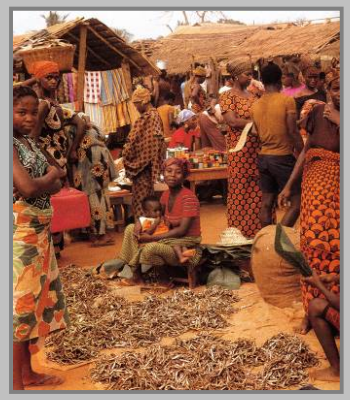
The Evolution of Cooperation & Trading



from microbes to man

Ronald Noë

Centre d'Ecologie, Physiologie et Ethologie, CNRS
&
Psychology, Université Louis-Pasteur

Strasbourg, France

Cooperation is omnipresent in nature

… and presents itself in many different forms

New Scientist
7 Oct. 2000 p. 25

Cooperative hunting

Bruce Davidson
Encycl. of Mammals p. 63

Inter-specific cooperation

trading nectar against transport of pollen

Symbiosis

- trading nutrients
- protection against dehydration

F. Grehan/Cosmos

Cooperation among humans shows similarities ..

trading transport for money in Calcutta

cooperative hunting by !San men

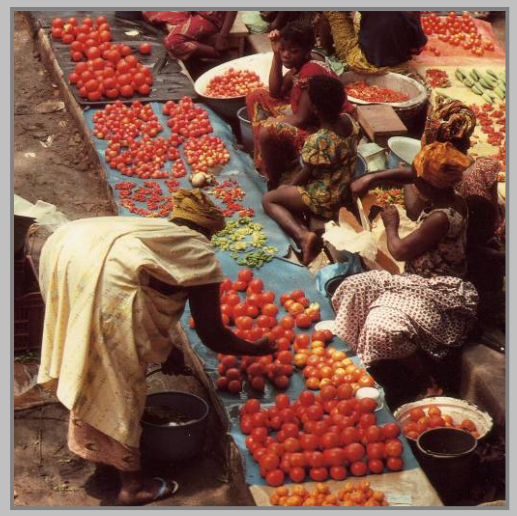
.. but can also take a very different dimension: collective action

Amish barn raising

Warfare: collective action with and against conspecifics

Waterloo

Trading and cooperation have much in common



local market Ivory Coast

Common characteristics of cooperation and trading

- investment in other agents
- risk of no returns

Considerable effort has been put in the study of control mechanisms

game theoretical models based on the Prisoner's Dilemma and related paradigms

The iterated Prisoner's Dilemma

player A \ player B	cooperate	defect
cooperate	3 / 3	4 / 1
defect	1 / 4	2 / 2

More interaction between theoreticians and empiricists would be desirable, not only to study partner control, but also …

- partner choice
- division of payoffs
- indirect reciprocity
- reputation
- power asymmetries
- punishment & harassment
- and more ….

Collective action and the management of public goods

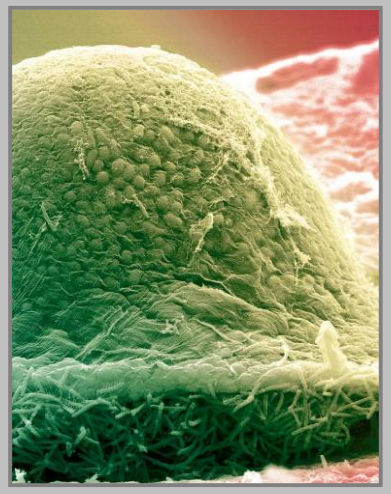
Participation in cooperation among large numbers of unrelated individuals could be used to define *'being human'*

Large scale cooperation among unrelated individuals became stable only after control mechanisms evolved

policing

religion

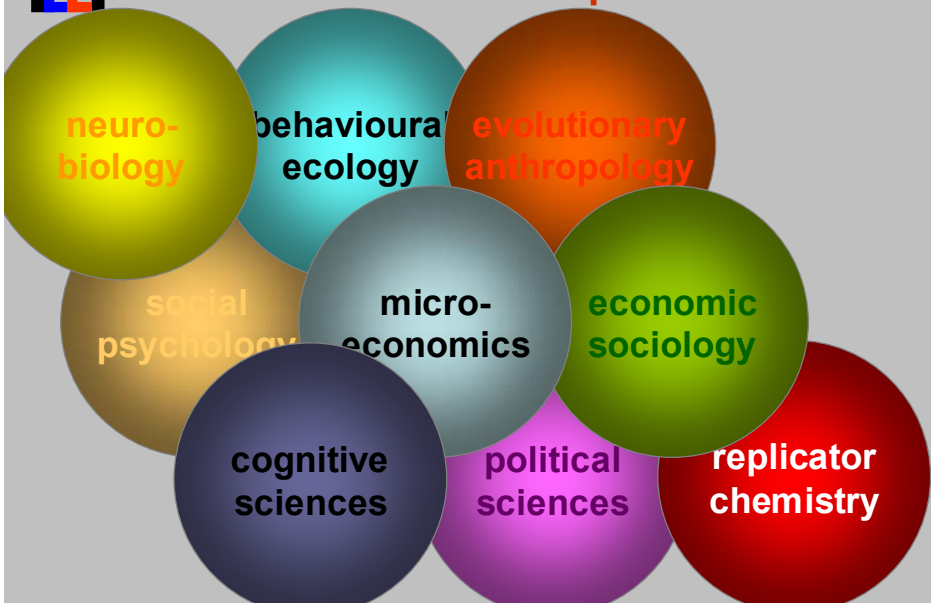
Bacteria are capable of collective action too, but only when closely related



