

Origins and Evolution of Language

Week 4: Human evolution, social learning and cumulative culture

Kenny Smith

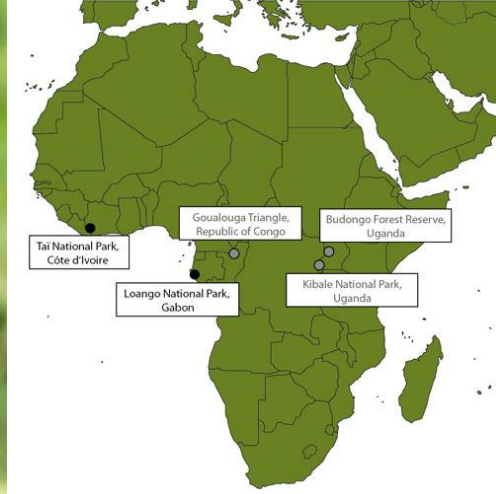
kenny.smith@ed.ac.uk

Wrapping up last week



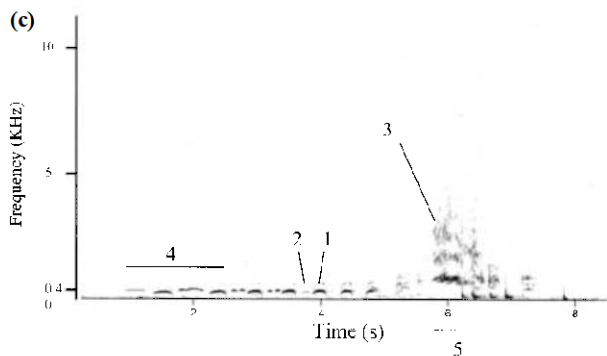
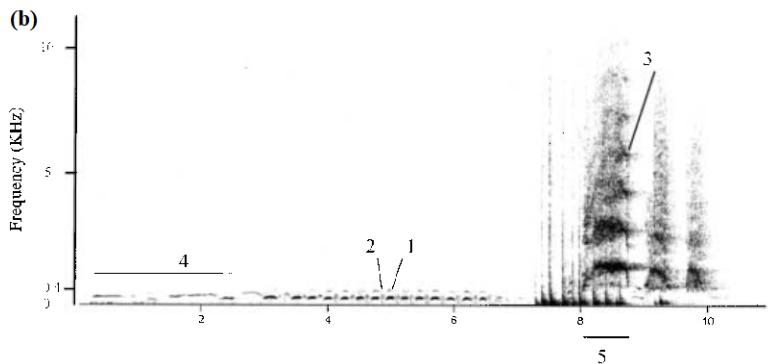
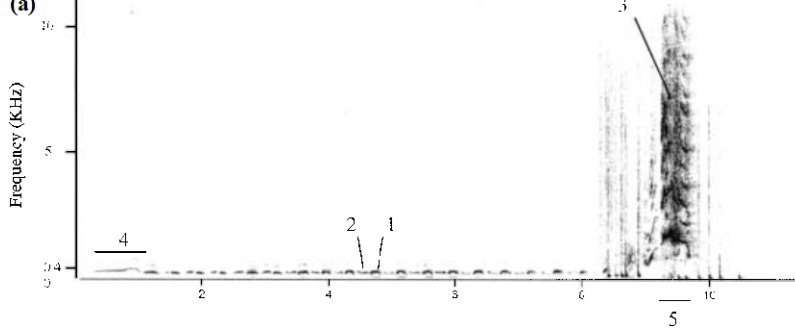
© Julie Goodall

Suggestive evidence for learned vocalizations in chimpanzees?



Pant hoots of chimpanzees vary between neighbouring groups

Crockford, C., Herbinger, I., Vigilant, L. & Boesch, C. (2004). Wild Chimpanzees Pant Hoot: A Case for Vocal Learning? *Evolutionary Psychology*, 2(1), 1-14.



Crockford et al. (2004): pant hoots of neighbouring groups differ in (e.g.):

- Length of intro (4)
- Peak frequency of screams (3)
- Duration of climax (5)

