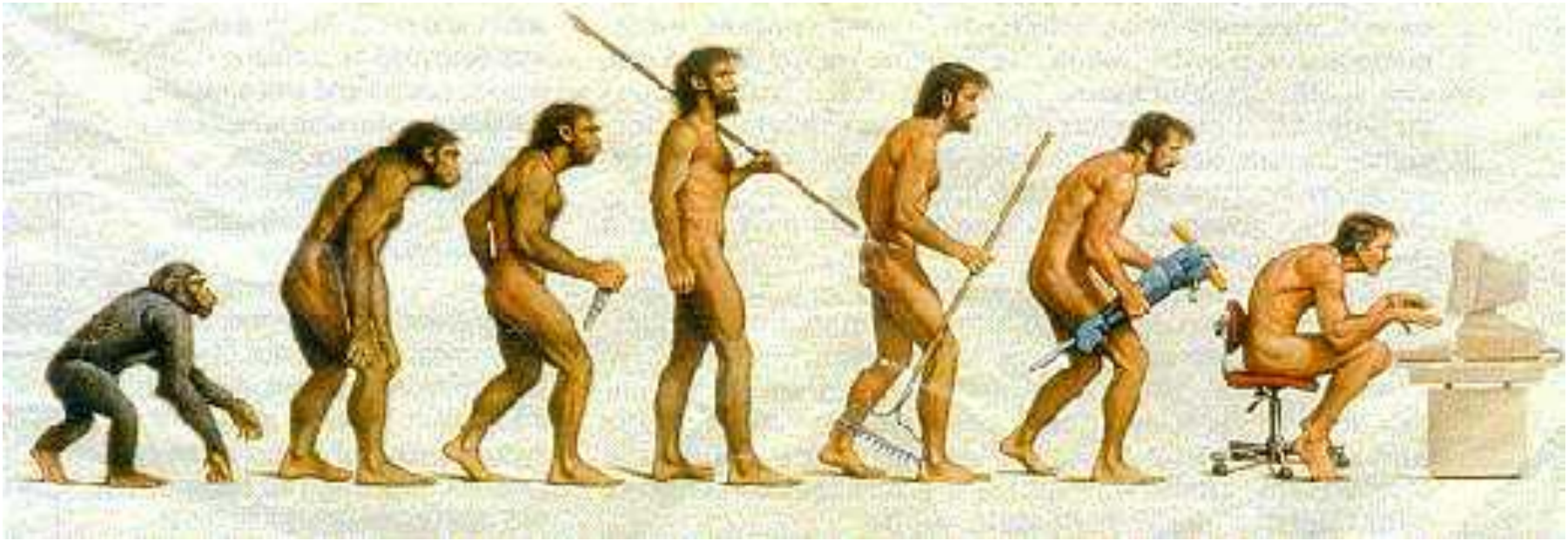
Evolutionary Theory: The Basics

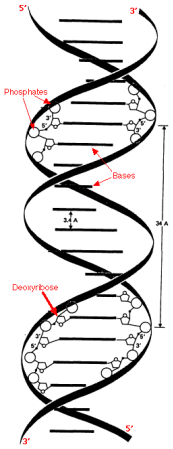
Cogs 184 * Modeling Cognitive Evolution

When constructing an evolutionary scenario…



…need to understand, apply Biological Principles!

Some Basic Concepts



- Geneotype
  - The organism's genetic makeup
  - Mostly recipes for building proteins
  - Alleles (versions) of a gene can be dom/recessive

- Phenotype
  - The organism's physical & behavioral characteristics




Some Basic Concepts

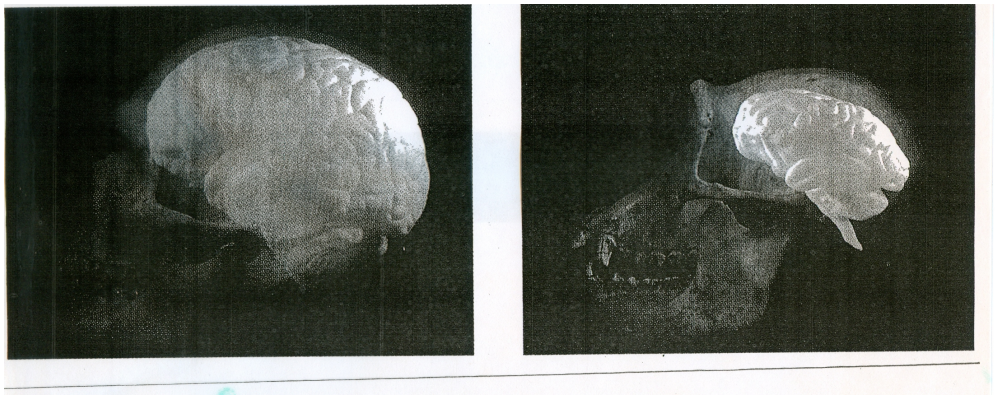
- Most phenotypic traits are polygenetic
  - e.g. Even eye color requires 6 genes to code for
  - So how silly is it to discuss/seek "*the* language gene"

