Origins and Evolution of Language
Week 6: Human evolution, social learning and cumulative culture

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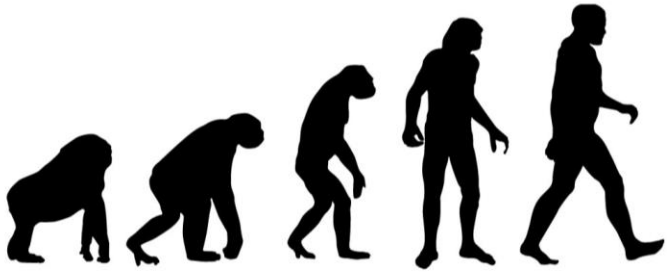
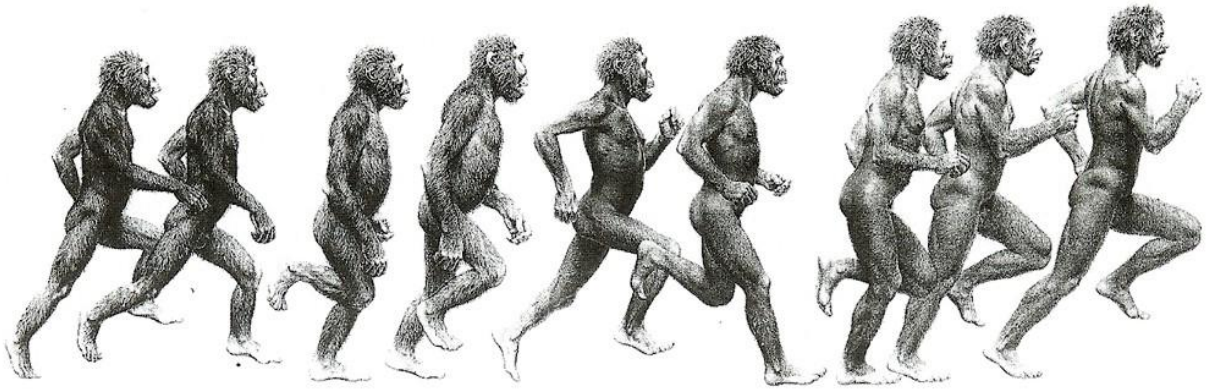
Plan for today

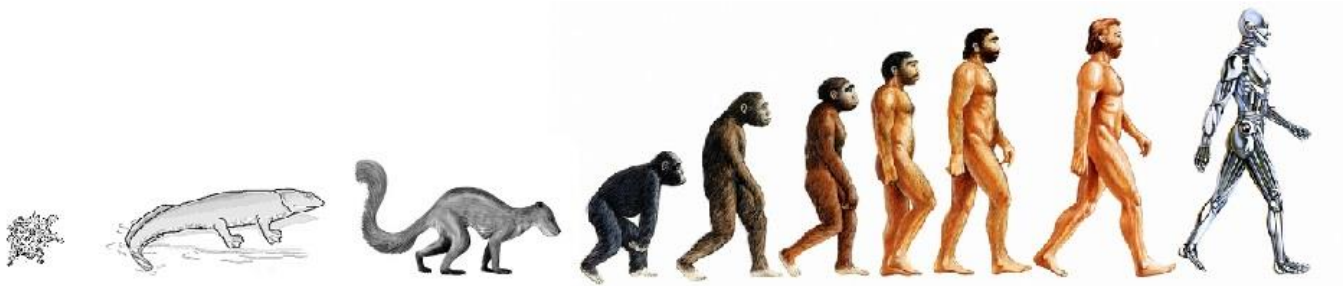
- Human evolution: quick summary of Fitch chapter 7
  - Visual illustration of timeline of human evolution
  - Visual illustration of brain size evolution
- Technology, cumulative culture, and language
  - A look at the early evolution of tools
  - Tool use and social learning
  - Tool use and language?

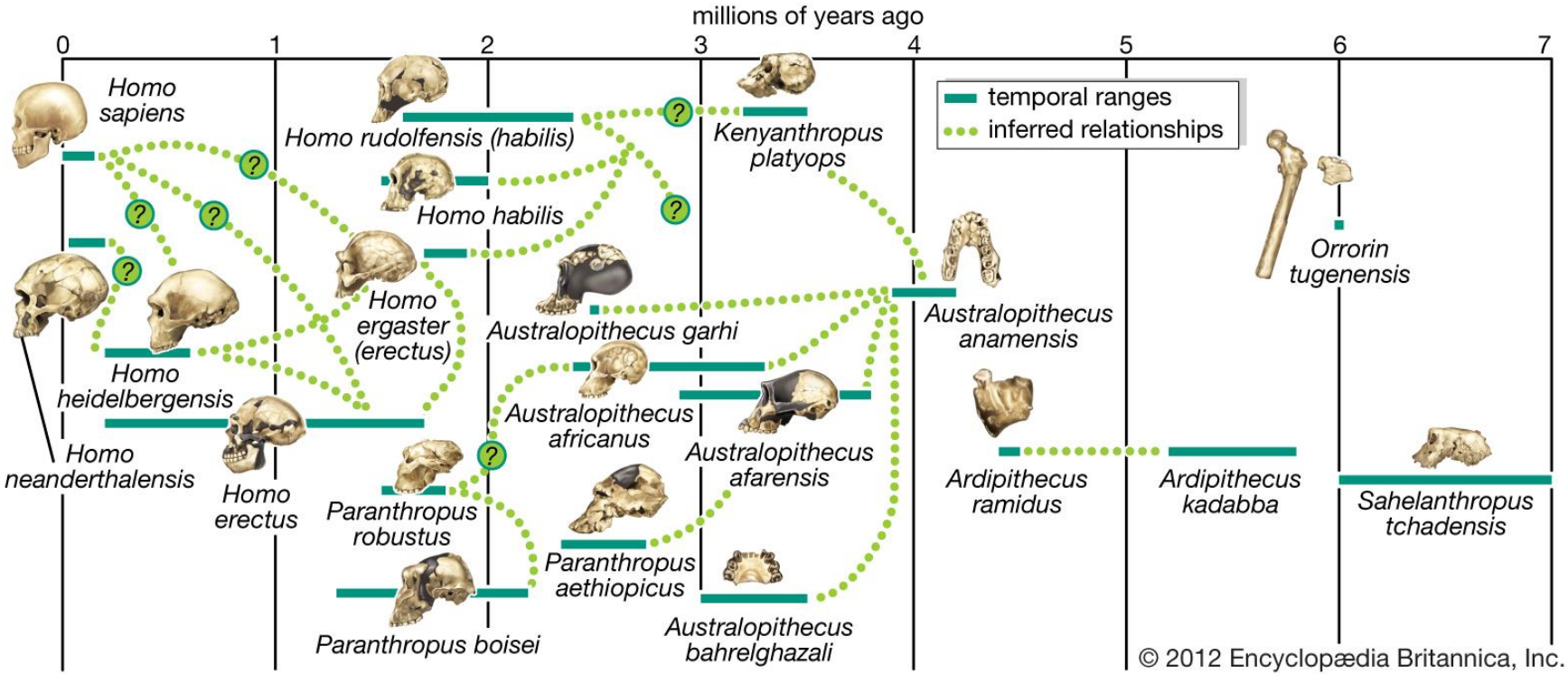
Summary of Fitch Chapter 7



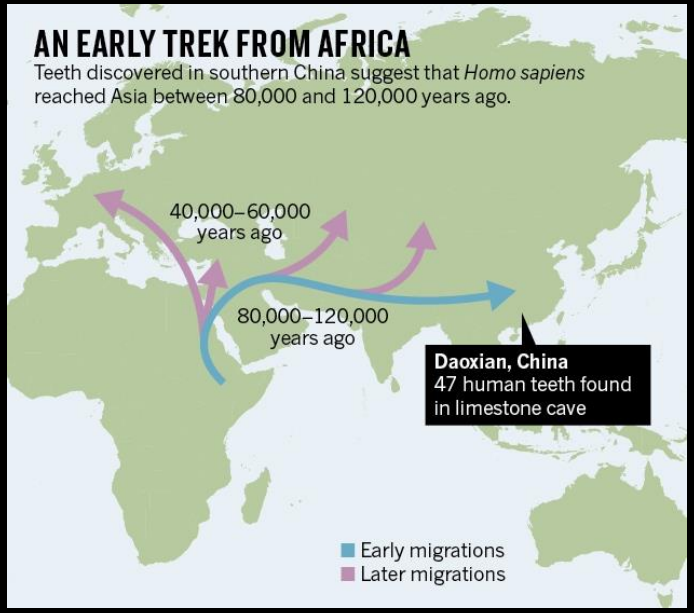


A. afarensis *A.africanus* *A. robustus* *A.boisei* *H. habilis* *H. erectus* *H. sapiens (archaic)* *H. sapiens (Neandertal)* H. sapiens (modern)

