

# Adaptation or plasticity?

Examples caused by climate change:  
*adaptation or plasticity?*

- Adaptation

- Improvement of the function of a trait, in a particular environment, as a result of natural selection

- Plasticity

- Molding or influence of an organism's features by its environment, not caused by changes in its genes
- Maternal effects
  - Mother provides RNA, proteins (hormones) to egg, embryo

- Canadian squirrels are breeding earlier in the year
- Some plants in northeast US are flowering earlier than they did in the past
- Butterflies in central California are taking flight earlier than they used to
- North American mosquitoes wait longer before going dormant for the winter
- Alpine plants in Switzerland and Austria are now found at higher elevation than in the past

← adaptation

← plasticity

← plasticity

← adaptation

← plasticity

# Grasshoppers living near noisy highway produce different pitch than grasshoppers far away

- Highway noise drowns out frequency attractive to female grasshoppers
- So male grasshoppers near highway must change their pitch, or else they won't reproduce
- Is observed change because of
  - adaptation (over many generations)?
  - or plasticity (in one generation)?
- Answer: It isn't yet clear -- research is in progress to answer this question



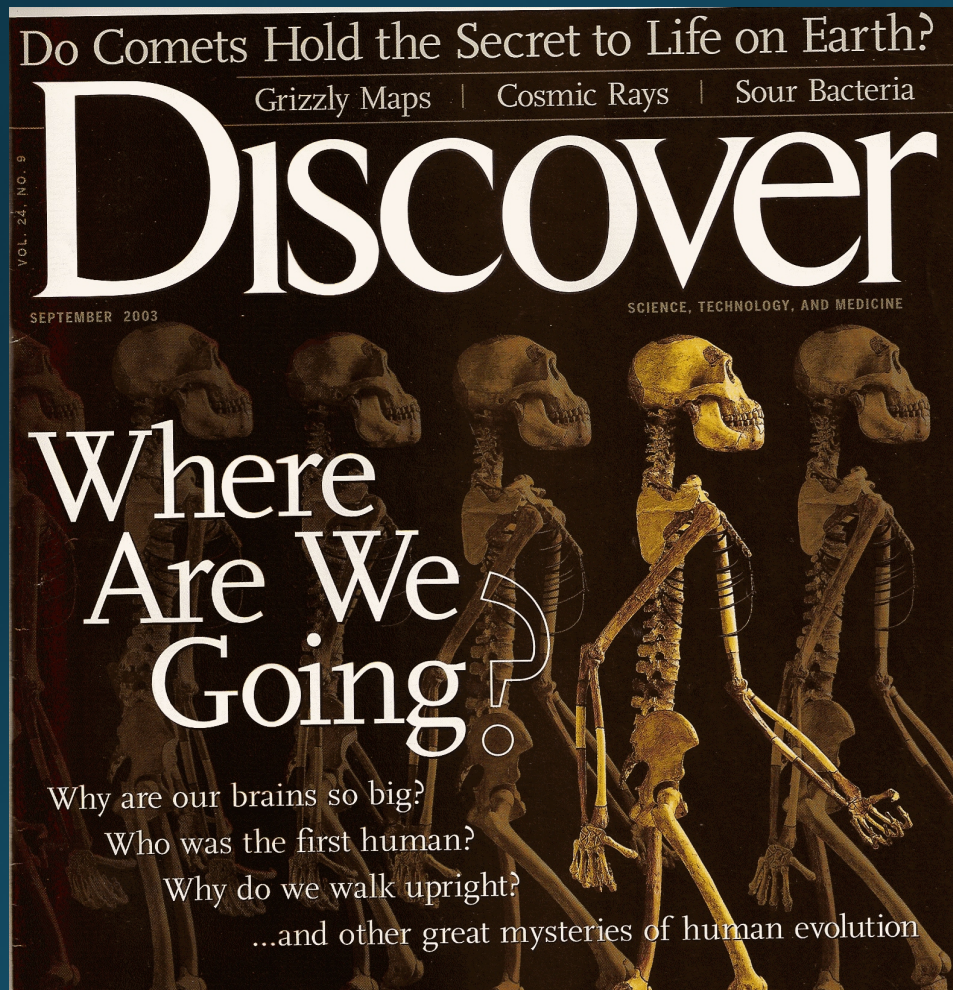
# “Genes may often be followers rather than leaders in phenotypic evolution”\*

- New environmental condition
  - Plastic response
    - Novel phenotype
      - Genetic accommodation
- This is the “Phenotype-first” viewpoint
  - The change in phenotype is *not* “cobbled together” from many small genetic mutations

\*Mary Jane West-Eberhard (Smithsonian Tropical Research Institute), *Developmental Plasticity and Evolution* (Oxford, 2003)



