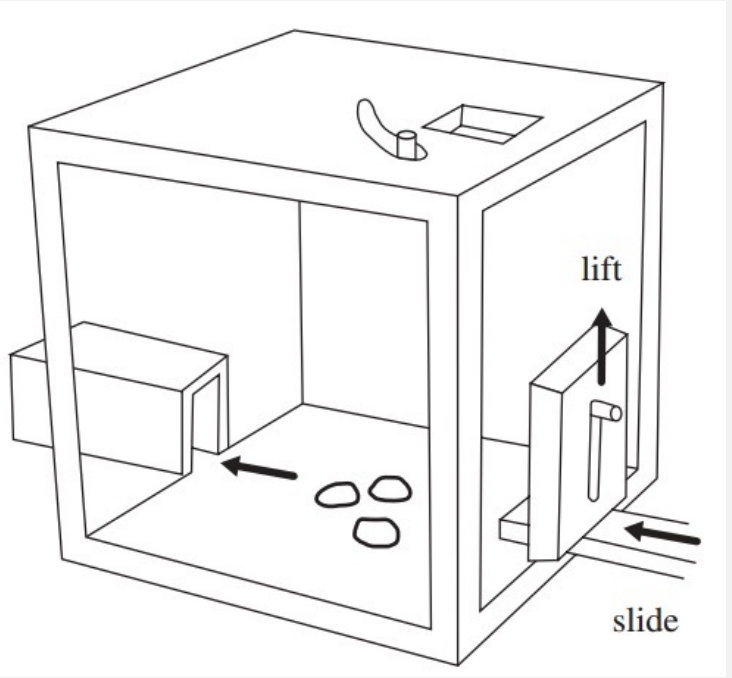


Figure 1. A schematic diagram of the apparatus used in the present experiment.

Whiten et al. (1996)

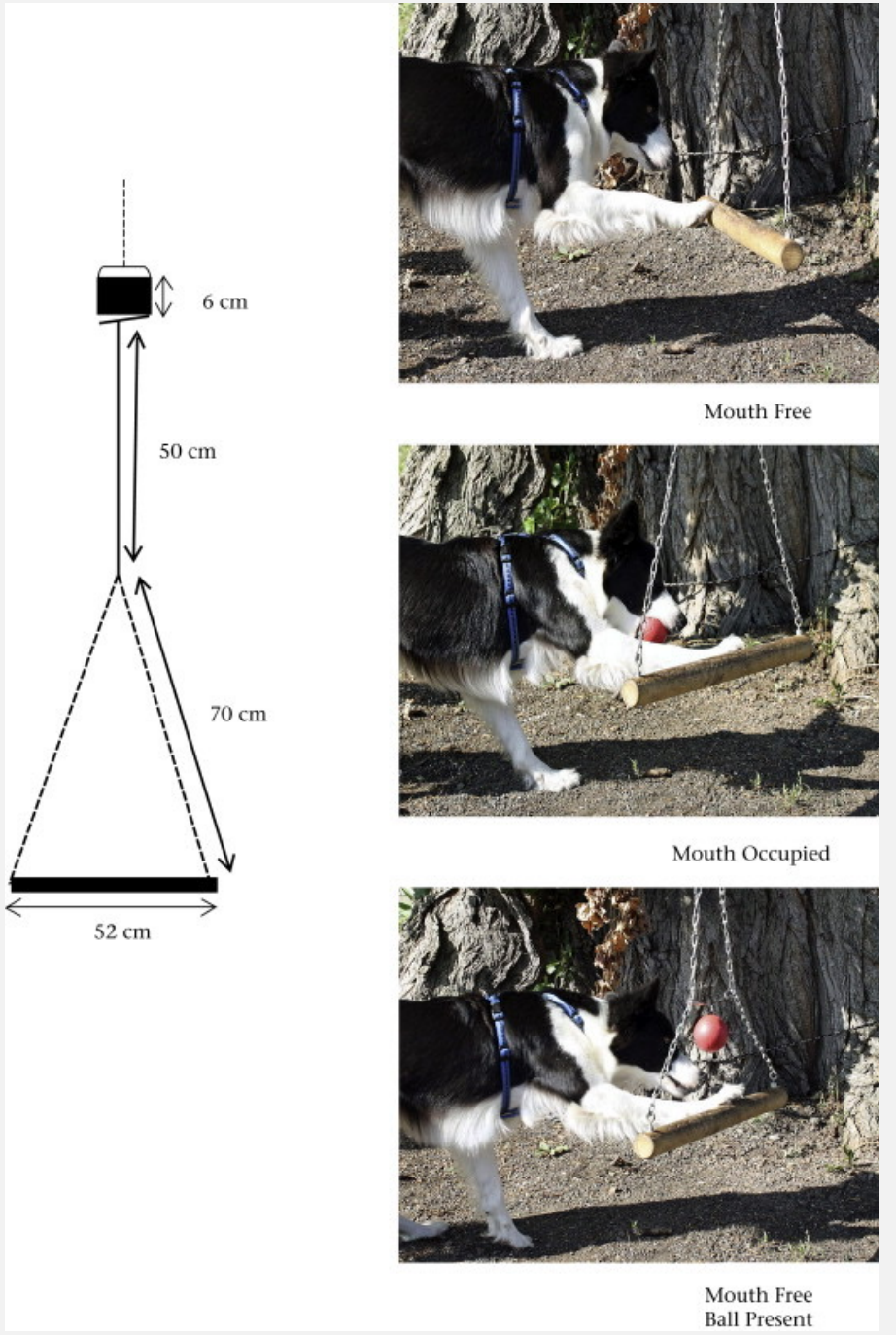
- Two-action task for children and chimpanzees
- Box apparatus containing fruit



Whiten, A., Custance, D. M., Gomez, J. C., Teixidor, P., & Bard, K. A. (1996). Imitative Learning of Artificial Fruit Processing in Children (Homo sapiens) and Chimpanzees (Pan troglodytes). *Journal of Comparative Psychology*, *110*(1), 3–14. https://doi.org/10.1037/0735-7036.110.1.3

Rational imitation

- Observer copies the form of demonstrator's behaviour but only if there is "rational" reason for that behaviour
- Range et al. (2007) – domestic dogs



Kaminski, J., Nitzschner, M., Wobber, V., Tennie, C., Bräuer, J., Call, J., & Tomasello, M. (2011). Do dogs distinguish rational from irrational acts? *Animal Behaviour*, *81*(1), 195–203. https://doi.org/https://doi.org/10.1016/j.anbehav.2010.10.001

Ethological observations of imitation

- songbirds: https://www.youtube.com/watch?v=mSB71jNq-yQ

Specialised or general learning mechanism?

- Heyes (1994) – different phenomena studies within the realm of social learning correspond to different types of asocial learning

Social learning	**Asocial learning**
Stimulus/local enhancement	Habituation, sensitization
Observational conditioning	Pavlovian conditioning
Imitation, emulation	Instrumental conditioning

Adaptive specialisation to living in groups?

- Templeton et al. (1999) – pinyon jays and Clark's nutcrackers on motor and discrimination tasks

Adaptive specialisation to living in groups?