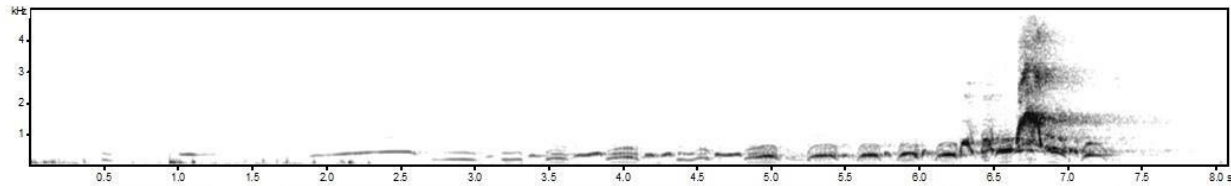
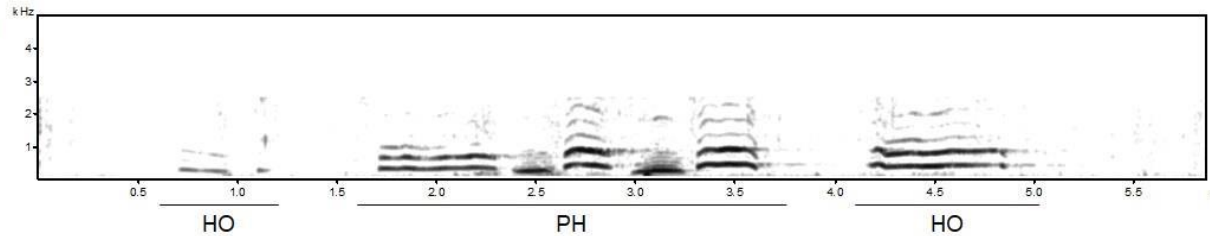
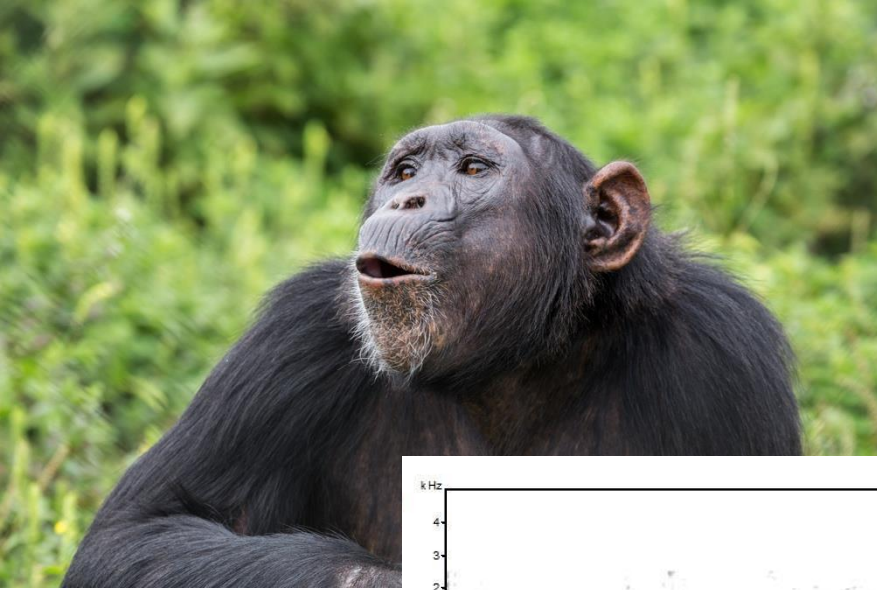
But Desai et al. (2022) fail to replicate in Gombe National Park

- Substantial inter-individual differences, small sample sizes

Crockford, C., Herbinger, I., Vigilant, L. & Boesch, C. (2004). Wild Chimpanzees Produce Group-Specific Calls: a Case for Vocal Learning? *Ethology*, 110, 221–243.

Desai, N. P., Fedurek, P., Slocombe, K. E., & Wilson, M. L. (2022). Chimpanzee pant-hoots encode individual information more reliably than group differences. *American Journal of Primatology*, 84, e23430.

A lot is not known about call combinations in chimpanzees!



Girard-Buttoz, C., Zaccarella, E., Bortolato, T., Friederici, A. D., Wittig, R. M., & Crockford, C. (2022). Chimpanzees produce diverse vocal sequences with ordered and recombinatorial properties. *Communications Biology*, 5, 410.

Summary of last week

- Intentional communication
 - Rare in primates, perhaps present in chimpanzees?
- Structured communication
 - Rare and limited in most primates, common in songbirds
 - Generally structure not subserving meaning
- Learned communication
 - Rare in primates (but perhaps present in chimpanzees?), common in songbirds

Communication in the Last Common Ancestor of chimps and humans?

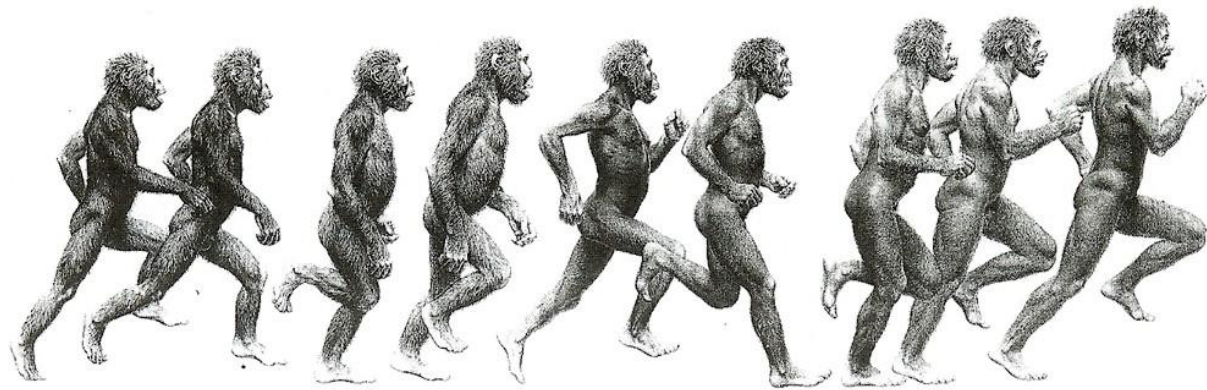
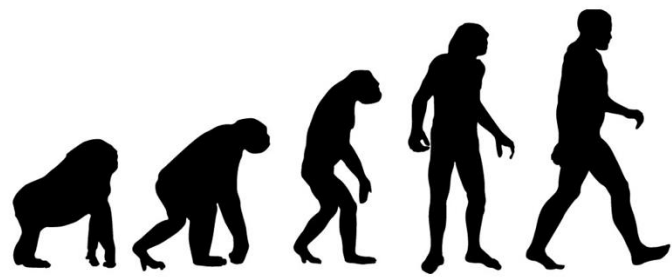
- Not 2nd order intentional?
- No/minimal use of structure subserving meaning?
- Probably not learned?

