

## Evolution of Hominin Brain Size

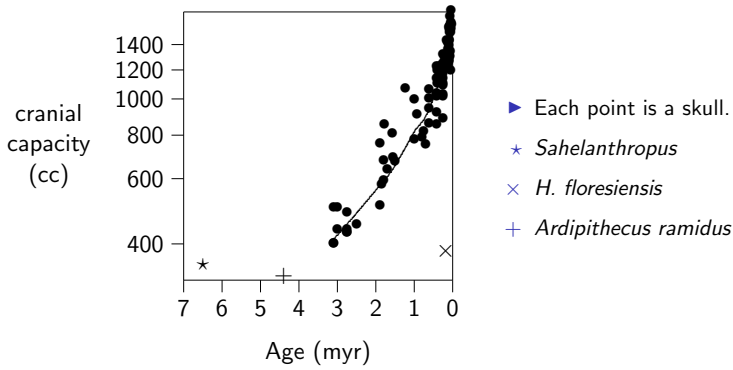
Alan R. Rogers

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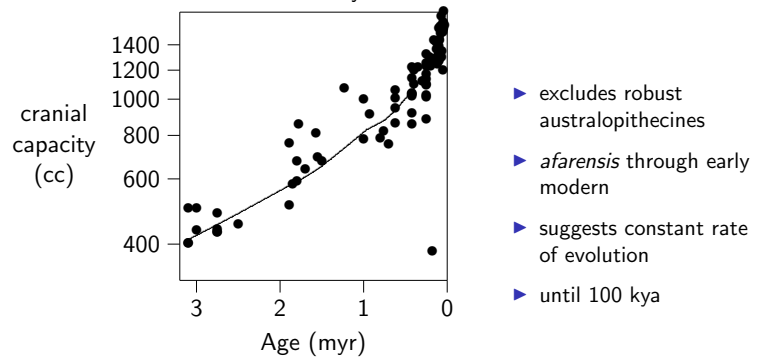
## Evolution of Hominin Brain Size

- ▶ History of brain size
- ▶ Are big brains a side effect of big bodies?
- ▶ Why did selection favor big brains? (1) Unpredictable food resource, (2) Unpredictable climate, (3) Expensive tissue hypothesis, (4) Social brain hypothesis.
- ▶ Conclusions