- But: social and asocial learning abilities tend to co-vary across species (Lefebvre & Giraldeau, 1996) and within species (Boogert et al., 2008)
- Non-social species can learn socially (Wilkinson et al., 2010)
- Dolman et al. (1996) – animals may learn better from demonstrator they do not compete with

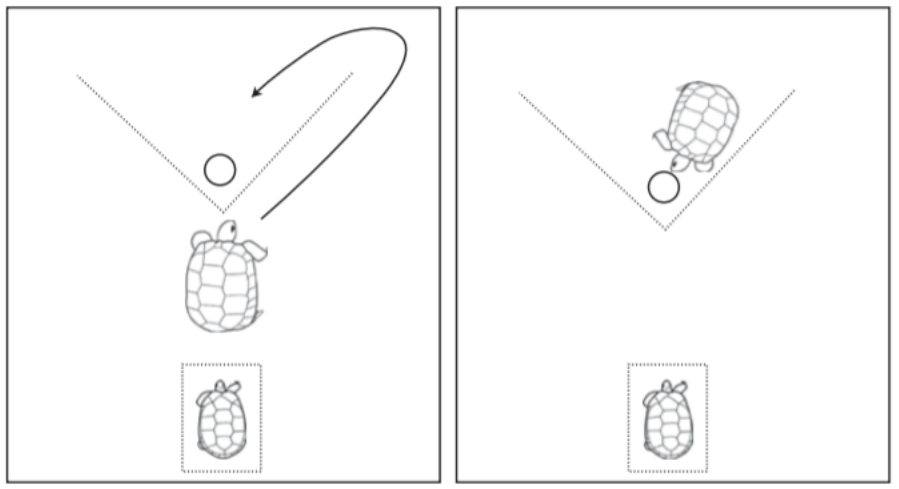


Figure 1. The experimental setup. The arrow indicates the direction in which the demonstrator moved.

Wilkinson, A., Kuenstner, K., Mueller, J., & Huber, L. (2010). Social learning in a non-social reptile (Geochelone carbonaria). *Biology Letters*, *6*(5), 614–616. https://doi.org/10.1098/rsbl.2010.0092

Function of Social learning

- Complex and time-consuming skills
- High cost to mistakes

When to learn socially?

- Roger's paradox (Roger, 1998) – fitness advantage of social learning decreases as the prevalence of social learning increases

- Important research question: when and whom to copy

Non-human culture

- How to define culture?
- Whiten et al. (1999) – behaviour transmitted repeatedly through social learning in such a way that it becomes a population level characteristic

Most tool inventions food-related

- Jill Pruetz observed chimpanzees create spear-like objects and use them to hunt strepsirrhines

Cultural differences in animal populations

- Sweet-potato washing in Japanese macaques at Koshima (Kawai, 1965)

Discussion questions

1. Do you think imitation is necessarily more complex than the other types of social learning and why?
2. Why is social learning useful?
3. What is unique about human culture (if anything)?

Recap

- Social learning – learning from another agent and its products
- Different types
- General learning process with selection for social input or special adaptation to living in social groups
- When and from whom to learn matters
- Material culture – passed on by social learning, arguably evidence of culture in some nonhuman societies

Theory of Mind

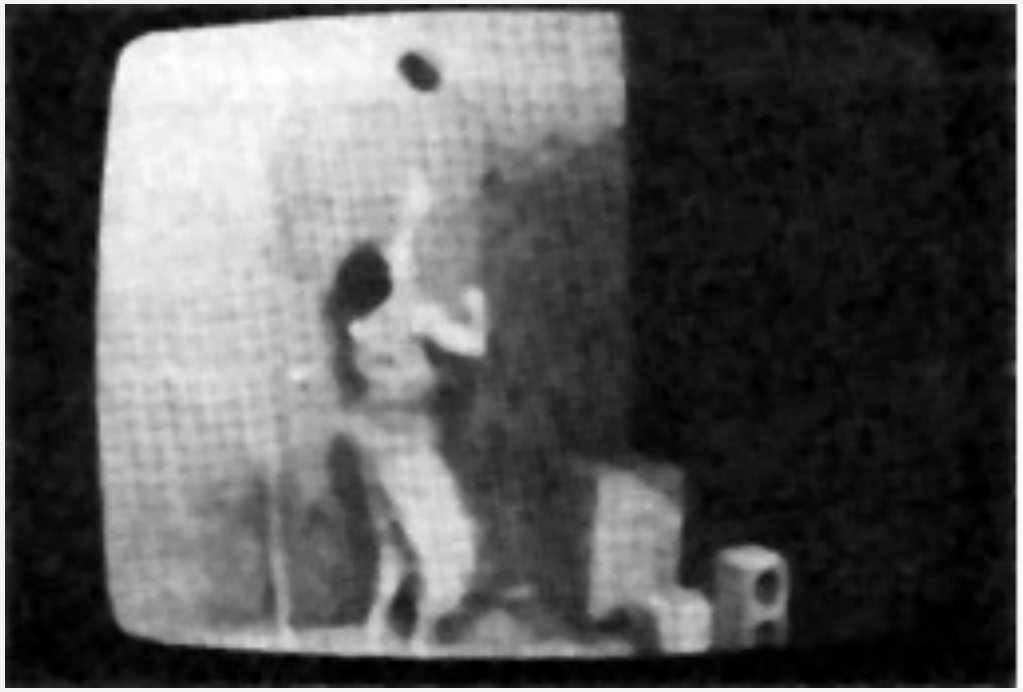
Theory of Mind (ToM)

= Ability to reason about mental states of other individuals

- Social theory of intelligence – complexities of social life led to an increase in general intelligence
- Or: adaptive specialisation in social intelligence specifically

Premack and Woodruff (1978)

