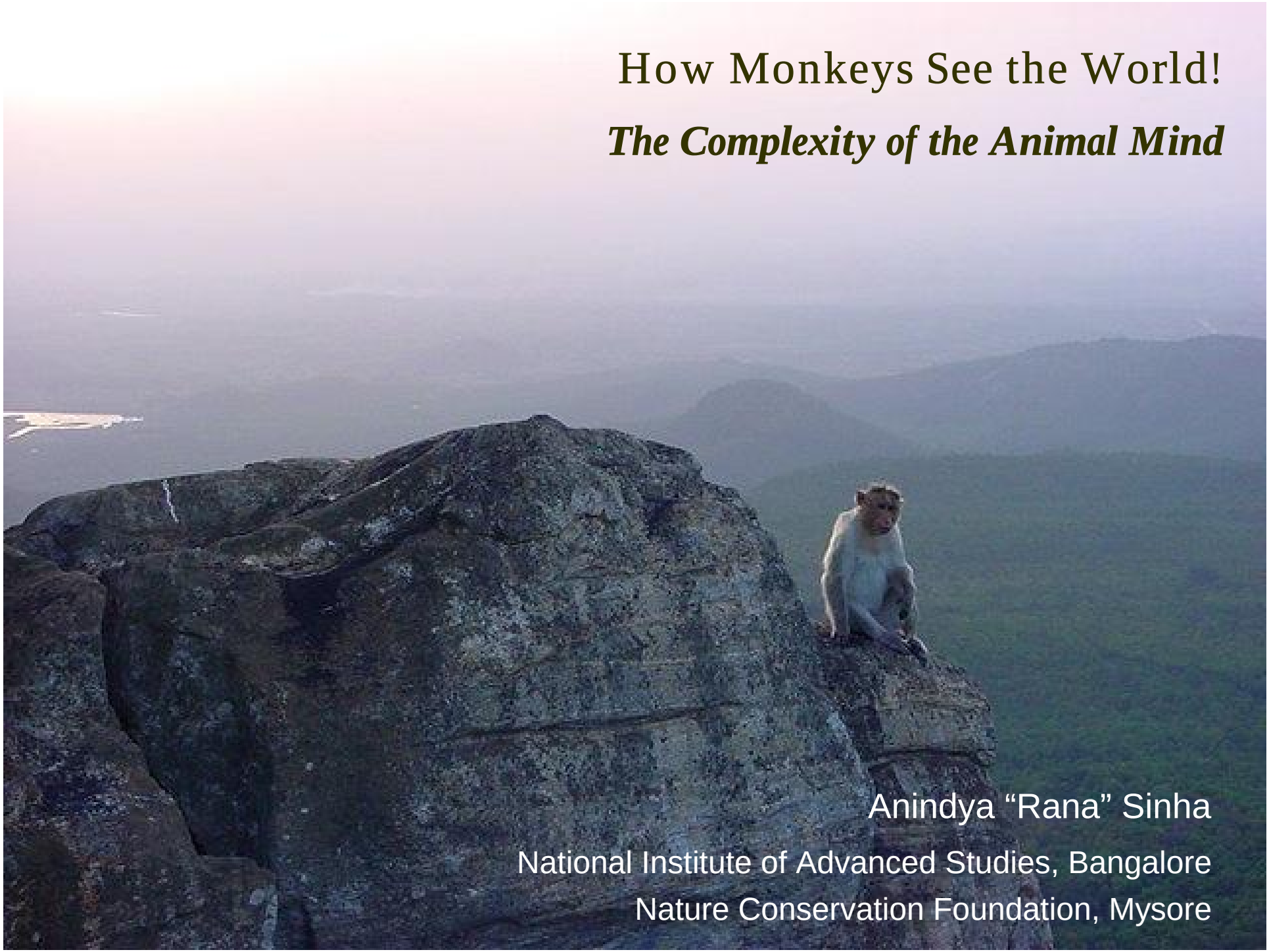
How Monkeys See the World!

