

HEB 1330: Primate Social Behavior

Cooperation in primates



Overview

- 1) What is cooperation?
- 2) Cooperation among kin
- 3) Cooperation among non-kin



Reading: Cheney et al. 2010

Vervet Alarm Calling



<http://www.arkive.org/vervet/chlorocebus-pygerythrus/video-11a.html>

Classification of social behaviour

		Recipient	
		+	-
Actor	+	Mutually beneficial behaviour	Selfish behaviour
	-	Altruistic behaviour	Spiteful behaviour

Classification of social behaviour

Examples for each type of behavior in the context of prey predator interaction?

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Classification of social behaviour

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Stay Quiet/ Team up to mob snake / Sacrifice yourself / Forced joint sacrifice

Classification of social behaviour

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		+	-
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ocial behaviour

f behavior in the context of prey

Recipient

Actor

		-
+	Mutually beneficial behaviour Team up to mob snake	Selfish behaviour Stay Quiet
-	Altruistic behaviour Sacrifice yourself	Spiteful behaviour Forced joint sacrifice

Classification of social behaviour

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Classification of social behaviour



Coalitions



Food sharing



Allomaternal care

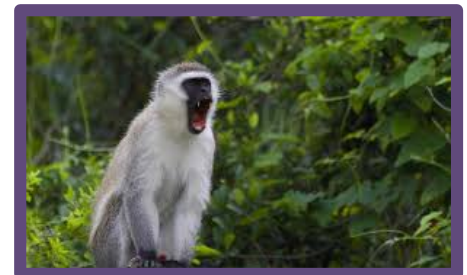


Territorial defense

Recipient

Actor

		+
-	Altruistic behaviour	



Alarm call

Classification of social behaviour



"He who was ready to sacrifice his life, as many a savage has been, rather than betray his comrades, would often leave no offspring to inherit his noble nature."

Darwin, *The Descent of Man*

Recipient

Actor

		+
-	Altruistic behaviour	

What is cooperation?

Cooperation is an action that (1) benefits both a recipient and the actor (**mutual benefit**)
or (2) provides a benefit to another individual (recipient) but not to the actor (**altruism**, or investment)

Recipient

Actor

		Recipient	
		+	
Actor	+	Mutually beneficial behaviour	
	-	Altruistic behaviour	

What is cooperation?

When an individual acts in a way that benefits others and behavior is (partially) selected for these benefits to other

		Recipient	
		+	-
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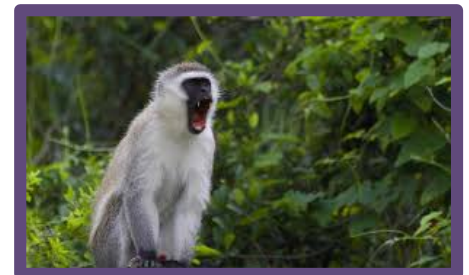
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Territorial defense



Alarm call

What is cooperation?

When an individual acts in a way that benefits others and behavior is (partially) selected for these benefits to other

Recipient

+

Why cooperate when you could
'cheat' and reap the benefits from
others' cooperation without
suffering any costs?

-

Altruistic behaviour



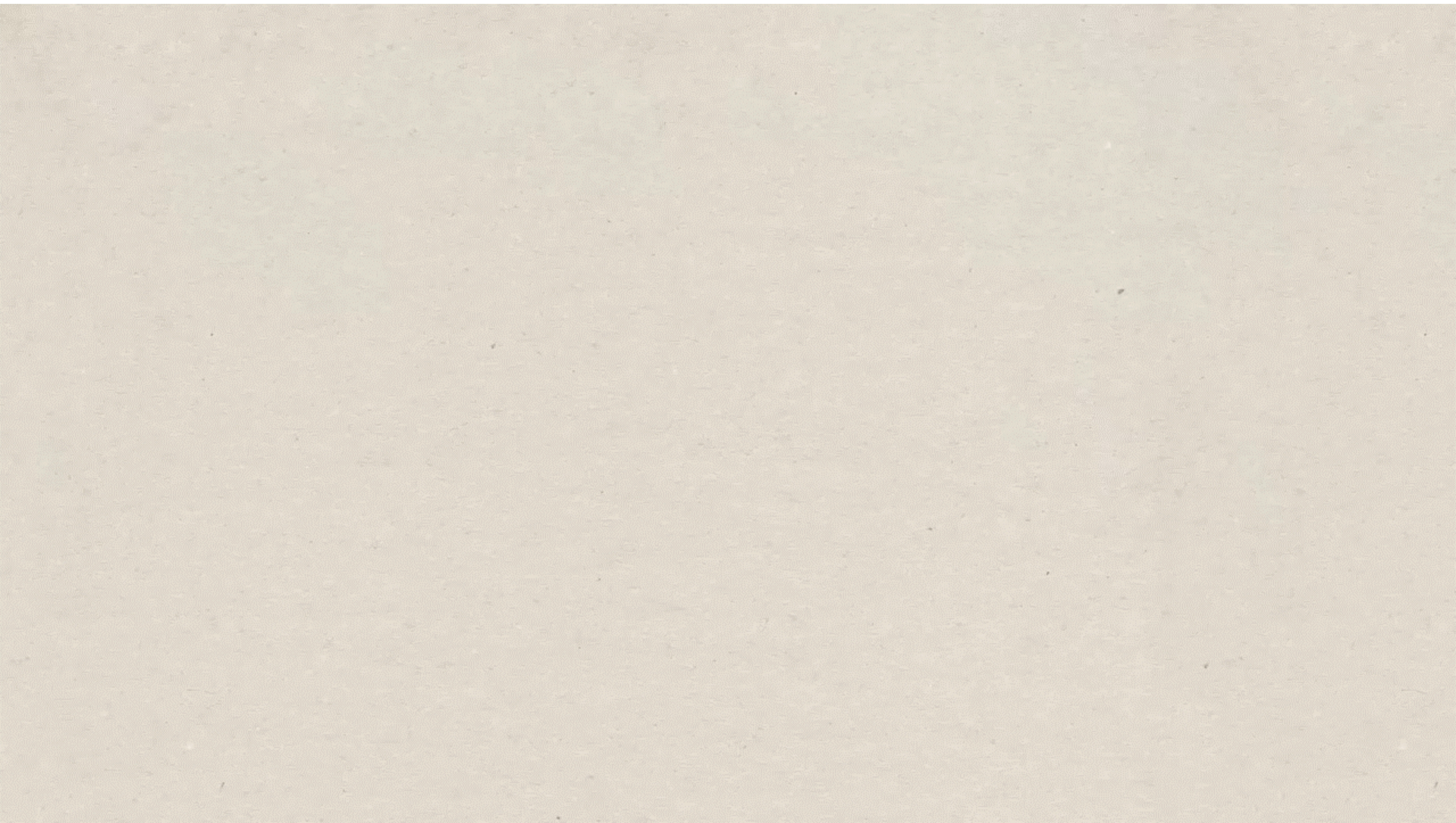
Territorial defense



Alarm call

Prisoner's dilemma

(<https://www.youtube.com/watch?v=t9Lo2fgxWHw>)



Prisoner's dilemma

Individual B

Individual A

	cooperate	defect
cooperate	R=2 Mutual cooperation	S=0 Sucker's payoff
defect	T=3 Temptation to defect	P=1 Punishment for mutual defection

Way out of Prisoner's dilemma

Explanation	Description
Kin selection	Helping individuals that share copies of the same gene
By-product benefits	Cooperation arises as a byproduct of an otherwise selfish act
Reciprocity	Helping another individual because that individual will then help them back
Enforcement	Rewarding cooperation and/or punish free riders

Overview

- 1) What is cooperation?
- 2) Cooperation among kin
- 3) Cooperation among non-kin



Reading: Cheney et al. 2010

Overview

1) What is cooperation?

2) Cooperation among kin

- Kin selection theory (Hamilton's inequality)
- Kin-biased behavior
- Kin recognition

3) Cooperation among non-kin



Reading: Cheney et al. 2010

Kin Selection



Helping relatives
even at a cost to
yourself passes
on shared alleles

Basic Genetics

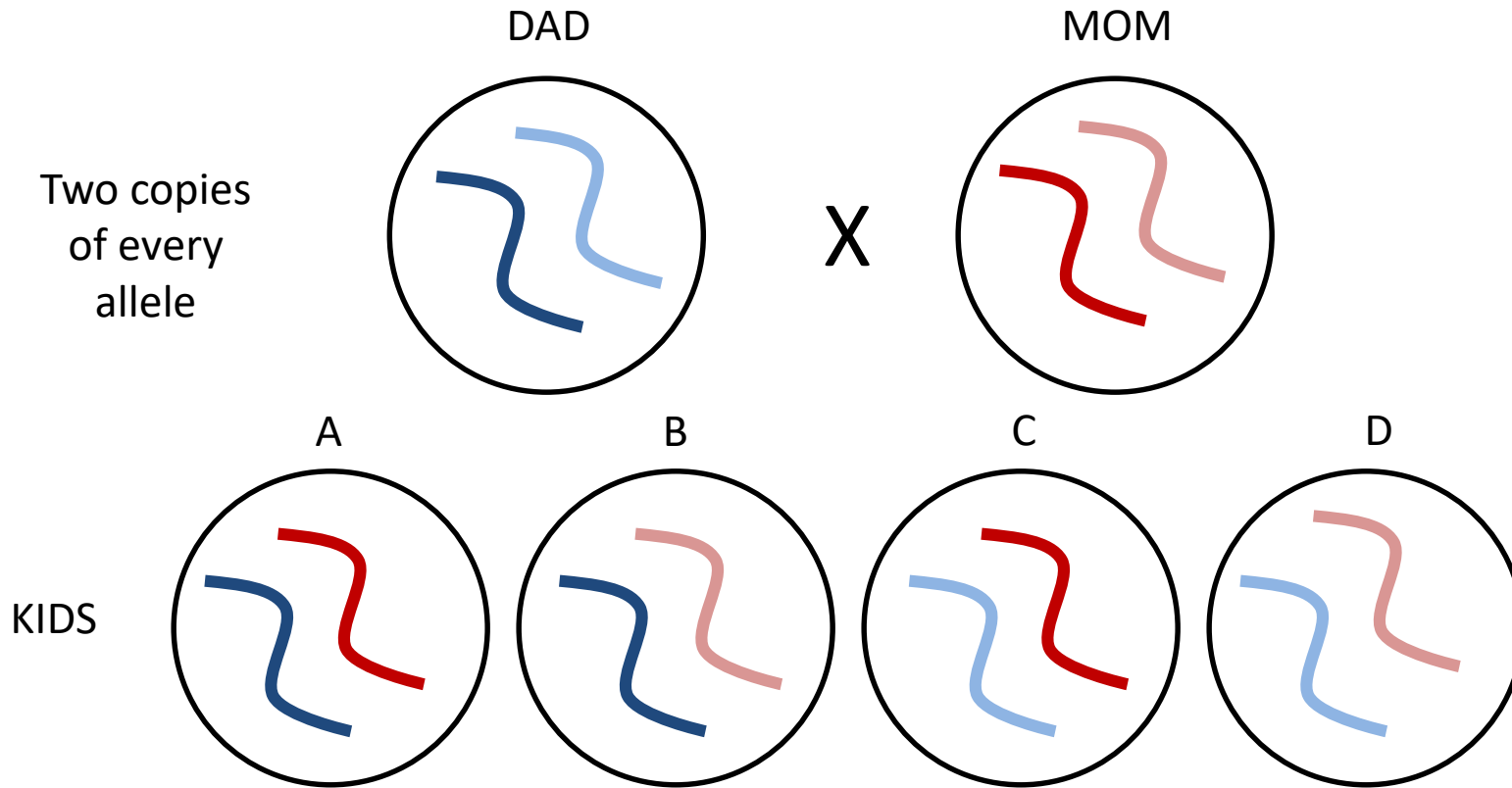
DNA



- *Genes* code for traits
 - e.g. eye color
- *Allele* = a version of a gene
 - e.g. blue eyes
- A diploid individual has two alleles of each gene
- During sexual reproduction, one allele from each parent is passed on to offspring