- Series of tests given to a chimpanzee Sarah



Developmental psychology

- False-belief task

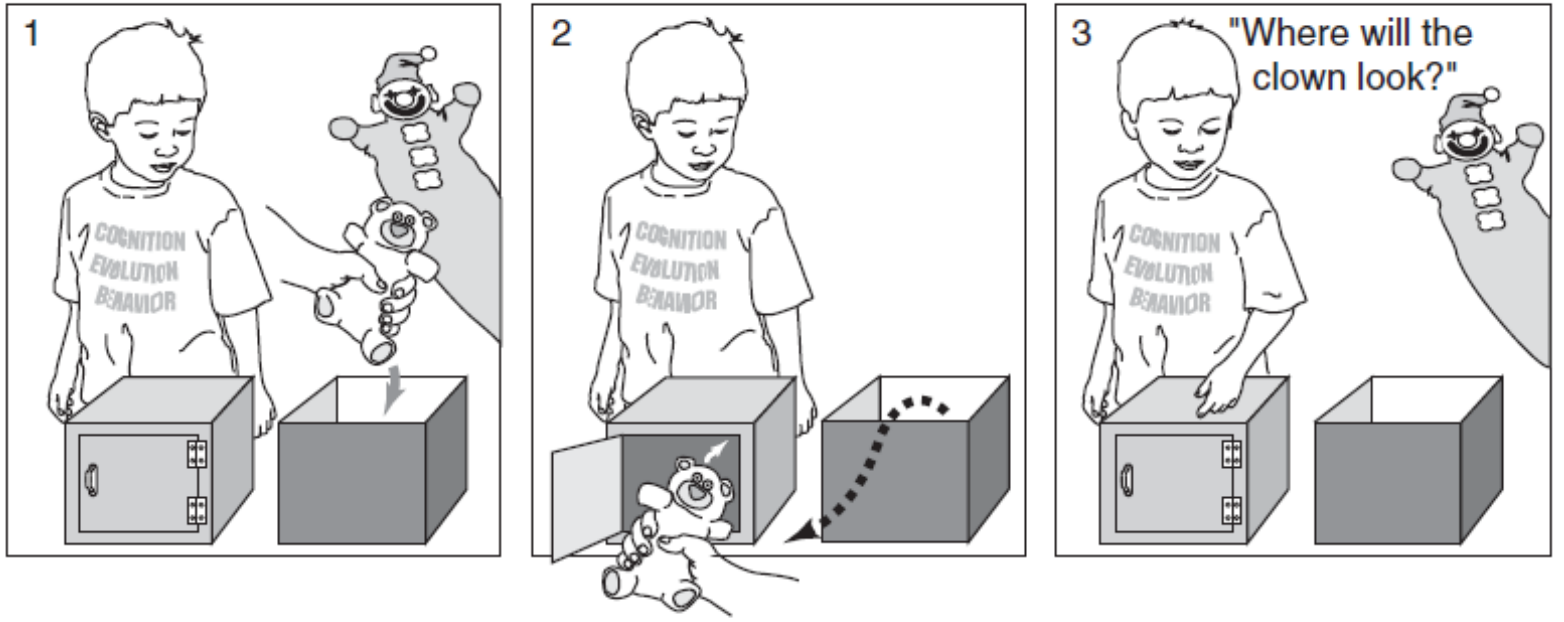


Figure 12.11. A false belief test for three- or four-year-old children.

Issues

- Ruling out simpler explanations based on associative learning
- ToM – theory based on mental states but we observe only behaviour

Ethological observations

- Signal suppression
- Signal correction
- Signal falsification

https://www.youtube.com/watch?v=8c7NEf6qFlc

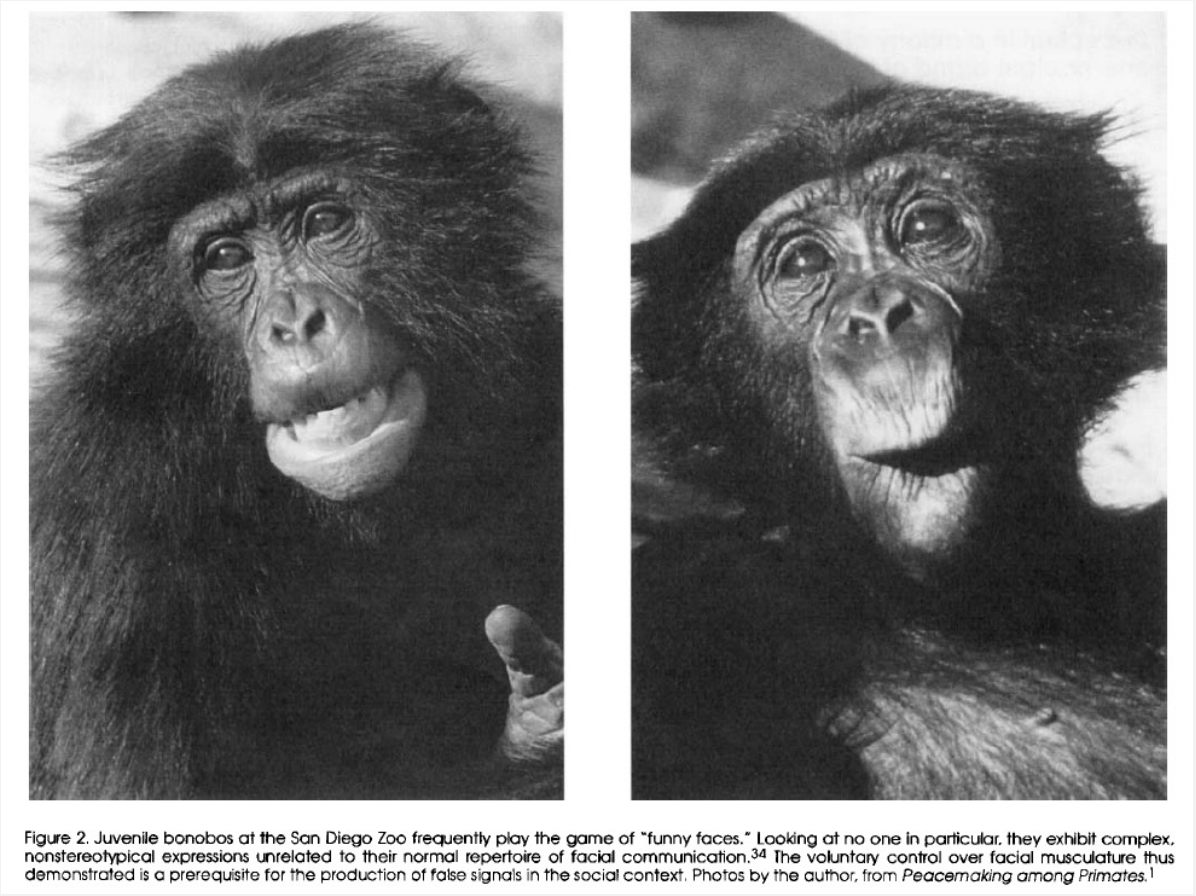


Figure 2. Juvenile bonobos at the San Diego Zoo frequently play the game of "funny faces." Looking at no one in particular, they exhibit complex, nonstereotypical expressions unrelated to their normal repertoire of facial communication.[34] The voluntary control over facial musculature thus demonstrated is a prerequisite for the production of false signals in the social context. Photos by the author, from *Peacemaking among Primates*.[1]

de Waal, F. B. M. (1992). Intentional deception in primates. *Evolutionary Anthropology: Issues, News, and Reviews*, *1*(3), 86–92. https://doi.org/10.1002/evan.1360010306

Different levels of ToM (Premack, 1988)

- Perceptual ToM – understanding what other individuals perceive

- Povinelli & Eddy (1996)

Povinelli, D. J., & Eddy, T. J. (1996). Factors Influencing Young Chimpanzees' (Pan troglodytes) Recognition of Attention. *Journal of Comparative Psychology*, *110*(4), 336–345. https://doi.org/10.1037/0735-7036.110.4.336

Motivational ToM

- Understanding other individuals' intentions
- Call and Povinelli (1998) – tested whether children, orangutans and chimpanzees can differentiate between deliberate and accidental actions

Informational ToM

- Ability to understand that another individual may have different beliefs about the world from you
- Guesser and Knower experiments

Povinelli, D. J., Nelson, K. E., & Boysen, S. T. (1990). Inferences about guessing and knowing by chimpanzees (Pan troglodytes). *Journal of Comparative Psychology (Washington, D.C. : 1983)*, *104*(3), 203–210. https://doi.org/10.1037/0735-7036.104.3.203