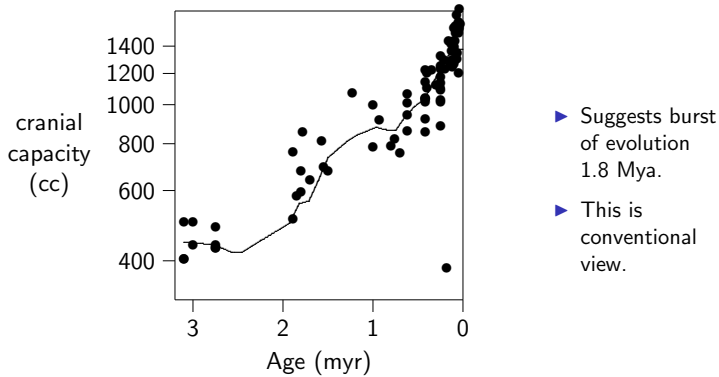
Cranial Capacities of Fossil Hominids



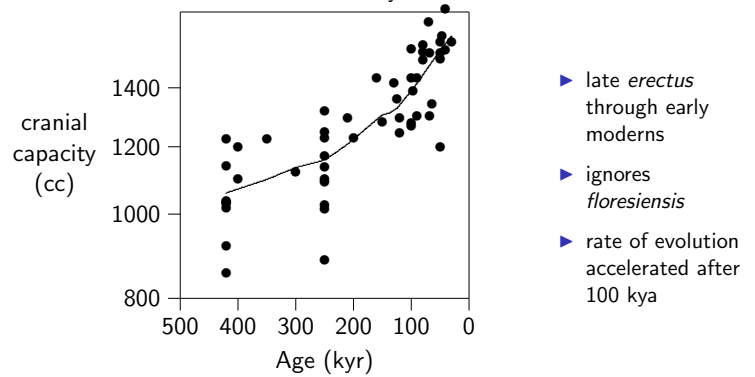
Past 3 Myr



Smoothed Less



The Last 500kya



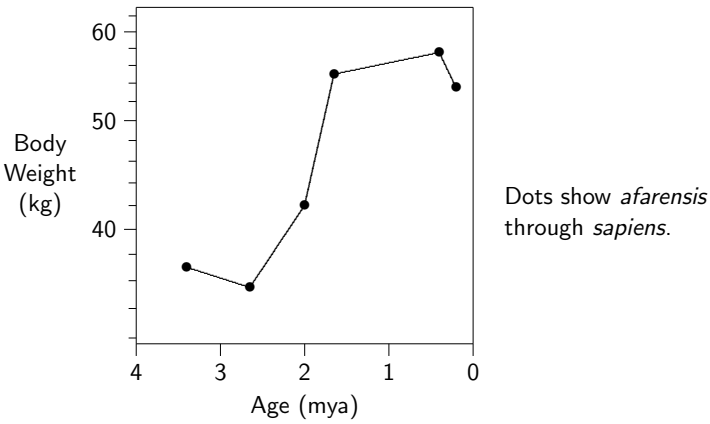
### Summary of Brain Evolution

- 3 myr–100 kya: Trajectory unclear. Either
  - ▶ constant rate, or
  - ▶ rapid change at 2 myr, then slow.
- after 100 kya: Rapid change.

### Are big brains really an adaptation?

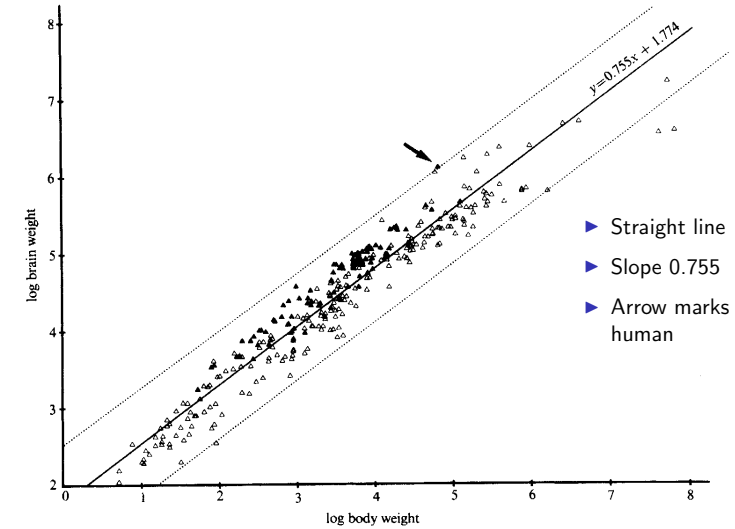
Perhaps selection favored large bodies, and brains increased as a side-effect.  
 Body size did increase during the Pleistocene...

### Body weight increased during Pleistocene

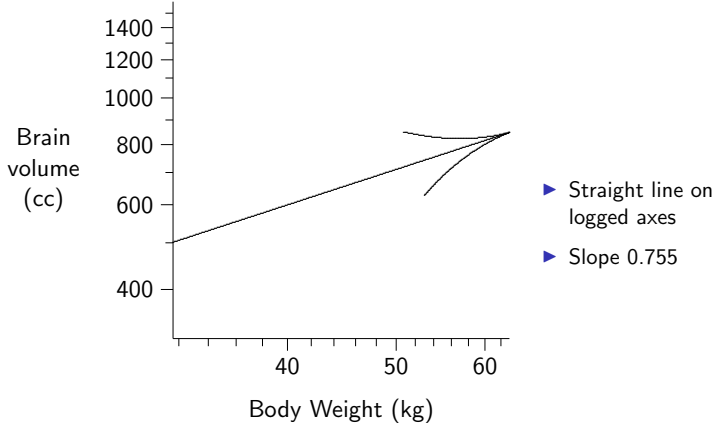


Furthermore, large animals have large brains...

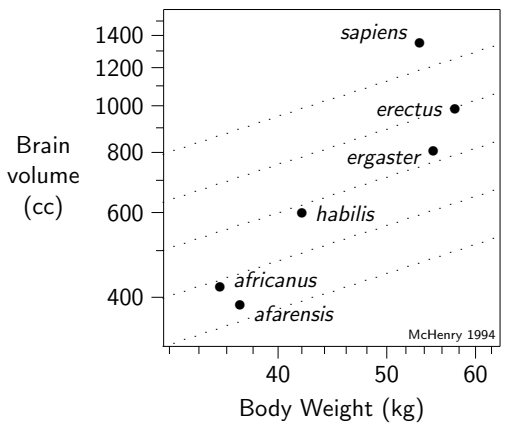
### Log brain vs body weight in mammals



If hominins had followed the general mammalian pattern, the brain-body graph would look like this:



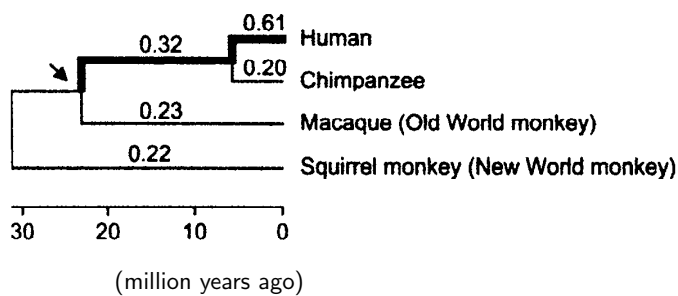
### Hominin brains vs bodies



- ▶ Dotted lines show expected slope.
- ▶ Hominin brains increase faster than expected.

