Energy, Food, and Brains

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Good news about human energy budget

Walking and (especially) jogging are energetically efficient.

Energetic cost of travel was predicted for average quadrupedal mammal of same body size.

Speed (km/hr^2)	Subject	Observed/ predicted cost ($\times 100$)
2.9	Chimp	149%
	Human	86%
4.5	Chimp	148%
	Human	94%

Humans use 58% the energy of a chimp of same size.

What we're good at and poor at

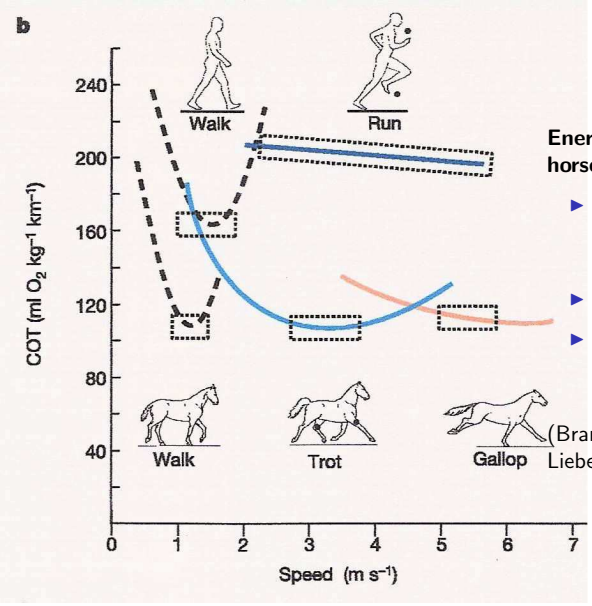
- We're slow: any predator can catch us.
- Running fast is energetically inefficient.
- We excel at jogging and walking.
- We can go far in a day.

Recent evolution has made us better runners.

Of 31 recently-evolved skeletal characters:

- 30 affect running more than walking
- 1 affects running and walking equally

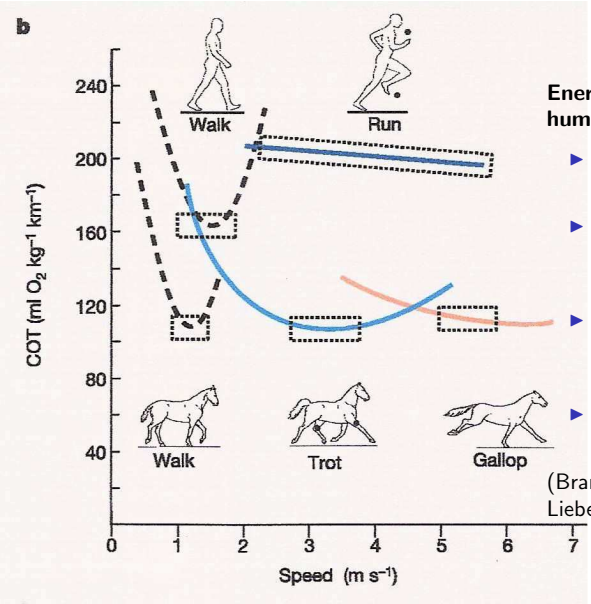
(Bramble & Lieberman 2004)



Energetic cost of horse gaits

- Y-axis is energetic cost per kilometer
- horse has 3 gaits
- Each works well in narrow range of speeds

(Bramble & Lieberman 2004)



Energetic cost of human gaits

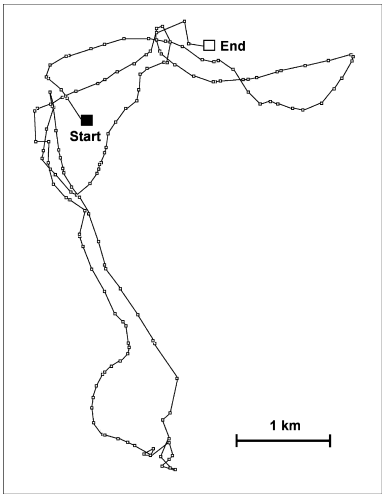
- Humans have 2 gaits
- Walking works well in narrow range of speed.
- Running works well over wide range of speed.
- Humans can run long distances.

(Bramble & Lieberman 2004)

Why is running useful?

- scavenging
- persistence hunting (more on this later)

A human persistence hunt



Route of a human running down a kudu bull.

