Prosocial behavior: Kin selection

9-20-07

Announcements

- Research starts next class
- Exam scores
  - Average: 82
- Readings:
  - Chapter 13 pages 535-549

Next 2 Lectures

- What is altruism?
- Why was altruism viewed as a mystery?
- What do the lessons of indiscriminate altruists and green beards teach us?
- How does relatedness lead to altruism?
- What is Hamilton’s rule?
- What is an Evolutionary Stable Strategy?
- How do we detect kin?
- What is Parent-Offspring conflict?

Routes to altruism

- Kin selection/Inclusive Fitness
- Reciprocal Altruism
- Friendships & Deep Engagements

Definition of altruism

- A design feature (gene) that causes its bearer to behave in ways that:
  - increases another individual's chances of surviving and reproducing
    - i.e., their fitness
  - and decreases their own fitness

The problem of altruism

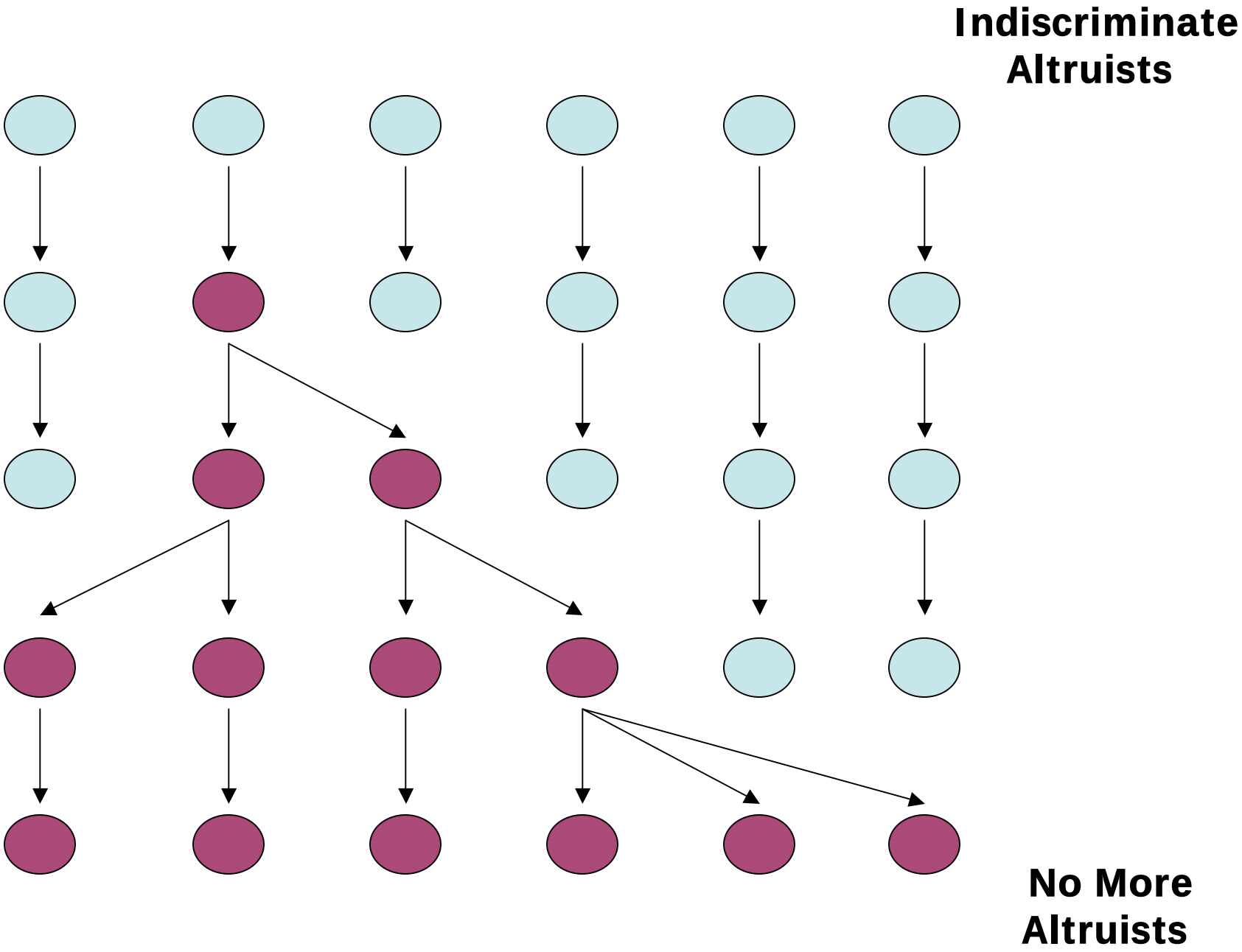
- Natural selection → differential reproduction
- A design that helps others is costly.
- Consider the fate of a mutation that helped others versus one that was selfish
  - How in the world can a gene that causes its bearer to suffer a reduced probability of survival and reproduction evolve???????????
- Doesn't this mean that selection can never favor altruism?
- How can niceness (altruism) evolve?

