

Origins and Evolution of Language

Week 4: Human evolution, social learning and cumulative culture

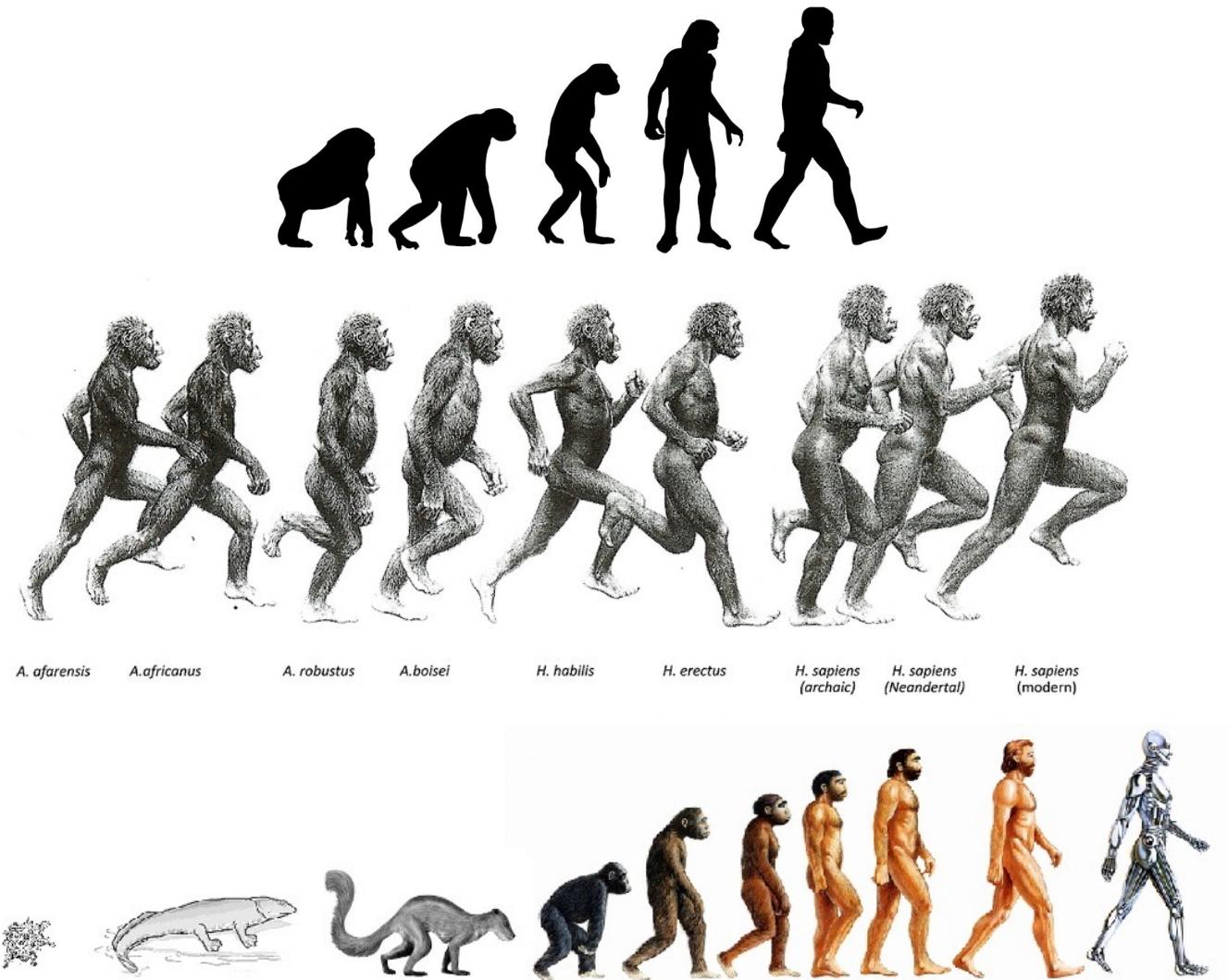
Kenny Smith

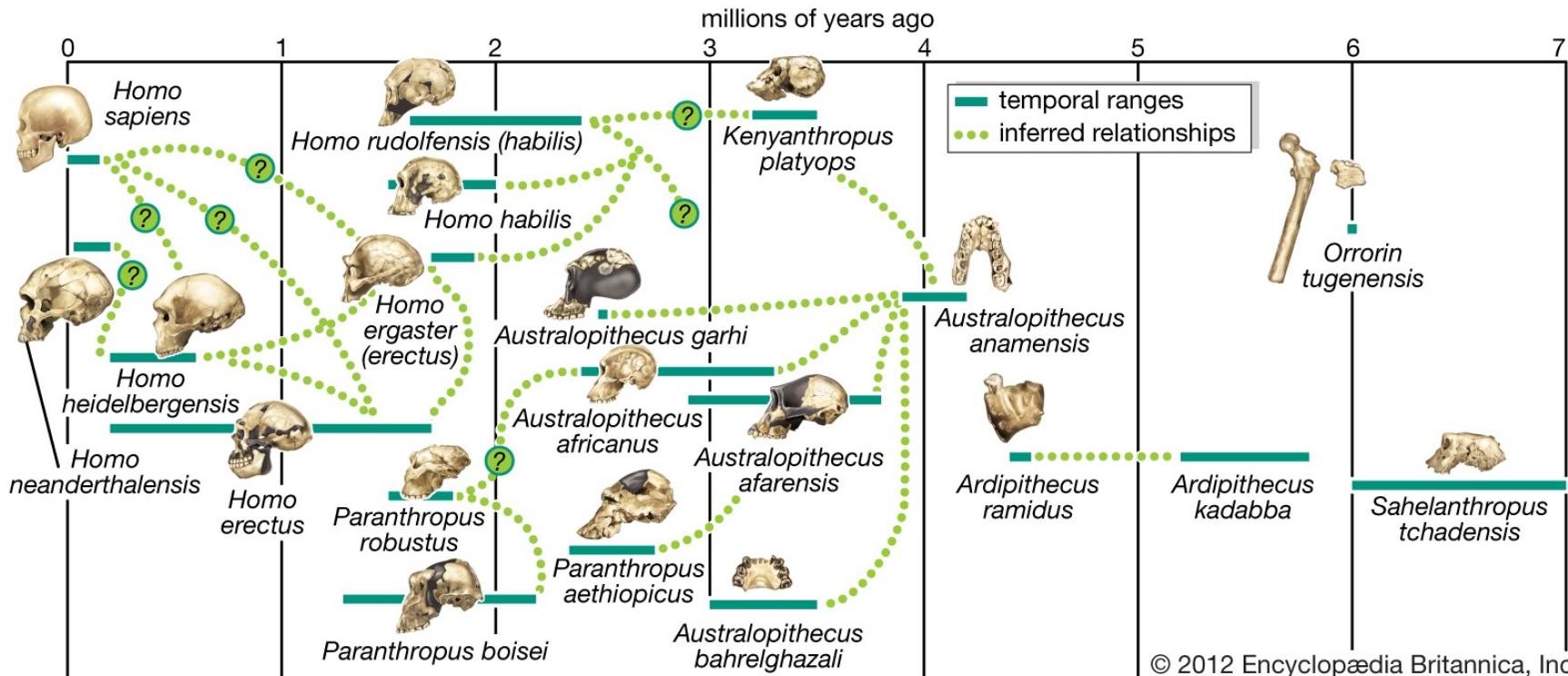
kenny.smith@ed.ac.uk

Plan for today

- Human evolution: quick summary of Fitch chapter 7
 - Visual illustration of timeline of human evolution
 - Visual illustration of brain size evolution
- Technology, cumulative culture, and language

