

PROJECT 01956/Evo.Res.Con.Edu

**Unraveling the educational potential of the research
and concepts of evolution**

Altruistic behavior in an evolutionary perspective

Altruistic behavior in an evolutionary perspective

Direction 2: In-depth focus on the concepts of diversity and multiculturalism through the lens of evolutionary Theory .

Altruistic behavior

(in an evolutionary perspective)



Kelin and Hubert (Minden Pictures): Juvenile harvest mice (*Micromys minutus*).
<https://www.mindenpictures.com/stock-photo-harvest-mouse-micromys-minutus-juveniles-with-one-hanging-from-tail-naturephotography-image00492462.html>

Part A

- Basic concepts-contrasts
- Examples and experiments in the natural world

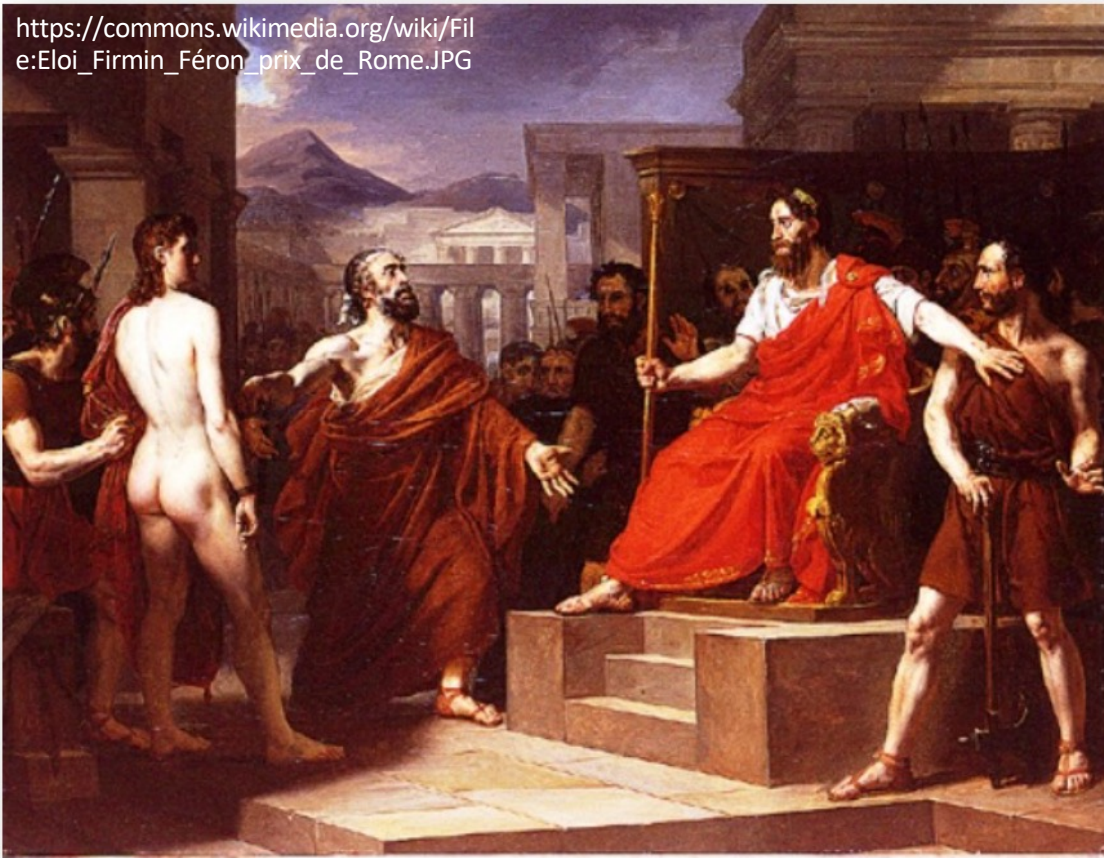
Part B

- Tests
- Mechanisms-interpretations

1. Basic concepts and contrasts

A fascinating story

Damon and Phintias



https://commons.wikimedia.org/wiki/File:Eloi_Firmin_Féron_prix_de_Rome.JPG

Diodorus Siculus, *Diodorus in Sicily*, Cambridge University Press, 1989. 10th Volume, excerpt 4 [3]-[4]-[5]-[6]. https://el.wikisource.org/wiki/Ιστορική_Βιβλιοθήκη/I. The original source is in Ancient Greek. The text was translated in English (on the right).

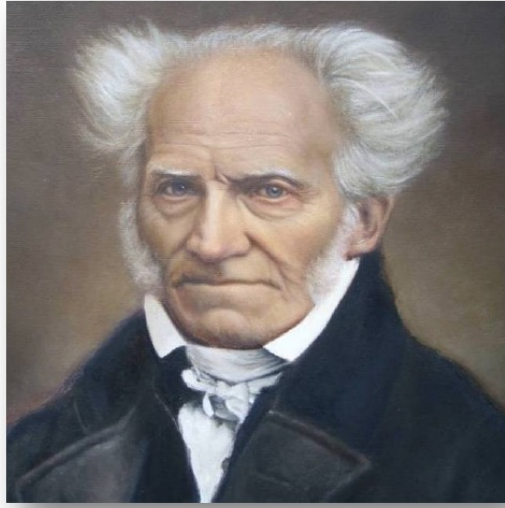
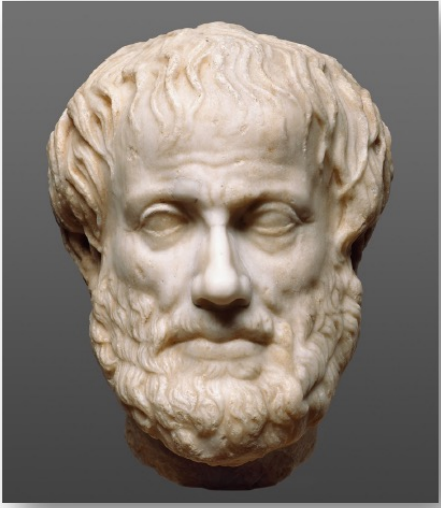
When Dionysius was a tyrant of Syracuse, Phintias, a Pythagorean, was accused of plotting against the tyrant and sentenced to death. He asked Dionysius for some time to settle his affairs, proposing that the tyrant take one of his friends as a hostage. Were he to fail to appear on execution day, the hostage would be killed in his stead.

When the tyrant wondered who would agree to place his life on the line for him, Phintias sought out his friend Damon, a Pythagorean philosopher, who immediately gave himself up as hostage.

Some lauded Damon's loyalty, but others thought he must surely be mad to sacrifice himself like this.

As the execution day drew near, the whole city gathered to see whether Phintias would prove true to his word. And, in the final moment, when all hope was lost and the execution was about to begin, Phintias came running in to save his friend.

Dionysius was astonished. He immediately freed the men and begged them to accept him as their friend too.



Us and them

- For **Schopenhauer**, egoism is a natural condition:

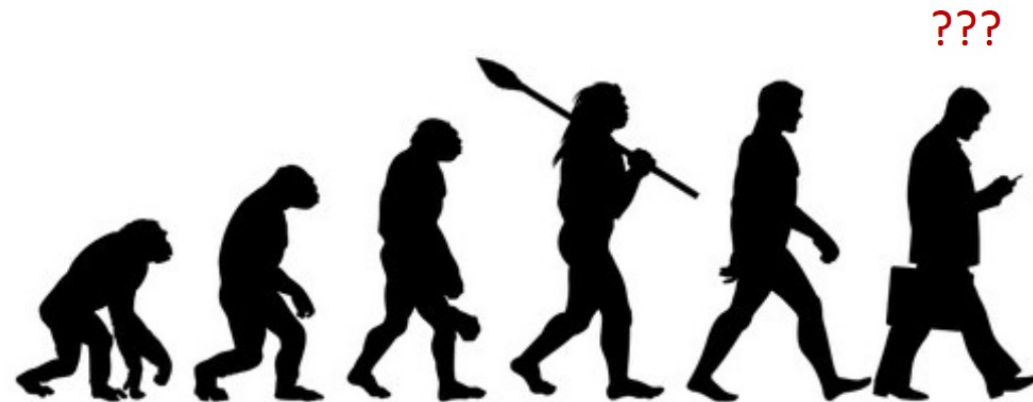
“By nature, egoism has no limits, it is colossal, it looms over the world. If any individual was given the right to choose between damage to themselves or damage to others, the decision would be plainly obvious in the vast majority of cases. The reason being that, eventually [...] from the perspective of each one of us, we are the whole world. Anything that exists objectively (external to the self), is only indirectly existing.”

- **Aristotle** defines *grace* as kindness, helping those in need, without expecting any reward.
- **Democritus** believed that the generous or *merciful* person is the one who gives by choice, expecting no reward.

Positive social behavior (prosocial behavior)

- Aid.
- Grooming.
- Sharing.
- Cooperation.
- Reciprocation.
- **Altruism.**

Evolution and *Homo economicus*





Altruism: helping others at one's own expense

- **Psychological/moral** altruism: powered by the motives of the “benefactor”
- **Biological** altruism: powered by the benefit of the “beneficiaries”



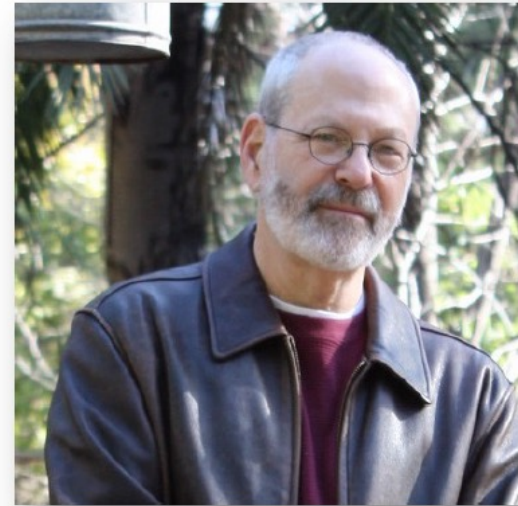
The model of Elliot Sober

Psychological altruism:

- Requires intelligence.
- Independent from reproductive success.
- Cost/benefits are not balanced (donation).
- Not “instrumental”.

Biological altruism:

- Does not require intelligence.
- Reproductive benefits are the sole criterion.
- Cost balances out benefits.

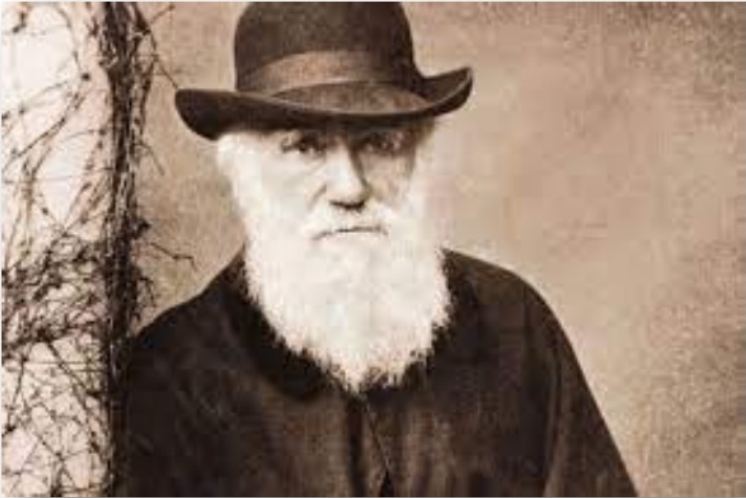


Psychological altruism is not related to natural selection. This behavior emerged as a product of the evolution of (higher) mental functions.

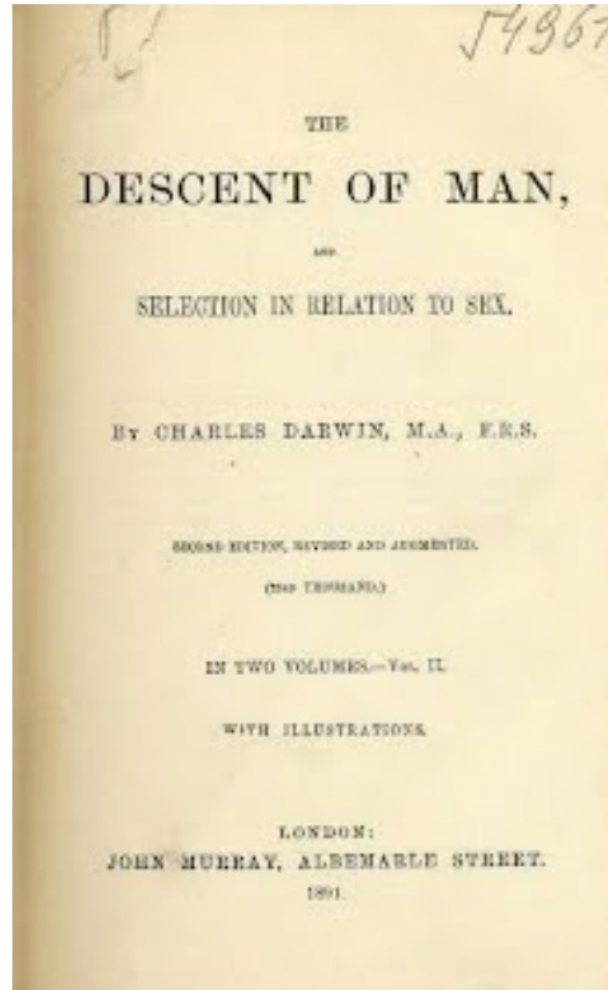
Biological altruism can be better explained on a team level.