# Discover Magazine, 2003\*: There are at least eight great mysteries about the origin of humans



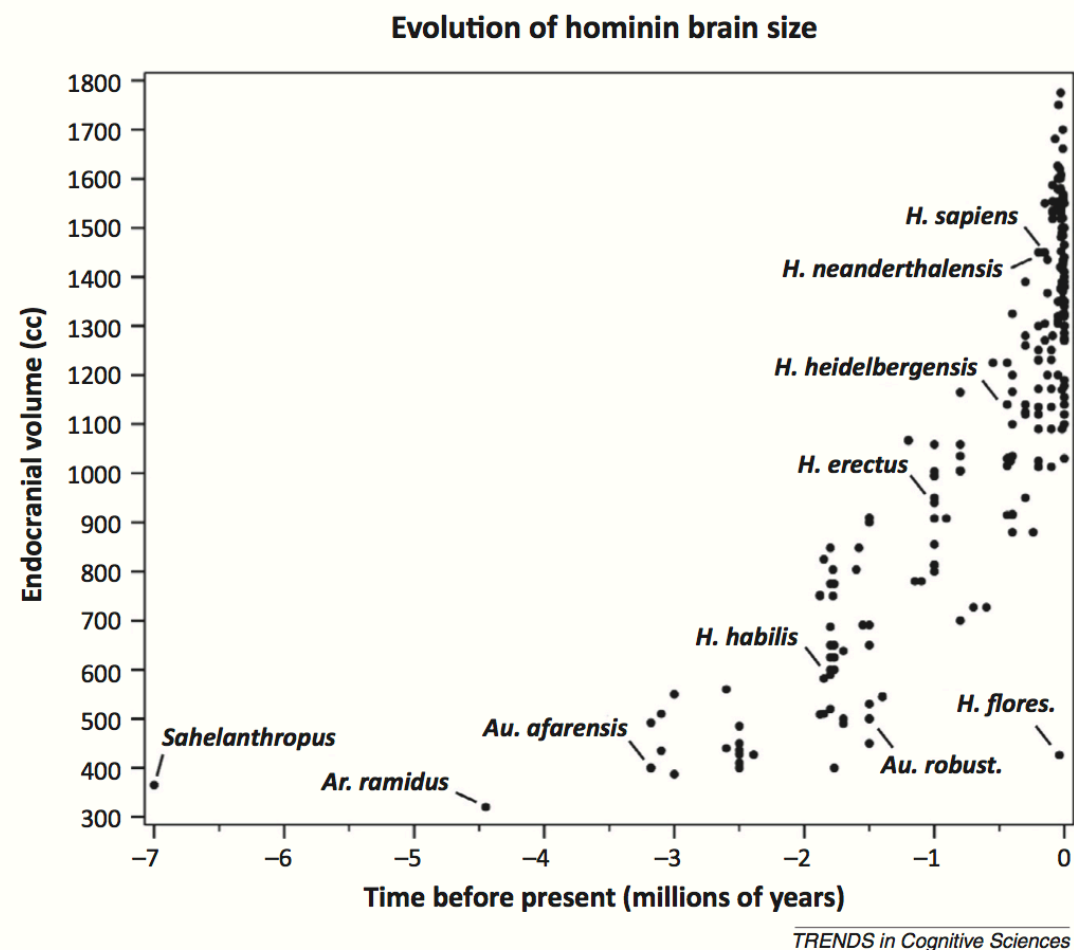
- Who was the first hominin?
- Why do we walk upright?
- Why are our brains so big? ←
- When did tool-making begin?
- How did we get modern minds?
- Why did we outlive our relatives? ←
- What genes make us human?
- Have we stopped evolving?
- [Why did we get naked?]
- [Why are we so comfortable with fire?]

\*Carl Zimmer, "Great Mysteries of Human Evolution", *Discover*, September 2003



# How could hominin brains get so big so fast?

- Hominin brains began dramatic expansion 2-3 million years ago



**Figure I.** Hominin brain evolution estimated from fossil endocrasts.

If big brains are such a great advantage, where is everybody else?