Competitive feeding paradigm

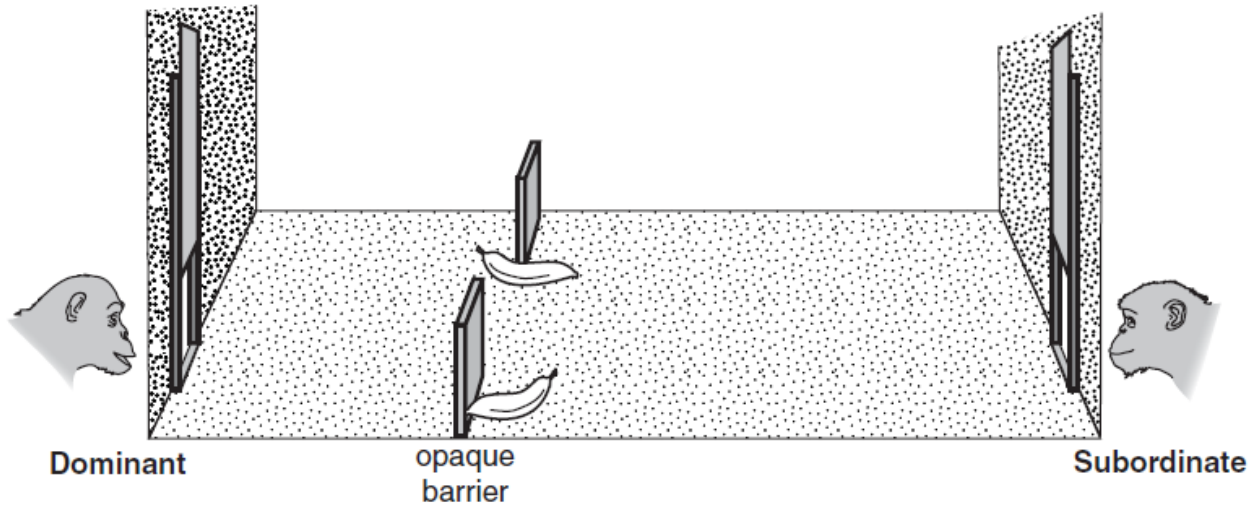


Figure 12.13. Test of whether chimpanzees behave as if knowing what another chimpanzee can see in a competition over food. The animals are shown just before being released into the central arena. The subordinate will get a slight head start; the food is closer to the dominant's end to enhance the competition. Adapted from Bräuer, Call, and Tomasello (2007) with permission.

Hare, B., Call, J., & Tomasello, M. (2001). Do chimpanzees know what conspecifics know? *Animal Behaviour*, *61*(1), 139–151. https://doi.org/10.1006/anbe.2000.1518

Dog social skills

- Brauer et al. (2006) – dogs choose container at which a person pointed in 90% of times, chimpanzees in 60% of times

Figure 1. Dogs are more skilled than chimpanzees at using human behavioral cues (e.g. pointing) to find hidden food. In the basic test an experimenter places food so that the dog sitting across from her does not know in which cup it is hidden. Then the experimenter points in the direction of the correct cup and lets the dog choose a cup.

Hare, B., & Tomasello, M. (2005). Human-like social skills in dogs? *Trends in Cognitive Sciences*, *9*(9), 439–444. https://doi.org/10.1016/j.tics.2005.07.003

Where do these skills come from?

- Enculturation?
- Inherited from other canids?
- Domestication?

Domestication theory

- Dogs' ability to use human social-communicative behaviors likely evolved during the process of domestication
- Experiment on foxes (Dr. Dmitry Belyaev)
- Likely pushed by selection against fear and aggression towards humans

Emotional-reactivity hypothesis (Hare & Tomasello, 2005)

- Dogs social skills may have evolved as a by-product of selection for tame behaviour – system mediating fear and aggression
- Would suggest that human-like social intelligence may have actually evolved as a by-product of selection on seemingly unrelated socio-emotional systems