Sober, In *Evol. Ethics* (1993); Sober, *Can. J. Phil.* (1998)

Altruism through the eyes of Charles Darwin

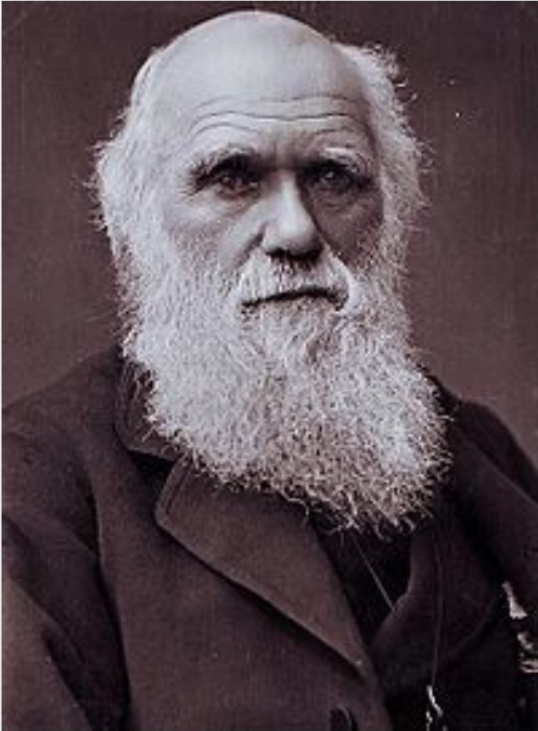


“No race would be able to maintain its cohesion if murder, theft and betrayal were so common.”



“When two tribes of prehistoric people living in the same environment started competing against each other, other things being equal, the tribe with a greater number of brave, compassionate and honest members, eager to warn the others of danger, to help and defend them, would have better odds of (evolutionary) success and eventually prevail.”




The dilemma



“It’s extremely doubtful whether the descendants of the most compassionate and beneficial parents or of the most honest companions would ever outnumber the descendants of egoistic and destructive parents. A person who is prepared to place their life on the line (as were indeed many of the primitives), rather than betray their companions, will not leave any descendants to inherit their noble nature.”

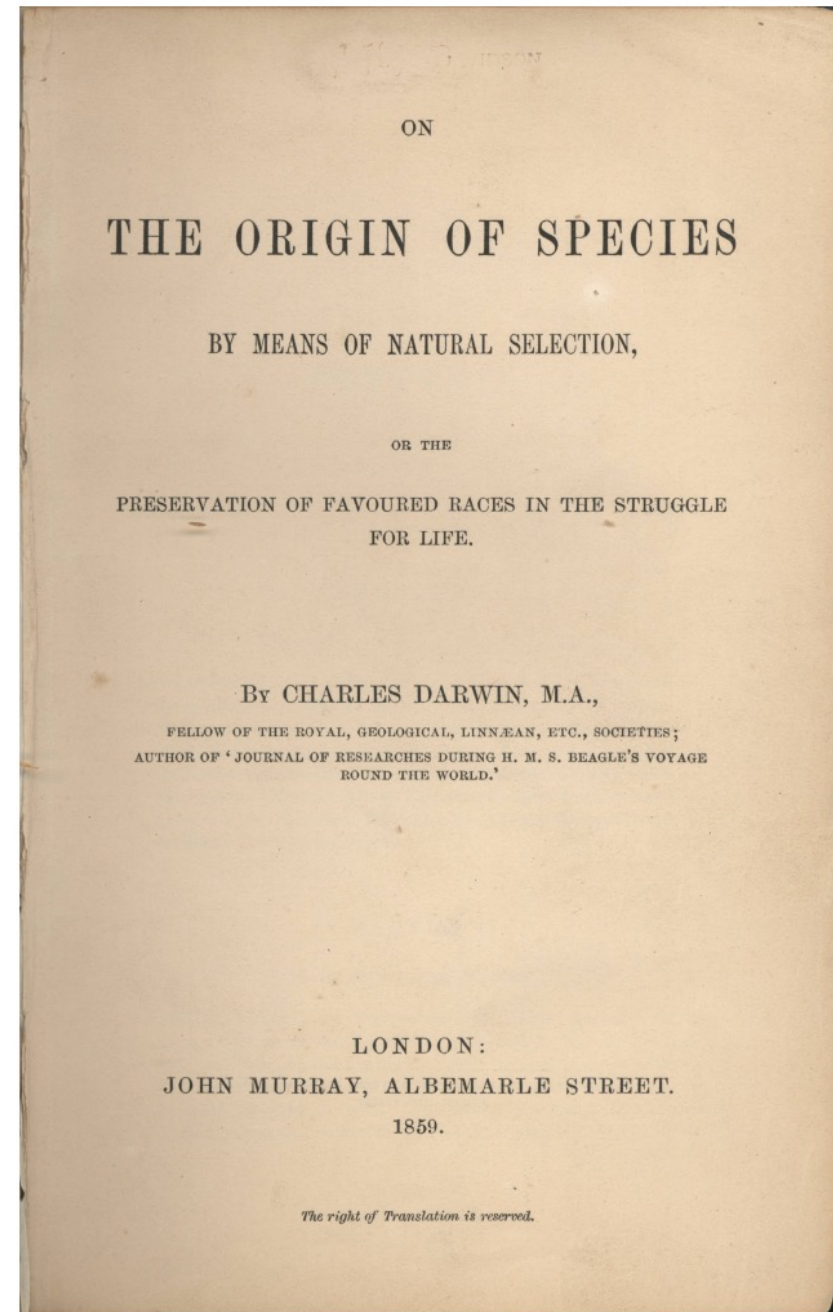
A major theoretical problem: altruism in “social insects”



Type of adult bee	What they do	How many in a honey bee colony	How many in a bumble bee colony	What they look like in a honey bee colony
Queen	Lay eggs	1	1	
Worker	Take care of larvae, build and clean nest, forage	10,000-50,000	Less than 50 to over 400, depending on species	
Male	Leave nest to mate, then die	100-500	0-50, depending on species and season	

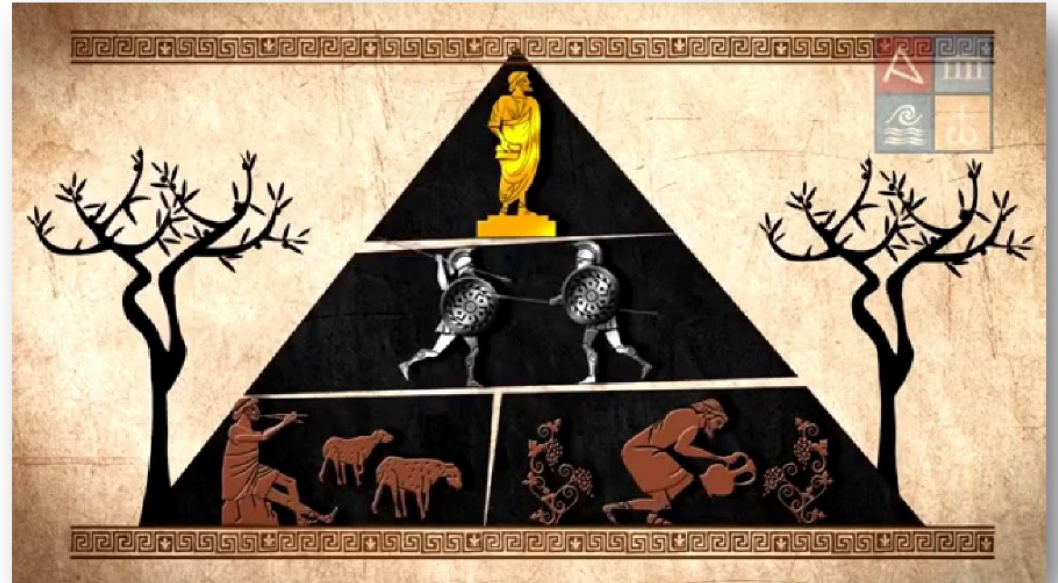
“The altruism of social insects displayed a special difficulty, which at first seemed unsurpassed and essentially fatal to the whole theory: I'm referring to the sterile female individuals in insect societies.

... the problem ceases to exist if we remember that natural selection can also be applied on a family level, not just an individual level».



“Related” terms: moral theory, utilitarianism, virtue theory

- According to **Aristotle**, “*nature does nothing in vain*”. Nature has defined a purpose, an *end*, for humans, that is happiness. This purpose can only be achieved through virtue, overcoming passions.
- **Plato, Aristotle, Aquinas, Kant**, and others point out that the highest ideal is not altruism itself, but justice: to each their due.



Another problem: naturalistic fallacy

David Hume: **Is** does not imply **ought**!

- What is «natural» and what «unnatural»?
- Does evolution follow a plan?
- Do we need to adjust our behavior to that?



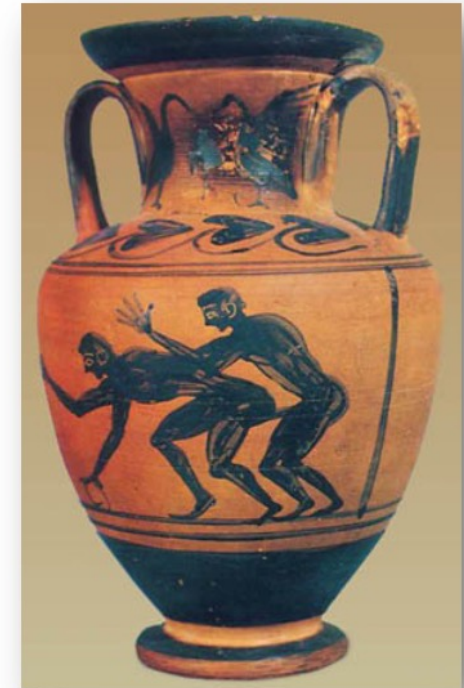
Anything we observe in nature isn't automatically "translated" into some functional or normative principle!

Through the deforming lens of physiocratic ethics

“The idea that everything we observe in nature is inherently “good” formed the basis of social darwinism, the theory stating that, by helping the poor and infirm, we interfere in the evolutionary process, which dictates the survival of the “fittest”. Following the same reasoning, the fact that animals indulge in incest, infanticide and cannibalism must mean these practices should be acceptable.” **Steven Pinker**

Michael Levin, 1984. Why Homosexuality is Abnormal.

«Towards supporting the idea that there’s something “abnormal” in homosexuality, the erect penis fits the vagina better than any other body orifice. The penis and vagina give the impression that they were made for each other. This impression stems from that fact and is another way for us to understand that the penis doesn’t exist for the purpose of penetrating another man’s anus - and that, by doing so, we are neither using it for what it is needed for, nor for its intended purpose.»



Relevant questions

- What is the exact role of reciprocity-mutuality?
- Is there genuine altruism in humans?
- Is it inherent or acquired?
- What is the role played by coercion/punishment in fostering positive social behavior?

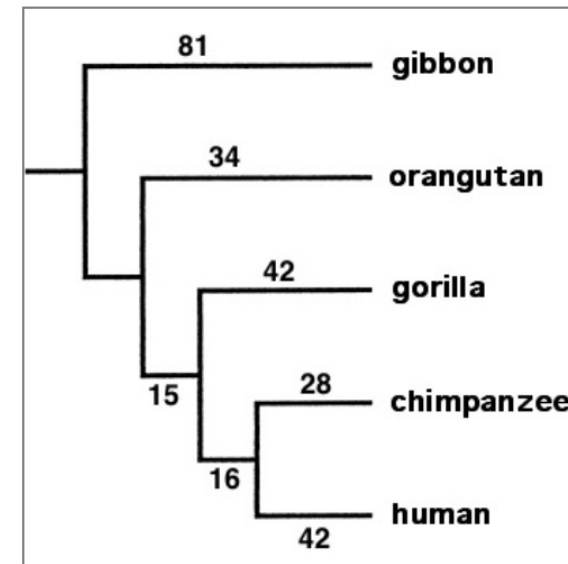
2. Examples and experiments in natural world

Chimpanzees (*Pan troglodytes*)



The *Pan* genus is man's closest relative.

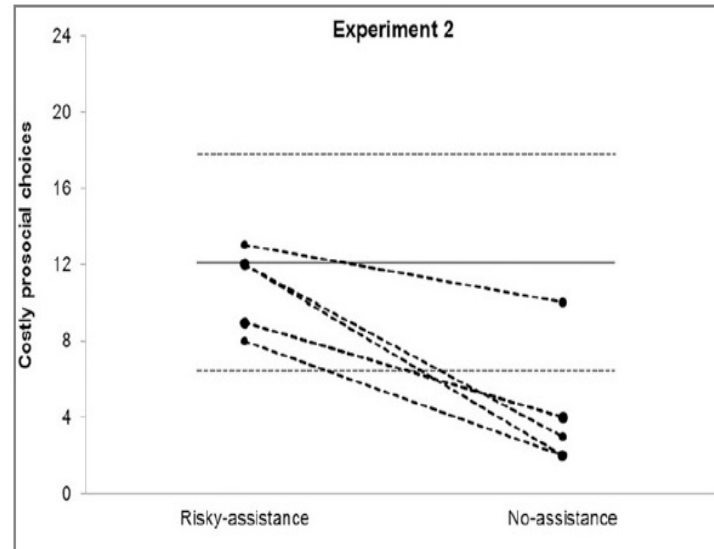
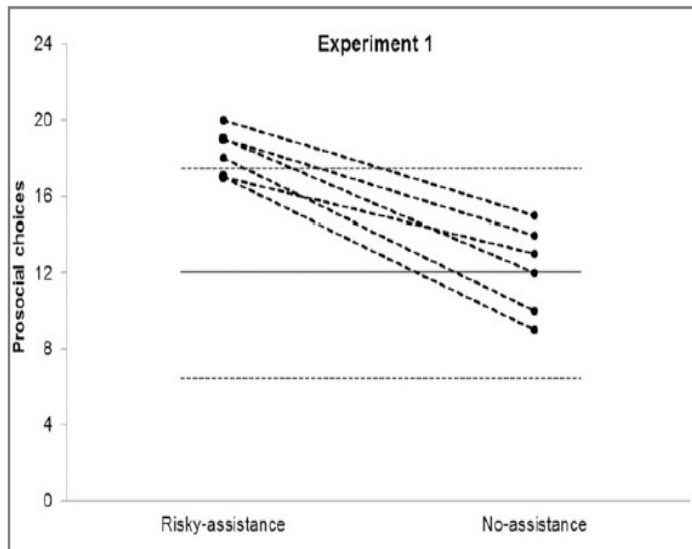
- Communities of 20-150 individuals.
- Hierarchy.
- “In-out” group behavior (fusion-fission).
- Males are dominant and form alliances.
- Conflicts are mostly territorial.
- Maternal care up to 6 years.