The Complexity of the Animal Mind



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Introduction

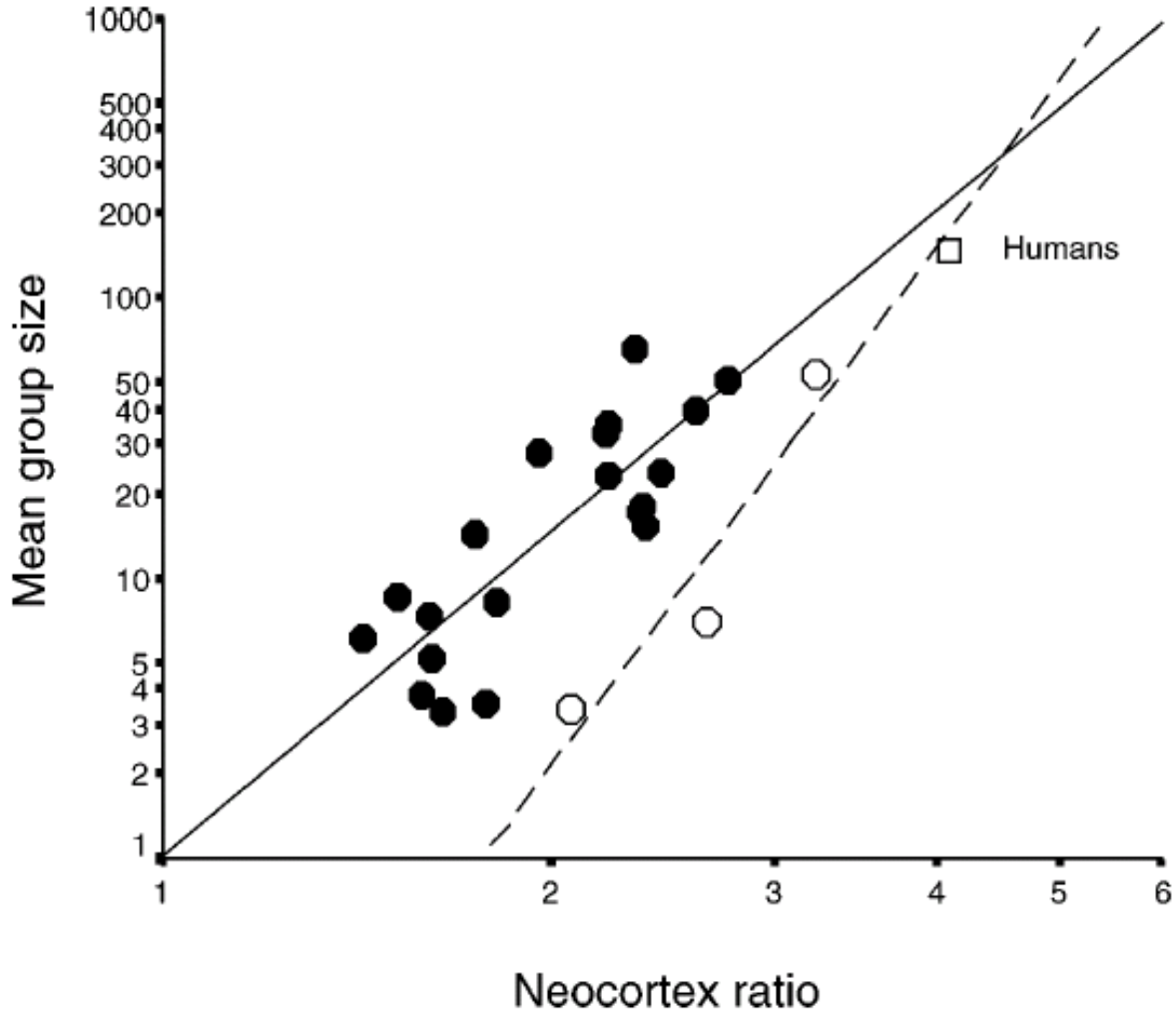
The importance of studying the primate mind

- What is it like to be a monkey?
- How did we come to be what we are today?
- Can we understand more fully how the primate brain works?

Distributed Cognition

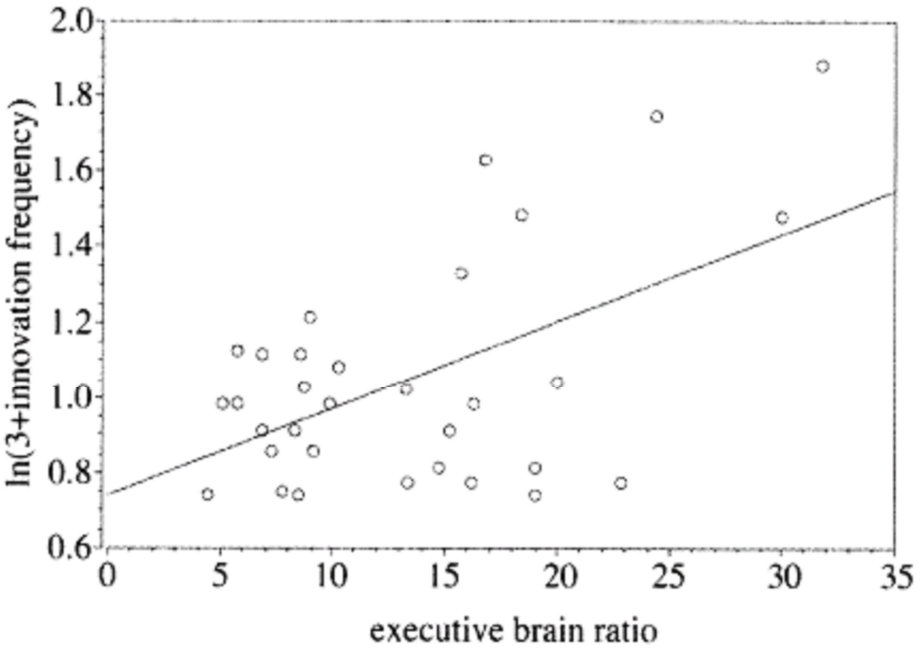
- Communicative interactions as directly observable cognitive events rather than using behaviour to infer invisible mental events such as intentions
- Embedding of cognition within the social interactions of primates and its manifestation through the behavioural coordination of interacting individuals
- Useful approach for modeling developmental and evolutionary processes, including development of phenotypic flexibility, social learning and the appearance of social traditions through behavioural transmission
- Primate cognitive evolution as manifested through changes in context-sensitivity and multi-tasking of individuals in social contexts as well as the coordination of social attention to each other
- Does not necessarily preclude the appearance of mental representation capabilities of individuals in some contexts and later stages of cognitive evolution