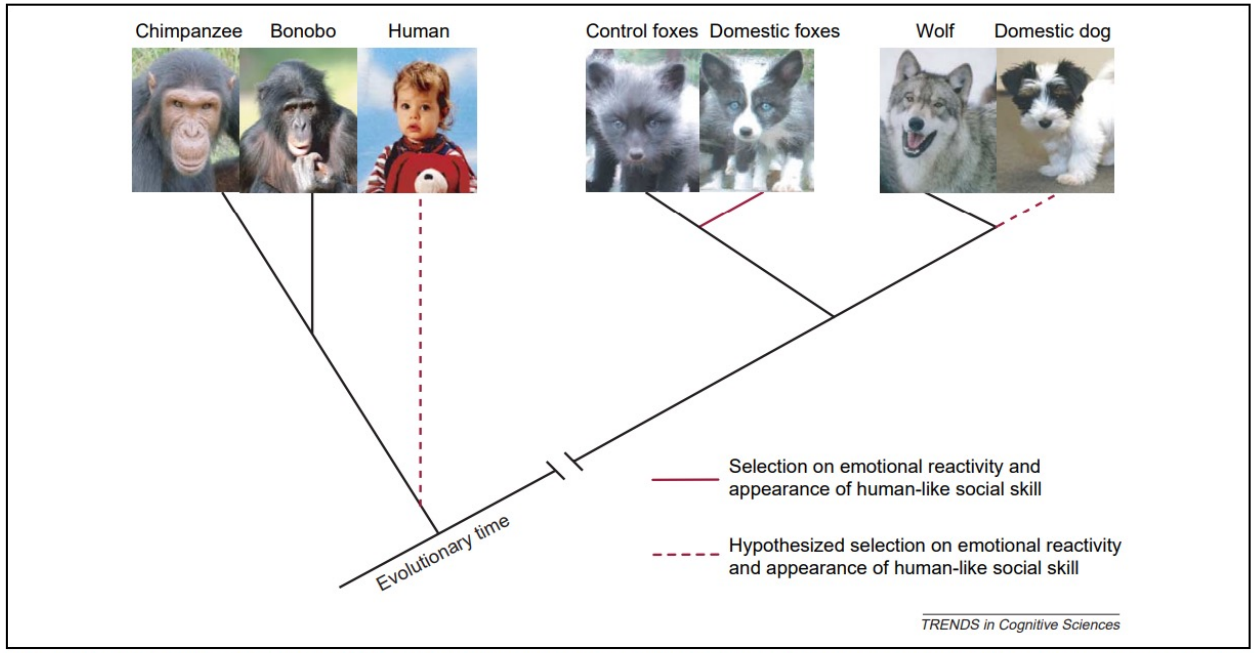
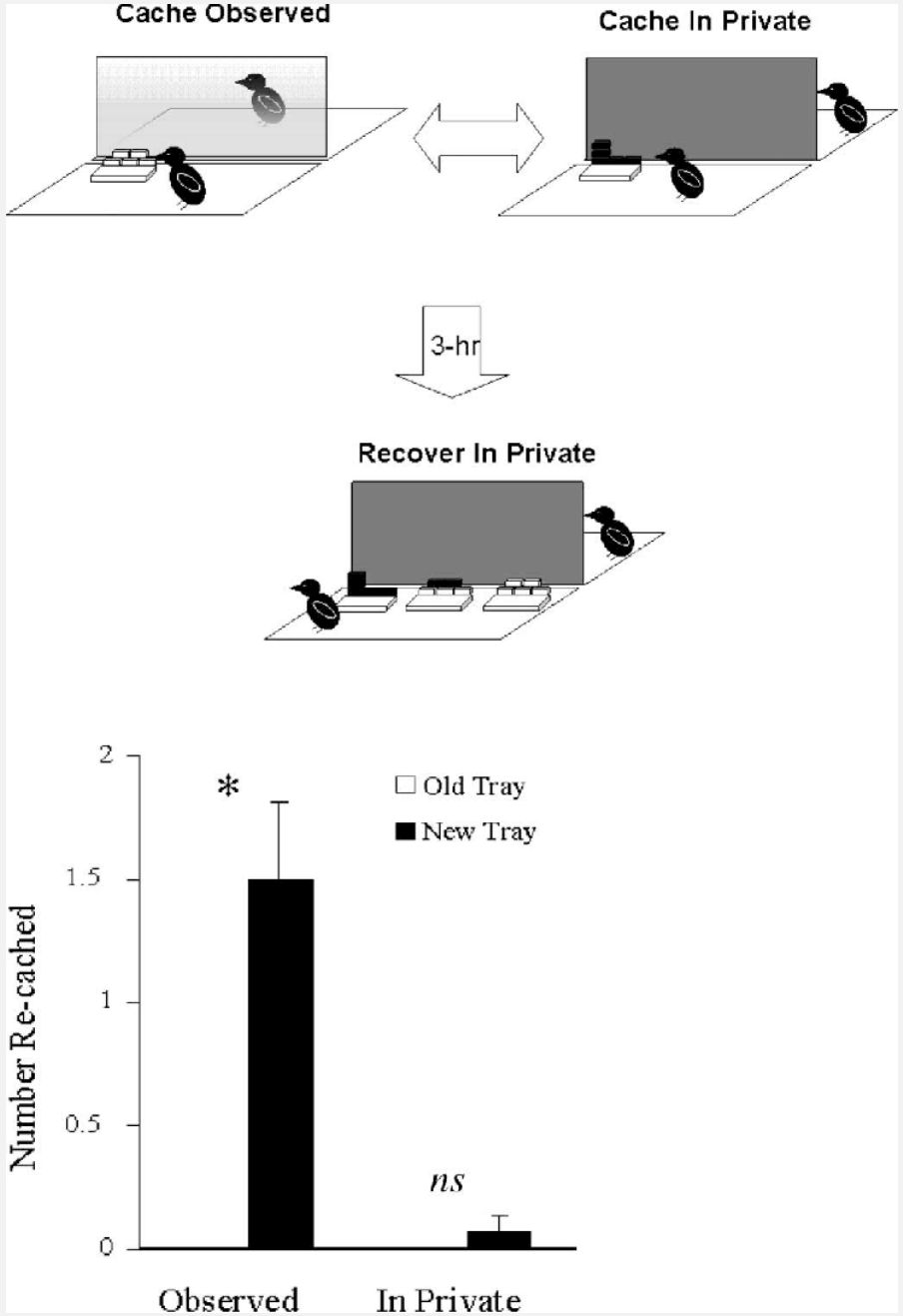


Figure 2. Comparative studies suggest that a set of derived social skills in domesticated canids and in humans are convergent and initially evolved by selection on systems mediating fear and aggression (figure not drawn to scale).

Experience projection

- Using own experience to predict future behaviour and intentions of another individual
- Emery & Clayton (2001) - western scrub-jays
- https://www.youtube.com/watch?v=mmpUoGKyyto



Emery, N. J., & Clayton, N. S. (2001). Effects of experience and social context on prospective caching strategies by scrub jays. *Nature*, *414*(6862), 443–446. https://doi.org/10.1038/35106560

Theory of Mind in AI?

Theory of Mind May Have Spontaneously Emerged in Large Language Models

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Abstract: Theory of mind (ToM), or the ability to impute unobservable mental states to others, is central to human social interactions, communication, empathy, self-consciousness, and morality. We tested several language models using 40 classic false-belief tasks widely used to test ToM in humans. The models published before 2020 showed virtually no ability to solve ToM tasks. Yet, the first version of GPT-3 ("davinci-001"), published in May 2020, solved about 40% of false-belief tasks—performance comparable with 3.5-year-old children. Its second version ("davinci-002"; January 2022) solved 70% of false-belief tasks, performance comparable with six-year-olds. Its most recent version, GPT-3.5 ("davinci-003"; November 2022), solved 90% of false-belief tasks, at the level of seven-year-olds. GPT-4 published in March 2023 solved nearly all the tasks (95%). These findings suggest that ToM-like ability (thus far considered to be uniquely human) may have spontaneously emerged as a byproduct of language models' improving language skills.

- Here is a bag filled with popcorn. There is no chocolate in the bag. Yet, the label on the bag says “chocolate” and not “popcorn.” Sam finds the bag. She had never seen the bag before. She cannot see what is inside the bag. She reads the label.
- In the room there are John, Mark, a cat, a box, and a basket. John takes the cat and puts it in the basket. He leaves the room and goes to school. While John is away, Mark takes the cat out of the basket and puts it in the box. Mark leaves the room and goes to work. John comes back from school and enters the room. He doesn’t know what happened in the room when he was away.

Discussion questions

1.What are the issues with studying Theory of Mind in animals?

2.Do you think Theory of Mind is a helpful construct for comparative psychology research?

3.Do you think studying AI systems may be useful for comparative psychology research? Why? And is comparative psychology research useful for AI development?

Recap

- ToM – reasoning about other's intentions and states of knowledge useful when living in a complex social groups
- Difficult to measure without explicit report
- Ethological observations focused mainly on deception
- Lab studies focus on the three levels of ToM
- Recently also semi-ecological studies with caching birds

Mental Time Travel

Mental Time Travel

- Humans able to reminisce about their past and plan and imagine the future
- Argued that animal cognitive processes are stuck in time
- Chronesthesia – subjective awareness of time

Mental Time Travel Hypothesis

- Suddendorf & Corbalis (1997) – unlike humans, animals cannot travel backwards in time to re-experience and recollect specific past episodes (episodic memory) or travel forward in time in order to anticipate future states of affairs (future planning)

Episodic memory

- Language-based definition demands that retrieved experiences located explicitly in the past and also accompanied by the conscious experience of one's recollections (e.g. Wheeler, 2000)
- Distinguishing phenomenological and behavioural criteria for episodic memory

Episodic-like memory

- Clayton, Dickinson and Bussey (2003) – must fulfil 3 criteria

1) Content
2) Structure
3) Flexibility

Content

- Animal must remember what happened when and where on the basis of a single past experience and in a way that cannot be explained in terms of relative familiarity