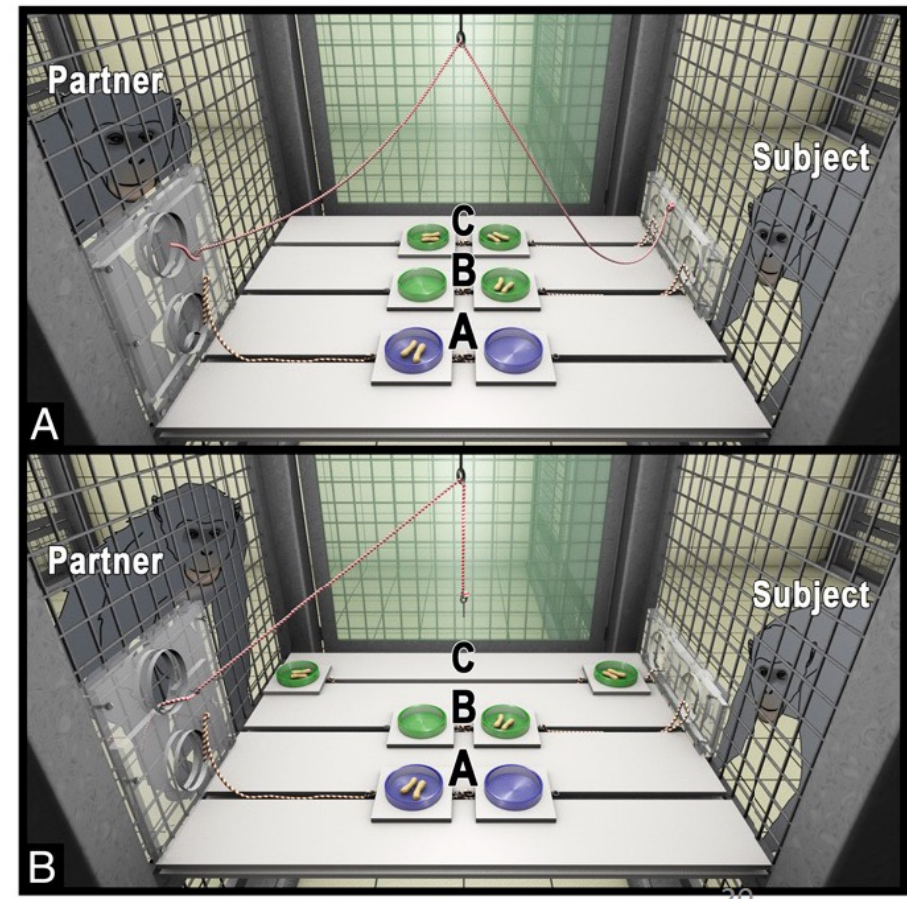
Social behavior in chimpanzees

- Cooperation.
- Mutual care (grooming).
- Sharing food.
- “Microservices” offered to group members or humans.
- Alliances.

The experiment of Schmelz *et al.* (2017)



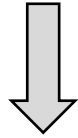
Experiment/condition	Option	Subject's payoff	Partner's payoff
Experiment 1	A		••
	B	••	
	C	••	••
Experiment 2	A		•••
	B	••••	
	C	•••	•••



Source: Schmelz *et al.*, *PNAS* (2017); Figures 1 (on the right), 2 (on the left) and Table 1 (upper right) (*Experiments 1 and 2*).

✓ Key finding:

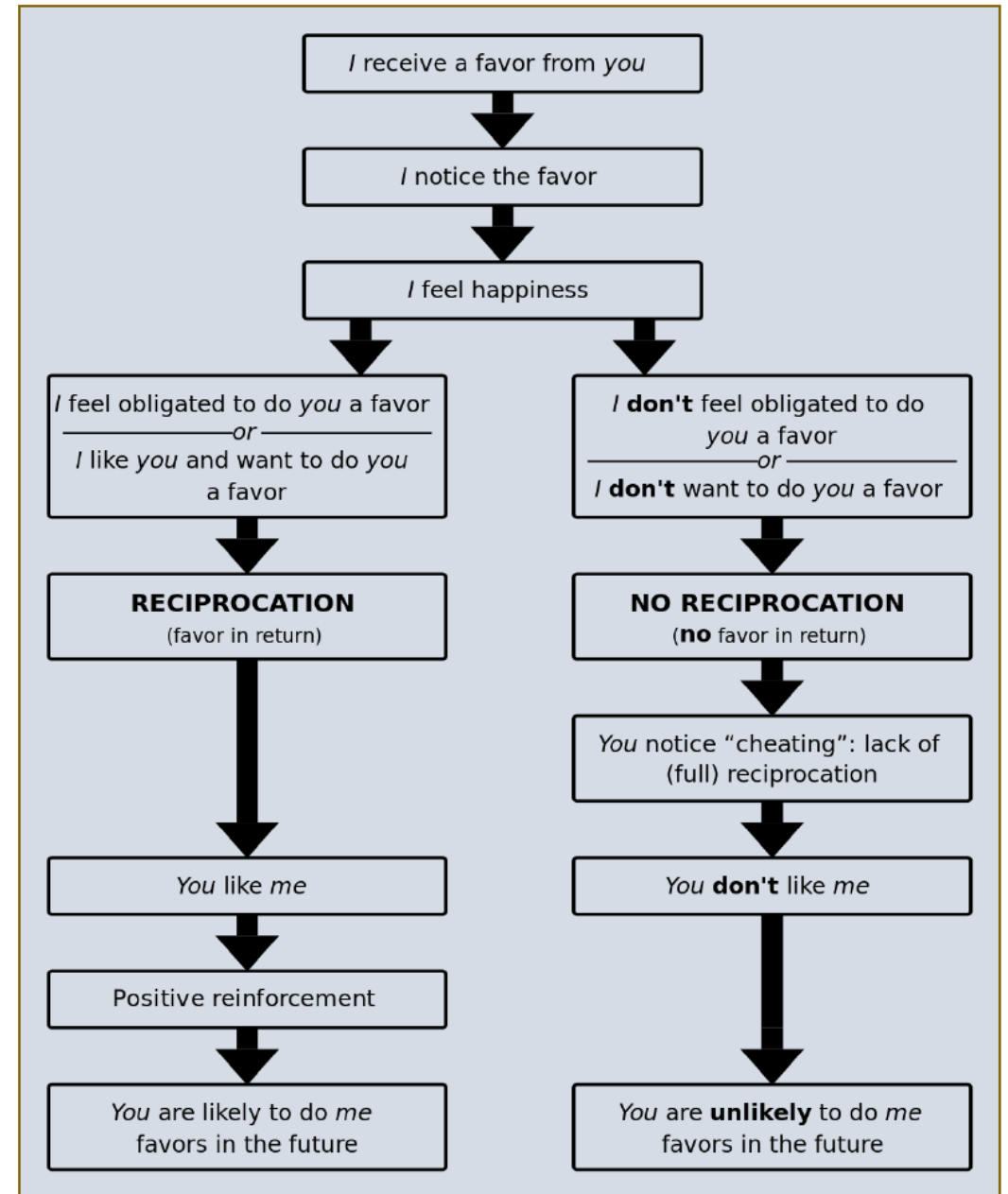
Chimpanzees are willing to reward members of their group at their personal cost, but only if others have rewarded them in the past, especially at the rewarder's own risk.



Mutuality (reciprocity)



- A form of self-interest?
- Non-genuine altruism?



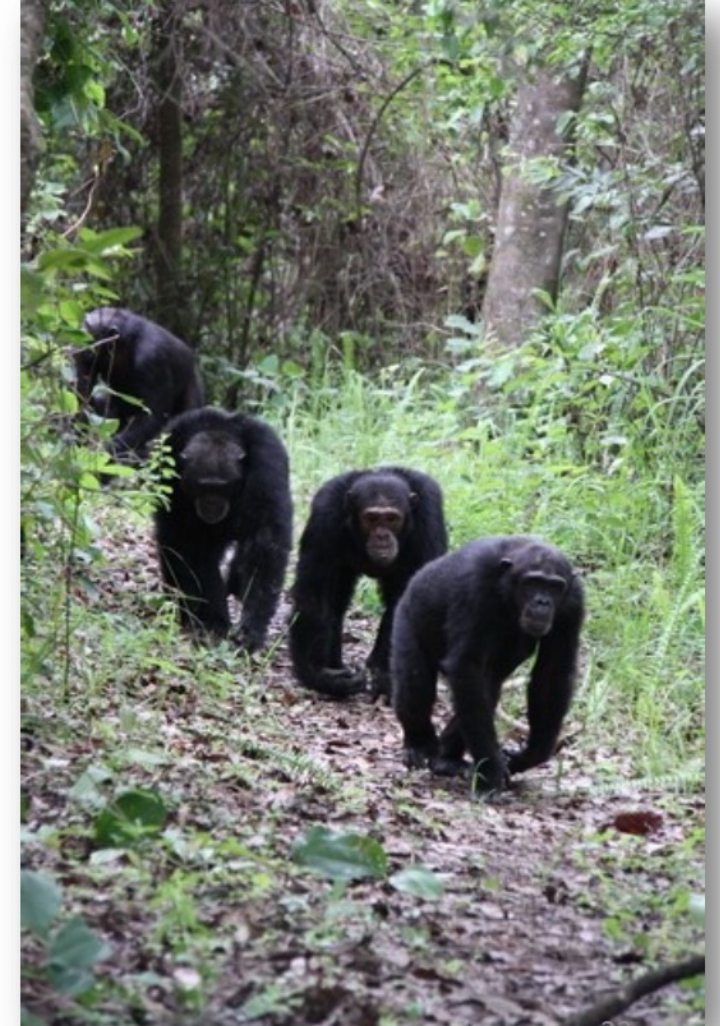
The experiment of Langergraber *et al.* (2017)



Langergraber *et al.*, *PNAS* (2017)

✓ Key findings:

- Participation in “patrols” is more frequent and fluctuates less than participation in violent activities in other primate species.
- Males often participate in patrols when they don’t have descendants in the group.
- Participation in patrols is not affected by team size.



❑ Bats



- Bats are mammals.
- Evolved >20 million years ago.
- Navigate using sound.
- Have noses equipped with sensitive temperature sensors.
- Can fly, jump, walk and run (on their hands!).
- Live in groups which also host “refugees”.
- Sated individuals feed hungry ones by convulsing their stomach to bring food to their mouths.
- Groom each other.

Social behavior in vampire bats

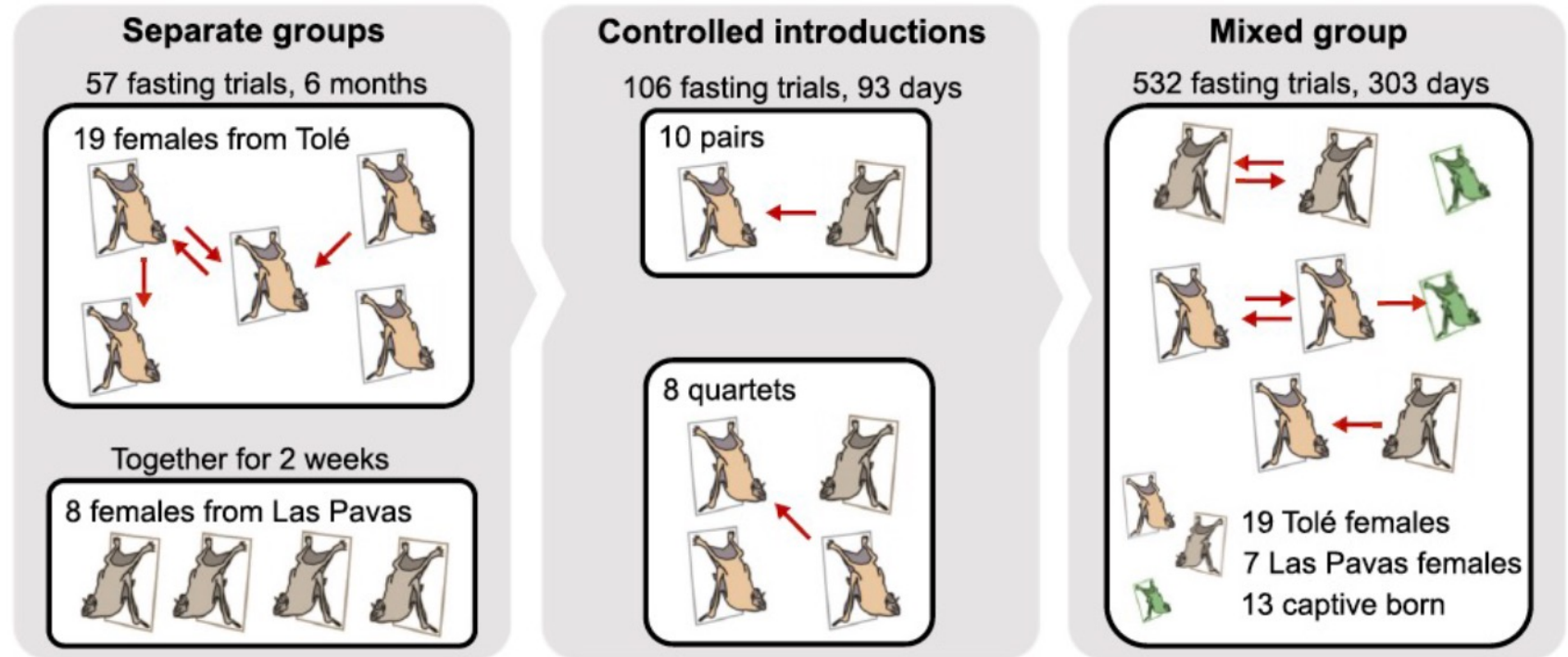
The experiment of Carter *et al.* (2020)