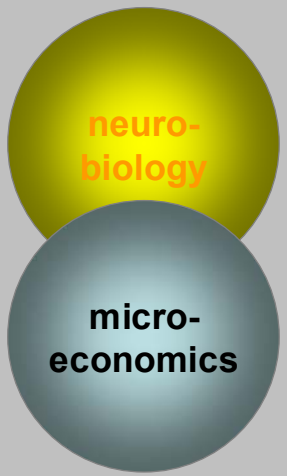
formation of fruiting bodies

swarming

Many disciplines and even more overlaps



Interdisciplinary research 1

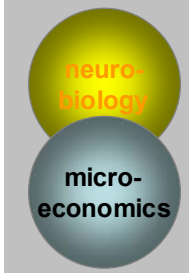


neuro-economics

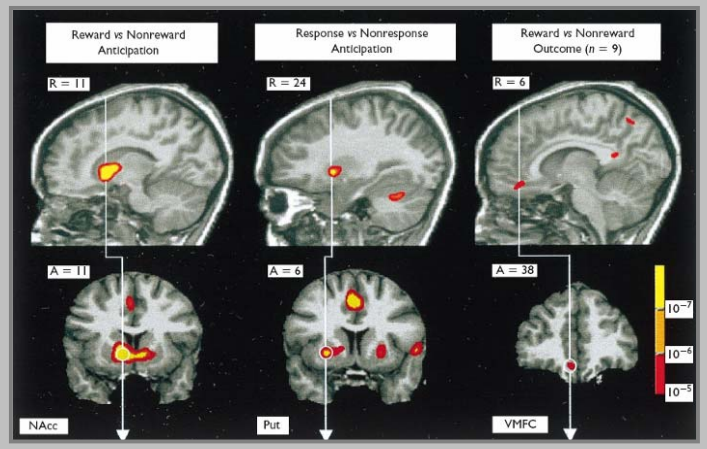
neuronal basis of:

- preference for certain items
- choice of certain partners
- detection of cheating
- altruistic punishment
- moral behaviour

Economic decisions and the brain

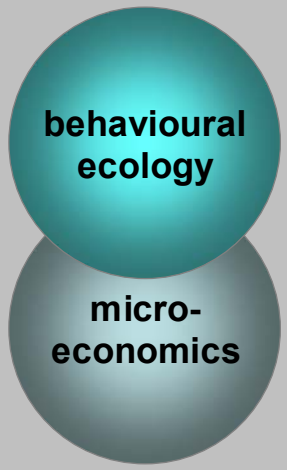


fMRI research in reward anticipation ('wanting') and reward outcome ('liking')



Knutson et al. (2001). NeuroReport 12 (17): 3683-3687 (Fig. 1)

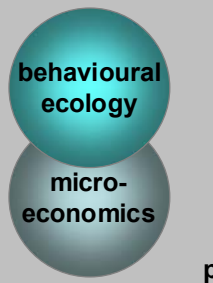
Interdisciplinary research 2

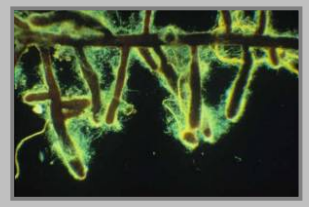


biological markets

- influence of supply & demand ratio on exchange rates
- partner choice as mechanism of selection
- exchanges without contracts

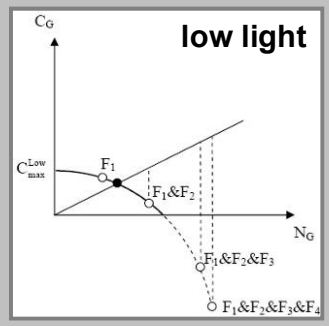
Mycorrhiza markets

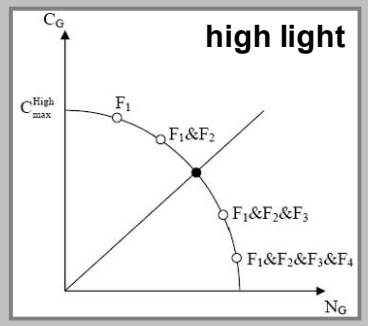




Kummel & Salant *(Ecology in press)*

plant – fungus cooperation



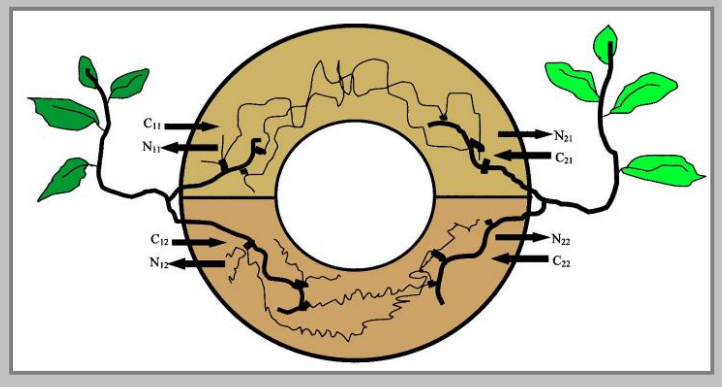


Carbon – nitrogen trade: when to trade with which fungus?