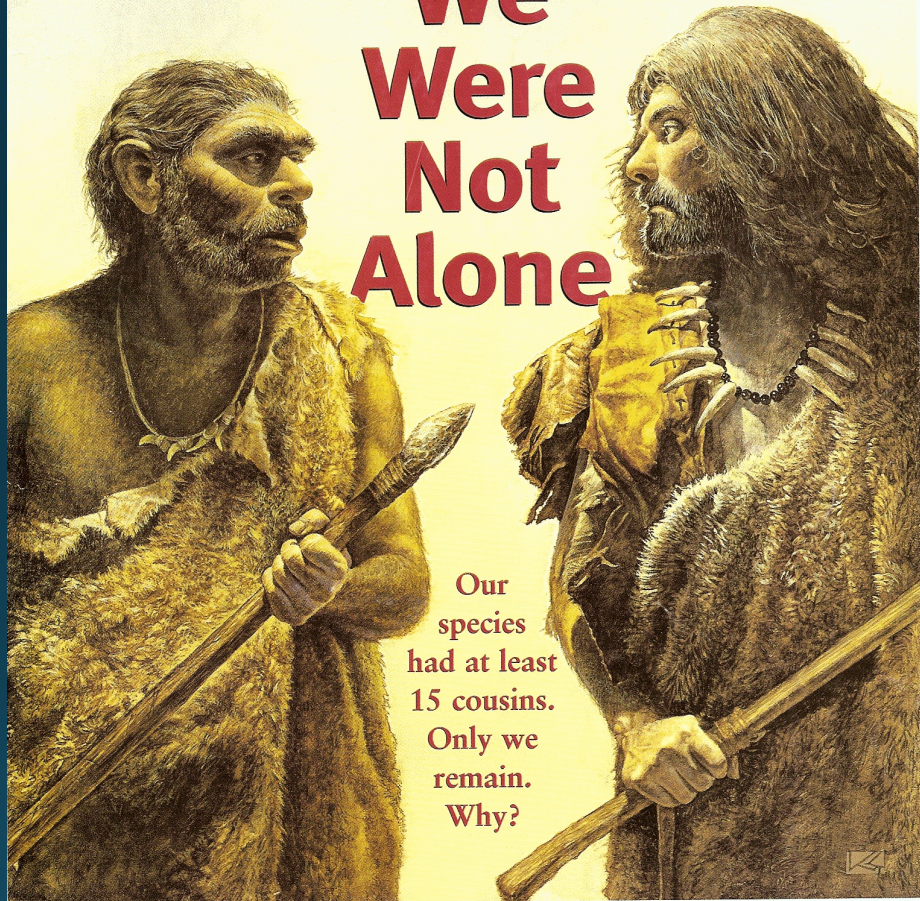
NEGATIVE ENERGY AND WARP DRIVE • MAGLEV TRAINS • SUPERHEAVY ELEMENTS

# SCIENTIFIC AMERICAN

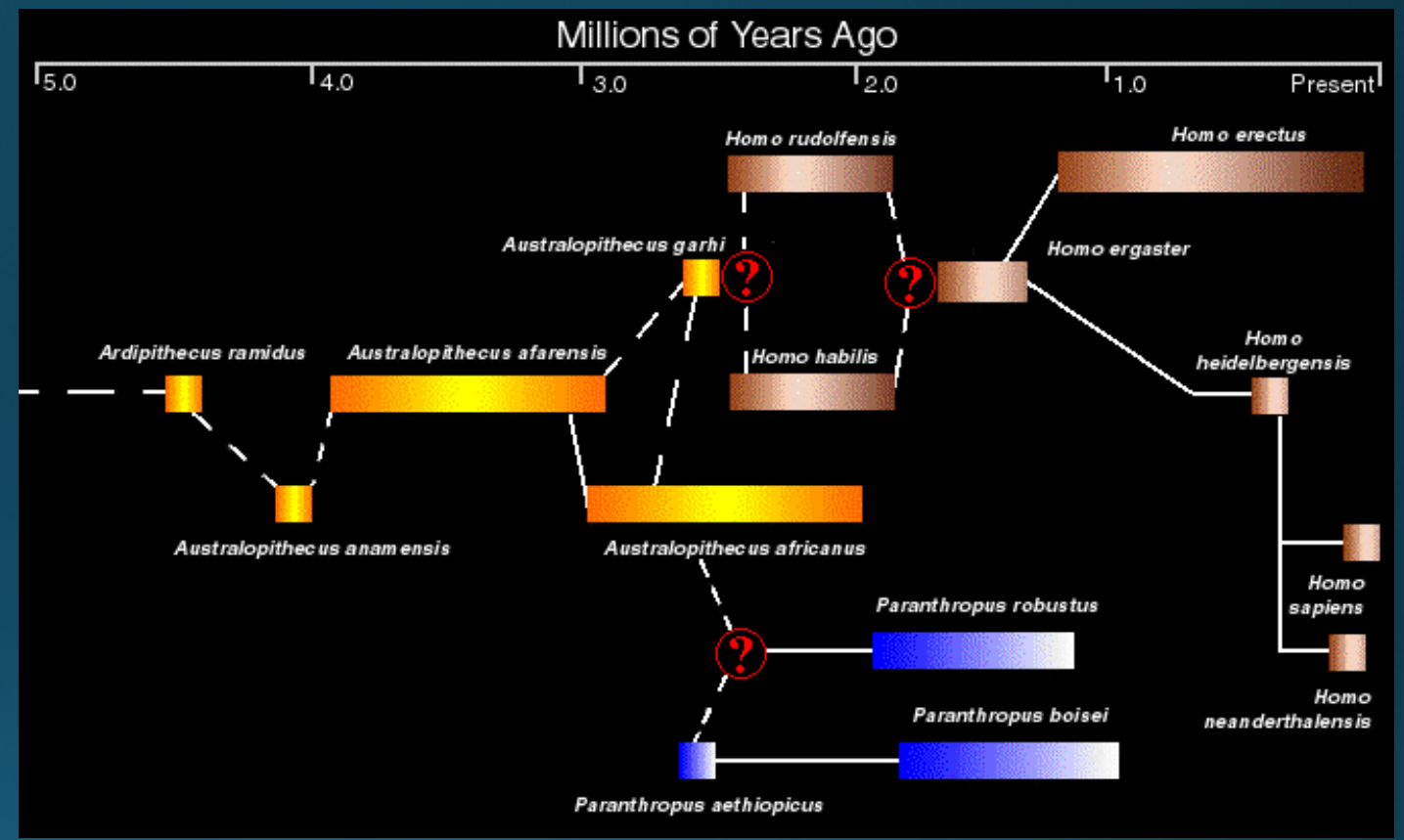
Beyond ice ages: **SNOWBALL EARTH**  
A startling theory of our planet's frozen past

JANUARY 2000 \$4.95 www.sciam.com

## We Were Not Alone



Our species had at least 15 cousins. Only we remain. Why?



If big brains are not a great advantage, why did brain size increase so dramatically?