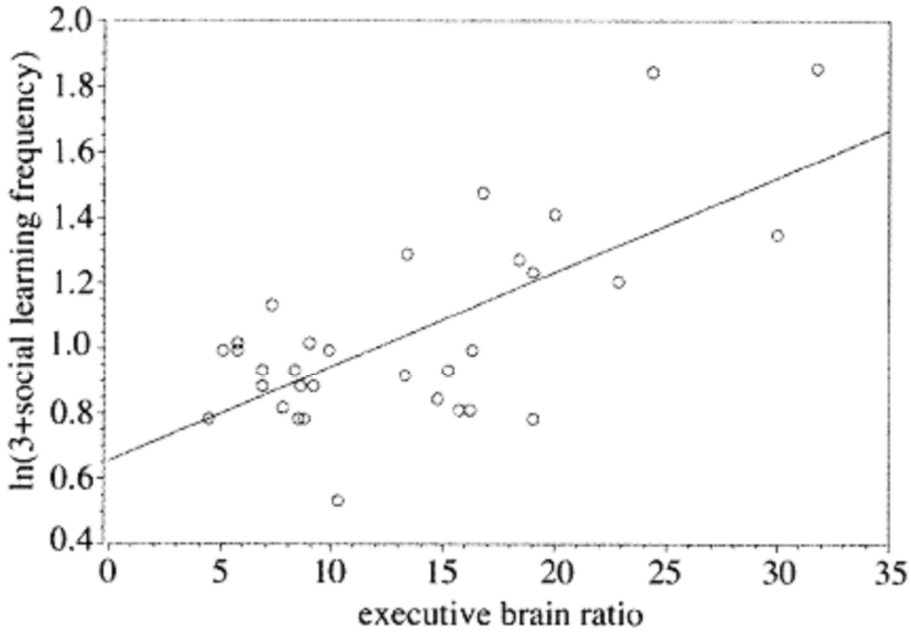
The Social Brain Hypothesis



Dunbar 2003

The Ecological Brain Hypothesis





Correlations between behavioural innovation and social learning with relative volume of the executive brain (neocortex and striatum volume relative to brainstem volume)

Reader and Laland 2002

Correlates of the Primate Social Brain

Significant correlation of social group size with:

- Absolute neocortex (primary visual cortex and non-striate cortex) volume
- Frontal lobe volume
- Volume of the basolateral complex of the amygdala

Significant correlation of relative neocortex volume with:

- Social group size
- Allogrooming clique size
- Social skills in male mating strategies
- Frequency of tactical deception
- Frequency of social play

The Primate Mind

- Has social complexity progressively evolved in primates?
- Has social complexity selected for enhanced cognitive abilities?
- Can certain higher cognitive attributes be defined functionally in non-verbalising primates?
- What could be the behavioural correlates of specific higher cognitive processes in wild primates?
- Are primates capable of reasoning and abstract thought in the absence of a complex language?
- Are primates perceptually and reflectively conscious?

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Primate Social Complexity

THE INDIVIDUAL

A rich repertoire of communicative behaviours to facilitate individual expression and develop complex social relationships

THE SOCIETY

Complex groups with individuals of different ages, sexes, dominance ranks and kinship

Development of sub-groups, temporary alliances and long-term relationships that cut across these categories

Complex network of associations and interactions with many alternative strategies for survival and reproduction

Long-lived social groups in which individuals can pursue a number of different strategies during their lifetimes