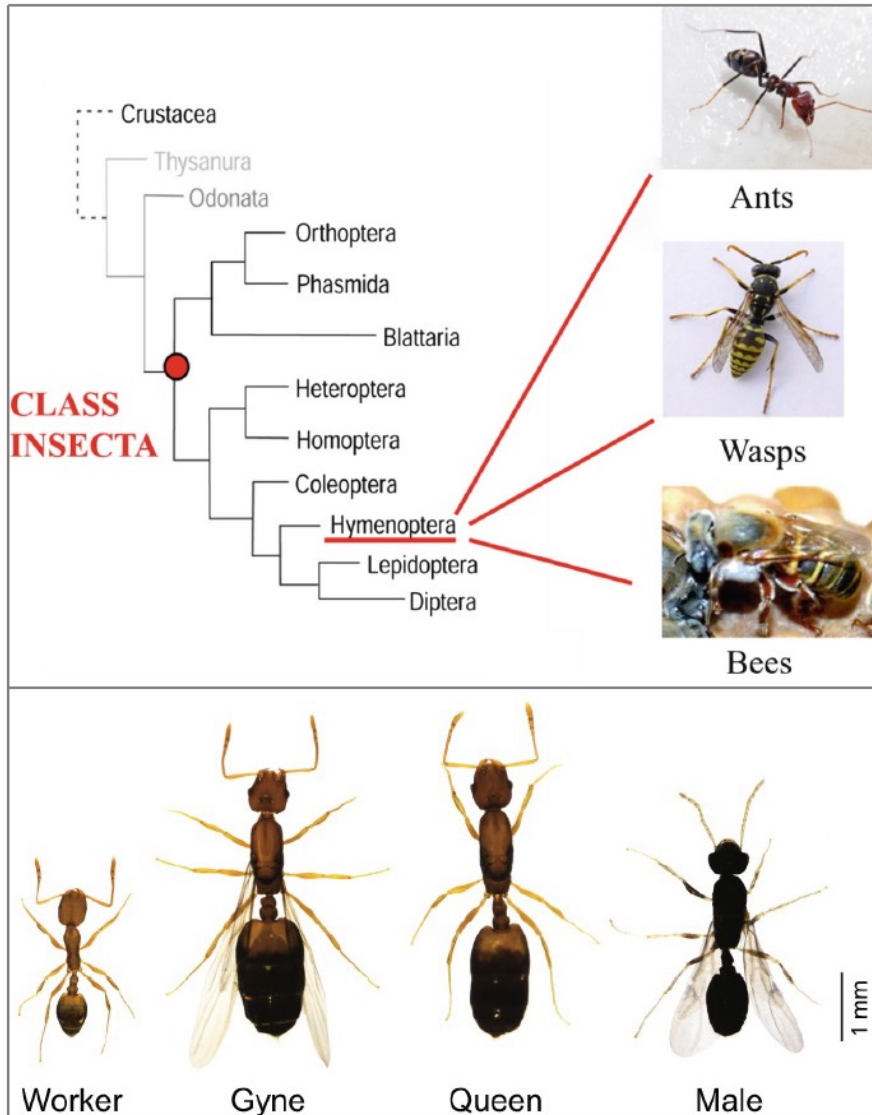
Carter *et al.*, *Curr. Biol.* (2020)

✓ Key findings:

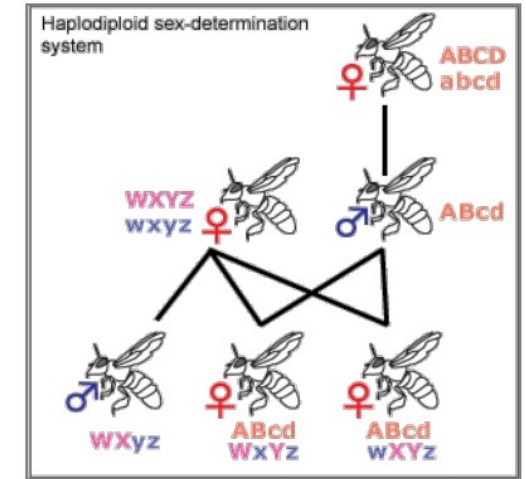
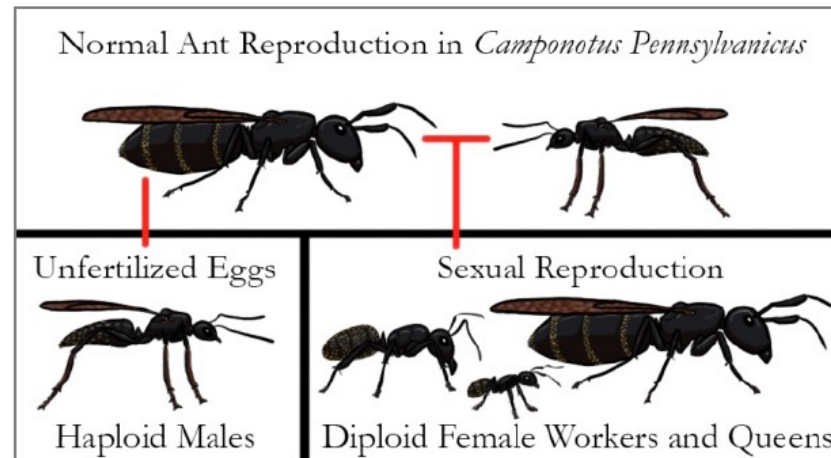
- In 243 “acquaintances” between wild female bats, 38 of them were sharing food (15,6%).
- Before demonstrating this behavior, the bats attempted to “groom” each other at a percentage of >50%.



Ants



- The queen gives birth and determines the sex of her descendants.
- Workers look after the entire swarm.



Sisters are more genetically similar to one another than to their own mother!

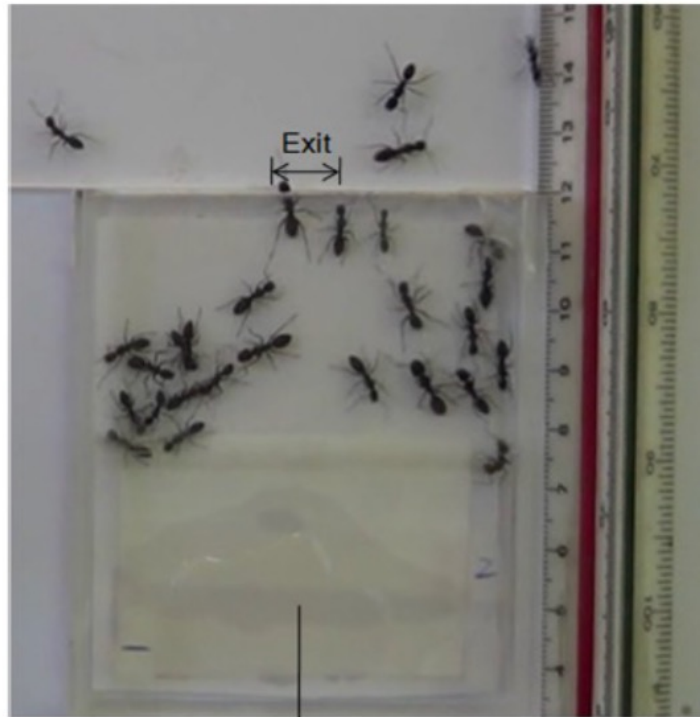
Genetic kinship in haplo-diploid species

	Mother	Sister	Daughter	Father	Brother	Son	Nephew
Female	0,50	0,75	0,50	0,50	0,25	0,50	0,37
Male	1,00	0,50	1,00	0,00	0,50	0,00	0,25

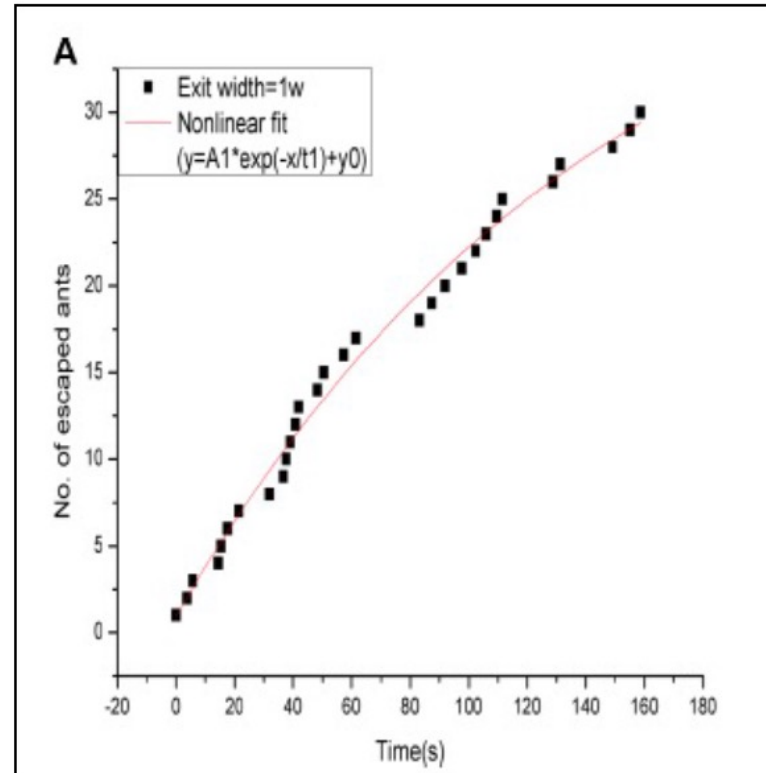
Cooperation, coordination, division of labor



The experiment of Wang *et al.* (2015)



Paper soaked in repellent
(Citronella oil)



Question

- What does the graph demonstrate?

✓ Key conclusions:

Contrary to humans and mice, where “egoistic behavior” is observed in overcrowded conditions (selfish evacuation behavior), ants form teams to facilitate an orderly evacuation through the single exit.

Eu-social behavior



E. O. Wilson

Wilson: *The Insect Societies* (1971)
Wilson and Hölldobler, *PNAS* (2005)

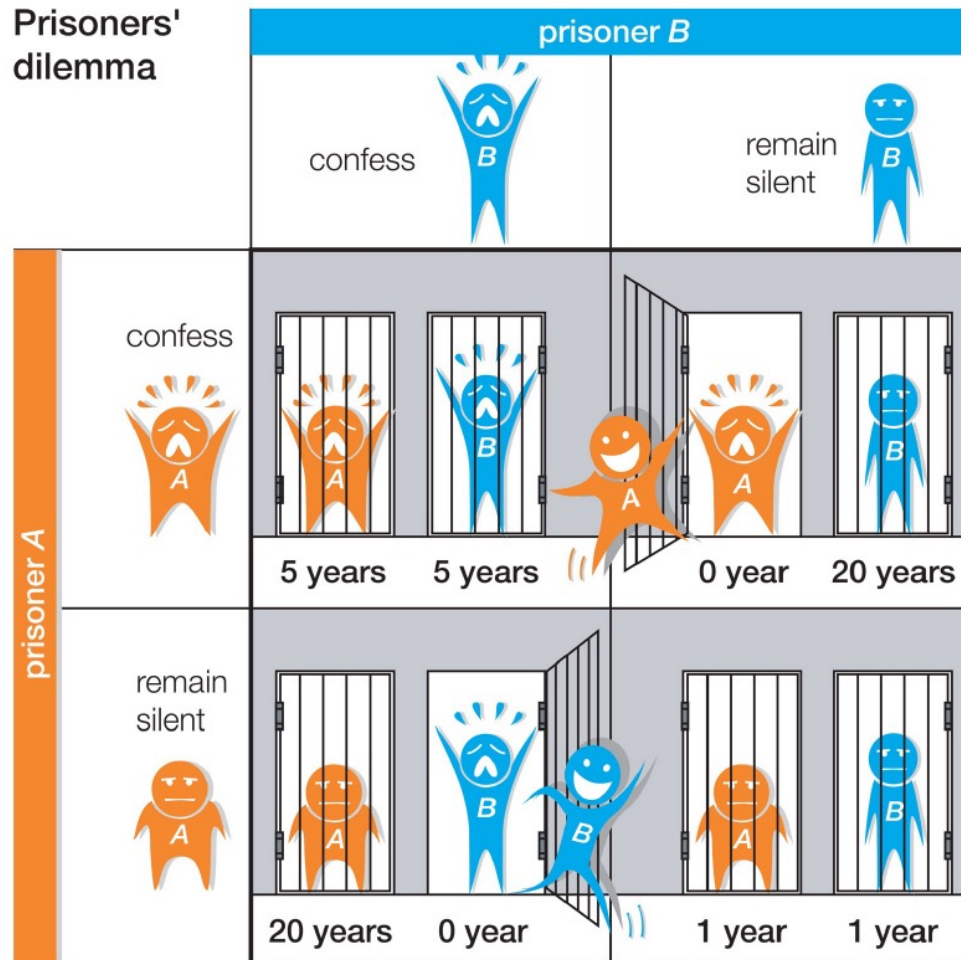
- Reproductive division of labor.
- Overlapping generations.
- Cooperative brood care.



3. Tests

The prisoner's dilemma

Example



© 2010 Encyclopædia Britannica, Inc.