- ▶ Brain size increased too fast.
- ▶ Not a side-effect of selection on bodies.
- ▶ Furthermore, brain proteins evolved rapidly...

### Brain Proteins Evolve Rapidly in Hominins

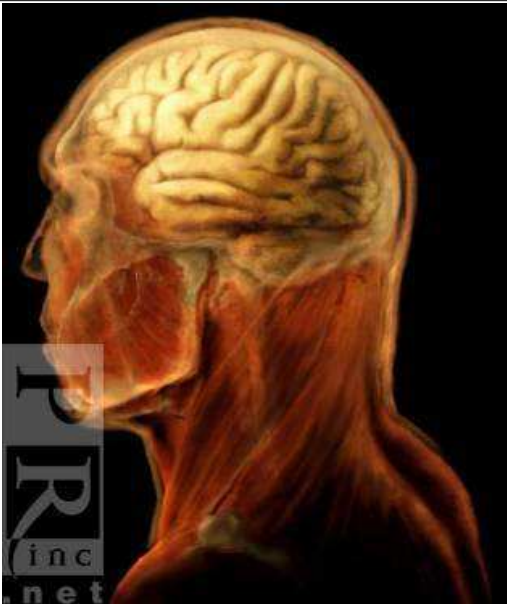


(Dorus et al 2004)

Conclusion: selection must have favored large brains. (Not just a side-effect of large bodies.)  
But why?

### Why might selection favor large brains?

- (1) *Unpredictable food resources.* (fruit, or prey)
  - (2) *Unpredictable climate.*
  - (3) *Expensive tissue.* Big brains are useful but costly. They evolve when animals have access to rich food.
  - (4) *Competition within large social groups.* Primates who live in large social groups have large brains.
- To test these ideas, we need to talk about the *neocortex*.



- ▶ Neocortex: outer portion of brain
- ▶ Highly folded in humans
- ▶ Responsible for reasoning and consciousness
- ▶ Varies in size across primates

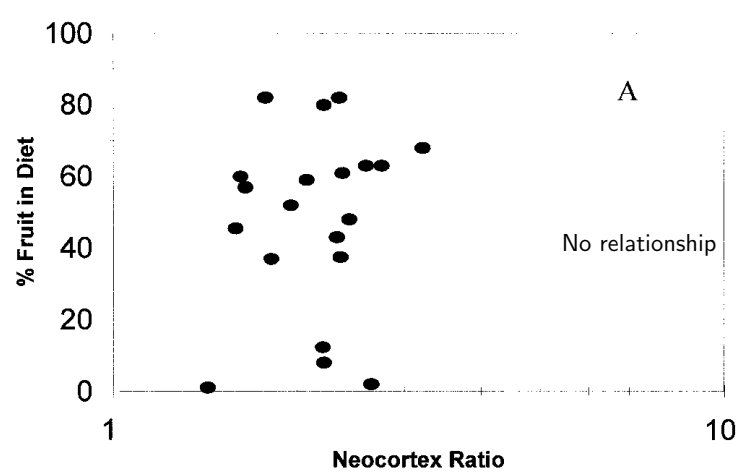
### Measuring size of neocortex

$$\text{Neocortex ratio} = \frac{\text{Neocortex weight}}{\text{Brain weight} - \text{Neocortex weight}}$$

In other words: the ratio of the weight of the neocortex to that of the remainder of the brain.

### Hypothesis 1: Big brains evolve in response to unpredictable food sources

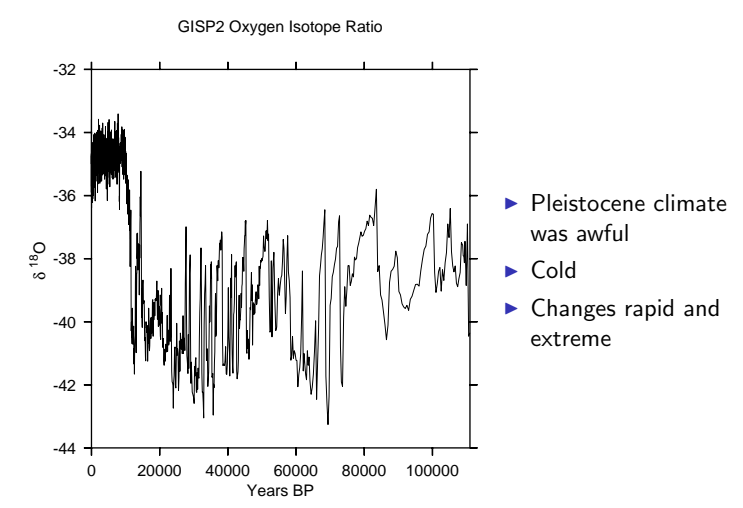
- ▶ Example: fruit trees do not bear fruit all year.
- ▶ When one tree is depleted, frugivores (fruit eaters) must find another.
- ▶ Must learn and remember locations of fruit trees in large area.
- ▶ Is neocortex ratio high in frugivores?