Basic Genetics



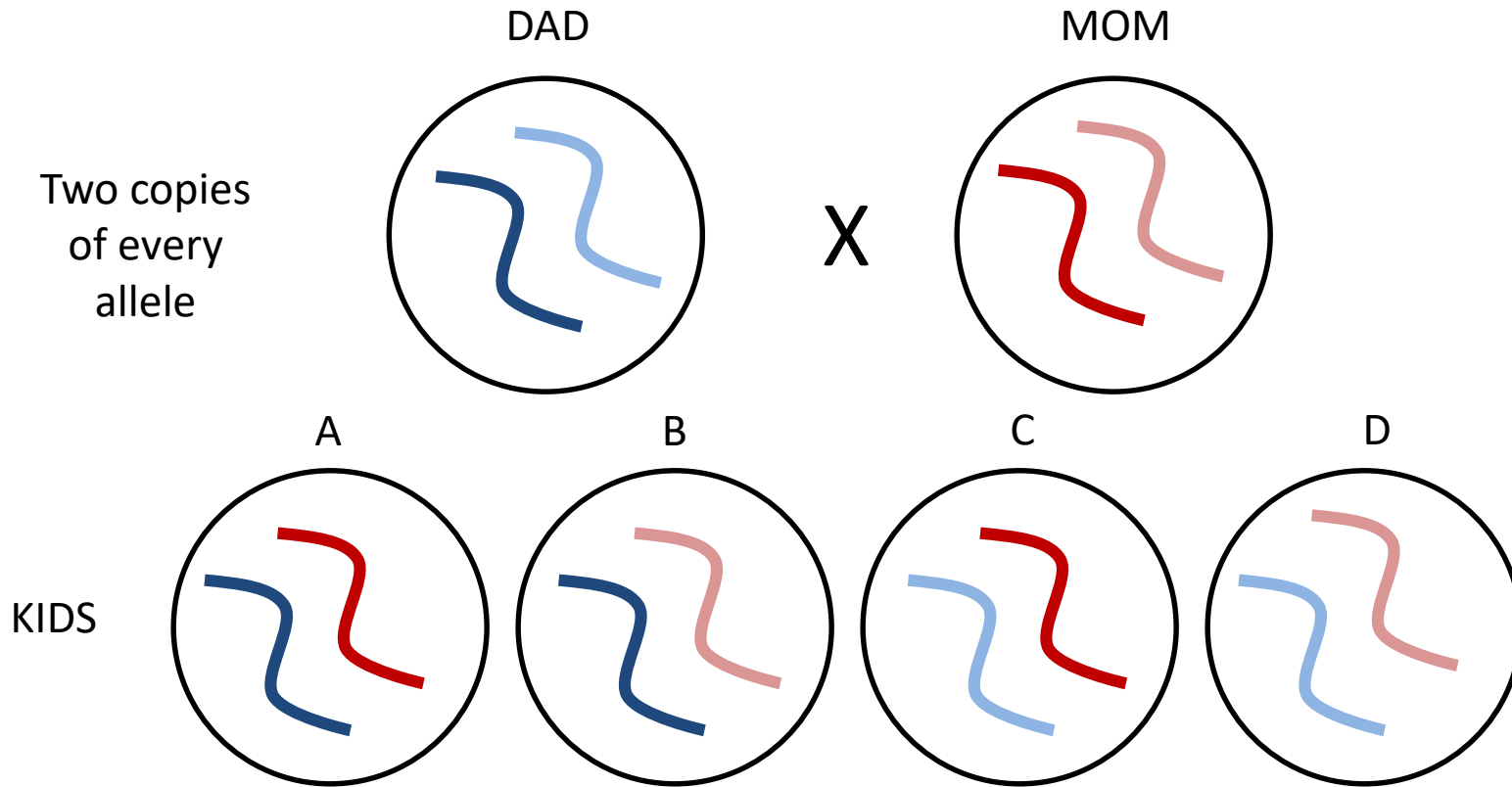
Pick an allele from A, what are the chances that B has a copy of the same allele?

(0.5 probability A got it from Mom) x (0.5 x probability B got it from Mom) = 0.25

(0.5 probability A got it from Dad) x (0.5 probability B got it from Dad) = 0.25

+ 0.5

Coefficient of Relatedness (r)



r = probability of sharing the same allele

(OR average % of alleles two individuals share)

Coefficient of Relatedness (r)

Relationship	Coefficient of Relatedness (r)
Full siblings	0.5
Parent-Offspring	0.5
Half siblings	0.25
Grandparent-Grandchild	0.25
First Cousins	0.125
Unrelated	~ 0

- closely related individuals are more likely to share the same allele for a given trait

OR

- on average, closely related individuals share a high percentage of the same alleles

Your alleles can survive to the next generation indirectly by helping your kin survive!

Calculation of fitness

Direct fitness

(alleles in next generation through own offspring)

+

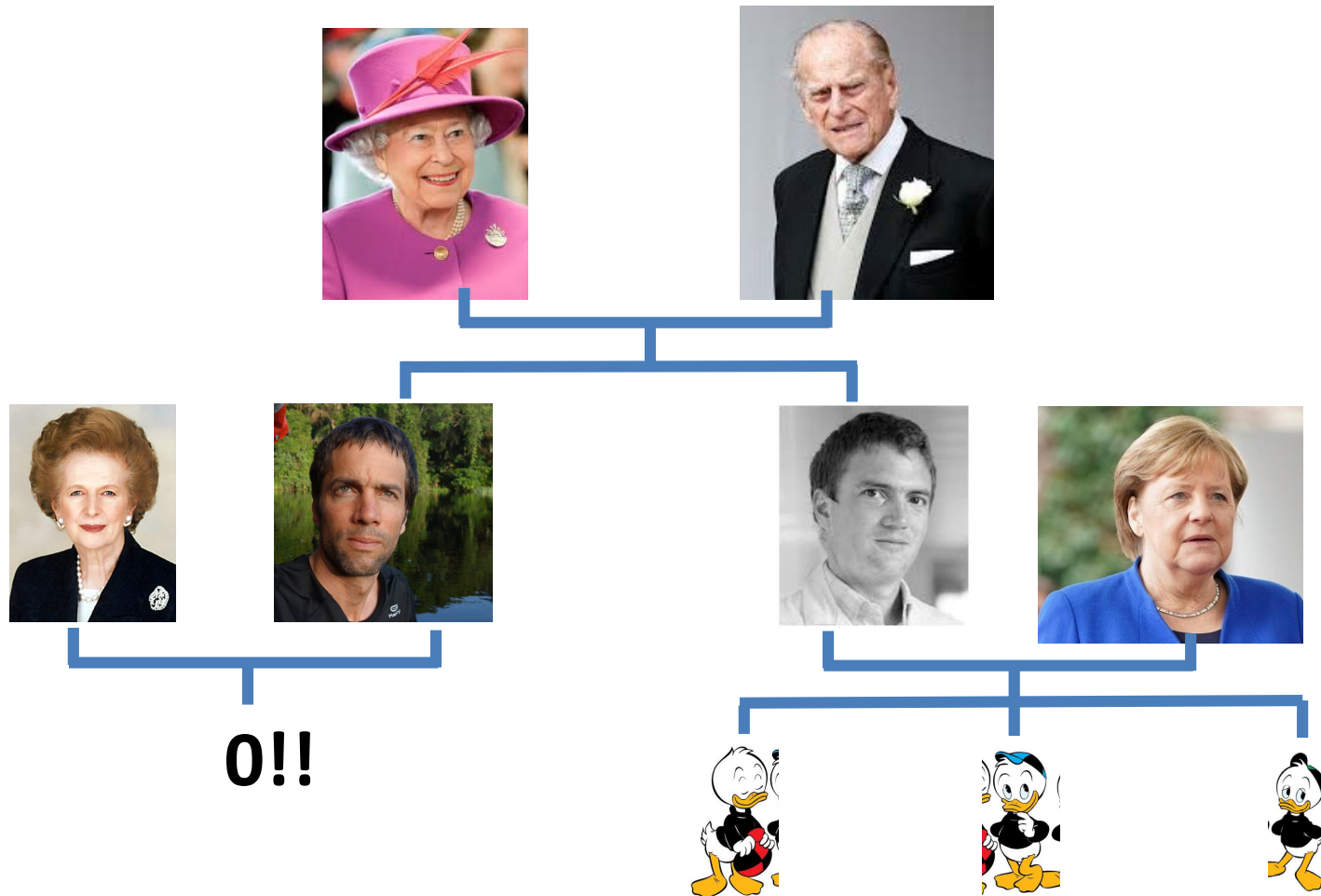
Indirect fitness

(alleles in next generation through offspring of kin)

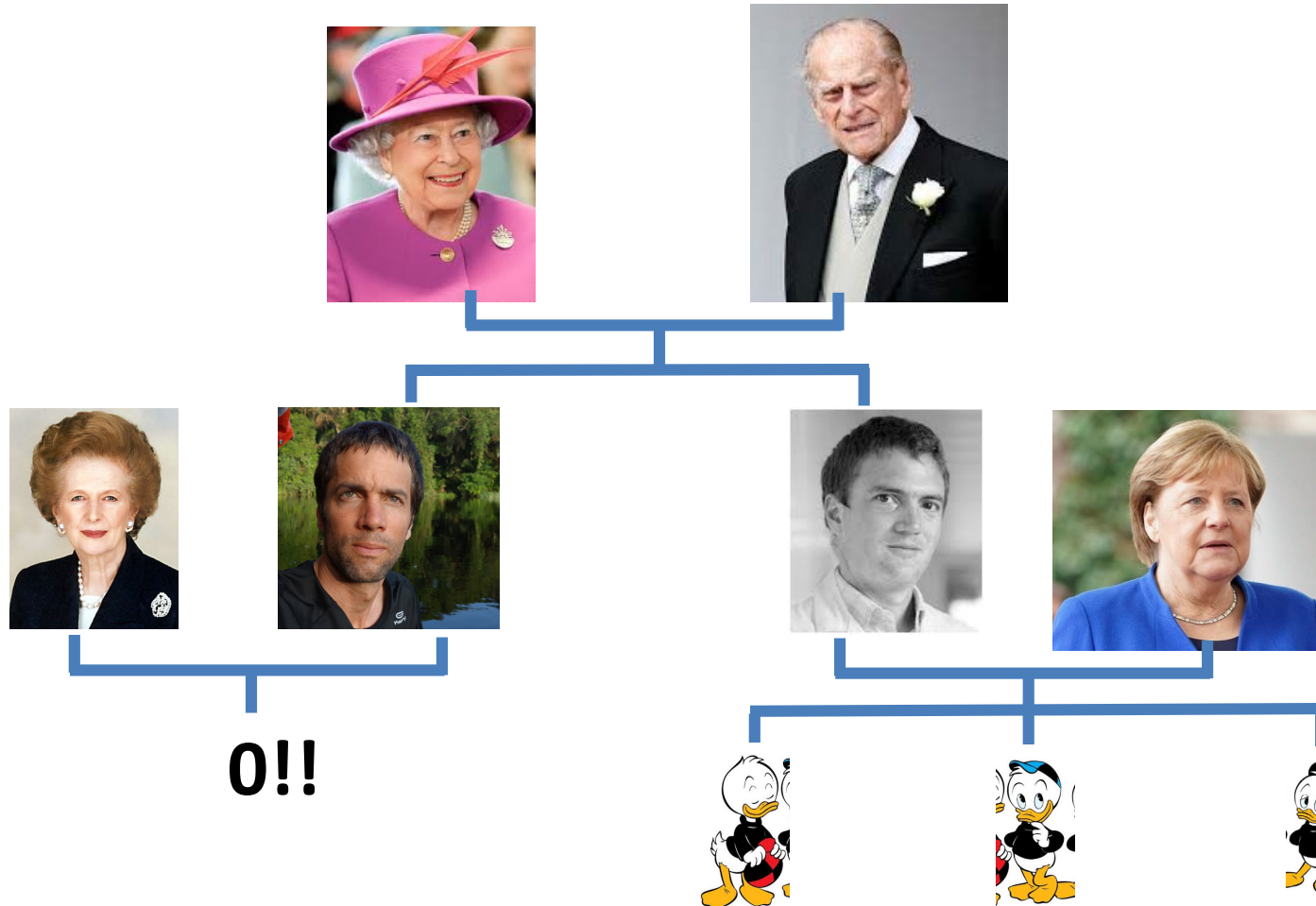
=

Inclusive fitness

Martin's fitness



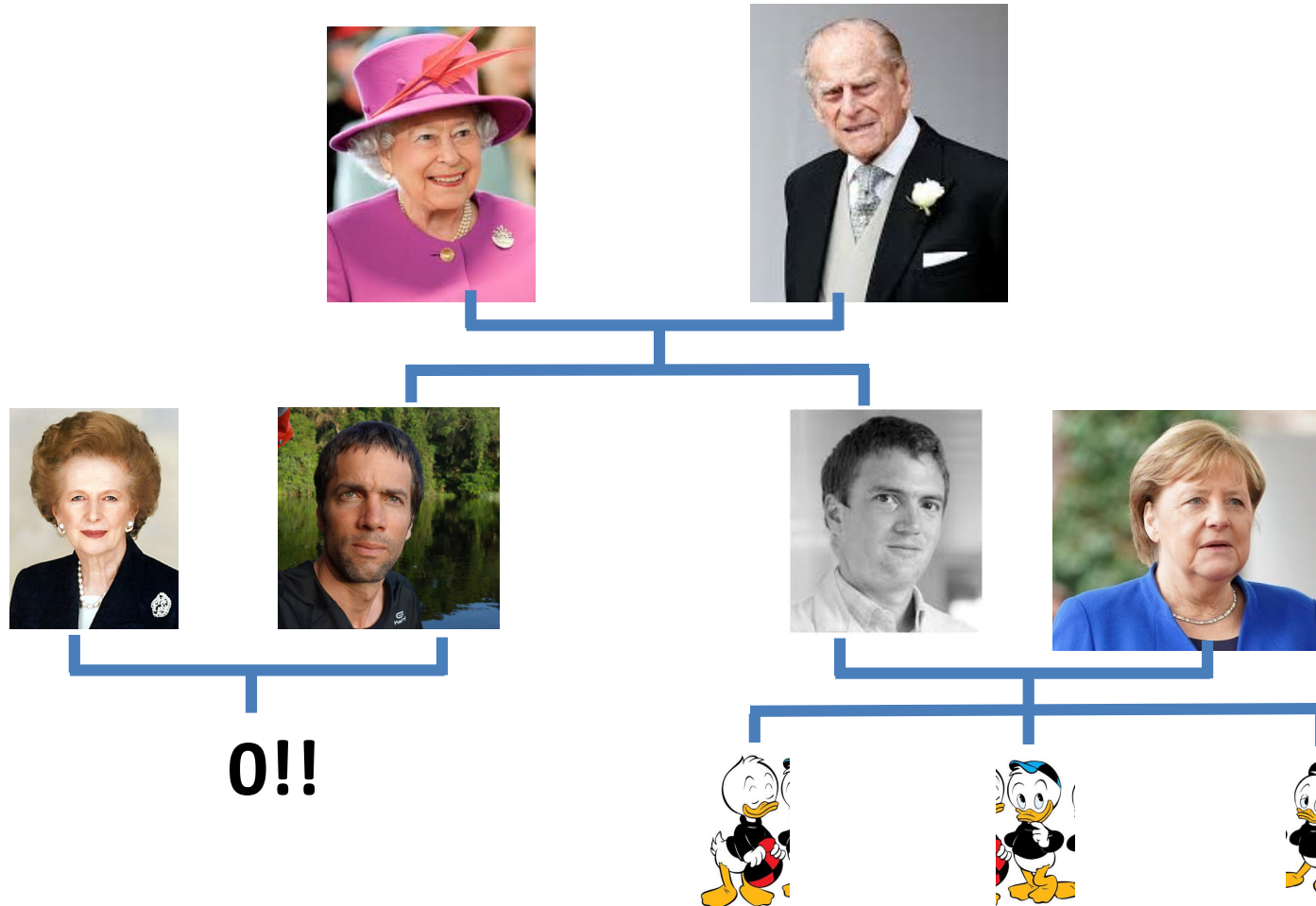
Martin's fitness



Direct fitness = 0

Indirect fitness = 3×0.25

Martin's fitness



my inclusive fitness = $0 + 0.75$

Hamilton's Rule

A behavior that is costly to the actor but beneficial to the recipient(s) can evolve if:

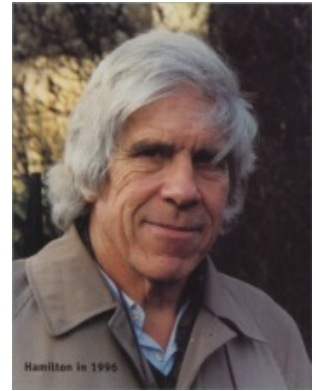
$$C < r * B$$

Where:

C is the cost to the actor

B is the benefit to the recipient

r is the coefficient of relatedness



As r increases, the benefits outweigh the costs

Hamilton's Rule

According to Hamilton's Rule, when would a altruistic behavior in A occur towards his/her full sibling, that reduces the fitness of A by one offspring?