FoxP2 Gene

Some Basic Concepts

- Most phenotypic traits are polygenetic
  - e.g. Even eye color requires 6 genes to code for
  - So how silly is it to discuss/seek "*the* language gene"

- Altho sometimes one small genetic change
  >> huge phenotypic effects
  - A change in a CONTROL gene (Operator, Supressor)
    - Can alter timing, order of processes
    - e.g. During brain development, cells first duplicate, then differentiate
    - By suppressing onset of differentiation, duplication continues longer
      >> can triple brain size!



Some Basic Concepts

- Because genetic material not generally available in fossils...
  - Although note recent Neanderthal discovery!

- We will mainly use phenotypic traits as the basis for our evolutionary scenarios
  - Note: This will mean ASSUMING those traits are HERETABLE!!

- "Heretiability" mainly genetic
  - We will later also discuss MEMES passed to next generation
  - **Meme** = cultural unit of selection
    - Religious practice
    - Writing
    - Democracy, etc. etc.

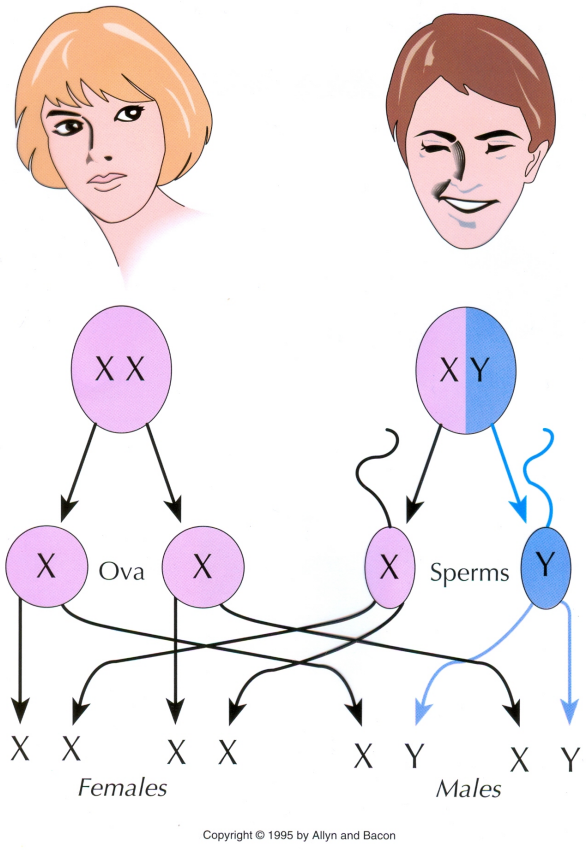
Evolution by Natural Selection

Charles Darwin

Evolution by Natural Selection

1) Variability, across a population, in a heritable trait

- Some sources of variance:
  - Recombination, Mutation (e.g. Insertion, Translocation), etc.



Evolution by Natural Selection

1) Variability, across a population, in a heritable trait

- Some sources of variance:
  - Recombination, Mutation (e.g. Insertion, Translocation), etc.
- Note, most genetic changes are deleterious > nonviable offspring

2) Selective environment

- So, context determines if a trait is "adaptive"
  - If new trait arises, can be selected by existing environment – or-
  - If environment changes, pre existing (or new) trait can now become adaptive

3) >> Differential reproduction

- In next generation, genome present in a larger portion of the population
- So, "Fitness" not generally about survival,
  but about a greater likelihood of reproducing

Evolution by Natural Selection

1) Variability, across a population, in a heritable trait

- Some sources of variance:
  - Recombination, Mutation (e.g. Insertion, Translocation), etc.
- Note, most genetic changes are deleterious > nonviable offspring