A Theory of Mind

Many primates know and predict one another's behaviour…

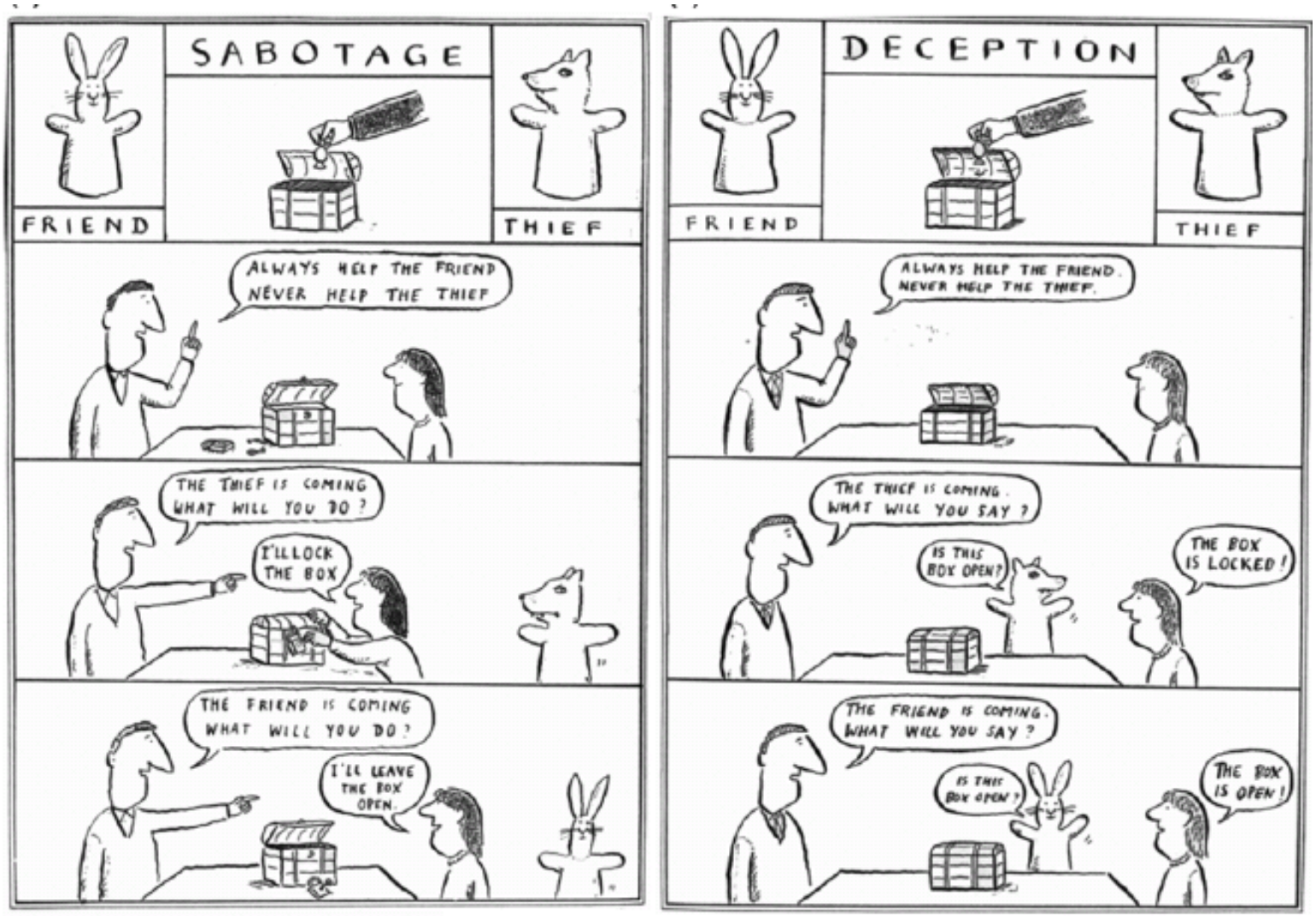
…are they as knowledgeable about one another's beliefs, emotions and intentions?

Theory of Mind, *Premack and Woodruff 1978*

The ability to attribute beliefs, knowledge and emotions to both oneself and others

Recognition of specific mental states in oneself and in others

A Theory of Mind



A Hard Problem!

Reading behaviour or reading minds?

Prediction of behaviour versus prediction of motives or beliefs

Trial-and-error mechanisms versus knowledge-based systems

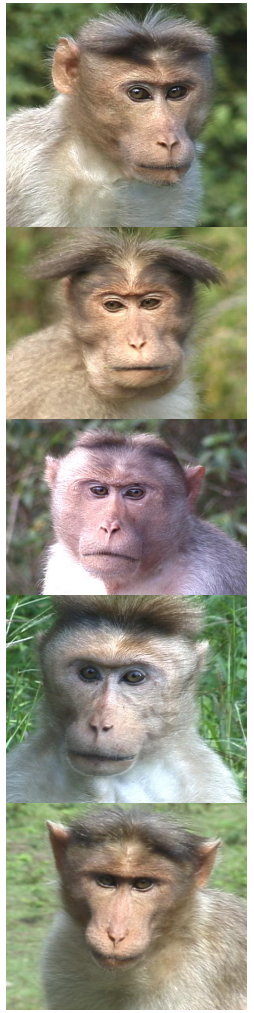
Social Cognition in Bonnet Macaques

Cognitive mechanisms underlying complex social processes – attribution of mental states?

- Social knowledge
- Tactical deception

Sinha 1998, 1999, 2002, 2003

The Bonnet Macaque *Macaca radiata*



- Multifemale, usually multimale, troops of 5-75 individuals
- Females generally philopatric, with strong linear dominance hierarchies
- Emigration of juvenile and adult males from their natal troops common, but not invariable; immigration permanent or transient
- Unstable dominance hierarchies among adult males through aggression and coalitions; unusually extensive affiliative interactions between males
- Society typically promiscuous with periodic consortships, ample mating opportunities, mutual tolerance among males and subtle female mate choice

Methods

- Habituation of troops, identification of individuals and systematic observation of behavioural interactions
- Observations spanned 10 hours on each sampling day (0800 - 1800 h)
- Focal animal sampling of 15 minutes duration on an individual chosen randomly
- Opportunistic sequence sampling
- Data based on 600 h of observation; focal animal sampling of 24.5 ± 2.8 h on the 11 adult females of the troop
- Statistical analyses of the behavioural data

Social Interactions and Individual Decisions

Female A approaches two allogrooming females B and C, both subordinate to her; either B or C retreats even before A can reach them