Summary of Fitch Chapter 7

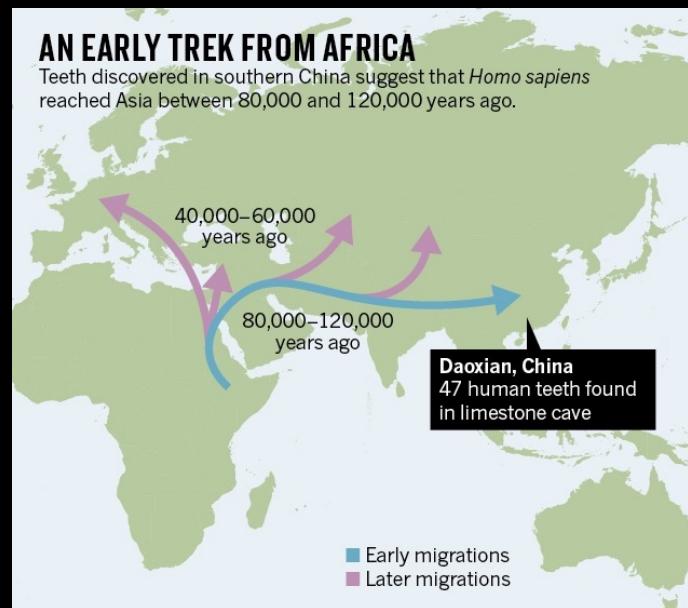




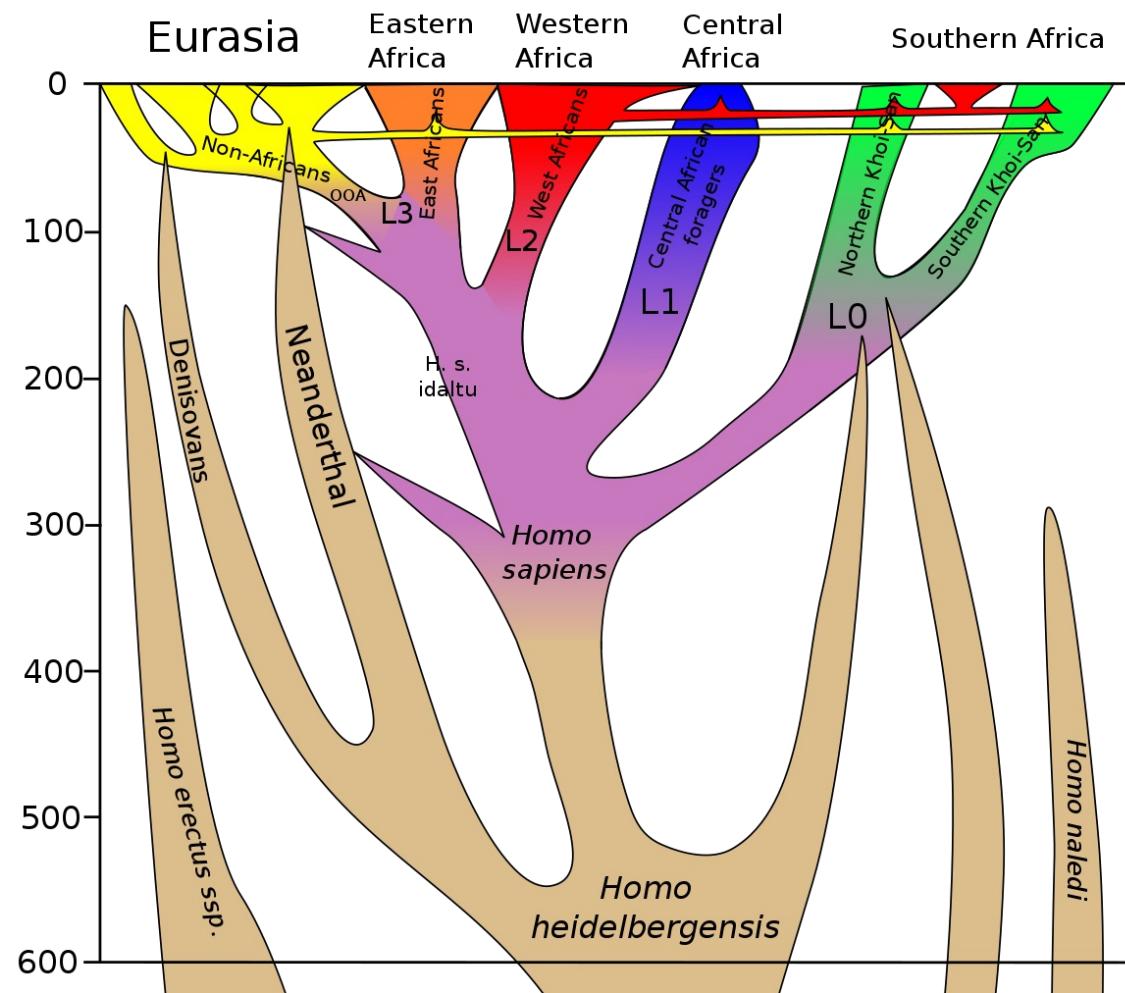
© 2012 Encyclopædia Britannica, Inc.



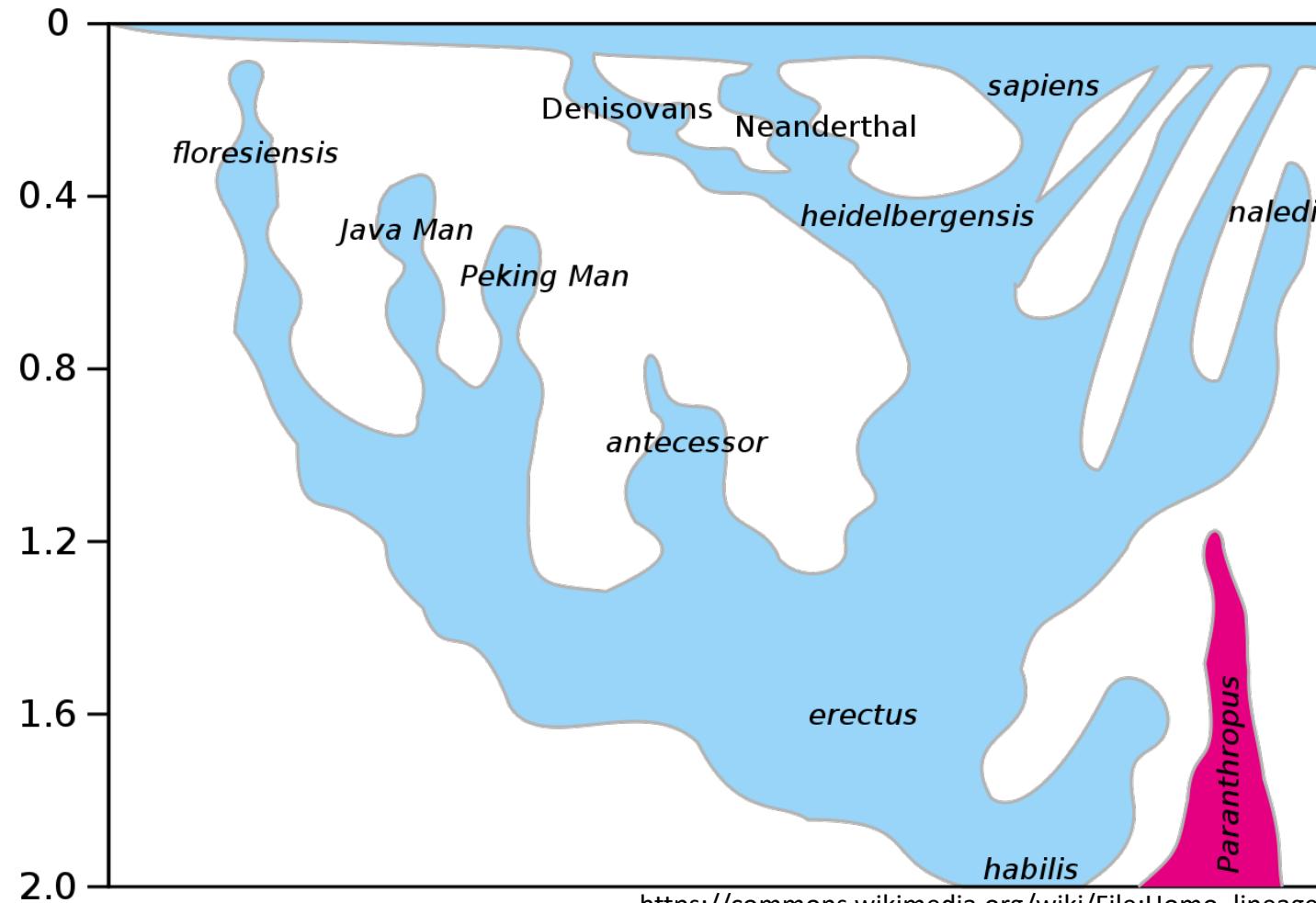
Berger, L. R. (2015). *Homo naledi*, a new species of the genus *Homo* from the Dinaledi Chamber, South Africa. *eLife*, 4, e09560