No support for hypothesis that brains are a response to unpredictable food resource.

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- ▶ Conclusions



- ▶ Pleistocene climate was awful
- ▶ Cold
- ▶ Changes rapid and extreme

Perhaps our ancestors needed to be smart to cope with the variable environment of the Pleistocene. (Richerson and Boyd) Brain size *did* increase during the Pleistocene. The rate of increase accelerated in the Late Pleistocene, when things were especially bad. Hypothesis may be true but is hard to test. Still just conjecture.

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### Expensive tissue hypothesis

- ▶ Big brains always useful, but also costly.
- ▶ Switch to a meat diet would reduce the cost, and thus favor big brains.

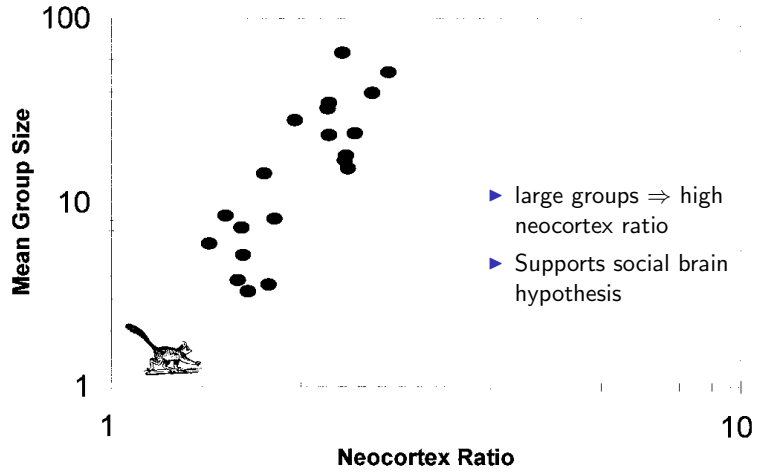
Will revisit it in a lecture on hunting.  
But not today.

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### Social Brain Hypothesis (Dunbar)

- ▶ Animals compete with others of their species.
- ▶ Those who live in groups compete more.
- ▶ The larger the group the more the competition.
- ▶ It takes brains to win.
- ▶ Predicts high neocortex ratio where groups are large.

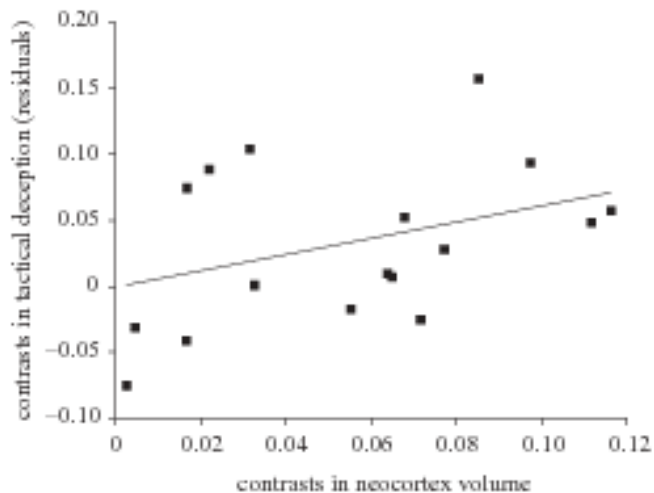


### Size of Human Social Groups

- ▶ Human brain size implies group size of about 150.
- ▶ Local groups of human hunter-gathers often number about 25.
- ▶ But these are temporary groupings formed from larger groups of about 150.
- ▶ 150 is the size of the most inclusive human group within which everyone knows everyone.

Why is so much neocortex needed when groups are large?

### More deception in species with large neocortex



### Summary

- ▶ 3 myr–100 kya: Trajectory unclear. Either
  - ▶ constant rate, or
  - ▶ rapid change at 2 myr, then slow.
- ▶ after 100 kya: Rapid change.
- ▶ Not a side-effect of selection for body size.
- ▶ Probably not a response to unpredictable food.

Selection may have favored big brains because

- ▶ Expensive tissue hypothesis: shift to mean reduced cost of brains
- ▶ Pleistocene climates favored flexible response
- ▶ Social brain hypothesis: large groups favor large brains