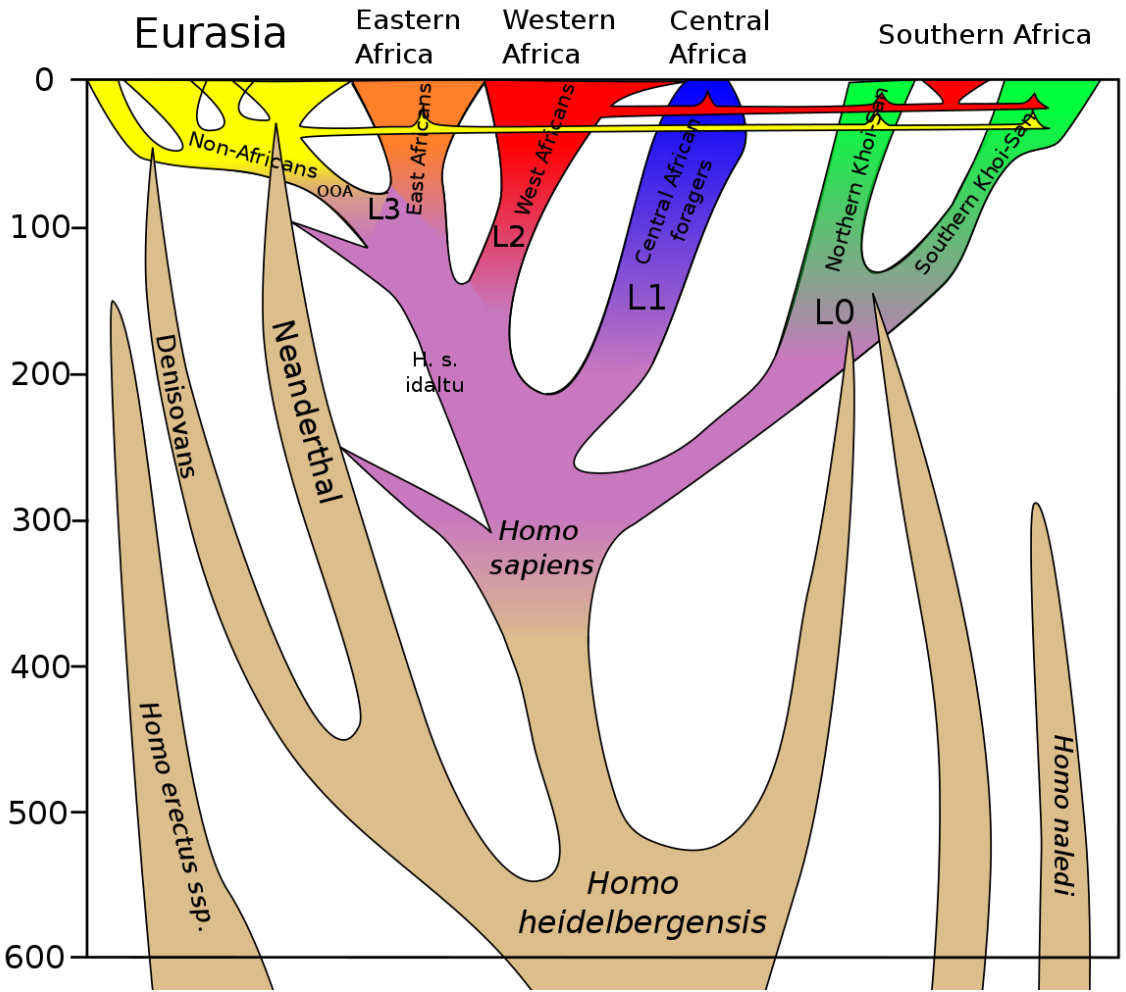



millions of years ago
0
1
2
3
4
5
6
7
temporal ranges
inferred relationships
Homo sapiens
Homo rudolfensis (habilis)
Kenyanthropus platyops
Homo habilis
Orrorin tugenensis
Homo ergaster (erectus)
Australopithecus garhi
Australopithecus anamensis
Homo heidelbergensis
Australopithecus africanus
Australopithecus afarensis
Homo neanderthalensis
Homo erectus
Paranthropus robustus
Ardipithecus ramidus
Ardipithecus kadabba
Sahelanthropus tchadensis
Paranthropus aethiopicus
Paranthropus boisei
Australopithecus bahrelghazali
© 2012 Encyclopædia Britannica, Inc.

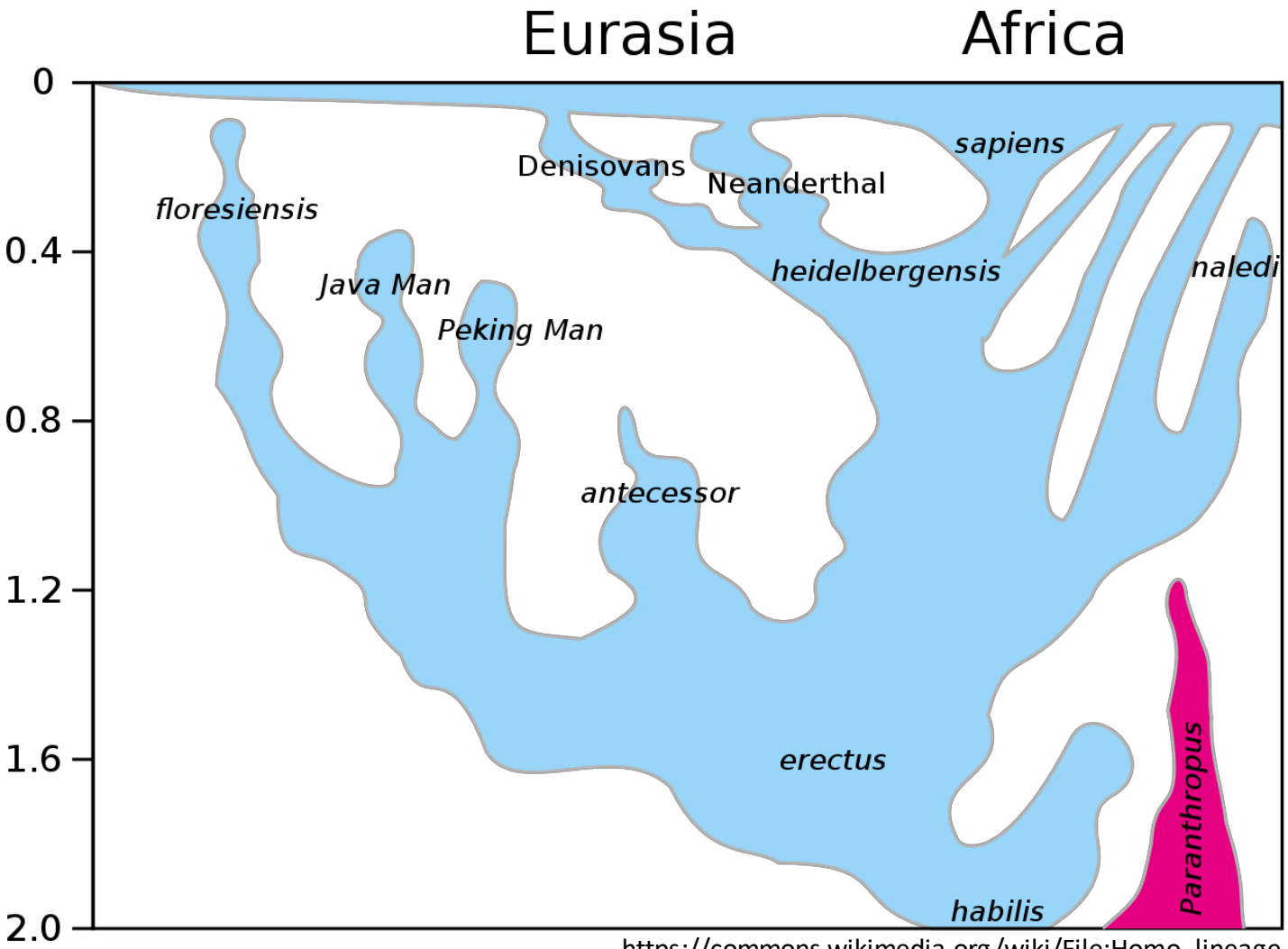
Berger, L. R. (2015). Homo naledi, a new species of the genus Homo from the Dinaledi Chamber, South Africa. *eLife, 4,* e09560