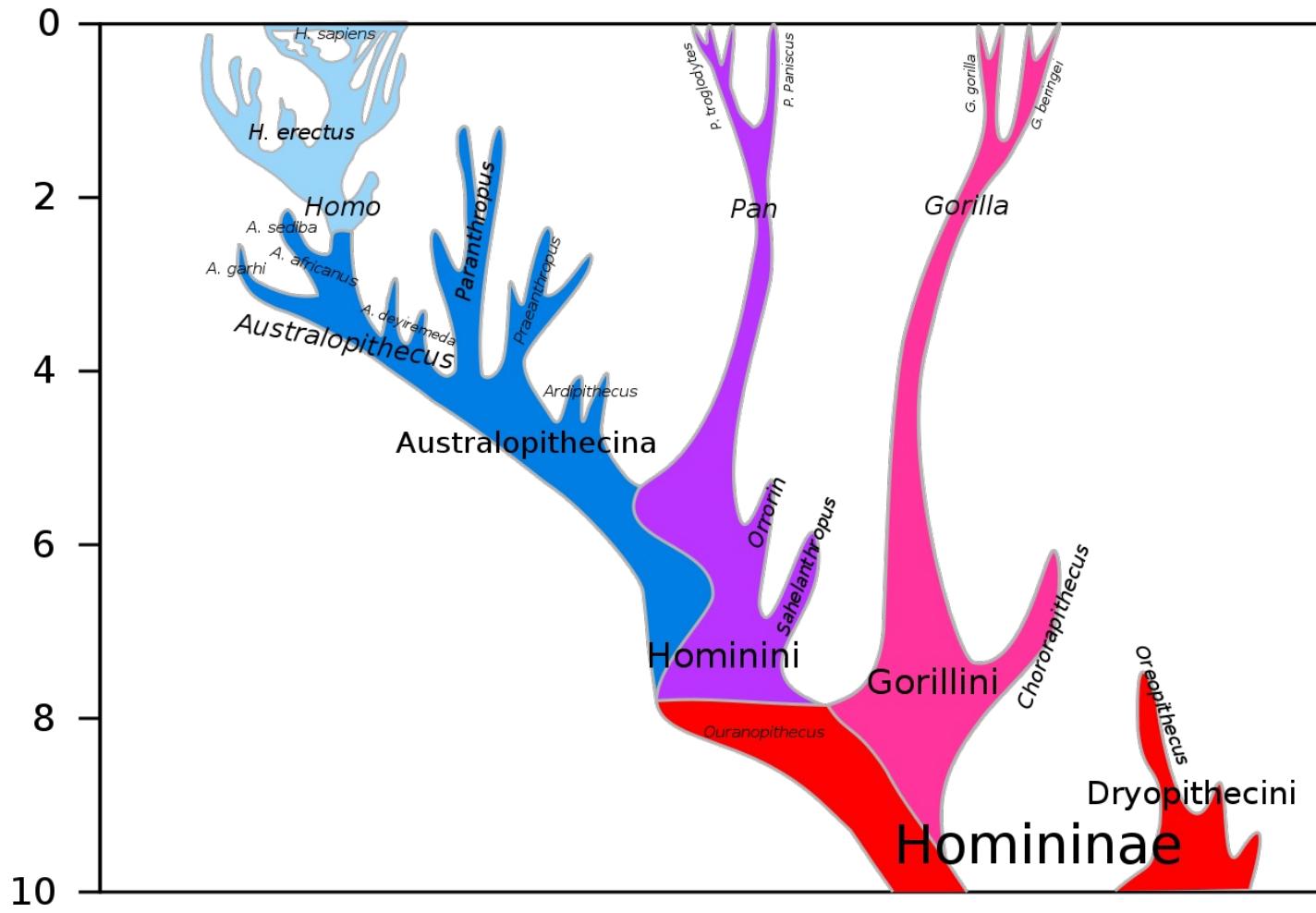


Liu, W., Martinón-Torres, M., Cai, Yj. et al. (2015). The earliest unequivocally modern humans in southern China. *Nature*, 526, 696–699.



Eurasia Africa

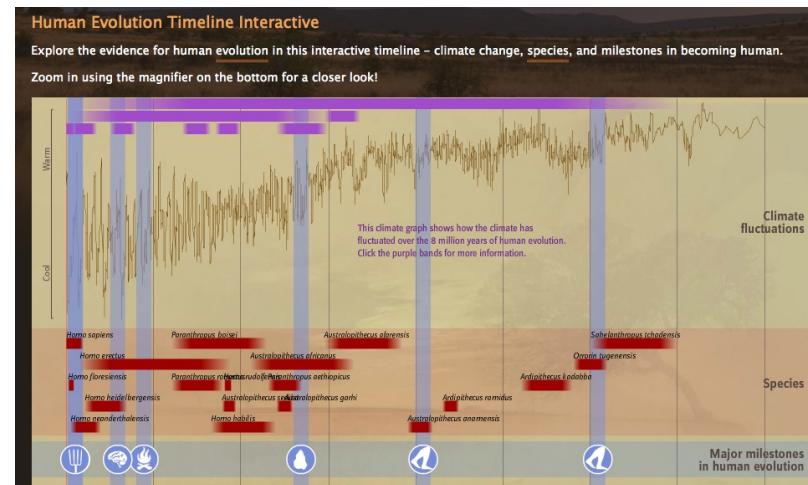
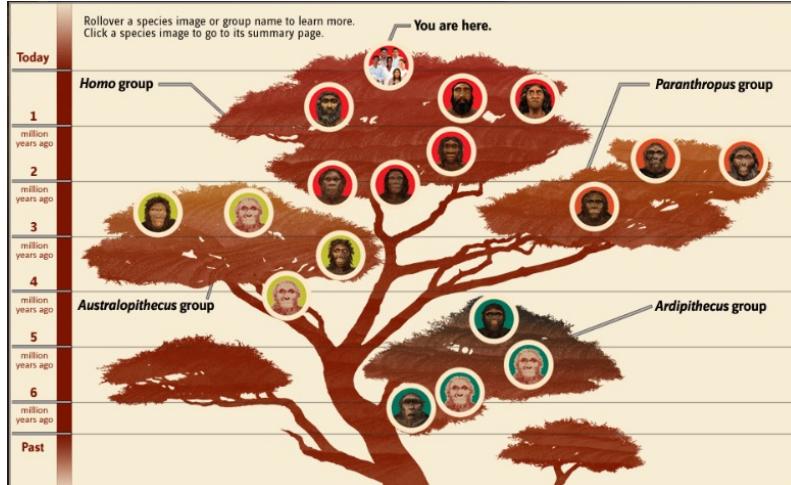




A useful resource: Smithsonian Human Evolution Timeline

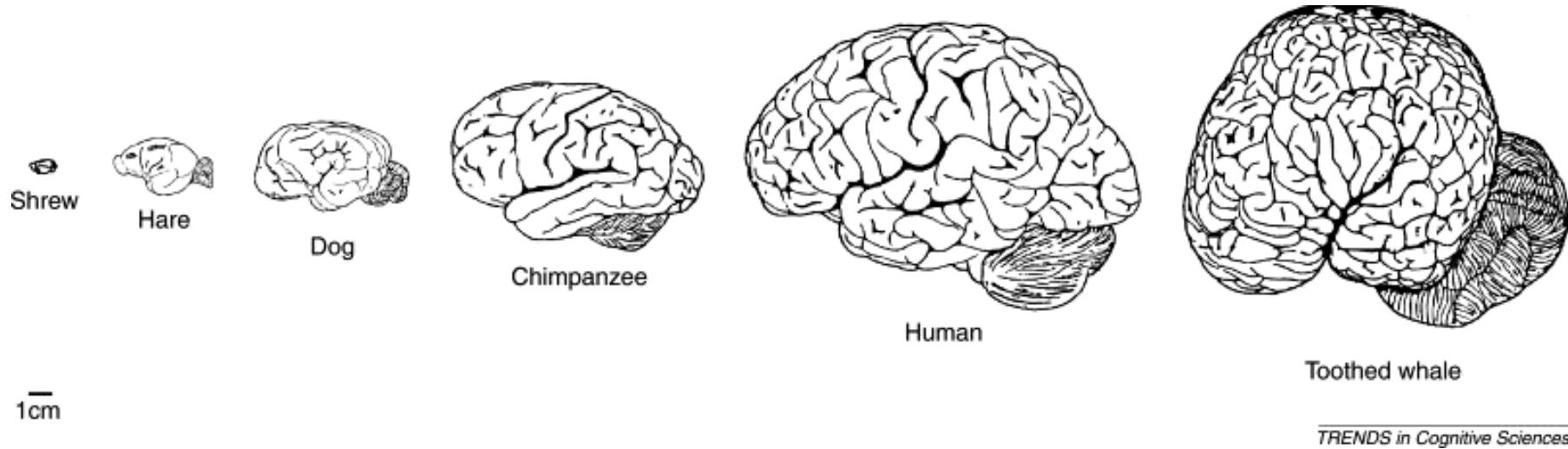
<http://humanorigins.si.edu/evidence/human-family-tree>

