EVOLUTIONARY ORIGINS OF SOCIAL INTELLIGENCE AND CULTURE: A NEUROSCIENTIFIC PERSPECTIVE

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  - Social learning versus imitation
- Symbols:
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- Cultural skills (tools and technology):
  - Modifying the brains using tools and technology
  - Mirror neurons, action understanding, and imitation
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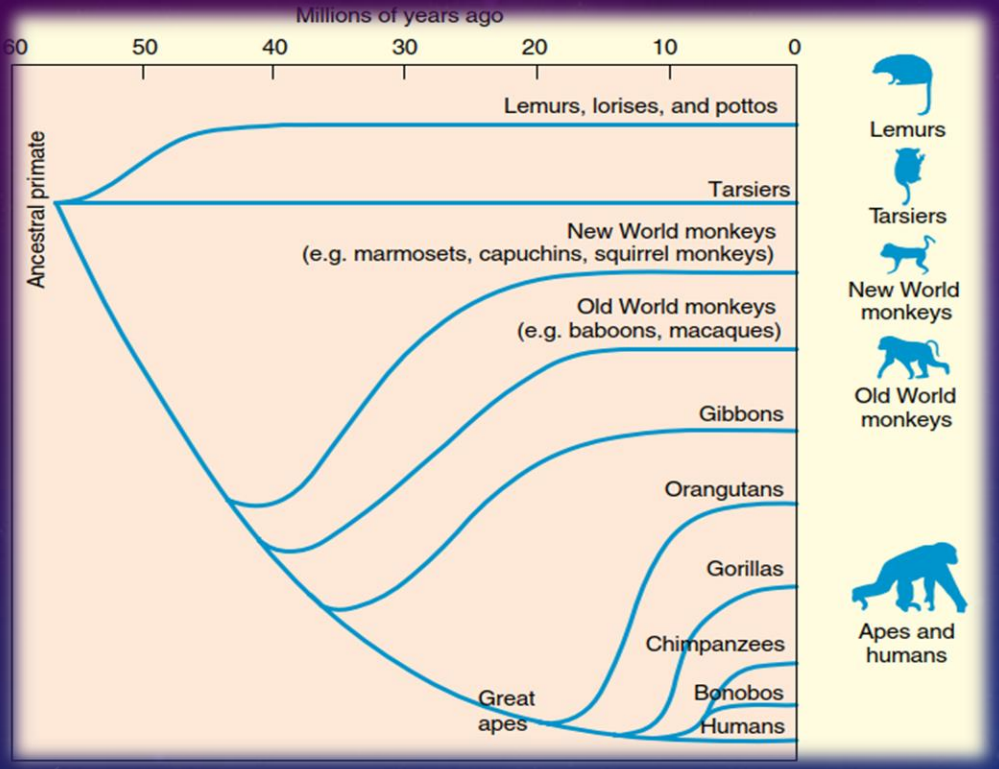
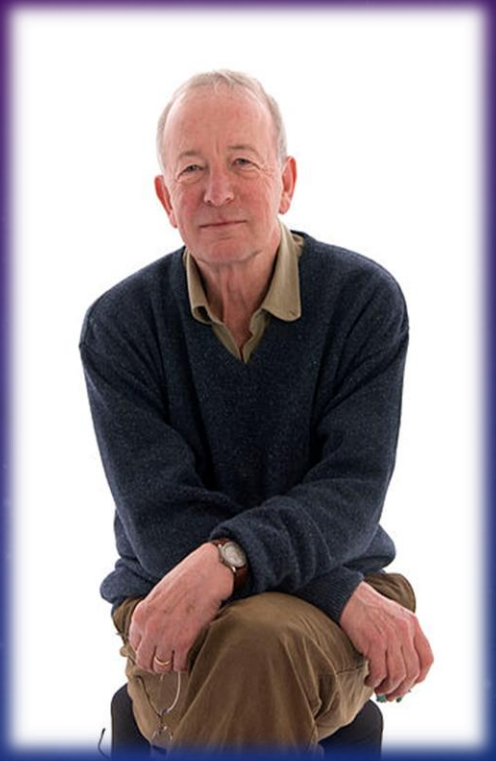
THE SOCIAL INTELLIGENCE HYPOTHESIS:





Social intelligence (1976)

Nicholas Humphrey

English neuropsychologist and evolutionary psychologist

Cambridge University

THE SOCIAL INTELLIGENCE HYPOTHESIS:

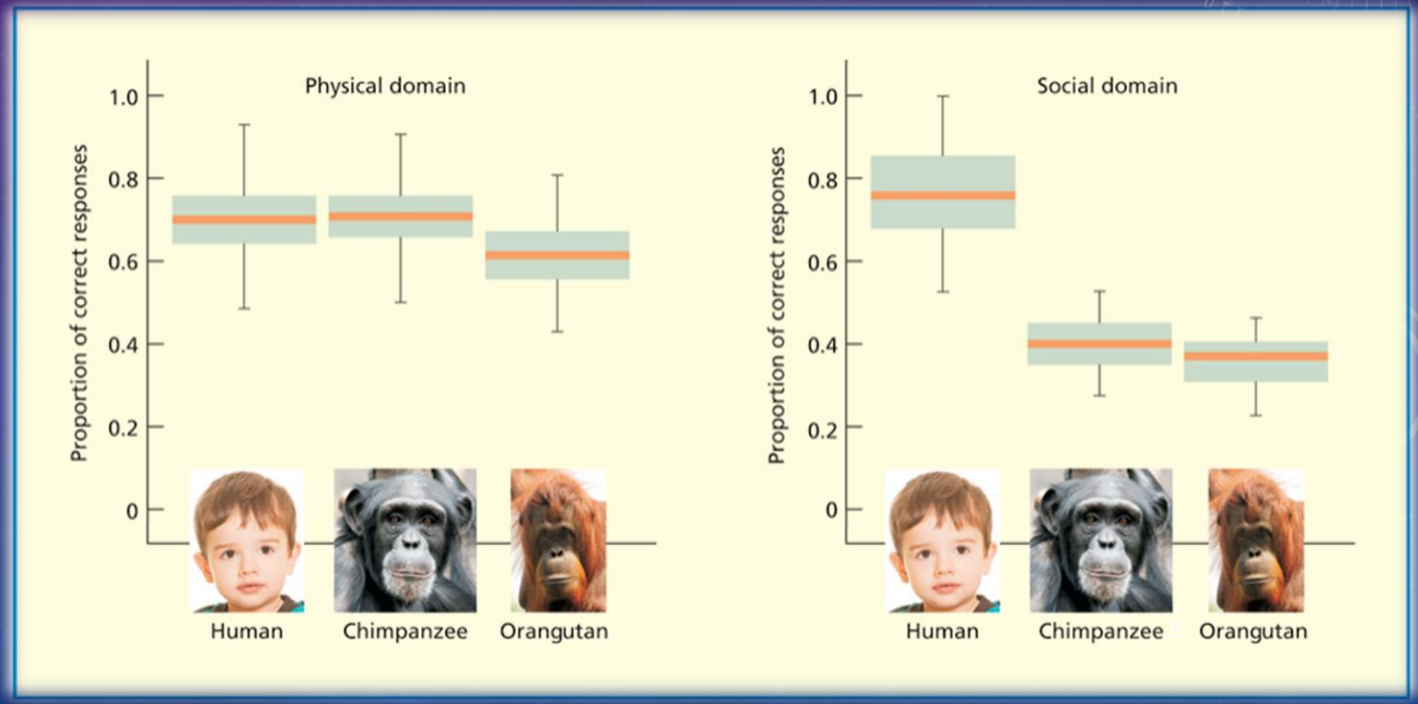
Michael Tomasello (2007)