Evidence for Kin Selection in Primates

Prediction: more cooperation in philopatric sex

→ Coalitions are prominent among

female macaques



Female philopatry

male chimpanzees



Male philopatry

Evidence for Kin Selection in Primates

Prediction: more cooperation in philopatric sex

→ Exception: Bonobos!!

female bonobos



Male philopatry

male chimpanzees



Male philopatry

Evidence for Kin Selection in Primates

Prediction: more cooperation among relatives



Grooming and proximity are directed more to kin than non-kin.

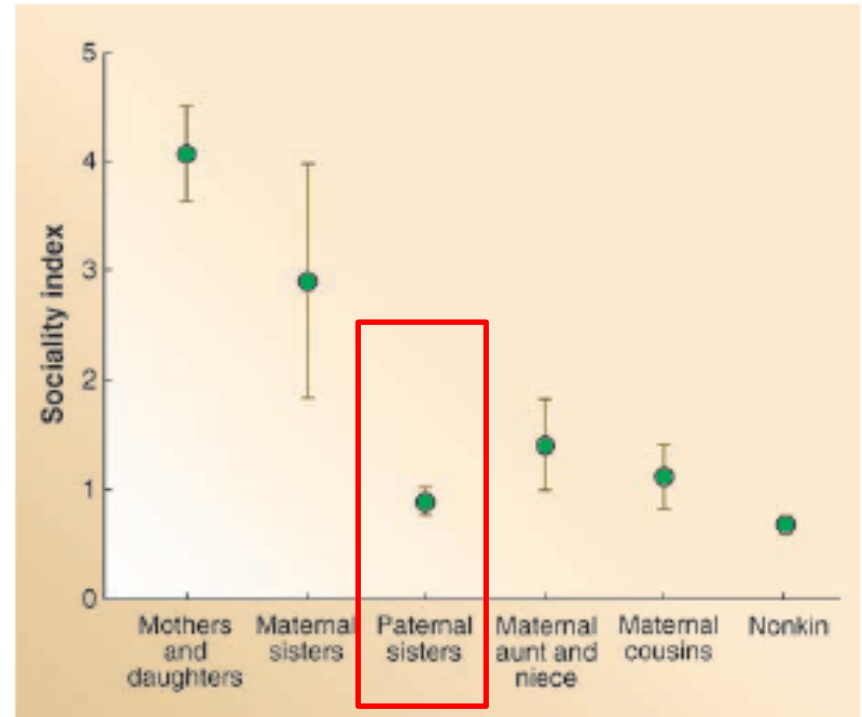
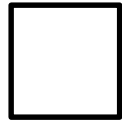


Fig. 2. The relationship between maternal and paternal kinship and the strength of social bonds among female baboons. The category of relatedness is plotted on the x axis, and the mean and standard error of values of the sociality index are plotted on the y axis. The sociality index is a composite measure of dyadic relationship strength based on the frequency of grooming and proximity. [Redrawn from (22)]

Evidence for Kin Selection in Primates

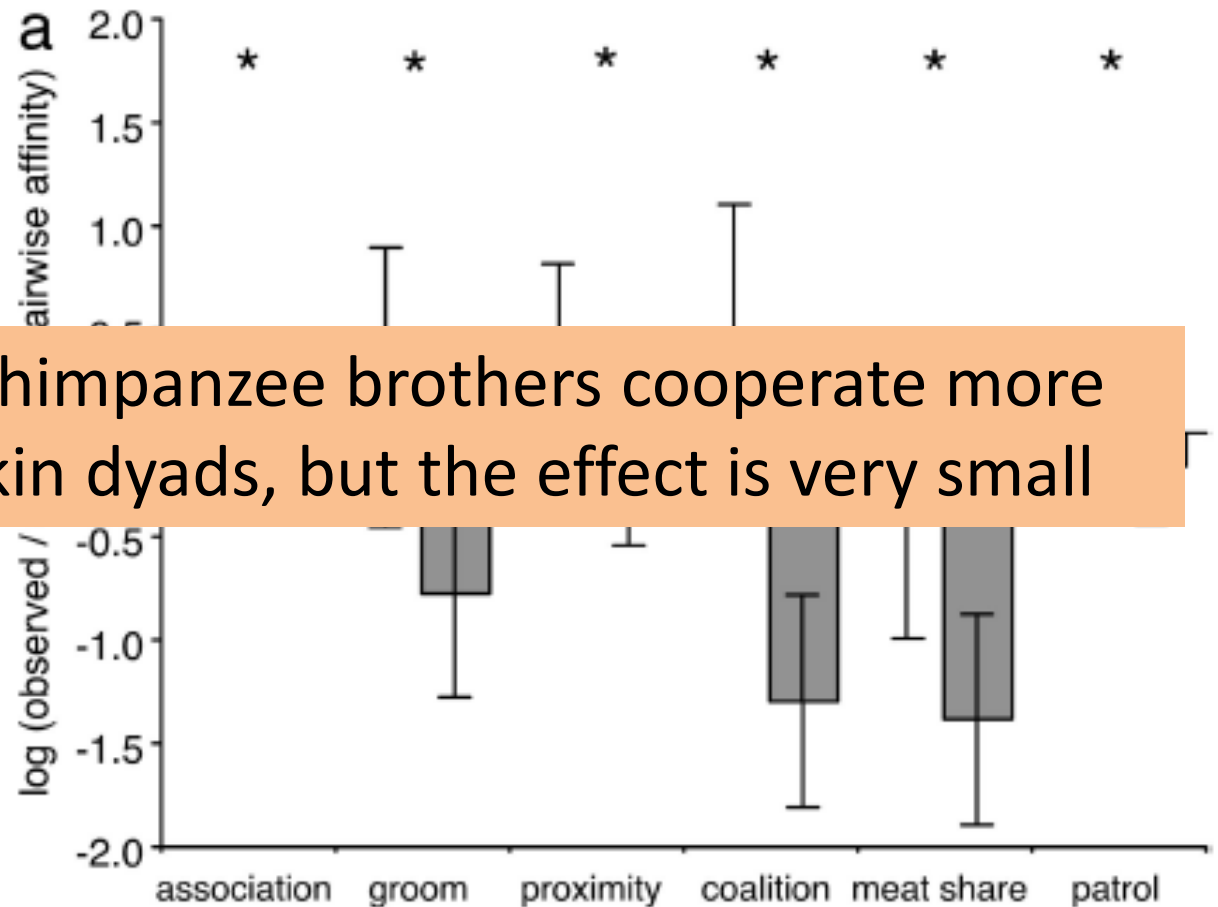
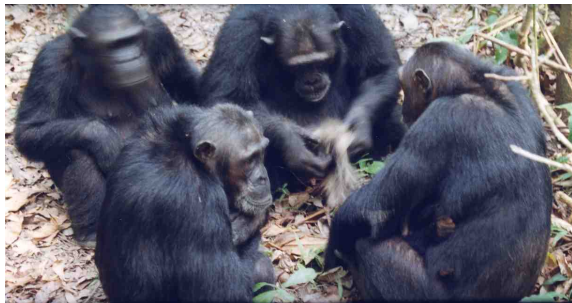
Prediction: Increased willingness to cooperate with relatives



Maternal Kin

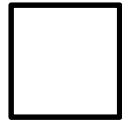


Maternal chimpanzee brothers cooperate more than non-kin dyads, but the effect is very small



Evidence for Kin Selection in Primates

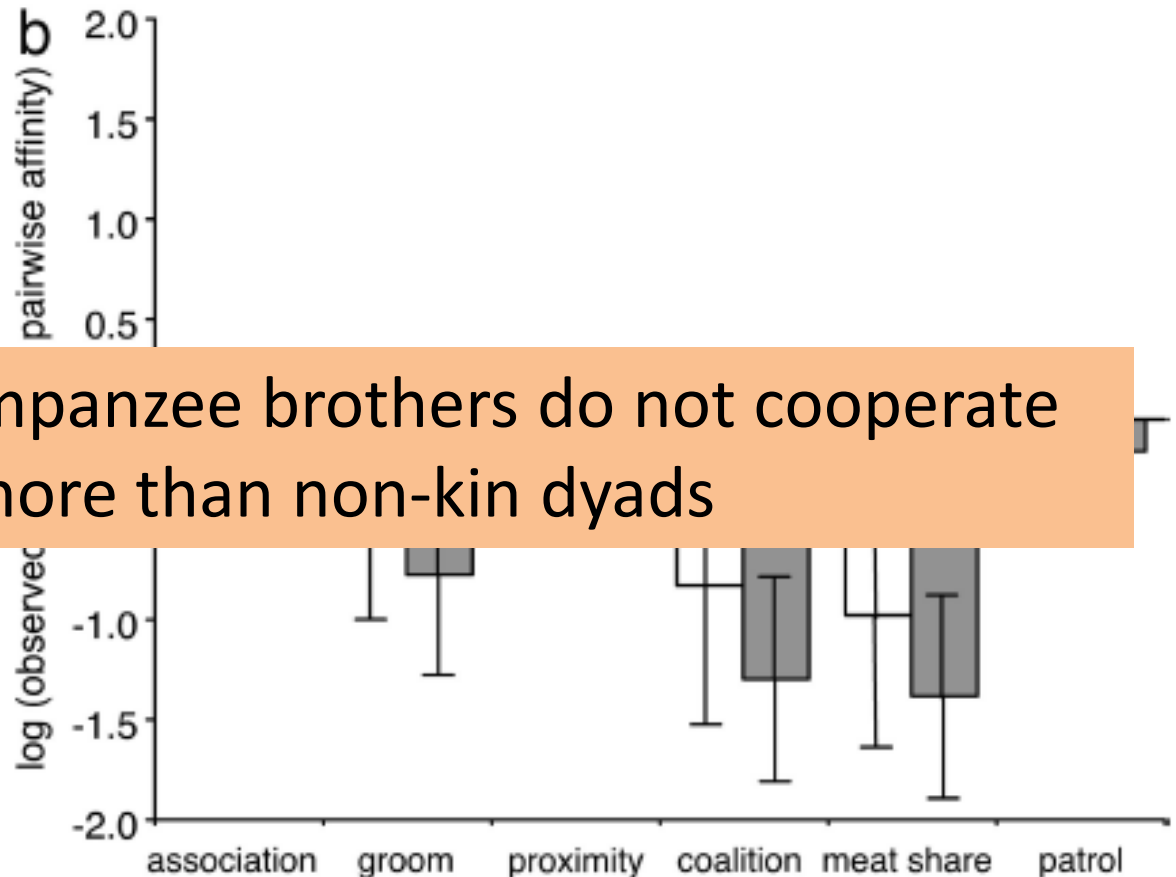
Prediction: Increased willingness to cooperate with relatives