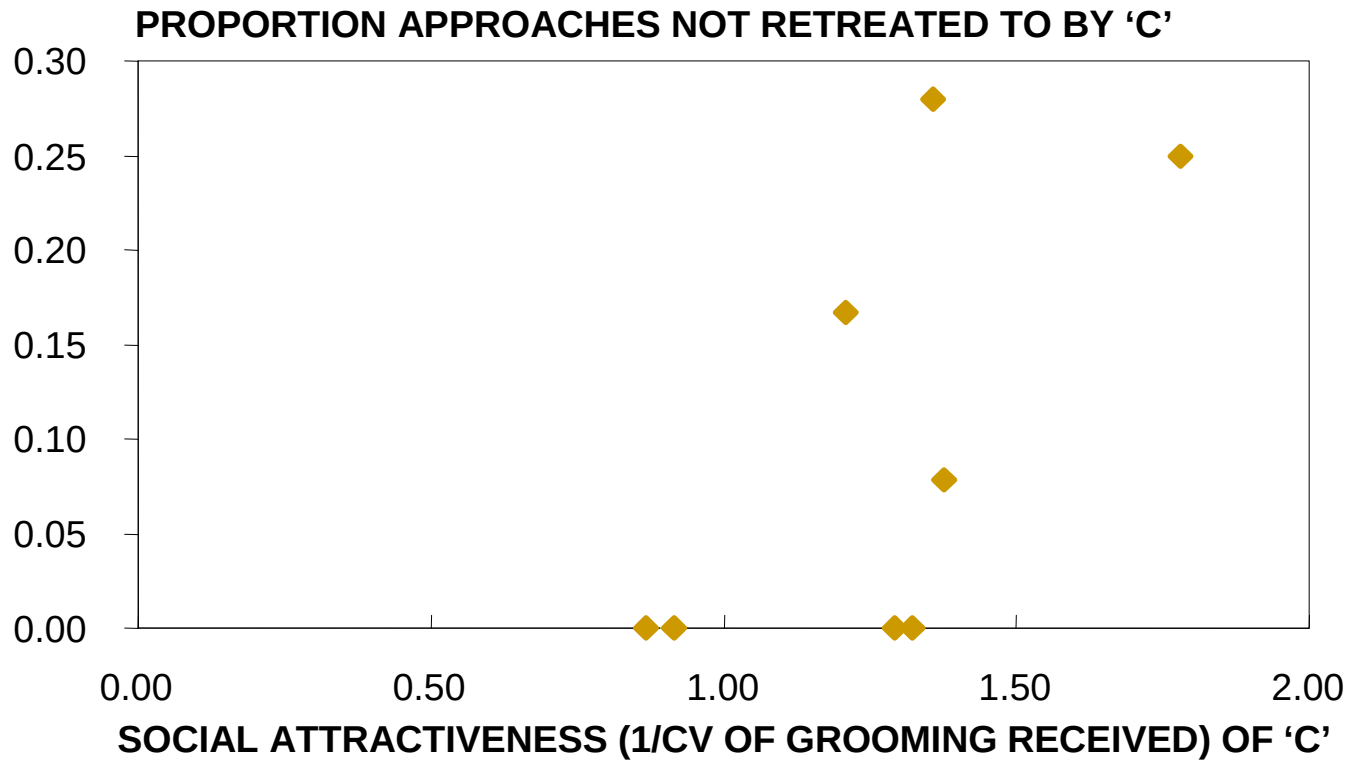
Out of many such observed events, the more subordinate member of the grooming dyad, C, retreats in *c*. 85% instances; B retreats only in *c*. 15% cases

Subordinate females generally prefer to avoid two higher-ranking individuals during allogrooming supplants

Why then did the dominant member of the grooming dyad retreat in the exceptional instances?