<http://humanorigins.si.edu/evidence/human-evolution-timeline-interactive>



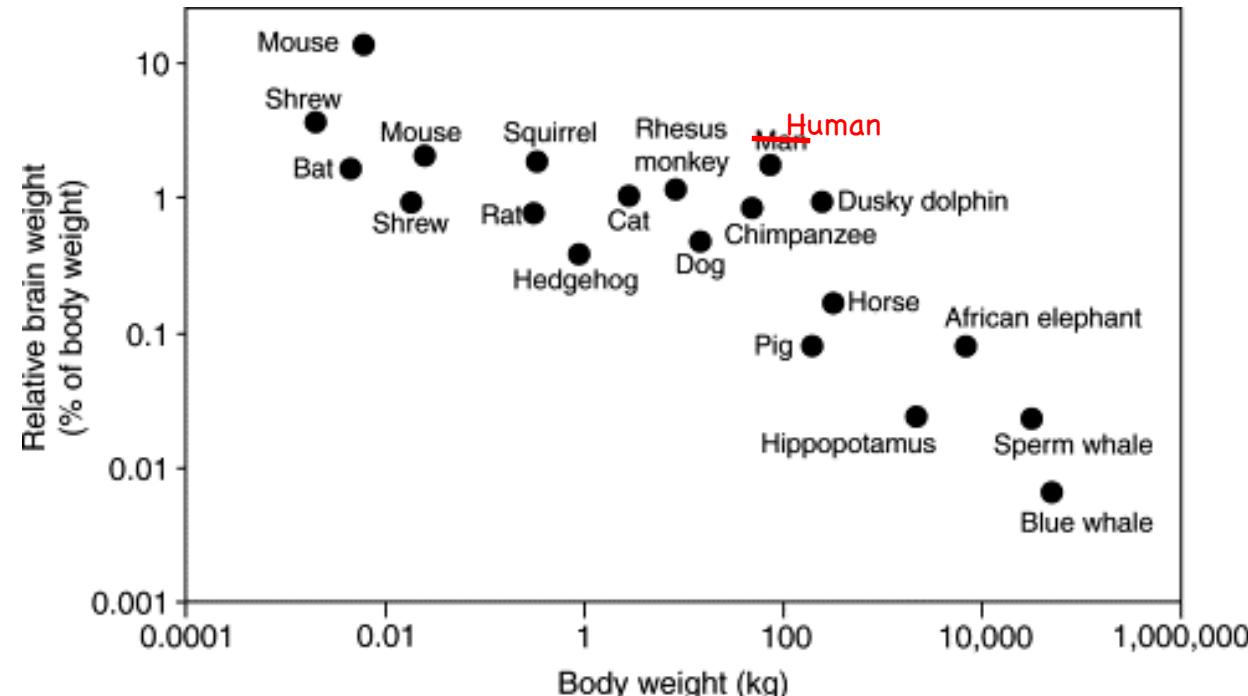
Evolution of brain size

Brain size: absolute size



Humans don't have the biggest brains, or the most folded cortex

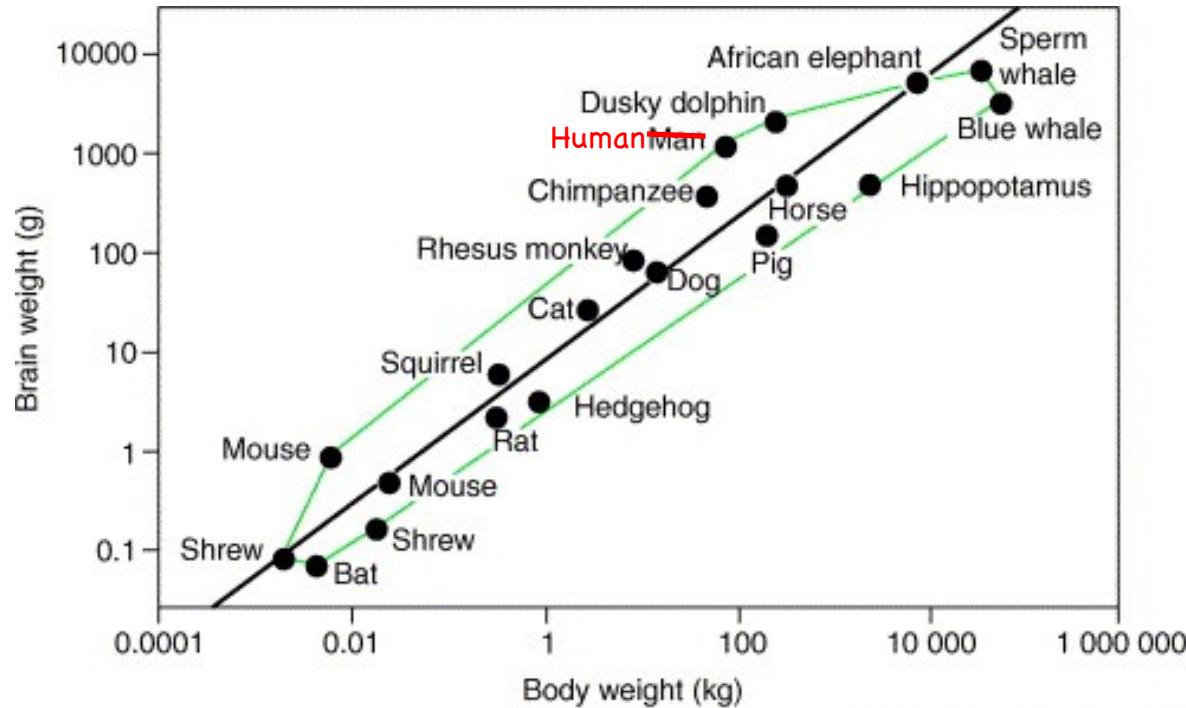
Brain size as a % of body size



TRENDS in Cognitive Sciences

Humans don't have the biggest brains as a % of body weight

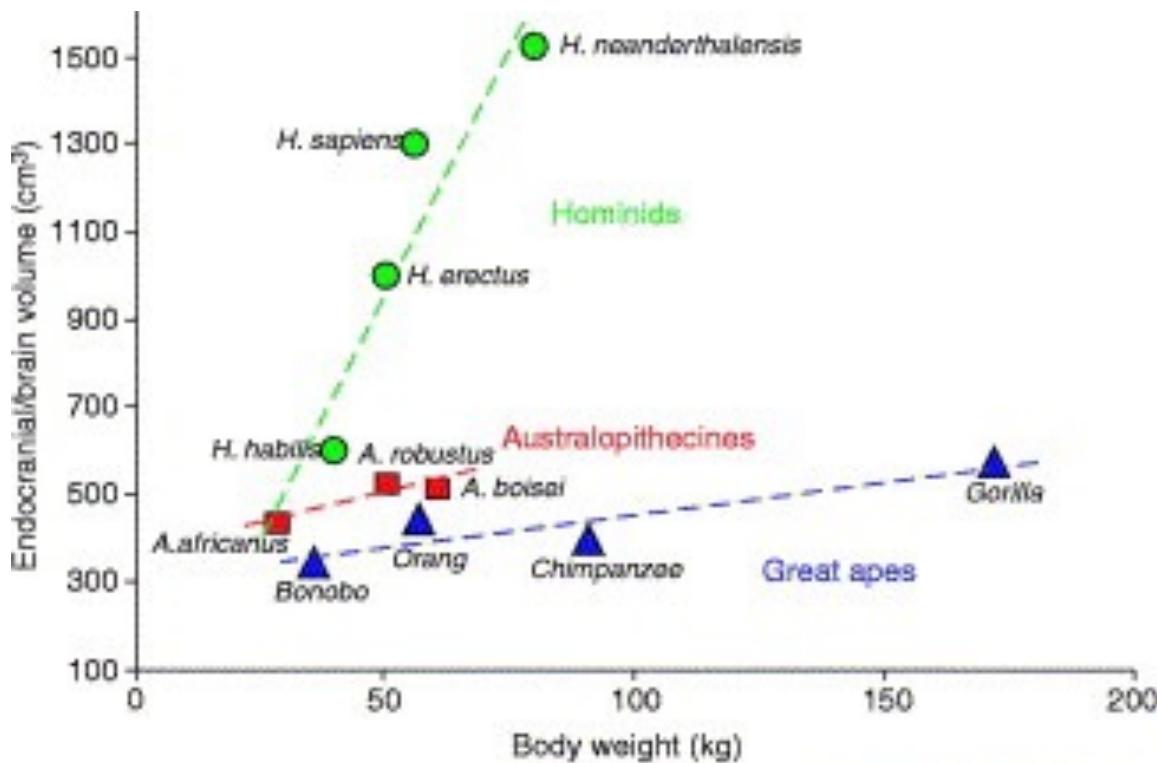
Relative size and encephalization quotient



TRENDS in Cognitive Sciences

Human brains are big **relative to the brain a mammal of our size should have**

The evolution of brain size



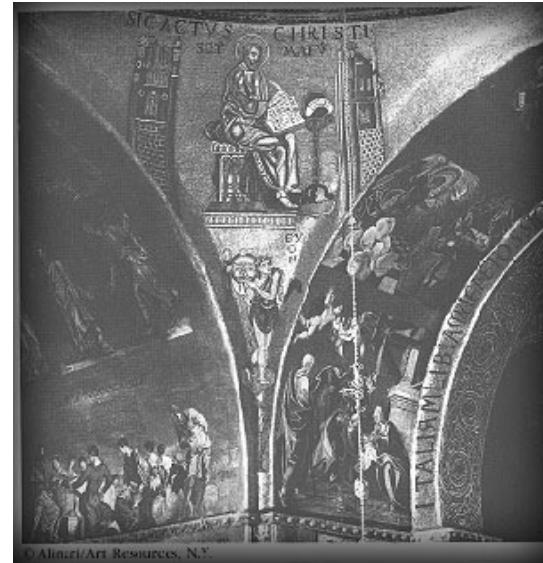
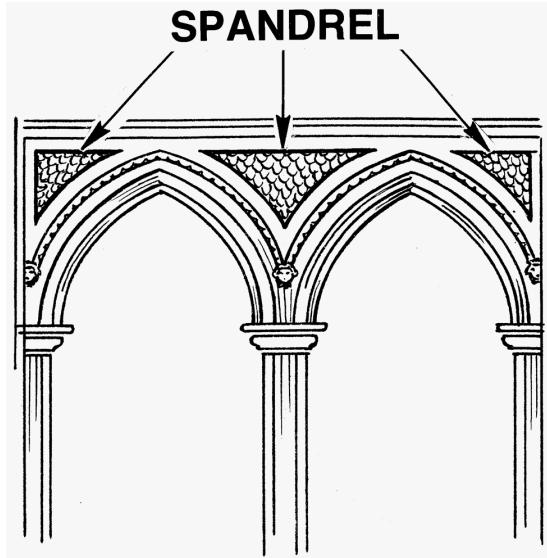
Why have we evolved relatively big brains?