American psychologist

Duke University

Social intelligence

Culture



➢ THE SOCIAL INTELLIGENCE HYPOTHESIS:

Three interpretations of social intelligence hypothesis (social brain hypothesis):

- 1 ‘Intelligence is manifested in social life.’

Intelligence should include problem solving in one’s social life. (accepted)

- 2 ‘Complex society selects for enhanced intelligence.’

There is something particularly demanding about problem solving in the social life that leads to a need for greater intelligence. (intelligence in broad sense)

- 3 ‘Complex society selects the specific characteristics of intelligence.’

Social pressures to be smarter select not only for the amount of intelligence but also the type of intelligence. (Specialized mechanisms for social problems like ToM that are not reducible to general intellect)

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THE SOCIAL INTELLIGENCE HYPOTHESIS:

- Social intelligence and brain size in primates and non-primates:

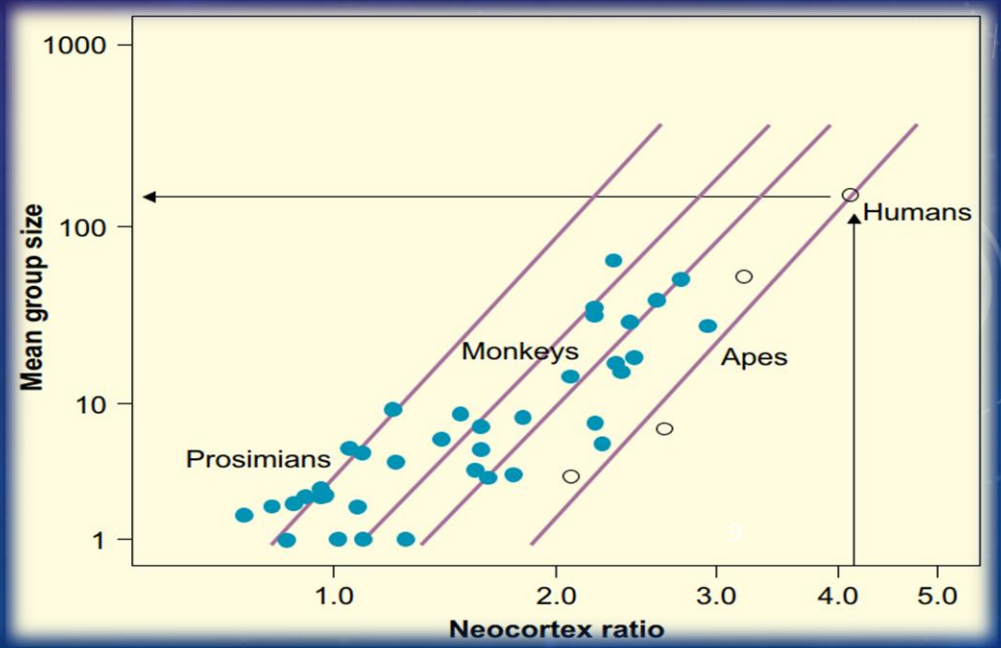
Robin Dunbar

British anthropologist and evolutionary psychologist

Head of the Social and Evolutionary Neuroscience Research Group

Department of Experimental Psychology

University of Oxford



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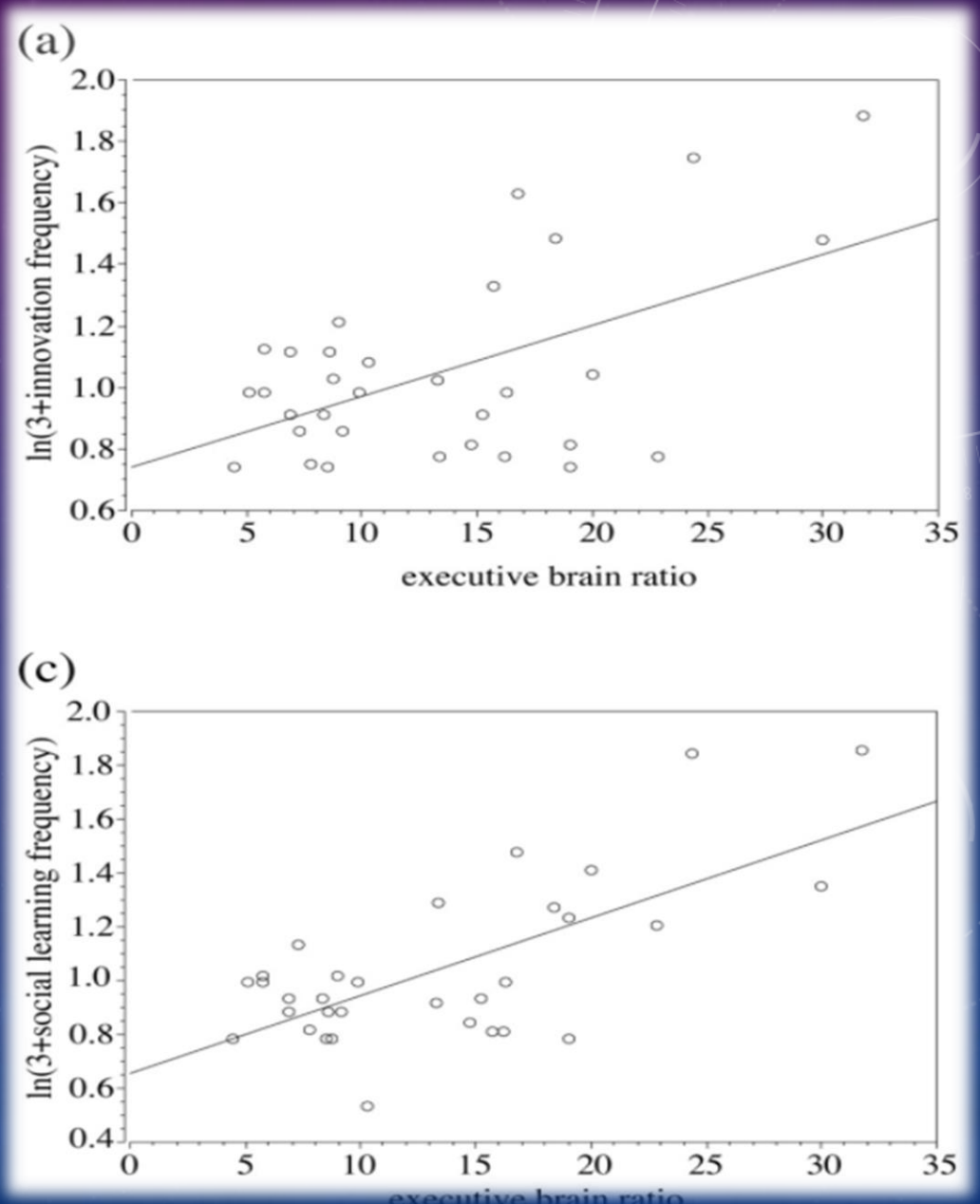
Social intelligence, innovation, and enhanced brain size in primates
Simon M. Reader, Kevin N. Laland
Proceedings of the National Academy of Sciences Apr
2002, 99 (7) 4436-4441; DOI: 10.1073/pnas.062041299

Nature Vs. Nurture



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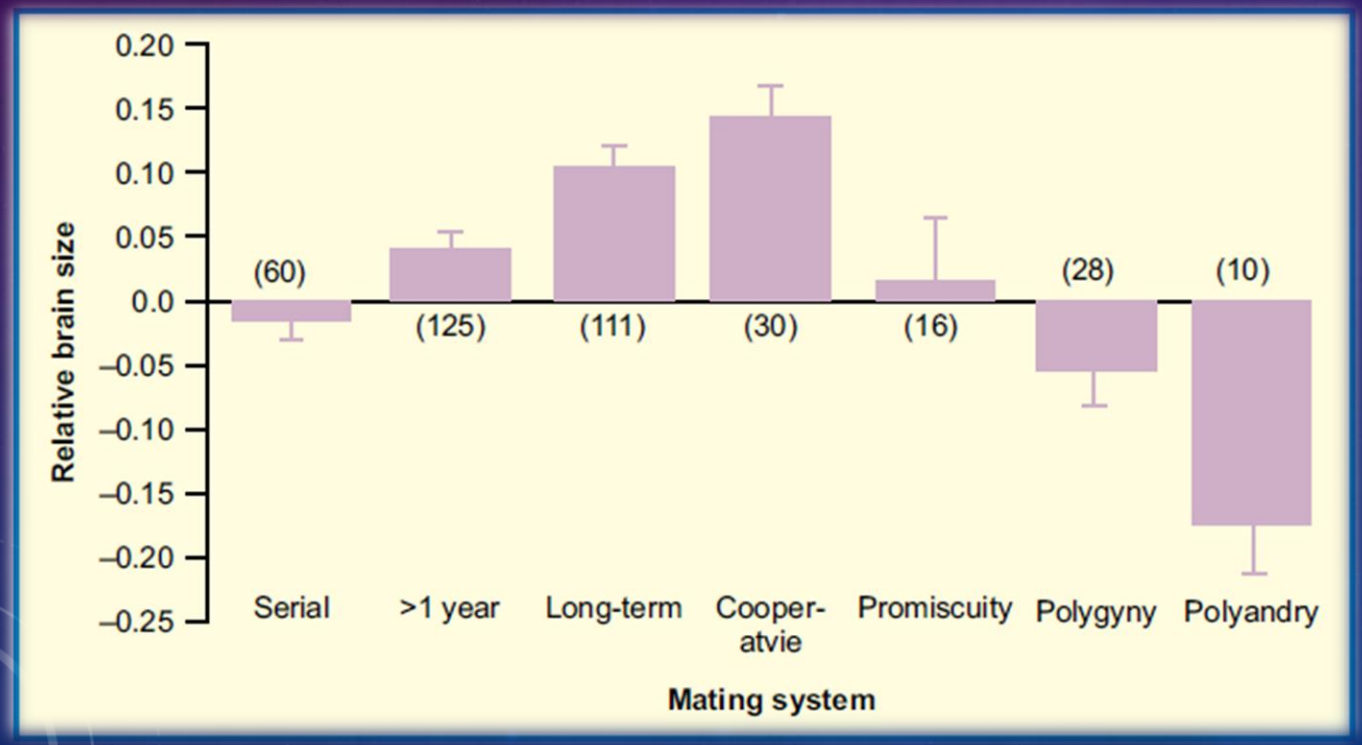
Emery NJ, Seed AM, von Bayern AM, Clayton NS.
Cognitive adaptations of social bonding in birds.
Philos Trans R Soc Lond B Biol Sci. 2007 Apr 29;362(1480):489-505.
doi: 10.1098/rstb.2006.1991. PMID: 17255008; PMCID: PMC2346513.