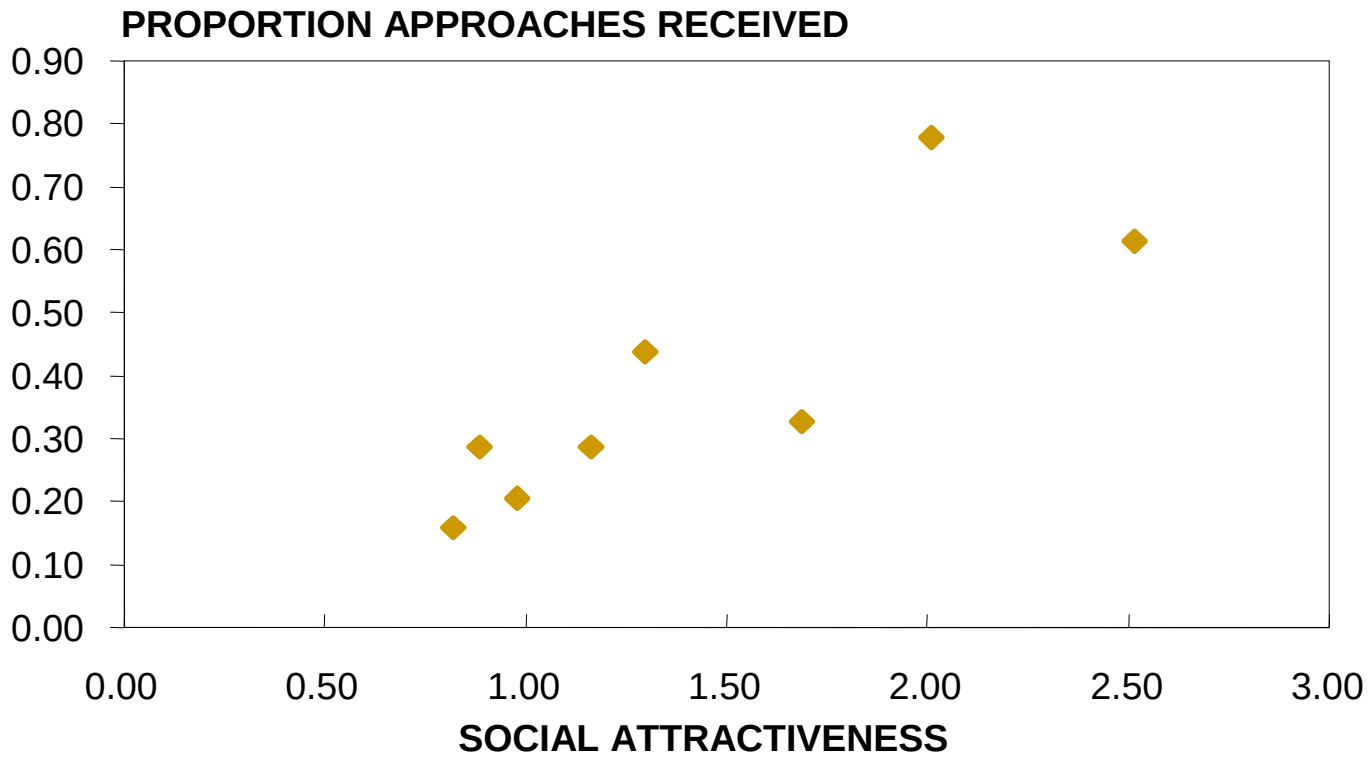
Knowledge of Allogrooming Relationships

- Dominant individuals (‘B’) tended to retreat more when their subordinate companions (‘C’) were more socially attractive in terms of the grooming that they received from other troop members



Knowledge of Dominance Ranks I

- A significant positive correlation between the social attractiveness of an individual and the number of times she was approached by others only when she was the dominant member of the dyad



Knowledge of Dominance Ranks II

- The approaching females preferentially allogroomed the more dominant member of the dyad

- When aggression was displayed by the approaching females, it was more often directed towards the subordinate members of the dyad

Logistic Regression Analysis I

Dependent variable

- Probability of retreat by any individual female

Independent variables

- The individual's own dominance rank
- Rank of the approaching dominant female, or rank difference with the approaching female
- Rank of the allogrooming companion, or rank difference with the allogrooming companion
- The individual's own social attractiveness
- Difference in attractiveness with the allogrooming companion

Logistic Regression Analysis II

The probability that the dominant member of a dyad would retreat when approached by a third individual increased simultaneously with

- The individual's own decreasing dominance rank
- Decreasing rank difference with the approaching individual
- Increasing rank difference with the subordinate member of the dyad

The probability of her retreat did not, however, depend on

- The absolute dominance ranks of the other two individuals
- The social attractiveness of either member of the dyad

Social Knowledge I

- Bonnet macaque females appear to know their own dominance ranks and those of other females relative to their own positions in the rank hierarchy

Knowledge is egotistical

- During interactions with multiple individuals, social decisions are made on the basis of integrated information

Knowledge is integrative

- Individuals know the social attractiveness of other females, but this knowledge seems to be utilised in terms of its correlation with that of dominance ranks

Is knowledge hierarchical?

Sinha 1998

Social Knowledge II

- Individual macaques appear to be aware of the social attractiveness of other individuals, rather than remember specific pair-wise affiliative relationships

- Individuals are knowledgeable about their own position in the dominance hierarchy and the relative dominance ranks of the other troop members

Abstraction and mental representation of personal attributes and those of other individuals

Sinha 1998, 2003

Social Knowledge III

- During triadic interactions, dominant individuals behave as if they ‘believe’ that an approaching individual is targeting their socially attractive companions

Attribution of motives to other individuals

Development of a valid ‘belief’ system

Failure to project one’s own experience on others?

Sinha 2003

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Intentionality

The Intentional Stance, *Dennett 1983-1988*

A theoretical framework to investigate attribution of mental states

Intentional phenomena refer to specific mental states including beliefs, desires or emotions

Different levels of intentionality

Zero-order:	no beliefs or desires at all; instinctive behaviour
First-order:	the subject has beliefs, but no beliefs about other individuals' beliefs
Higher-orders:	some conception about their own and other individuals' states of mind

‘Be what you would seem to be’

– or, if you’d like it put more simply –

‘Never imagine yourself not to be otherwise than what it might appear to others that what you were or might have been was not otherwise than what you had been would have appeared to them to be otherwise.’

Lewis Carroll

Alice’s Adventures in Wonderland, 1865

Intentionality and Attribution

Higher order intentionality requires...

- the ability to represent, simultaneously, two different states of the mind – those of the actor and of the audience
- the ability to recognise a discrepancy between the intentional states held by the two minds

Simultaneous recognition of different mental states

- Attribution of knowledge in children
- Autism in children and adults

Tactical Deception

Human-like deception requires...