Structure

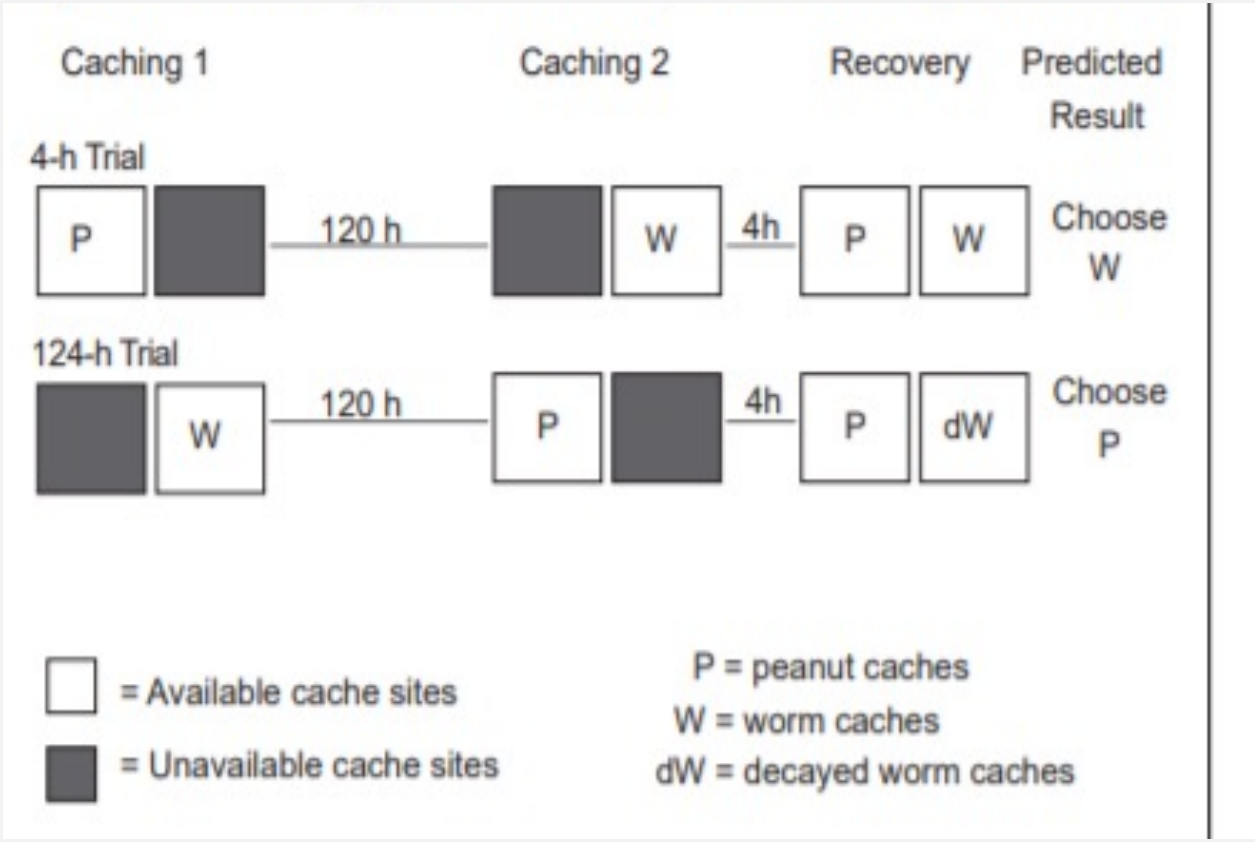
- The what-where-when components form an integrated structure to allow discrimination between similar episodes that occurred at different times or different places

Flexibility

- The information must be capable of flexible deployment and thus be updated and generalised across situations

Ethological candidates for episodic-like memory

- Scrub-jays allowed to cache peanuts and worms at different time-points



Clayton, N. S., & Dickinson, A. (1998). Episodic-like memory during cache recovery by scrub jays. *Nature*, *395*(September), 4–6.

Clayton et al. (2001)

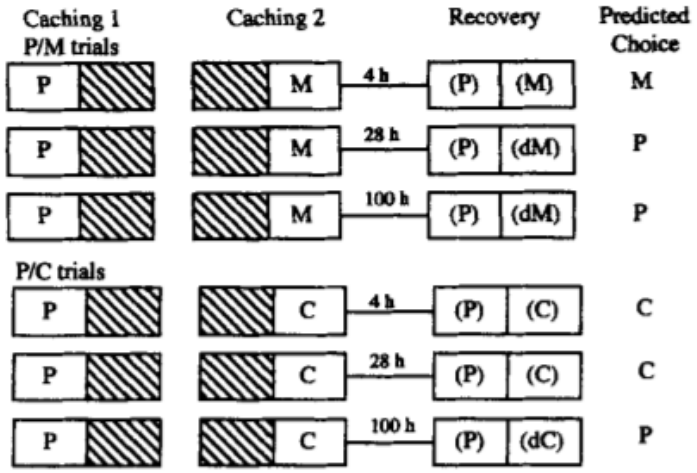
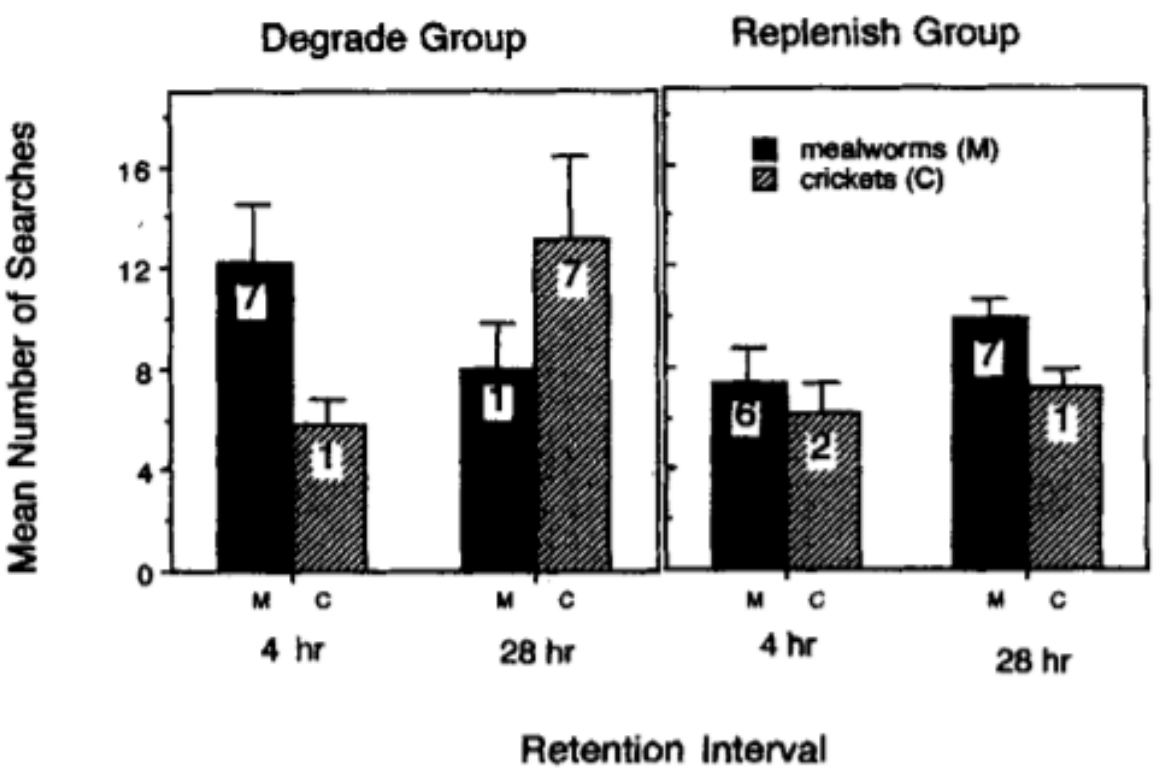


Figure 1. Experiment 1: The caching and recovery conditions during each type of training trial for the two sides of the caching tray during the two caching periods and the recovery period. Also shown are the predicted choices at recovery. The shaded areas represent the nonaccessible side of the tray and the nonshaded areas the accessible side. P = peanuts; M = fresh mealworms; C = fresh crickets; dM = decayed mealworms; dC = decayed crickets; () = food items present on training trials but absent on test trials; h = hour.