Ian Tattersall, "Once We Were Not Alone," *Scientific American*, January 2000

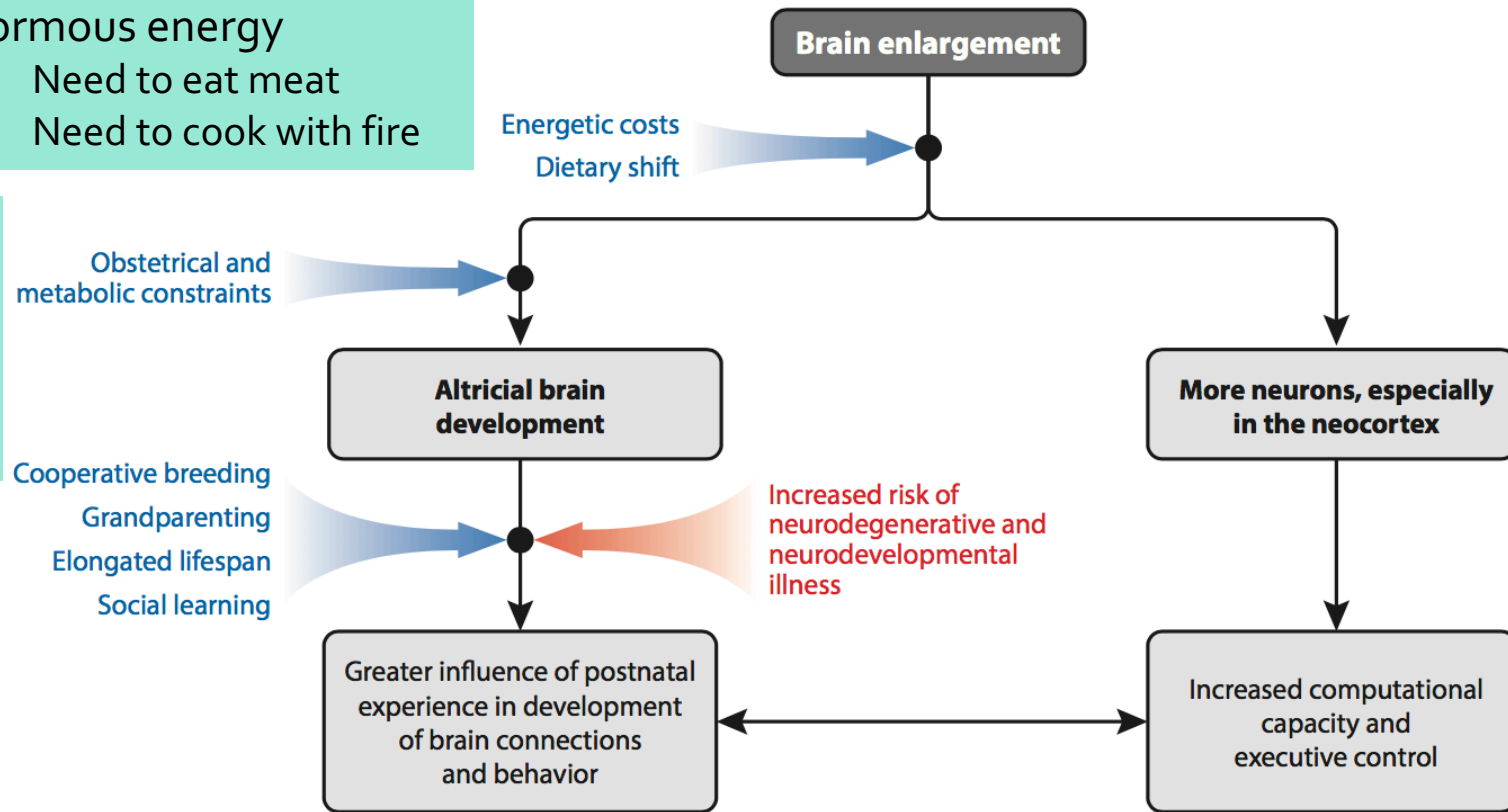


# Enlargement of the hominin brain had consequences

- Large brain consumes enormous energy
  - Need to eat meat
  - Need to cook with fire

- Mother can't
  - Deliver baby with larger head
  - Provide adequate nutrition *in utero*

*Altricial* species are those in which the young are incapable of moving around on their own soon after hatching or being born.