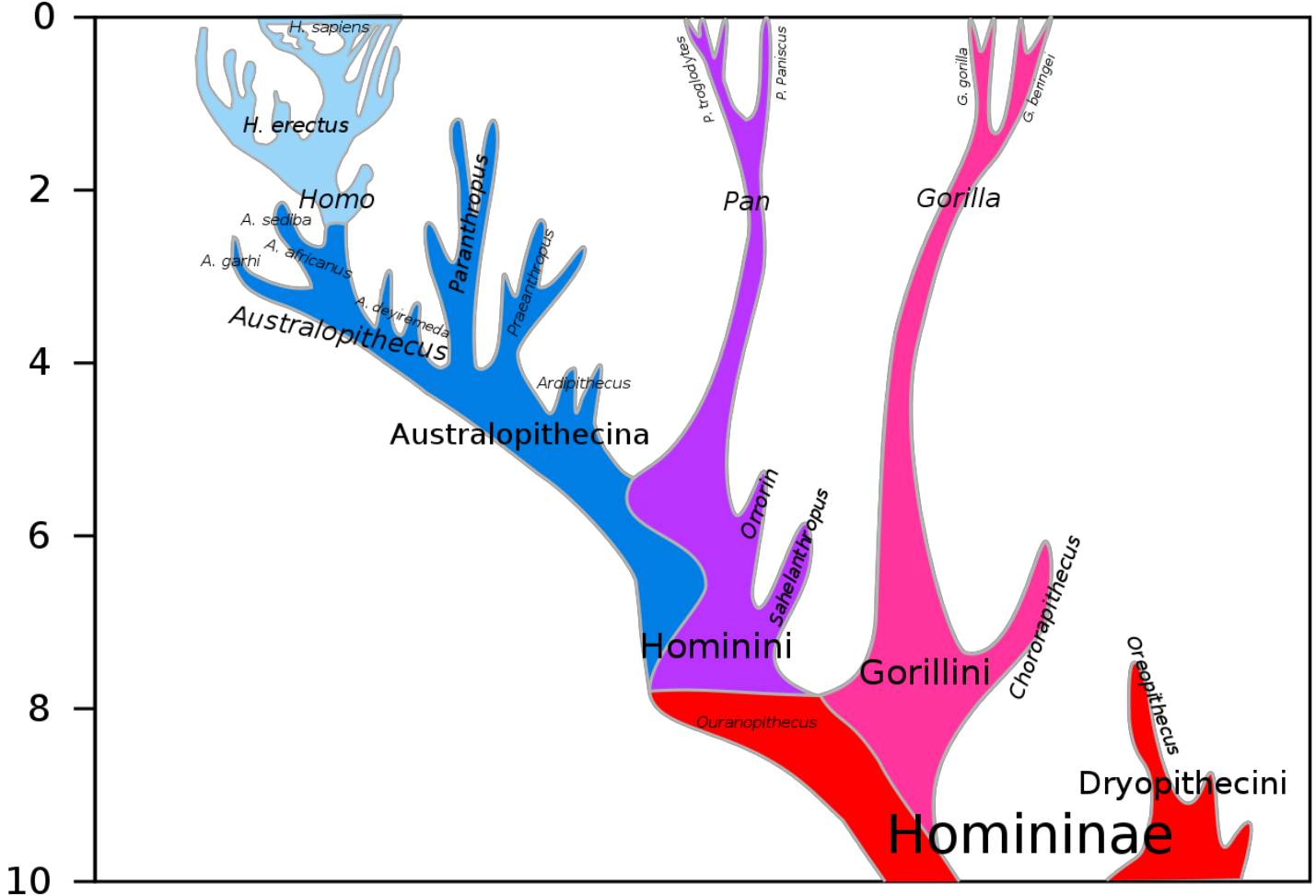
Liu, W., Martinón-Torres, M., Cai, Yj. et al. (2015). The earliest unequivocally modern humans in southern China. *Nature, 526,* 696–699.



https://commons.m.wikimedia.org/wiki/File:Homo_sapiens_lineage.svg#/media/File:Homo_sapiens_lineage.svg



https://commons.wikimedia.org/wiki/File:Homo_lineage_2017update.svg

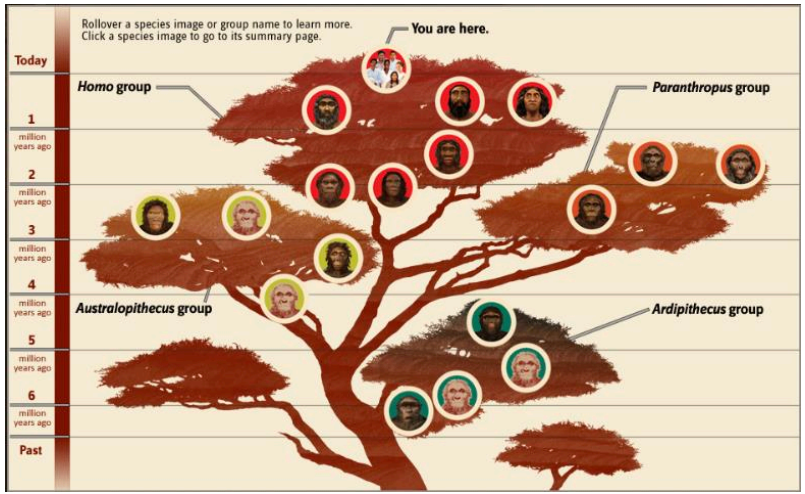


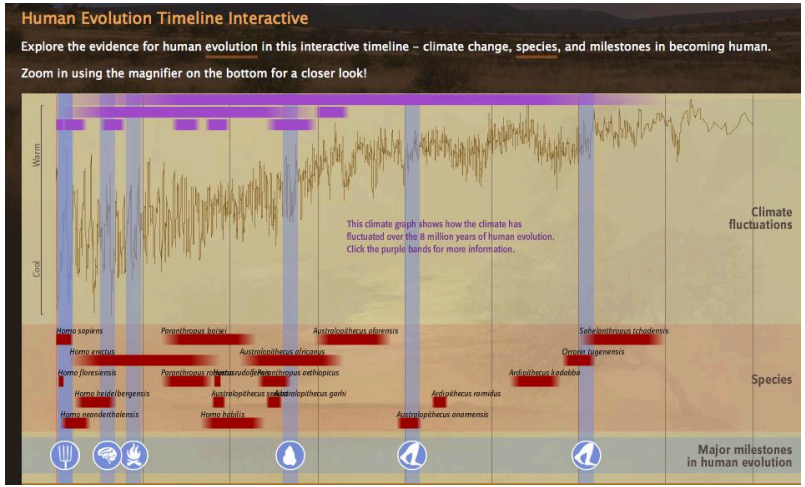
https://commons.wikimedia.org/wiki/File:Hominini_lineage.svg

A useful resource: Smithsonian Human Evolution Timeline

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

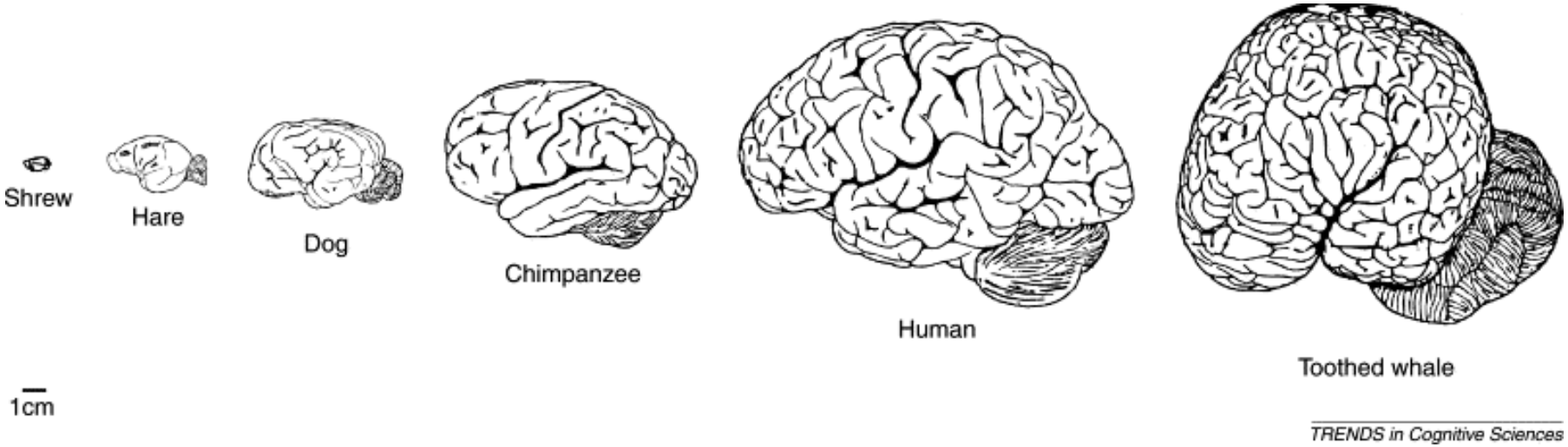
http://humanorigins.si.edu/evidence/human-evolution-timeline-interactive





