

The Modern Synthesis

- Coefficient of relatedness (r)
- Alleles
- Identical by descent (ibd)
- Hamilton's rule ($r > c/b$)
- Green beard
- Frequency-dependent selection
- Evolutionarily stable strategy (ESS)
- Autosome
- Heritable
- Reciprocal altruism
- Costly signaling
- Deme selection
- Phenotype matching

Heritability

- The proportion of the total phenotypic variance in a population that is caused by genotypic variance.
- Heritable ≠ Genetic (Inherited)
- High heritability means that a relatively large proportion of total variance in the trait is caused by variance in genes, not caused by genes
- Low heritability means that trait variance caused by variance in the environment is relatively greater than that caused by variance in genes

$$\frac{V_{\text{genetic}}}{V_{\text{genetic}} + V_{\text{environmental}}}$$

Twin Studies and Heritability

Behavioural geneticists often use the correlations between traits in identical (MZ) and fraternal (DZ) twins to determine the proportion of variance due to environmental factors and that due to genetic factors.

If MZ and DZ twins have equally similar environments, the differences in the correlations must be due to differences in genes.

Why is there heritable variation left?

- Variability represents functionless noise
 - The gene has not yet gone to fixation.
- Spatial or temporal heterogeneity of selection
 - Variation in the environment may cause different genes to be most adaptive in different times or places.
- Frequency-dependent selection
 - The fitness of a trait may be a function of its frequency in the population. If its fitness is higher than alternatives only when rare, selection will maintain the trait at low frequency.
- Heterozygote advantage
 - If having more than one allele type is more advantageous than having only one, selection will maintain more than one allele type, resulting in some homozygous individuals.

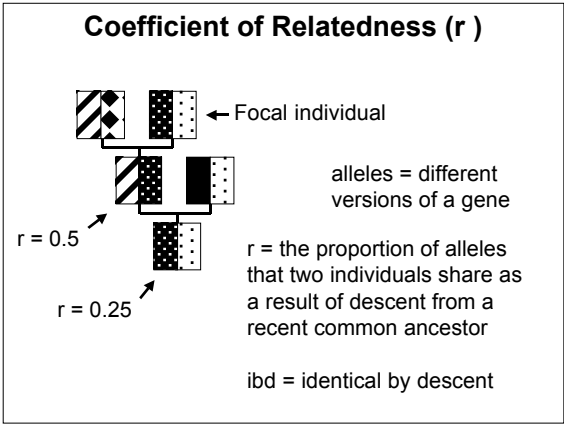
Evolutionarily Stable Strategies

- An ESS is a strategy which, if nearly universal in a population, can not be beaten by any other strategy.
- An ESS could be worse than another strategy when rare.
- In an anonymous one-shot Prisoner's Dilemma, the ESS is to always defect.
- How could cooperate ever be an ESS?

		cooperate		defect	
cooperate	cooperate	3	3	0	5
	defect	5	0	1	1

Why Are Organisms Ever Altruistic?

- Kin Selection
- Reciprocal Altruism
- Costly Signaling
- Group Selection?



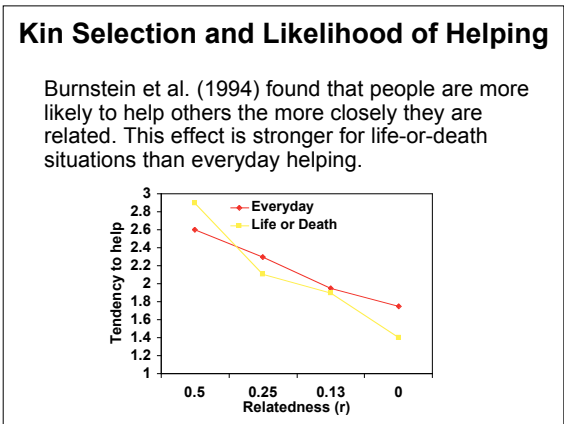
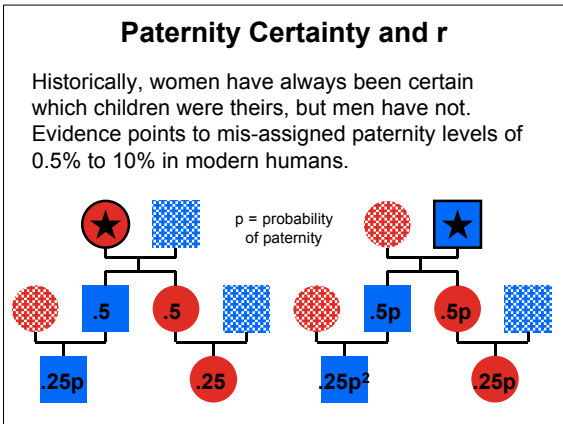
Hamilton's Rule