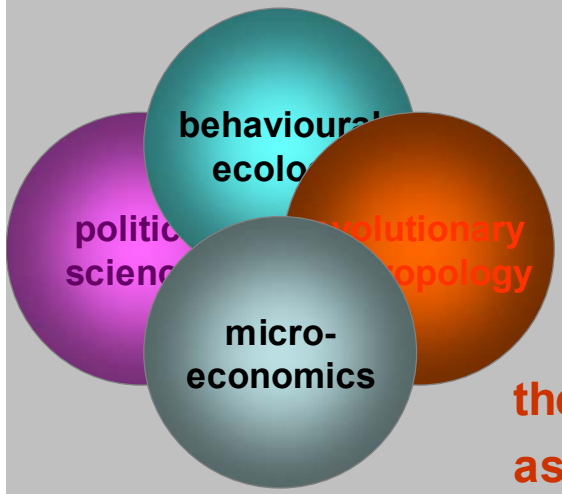
Mycorrhiza markets

2 plants under different light conditions in interaction with 2 fungus species

Kummel & Salant *(Ecology in press)*



Interdisciplinary research 3



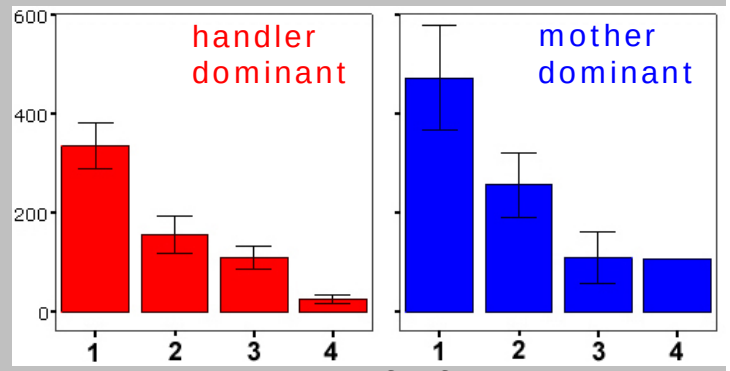
the role of power asymmetries

Paying for cuddling

S. P. Henzi

Female baboons have to groom the mother before getting access to the infant

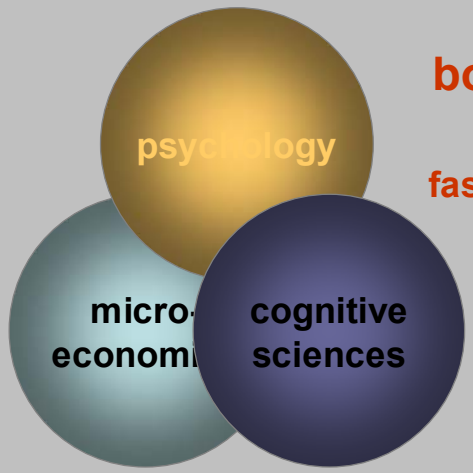
The baboon baby market



- higher ranking mother ► higher price
- fewer infants ► higher price

Barrett & Henzi 2005 *(in Kappeler & van Schaik ed)*

Interdisciplinary research 4



bounded rationality

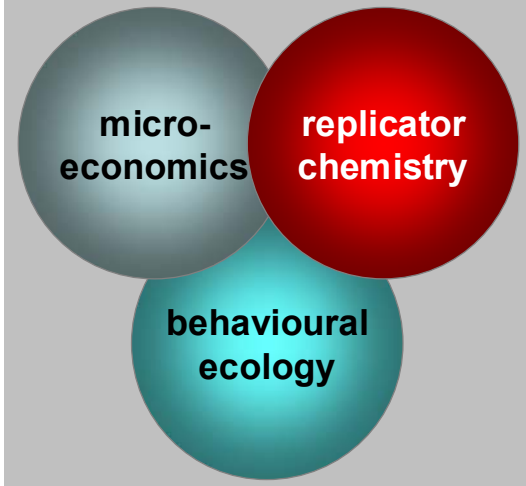
fast & frugal heuristics in decision making

Eörs Szathmáry

Collegium Budapest (Institute for Advanced Study)
&
Plant Taxonomy and Ecology, Eötvös University

Budapest, Hungary

Interdisciplinary research 5



molecular cooperation

The origin of life is understood as complex molecular cooperation

The major transitions

Table 1. The major transitions in evolution

Before		*After*
Replicating molecules		Populations of molecules in protocells
Independently replicating genes		Chromosomes
RNA as gene and enzyme	*	DNA genes, protein enzymes
Bacterial cells (prokaryotes)	*	Cells with nuclei and organelles (eukaryotes)
Asexual clones	*	Sexual populations
Single-celled organisms		Animals, plants and fungi
Solitary individuals		Colonies with non-reproductive castes
Prelinguistic societies	*	Human societies with language

Reproduced from Maynard Smith J and Szathmáry E (1999) *The Origins of Life. From the Birth of Life to the Origin of Language.* Oxford: Oxford University Press.