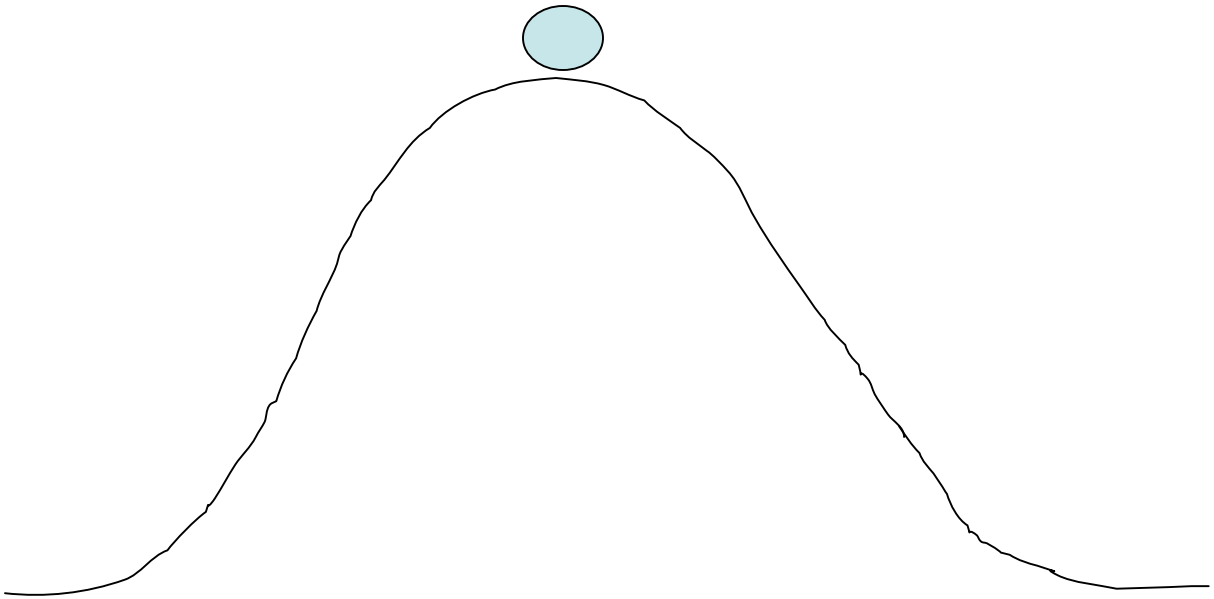
Let’s start with a population of…

- Indiscriminate Altruists
  - Doesn’t care about who receives their help
  - Doesn’t care if the favor is ever returned
  - Doesn’t care about the cost of help
- Everybody has the gene to help others whenever, where ever, etc.

Imagine a mutation…

- Causes an individual to receive help but never give it!
  - Not incurring same costs
  - Only benefiting
  - Which behavior will win out?
- What would happen?


Indiscriminate Altruists
No More Altruists



Population frequency of indiscriminant altruists

- Question:
- If not indiscriminate altruism, what are the conditions under which caring for another’s welfare can evolve?

- We’re talking about the selection of genes that produce helping behavior.
- How can a particular gene that causes helping behavior spread?
- If you help individuals at random, this cannot change the frequency of any allele
  - time they share the same allele canceled by the times they do not.