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THE SOCIAL INTELLIGENCE HYPOTHESIS:

- Language evolution and the social intelligence hypothesis:

Chomsky (1980), Gould (1991), and Dunbar (2004):

Language evolved as a by-product of social pressures for big brain

Language as a multi-faceted entity:

speech production, syntax, semantic concepts, and so on
(Fitch, Hauser, & Chomsky, 2005; Pinker & Jackendoff, 2005)

Examples:

The descent of the human larynx, and syntax

Pinker and Bloom (1990):

Language evolved as a response to specific communicative needs

➢ THE SOCIAL INTELLIGENCE HYPOTHESIS:

➢ Evaluation:

➢ Human friendships in cyber age:

- ~150 individuals has been given as an estimate of the number of people with whom there is a mutual understanding of reciprocity: i.e. they feel they could call on you in a time of need and vice versa
- The size of amygdala – linked to emotional processing – was positively correlated with the number of friends (Bickart, Wright, Dautoff, Dickerson, & Barrett, 2011; Kanai, Bahrami, Roylance, & Rees, 2012)
- The number of Facebook friends is correlated with the size of the superior temporal sulcus (involved in person perception) and the entorhinal cortex (involved in memory, e.g. for face-name associations) (Kanai, Bahrami, Roylance, & Rees, 2012)

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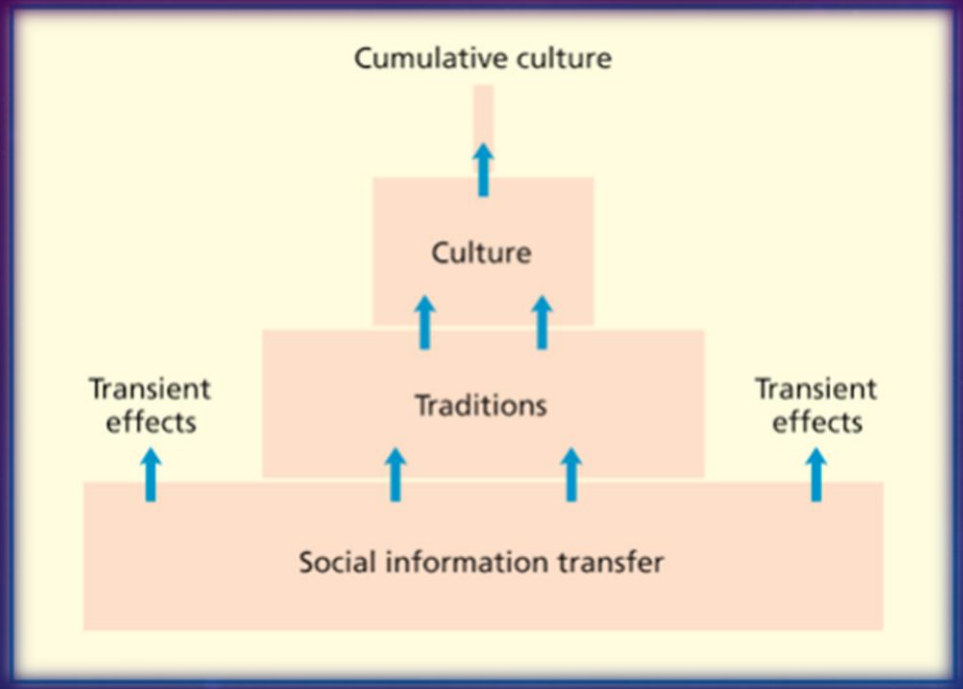
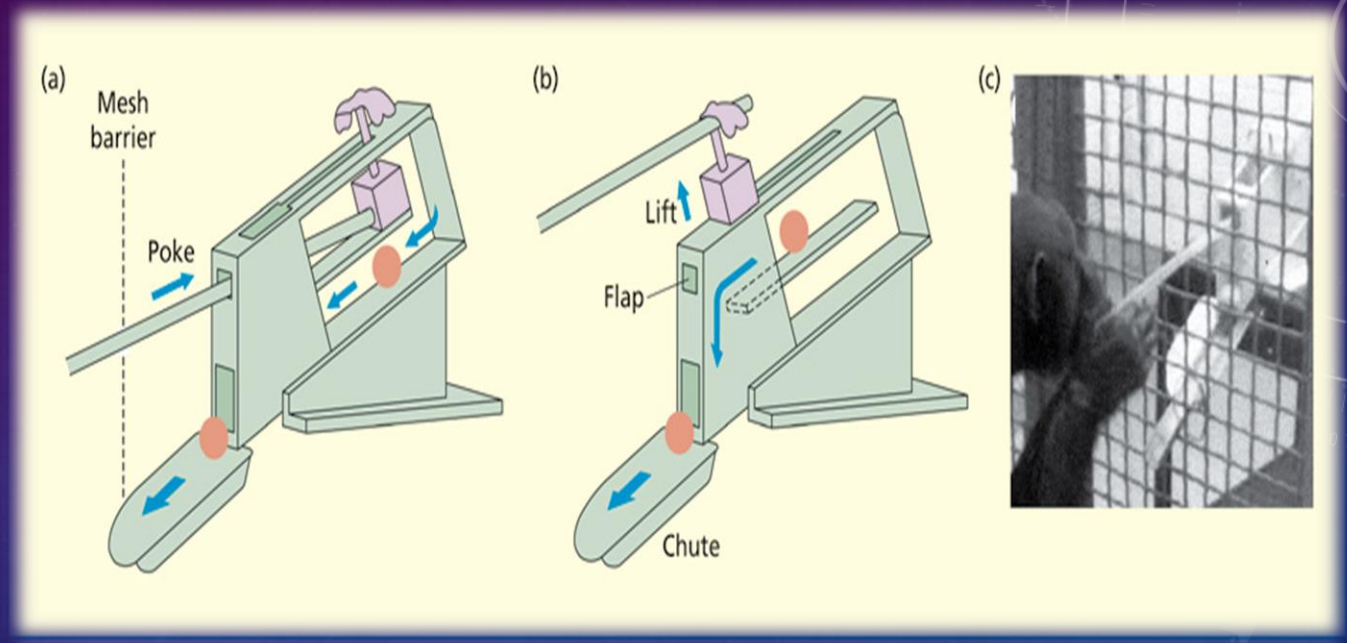