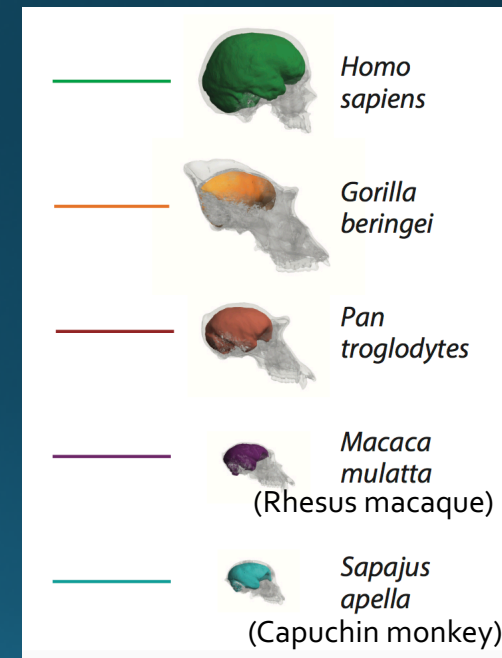
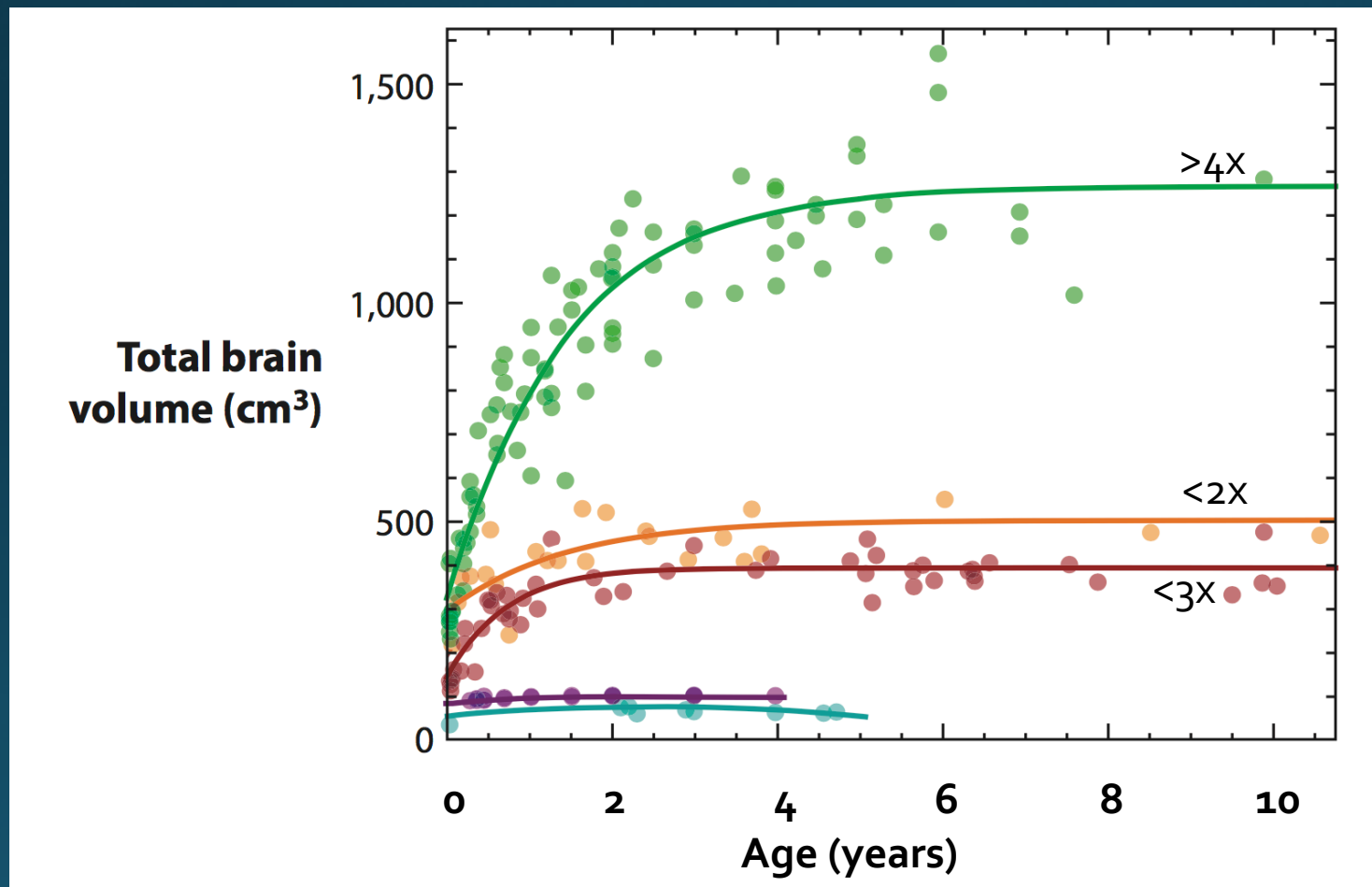
**Figure 5**

A model of the evolution of human brain plasticity and its interactions with life history and cognition.

Sherwood and Gomez-Robles, "Brain plasticity and human evolution," *Ann. Rev. Anthropol.* 2017, 46:399-419

# Brain volume of human babies continues to increase at an extremely rapid rate *after birth*

- Growth is much faster than in other primates



Sherwood and Gomez-Robles, "Brain plasticity and human evolution," *Ann. Rev. Anthropol.* 2017, 46:399-419



# Humans have created the “cultural niche”

- **Accumulation** of information spreading both horizontally and vertically
  - Learning or “copying” is crucial
- **Innovative** tools and practices that no individual would likely be able to invent on their own



# Human behavior is shaped by *social learning* to an extent that is unrivaled in the natural world\*

- Human brain anatomy and function have evolved to be *highly responsive to experience from the environment*
  - especially milieu of *social interactions*
- Human brain is specialized by evolution for an *extraordinary degree of plasticity*
  - Human brain remains highly plastic into adulthood



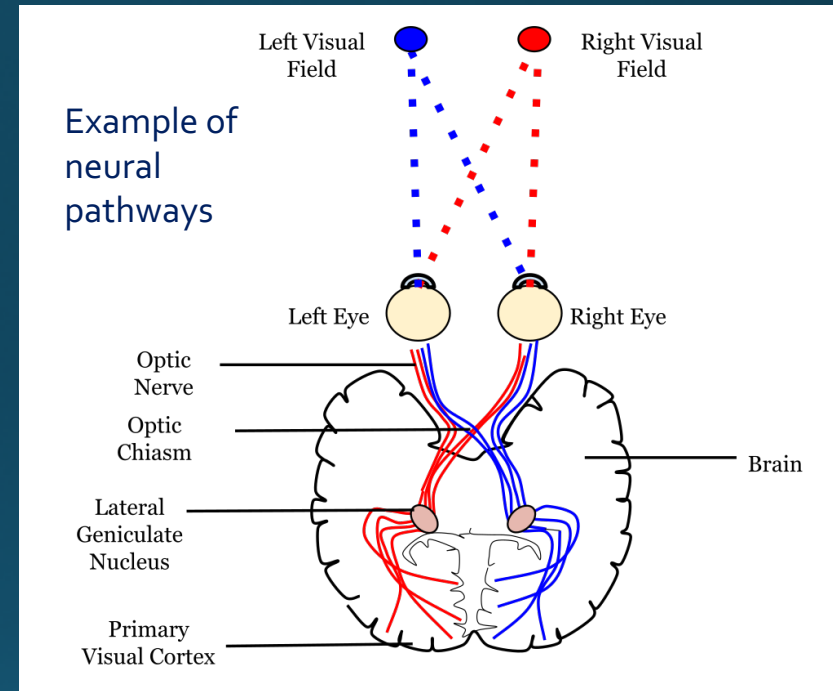
San hunters teaching tracking skills

- Social environment *shapes brain structure and function* across modern human populations owing to *innate plasticity* of brain development