Paternal Kin

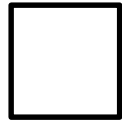


Paternal chimpanzee brothers do not cooperate more than non-kin dyads

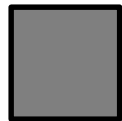


Evidence for Kin Selection in Primates

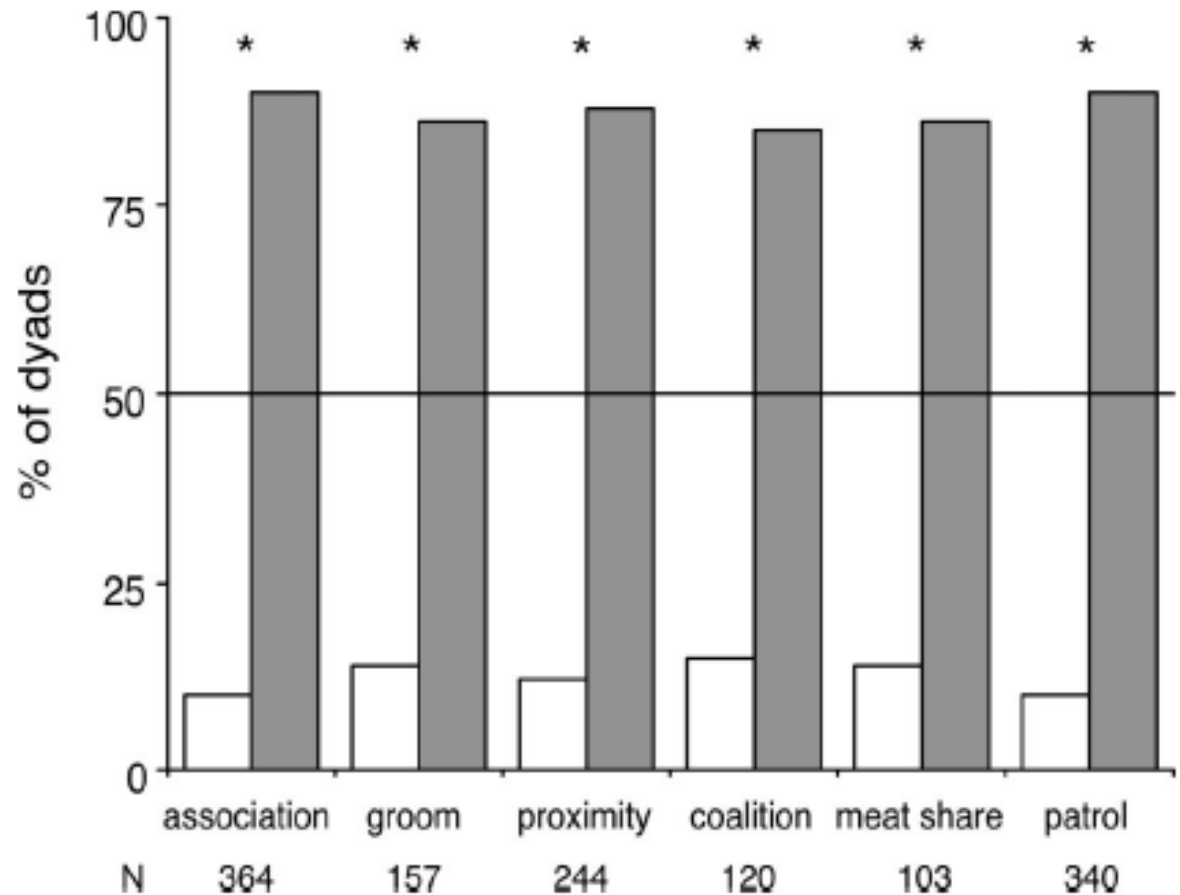
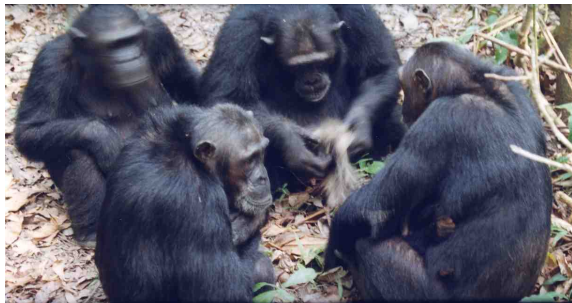
Prediction: Increased willingness to cooperate with relatives



Maternal Kin



Non-Kin



Kin Recognition

To cooperate more with your kin, you have to recognize them!

- Ideas of potential ways to recognize kinship?

Kin Recognition

To cooperate more with your kin, you have to recognize them!

A Phenotype Matching: If we smell/look similar, then we're kin

B Early Association: If we grew up together, we're kin

- Might explain difference between maternal and paternal siblings

Phenotype Matching

Kin discrimination by odor

In which primate group do you think that might be particularly important?

Phenotype Matching

Kin discrimination by odor

Might particularly important in strepsirrhines



Strepsirrhines

Phenotype Matching

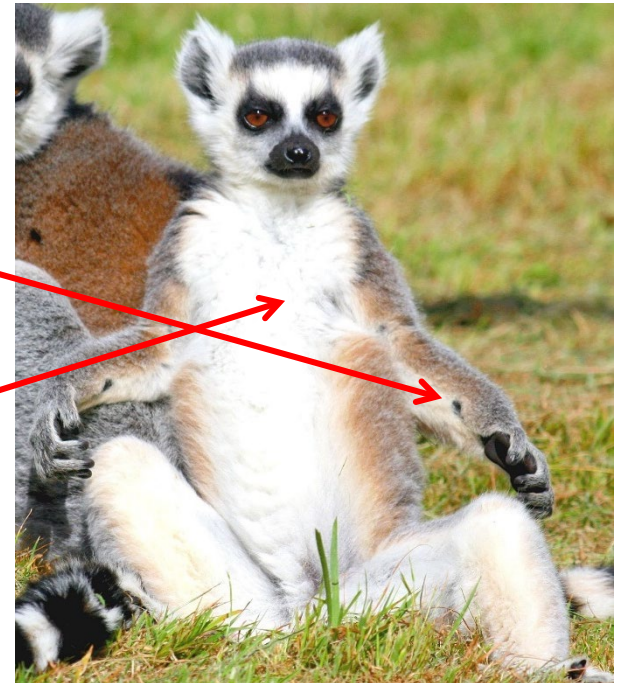
Kin discrimination by odor

Might particularly important in strepsirrhines

> 200 chemicals; “musky”

Wrist gland

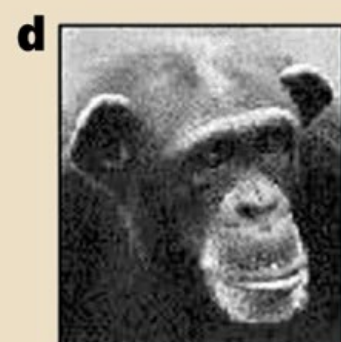
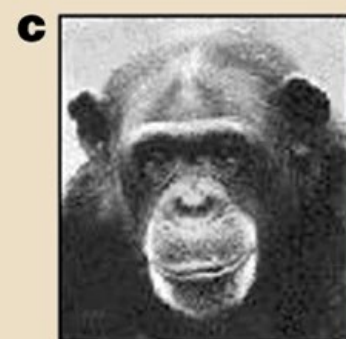
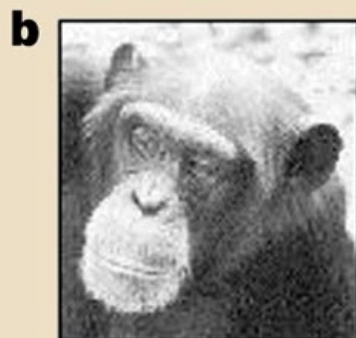
Chest gland



Strepsirrhines

Phenotype Matching

Kin discrimination by visual cue



a**e****b****f****c****g****d****h**

Which image is more similar to the target?



much more
similar

slightly more
similar



slightly more
similar

much more
similar



Submit

Phenotype Matching

Kin discrimination by visual cue

Humans can often match close relatives in other species, maybe primates can too

<i>Observers</i>	<i>Species</i>
Humans	Macaques
	Chimpanzees
“ “	Gorillas
“ “	Mandrills
“ “	Humans
Chimpanzees	Chimpanzees*

*Initially only in mother-son pairs – but the non-recognition of mother-daughter seems to have been a false result (an artefact of poor photos), not an adaptive difference.

Familiarity

Kin discrimination by maternal association



Familiarity

Kin discrimination by maternal association

→ likely mechanism of kin discrimination

Birth -> mothers recognize offspring by **proximity***
-> mother and offspring **learn** to identify each other
-> treat familiars of mother as **kin**

*In captivity, mothers who are given non-kin neonates rear them as their own

Overview

- 1) What is cooperation?
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 - Mutualism
 - Reciprocal Altruism
 - Biological markets
 - Picking Cooperation Partners



Way out of Prisoner's dilemma

Explanation	Description
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By-product benefits (Mutualism)	Cooperation arises as a byproduct of an otherwise selfish act
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By-product benefits of cooperation

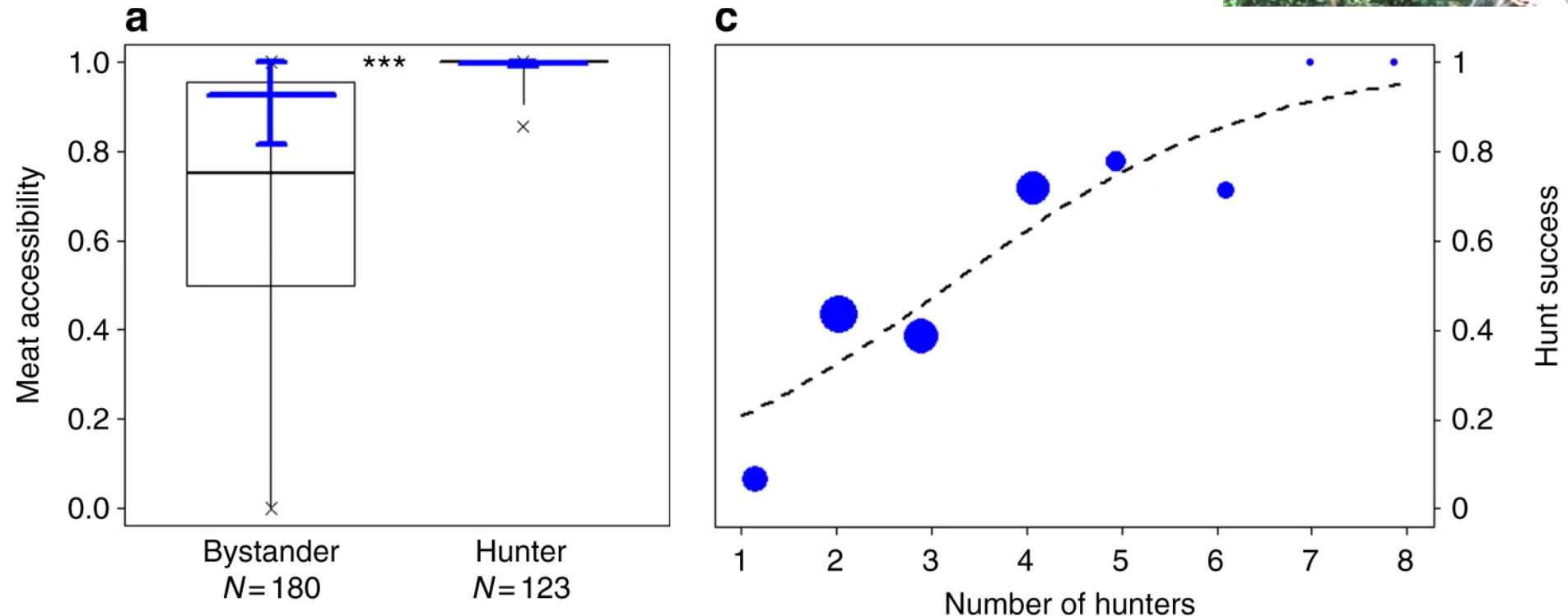
- Helper is cooperating because of selfish benefit (no temptation to defect)
- Not cognitively complex
- Evolutionary stable



<https://www.youtube.com/watch?v=mpYViR9MqrU>



By-product benefits of cooperation



- Helper is cooperating because of selfish benefit (no temptation to defect)
- “Not cognitively complex”

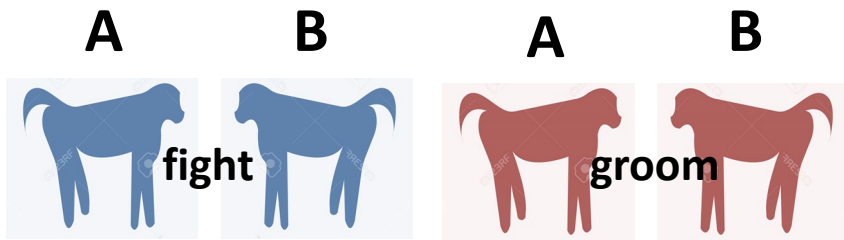
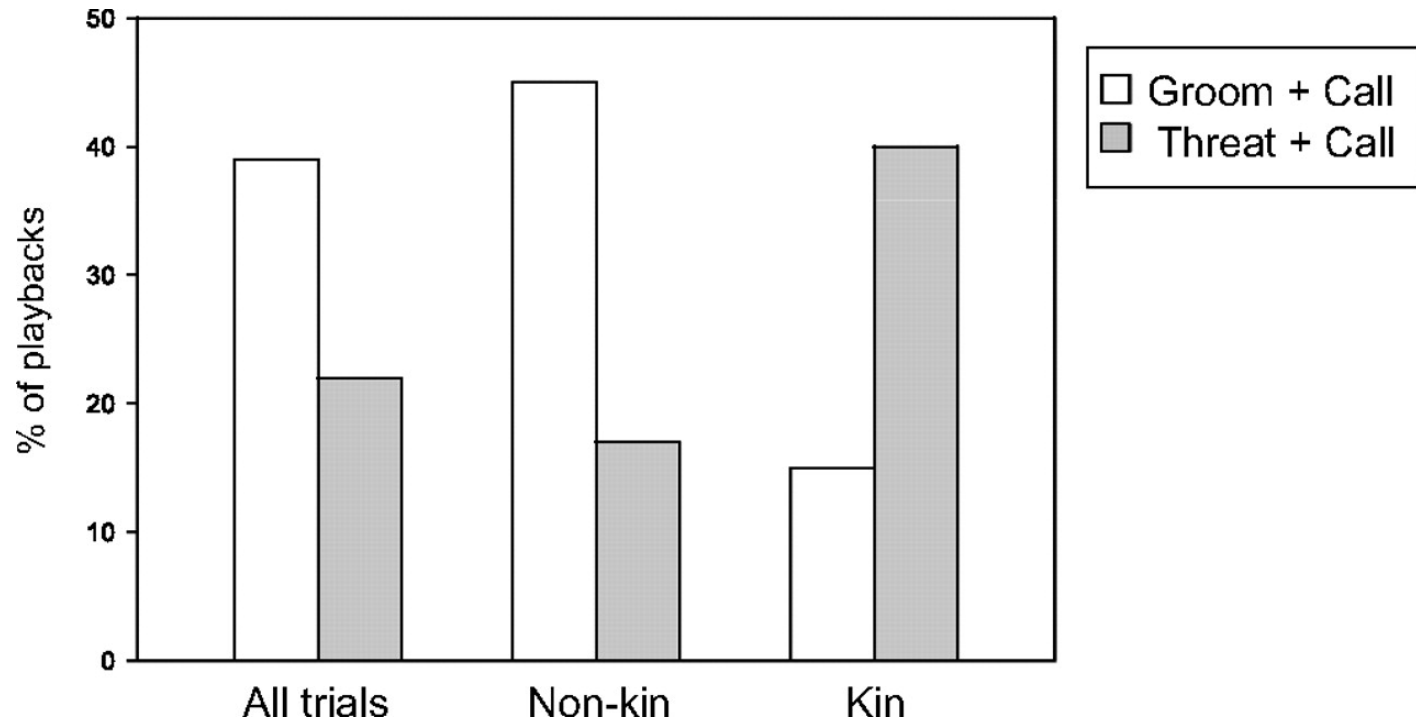
Reciprocity