But remember Fitch's point: their communication system may underrepresent their cognitive capacities!



Plan for today

- Human evolution: quick summary
 - Visual illustration of timeline of human evolution
 - Visual illustration of brain size evolution
- Technology, art, cumulative culture, and language
 - A look at the early evolution of tools
 - Symbolic behaviour 70kya?
 - Tool use and social learning in other species



A. afarensis

A. africanus

A. robustus

A. boisei

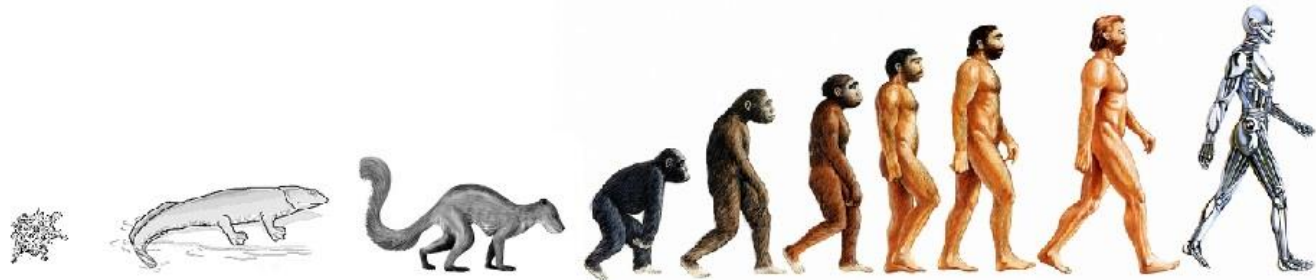
H. habilis

H. erectus

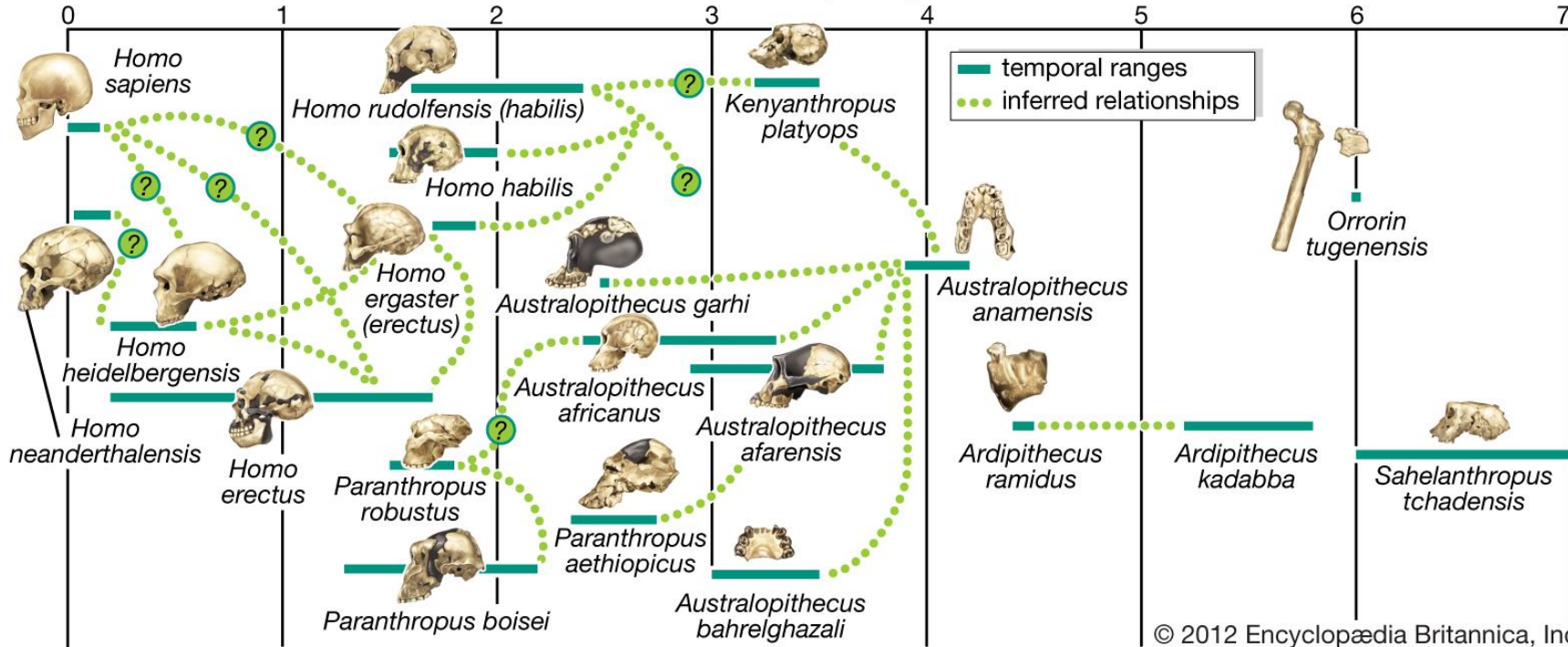
H. sapiens
(archaic)