Rule

	C	D
C	1	S
D	T	0

$$T > 1$$

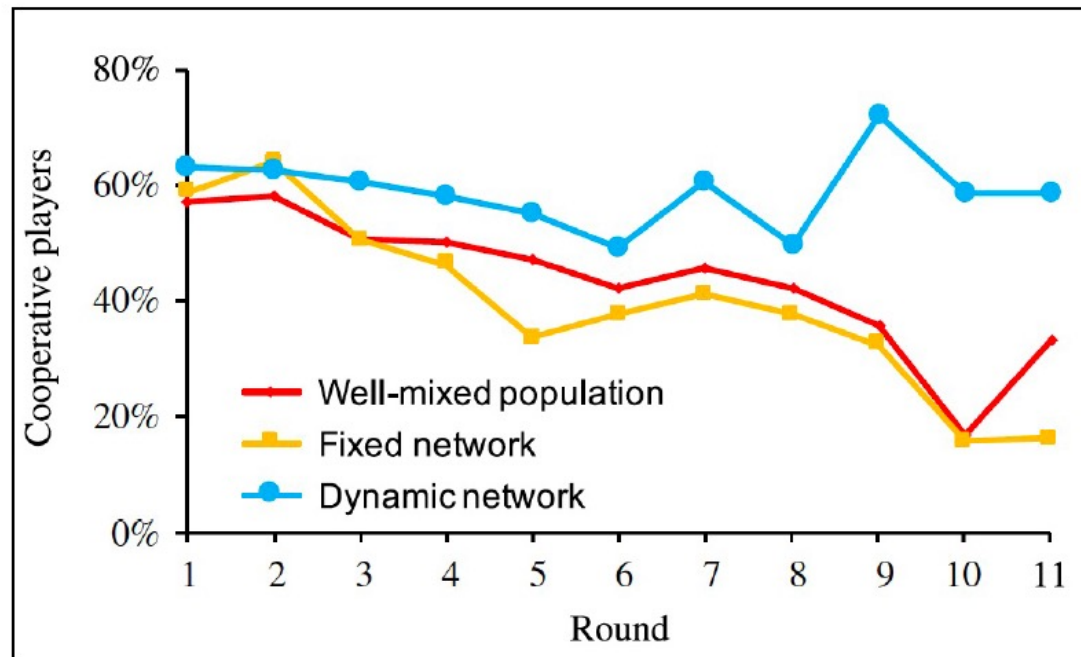
$$S < 0$$

Questions

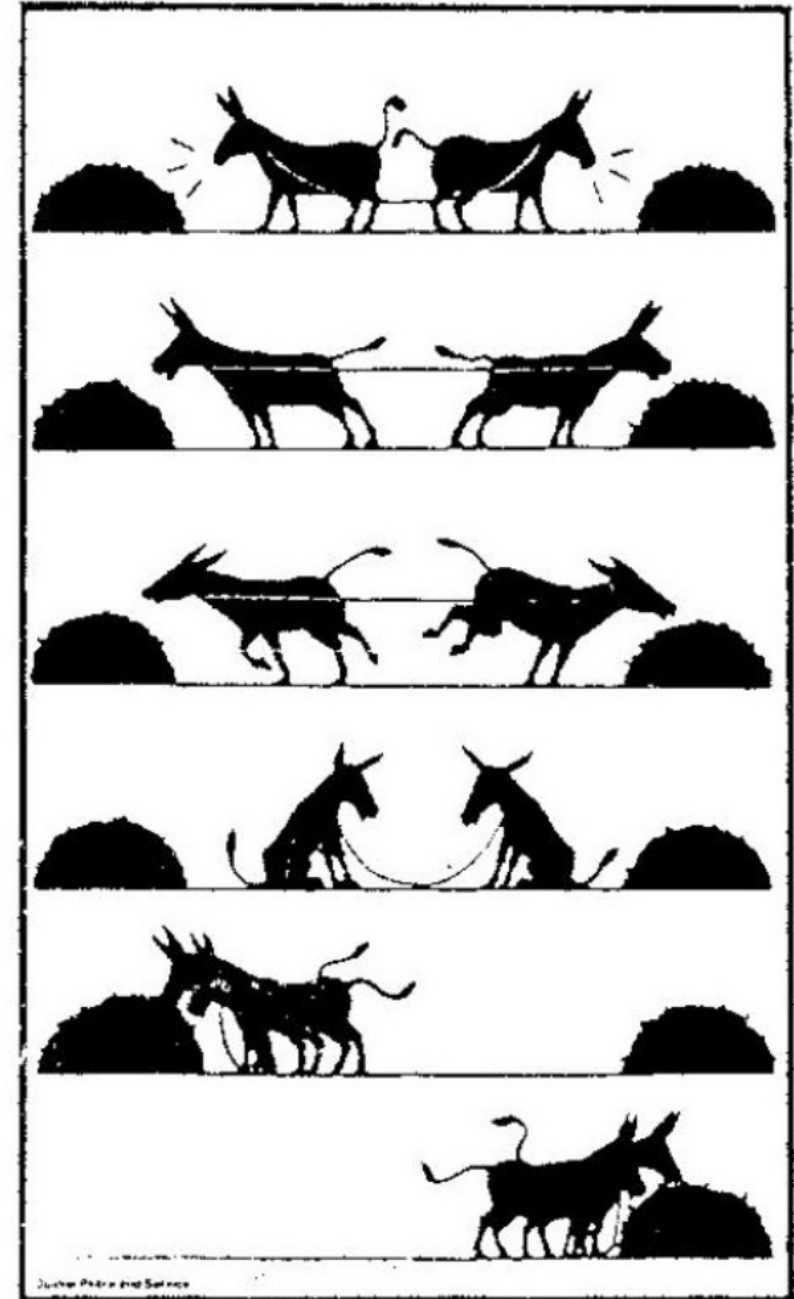
- Which possibilities have to be excluded before reaching any conclusions?
- What method (variation of the test) could be used to examine these possibilities?
- Can we predict, in advance, the most successful strategy?

✓ What results show:

- In vast majority of tests carried out so far, “**Tit for Tat**” has emerged as the most successful strategy, being a practice that is at once **nice**, **retaliative**, and **forgiving**.

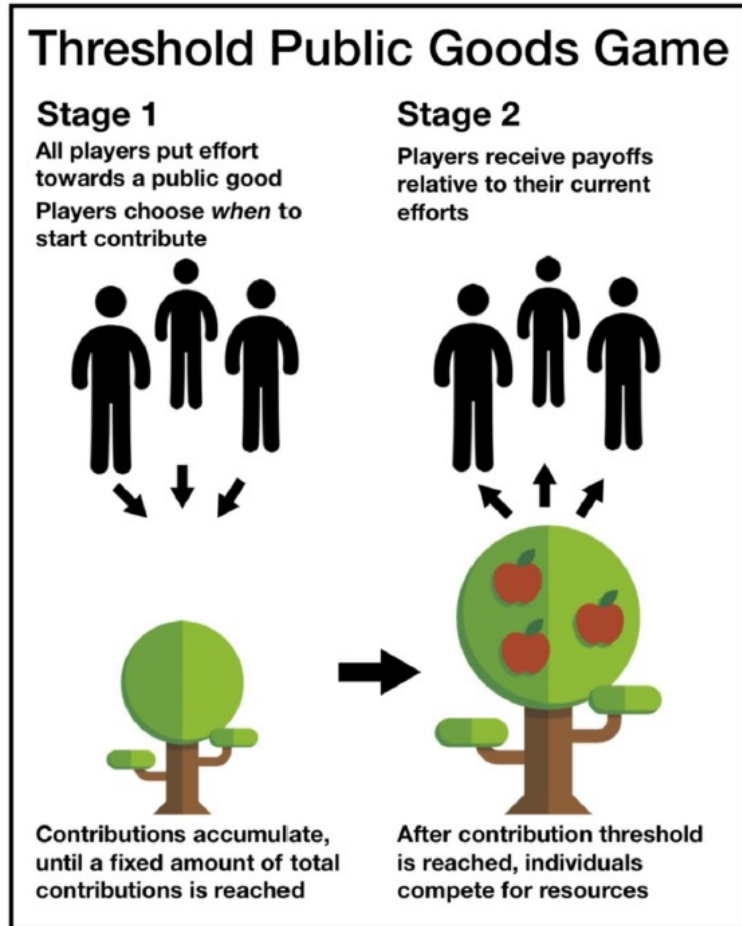


Cardinot *et al.*, *Sci. Rep.* (2018)

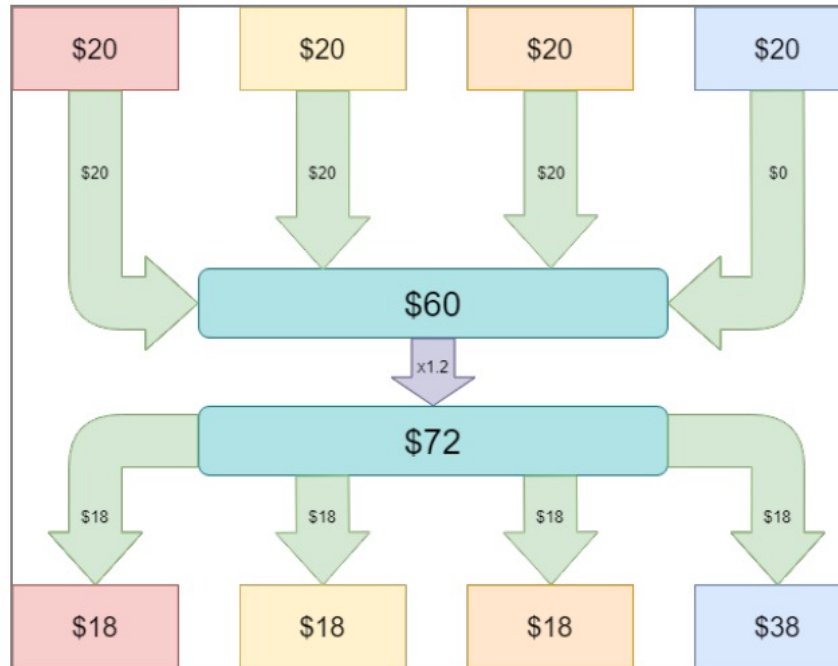


The public goods game

Rules



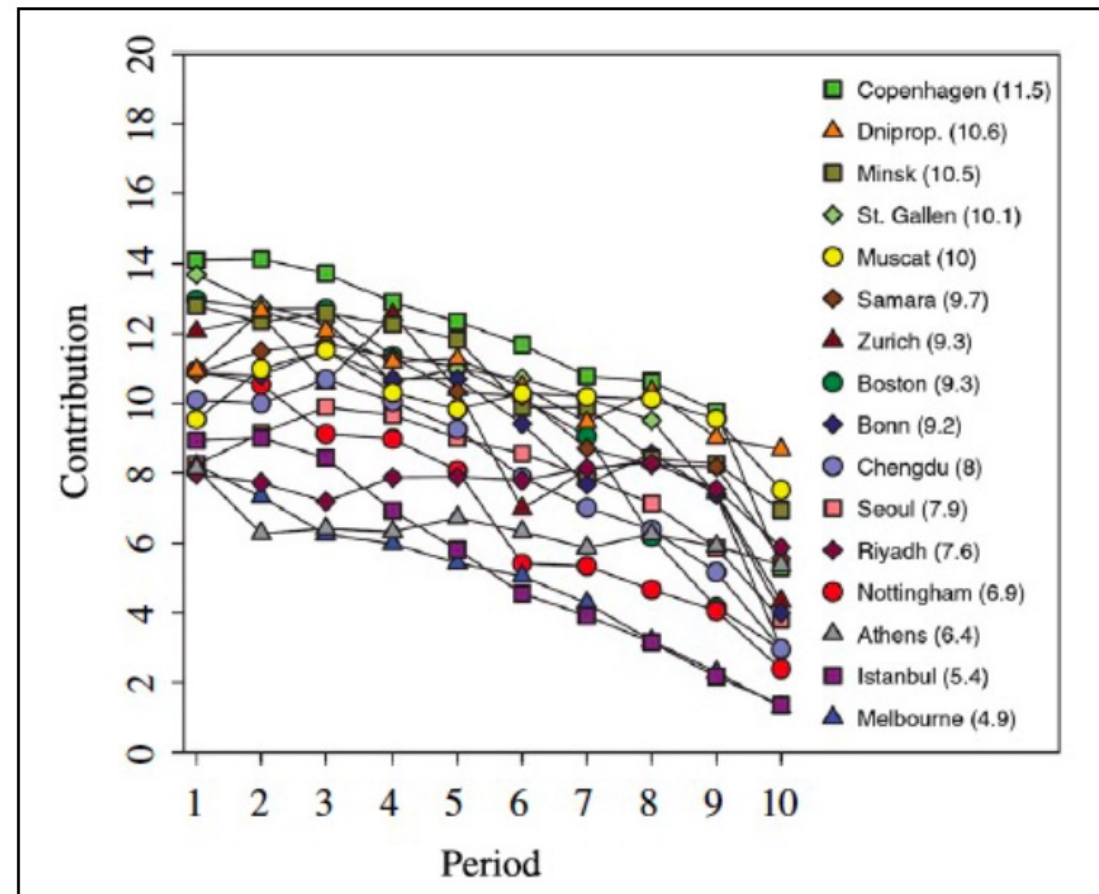
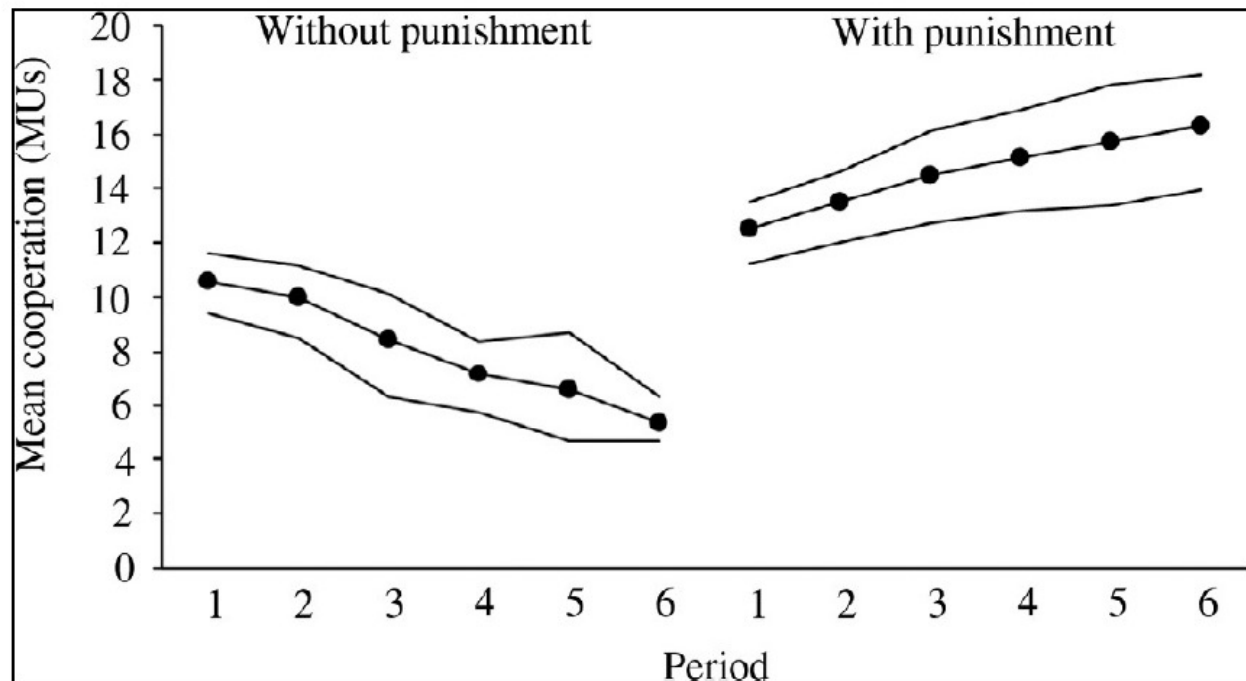
Example