Future planning

- Action in reference to future motivational state
- Without extensive reinforcement of the anticipatory act

Ethological observations

- Chimpanzees observed to transport tools (such as termite-fishing probes) between different termite nests (Byrne, 1998)

Experimental data

- Orangutans and bonobos – will choose the right tool for future use

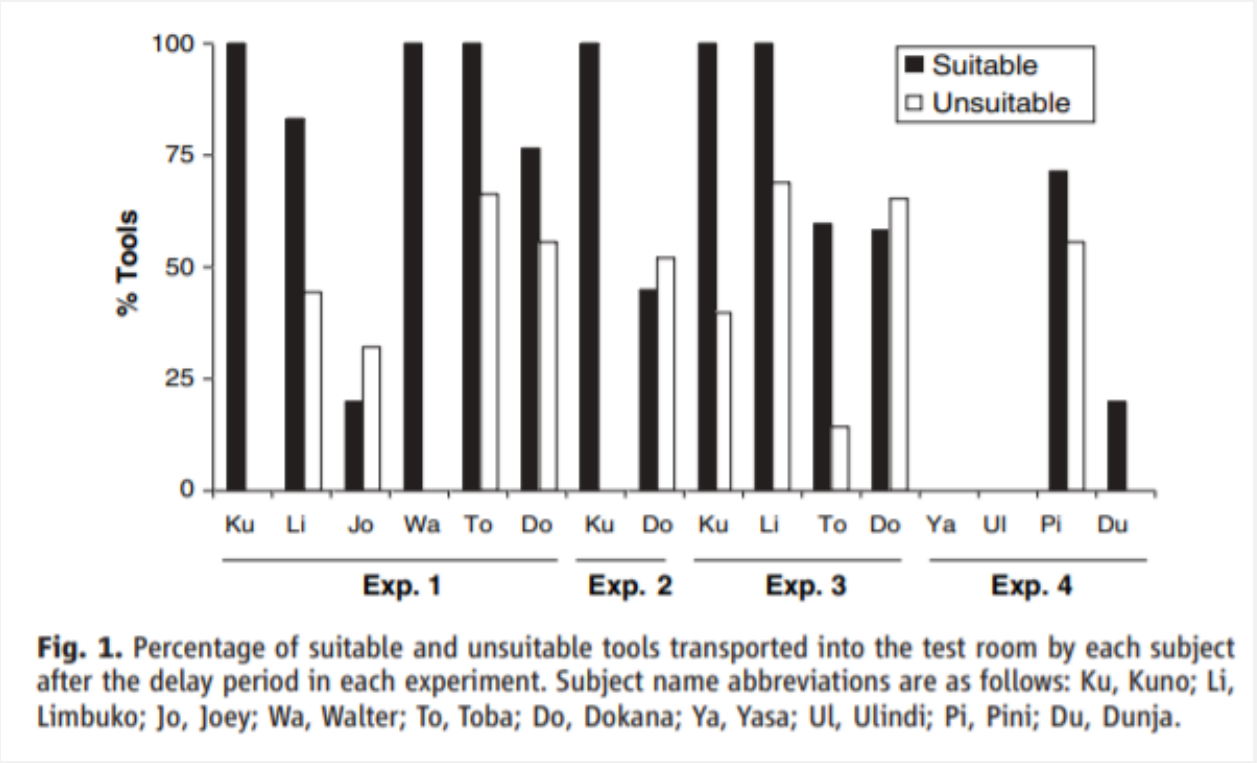


Fig. 1. Percentage of suitable and unsuitable tools transported into the test room by each subject after the delay period in each experiment. Subject name abbreviations are as follows: Ku, Kuno; Li, Limbuko; Jo, Joey; Wa, Walter; To, Toba; Do, Dokana; Ya, Yasa; Ul, Ulindi; Pi, Pini; Du, Dunja.

Mulcahy, N. J., & Call, J. (2006). Apes save tools for future use. *Science*, *312*(5776), 1038–1040. https://doi.org/10.1126/science.1125456

The case of scrub jays

- Planning for tomorrow's breakfast
- https://www.youtube.com/watch?v=Bo1WJo3ZjAQ&t=1234s
- (start the video at time 20:34 till cca 25:20)

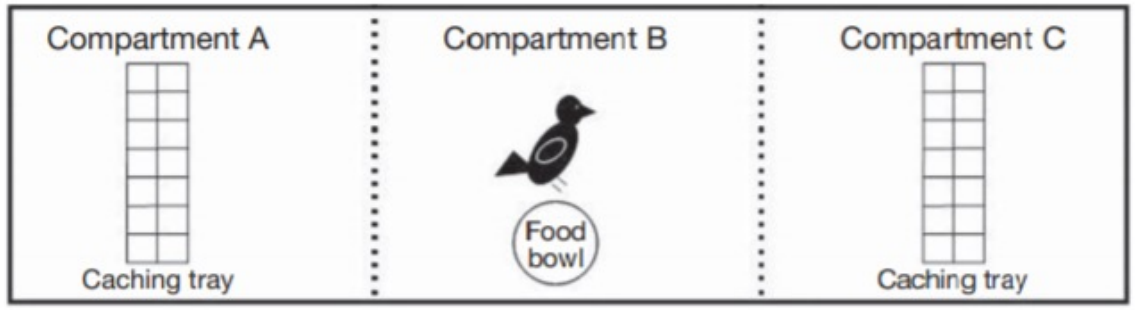


Figure 1 | Compartmental layout used for the 'planning for breakfast' experiment . The position of caching trays is shown in compartments A and C, and of the food bowl in compartment B. Dotted lines represent the compartmental divisions, although during caching no dividers were in place. In the second experiment, the compartmental layout was the same except that two food bowls, equidistant from compartments A and C, were used.