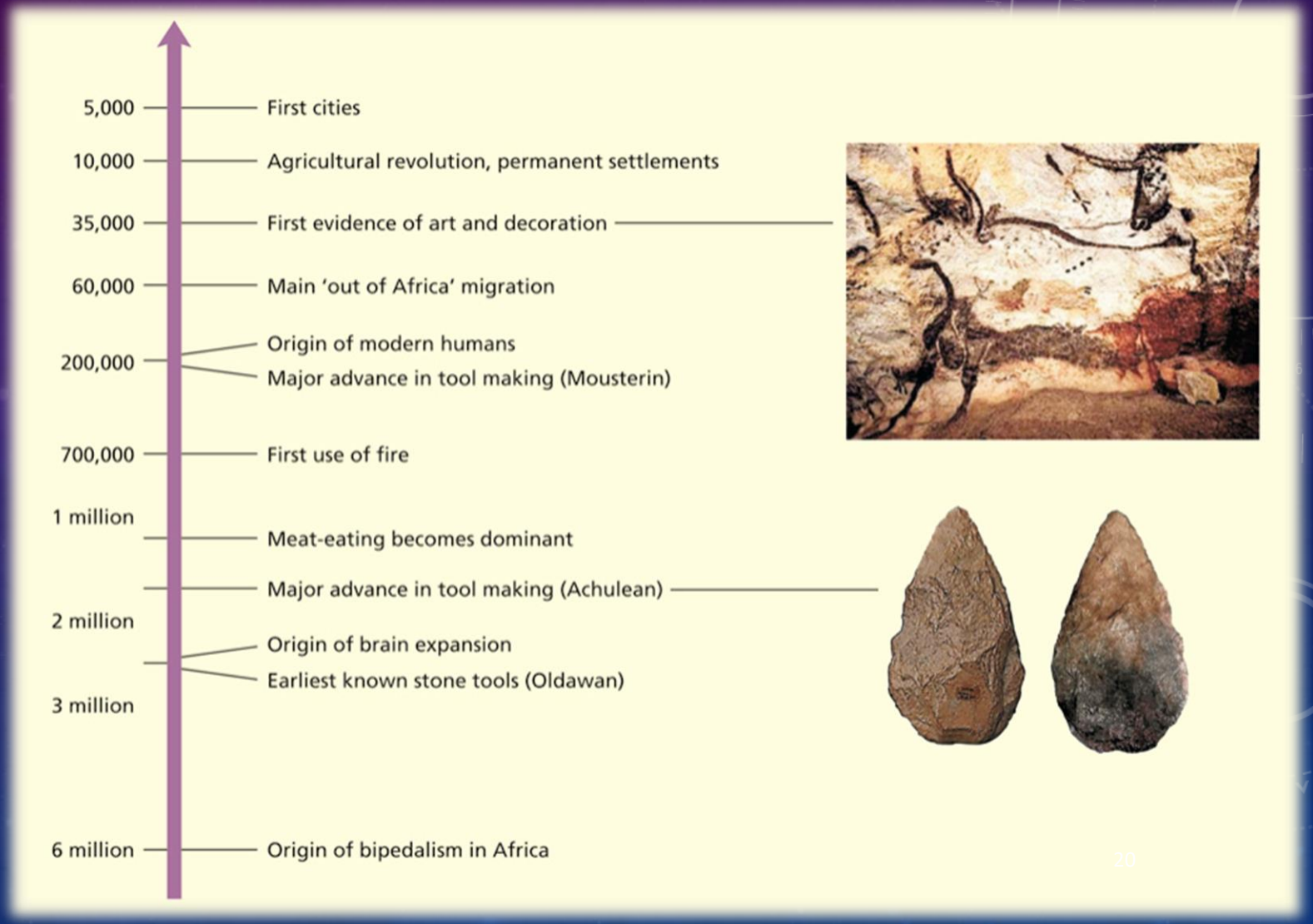
Whiten and van Schaik (2007) The Royal Society



Whiten et al. (2005) Nature Publishing Group

EVOLUTIONARY ORIGINS OF CULTURE:

- Prehistoric origins of human culture:



Significant milestones in human evolution and human culture

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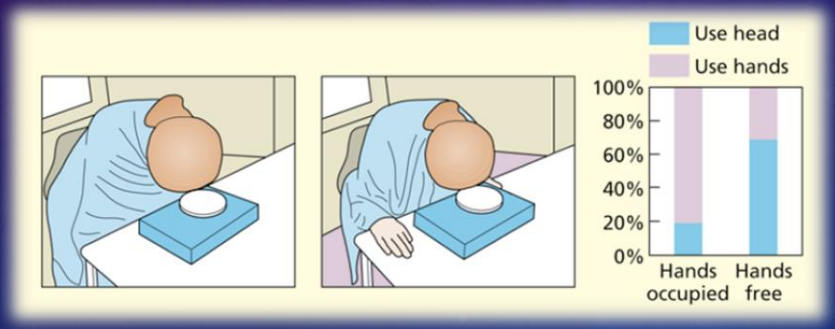
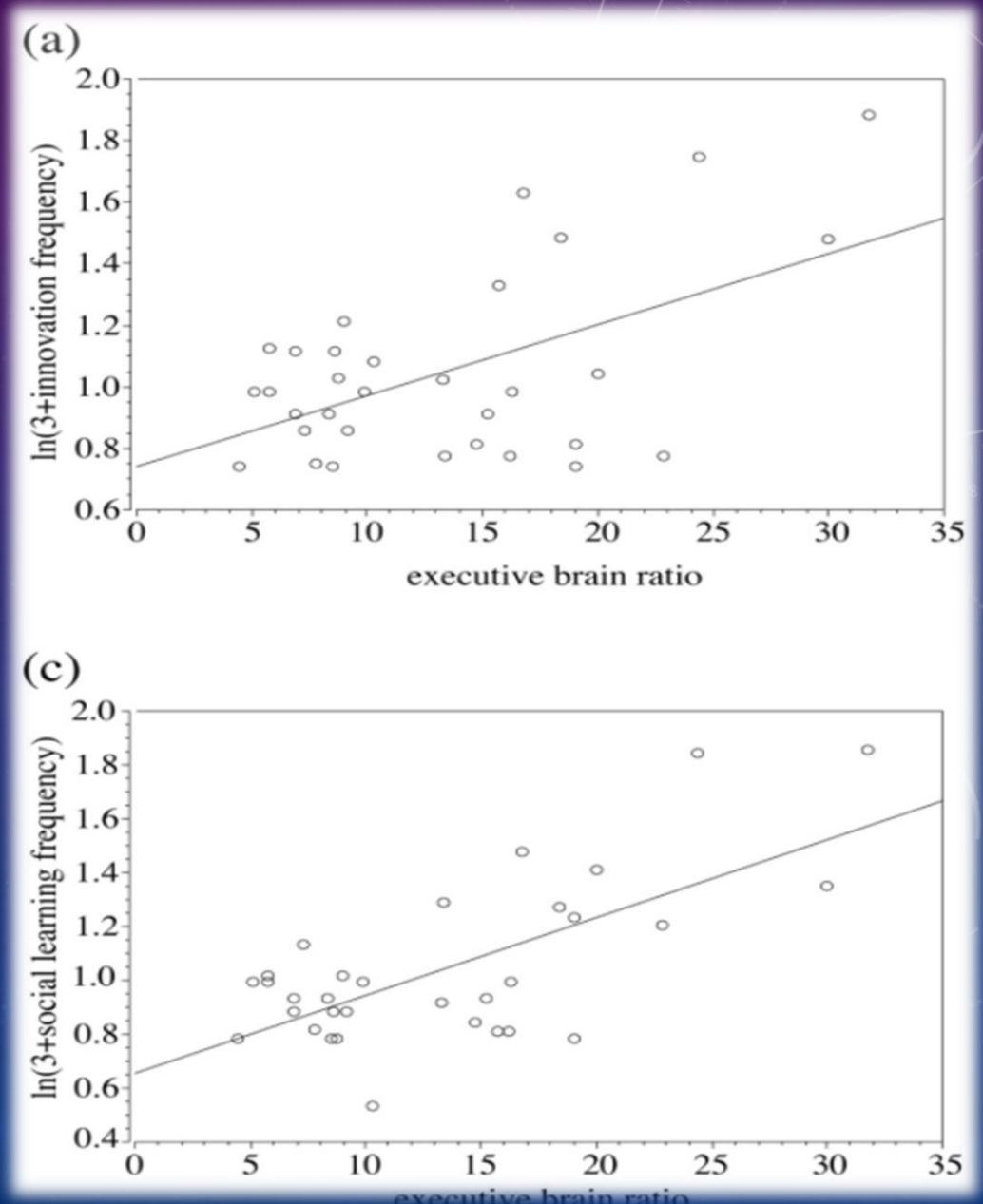
➢ EVOLUTIONARY ORIGINS OF CULTURE:

- ➢ Social learning versus imitation:
- Different kinds of social learning:

1. Imitation
2. Mimicking
3. Stimulus enhancement or local enhancement
4. Contagion



- ➢ Evaluation



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➢ SYMBOLS:

- Symbols that are products of culture and one might think a fully cultural invention, e.g. literacy, may end up using different brain circuits in different people

- This does not appear to be the case and the neural circuits for writing and calculation appear to be quite conserved across individuals and across cultures (Dehaene & Cohen, 2007)

➢ Neuronal recycling and extended cognition:

- Neuronal recycling: neural resources, set aside for other functions in our evolutionary past, may be recruited by cultural knowledge:

- left ventral visual stream, termed the visual word form area (VWFA) responds to visual presentation of letter strings more than other objects and may have evolved for certain types of object recognition

- Intraparietal sulcus in parietal lobes that responds during arithmetic tasks, and when viewing different types of numerical symbols (digits, dot patterns, number words) both within (e.g. Piazza, Izard, Pinel, Le Bihan, & Dehaene, 2004) and across cultures (Tang et al., 2006)

➢ SYMBOLS:

➢ Neuronal recycling and extended cognition:

- Certain forms of higher math (e.g. algebra, multi-digit calculations) can be performed with ease using pen and paper (or calculator and computer) because these systems effectively function as externalized working memories enabling humans to escape the confounds of our own limited capacity and error-prone memory systems

- By offloading certain cognitive capacities (e.g. for remembering, calculating, reaching) onto external technology, it is claimed that we create an extended cognition that bridges the brain-based and material-based worlds (Clark, 2008)

- Although systems of writing and number representation can be considered social that had been invented and passed on by the collective action of many minds but they have had more direct influences on the nature of social interactions

- An example is money - It serve two broad social functions:

1. as a means of social exchange (related to the notion of reciprocal altruism: 'if you scratch my back, I'll scratch yours')
2. and also as a way of displaying or achieving a higher social rank through conspicuous consumption or benevolence

- This is an interesting example of how our culture mirrors our biology (Lea & Webley, 2006)

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➢ CULTURAL SKILLS (TOOLS AND TECHNOLOGY):

- Cultural symbols > enable us escape constraints of our minds
- Cultural tools > free us from constraints of our bodies
- The human body is not adapted for flying or chopping trees, but our brains are adapted to create useful objects (tools) and transmit this information, socially, from person to person
- Clark (2003) dismisses the notion, popular in evolutionary psychology, that modern-day humans are stuck with the Stone Age minds that were selected for in our earliest ancestors
- We are 'natural-born cyborgs' capable of creating complex technologies
- The technology and the ideas behind them are themselves passed from person to person (and modified over time), not in the genes but by social and cultural transmission

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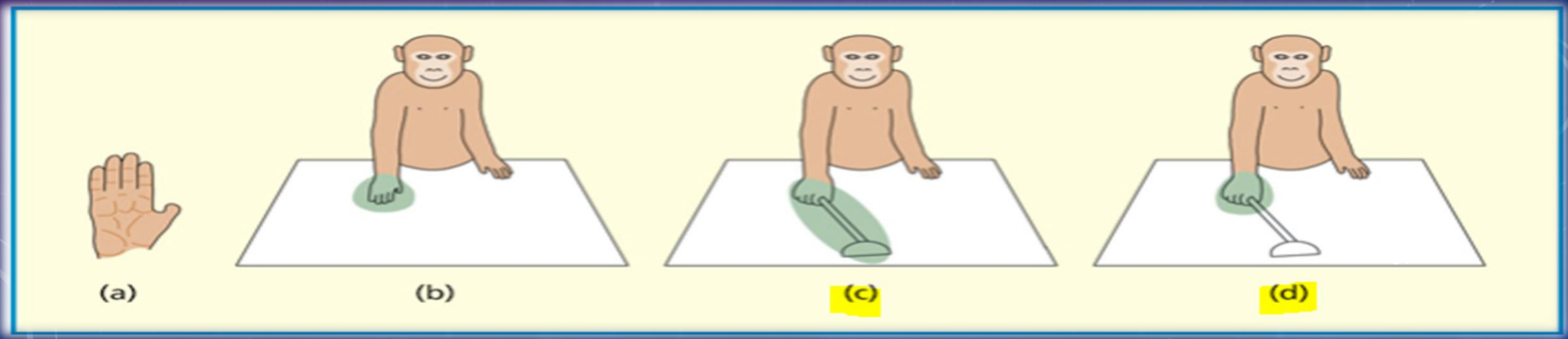
➢ CULTURAL SKILLS (TOOLS AND TECHNOLOGY):