Question

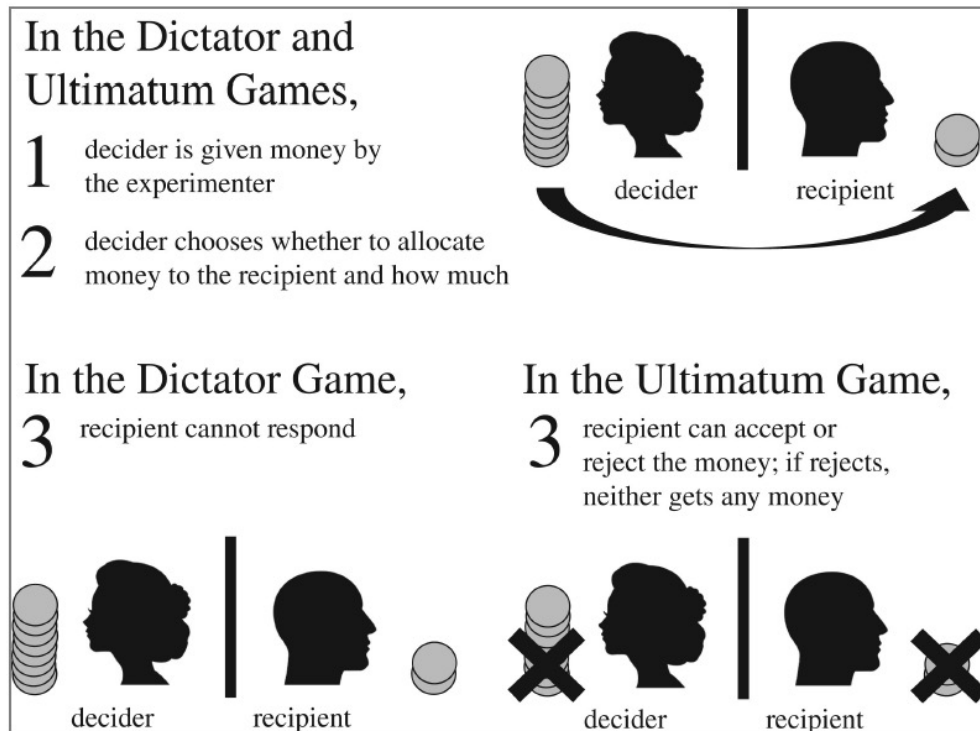
- *What is the expected dominant strategy here?*

✓ What results show:

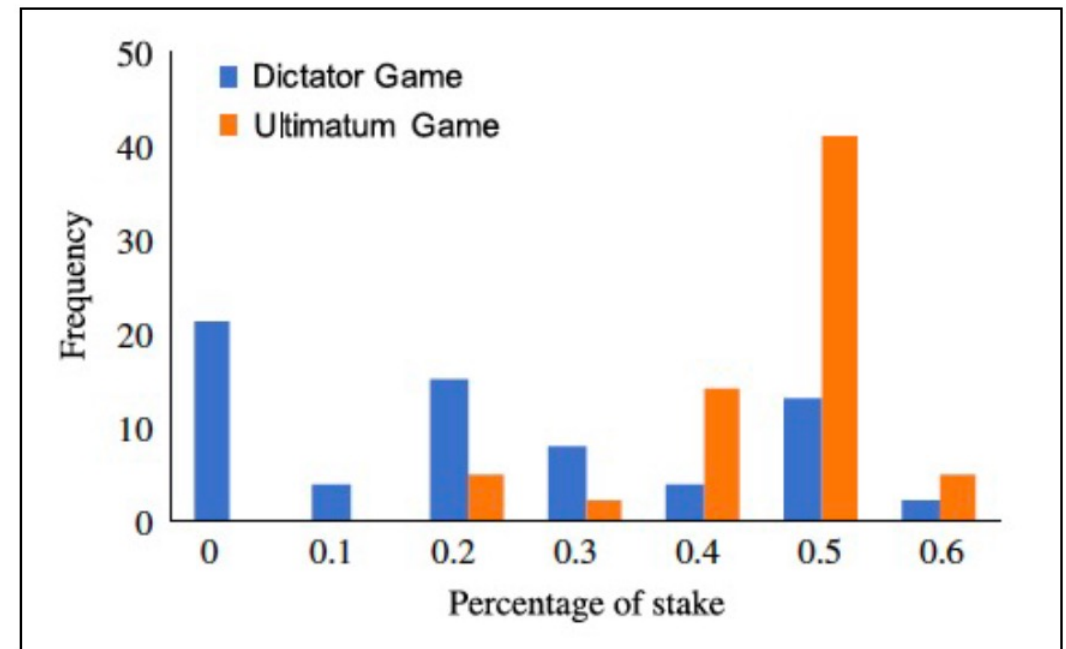


The ultimatum/dictator game

Rules



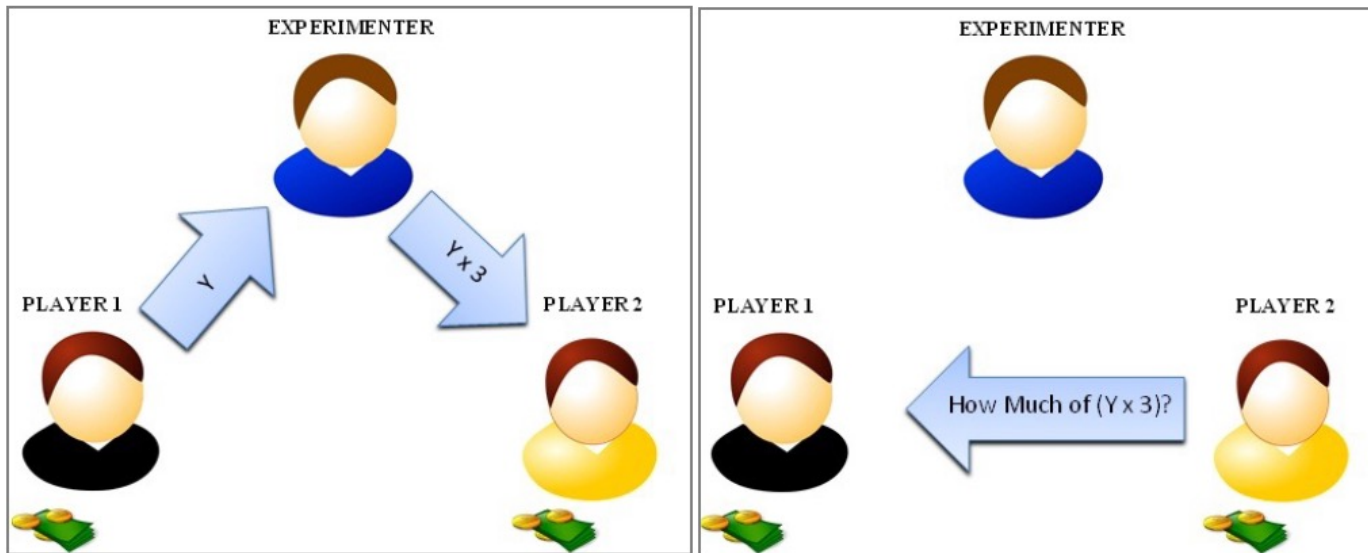
✓ What results show:



- Women: **Rawls model**, significantly more altruistic when the endowment is larger.
- Men: **utilitarian model**, more generous when the endowment is smaller.

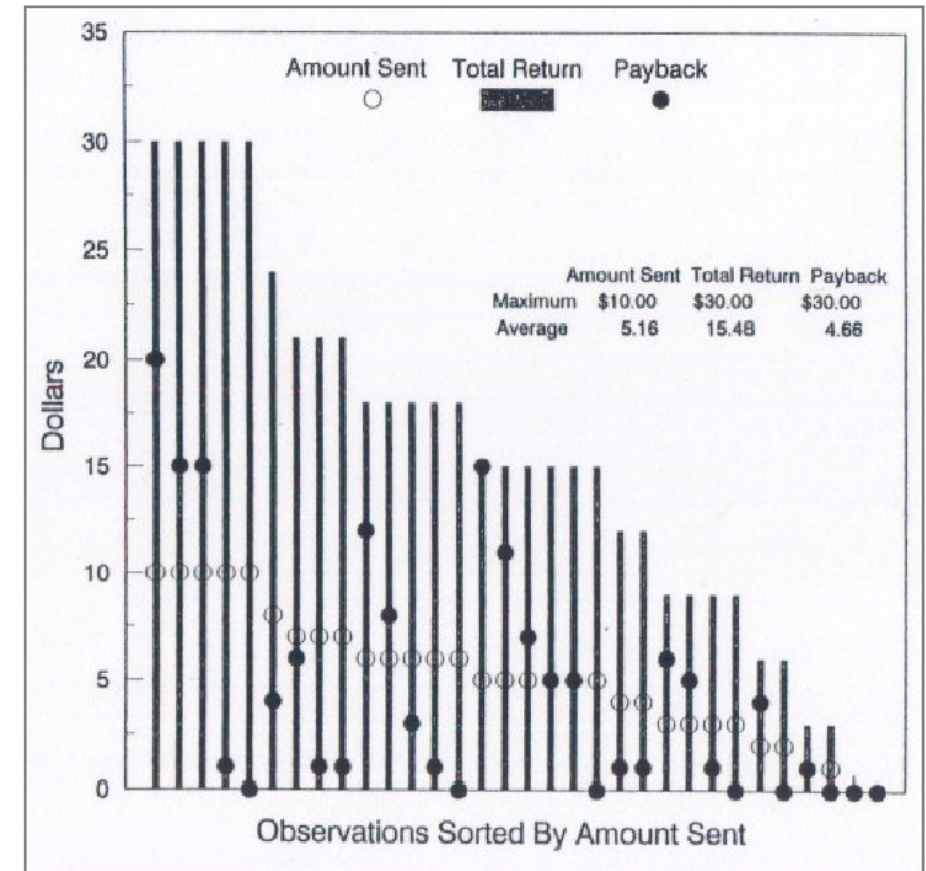
The trust and gift exchange games

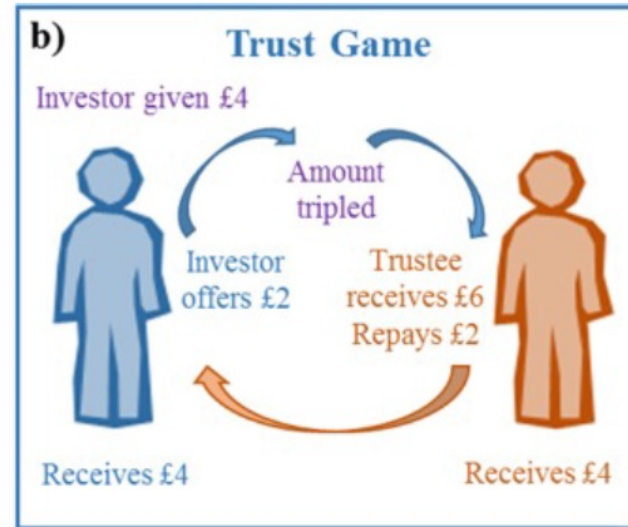
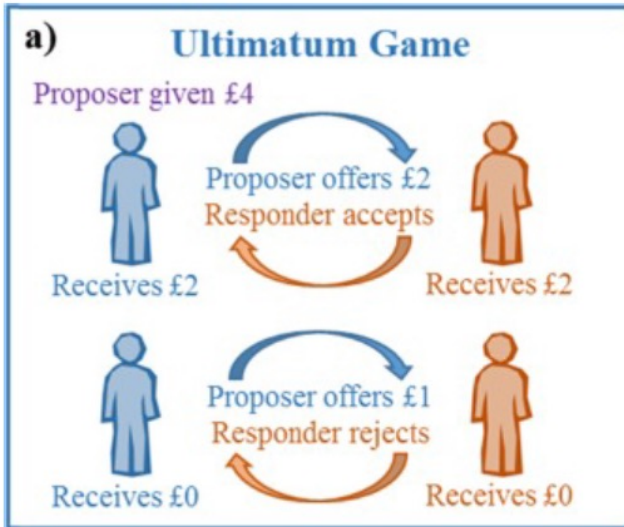
Rules



The experiment of Berg *et al.* (1995)

- The baker example.
- The repair shop example.





c) Prisoner's Dilemma

Both players given £2

		Player B	
		Cooperate	Defect
Player A	Cooperate	Player A: 5 Player B: 5	Player A: 0 Player B: 8
	Defect	Player A: 8 Player B: 0	Player A: 2 Player B: 2



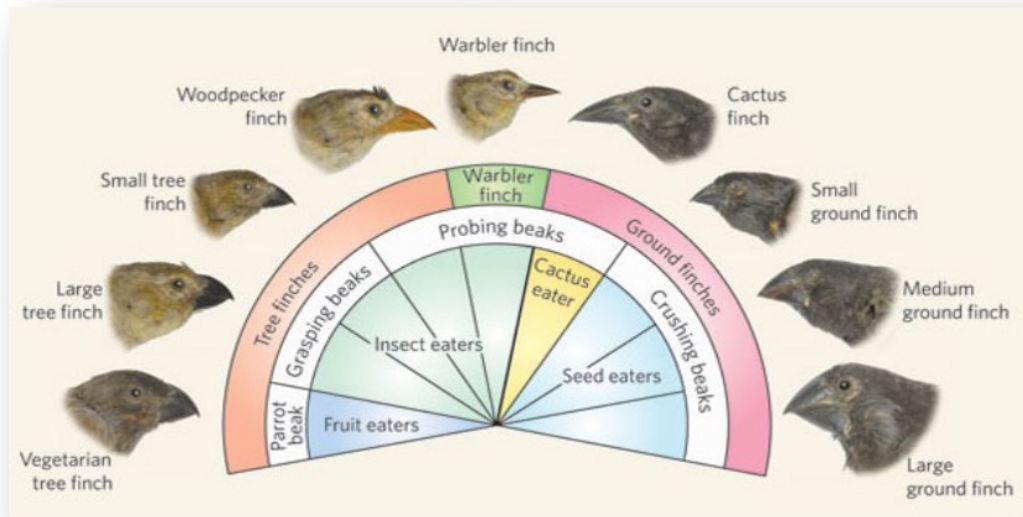
Question

- Which of the games excludes retaliative altruism?