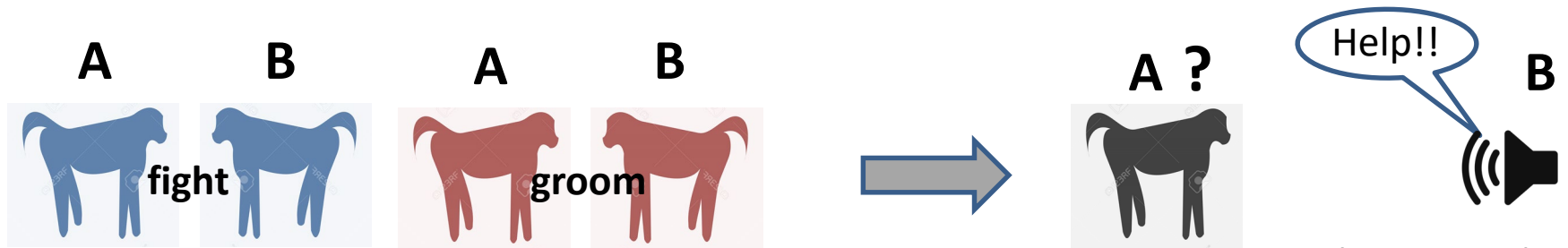
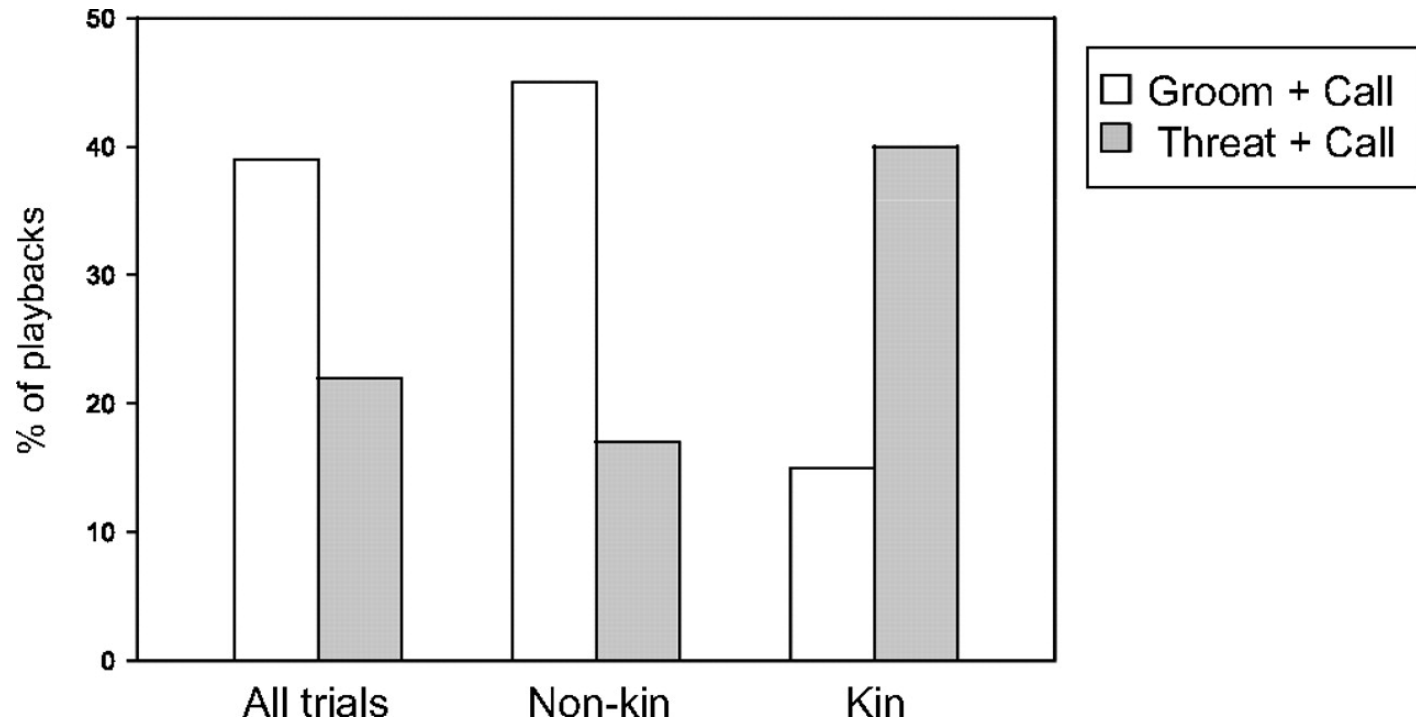
- Immediate costs offset by future benefits
- You scratch my back and I'll scratch your back (later)
 - repeated interactions
- Memory of past interactions?



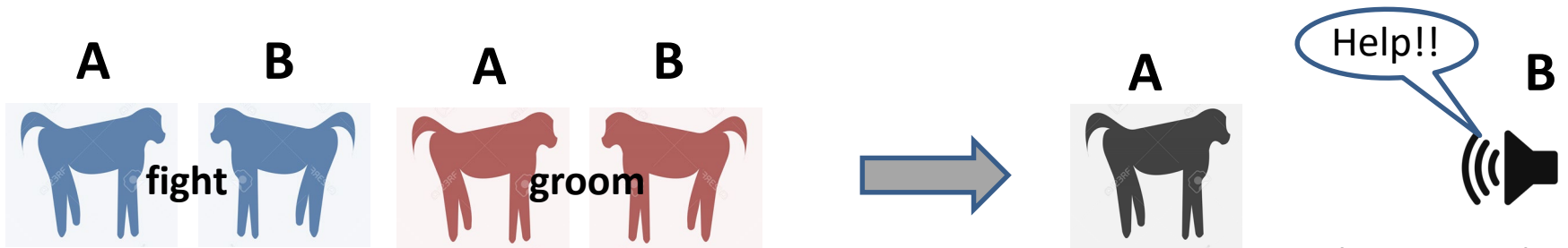
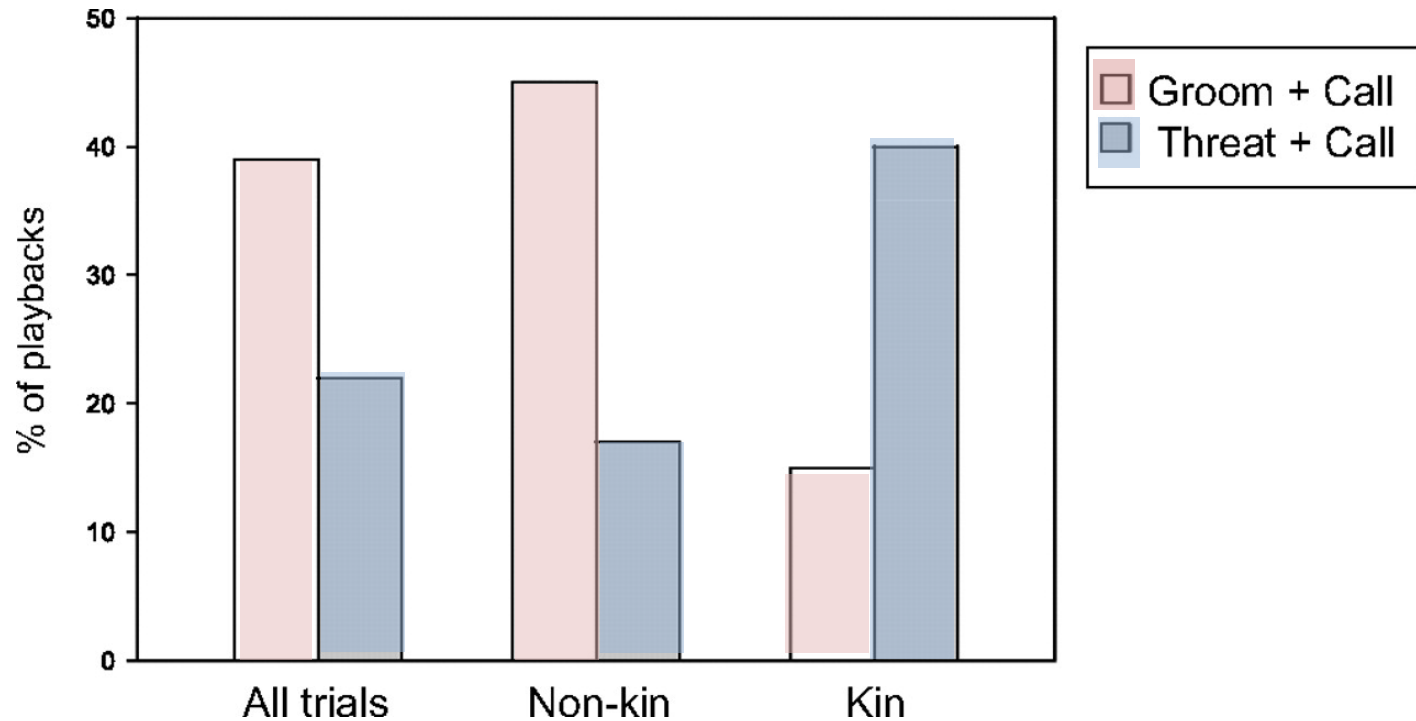
Memory of past interactions