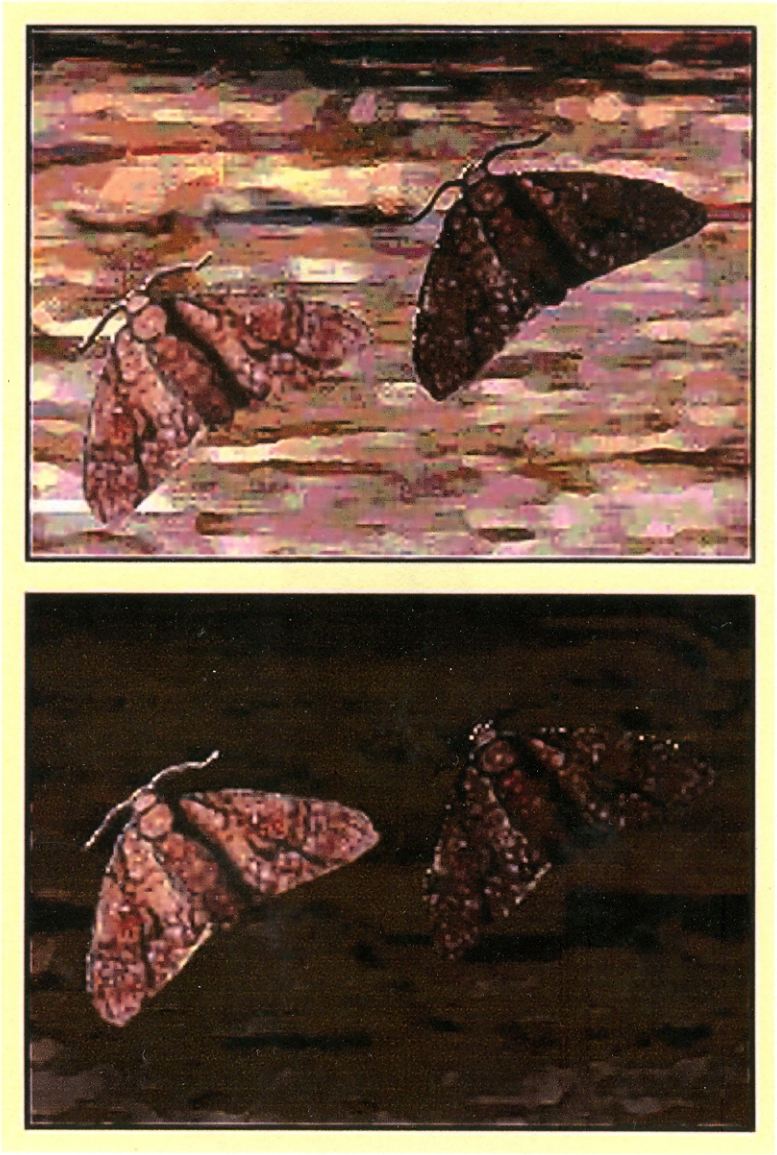
2) Selective environment

- So, context determines if a trait is "adaptive"
  - If new trait arises, can be selected by existing environment – or-
  - If environment changes, pre existing (or new) trait can now become adaptive

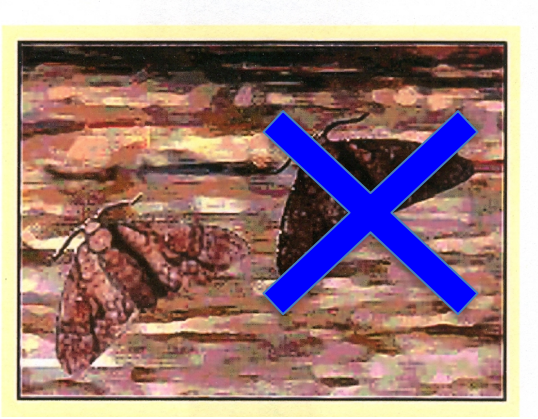
3) >> Differential reproduction

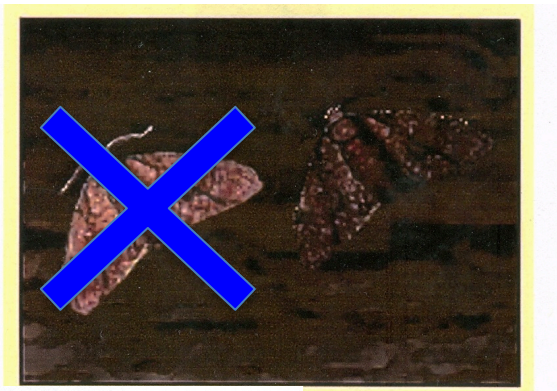
- In next generation, genome present in a larger portion of the population
- So, "Fitness" not generally about survival,
  but about a greater likelihood of reproducing