*** These transitions are regarded as 'difficult'**

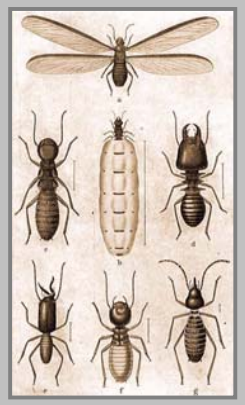
Egalitarian and fraternal major transitions

Table 2. Egalitarian and fraternal major transitions

	Egalitarian	*Fraternal*
Examples	Different molecules in compartments, chromosomes, nucleus and organelles, sex	Same molecules in compartments, organelles in the same cell, cells in individuals, individuals in colonies
Units	Unlike, nonfungible	Like, fungible
Reproductive division of labor	No	Yes
Control of conflicts	Fairness in reproduction, mutual dependence	Kinship
Initial advantage	Combination of functions	Economies of scale
Means of increase in complexity	Symbiosis	Epigenesis
Greatest hurdle	Control of conflicts	Initial advantage

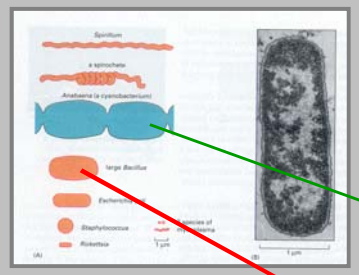
Reproduced from Queller DC (1997) Cooperators since life began. *Quarterly Review of Biology* **72**: 184–188.

Termites: fraternal transition



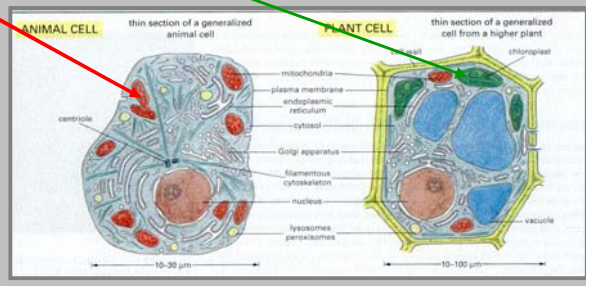
- **Kinship is the most important factor**
- **Reproductive (and other division of labour) readily arises**
- **Niche construction: „the wisdom of the hive"**

Eukaryotic cells: egalitarian transition

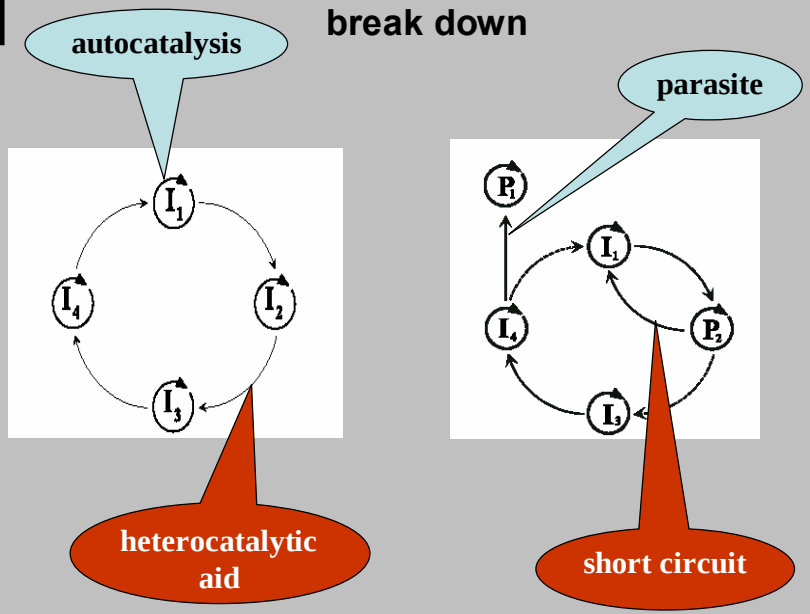


- Reproductive division of labour is impossible
- Compartments with different genetic origin must be centrally regulated for reproduction

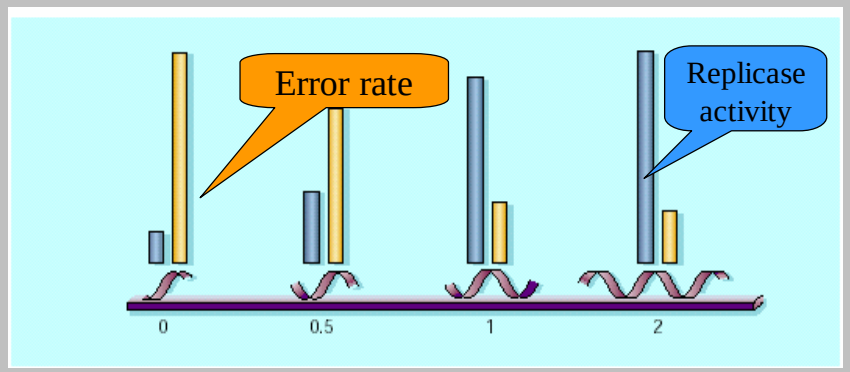
Different bacterial lineages have contributed to the origin of eukaryotic cells