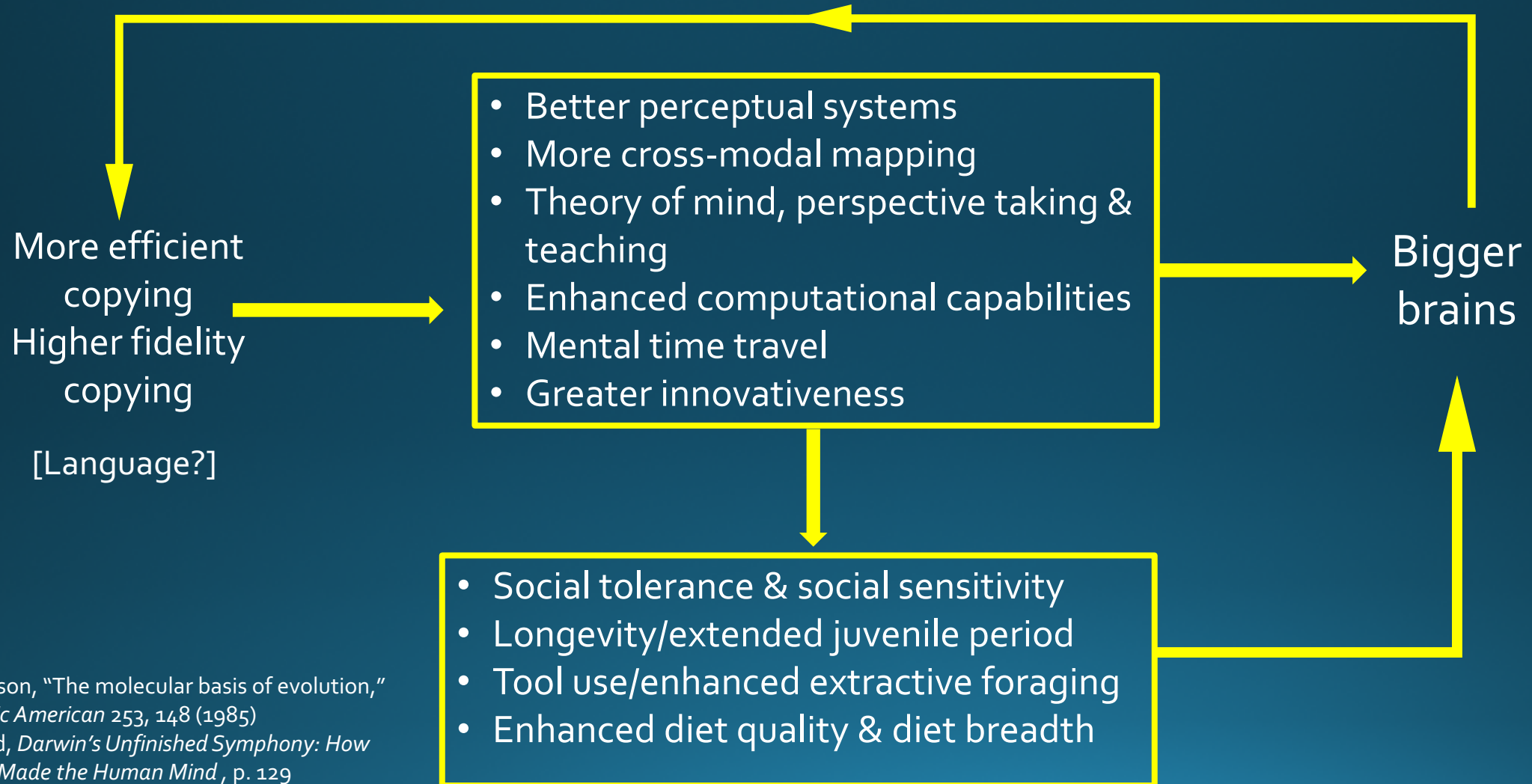
# Human brain is extraordinarily plastic

- Brain plasticity:
  - Processes by which
    - synaptic connections
    - axon fiber pathways
    - mapping of the cerebral cortexcan change during the lifespan in response to the environment and experience



- Neuroplasticity can allow recovery of function after stroke or traumatic brain injury
- Various lines of evidence imply that *brain plasticity has increased* throughout human evolution

# The “cultural drive” hypothesis: selection for more efficient and accurate social learning leads to increased brain size, which feeds back to enhance social learning





# Humans are strongly conditioned to care for helpless infants

- Extreme dependence on an extended network of caregivers during early life is a distinctive aspect of human sociality
- Demands of relatively helpless infants might have acted as a selective force to *increase human longevity*
  - Post-reproductive kin, especially grandmothers, would be vital to providing additional support to mothers