Evolution of brain size

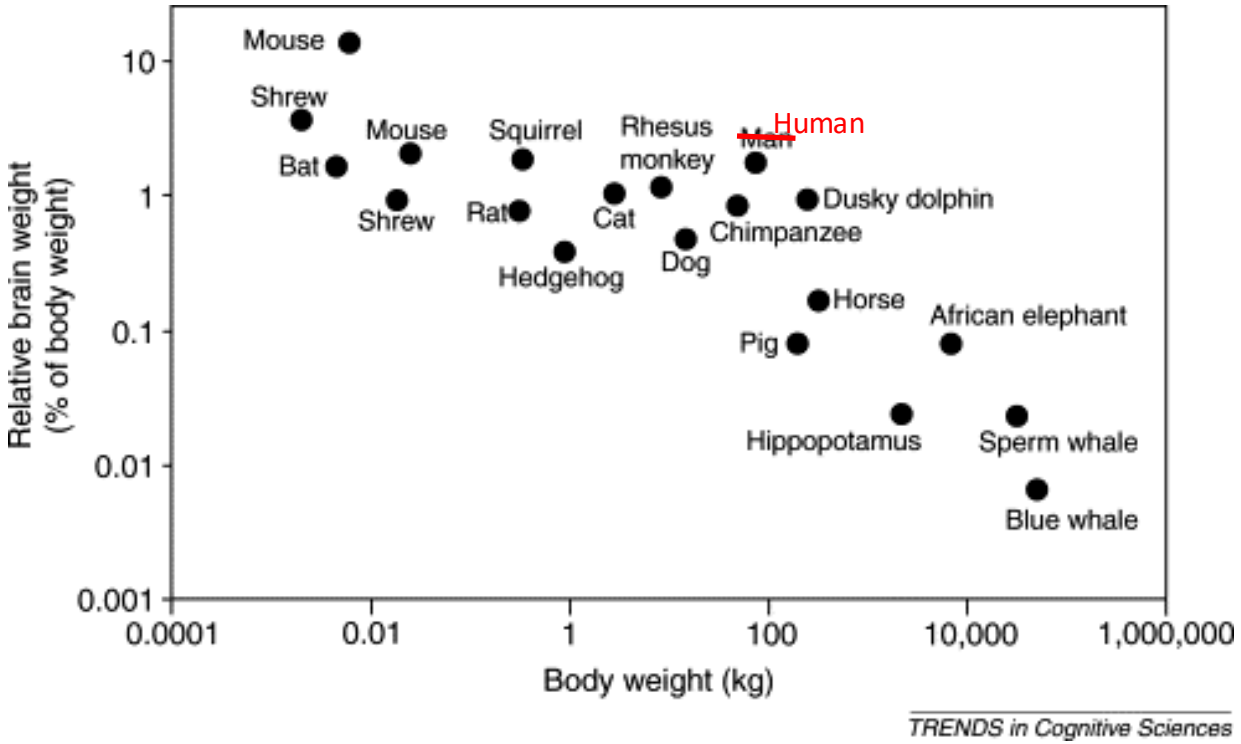
Brain size: absolute size



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

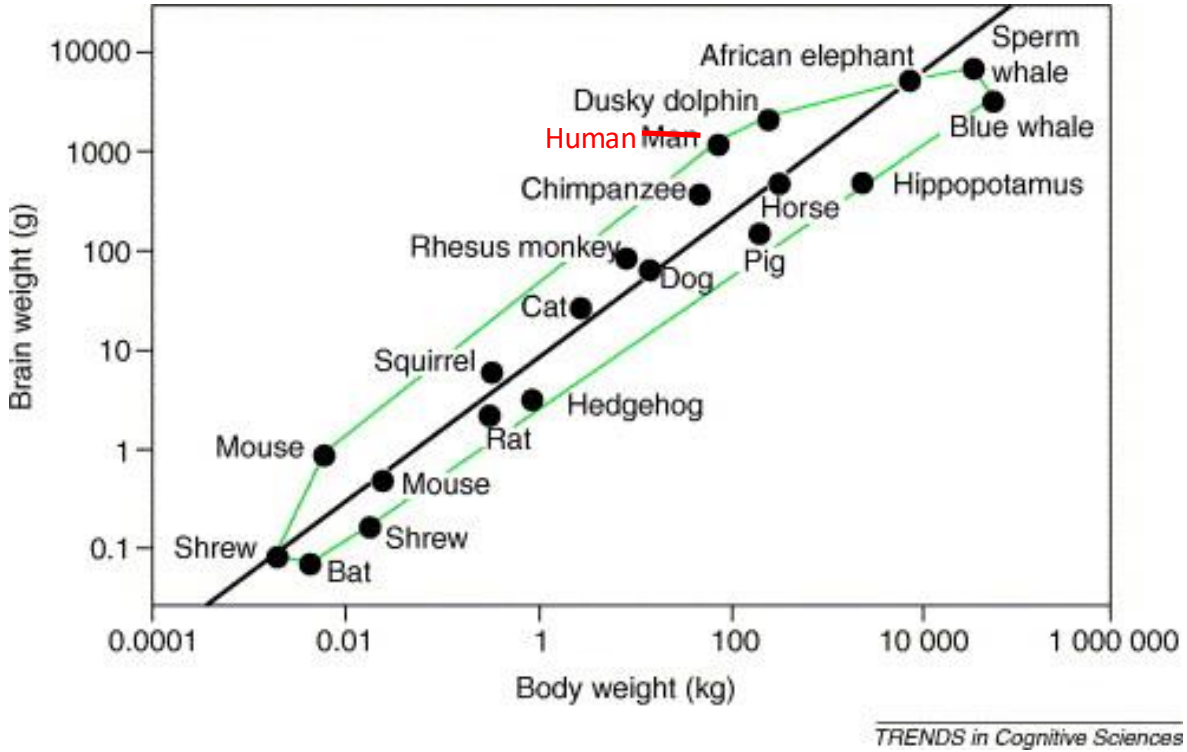
Roth, G., & Dicke, U. (2005). Evolution of brain and intelligence. *Trends in Cognitive Sciences, 9,* 250-257.

Brain size as a % of body size



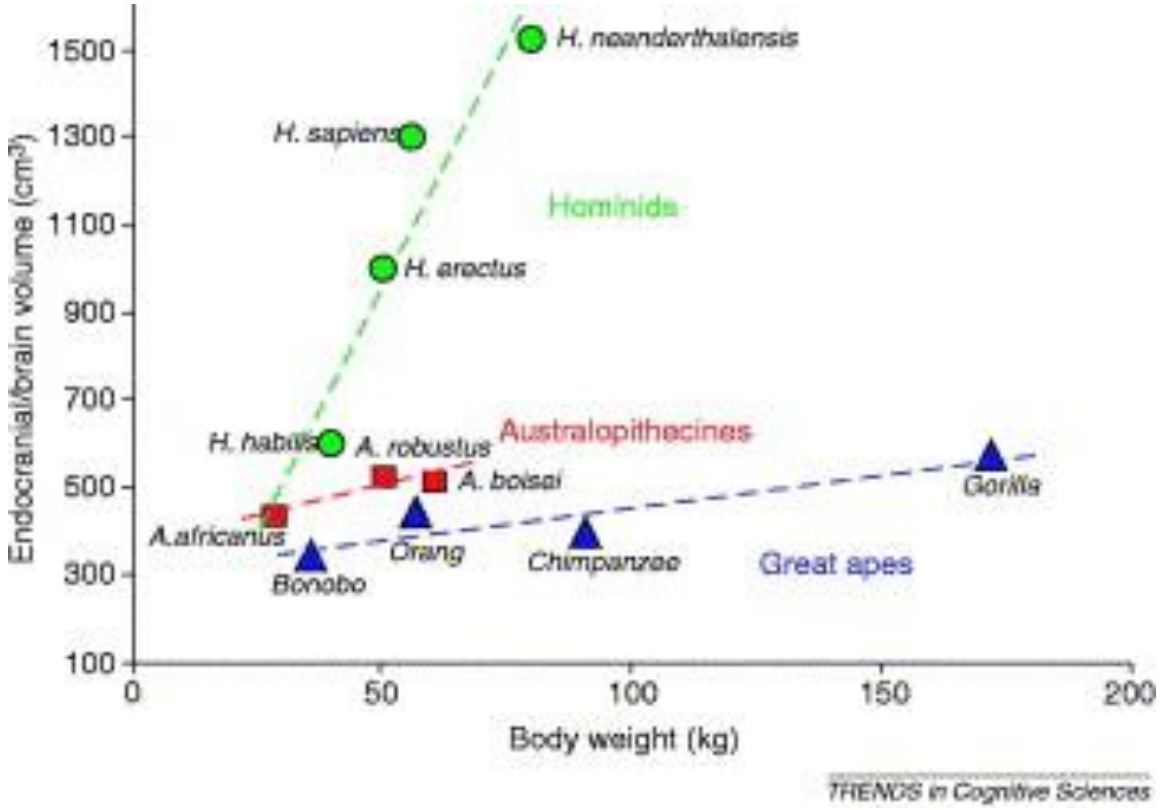
Humans don’t have the biggest brains as a % of body weight

Relative size and encephalization quotient



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

The evolution of brain size



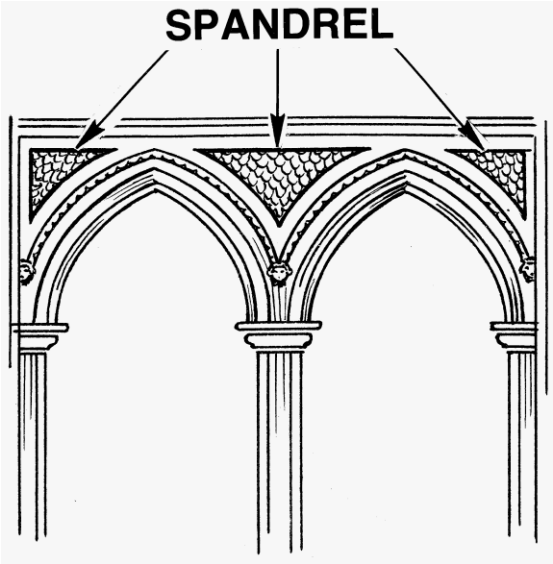
Why have we evolved relatively big brains?