Simple ideas about molecular cooperation break down

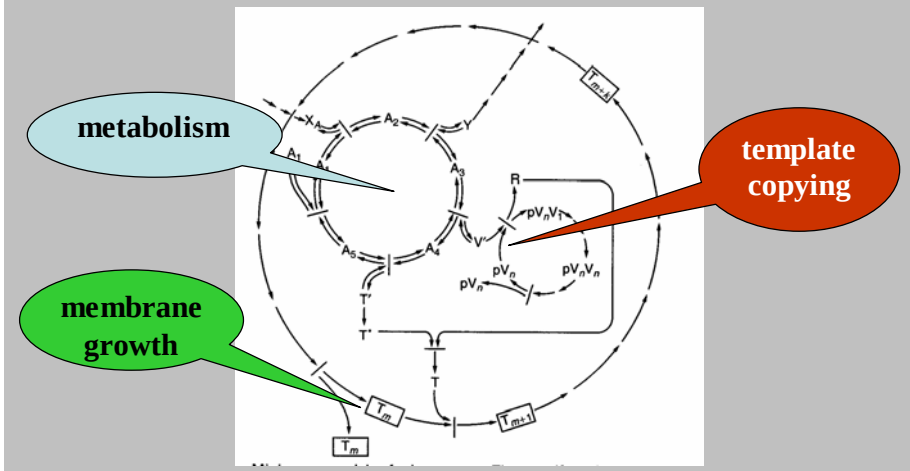


Cooperation on the surface allows the increase in complexity



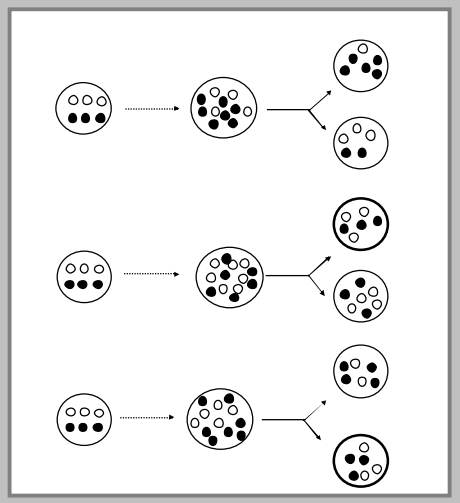
- Molecules interact with their neighbours
- Have limited diffusion on the surface

Life is the “symbiosis” of genes, metabolism and membrane



systems chemistry aims at synthesizing systems of molecular cooperation

Group selection of early replicators



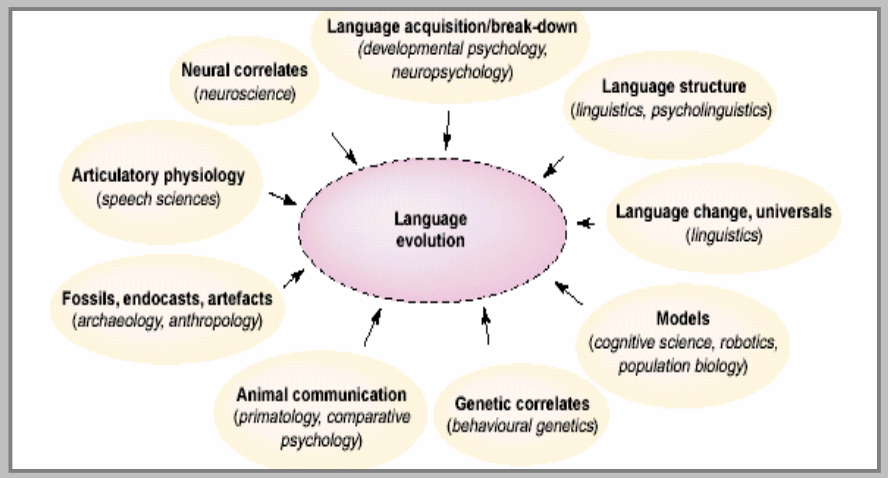
- A bag of genes: genes sitting in the same boat
- How fast can complexity increase?
- When did chromosomes arise?

Interdisciplinary research 6

the role of communication

co-evolution of language and complex forms of cooperation?

Understanding language evolution is difficult



The explanatory power of theories for the origin of language

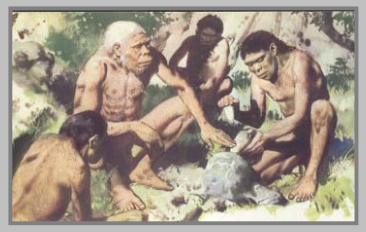
(1) selective advantage (2) honesty (3) grounded in reality
(4) power of generalisations (5) cognitive abilities (6) uniqueness

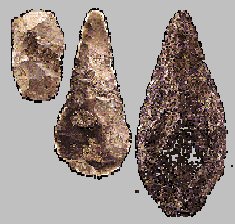
Theories/Questions	1	2	3	4	5	6
Language as a mental tool (Jerison, 1991; Burling, 1993)	+	+	-	+	-	-
Grooming hypothesis (Dunbar, 1998)	-	+	-	-	-	-
Gossip (Power, 1998)	+	-	-	+	-	-
Tool making (Greenfield, 1991)	+	+	+	+	+	-
Mating contract (Deacon, 1997)	-	-	-	-	-	-
Sexual selection (Miller, 2000)	+	-	-	-	-	-
Status for information (Dessalles, 2000)	+	-	-	+	-	-
Song hypothesis (Vaneechoutte & Skoyles, 1998)	-	-	-	-	-	+
Group bonding/ ritual (Knight, 1998)	-	+	-	-	-	-
Gestural theory (Hewes, 1973)	+	-	+	+	-	-
Hunting theories (Washburn & Lanchester, 1968)	+	+	+	+	-	-