Leibenberg (2006)

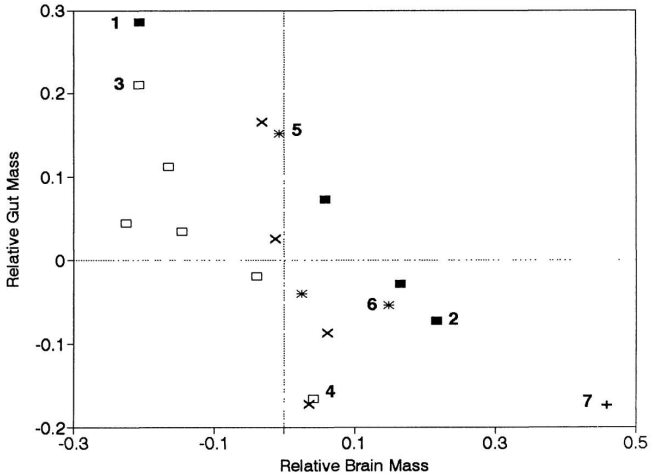
Bad news about human energy budget

- Brain tissue is expensive.
- Gram for gram, uses energy at 9 times rate of body as a whole.
- How did we afford our brains?

Primates with big brains

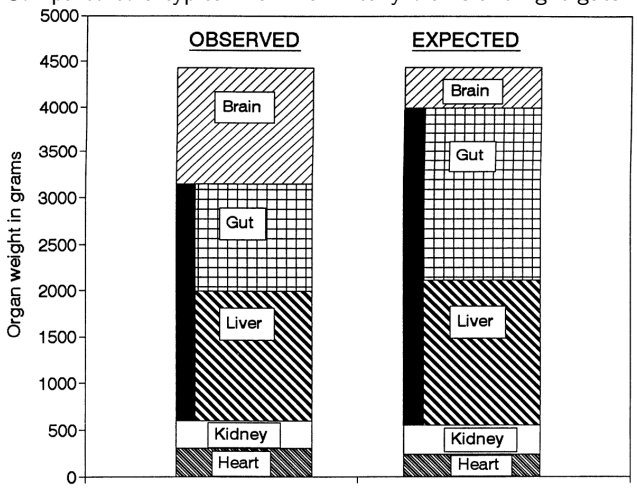
- eat rich food
- have small guts

Brain size versus gut size in primates



Left: humans. Right: typical mammal

Compared to a typical mammal: heavy brains and light guts.

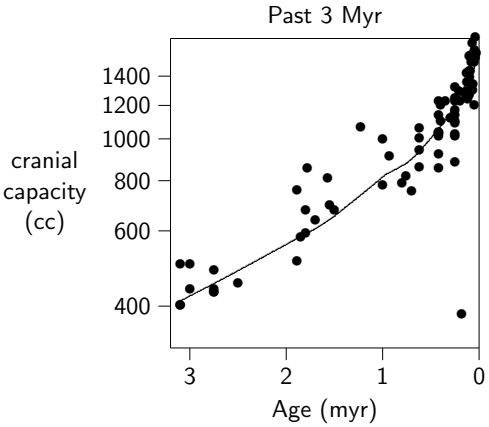


Expensive tissue hypothesis

- Large brain and small gut must have evolved together.
- There is no other way to afford the brain.

(Aiello & Wheeler)

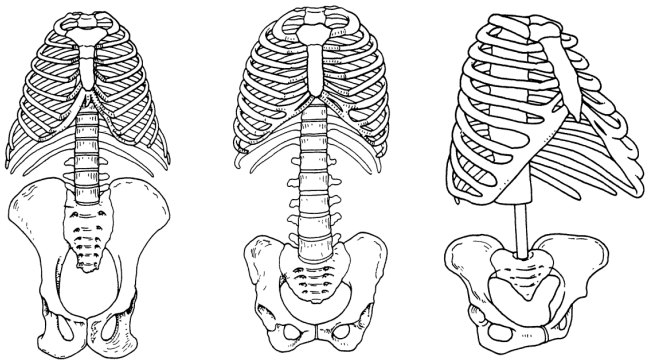
When did we get big brains?

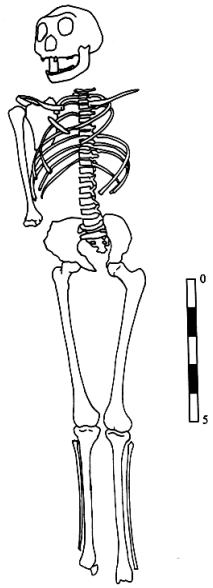


- Brain size has been increasing for 2 my.
- What happened to guts?

Small guts imply narrow rib cage

Trunks of chimp (L), human (C), and afarensis (R)





Narrow rib cage

- implies small gut & rich food
- appears with *Homo ergaster*, 1.7 mya
- just as brains were increasing
- shown here: Nariokotome boy

Hunting hypothesis (Leonard)

- Modern hunter-gatherers get 50% of calories from meat.
- Chimps get 6%.
- Meat is rich in energy.
- Perhaps hominins fed their brains with meat, and followed game animals out of Africa.

I'll say more about this idea in a later lecture.