- the actor to create a false belief in the mind of the audience
- the actor to recognise that the audience's mental state can be altered without changing one's own

Tactical deception in primates requires…

- use of an act from the normal repertoire of the actor in a situation where it is likely to be misinterpreted by the audience
- the actor to benefit from the use of such a tactic

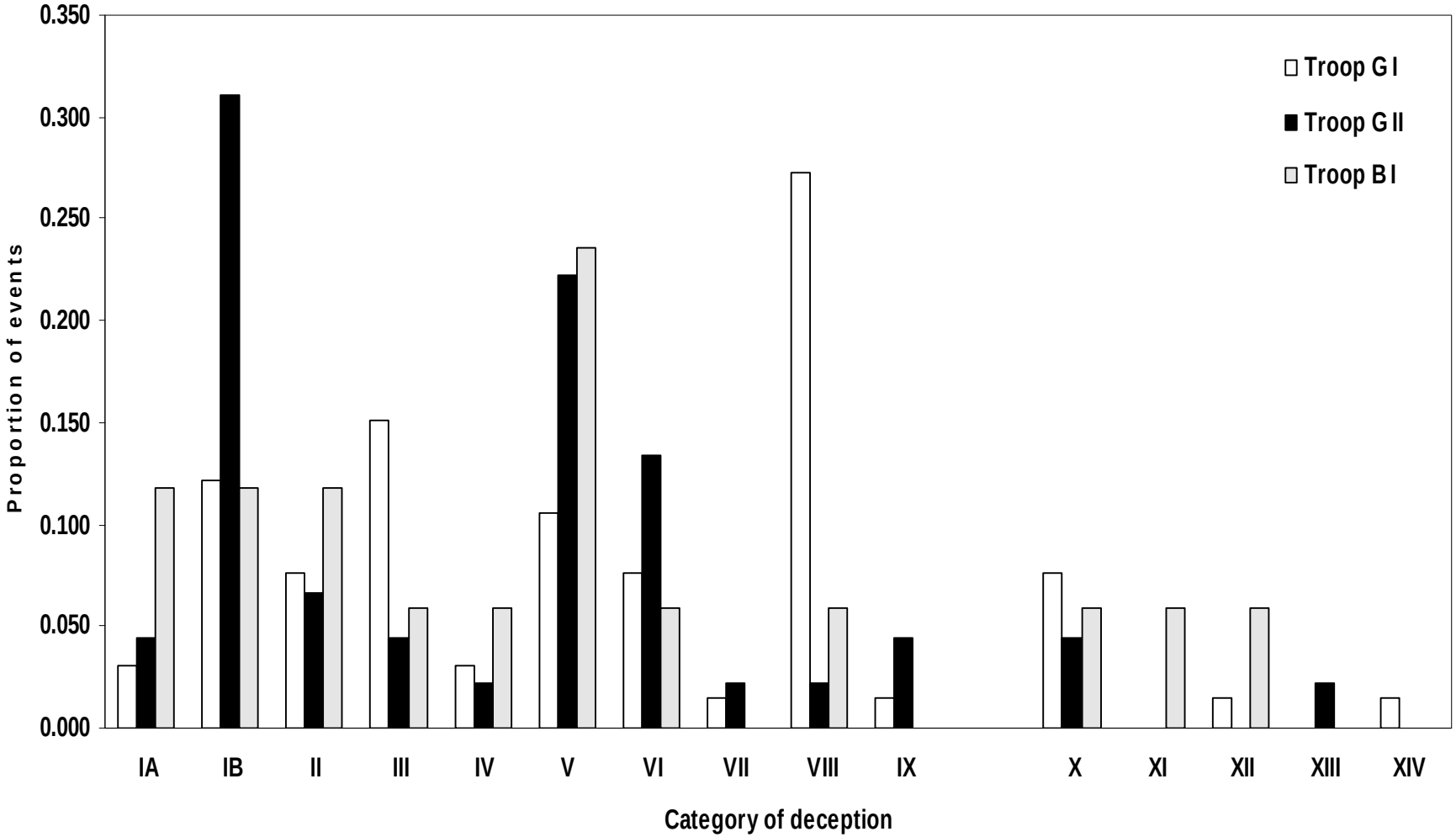
Can some of these acts of tactical deception be genuinely intentional in that the actor truly attempts to alter the mental state of the audience?

Categories of Deception: Simple

- Concealment
  - by hiding - behind a physical barrier
  - by hiding - away from the group
  - by inhibiting interest in object
  - by ignoring
- Distraction
  - by calling
  - by threat
  - by close-range behaviour
- Creating an image
  - neutral
  - affiliative
- Deflection to third party