Fitch, 2010, p. 290-291: “overall brain size may provide one of the major ‘handles’ that natural selection can modify directly ... it is therefore likely that selection for one or more specific types of intelligence (e.g. toolmaking, extractive foraging, social intelligence, etc.) might have led to the sorts of neural changes necessary for more complex semantics or syntax”

- Language faculty as a (modified) **spandrel**?

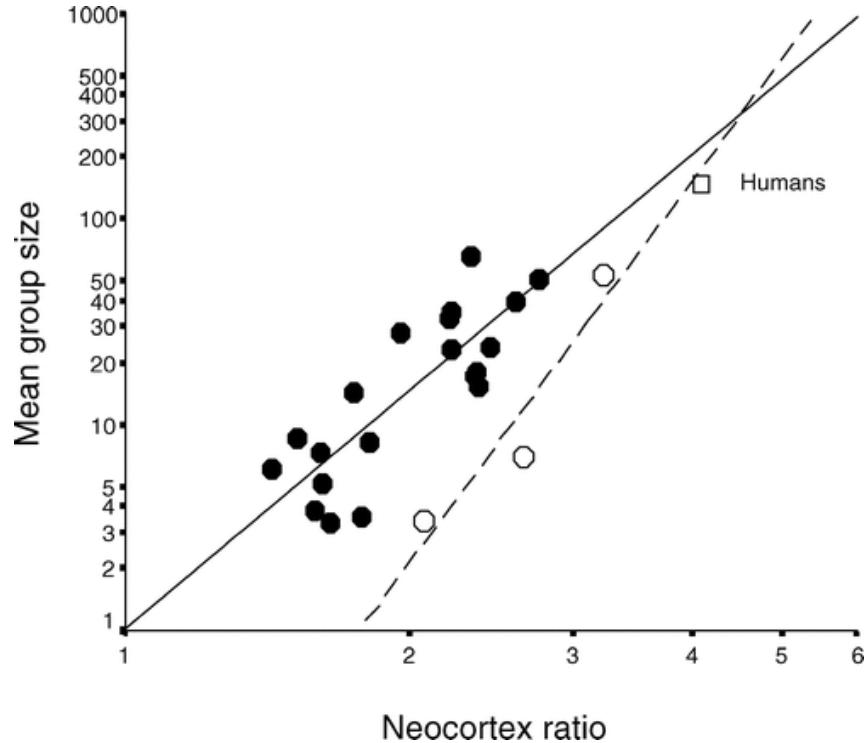
Spandrels

Traits present for reasons of architecture, development or history



S. J. Gould and R. C. Lewontin. The Spandrels of San Marco and the Panglossian Paradigm: A Critique of the Adaptationist Programme. *Proceedings of the Royal Society of London B*, 205, 581-598

Neocortex size and group size

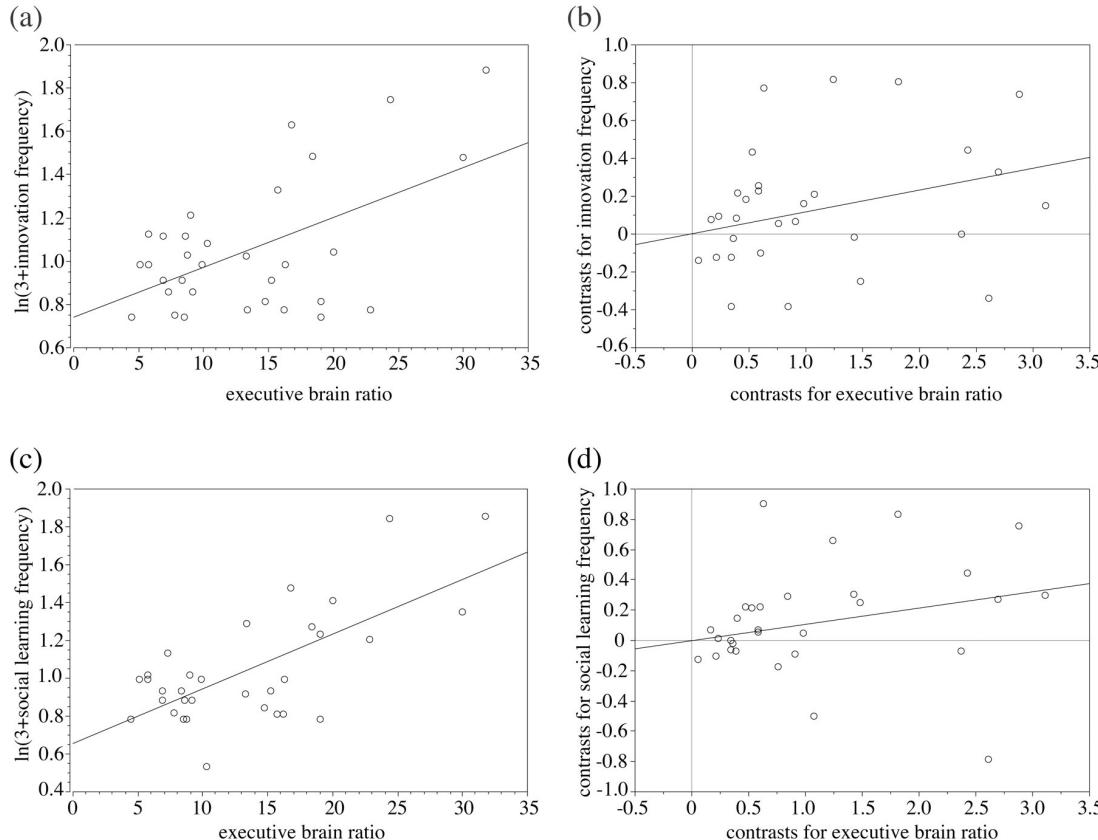


Dunbar, R. I. M. (2003). The Social Brain: Mind, Language, and Society in Evolutionary Perspective. *Annual Review of Anthropology*, 32, 163-181.

Why might brain size be related to group size?

- A. Cooperative foraging / hunting / collective predator defense in larger groups will result in more abundant food, required to support big brains.
- B. Larger groups involve greater memory demands in tracking group members and facts about group members.
- C. Larger groups are politically more complex, requiring greater levels of Machiavellian intelligence.
- D. Something else.

Brain size and social learning, innovation and tool use

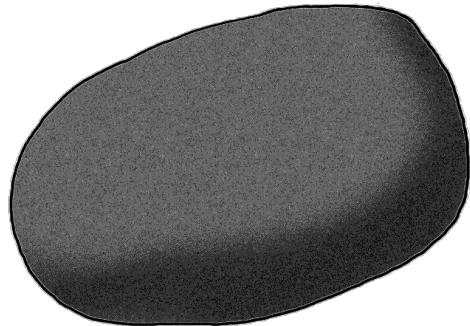


Technology, cumulative culture, and language

DEVELOPMENT OF STONE TOOL TECHNOLOGY IN EASTERN AFRICA



Mousterian
0.3 MYA – 40KYA



Upper Paleolithic Revolution
“Great Leap Forward”, 100-40KYA (?)





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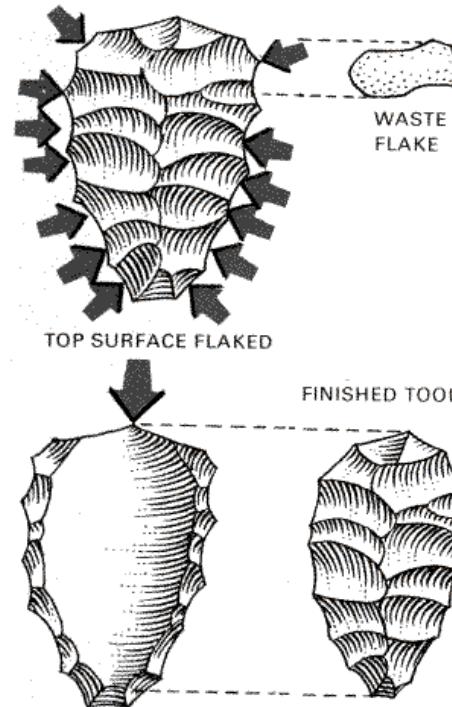
Proffitt, T., Luncz, L., Falótico, T. et al. (2016). Wild monkeys flake stone tools. *Nature*, 539, 85–88 .