What if you knew who shared the same gene (and behavior)?

- What if there was a mutation that caused someone to help another individual who happened to have the same gene?
- How would you know they had the same gene?
  - What if there was a marking
    - like a green beard.

Green Beards

- So let’s say a gene has two effects:
  - produces a greenish beard
  - motivates helping toward those who have a green beard.

“Grow a green beard and be nice to others who have one too”

A mutation!

“Grow a green beard”

The lesson of indiscriminate altruists and green beards

- Evolution of altruism is not straight forward.
- Is there someway to know who has a probability of sharing a particular gene in common?
- Who has a high probability of sharing a particular gene?

Have to think about the different ways a gene can spread.

- How can a gene increase in frequency?
- Answer:
  - It can make copies of itself
  - It can help make copies of copies of itself
    - Intentional language warning!

YOUR FAMILY: CLOSE GENETIC RELATIVES

Kin Selection/Inclusive Fitness Theory

- W.D. Hamilton (1964)
  - An allele may spread because it causes its bearer to reproduce (RS), OR…
  - because it causes its bearer to help others to reproduce who are likely to carry the same gene.
- This is called ***kin selection*** because individuals who are likely to carry the same genes are genetic relatives.
  - have the same genes from having ancestors in common.

Fitness and Inclusive Fitness

- Fitness:
  - The ability for a design feature to reproduce itself by promoting the survival and reproduction of its bearer

- Inclusive fitness:
  - The ability of a gene (design feature) to cause its own spread either through its bearer or those having a high probability of ***sharing the gene***, close genetic relatives.

But, don’t we all share genes?

- By virtue of being members of the same species, we all share approximately 99% of the same genes.

- However, the variation in the other 1% of the genome allows for the evolution of kin selection.

Degree of relatedness (r)

- *r* is the probability an allele present in one individual is present in another individual, over and above the population average frequency of the allele.
- *r* is the probability that alleles sampled from 2 individuals are identical by descent
- Events of mating organize relatedness between individuals.

Degree of relatedness (r)

- r =0.5 for:

  Parents & offspring

  Siblings
- r=0.25 between:

  Grandparents & grandchildren

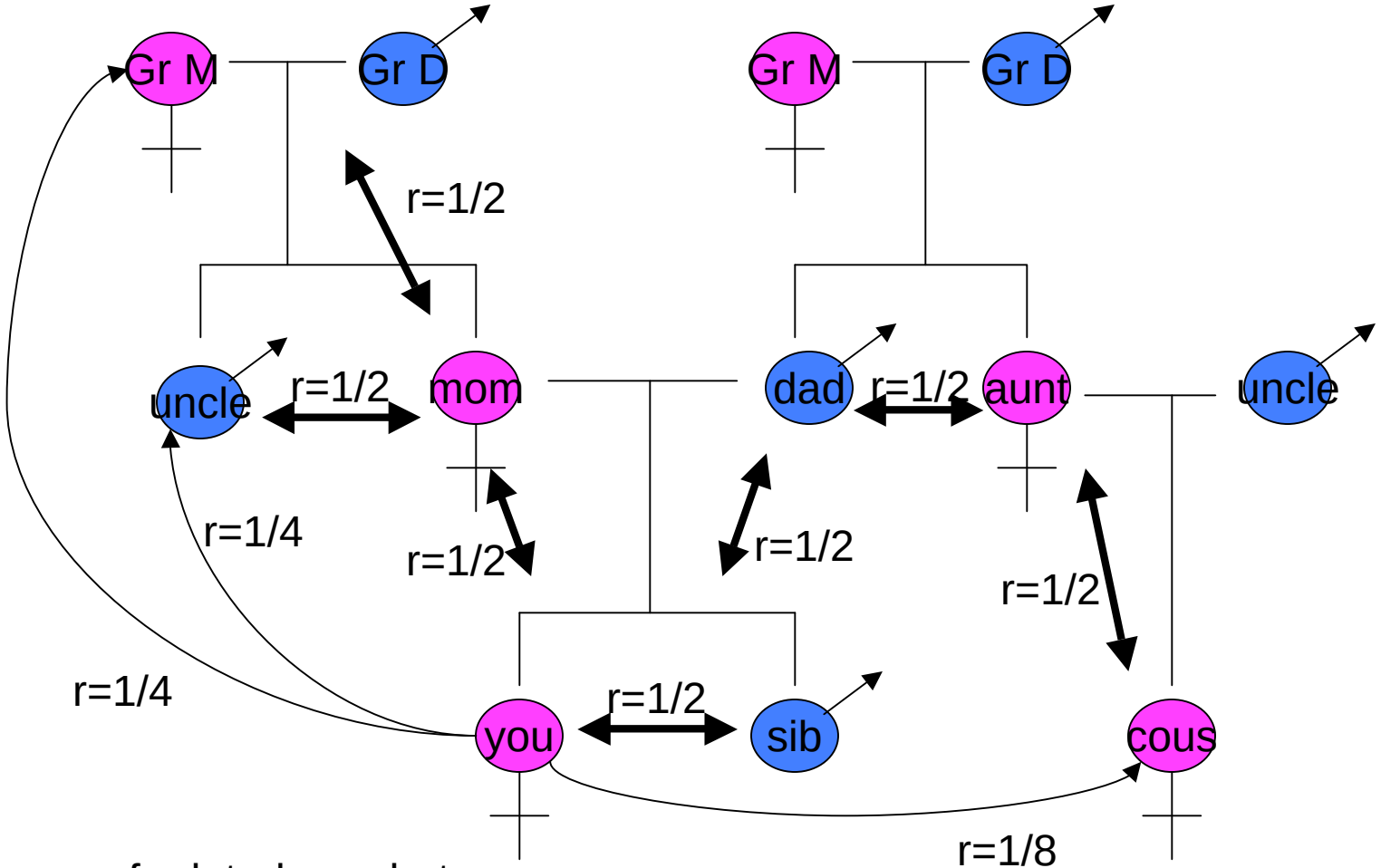
  Uncles or aunts & nieces or nephews

  Half siblings
- r=0.125 between:

  1st cousins
- r=0 between:

  Step parents & children

  Step siblings



Degrees of relatedness between:
You and mom, you and dad, you and sib = ½
You and uncle = ½ * ½ = ¼
You and grandparents = ½ * ½ = ¼
You and cousin = ½ * ½ * ½ = 1/8

- Asexually reproduced individuals, and identical twins, are genetically identical.
- Therefore, r=1.0

Hamilton's Rule

- When should you help someone?
- When the $B_{\text{to them}} > C_{\text{to you}}$
- But need to take into account probability of sharing the same gene (allele) for helping
- Whether you help someone is a function of:
  - The probability you share the same gene (r)
  - How costly it would be to help (C)
  - How much of a benefit the person receives (B)
- Hamilton's rule: rB>C
- In general, the more related, the greater the helping behavior.

rB>C

- Should you help your sibling?
  - B = 10, C=6, r = ½
  - rB>C? (1/2)10 > 6? 5 > 6? No!
    - Does not pay to help in this situation

- Should you help your sibling?
  - B = 8, C = 3, r = ½
  - rB>C? (1/2)8 > 3? 4 > 3? Yes!
    - So it pays to help
  - What if it was an uncle or aunt? (r=1/4)

Evolutionary Stable Strategy

- An ESS is a behavior/strategy/trait that is the optimal solution and cannot be replaced or out-competed by mutants.
- Whatever the relative proportion of a gene, following Hamilton's rule is the most effective rule.
  - Stable against invasion
  - therefore, those genes will be most retained, less displaced, that create effects that follow Hamilton's rule.
  - Aliens

Studies on kin-directed altruism

- Who leaves how much to whom?
  - Smith et al (1987) looked at 1000 British Columbian wills.
  - Judge and Hrdy (1992) 1500 inheritances from Sacramento California between 1890-1984.
  - Webster (2003) survey to college undergraduates.
- All found the following:
  - Benefactors left the greatest % to their closest genetic relatives, a lesser % to those more distantly related, and the least to non-kin or organizations.

How do we know “r”?
Kin Detection

How do we know who counts as a mother, father, sibling, or offspring?

What are the cues we use?

- mother?
- father?
- offspring?
- sibling?