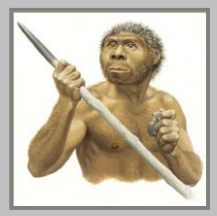
An educated guess

The evolution of human language had something to do with the following activities

- Mental representations/ mental models
- Tool making
- Gesturing
- Co-operative hunting (planning)
- Individual recognition
- Population structure (fission/fusion society)







The ultimate goal is to re-enact this transition in simulated and embodied agents

Samuel Bowles

Economics, University of Siena

Siena, Italy

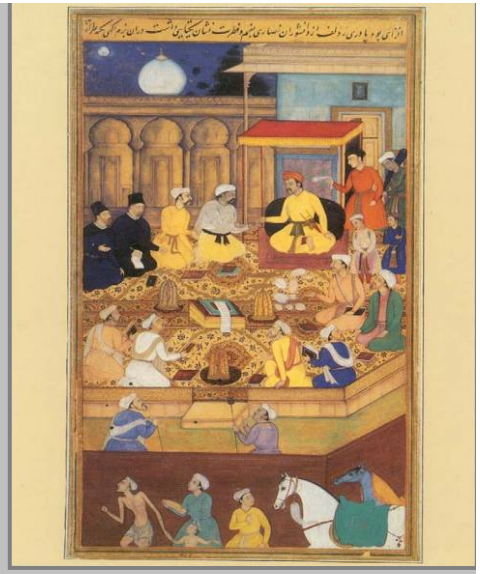
&

Behavioral Sciences Program, Santa Fe Institute

Santa Fe, USA

Are humans a special case?

- Vast behavioral differences among groups
- Kinds and scope of cooperation
- Trade among millions of anonymous individuals
- Other- regarding preferences



Akbar and his court

What distinctively human characteristics explain the differences in the extent and types of cooperation and trade? Possibilities include:

- Long lives, large cognitive capacity and language
- Can formulate, communicate and enforce moral rules
- Evolved meat-intensive diet
- Docility/socialization: internalization of norms
- Heightened in-group out-group distinctions
- Projectile weapons: lethal warfare, low cost punishment of defectors
- Social institutions as a form of niche construction

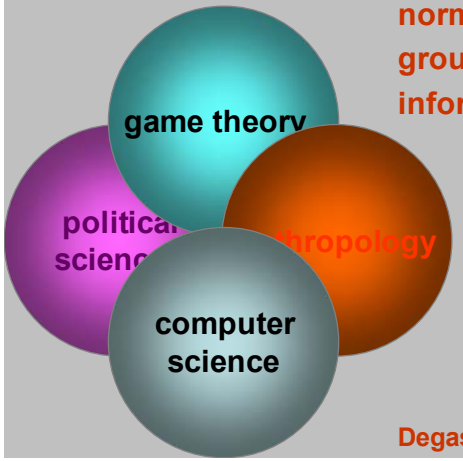
Puzzles

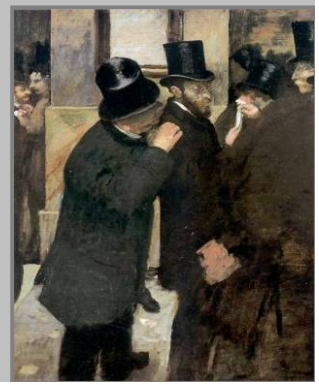
Is human cooperation and trading supported entirely by self-regarding motives, or are other-regarding motives (social preferences) involved?

Donald Trump Mother Theresa

Puzzles

If self-regarding motives are the main support for cooperation did they evolve by reciprocal altruism? Indirect reciprocity? Can these models explain the adherence to norms of cooperation in large groups with noisy or private information?

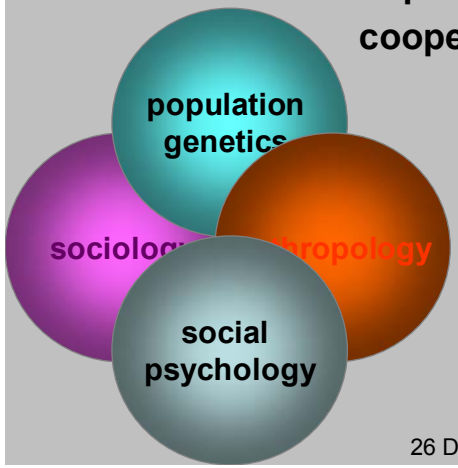


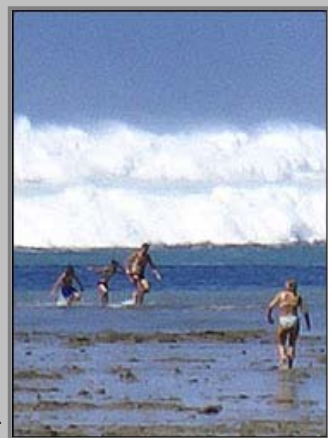


Degas, La Bourse

Puzzles

Is kin altruism the template for more extensive forms of cooperation, and how important is it in explaining cooperation?