<https://www.youtube.com/watch?v=SrvPOkMs4U4>

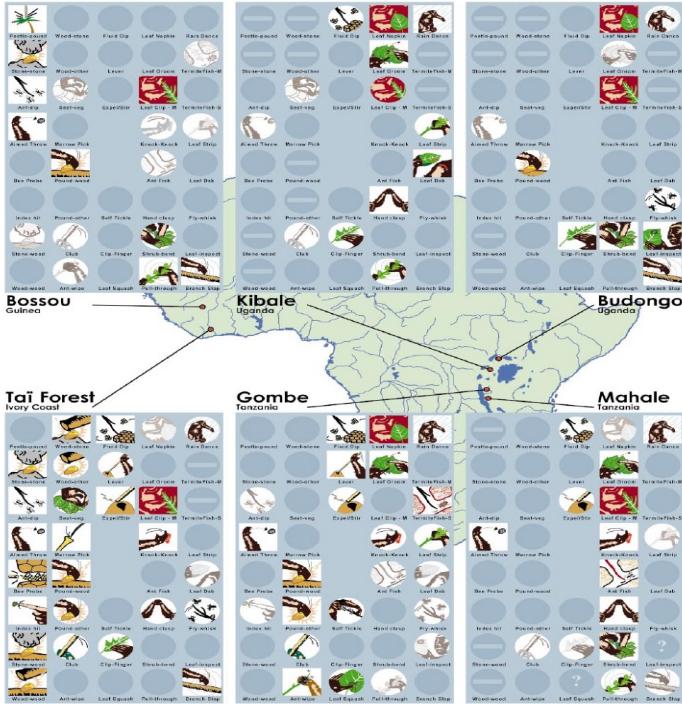
Tools, social learning, and culture

How did individuals acquire these skills?

- Individual trial-and-error learning?
- Emulation?
- Imitation?
- Teaching?
- Teaching with language?



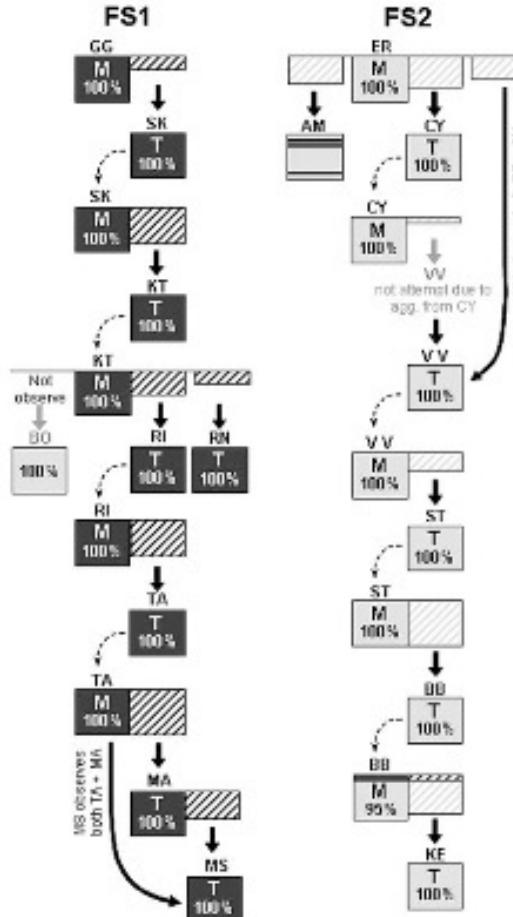
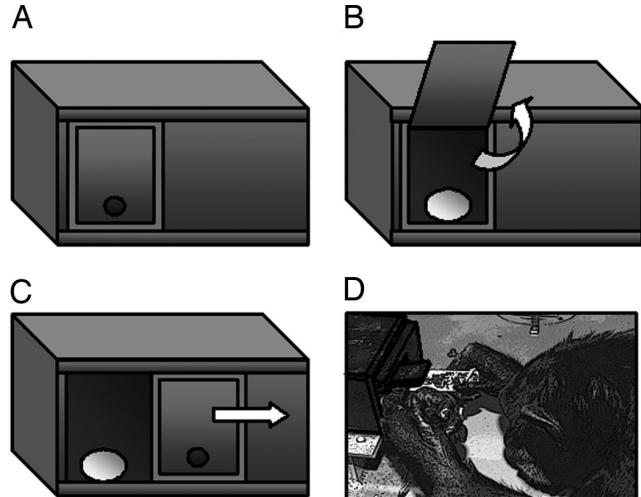
Social learning and culture in chimpanzees



Behavioural variation in chimpanzee populations

- E.g. some groups crack nuts, some don't
 - Some variation hard to explain due to differences in environment
 - Probably (?) cultural

Social learning and culture in chimpanzees



Social learning and culture in bumblebees (!)

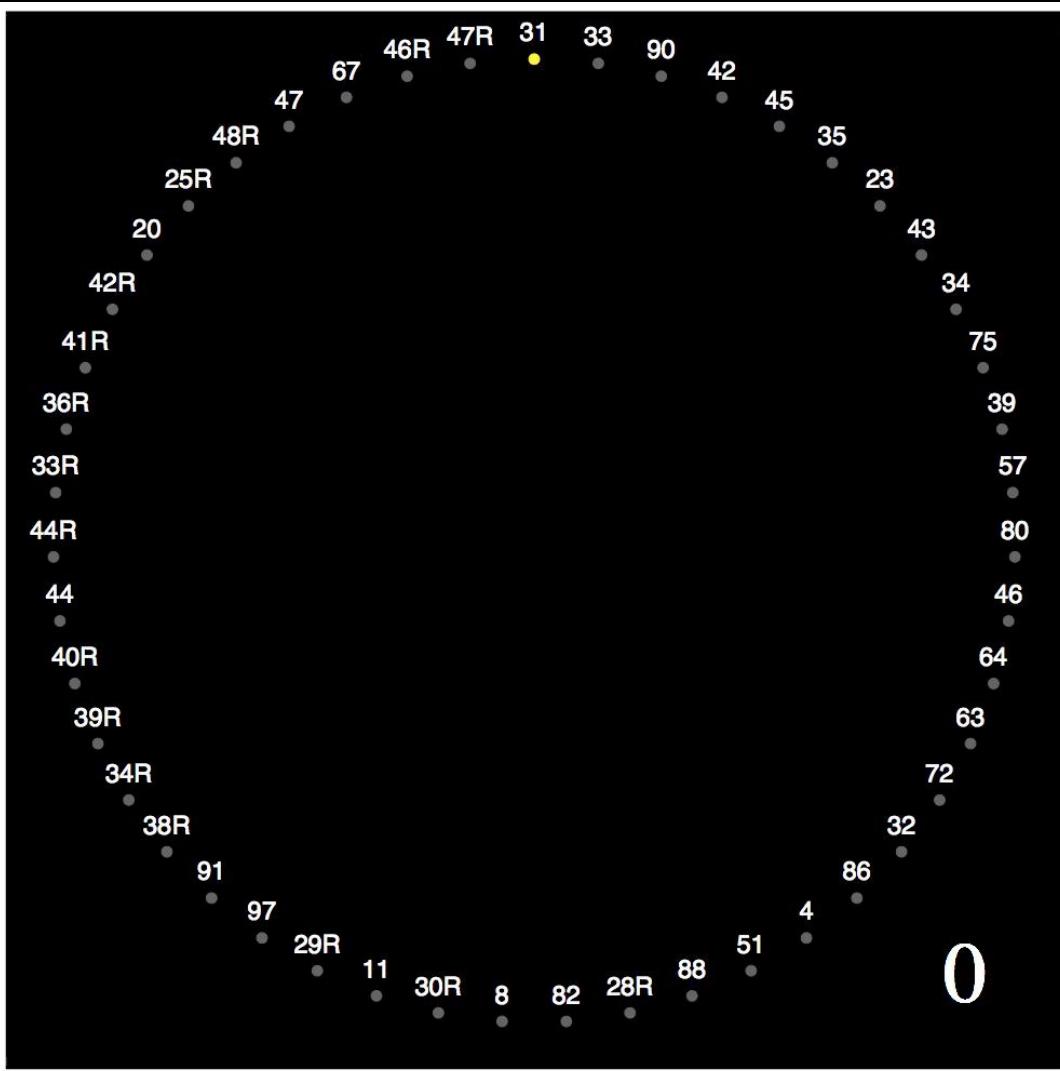


Alem, S. et al, (2016) Associative Mechanisms Allow for Social Learning and Cultural Transmission of String Pulling in an Insect. *PLoS Biology*, 14, e1002564.

Social learning and culture in bumblebees (!)

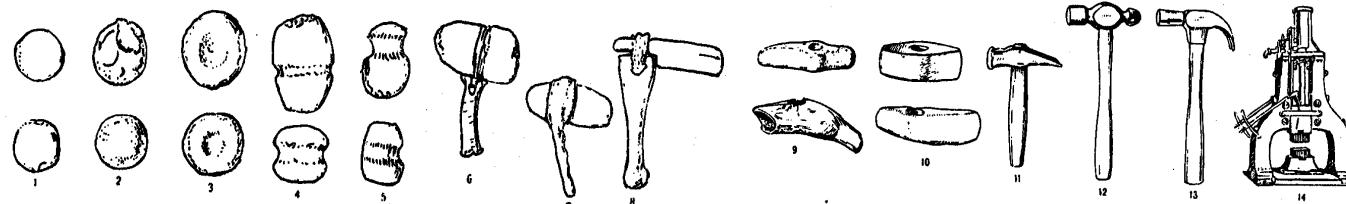
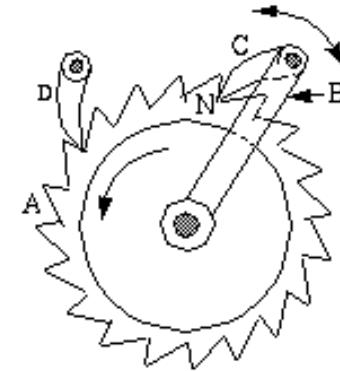


Alem, S. et al, (2016) Associative Mechanisms Allow for Social Learning and Cultural Transmission of String Pulling in an Insect. *PLoS Biology*, 14, e1002564.