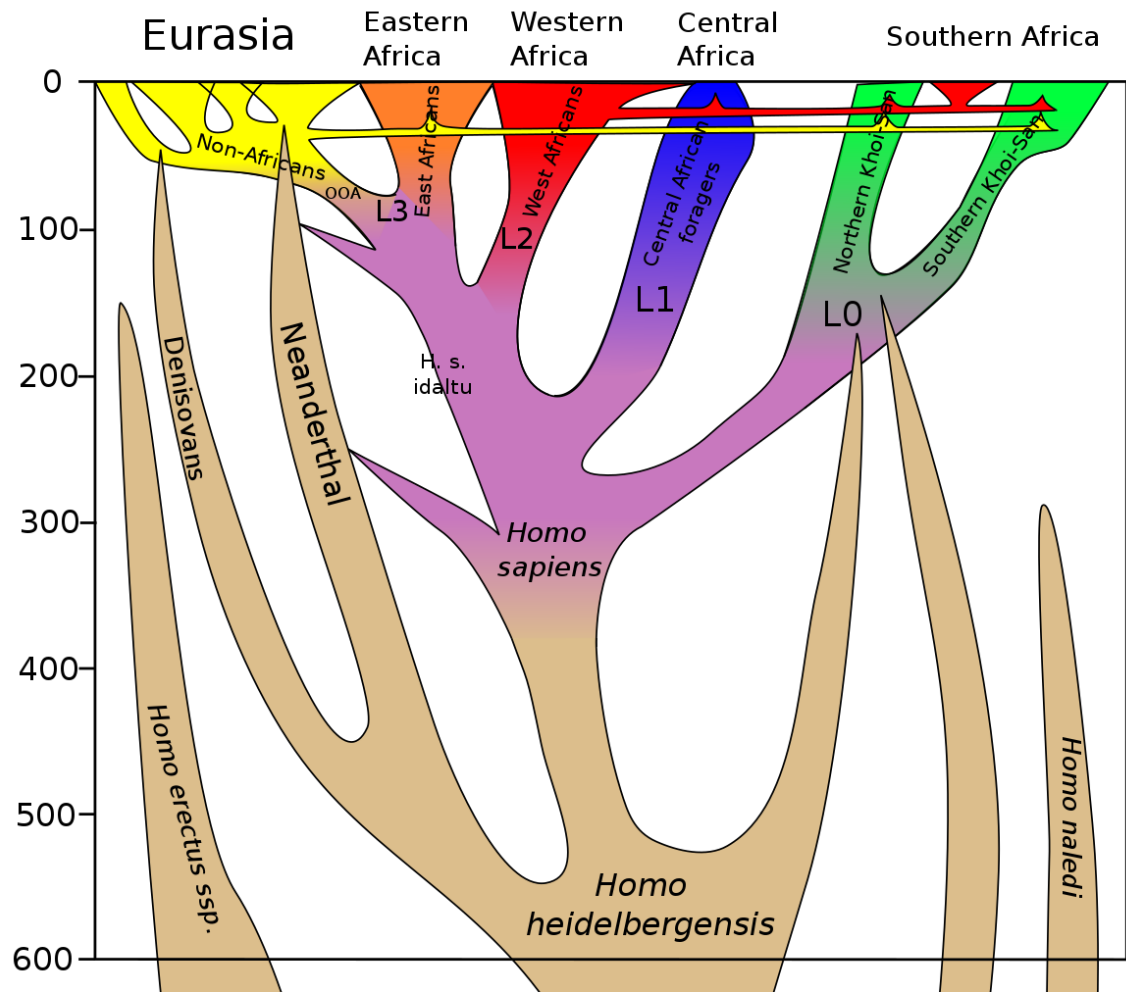
H. sapiens
(Neandertal)