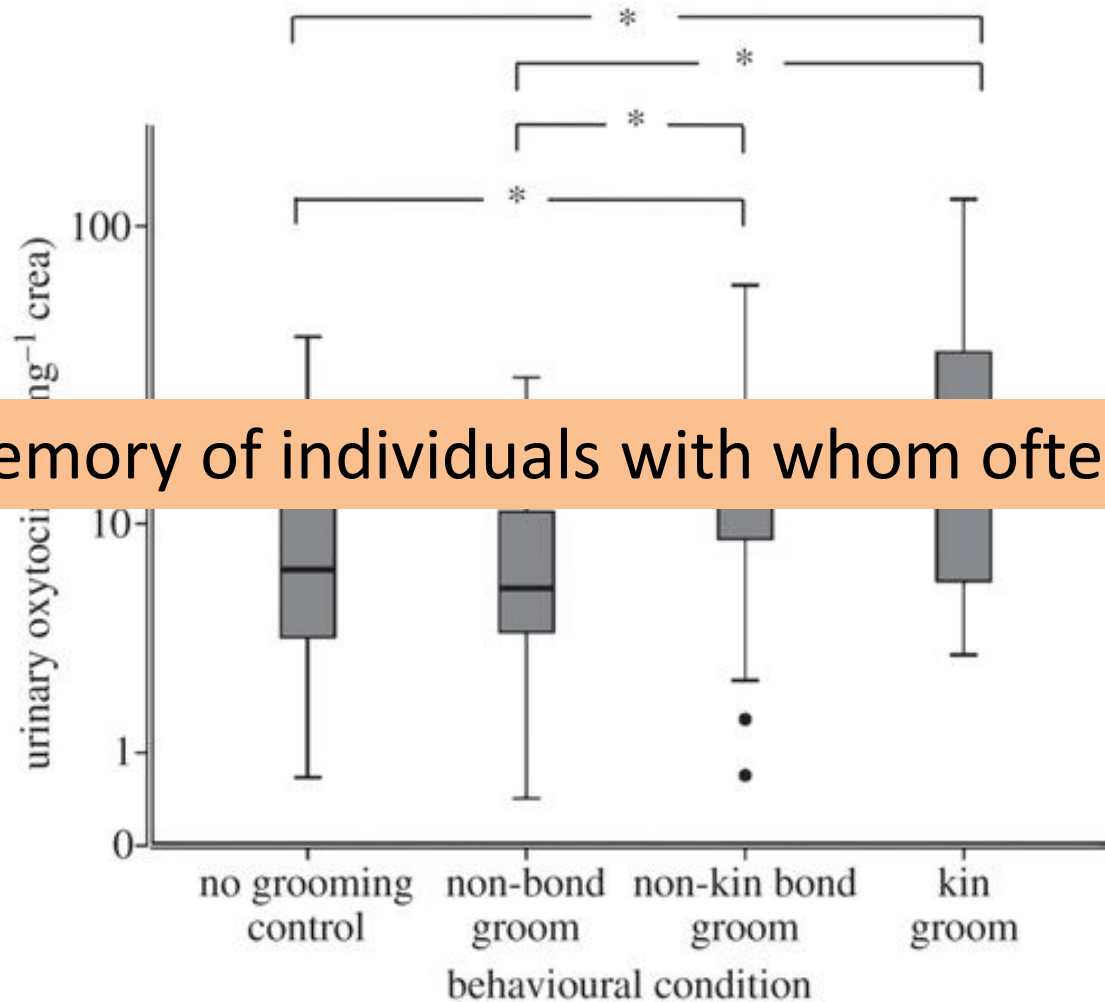
Memory of past interactions



Memory of past interactions



Emotional bookkeeping

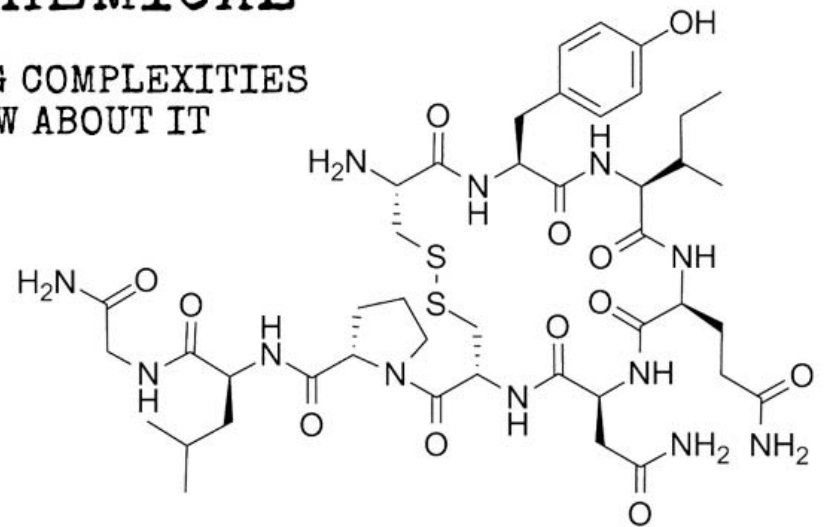


Bodily memory of individuals with whom often interactions

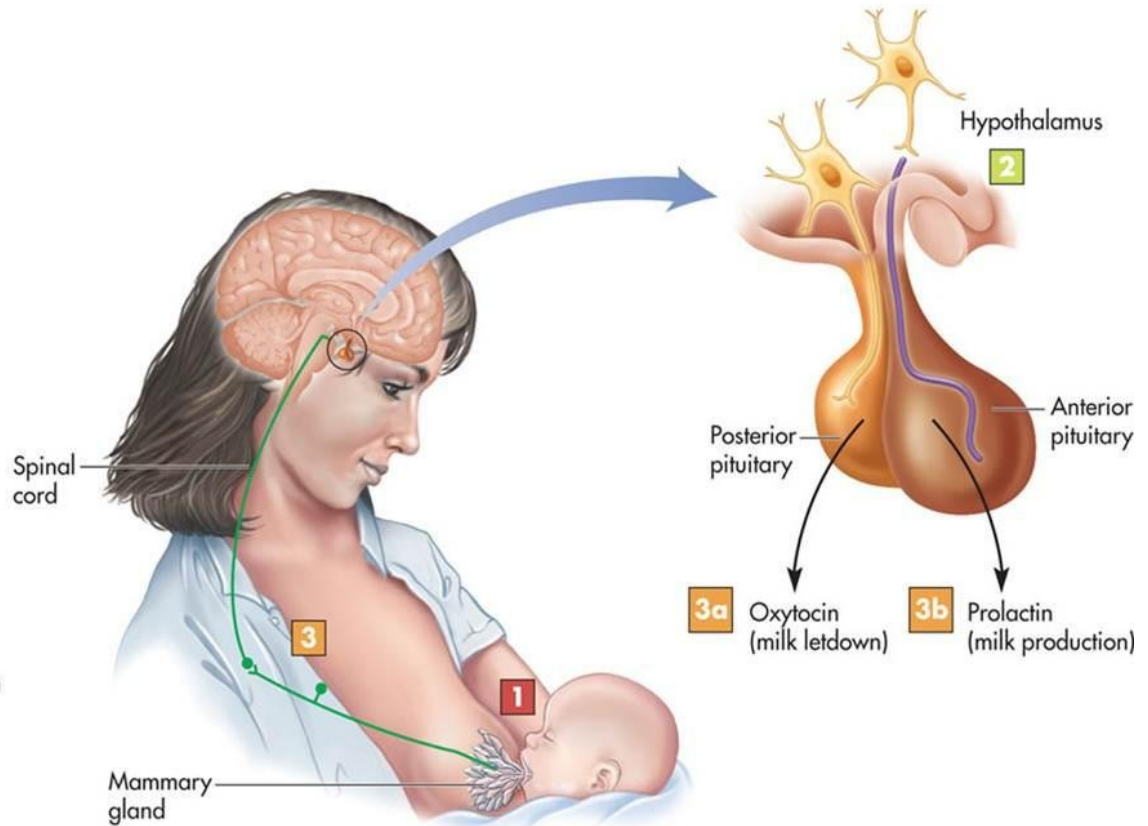
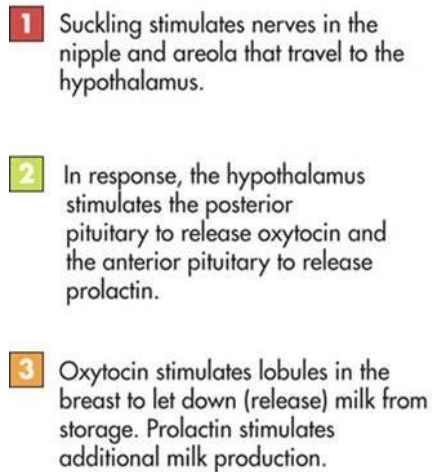
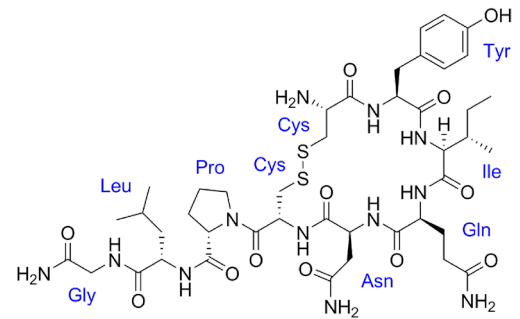


OXYTOCIN: THE LOVE CHEMICAL

AND THE SURPRISING COMPLEXITIES
YOU DIDN'T KNOW ABOUT IT



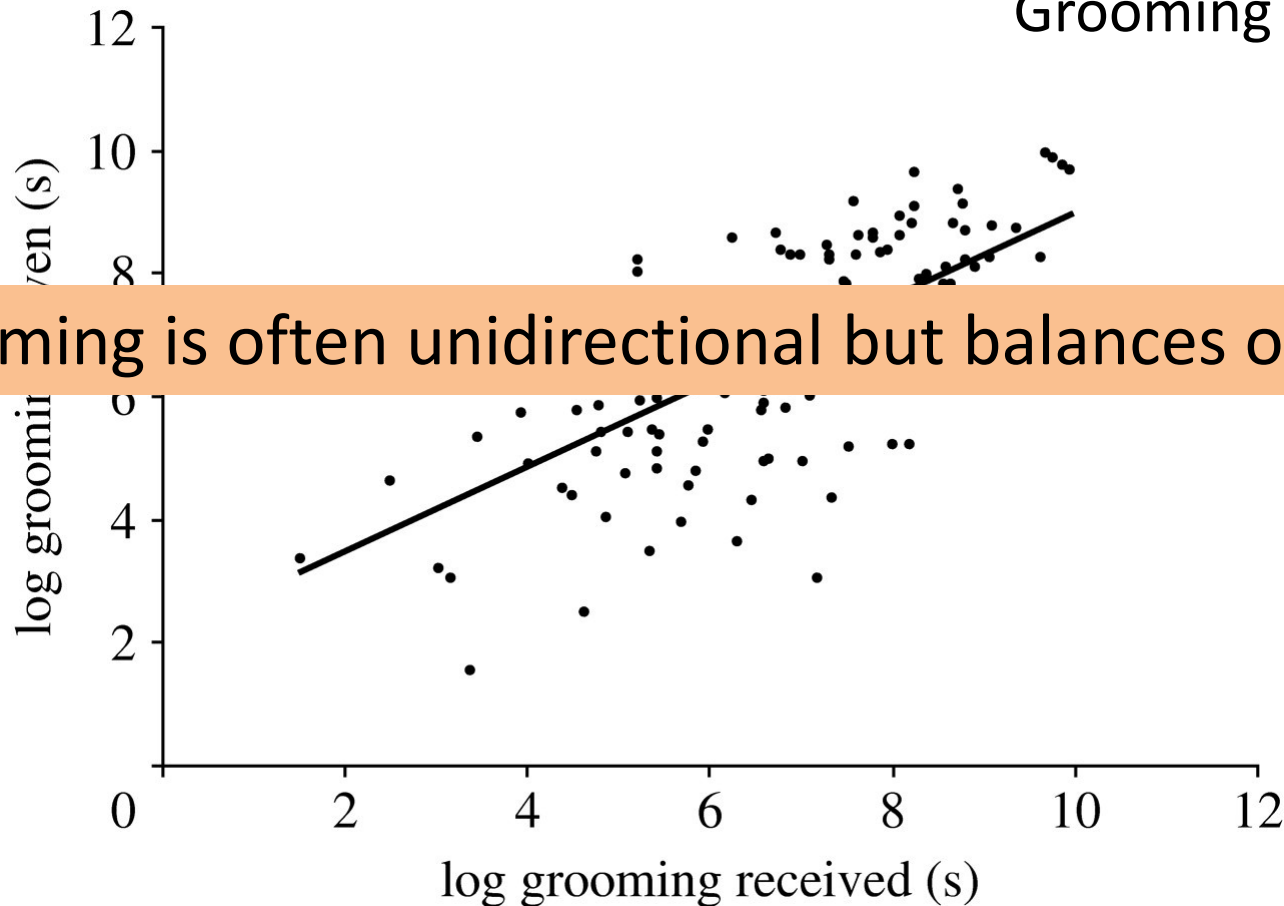
Oxytocin



Emotional bookkeeping

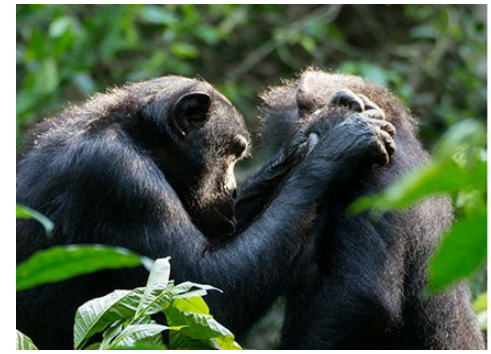


Grooming in chimpanzees

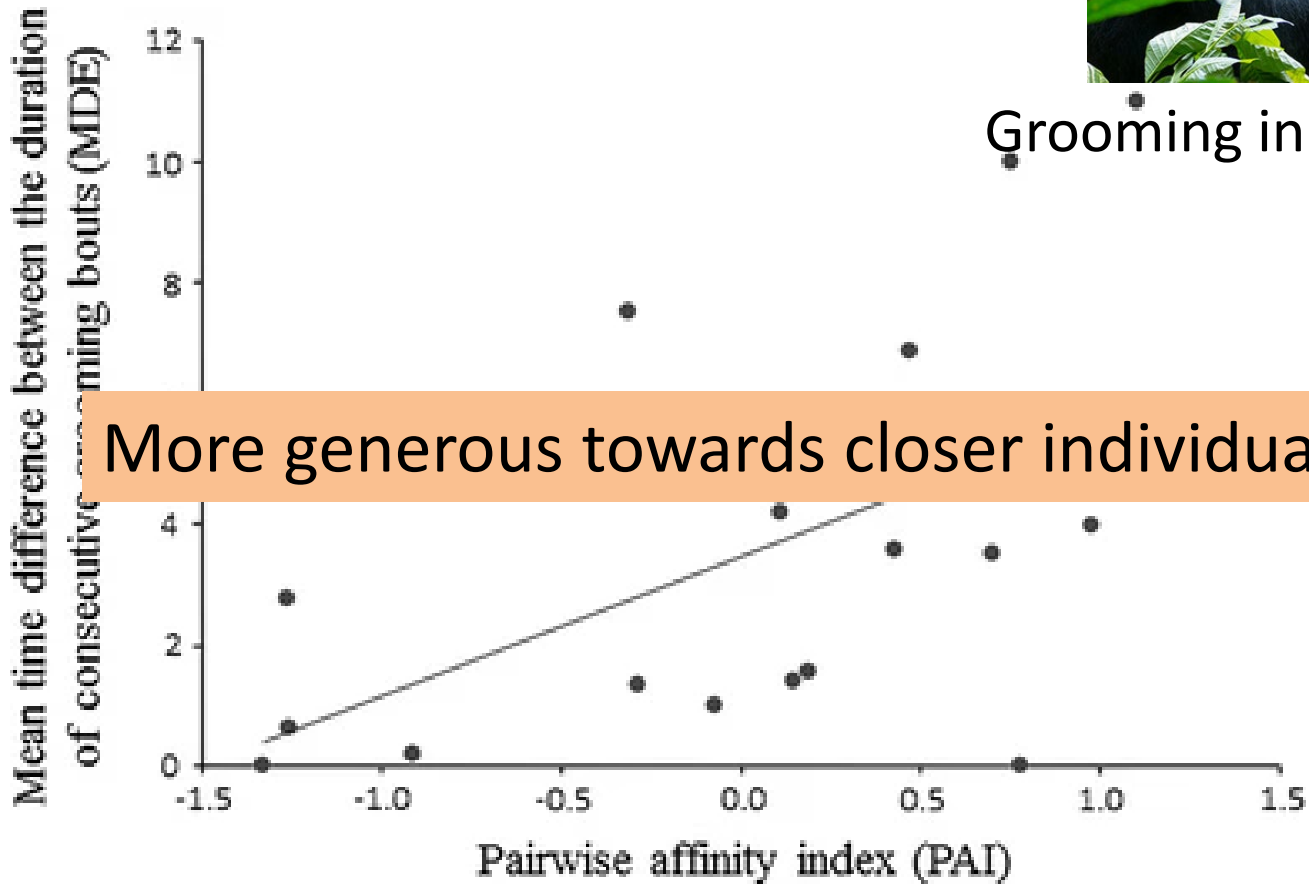


Grooming is often unidirectional but balances out over time

Emotional bookkeeping



Grooming in bonobos



Biological markets

Different currencies can be exchanged, and individuals differ in the services that they can offer