Cumulative cultural evolution

Behaviour and artefacts become increasingly complex, such that each generation uses techniques and objects they could never have invented by themselves



Products of CCE: technology, complex societies, **language**, ...

Cumulative cultural evolution in non-humans?

“the human attributes that are described as ‘cultural’ in ordinary discourse, seem to be a good deal more complex than, for example, potato washing and termite-fishing...and it is plausible that their greater complexity derives from the accumulation of modifications”
(Heyes, 1993)



Cumulative cultural evolution in non-humans?

“Undoubtedly, given the investigative and manipulative tendencies of the young chimpanzee and his ability to learn through trial and error, almost all of the feeding and tool using behaviours I have described could be invented anew by each individual” (Goodall, 1970)



Goodall, J. (1970). Tool using in primates and other vertebrates. *Advances in the Study of Behaviour*, 3, 195-250.

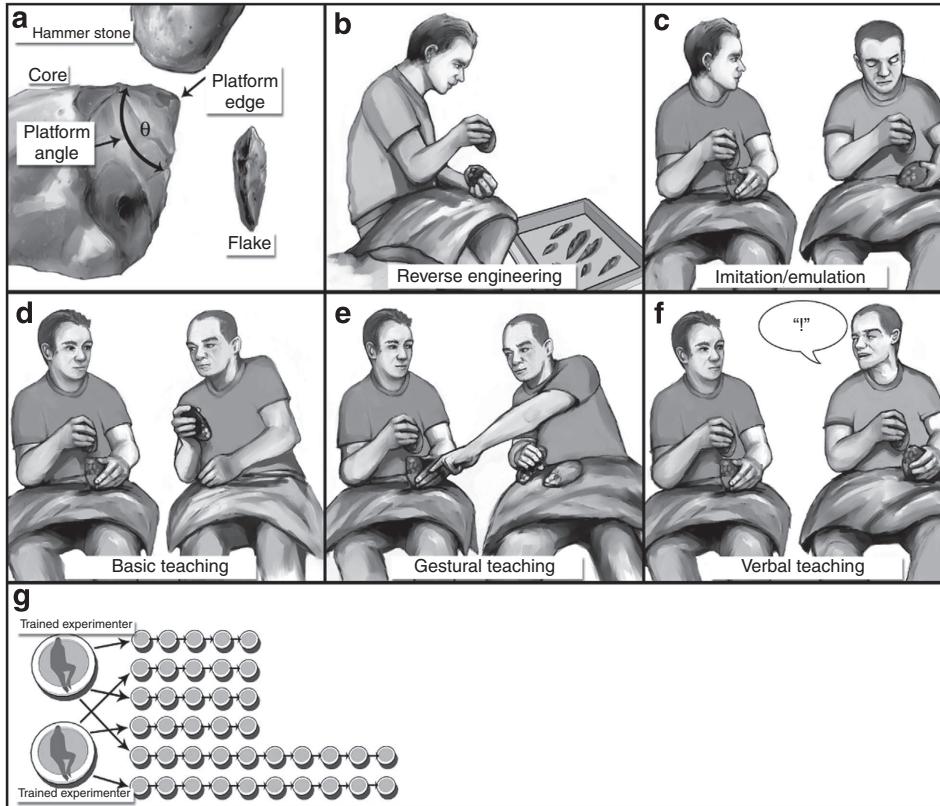
Culture in non-humans??

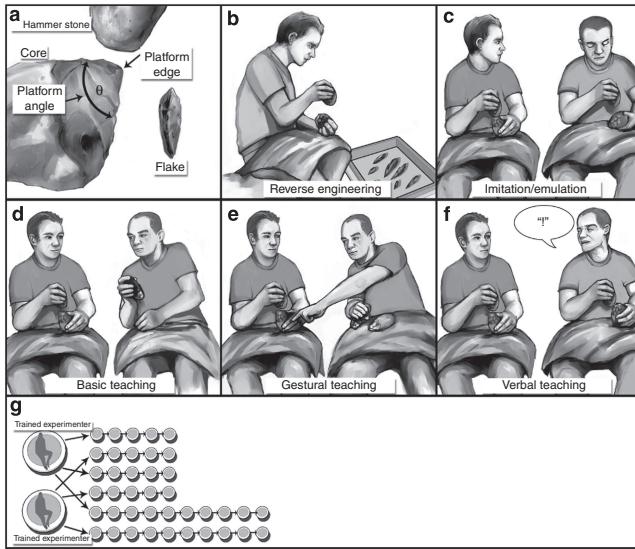
“stick pounding is a behavioral form that can be reinnovated by naïve chimpanzees. Thus, this study adds to the growing body of evidence for the view that some chimpanzee tool-use behavioral forms can be reinnovated by naïve individuals”
(Bandini & Tennie, 2019, p. 8)



Bandini, E., & Tennie, C. (2019). Individual acquisition of “stick pounding” behavior by naïve chimpanzees. *American Journal of Primatology*, 81, e22987.

Is imitation enough to preserve stone tool technology?

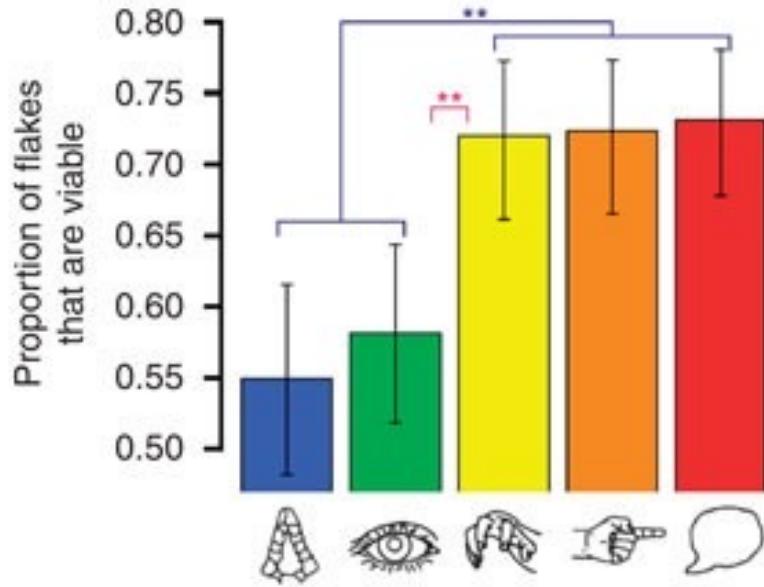
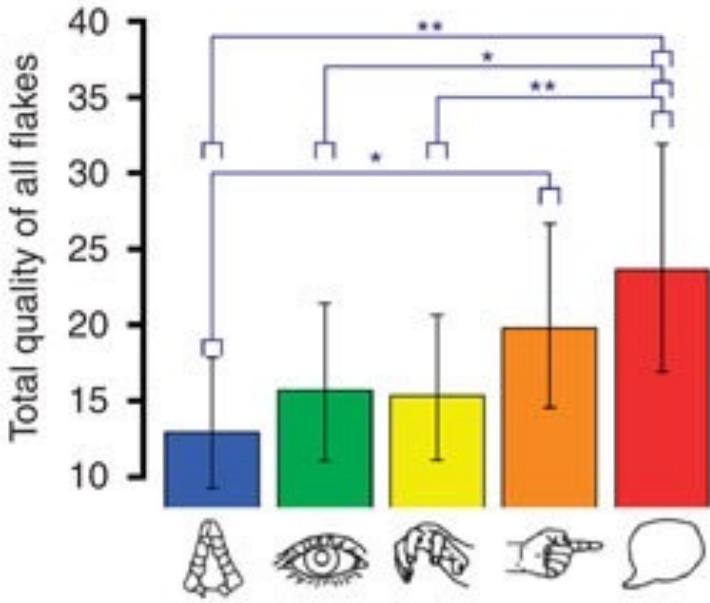