- ➢ Modifying the brains using tools and technology:
- Neurons' receptive fields
- Changes of receptive fields as a result of tool use (Iriki, Tanaka, and Iwamura, 1996):

They reported the receptive field was no longer centered on the arm but was elongated down the length of the tool itself

- As if the monkey's neural representation of its body had been stretched to incorporate the tool



➢ CULTURAL SKILLS (TOOLS AND TECHNOLOGY):

- ➢ Modifying the brains using tools and technology:
- In humans there is evidence that multi-sensory processing of space is extended by tool use (Serino, Bassolino, Farne, & Ladavas, 2007):
- When sighted people are trained to use a blind-person's cane there is evidence that multi-sensory space becomes expanded along the length of the cane
- Flashes of light both near the hand and at the end of a tool can facilitate detection of a tactile stimulus on the hand after tool use (Holmes, Calvert, & Spence, 2007)
- Prior to tool use, only a flash of light on or near the hand (but not the end of the tool) has this effect

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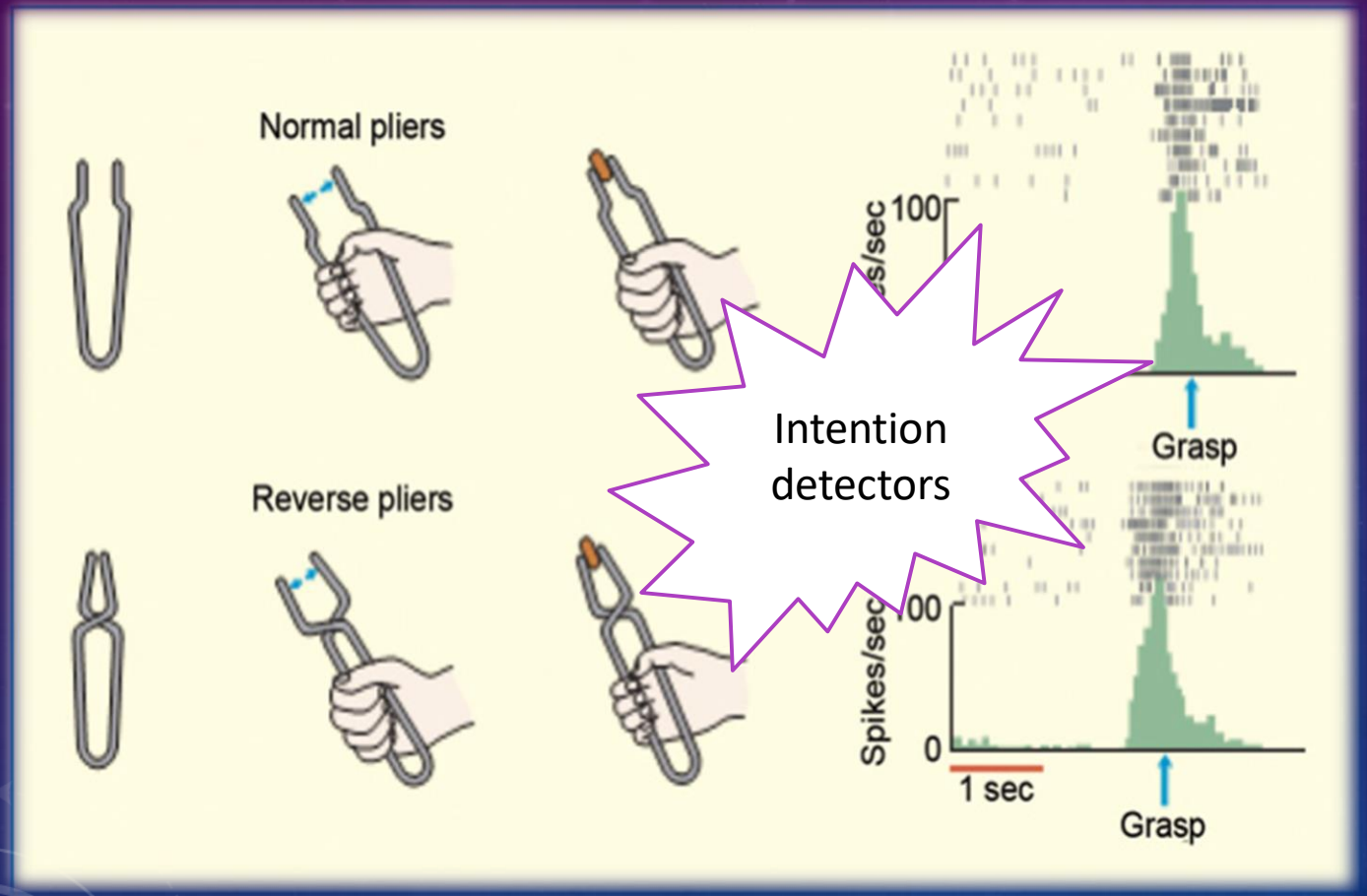
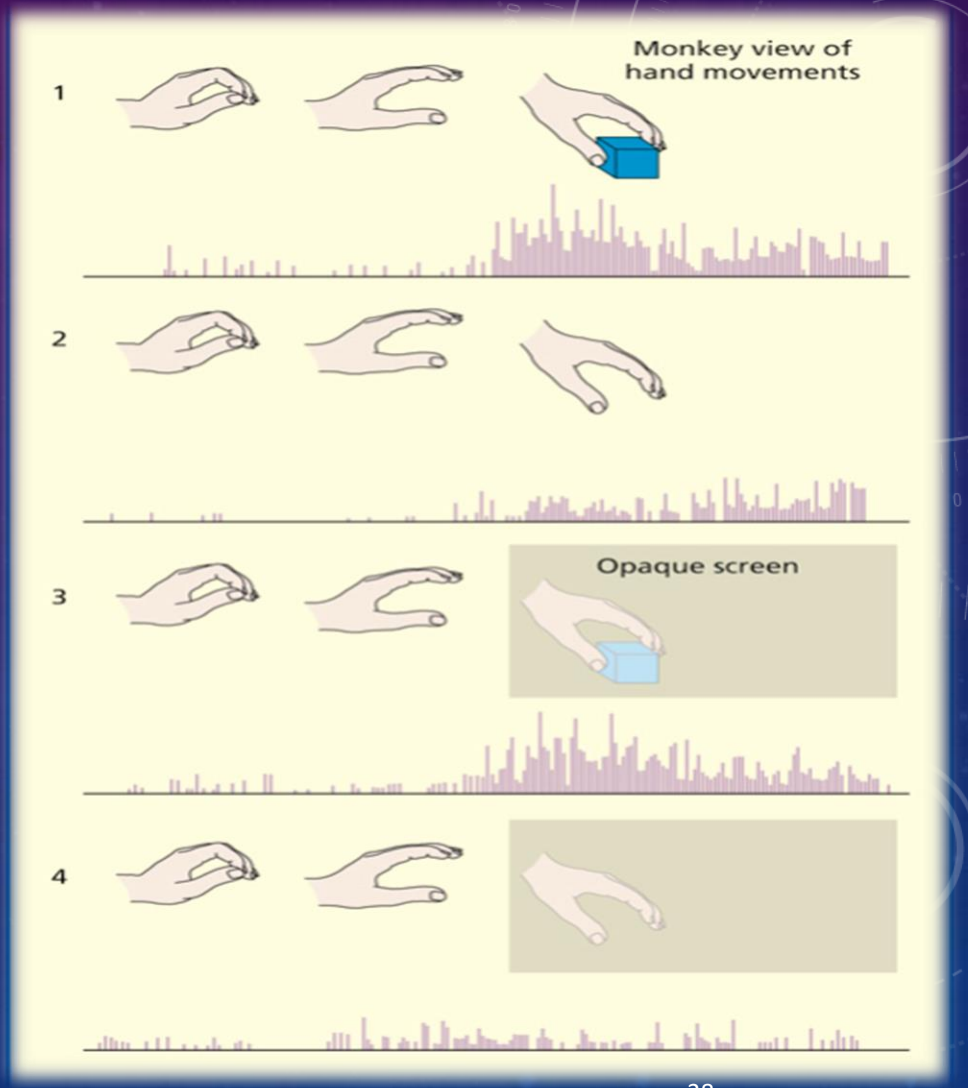