# Humans are strongly conditioned to care for helpless infants (cont'd.)



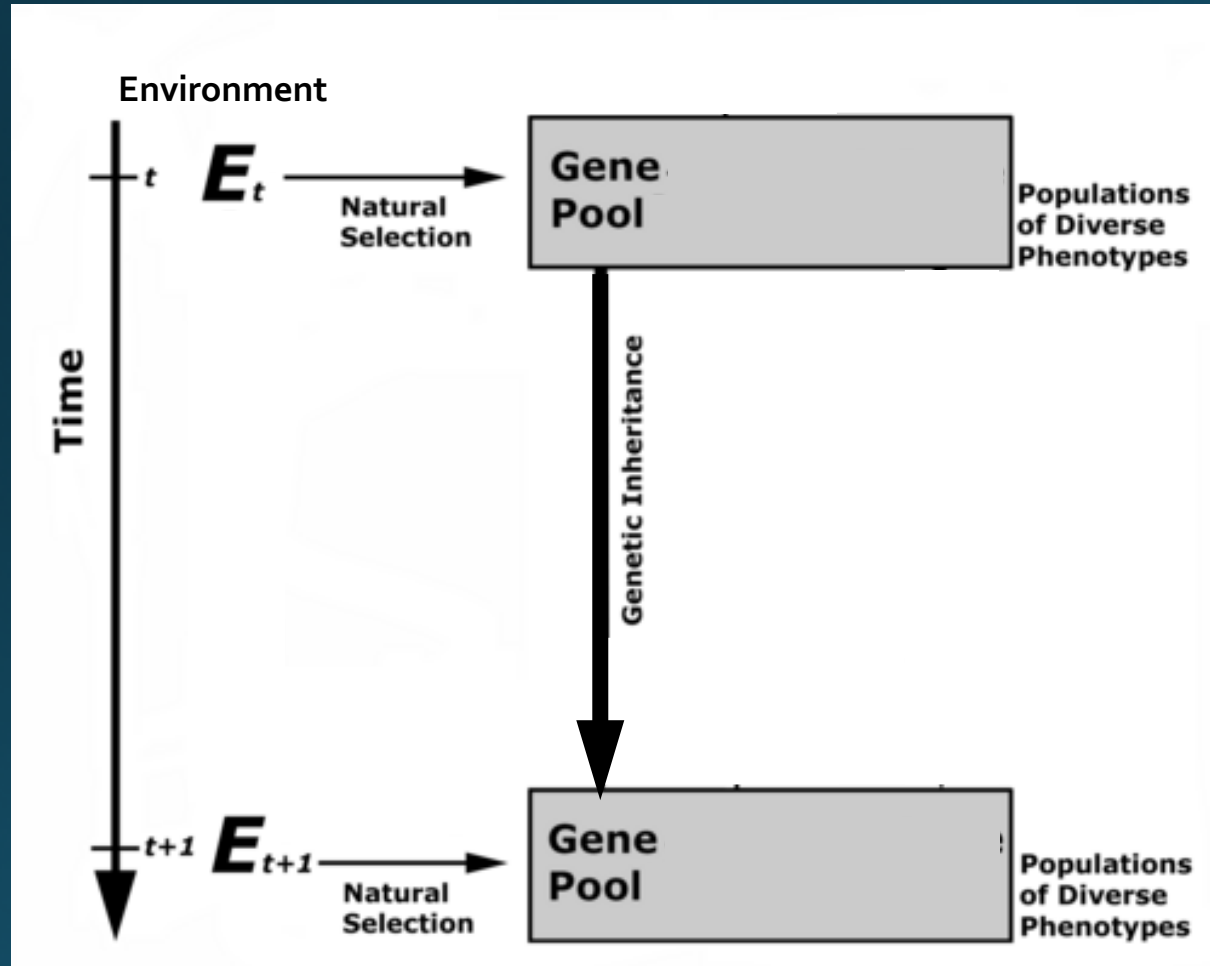
**MISSOULA, Mont.** (July 11, 2018)-- A faint whimper in the darkness was all it took. Missoula County Sheriff's Deputy Ross Jessop and U.S. Forest Service Law Enforcement Officer Nick Scholz rushed toward the sound after hours spent searching the Montana woods for a missing infant.

Jessop was about to take another step when he heard a stick crack underfoot. He looked down to find a cold, wet, soiled 5-month-old boy face-down buried under a pile of debris.

"I abandoned any police training or any chance of saving evidence there - I didn't care," Jessop, a father of three, told reporters on Tuesday. "I scooped up the baby, made sure he was breathing. He had a sparkle in his eye. (I) warmed him up, gave him a couple of kisses and just held him."

The baby, who had been abandoned for at least nine hours before Jessop and Scholz found him at 2:30 a.m. Sunday, was cold, hungry and had scrapes and bruises, but was otherwise in good condition. They wrapped him in a coat and carried the boy out of the woods to safety.