H. sapiens
(modern)



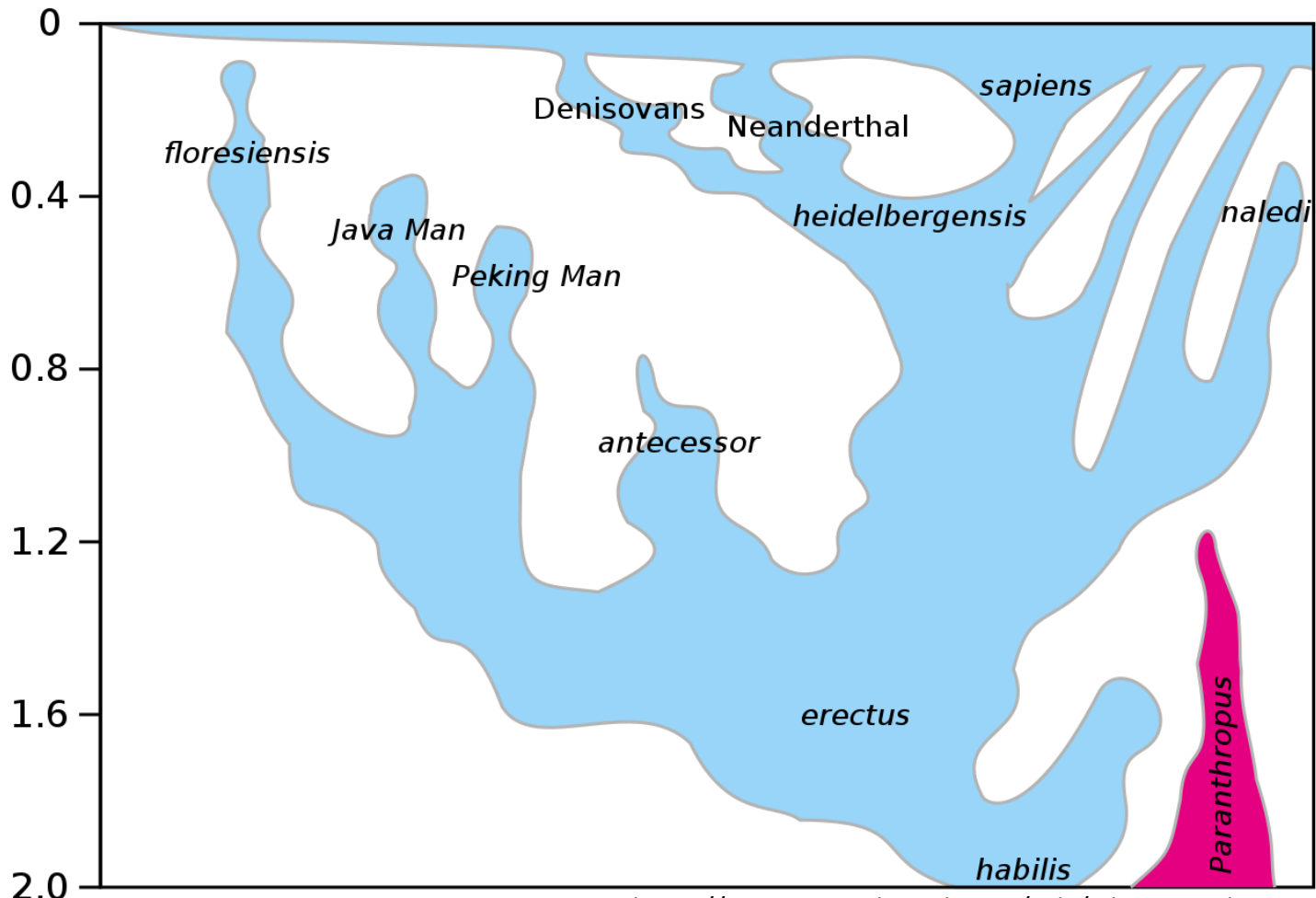
millions of years ago

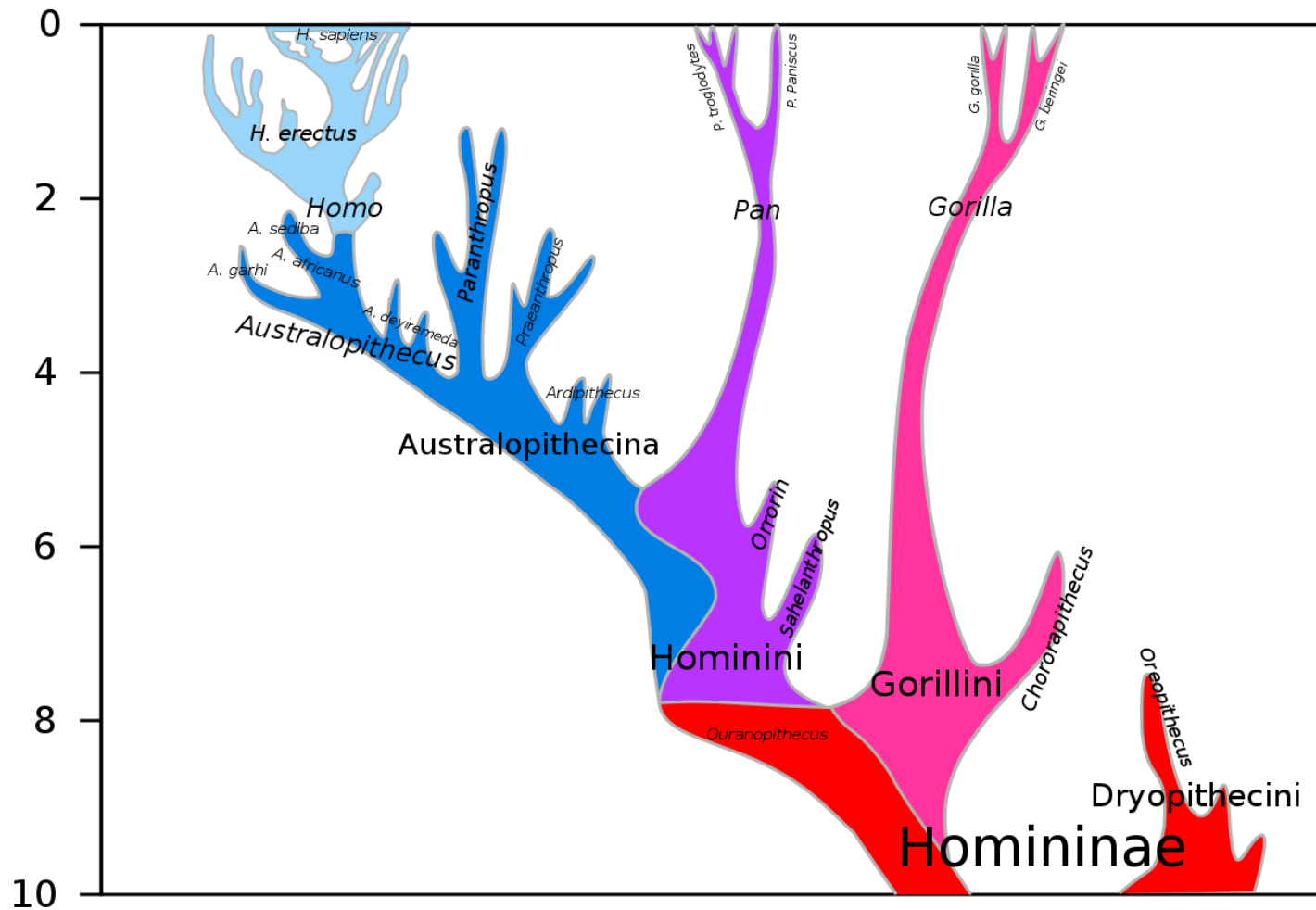




Eurasia

Africa

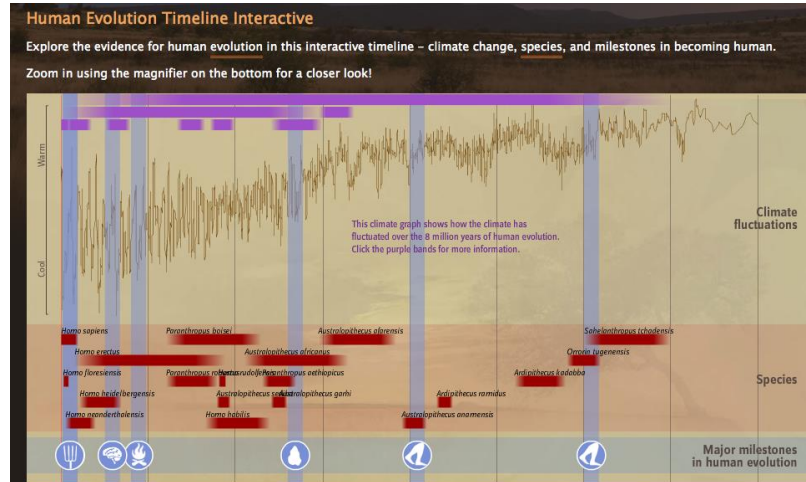