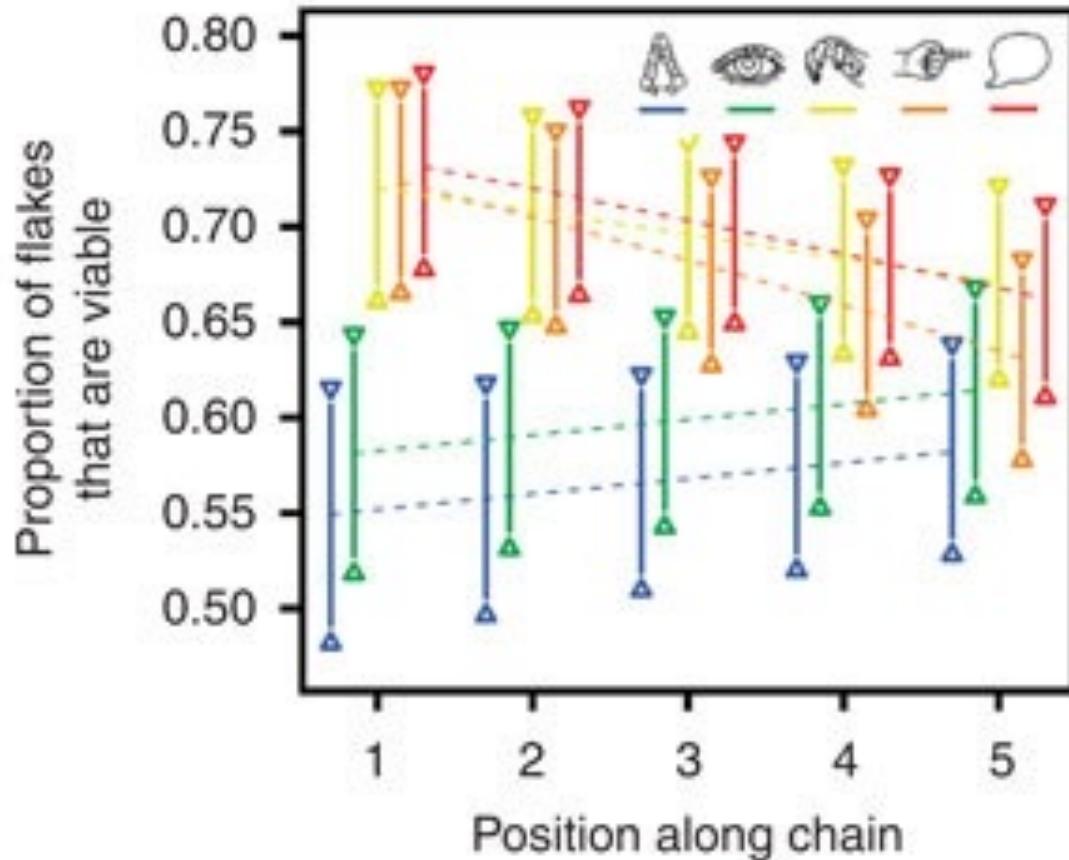
How do you think it's going to turn out?

- A: Language will beat all these other mechanisms.
- B: More sophisticated teaching is better, but in a smooth, gradual way.
- C: Any kind of teaching is better than none, language isn't special.
- D: I don't care too much what the results are here, this experiment isn't capturing what I think is important.

Does language-based teaching make you better at the task?

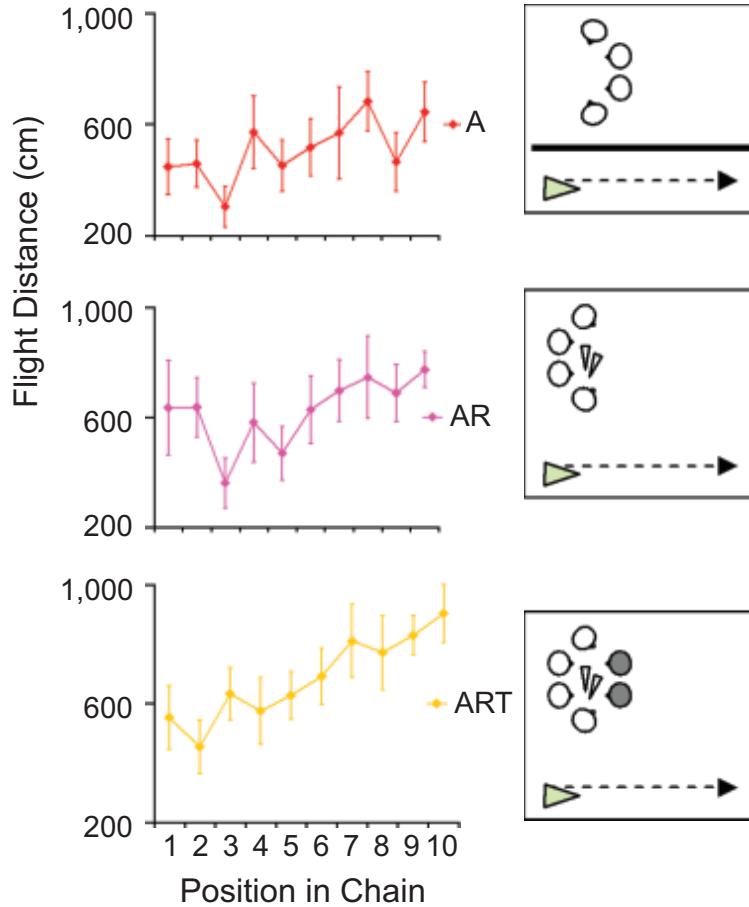


Is imitation enough to preserve stone tool technology?



Morgan, T. J. H., et al., (2015). Experimental evidence for the co-evolution of hominin tool-making teaching and language. *Nature Communications*, 6, 6029.

Although: no benefit
for teaching in a paper
plane task

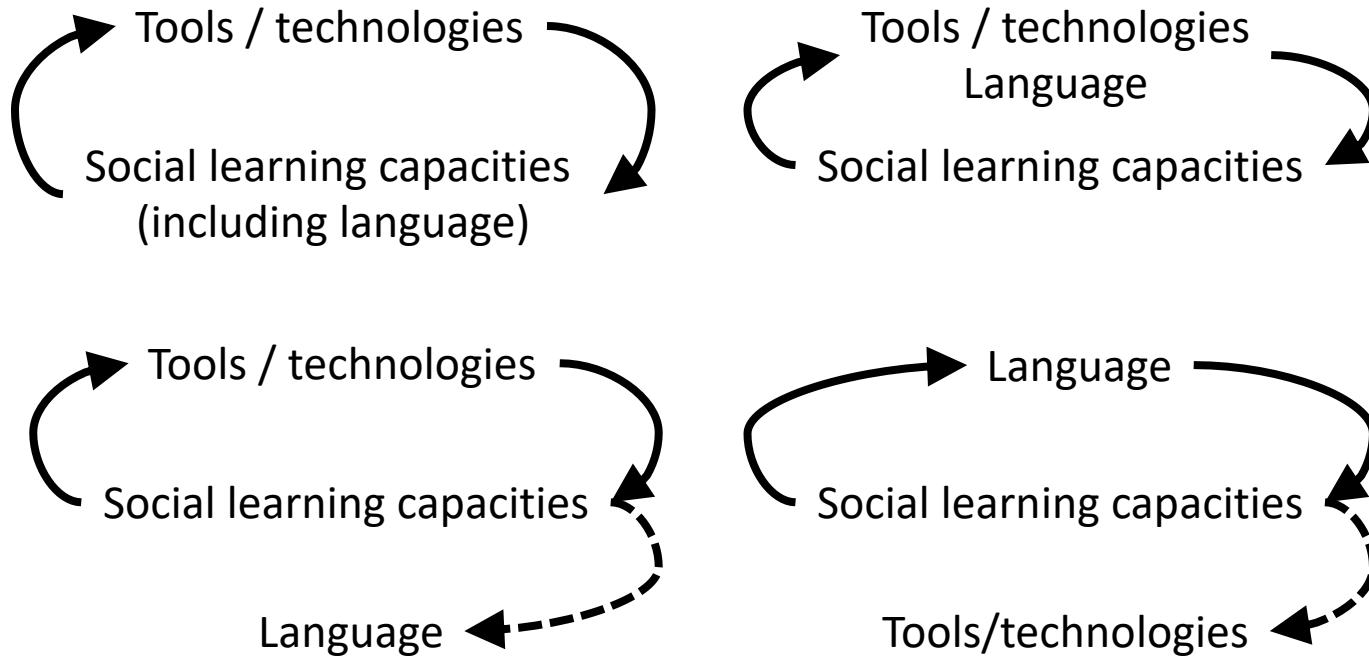


Co-evolution of technology, teaching and language (?)

“our data imply that Oldowan tool making would have created a continuous selective gradient leading from observational learning to much more complex verbal teaching. This process need not have taken place entirely within the Oldowan, but was probably already underway during the Oldowan and likely continued well after, as Oldowan tools continued to be made for hundreds of thousands of years beyond the Oldowan time period.

Furthermore, assuming that the transmission of more complex technologies also benefits from more complex means of communication, later technologies would have reinforced the gene-culture co-evolutionary dynamic. Such a process could have lasted for millions of years (and may be ongoing), with more complex communication allowing the stable and rapid transmission of increasingly complex technologies, which in turn generate selection for even more complex communication and cognition, and so forth. Although this places little necessary constraint on when teaching and language may have evolved, our central contribution is to provide evidence that Oldowan tools, produced by hominins since at least 2.5 mya, were involved in this dynamic.” (Morgan et al., 2015)

Co-evolution of technology, social learning, and language: some scenarios



Summary of today

- Human evolution
 - Bushy, not linear
 - Rapid evolution of brain size
 - Evolution of technology, The Great Leap Forward
- Social learning, tool use, and language
 - High-fidelity social learning required to sustain tool use
 - Drove the evolution of language?
 - Drove selection for social learning in general (reappropriated for language)?

Next up

- Debate tutorial
 - Inferring language from archaeology?
- Next lecture: the evolution of speech, comparative psychology of language learning