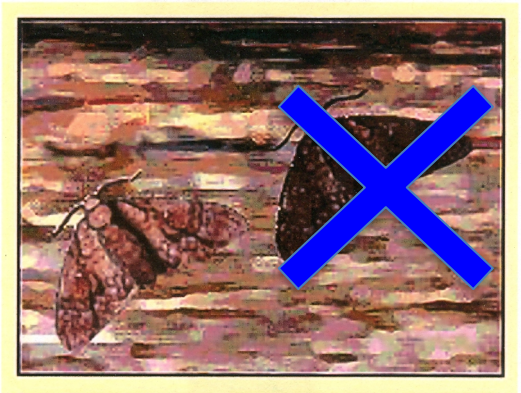
e.g. The PepperedMoth

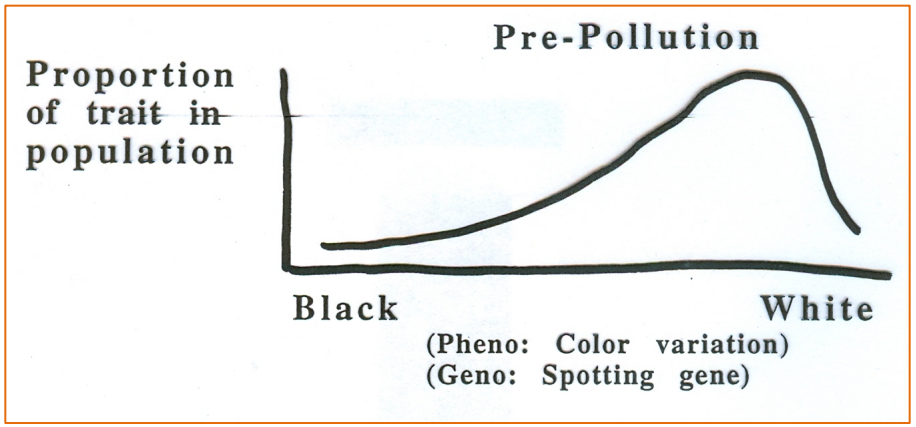


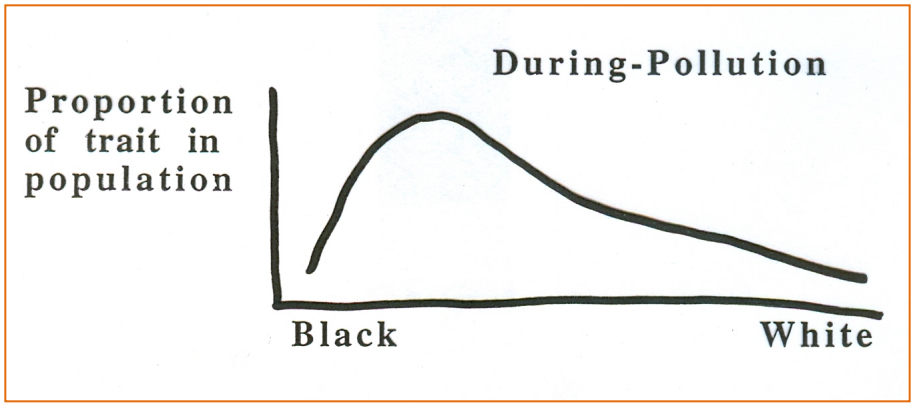
e.g. The PepperedMoth

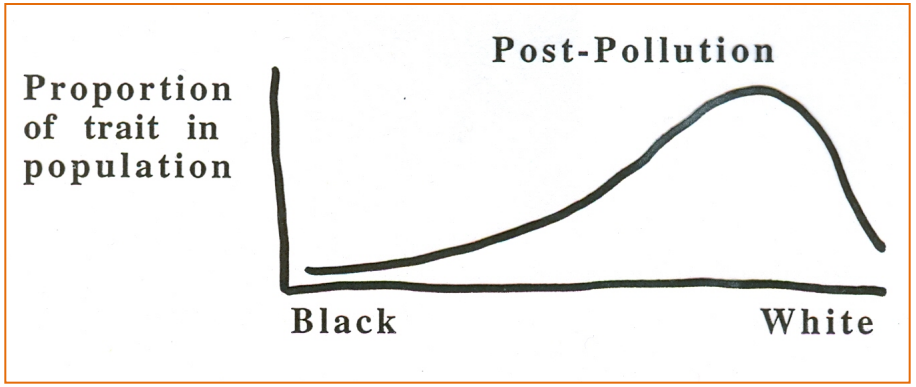












Teleological Error

- Evolution is NOT a goal-oriented process!
  - So, you may NOT say:
    "Humans evolved speech *in order to* better communicate"