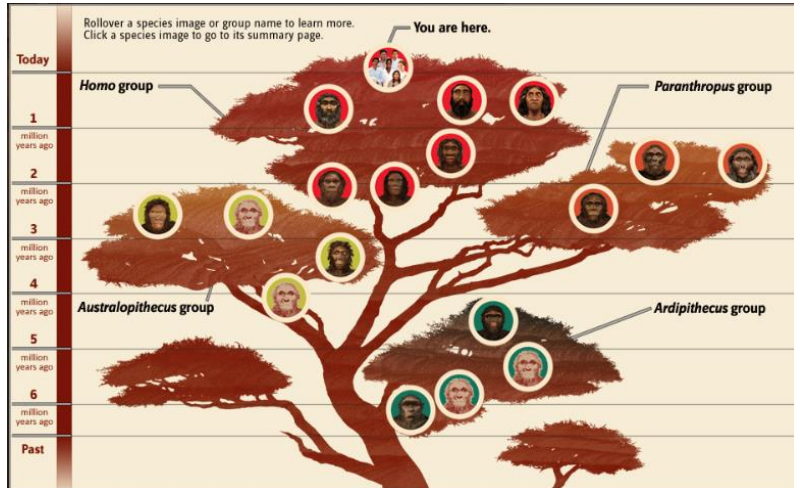




A useful resource: Smithsonian Human Evolution Timeline

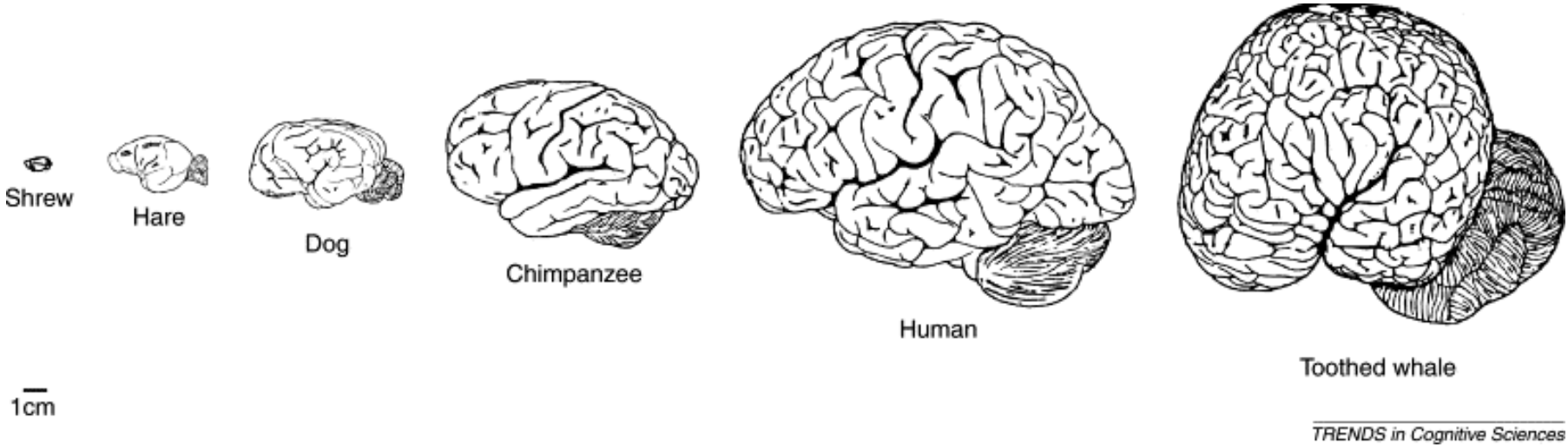
<http://humanorigins.si.edu/evidence/human-family-tree>