4. Mechanisms - interpretations

Individual selection

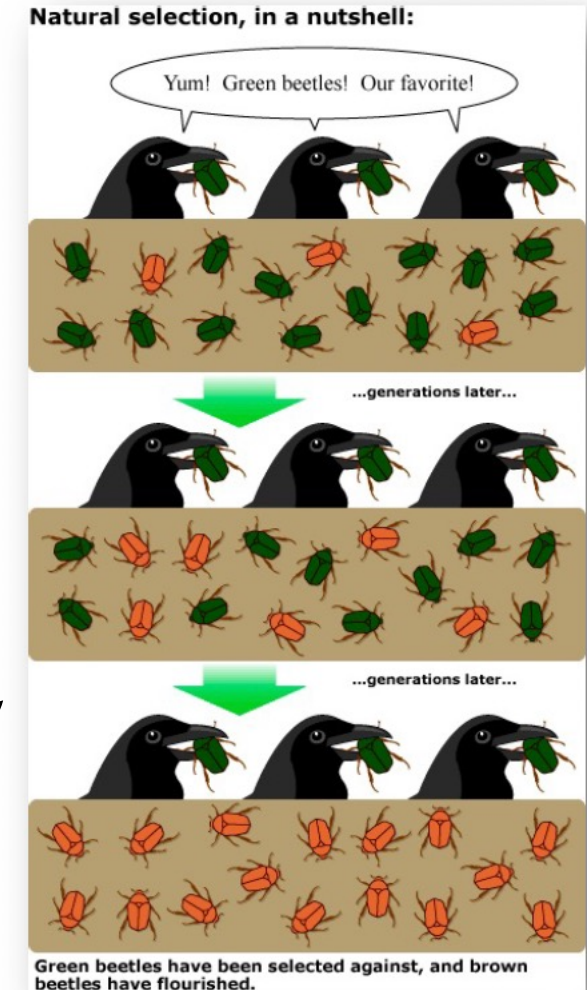
Darwin, 1859

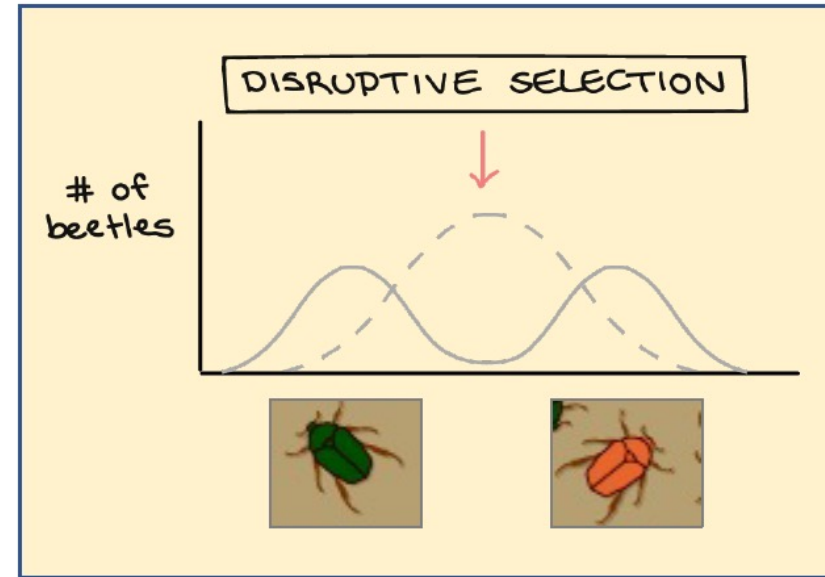
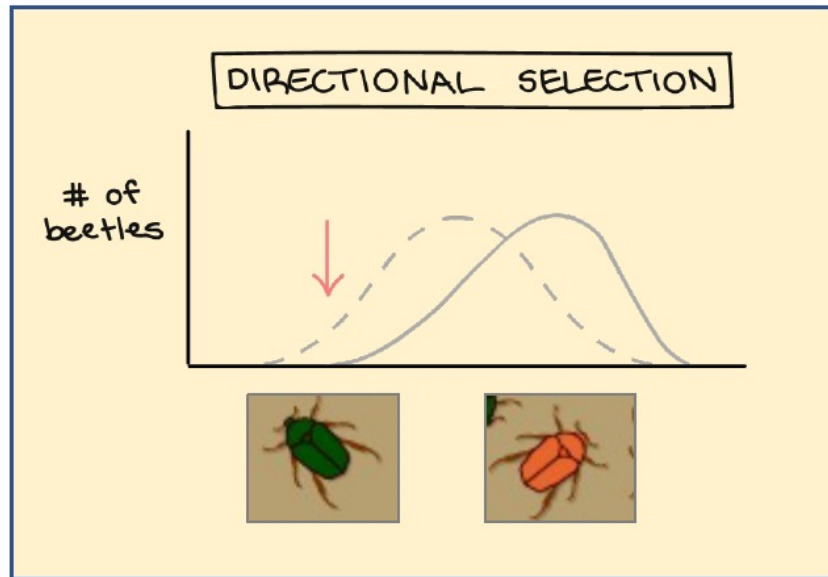


- Selection is phenotype-based!!

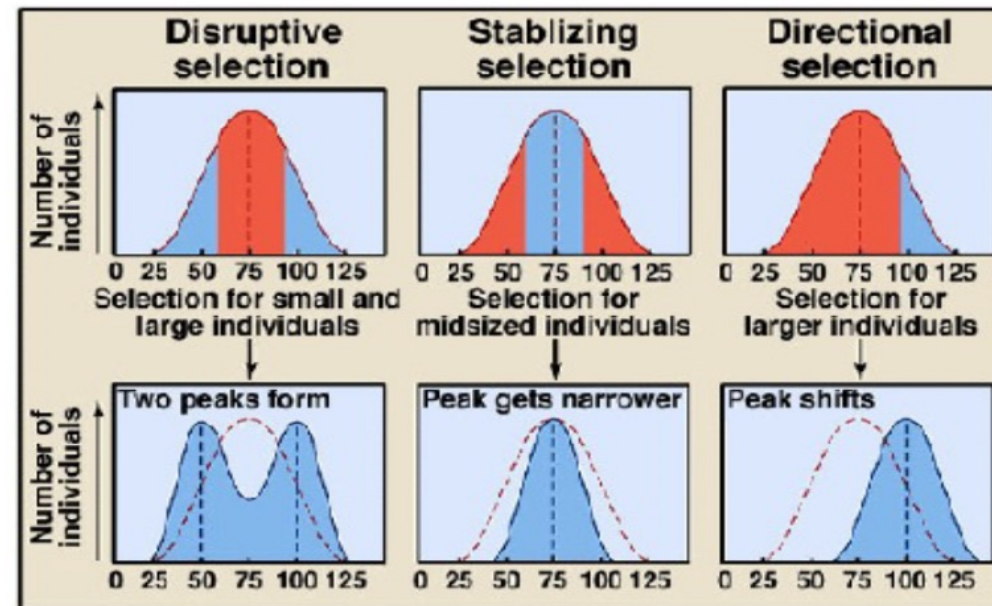
Question

- *What happens when individuals with slightly different characteristics don't produce any descendants?*

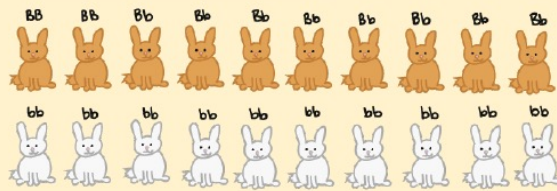




A population's fitness increase rate is a function of genetic diversity within the same population.



STARTING POPULATION:



Freq. of B = $p = 0.3$
Freq. of b = $q = 0.7$

50% brown rabbits
50% white rabbits

SELECTION -
half the white
rabbits are eaten

SURVIVORS:

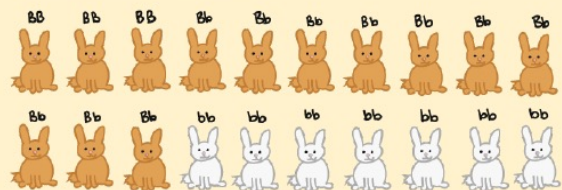


Freq. of B = $p = 0.4$
Freq. of b = $q = 0.6$

67% brown rabbits
33% white rabbits

Survivors
reproduce

NEXT GENERATION:



Freq. of B = $p = 0.4$
Freq. of b = $q = 0.6$

65% brown rabbits
35% white rabbits

9/11/21



$b=1.0$
 $w=0.0$



$b=0.5$
 $w=0.5$



$b=0.0$
 $w=1.0$



$b=1.0$
 $w=0.0$



$b=1.0$
 $w=0.0$



$b=0.75$
 $w=0.33$

ALT-M

Kin selection

Haldane 1932, Hamilton 1963, 1964

Rule

$$\sum r \cdot b > c$$

- Haplo-diploid insects.
- Monandrous-polyandrous queens.
- Meerkats-ground squirrels.
- Certain shrimp species.

Inclusive fitness: reproductive success without individual producing descendants of its own.

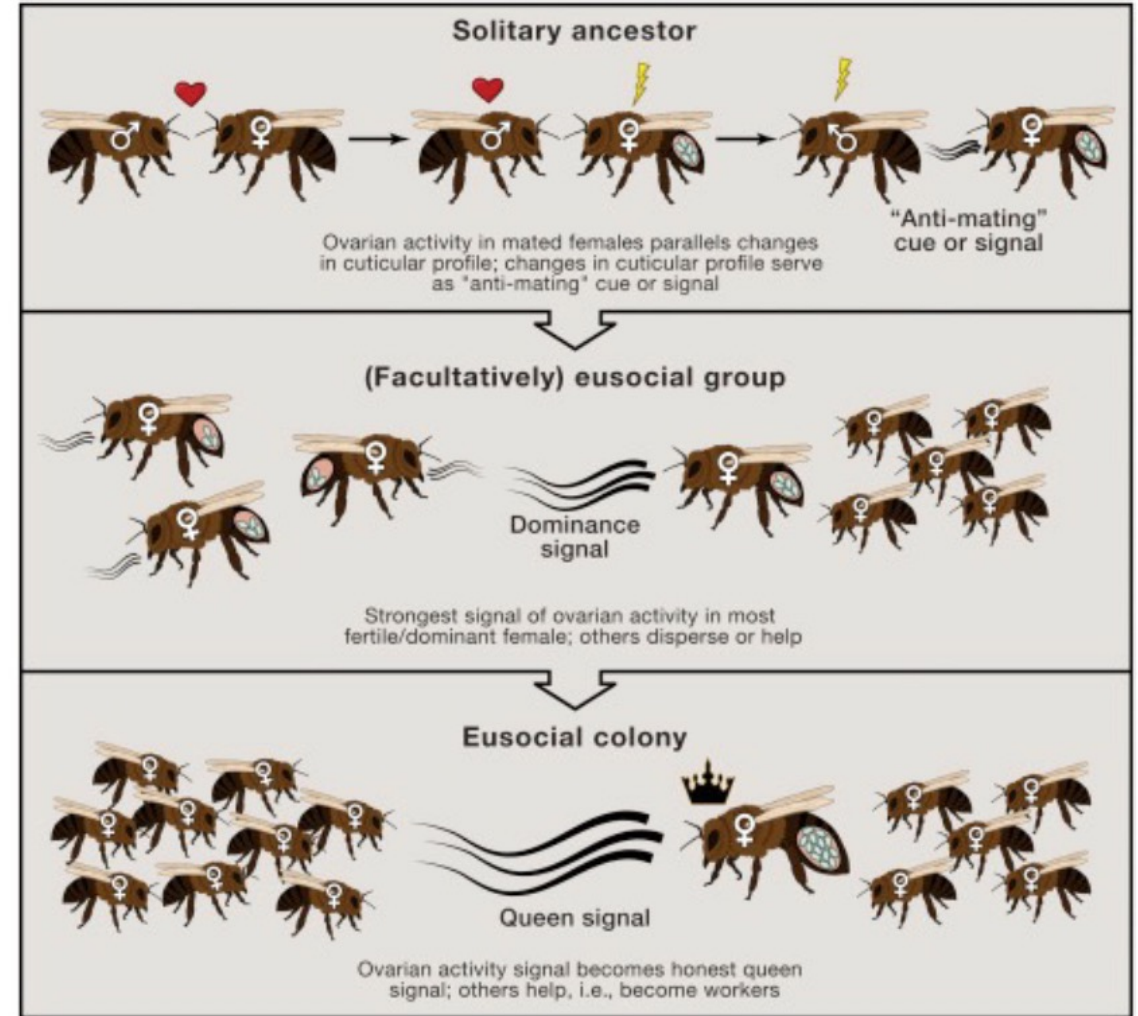


Hamilton, *The American Naturalist* (1963)
Haldane: *The causes of evolution* (1932)

Group selection

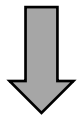
Wilson 1975, 1980, 2016; Sober, Wilson 1998

1. Altruistic individuals are “grouped”.
2. Group prevalence.
3. Individuals dispersed throughout the wider community.
4. Increase in the frequency of altruistic individuals, consolidation of their behavior.
5. Creation of eu-social species.