Mirror neurons respond to the same goal rather than the same action (Umitla, et al., 2008)



Mirror neurons respond to inferred goal-directed actions as well as observed action (Rizzolati, et al., 2006)

➢ CULTURAL SKILLS (TOOLS AND TECHNOLOGY):

➢Mirror neurons, action understanding, and imitation:

When the action is different, but the goal is the same, the neural response is determined by the goal.

Studies such as these have been used to argue that mirror neurons enable understanding of at least one mental state: intentions

- Premotor cortex contains abstract representations of action intentions that are used both for planning one's own actions and interpreting the actions of others
- Mirror neurons in the parietal lobe tend to be more sensitive to the wider context based on next goals. For example if the goal of grasping action is to eat object or put it in a container (Bonini et al., 2010)
- The primary motor cortex itself contains neurons with motor and visual properties, but they respond to the mechanics of particular movements rather than more abstract features such as goals (Dushanova & Donoghue, 2010)
- Other regions such as the superior temporal sulcus also respond to specific movements of body parts but have a purely visual component (Perrett et al., 1989) that may act as input to the mirror neuron system

➢ CULTURAL SKILLS (TOOLS AND TECHNOLOGY):

➢Mirror neurons, action understanding, and imitation:

- The human analogue of area F5 of monkeys' is believed to be in Broca's area (specifically in Brodmann's area 44) extending into the premotor area (Rizzolatti, Fogassi, & Gallese, 2002).
- This region is activated by the observation of hand movements, particularly when imitation is required (Iacoboni et al., 1999), and also the observation of lip movements within the human repertoire (e.g. biting and speaking but not barking) (Buccino et al., 2004).
- Critics:
- Associative learning: we see the visual consequences of our actions and learn to associate action observation and action execution together
- Another theory: Mirror neurons' function is to predict what the consequences of actions are

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➢ CULTURAL SKILLS (TOOLS AND TECHNOLOGY):

➢ Why monkeys do not use tools ?!

- One potentially fatal flaw in the story of mirror neurons, imitation, and tool use:

mirror neurons are assumed to be present in monkeys, chimpanzees, and humans

but evidence for tool use in the wild is virtually nonexistent for monkeys, common in chimpanzees, and extensive in humans

Answer:

- Mirror neurons may be a necessary precursor to imitative tool use but are not sufficient (Iriki, 2006; Iriki & Sakura, 2008 ; Rizzolatti, 2005)
- Macaque monkeys can use tools in the laboratory but only after extensive training. It takes a minimum of 10–14 days of intensive training using a specially developed training regime (e.g. Hihara et al., 2006)
- The key question is what are the differences in the brains of macaque monkeys who have acquired tool use versus those that have not?

➢ CULTURAL SKILLS (TOOLS AND TECHNOLOGY):

➢ Why monkeys do not use tools ?!

- The answer, according to Iriki and Sakura (2008), lies in the way that two particular regions are connected:
- In monkeys who are proficient tool-users there are extra connections between the intraparietal sulcus and the temporo-parietal junction that are absent in monkeys who cannot use tools (Hihara et al., 2006)
- The intraparietal region contains ***neurons whose visual receptive fields are extended via tool use*** and also ***mirror neurons***
- The temporo-parietal junction, in humans, has been implicated both in ***theory of mind*** (Frith & Frith, 2003) and in ***feelings of embodiment*** (Blanke et al., 2005)
- The implication of this finding, in evolutionary terms, is that the human brain may have evolved (via genetic modification) stable connections between these two regions that are normally absent in many other primates
- This may enable humans to link neural mechanisms related to tool use (e.g. multi-sensory visuo-tactile neurons) with mechanisms related more closely to social cognition (perspective taking, theory of mind)

EVOLUTIONARY ORIGINS OF SOCIAL INTELLIGENCE AND CULTURE: A NEUROSCIENTIFIC PERSPECTIVE

- ✓ The social intelligence hypothesis:
- ✓ Social intelligence and brain size in primates and non-primates
- ✓ Language evolution and the social intelligence hypothesis
- ✓ Evolutionary origins of culture:
- ✓ Culture in non-human species
- ✓ Social learning versus imitation
- ✓ Symbols:
- ✓ Neuronal recycling and extended cognition
- ✓ Cultural skills (tools and technology):
- ✓ Modifying the brains using tools and technology
- ✓ Mirror neurons, action understanding, and imitation
- ➢ Why monkeys do not use tools ?!

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✓Thanks for your attention