- r = relatedness
- c = cost to the actor
- b = benefit to the recipient
- If a trait causes an actor to direct altruistic behaviour towards a recipient with relatedness r , and $r > c/b$, then the genes influencing that trait will be favoured by natural selection.
- Relatedness is only important because it is a statistical indicator of whether an individual shares the gene influencing the trait.

$$r > \frac{c}{b}$$

Green Beard Hypothesis

- If a gene causes a trait, such as a green beard, AND the ability to detect the trait in others AND direction of altruistic behaviour towards such individuals, the gene would be favoured by natural selection.
- This seems highly unlikely, but evidence has been found of such a gene in red fire ants (Keller & Ross, 1998).



Kin Selection and Food Sharing

In 1983, Ifaluk, a Micronesian atoll totaling 0.6 square miles, had a population of just 446 people in 56 households.

For 12 consecutive days, adults in 10 households kept records of the food they gave to other households and of what they received. Sharing food between households on the separate "islets" entailed a walk of 300 yards, including wading a shallow channel.

Betzig & Turke (1986) computed the pairwise r for all dyads (pairs of people) on Ifaluk as a whole, and compared it to the same measure for all dyads across households that shared food.

Food sharers	$r = 0.056$ ($n = 84$)
on islet	$r = 0.049$ ($n = 62$)
between islets	$r = 0.076$ ($n = 22$)
All dyads	$r = 0.027$ ($n = 1540$)

Kin Selection and Group Solidarity

An Amish Church in Pennsylvania fissioned in 1978. The 228 married people divided into two churches, one with 142 members, the other 86.

After the split, the relatedness of members of the same congregation had gone up, and the average relatedness of pairs of persons in different congregations was lower.

Even in this endogamous community, where > 90% of pairs shared a known common ancestor, social solidarity apparently tracked r . The sex difference reflects the patrilineal ideology of the community. (Hurd 1983)

	Pairs of males	Pairs of females
Average r before split	.069	.069
After split :		
within congregations	.085	.071
across congregations	.052	.050

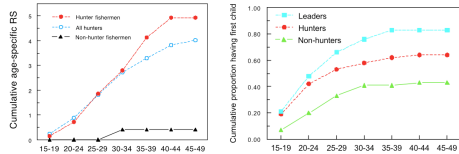
Reciprocal Altruism

- In a sequential Prisoner's Dilemma, Clark & Sefton (1999) found that cooperation or defection by the other player in the last game is the most important predictor of cooperation or defection.
- Reciprocal altruism requires:
 - Repeated interactions between individuals
 - Memory for which individuals you interact with and whether they cooperated or defected (cheater detection and punishment)

Costly Signaling

Meriam turtle hunters have:

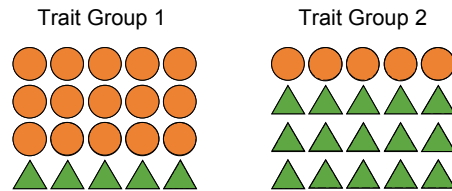
- Earlier onset of reproduction
- Higher average number of mates
- Higher age-specific reproductive success



(Bird, Smith & Bird, 2001)

Deme Selection

- Altruistic individuals
- ▲ Selfish individuals



Kin Recognition

- Association
- Situation
- Location
- Social Learning
- Phenotype Matching
 - Odour / MHC
 - Physical Resemblance