Biological markets

Phase 0
B



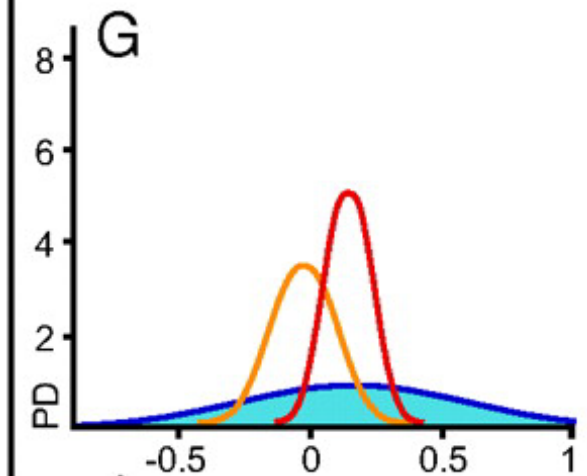
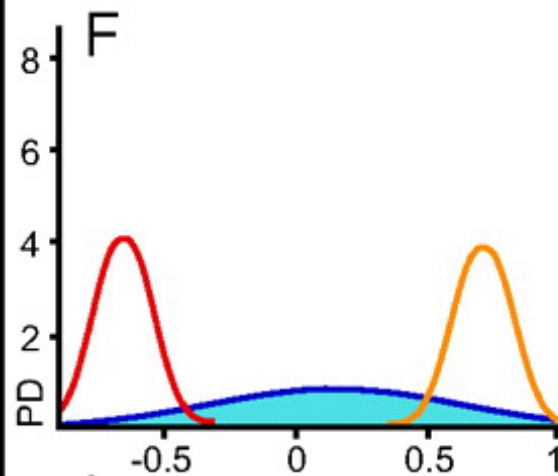
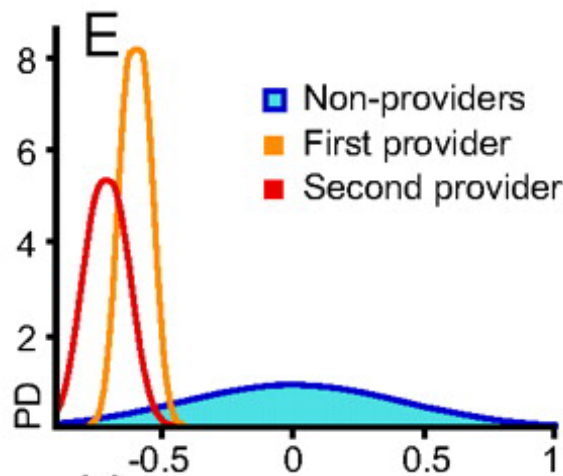
Phase 1
C



Phase 2
D



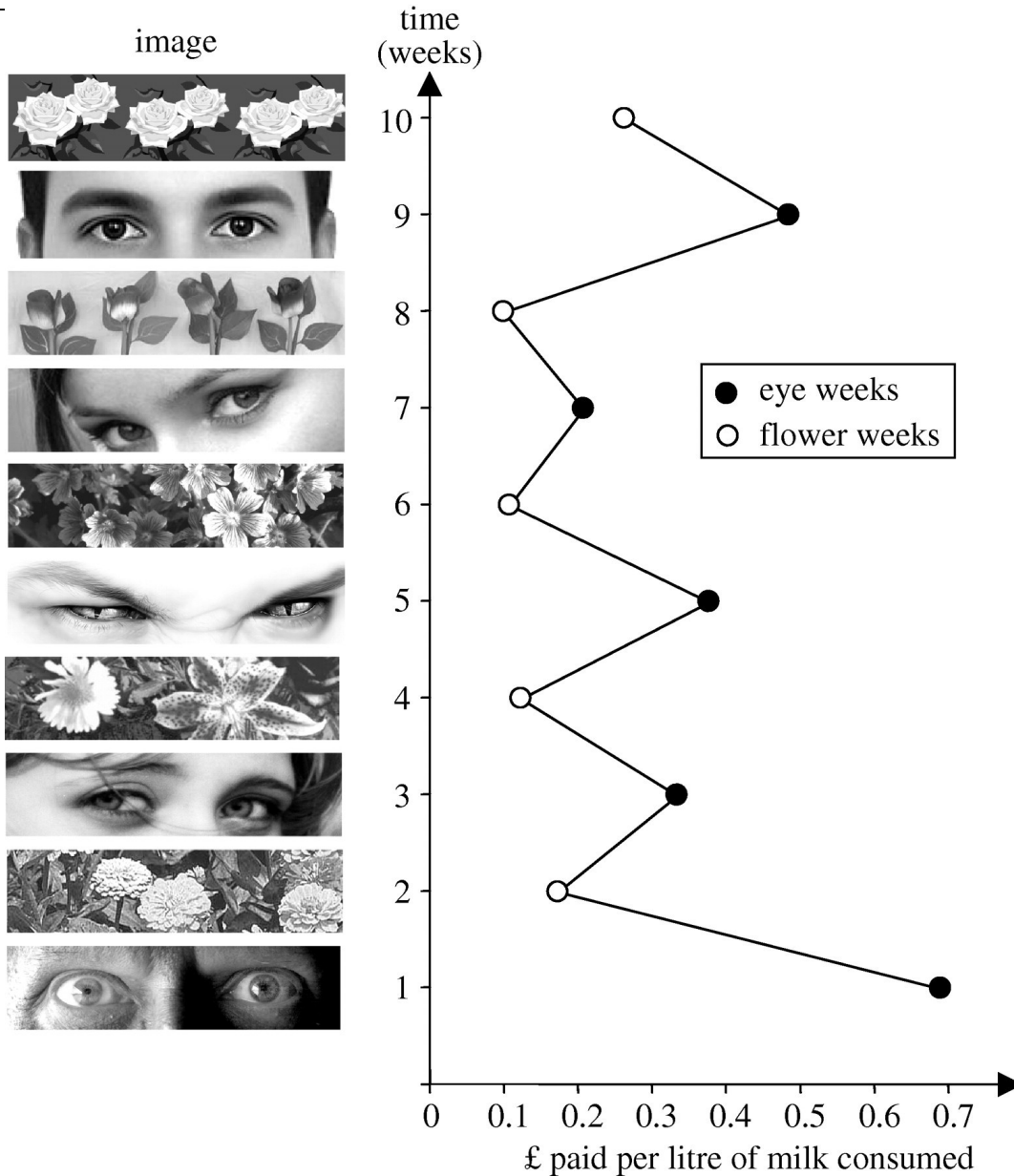
Individual differences in supply and demand of services



Grooming received/grooming given

Fruteau et al 2009

Enforcement of cooperation



Overview

1) What is cooperation?

2) Cooperation among kin

- Kin selection theory (Hamilton's inequality)
- Kin-biased behavior
- Kin recognition

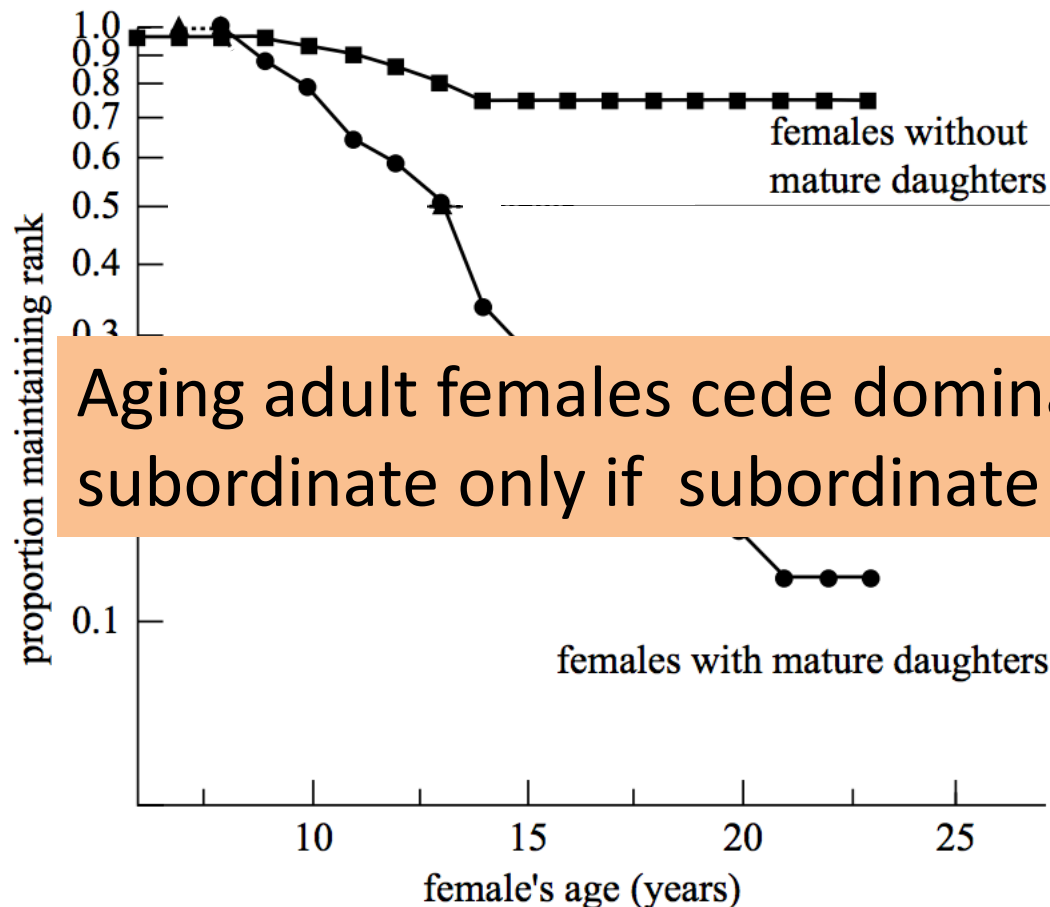
3) Cooperation among non-kin

- Mutualism
- Reciprocal Altruism
- Biological markets
- Picking Cooperation Partners



Evidence for Kin Selection in Primates

Prediction: Increased willingness to give up dominance to relatives



Yellow baboons, Amboseli

Phenotype Matching

Kin discrimination by odor

In which primate group do you think that might be particularly important?



Strepsirrhines

Phenotype Matching

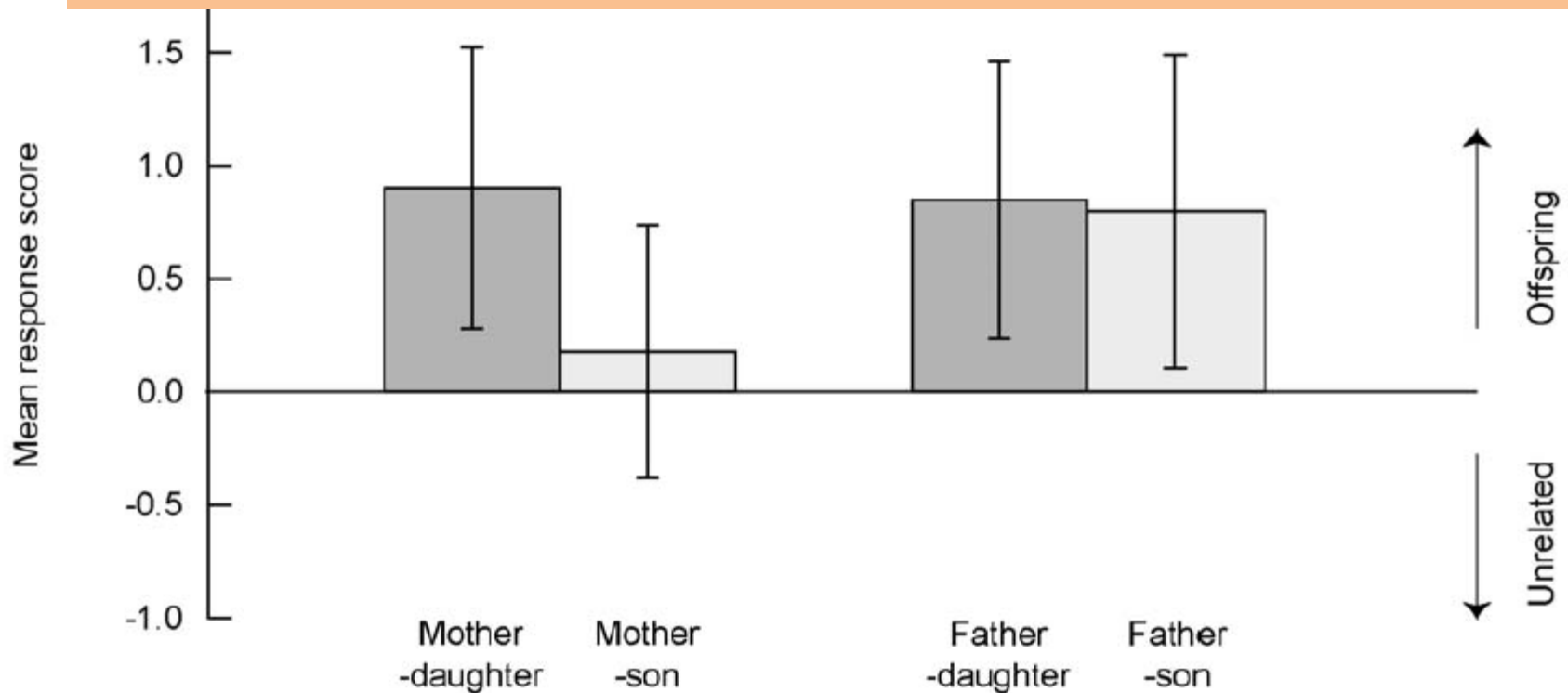
Kin discrimination by visual cue

Could monkeys **use** facial cues to recognize paternal kin?