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



Evolution of brain size

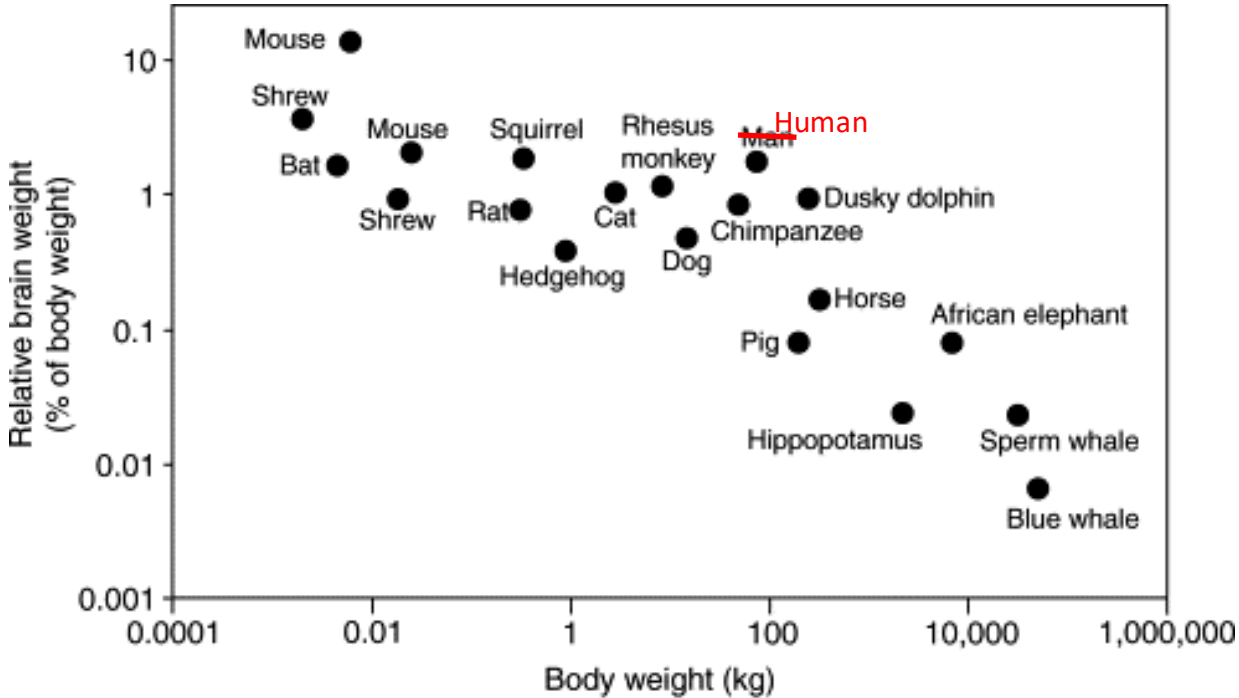
Brain size: absolute size



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

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

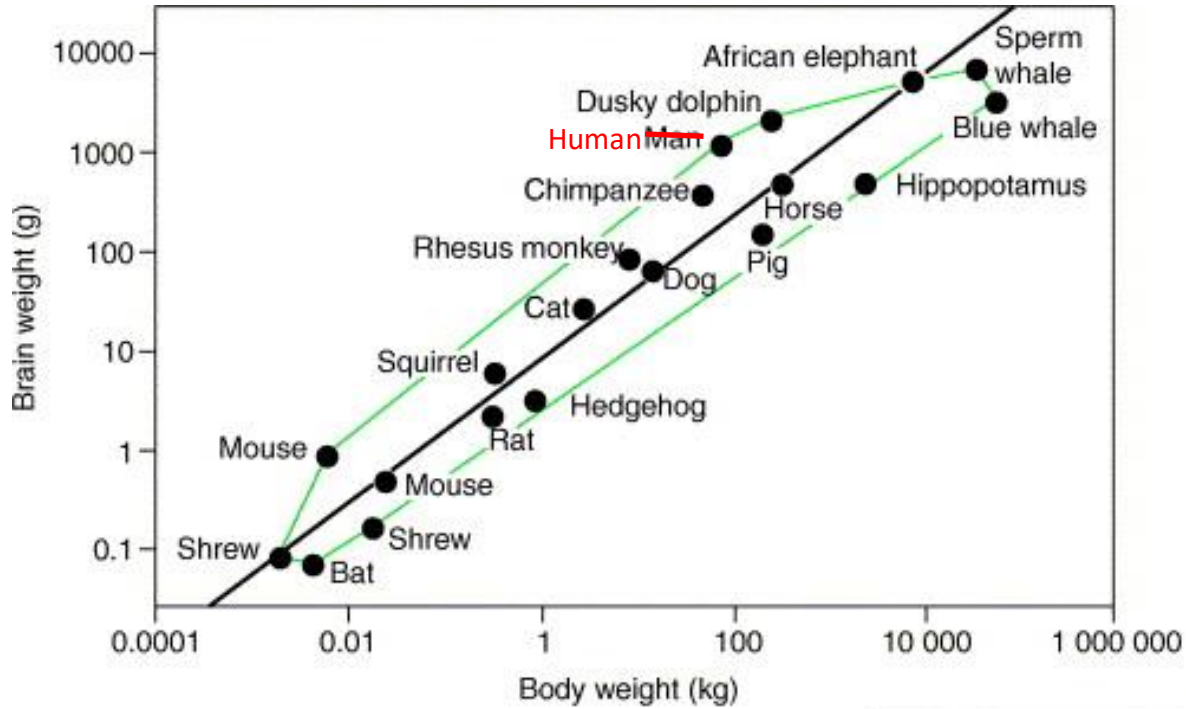
Brain size as a % of body size