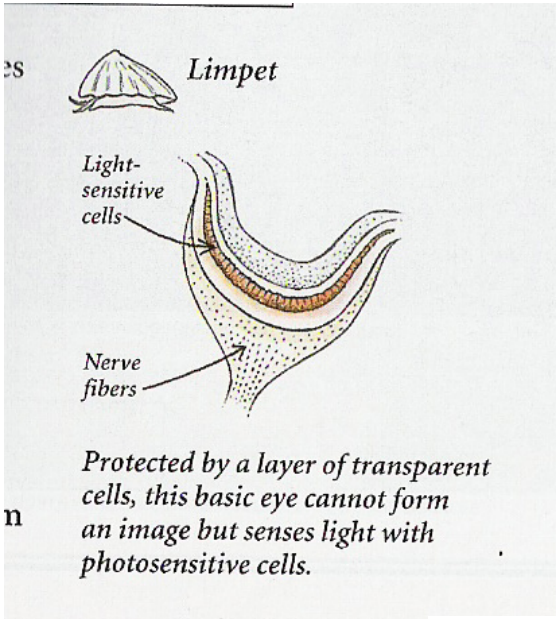
- It is, instead, a random process by which traits are better enabled by current environment
  - So, you MAY say:
    "Since those who could speak reaped the advantages
    of improved communication,
    they were more reproductively successful
    and thus passed on the genes for speech"

Tinkering

- Evolution occurs through SMALL changes in existing structures
  - Most genetic changes are deleterious
  - Occasionally such changes can confer a reproductive advantage…