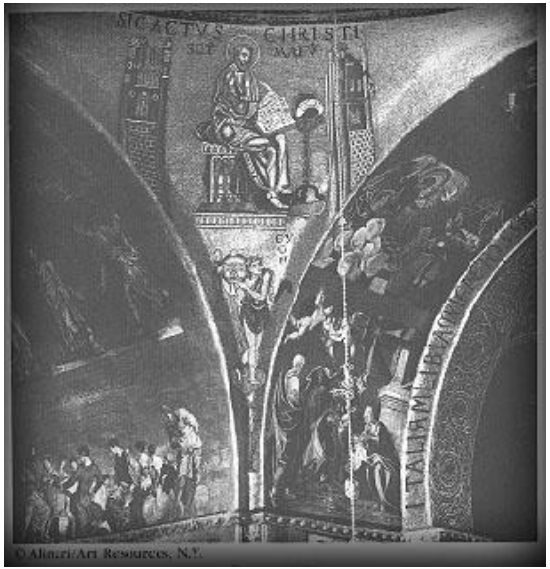
Fitch, 2010, p. 290-291: “overall brain size may provide one of the major ‘handles’ that natural selection can modify directly … it is therefore likely that selection for one or more specific types of intelligence (e.g. toolmaking, extractive foraging, social intelligence, etc.) might have led to the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

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

Spandrels

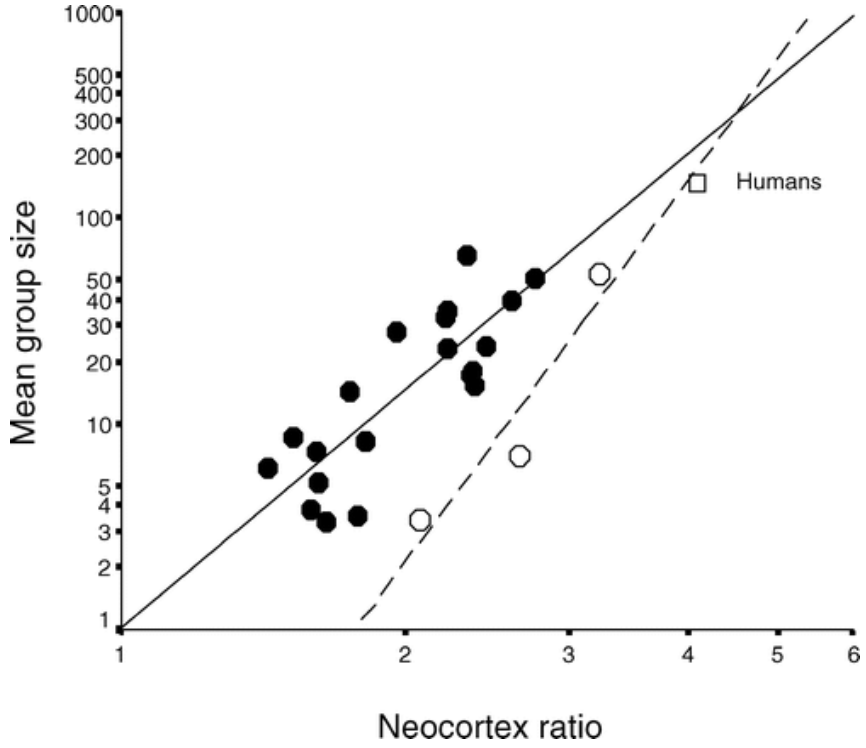
Traits present for reasons of architecture, development or history





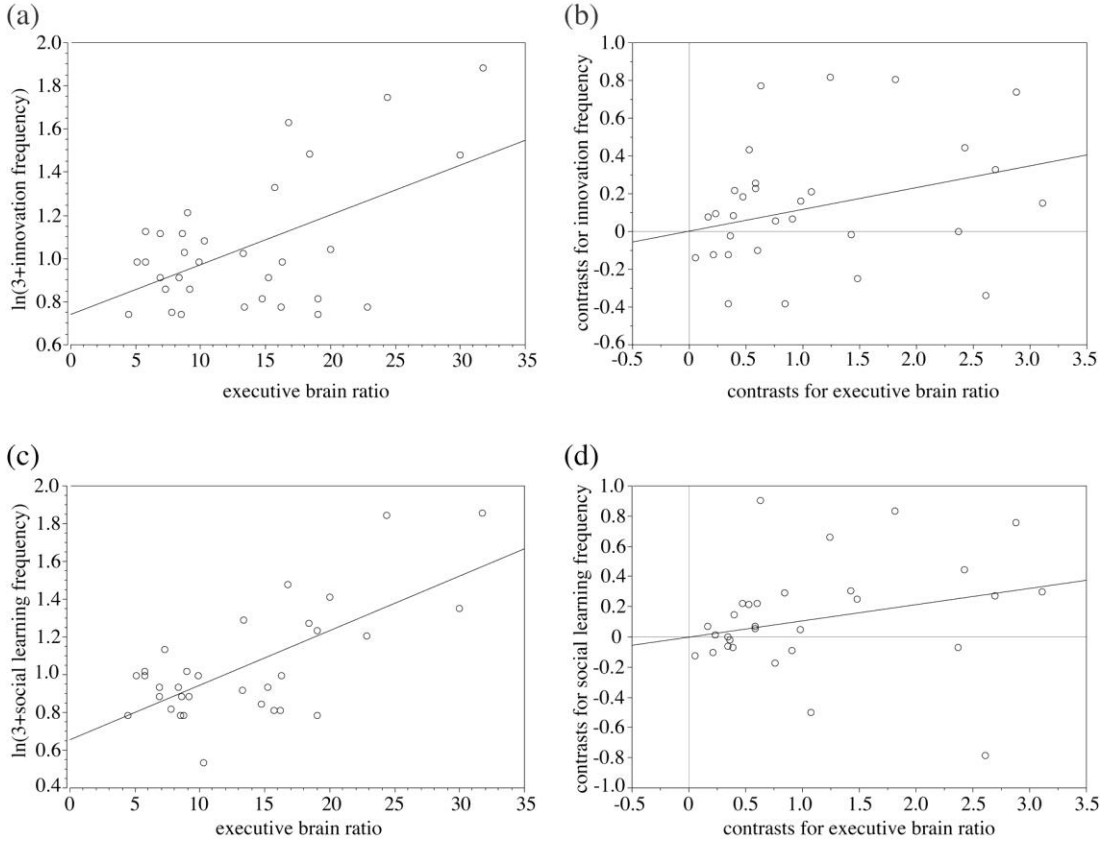
S. J. Gould and R. C. Lewontin. The Spandrels of San Marco and the Panglossian Paradigm: A Critique of the Adaptationist Programme. Proceedings of the Royal Society of London B, 205, 581-598

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.

Brain size and social learning, innovation and tool use



Reader, S. M., & Laland, K. N. (2002). Social intelligence, innovation, and enhanced brain size in primates. *PNAS, 99,* 4436-4441.

Technology, cumulative culture, and language

DEVELOPMENT OF STONE TOOL TECHNOLOGY IN EASTERN AFRICA

Location of Lomekwi 3 site

ACHEULEAN
Hand axes begin to appear 1.76 MYA.

OLDOWAN
"Pebble cores" begin to appear ~2.6 MYA.

LOMEKWIAN
Earliest knapped tools discovered. Date: 3.3 MYA.

Millions of Years Ago

0.5
1.0
1.5
2.0
2.5
3.0
3.5

Indicates periods of large (>100K years) gaps in stone tool evidence

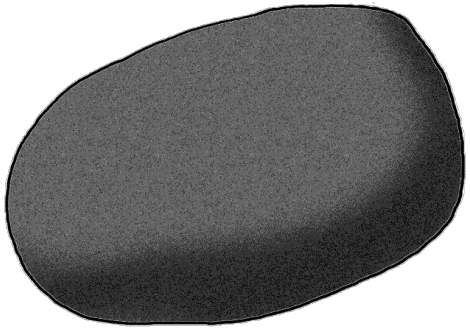
MAJOR EVENTS

- Climate shift to 100K-year glacial cycles
- *Homo erectus* appears in fossil record
- Cooler, dryer climate in Eastern Africa
- Oldest known *Homo* fossils
- Oldest known stone tools

TURKANA BASIN INSTITUTE

Stony Brook University

Mousterian
0.3 MYA – 40KYA



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

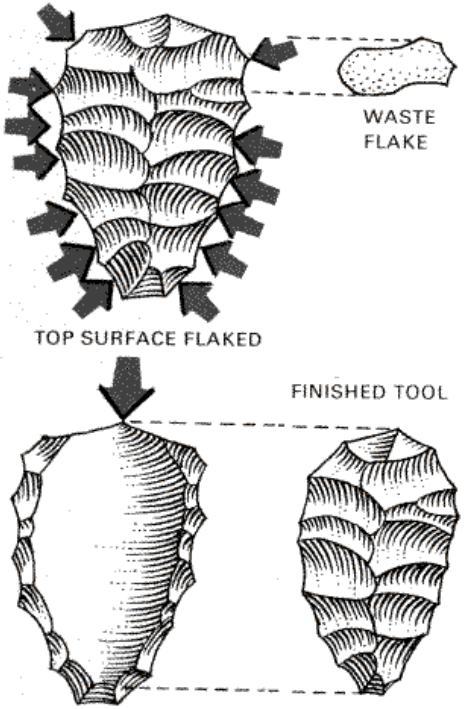
Proffitt, T., Luncz, L., Falótico, T. et al. (2016). Wild monkeys flake stone tools. *Nature, 539*, 85–88 .

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

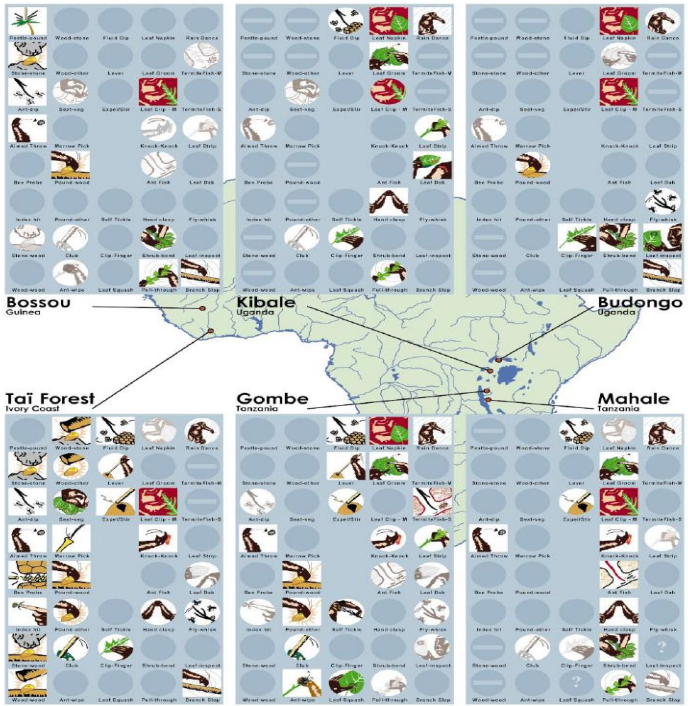
Tools, social learning, and culture

How did individuals acquire these skills?