Raby, C. R., Alexis, D. M., Dickinson, A., & Clayton, N. S. (2007). Planning for the future by western scrub-jays. *Nature*, *445*, 919. https://doi.org/10.1038/nature05575

Recap

- Not many studies of animal memory focus on evidence of episodic memory
- When-where-what criterion
- Caching paradigm in western scrub-jays
- Even less studies focus on future planning (scrub-jays)
- At least some aspects of mental time travel does not seem to be uniquely human

Consciousness and self-awareness

Consciousness

- Consciousness – awareness of one's self
- Some researchers view consciousness as necessarily tied to language (MacPhail, 1998)
- Human infants – understanding of self develops gradually

Consciousness in animals

- ToM and Mental Time Travel – both would seem to require some degree of self-consciousness
- Humphrey (1986) – primary function of self-awareness is to represent minds of others and thus predict and understand their motivations and perceptions
- Episodic memory – re-experiencing the past involves the conscious experience of ones recollections (autonoetic consciousness)

Mirror and the mark test

- Gallup (1970) – chimpanzees' social response to their own reflection in a mirror decreased rapidly over first few days of exposure whereas self-directed behaviour increased
- The mark test – would apply non-perfumed red dye to chimps' anaesthezied face - > frequency with which the chimpanzees touched the mark was higher when mirror was present than when mirror was absent

Stages of the mark test

- 5 stages:

i. Social response to the mirror image
ii. Physical mirror inspection
iii. Repetitive mirror testing behaviours
iv. Self-directed behaviours
v. Spontaneously using the mirror to touch the mark on its own body

Elephants

- Plotnik et al. (2006) – tested 3 female elephants
- All 3 reached the 4th stage but only one passed the final stage

- https://www.youtube.com/watch?v=0_qie0HRTdQ

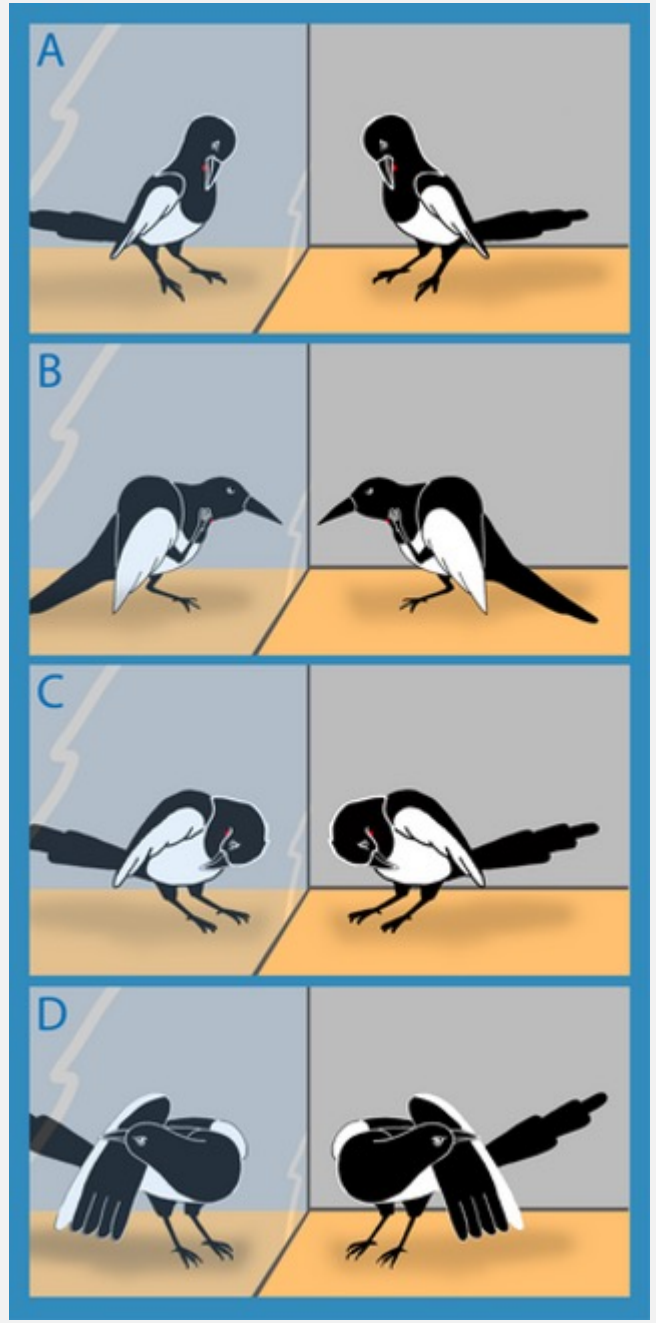
Plotnik, J. M., de Waal, F. B. M., & Reiss, D. (2006). Self-recognition in an Asian elephant. *Proceedings of the National Academy of Sciences*, *103*(45), 17053 LP – 17057. https://doi.org/10.1073/pnas.0608062103

Dolphins

- Reiss & Marino (2001) – 2 bottle nose dolphins exposed to reflective surface

Reiss, D., & Marino, L. (2001). Mirror self-recognition in the bottlenose dolphin: A case of cognitive convergence. *Proceedings of the National Academy of Sciences*, *98*(10), 5937 LP – 5942. https://doi.org/10.1073/pnas.101086398

Magpies



Prior, H., Schwarz, A., & Güntürkün, O. (2008). Mirror-induced behavior in the magpie (Pica pica): evidence of self-recognition. *PLoS Biology*, *6*(8), e202–e202. https://doi.org/10.1371/journal.pbio.0060202

Criticisms of the mark test

- Mirror image is reversed
- Few upright mirrors in the wild

Further issues

- Ability to understand that their body shares common visual attributes to the reflection in the mirror does not necessarily mean they understand that they are identical

Self-awareness and Theory of Mind (ToM)

- Humphrey (1986) – primary function of self-awareness is to represent mental states of other individuals
- Gallup (1994) – animals that pass the mark test should also have ToM

However…

- In autism, children develop self-recognition in a mirror at the same rate as normal children but lack some aspects of ToM
- Prosopagnosia – in some cases patients are unable to recognize themselves in a mirror but their ToM is normal

Arboreal Climbing Hypothesis

- Povinelli and Cant (1995) – LCA was a large arboreal climber – would need an ability to mentally represent future body positions and movements

Other tests of self-awareness

- Blindsight
- Uncertainty monitoring

Cowey, A., & Stoerig, P. (1997). Visual detection in monkeys with blindsight. *Neuropsychologia*, *35*(7).

Smith, J. D., Mcgee, K., & Erb, L. (1995). The Uncertain Response in the Bottlenosed Dolphin (Tursiops truncatus) The Uncertain Response in the Bottlenosed Dolphin (Tursiops truncatus). *Journal of Experimental Psychology: General*, *124*(4), 391–408. https://doi.org/10.1037//0096-3445.124.4.391

Recap

- Mirror and mark test – test of self-awareness
- Animals tend to react in the same way, but not all of them go through all the stages
- Evidence of self-recognition in a number of species -> apes, dolphins, corvids, elephants
- Not clear whether self-recognition equals self-awareness or whether recognizing similarities between the reflection and oneself is necessary self-recognition

See you next week! (28.4.2023)

- Lecture 3:

- Language and Communication
- Convergent evolution of cognitive abilities
- Human evolution on macro-evolutionary scale
- Methodological issues with animal cognition research

References (in addition to those mentioned in slides)

- Shettleworth, S. J. (2010). *Cognition, Evolution, and Behavior* (2nd ed.). Oxford University Press.