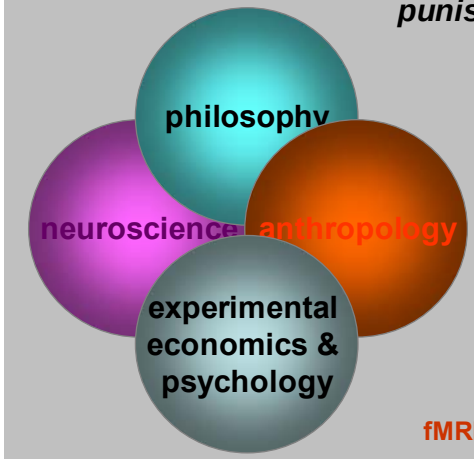




26 December 2004

Puzzles

If other-regarding motives are involved, are they best described by *inequality aversion*, *resistance to domination*, *altruistic punishment*, *strong reciprocity*?

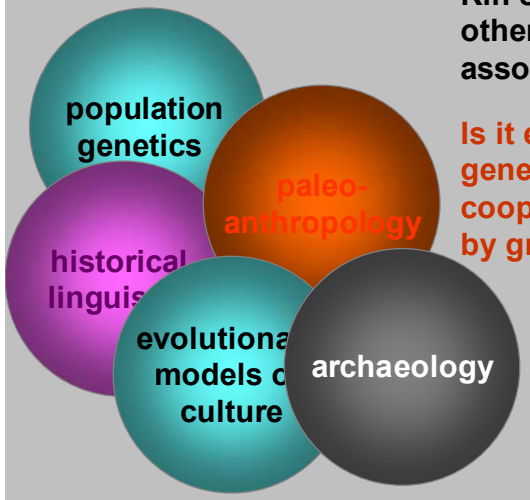


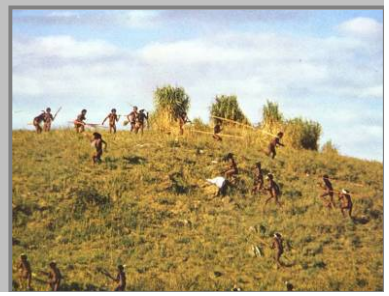
fMRI scan of an Ultimatum Game subject
Greene et al.

Puzzles

How could altruistic behaviours emerge and proliferate among humans? Kin selection, group selection, other forms of positive assortment?

Is it empirically plausible that a genetic predisposition to cooperate could have evolved by group selection?

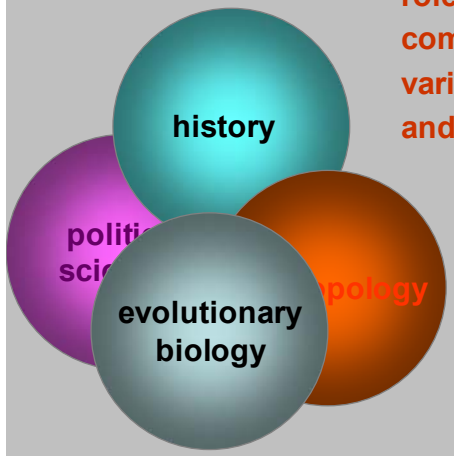


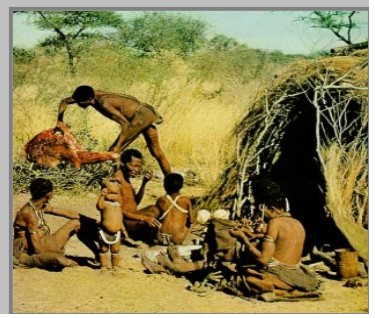


Warfare in PNG

Puzzles

Social institutions are an example of human niche construction that support cooperation: what is the role of suppression of within-group competition and phenotypic variance reduction (ie reproductive and other forms of levelling)?





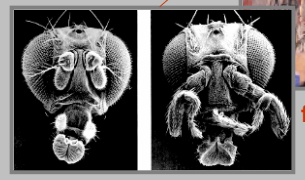
Meat sharing in the Kalahari

Puzzles

Conflicts over the division of the gains to cooperation may preclude cooperative solutions: when does this occur and how can it be avoided?

El Salvador, 1991

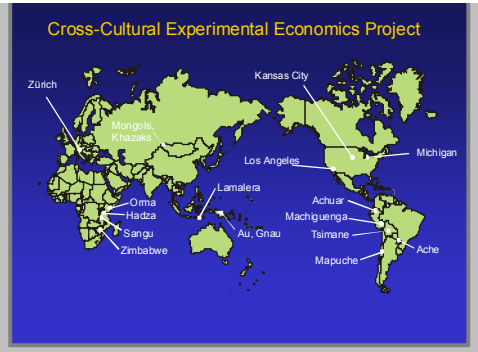
Example: What can econs and other social sci.s learn from biologists?