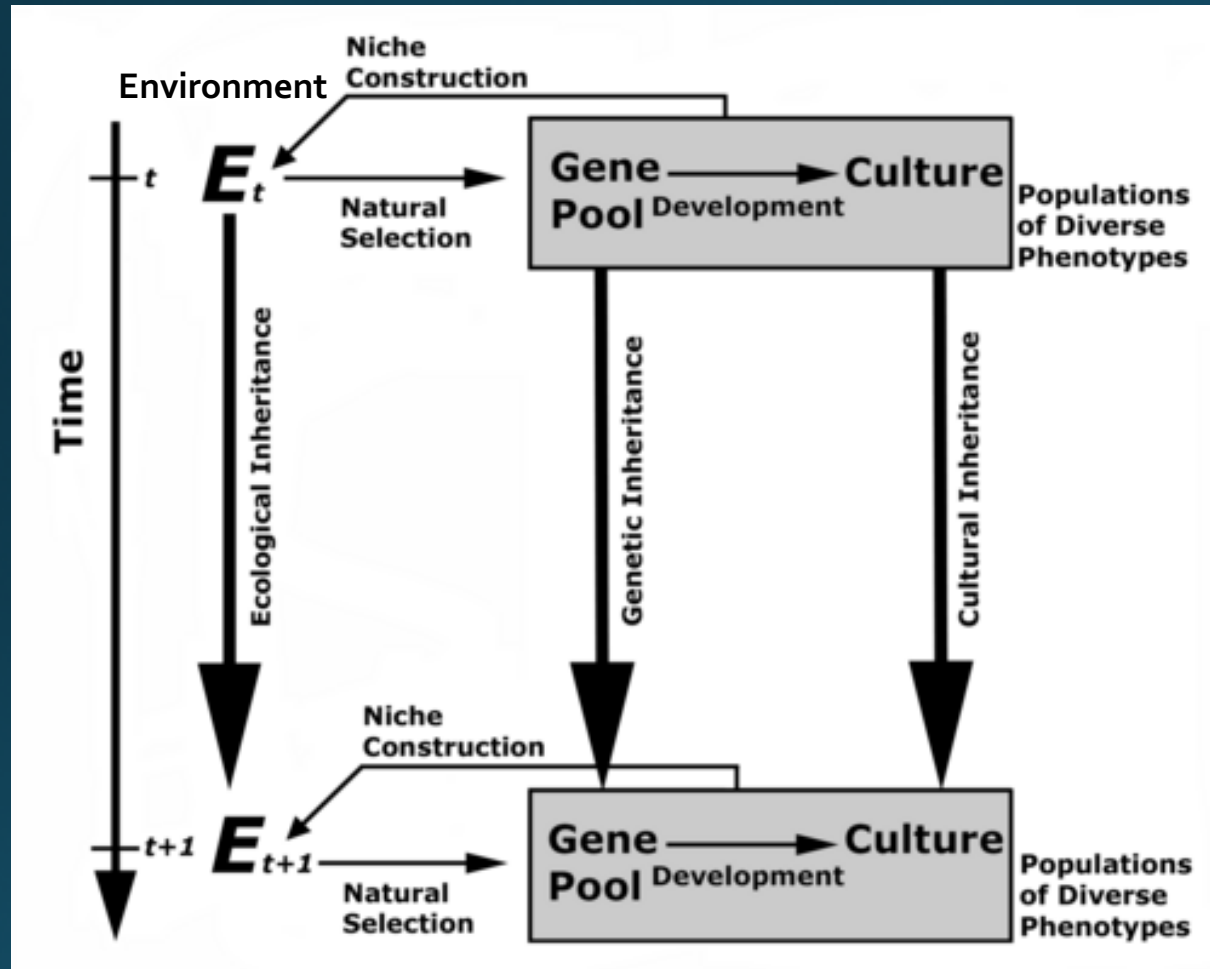
# Neo-Darwinian picture is simple and mechanistic



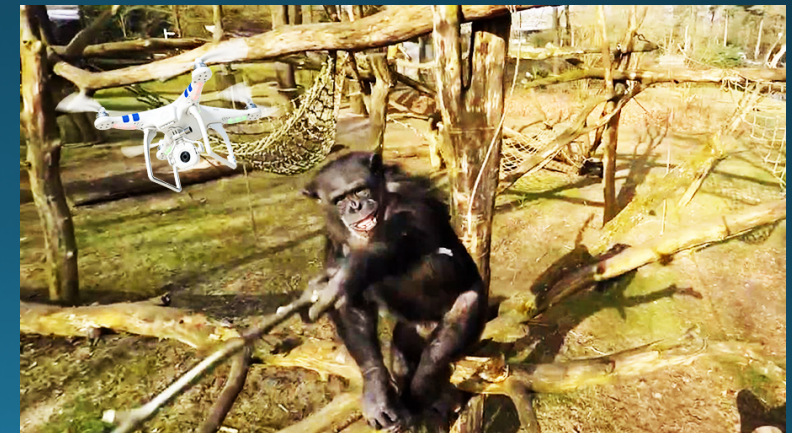
- Evolution proceeds by
  - Natural selection
  - Genetic drift
  - Gene flow
  - Recombination
- Organisms are passive



# The extended synthesis gives organisms a role



- Organisms
  - Change their environment
  - Learn, change, transmit their culture
- Perhaps it is useful to ask whether organisms have internal states\*:
  - Striving
  - Motivation
  - Will, intention, purpose



<https://semioticon.com/se0/N/niche.html#>  
<https://synergy.st-andrews.ac.uk/niche/niche-construction-and-evolution/>

\*Emily R Herrington, "A place for striving and 'agency' in evolutionary theory?", ASA Conference, Golden, CO (2017)

<http://cameradronerusa.com/2015/09/02/monkey-attacks-camera-drone/>



# Questions for discussion:

- Does a chimpanzee have free will?
- Could hominins have been influencing their own evolution, even without realizing it?
- Have beavers (making dams) and termites (making mounds) been influencing their own evolution?
- Does God influence human culture?