Arguments against kin selection

- Relative rarity of altruistic species.
- Haplo-diploid insect species.
- Polyandrous queens.



Apis mellifera bee sister-workers have a genetic similarity index of 0.30 (instead of the 0.75 found in haplo-diploid species).

However, $<1/1,000$ of them produce eggs and $<1/10,000$ of larvae will develop into a queen!

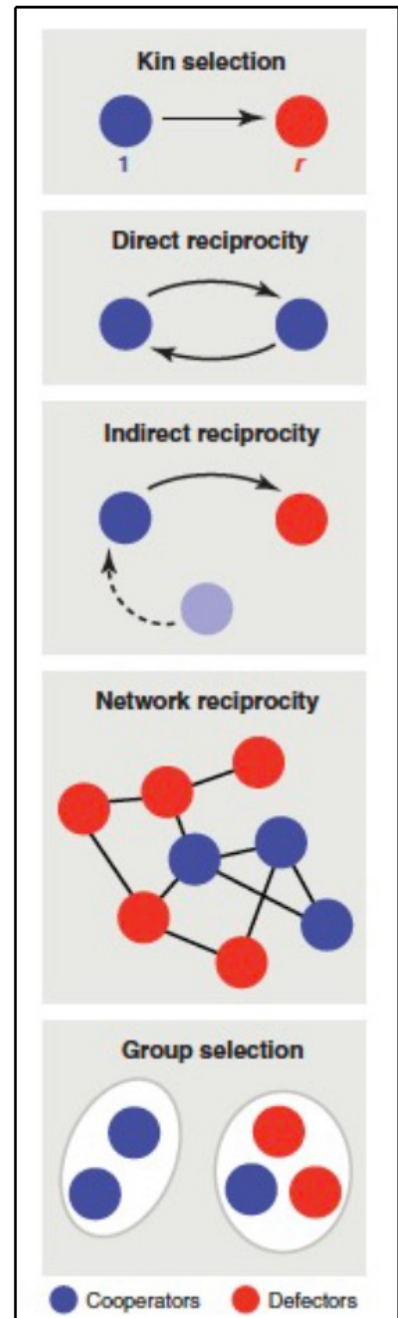
The same is observed in termites and certain beetle and shrimp species.

Arguments against group selection

- Groups become separated much more rarely than individuals reproduce. As a consequence, group selection would be unlikely to overcome a group's tendency to quickly lose its altruistic characteristics due to the prevalence of “egoists”.
- The importance of the environment in shaping behavior is diminished.
- Mechanistic transfer of value principles in Biology.

Multiparametric selection

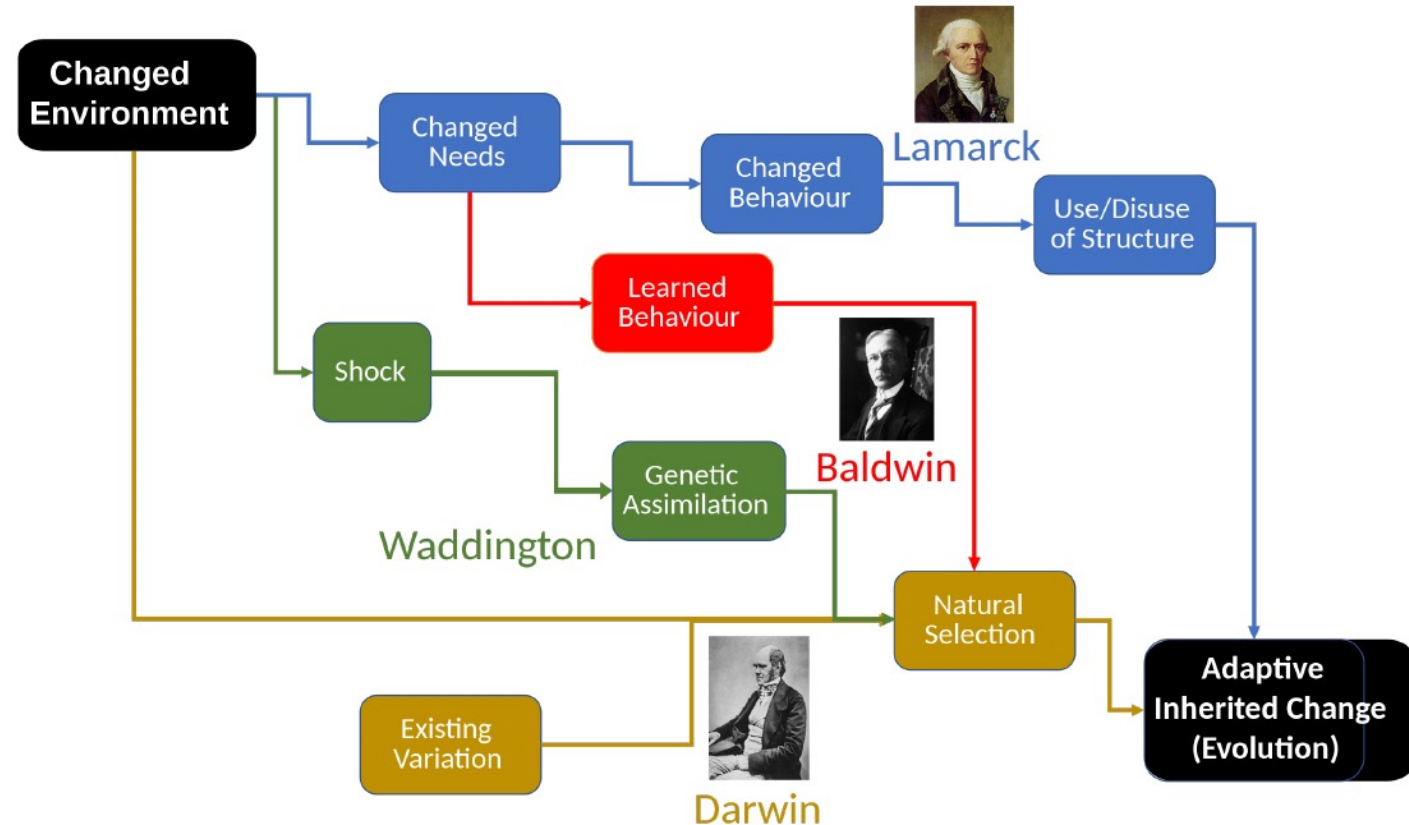
		Payoff matrix		Cooperation is...			
		C	D	ESS	RD	AD	
Kin selection	C	$(b-c)(1+r)$	$br-c$	$\frac{b}{c} > \frac{1}{r}$	$\frac{b}{c} > \frac{1}{r}$	$\frac{b}{c} > \frac{1}{r}$	r ...genetic relatedness
	D	$b-rc$	0				
Direct reciprocity	C	$(b-c)/(1-w)$	$-c$	$\frac{b}{c} > \frac{1}{w}$	$\frac{b}{c} > \frac{2-w}{w}$	$\frac{b}{c} > \frac{3-2w}{w}$	w ...probability of next round
	D	b	0				
Indirect reciprocity	C	$b-c$	$-c(1-q)$	$\frac{b}{c} > \frac{1}{q}$	$\frac{b}{c} > \frac{2-q}{q}$	$\frac{b}{c} > \frac{3-2q}{q}$	q ...social acquaintanceship
	D	$b(1-q)$	0				
Network reciprocity	C	$b-c$	$H-c$	$\frac{b}{c} > k$	$\frac{b}{c} > k$	$\frac{b}{c} > k$	k ...number of neighbors
	D	$b-H$	0				
Group selection	C	$(b-c)(m+n)$	$(b-c)m-cn$	$\frac{b}{c} > 1 + \frac{n}{m}$	$\frac{b}{c} > 1 + \frac{n}{m}$	$\frac{b}{c} > 1 + \frac{n}{m}$	n ...group size m ...number of groups
	D	bn	0				



The Baldwin effect (Baldwin, 1896, 1897)

Learning ability selection:

- Changes in a characteristic of an organism over the course of its lifespan, as a result of interaction with the environment, are gradually assimilated into the organism's developmental or epigenetic profile.



- A non-Lamarckian mechanism!



“An evolutionary characteristic that has emerged in a given way can have ramifications that may not be entirely predictable based on evolutionary logic.”
Sober, 1993



For example, humans possess the ability to write poems, compose music, and perform mathematical calculations.

Sober, In the book: *Evolutionary Ethics* (1993)

Altruism according to Baldwin

- “Social heredity” preserves functions that haven’t yet become (or will never be) “naturally inheritable”.
- Altruism is a social tendency demonstrated by certain individuals, whose practices maintain group cohesion.
- Intelligence is required to pass down such behavior from generation to generation, through education, imitation, acceptance, and punishment.
- There may be a cost/benefit assessment involved, but not always.
- Genetic diversity is maintained.

Altruism and brain function

Rilling *et al.* (2002)

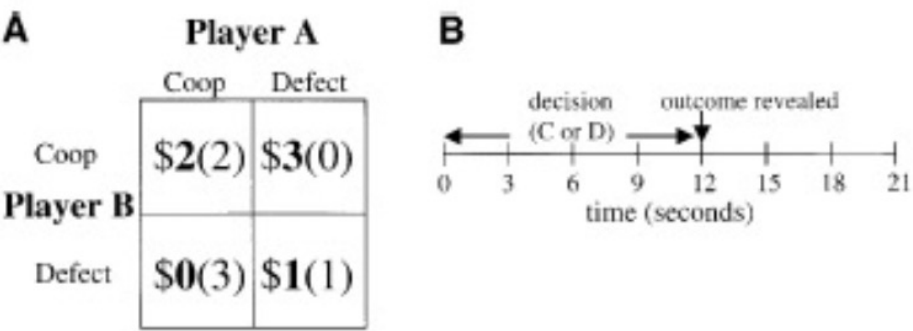
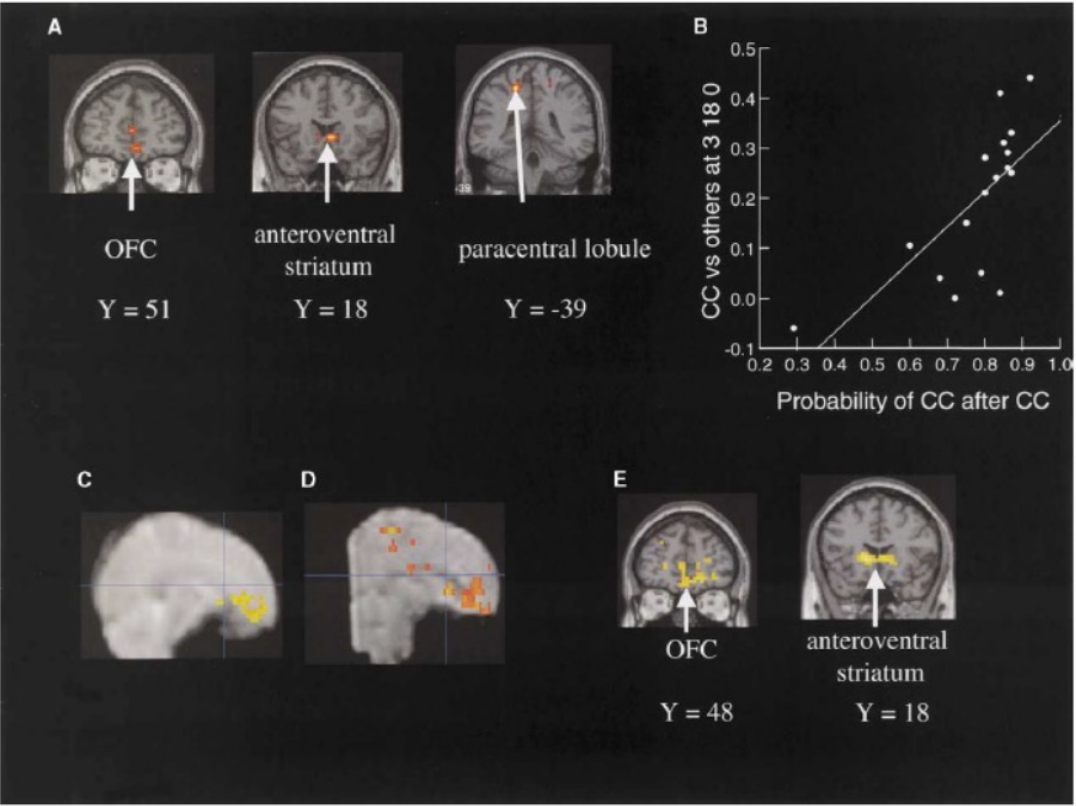


Table 1. Average Number of Outcome Types per Session, for Sessions with Presumed Human Playing Partners

Experiment	Partner	CC	CD	DC	DD	Total
1	unconstrained	11.2	2.3	3.2	3.2	20
1	confederate	6.4	4.6	4.2	4.7	20
2	open ended	11.9	3.8	3.6	4	23
2	closed	9.9	2.8	2.5	5	20



Two (plus one) general explanations

Non-inheritable ← Altruistic behavior → Inheritable



Imitation.

Education.

Rewarding.

Punishment.

?



Co-evolution

Individual selection.

Kin selection.

Group selection.

*Multiparameter
selection.*

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