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



Social learning and culture in chimpanzees

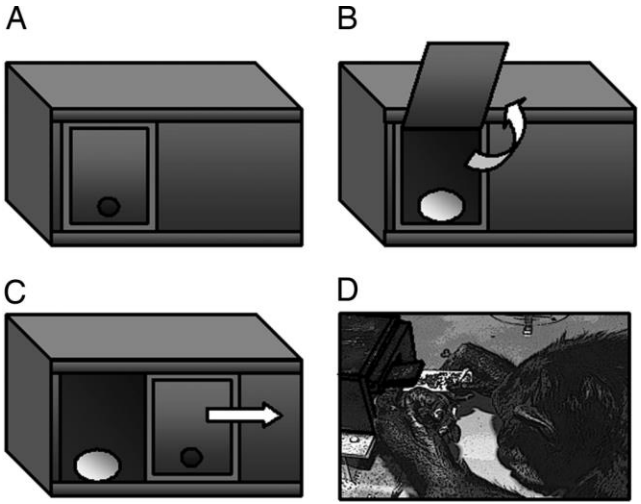


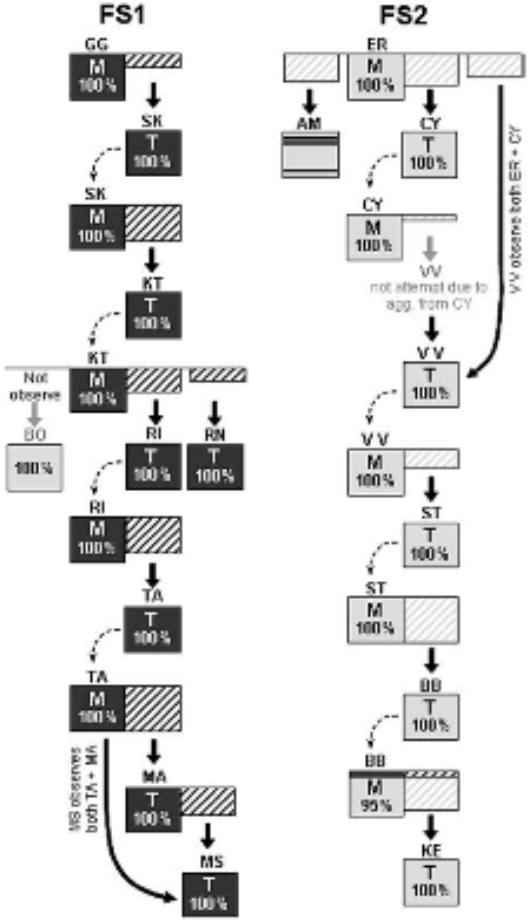
Behavioural variation in chimpanzee populations

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

Whiten, A., Goodall, J., McGrew, W. C., Nishida, T., Reynolds, V., Sugiyama, Y., et al. (1999). Cultures in chimpanzees. *Nature, 399,* 682–685.

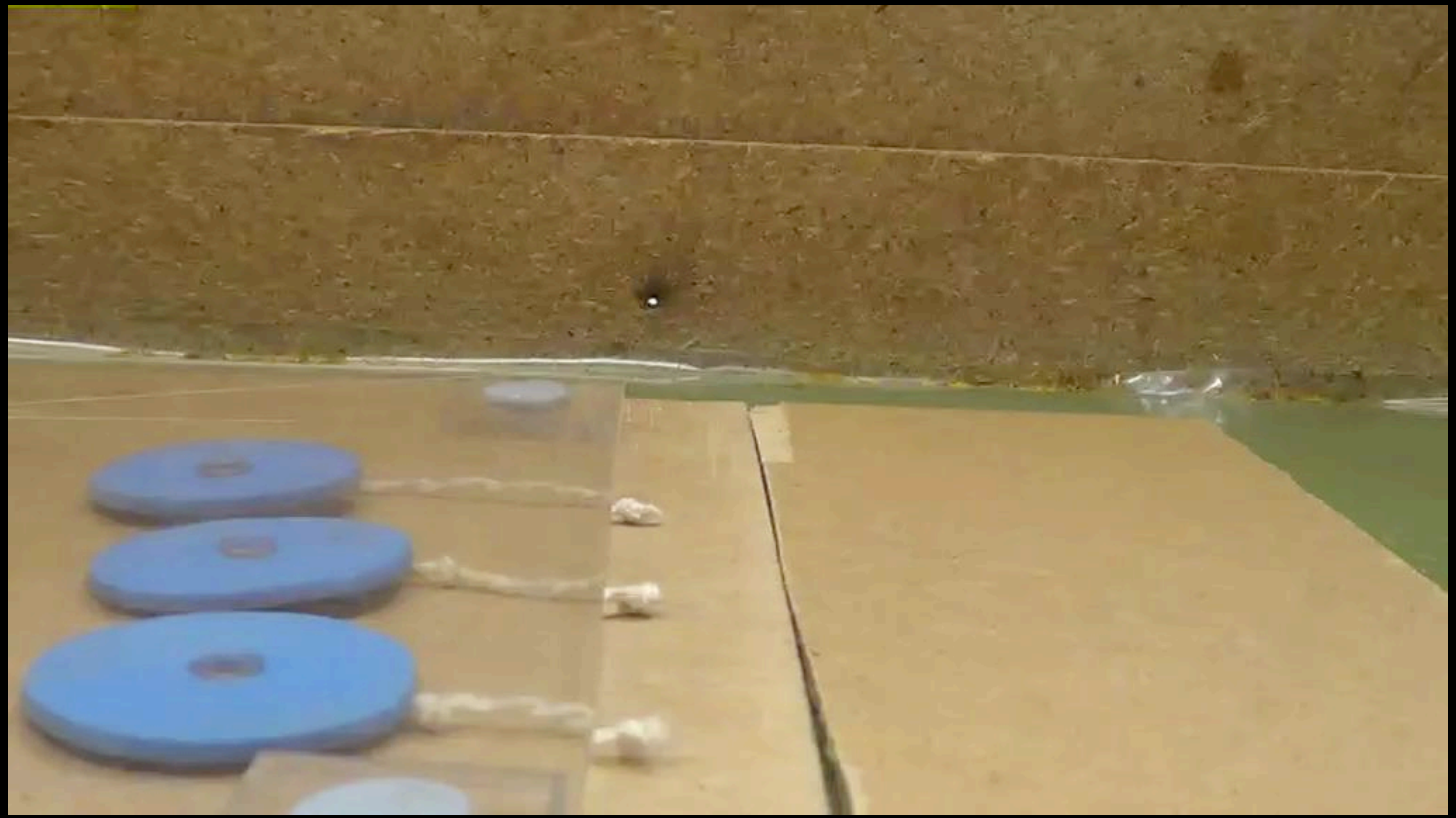
Social learning and culture in chimpanzees





Horner, V., Whiten, A., Flynn, E. & de Waal, F. B. M. (2006). Faithful replication of foraging techniques along cultural transmission chains by chimpanzees and children. *Proceedings of the National Academy of Science, USA, 103,* 13878-13883.