Tinkering

Tinkering



e.g. Evolution of the Eye through small changes pre-existing structures

Tinkering

Exaptation

Spiney projections originally adaptive for defense or temperature control…

Become “exapted” for Flight

Tinkering

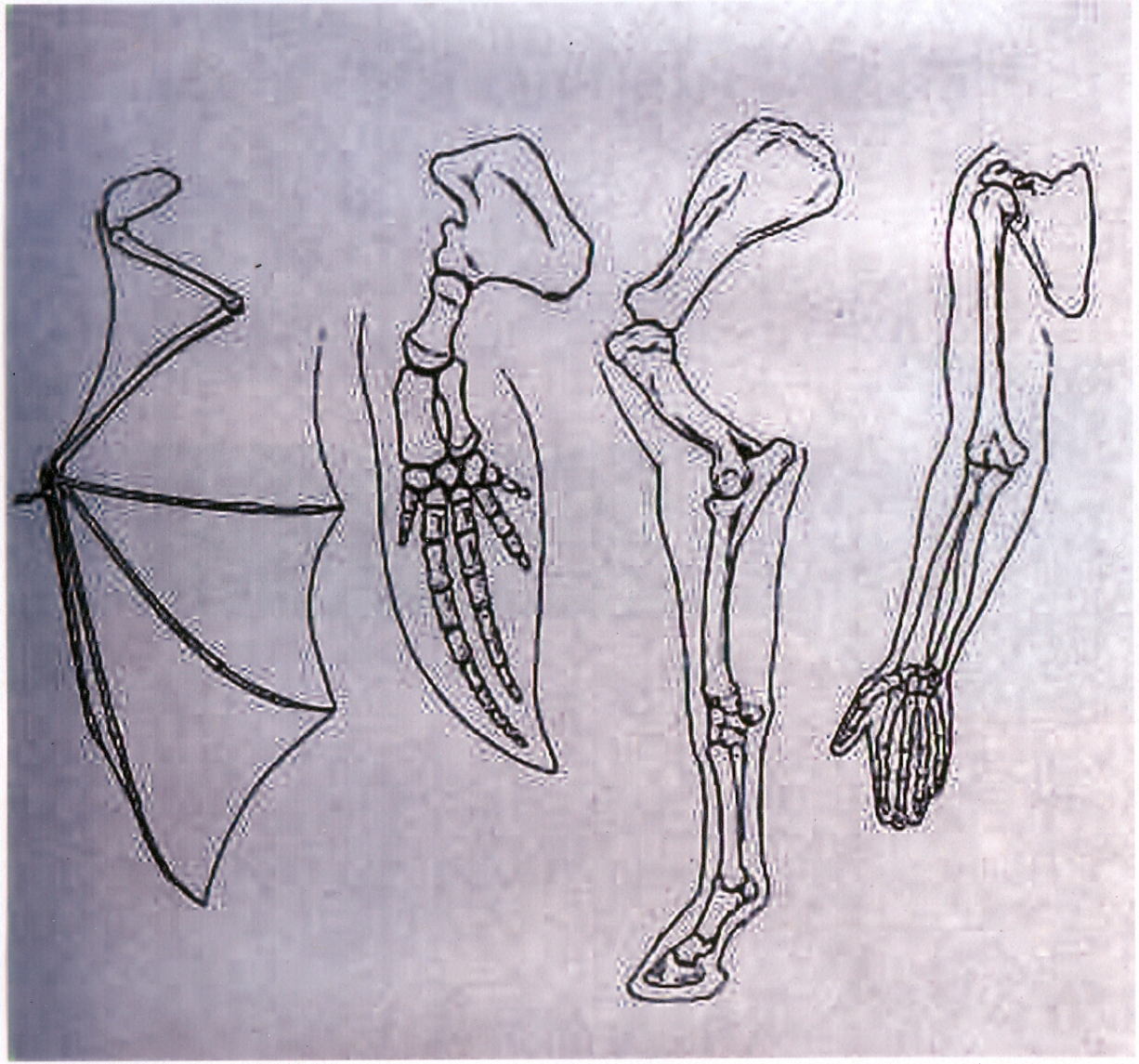
Exaptation

e.g. Primate tongue dexterity,
adaptive for shelling seeds…

…was then exapted for articulate speech

Convergence

Convergence



Homologues

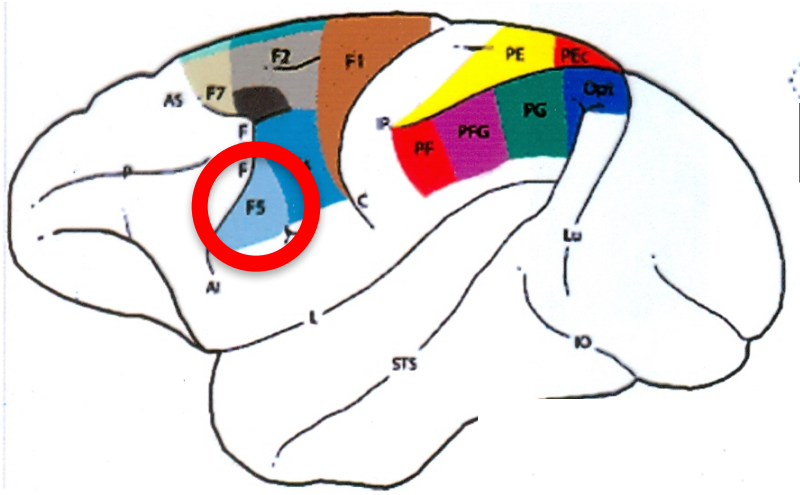
Derived from same structure, modified function

Convergence

Analogues

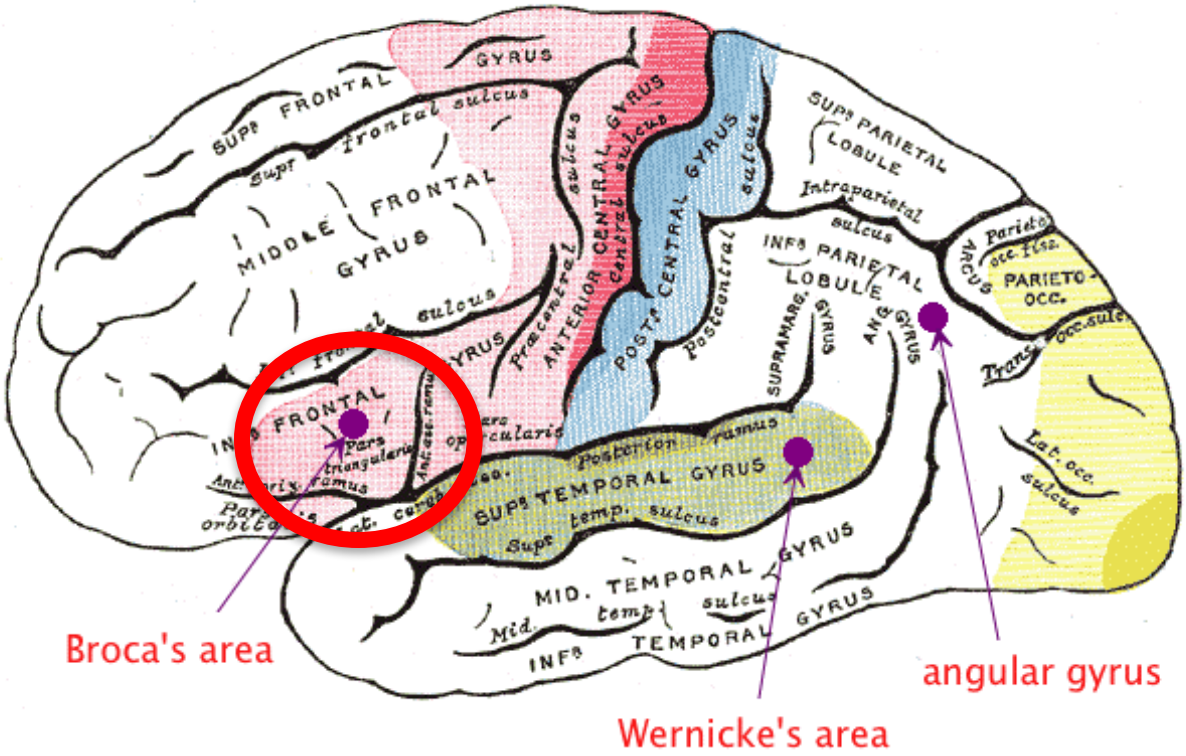
Similar solution arises
in different ways