Phenotype Matching

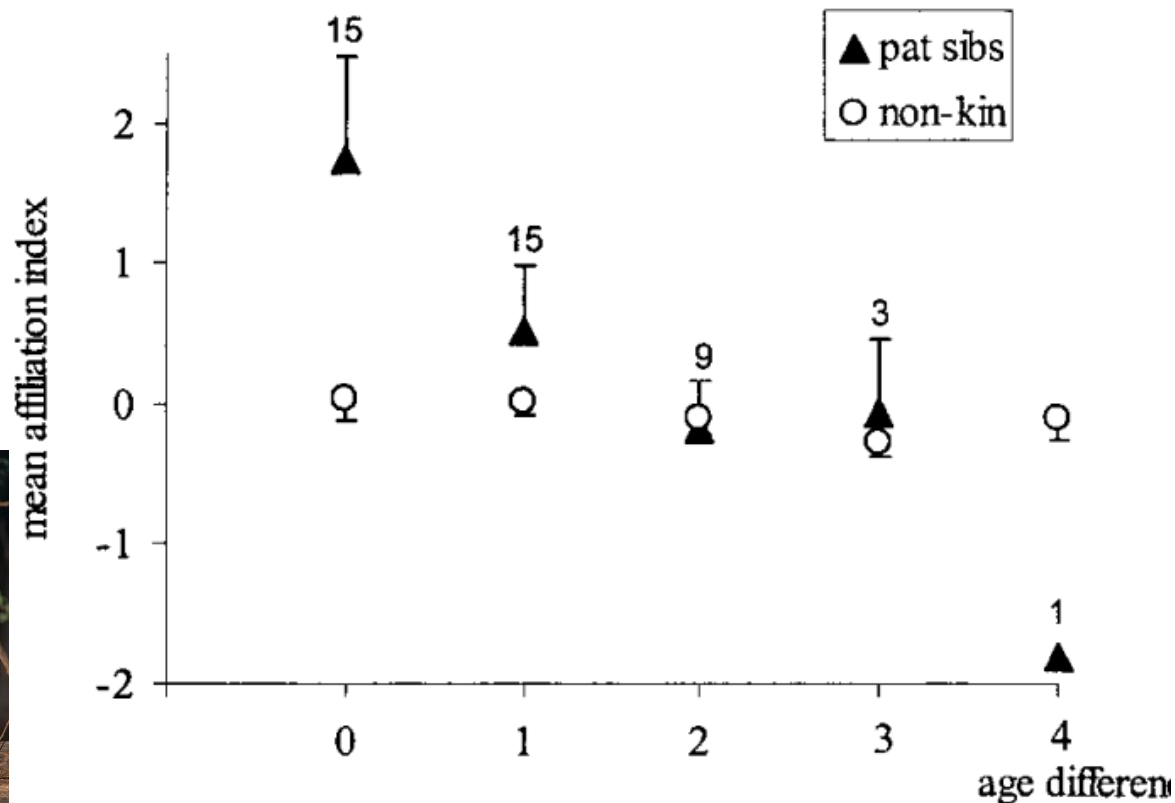
Kin discrimination by visual cue

Humans observers can discriminate paternal kinship



Familiarity

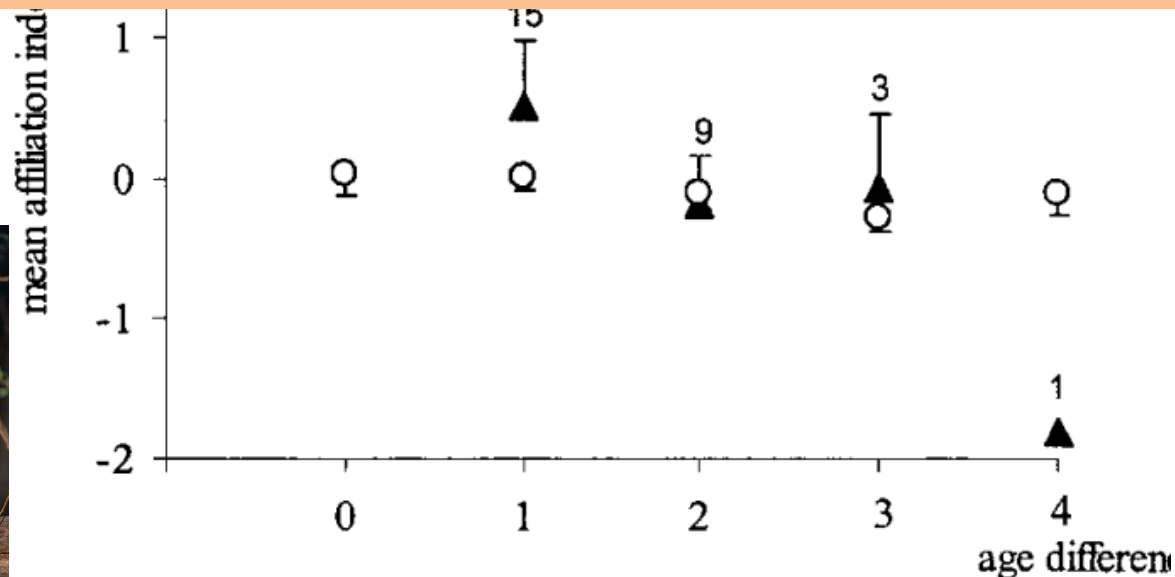
Females sometimes favor paternal kin (in multi-male groups without any apparent behavioral cues to kinship)



Familiarity

Females sometimes favor paternal kin (in multi-male groups without any apparent behavioral cues to kinship)

Paternal sisters within age-classes associated more strongly than non-paternal – but only when they were both within one year.



Familiarity

Females sometimes favor paternal kin (in multi-male groups without any apparent behavioral cues to kinship)

Paternal sisters within age-classes associated more strongly than non-paternal – but only when they were both within one year.

Many studies show no effect. (e.g. Cebus)



Picking Cooperation Partners

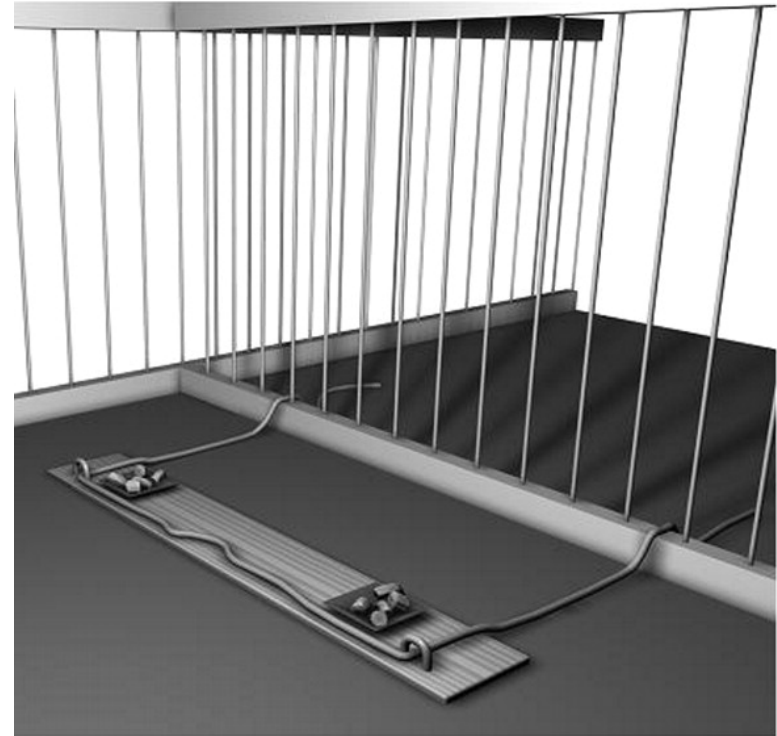
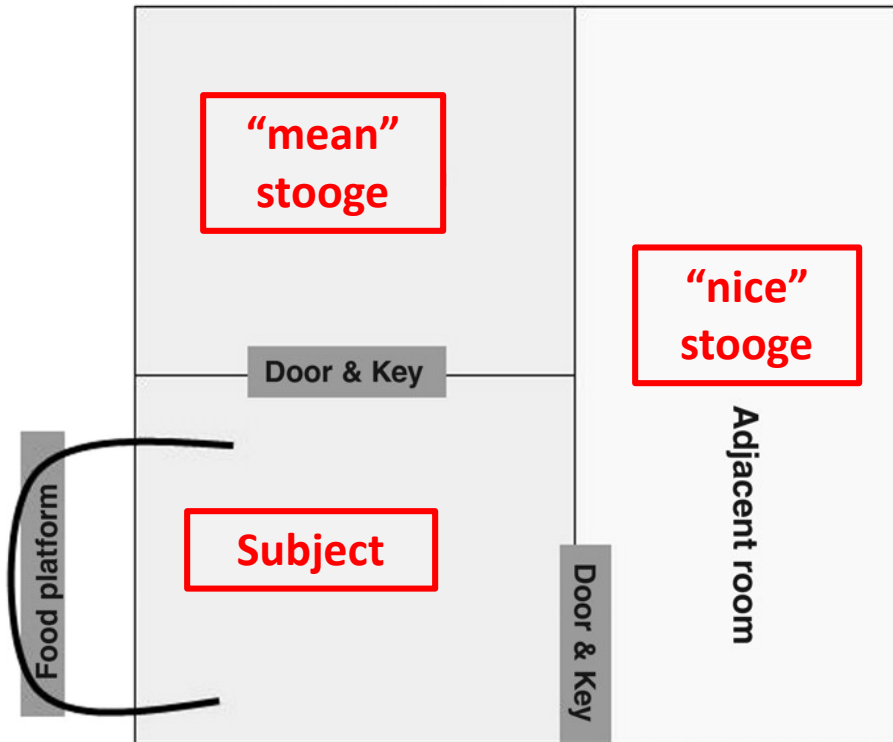
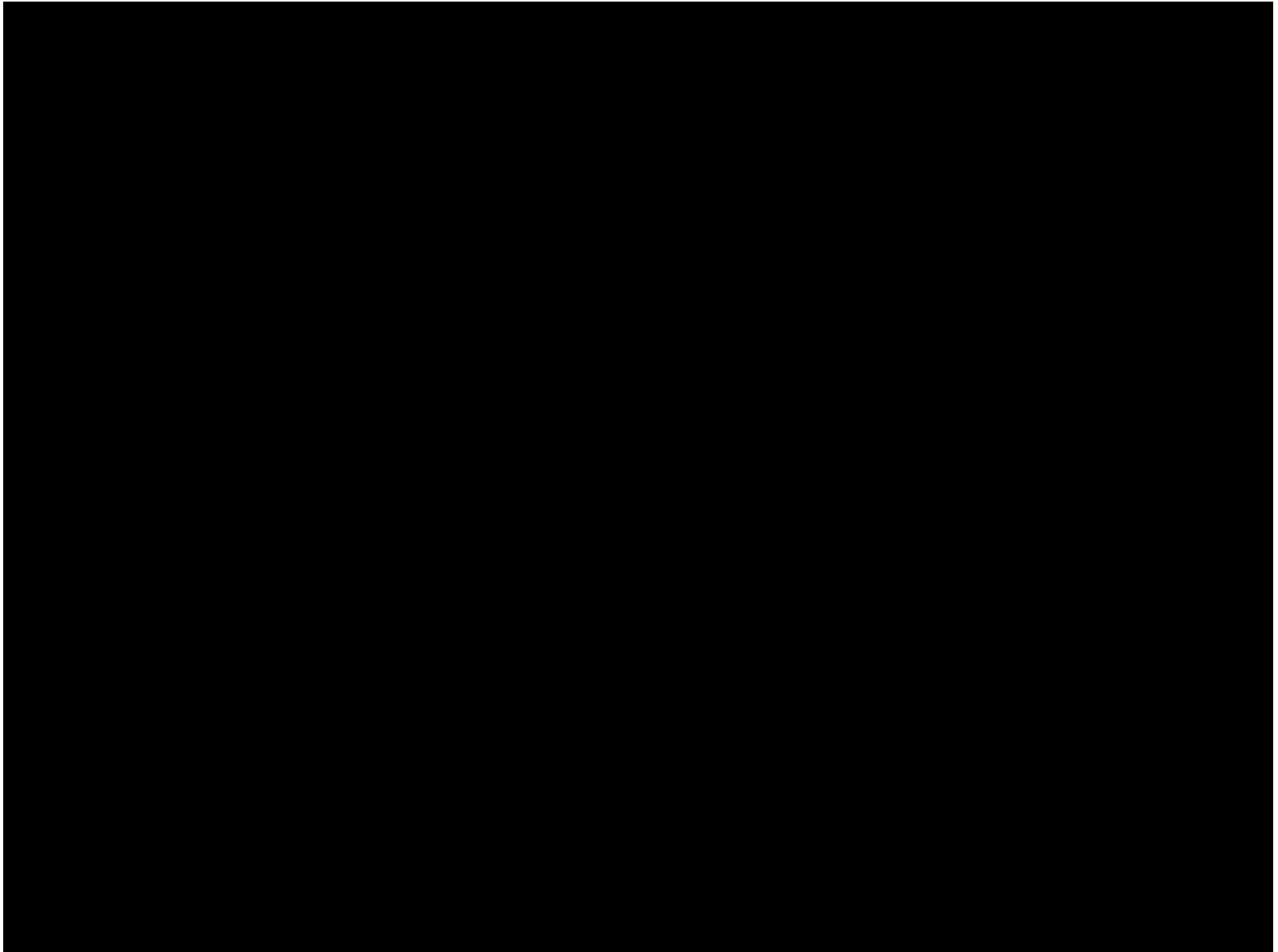


Fig. 1. Experimental setup. The baited food platform, metal loops, threaded rope extended into the test room, room layout used in the two studies, and placement of the food platform. In experiment 1, the subject was released from an adjacent room into the testing room, while the partner was "locked" in another adjacent room that only the subject could open with a key (a wooden peg) from inside the testing room. In experiment 2, the subject was released directly into the test room from a third adjacent room not represented here, while two potential partners were each locked in one of two adjacent rooms that the subject could again open with a key.

Cooperation and Social Relationships



Cooperation and Social Relationships

Experiment 2: Introduction phase

Recognition of Good Partners