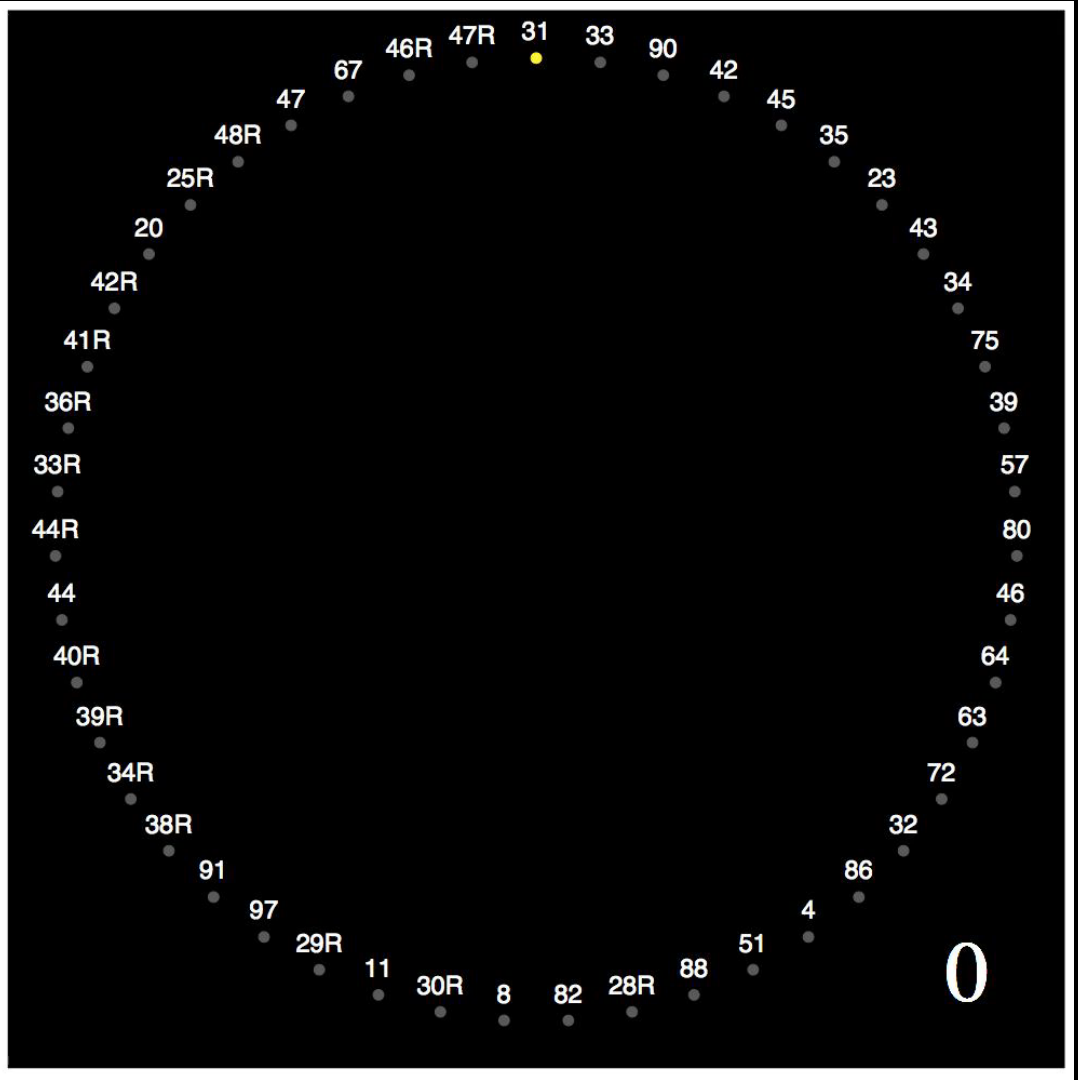
Social learning and culture in bumblebees (!)



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.


46R
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57
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80
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64
39R
63
34R
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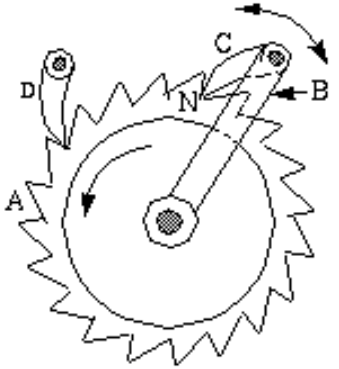
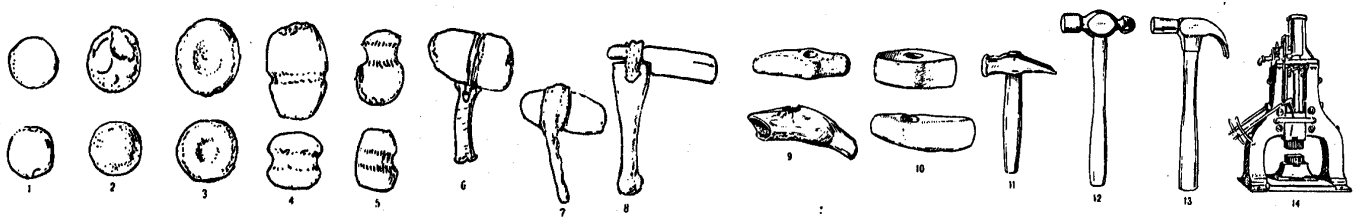
38R
32
91
86
97
4
29R
51
11
88
30R
28R
8
82
0

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)

Heyes, C. M. (1993). Imitation, culture and cognition. *Animal Behaviour, 46,* 999-1010.

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)

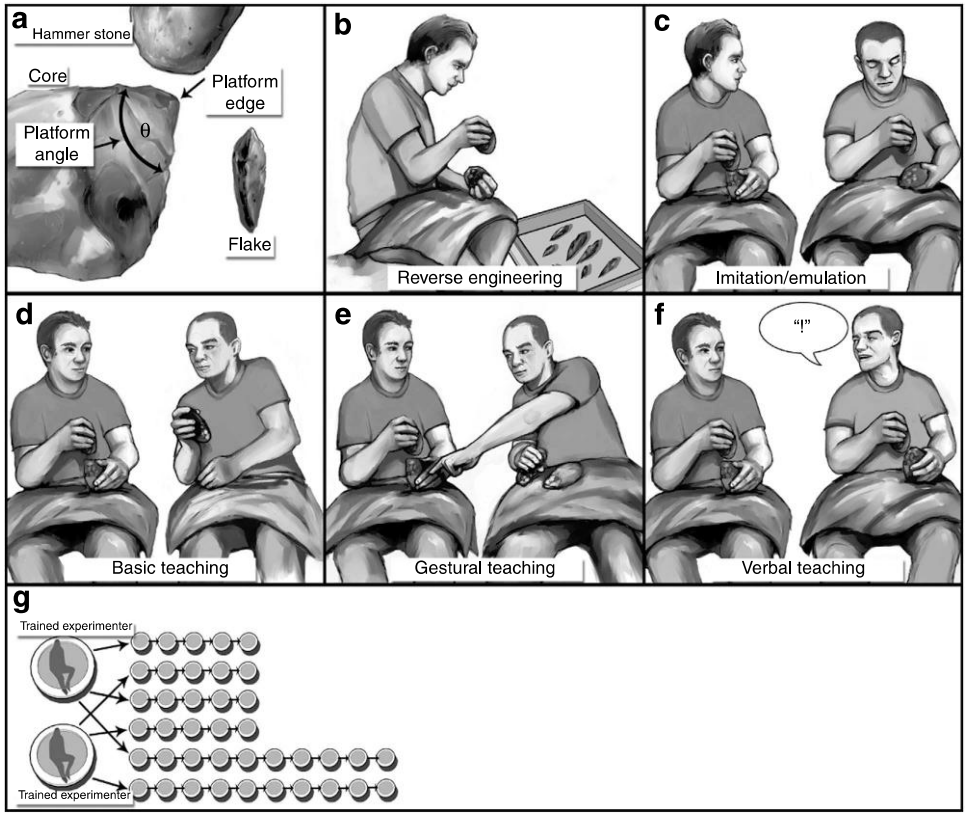
Goodall, J. (1970). Tool using in primates and other vertebrates. *Advances in the Study of Behaviour, 3,* 195-250.

Culture in non-humans??

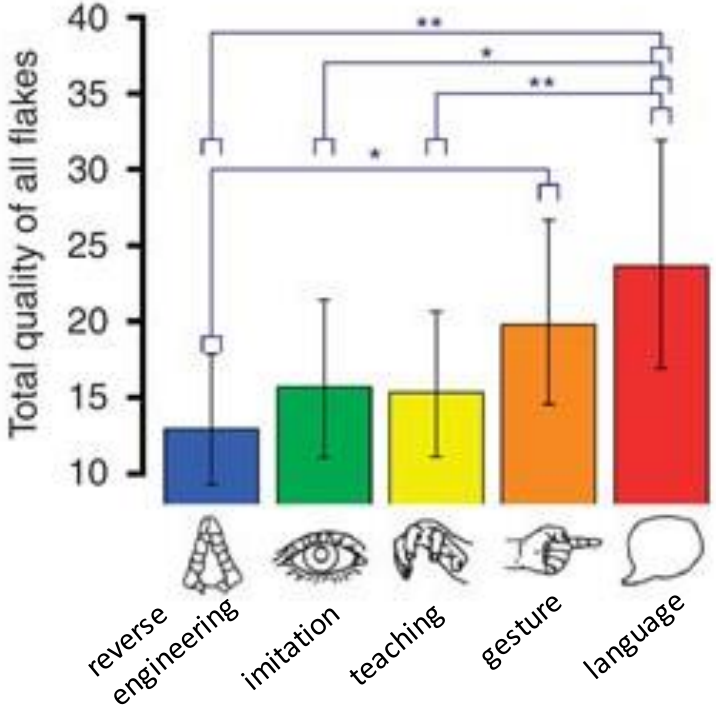
“stick pounding is a behavioral form that can be reinnovated by naive chimpanzees. Thus, this study adds to the growing body of evidence for the view that some chimpanzee tool-use behavioral forms can be reinnovated by naïve individuals” (Bandini & Tennie, 2019, p. 8)

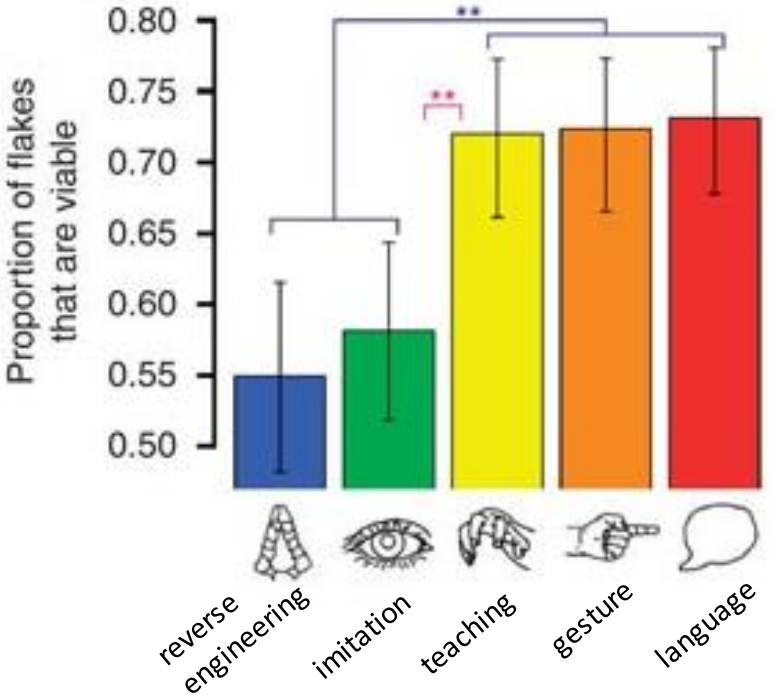
Bandini, E., & Tennie, C. (2019). Individual acquisition of “stick pounding” behavior by naïve chimpanzees. American Journal of Primatology, 81, e22987.

