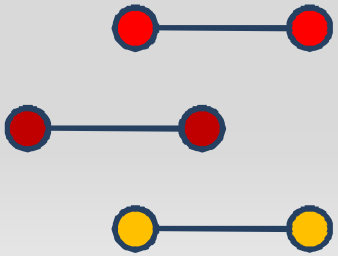
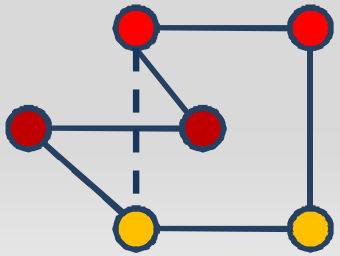
The formation of cooperating teams

Ronald Noë (Strasbourg, France)

partner control vs partner choice models of dyadic cooperation



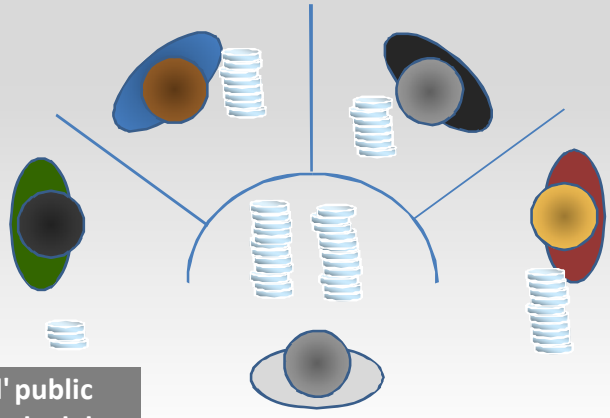
partner control models look at dyads in isolation



partner choice changes the dynamics

In recent years we have seen a similar development in public goods games

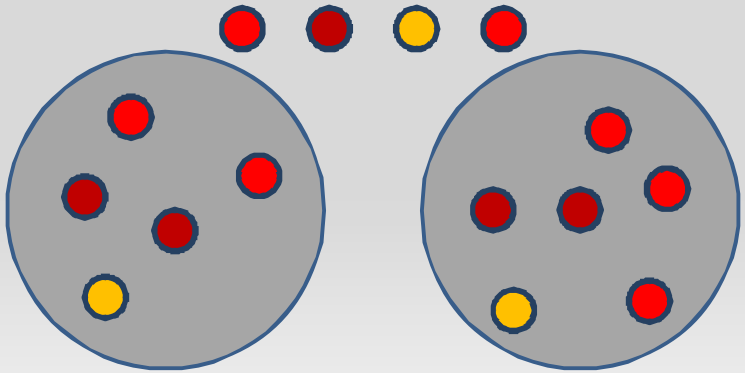
Player groups are fixed in size and partner choice plays no role in their composition in many studies



the 'standard' public goods game in the lab

experimenter

What happens if we allow dynamic group formation in public goods games?



mechanisms to consider include:

partner choice & expulsion *(by groups)*

group choice & transfers *(by individuals)*

Human cooperation is often team work

Team formation is dynamic:
the team's size and composition are determined by intrinsic and/or extrinsic factors

.. and so is animal cooperation in teams

(in this talk I'll only consider vertebrates)

In fact, I'll limit myself to non-human primates, because life is short and this talk is even shorter

Which kind of teams can we observe in non-human primates?

For example in chimpanzees:

Types of teams:

1. **the community** (N = 100 – 150)
2. **foraging parties** (N = 2 – 25)
3. **coalitions**
   - **male-male** (N = 2 – 10)
   - **female-female** (N = 2 – 10)
4. **mobbing gangs** (against predators)
5. **hunting parties** (males only)
6. **border patrols** (males only)

.. and in other primates:


gelada bachelor group

Types of teams:

1. harems
2. bachelor groups
3. sub-groups (less dynamic than foraging parties)
4. poly-specific associations


diana x red colobus mixed group

So what are the characteristics of these teams?

size & composition

	intrinsic factors	extrinsic factors
temporary	• coalition • hunting party	• foraging party • poly-specific association *(resource competition & predation)* • border patrol *(resource competition)*
permanent	• harem?	• (bisexual) social group *(predation)* • bachelor group *(exclusion & predation)*

.. and why do these teams form?

Resources ('goods') shared and produced by human teams

from Wikipedia "Public good"

	Excludable	Non-excludable
Rivalrous	**Private goods** • food • clothing • cars • personal electronics	**Common goods (Common-pool resources)** • fish stocks • timber • coal • national health service
Non-rivalrous	**Club goods** • cinemas • private parks • satellite television	**(Pure) Public goods** • free-to-air television • air • national defense

.. and why do these teams form?