Homologues



Area F5 of monkey brain

Broca's Area in human brain



Individual vs. Group Selection

Selection generally operates at the level of the INDIVIDUAL

We will NEVER say that X "evolved for the good of the species" – WRONG!!!

"Invoke "**Group Selection**" ONLY
when group traits determine reproductive success of members
in competition with other groups.

Sexual Selection

Selective environment is sexual competition and choice

Can result in an “Arm’s Race” or Evolutionary “Ratchet”

Sexual Selection

Female deer choose males with largest antlers

Since antlers are costly, indicates male is strong enough to bear such costs

Handicap Principle

Sexual Selection

Typically in mammals –
<u>Males compete,</u>
<u>Females choose</u>

Sexual Selection

Typically in mammals –
Males compete,
Females choose

In humans,
exaggerated female form
suggests at some point
Females competed,
Males chose.

Kin Selection

“Altruism” = Agent incurs a cost that benefits another

Occurs between **related** individuals**.**

Reciprocal Altruism

Under special circumstances,
altruism can occur between **<u>unrelated</u>** individuals

"**Reciprocal Altruism**" = X incurs a cost for Y,
as long as Y will reciprocate at a later time

Can be an ESS ("Evolutionarily Stable Strategy") if...

1) Participants long-lived

2) Live in coherent group so have repeated encounters

3) Sufficient cognition to track currency, debt, cheaters, etc.

e.g. Primates who have groomed recently
more likely to also aid one another in fights

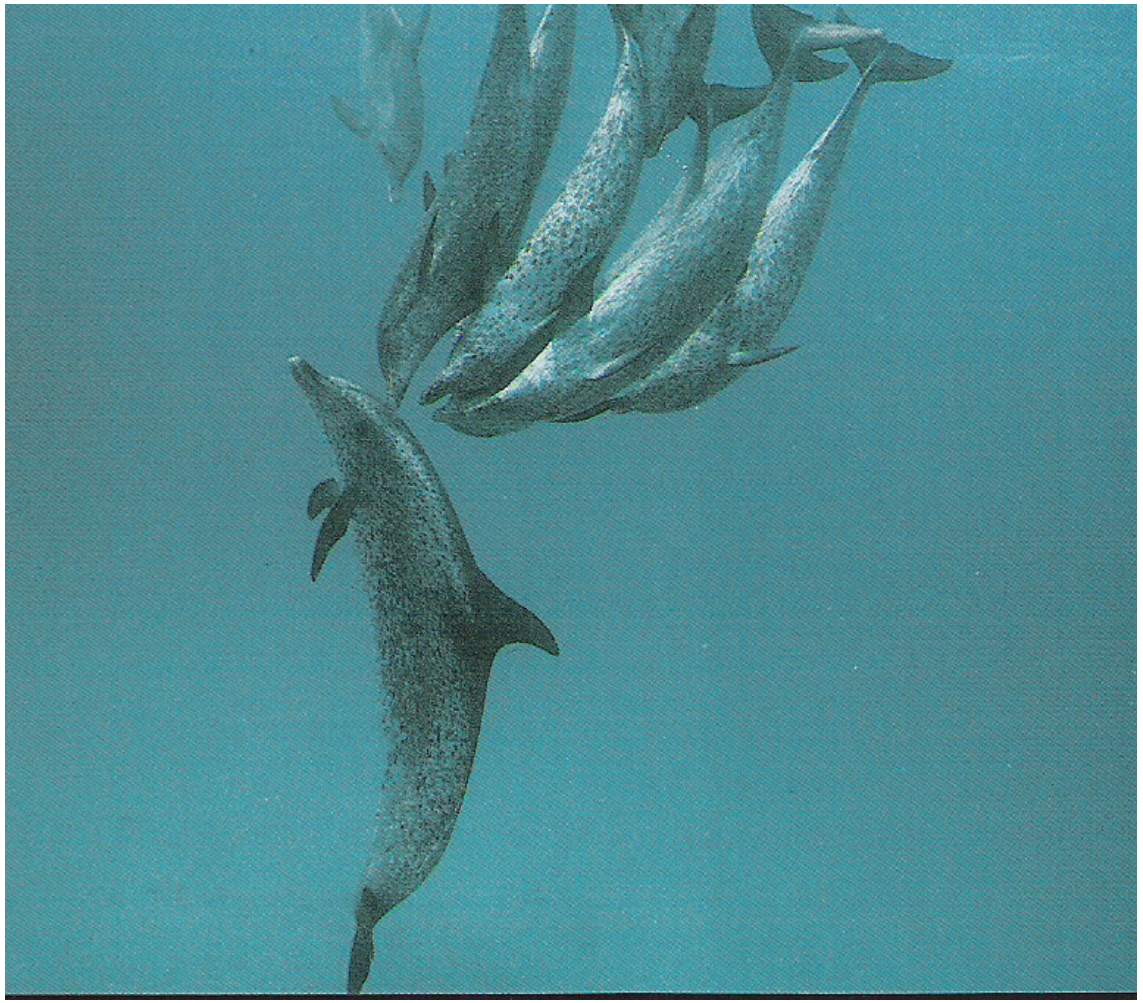
So, grooming and aid-in-fight are "currency"
in this socio-economy