Is imitation enough to preserve stone tool technology?



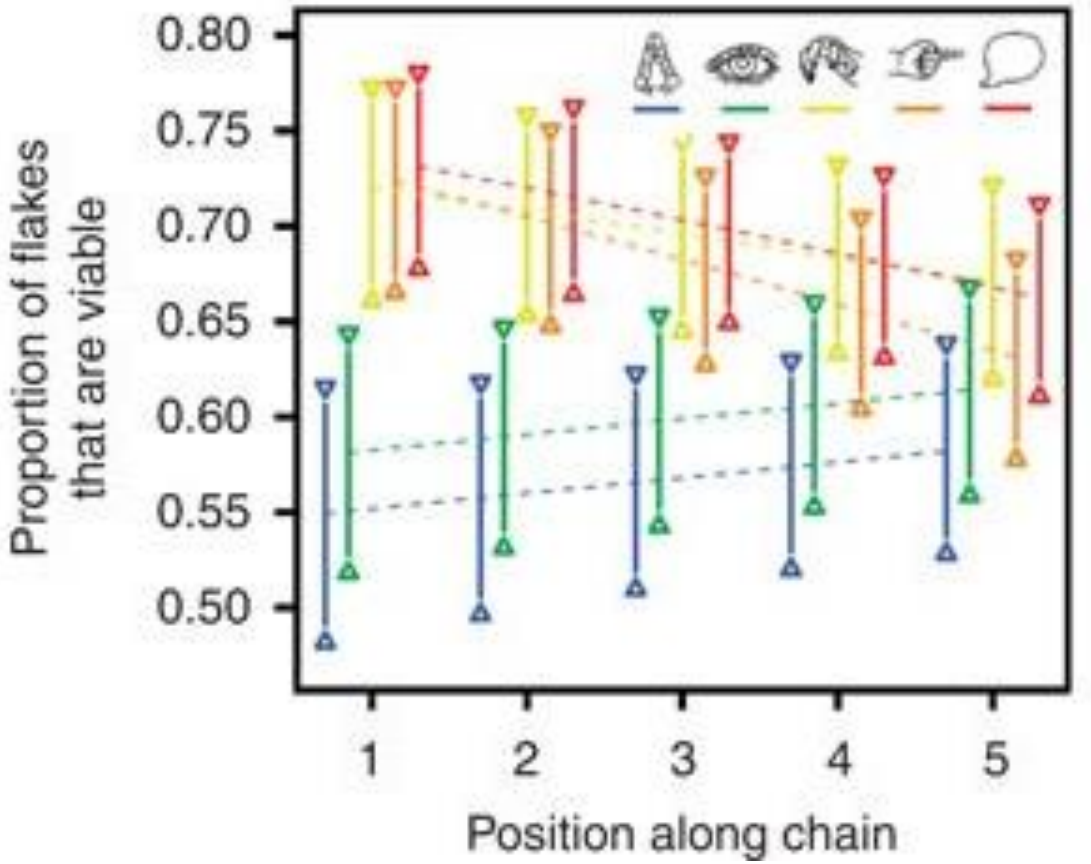
Does language-based teaching make you better at the task?





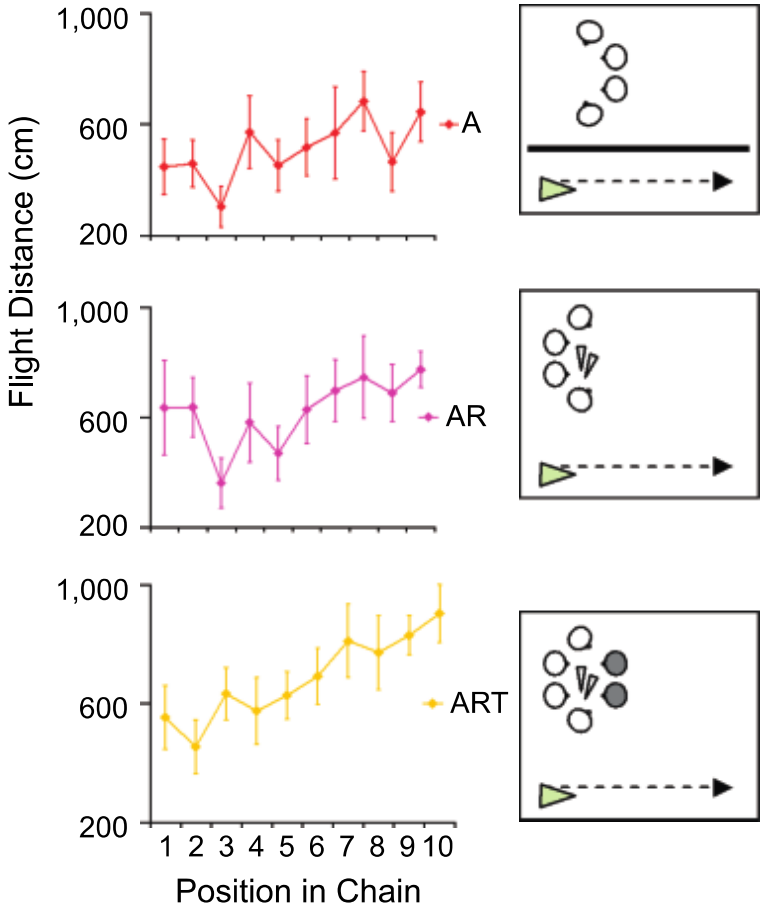
Morgan, T. J. H., et al., (2015). Experimental evidence for the co-evolution of hominin tool-making teaching and language. *Nature Communications, 6,* 6029.

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



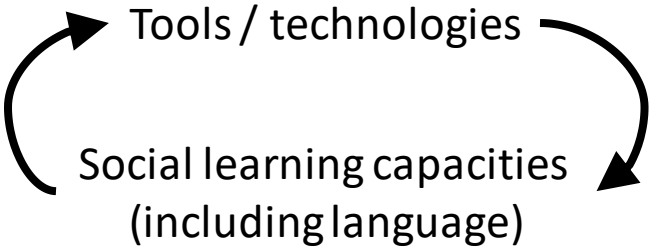
Caldwell, C. A., and Millen, A. E. (2009). Social learning mechanisms and cumulative cultural evolution: Is imitation necessary? *Psychological Science, 20,* 1478-1483.

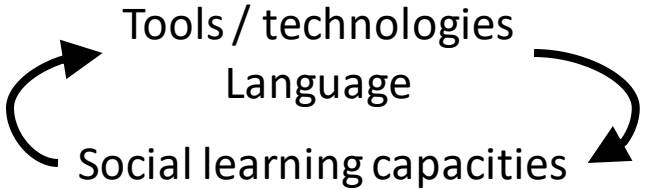
Co-evolution of technology, teaching and language (?)

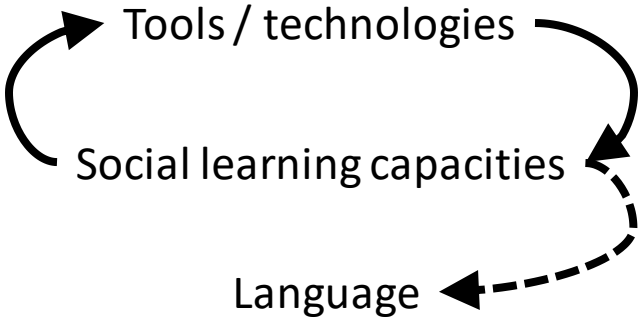
"our data imply that Oldowan tool making would have created a continuous selective gradient leading from observational learning to much more complex verbal teaching. This process need not have taken place entirely within the Oldowan, but was probably already underway during the Oldowan and likely continued 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)

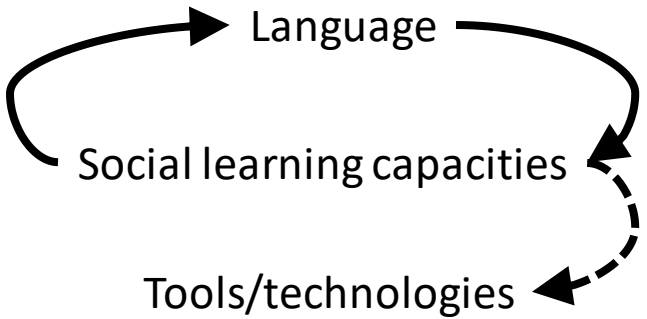
Morgan, T. J. H., et al., (2015). Experimental evidence for the co-evolution of hominin tool-making teaching and language. *Nature Communications, 6,* 6029.

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

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