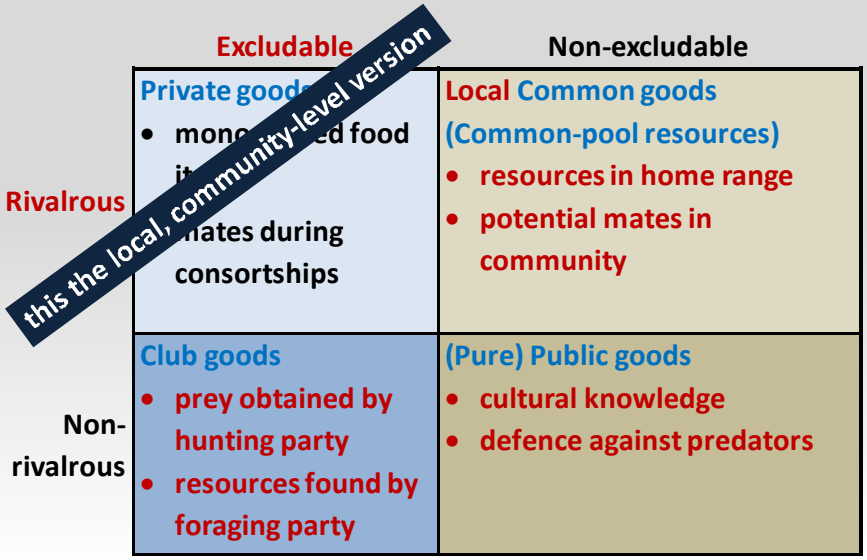
Resources ('goods') shared and produced by chimp teams

however, this the global, species-wide version

	Excludable	Non-excludable
Rivalrous	**Private goods** • mono[illegible]ed food it[illegible] [illegible]ates during consortships	**Common goods (Common-pool resources)** • resources in species range of distribution • potential mates
Non-rivalrous	**Club goods** • resources in territory • mates in group • cultural knowledge	**(Pure) Public goods** • population-wide cultural knowledge

.. and why do these teams form?

Resources ('goods') shared and produced by chimp teams



How do teams form?

Which mechanisms determine their size and composition?

Temporary teams producing a shareable common good

- ► human example: *Lamalera whale hunt*
- ► primate example: *chimps hunting red colobus monkeys*

- there is an optimal group size:
  - *too few: hunt fails*
  - *too many: spoils get thin*
- optimum team size < total number of hunters
- preference for fellow hunters on basis of reputation
  - hunting skills
  - willingness to share

Permanent team formed to attain multiple goals

- ► human example: *political parties*
- ► primate example: *'permanent' bisexual groups*

The bigger the better?

- more power relative to other political parties / groups
- larger groups provide better defence against predators

but ….

- bigger teams lead to more internal competition
  - over lucrative positions (e.g. in party executive)
  - over resources

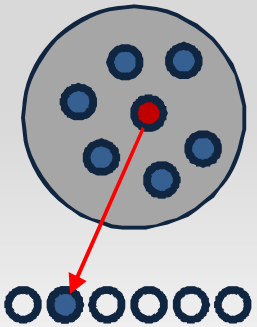
How do teams form? Which mechanisms determine their size and composition?

Example: permanent groups in non-human primates

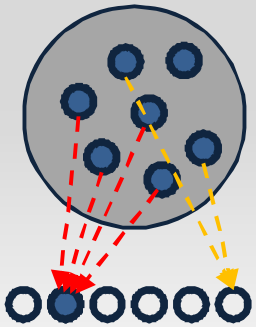
Contest competition over resources	Scramble competition over resources
► intra-group coalitions important	► intra-group coalitions not important
► kin coalitions require female philopatry	► female philopatry less advantageous
► groups likely to overshoot optimal size	► females roam to find groups of optimal size

How do teams form? Choice of individuals by teams

Recruitment of new members by **partner choice** among external individuals



Despotic partner choice



Democratic partner choice

How do teams form? Choice of individuals by teams

What are criteria for the choice of individuals?