Reciprocal Altruism

Only stable if can detect & punish "**Cheaters**"

"Cheater" accepts benefit,
but does NOT reciprocate

Sanctioning Cheaters



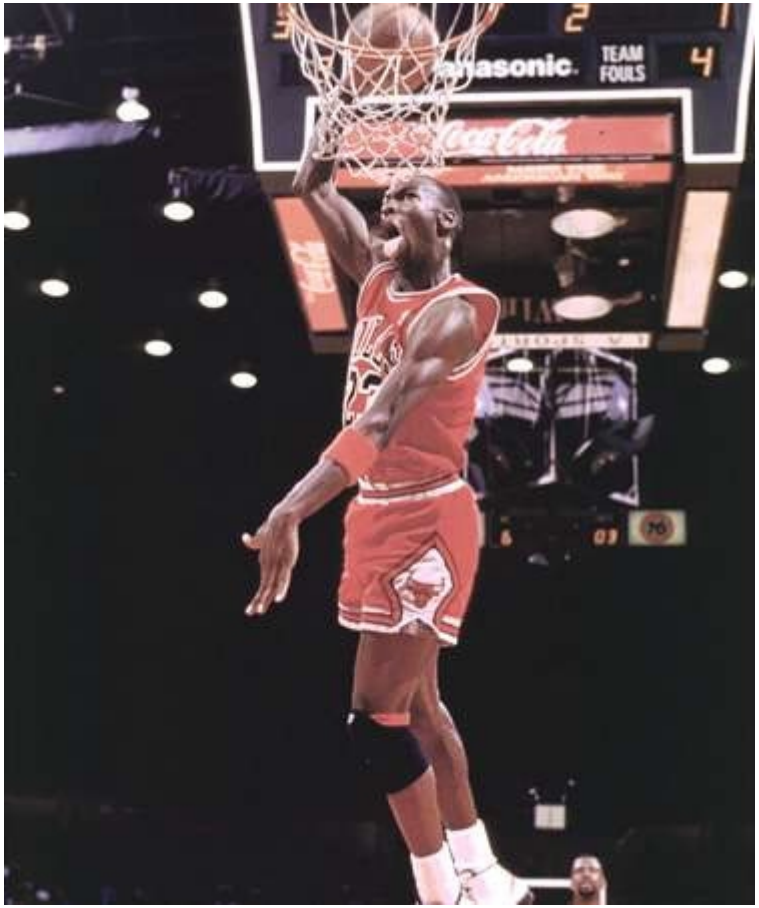
Unless sanctioned, cheaters can exploit system and win all benefits without cost

Co-Evolution

Evolution of one trait helps select for another

Can occur WITHIN an individual

e.g. Hand-Eye-Mouth Coordination in primates



Co-Evolution

Can occur ACROSS an individuals

e.g. Bat echolocation & Moth defensive reaction

Co-Evolution

Can result in "Arm's Race" or Evolutionary "Ratchet"

e.g. Deception & Counter-Deception

Co-Evolution

Includes “Arm’s Race” or Evolutionary “Ratchet”

e.g. Deception & Counter-Deception

And although the “evolutionary” accounts that you will read do not always follow these rules,
WE will!