Sinha 1999

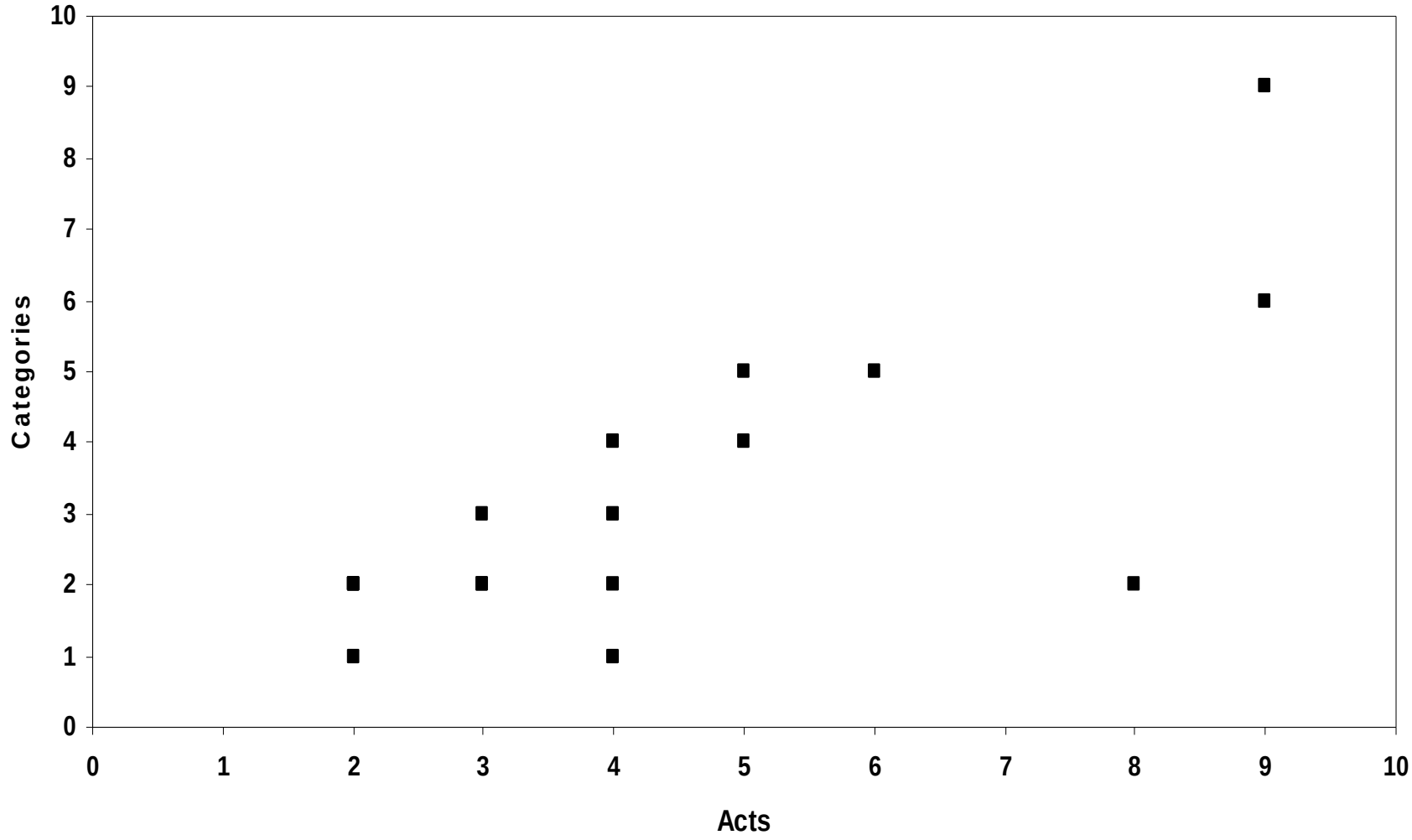
Categories of Deception: Troops



Categories of Deception: Males

TROOP B1												**16**
PK												**0**
HL			**1**									**1**
GD												**0**
PI												**0**
HS	**1**		**1**	**1**	**1**	**1**		**1**	**1**	**1**	**1**	**9**
OS	**1**	**1**				**1**	**1**					**4**
DS			**1**			**1**						**2**
TW												**0**

Categories and Events: Males



Intentionality in Deception I

- Individual males and females who exhibited high levels of deception deceived in many different categories
- Several young and otherwise ‘inexperienced’ individuals displayed complex deception involving a number of acts in different categories performed in quick succession
- Individuals did not invariably use deceptive strategies in apparently identical situations
- Some males changed their repertoire of deceptive acts following changes in the social environment

Mind-reading more parsimonious than behaviour-reading

Sinha 1999, 2003

Intentionality in Deception II

- Several events of deception by different individuals involved acts of physical concealment

Recognition of the visual perspective of others

- Deceiving individuals occasionally exhibit behavioural components that are not compatible with their apparent ‘belief’ system

An incomplete theory of mind…

Sinha 2003

Distributed Cognition in Bonnet Macaques

Use of innate social dominance rules in combination with individually-acquired learning of dominance ranks and affiliative relationships by female bonnet macaques while taking social decisions

These represent partly competing, partly mutually-supporting mechanisms that selection tunes to specific patterns of environmental variation within the niches of particular species

Sinha 1998, 2003

Distributed cognition in bonnet macaques leads to extensive behavioural coordination and a system of phenotypic flexibility in social strategies again by using a combination of innate rules with open systems of individual and social learning

Sinha 2005

The Macaque Mind

- Bonnet macaques are inherently capable of solving complex social problems, for example, through tactical deception
- Individual macaques may be able to form rudimentary mental representations: of themselves, of their social companions and of specific tools
- Interacting macaques appear to attribute motives to other individuals and exhibit visual perspective-taking
- Individuals may, however, fail to project their own experiences to other contexts
- Even if bonnet macaques have a rudimentary hypothesis of mind, it is perhaps an incomplete construct
- Bonnet macaques exhibit extensive phenotypic flexibility and behavioural transmission; they thus possess specific social learning and appropriate distributed cognitive abilities that may have promoted the establishment of behavioural traditions across different populations

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