1. **the candidates have "reputations"** (based on diligence, willingness to share, honesty, special skills, or whatever)
   - ► the one with the best reputation is chosen

2. **the candidates have no known history or visible signs of (suit)ability** (very rare in animals, notably in group-living species)
   - ► a candidate is randomly chosen and expelled from the team in case of lousy performance

How do teams form? Choice of individuals by teams

Essential differences in human and non-human team formation may include:

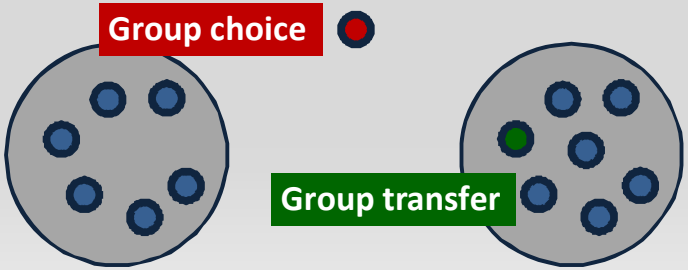
- voting over recruitment of individuals
- discussion of reputations
- exclusion of undesired members

Can animals exclude? *For example:* can chimps prevent a male from taking part in the hunt?

Probably not, but they may be able to prevent him from getting a share

How do teams form? Choice of teams by individuals

Group choice by individuals



So what kind of questions should be asked?

Do recruitment and group choice play a role ?

- are chimps free to choose their foraging party?
- can hunting teams exclude individuals from the hunt?

… and what differences does it make?

- are teams more efficient when partner choice determines their composition?
- do individuals have higher payoffs when they are free to choose among teams?

.. and what could/should be done?

Experimental work (notably human subjects):

- public goods games played with teams that form spontaneously out of a large set of subjects
  - size of team either free or set by experimenter
  - team formation either despotic or democratic
  - eventually, team switching possible after x rounds

.. and what could/should be done?

Observational work; animal field work:

- how do teams form?
  - foraging parties in fission-fusion species
  - hunting parties
  - mobbing gangs
- what criteria do individuals use to choose teams?
  - e.g. size and composition of foraging parties (notably sex ratio & relative rank of members)

.. and what could/should be done?

Observational work; anthropological field work:

- how do teams form?
  - hunting parties
  - work teams
- what criteria do individuals use to choose teams?
  - reputation

    e.g. non-intentional vs intentional non-cooperation

Example: work on Shuar "work teams" by Michael Price (2006):
Organizational Behavior and Human Decision Processes, 101, 20-35
Journal of Organizational Behavior, 27, 201-219

.. and what could/should be done?

Theoretical work:

- allow for dynamic team formation in models of public goods games:
  - variable team size
  - recruitment on basis of reputation
  - exclusion on basis of past behaviour
  - despotic recruitment and exclusion (role of leader)
  - democratic recruitment and exclusion (voting option)

Recently, a model with similar characteristics was proposed for indivisible public goods

Koike, S., Nakamaru, M. & Tsujimoto, M. 2010
Evolution of cooperation in rotating indivisible goods game.
Journal of Theoretical Biology, 264, 143-153

- inspired by ROSCAs (rotating savings and credit associations)

in which "*a reputation for honesty and reliability is an important asset*"

- propose a model based on a "rotating indivisible goods game"
- a peer selection rule based on reputation goes both ways: groups choose peers and individuals choose groups.
  It can also lead to exclusion of "defaulters"
- the model doesn't assume costly punishment etc.

.. and another one for public goods games with constant group size ..

Wu, T., Fu, F. & Wang, L. 2009
Partner selections in public goods games with constant group size.
Physical Review E, 80, 026121.

- models using Barabási-Albert (scale-free) networks
- notably interesting: reputation based partner selection
  - Conclusion of the authors: *"As a consequence, cooperation can be induced to a higher level"*
    (the paper is written in bit hard to read Janglish)

Some ingredients for a model or experiment?

- n groups of 4 players, initially of random composition
- 5 rounds of classical public goods (no contact; nicknames etc.)
- All n groups simultaneously vote to expel their 'worst' member (= member that gets 2 or 3 votes)
- List of nicknames of expelled members is made public with their average contributions
- Groups consisting of remaining 3 members vote, in randomly chosen order, for a new member
- Another 5 rounds of public goods etc.

Some ingredients for a model or experiment?

Many variations are possible, for example:

- After 5 rounds each player can apply for a group transfer:
  - The average payoff of each group is announced
  - Players can apply for membership in 1 group with their average contribution as their only known characteristic
  - The members of the solicited group (only those that did NOT demand transfer) vote about their acceptance
  - Any applicant with a majority vote is accepted

    i.e. group size is variable

    nevertheless more free-riders in larger groups?

last slide

We had many years of stagnation with theoreticians staring themselves blind on partner control models of dyadic cooperation.

Could we avoid the same thing from happening with n-agent cooperation?

My hunch is that the way teams form has more impact on outcomes than the way peers are controlled within teams