a point mutation (Drosophila)

fall of the Berlin Wall

- Variance reduction as a force propelling evolution
- Speciation as a model of the emergence of new social institutions
- Quorum sensing (e.g. in bacteria) and neutral mutations as a prototype for political action against the status quo (applications to the fall of Communism etc)
- Multilevel selection as a model of interactions of firms, firms, regions, and nations

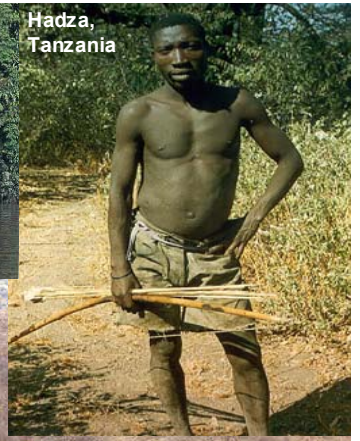


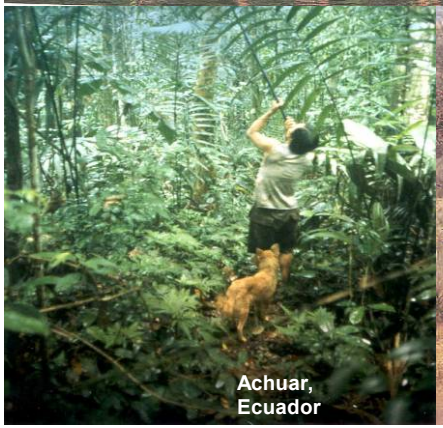
The question: **in an experimentally controlled interaction with real material stakes and identical incentives, how do 15 small-scale societies with differing cultures cooperate (or fail to do so) and police defectors?**

The research team: **decision scientists, game theorists, ethnographers, evolutionary modelers**

Funding: **The MacArthur Foundation**

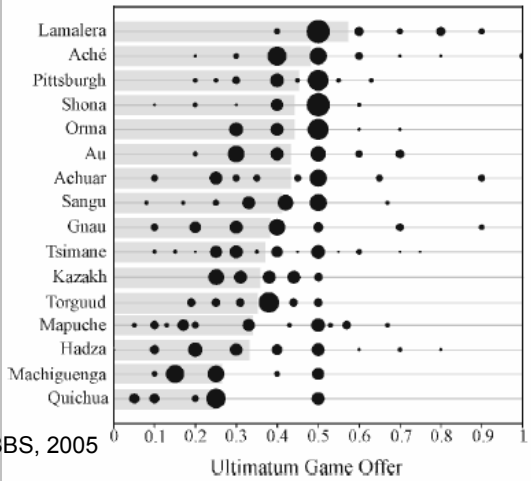
Joseph Henrich, Robert Boyd, Samuel Bowles, Colin Camerer, Ernst Fehr, Herbert Gintis, Richard McElreath, Michael Alvard, Abigail Barr, Jean Ensminger, Kim Hill, Francisco Gil-White, Michael Gurven, Frank Marlow, John Patton, Natalie Smith, and David Tracer





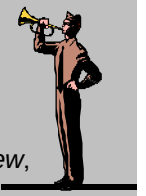
Results: cultural diversity, purely self interested subjects a small minority, strong impact of economic structure

Self interested subjects who believe others to be self interested would offer the least possible amount. Few did.



Henrich, Boyd, Bowles, et al, BBS, 2005

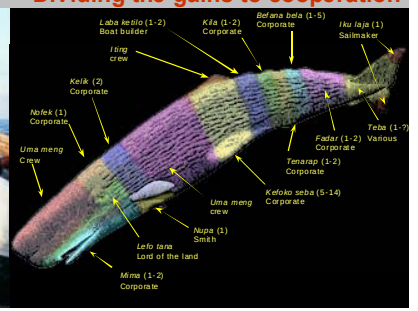
Payoffs to trans-disciplinary research in the cross cultural experiments project



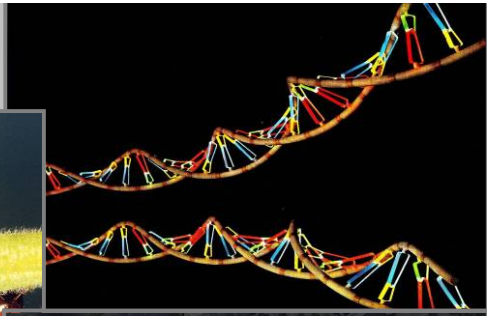
- Many peer reviewed and other papers (*American Economic Review*, *Behavior and Brain Science*, etc etc) and books
- An active learning process among the 17 participants; many of the anthropologists have since taken up both game theory and experimental methods; some economists have become serious students of anthropology.
- Imitations, spin offs in other disciplines, and a well funded second round

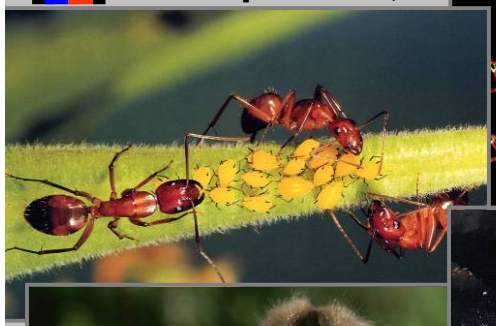
Lamalera whale hunters

Dividing the gains to cooperation



Cooperation is omnipresent,





.. but not that easy

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