TRENDS in Cognitive Sciences

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

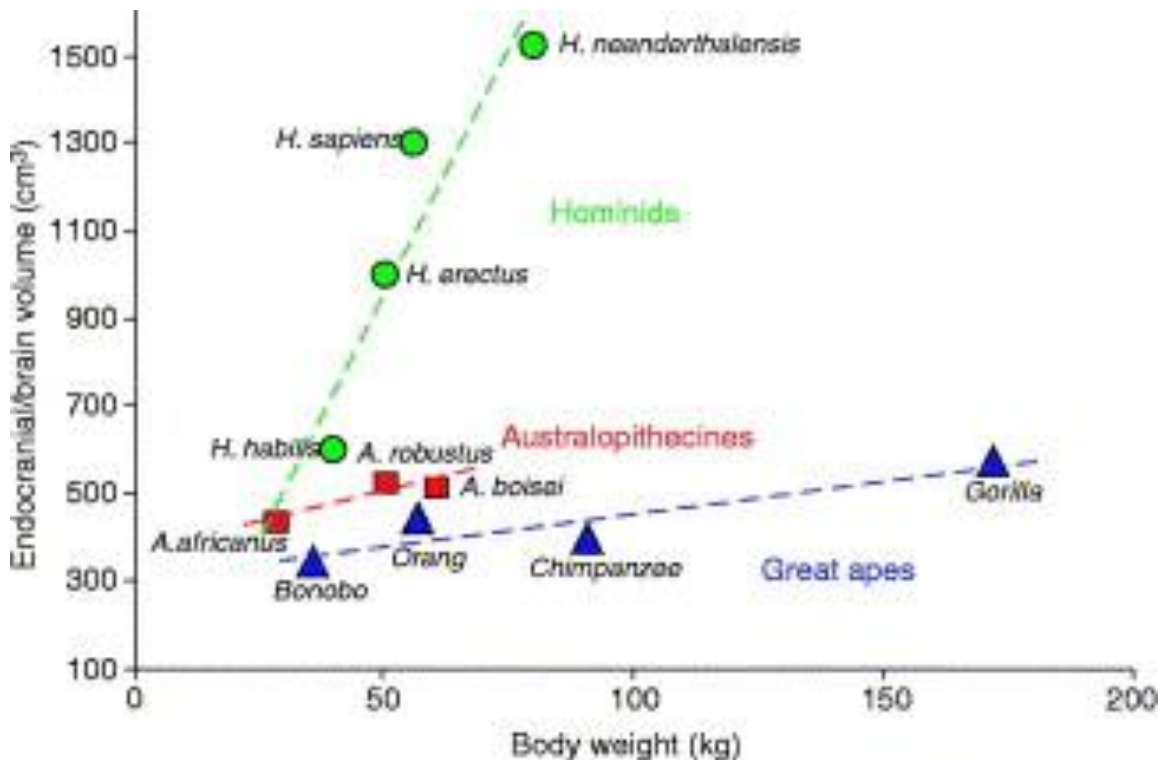
Relative size and encephalization quotient



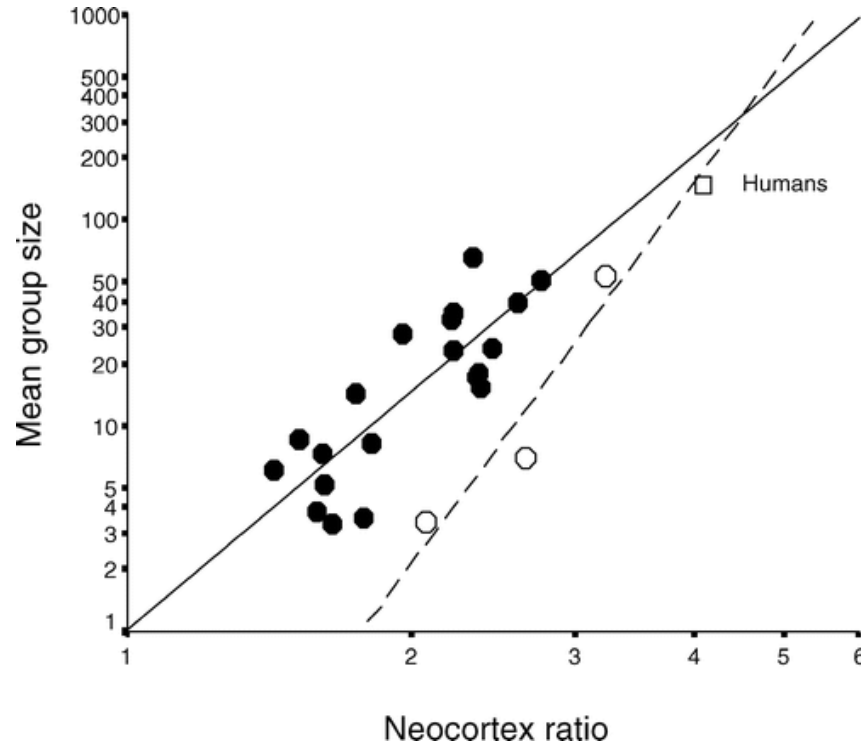
TRENDS in Cognitive Sciences

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

The evolution of brain size

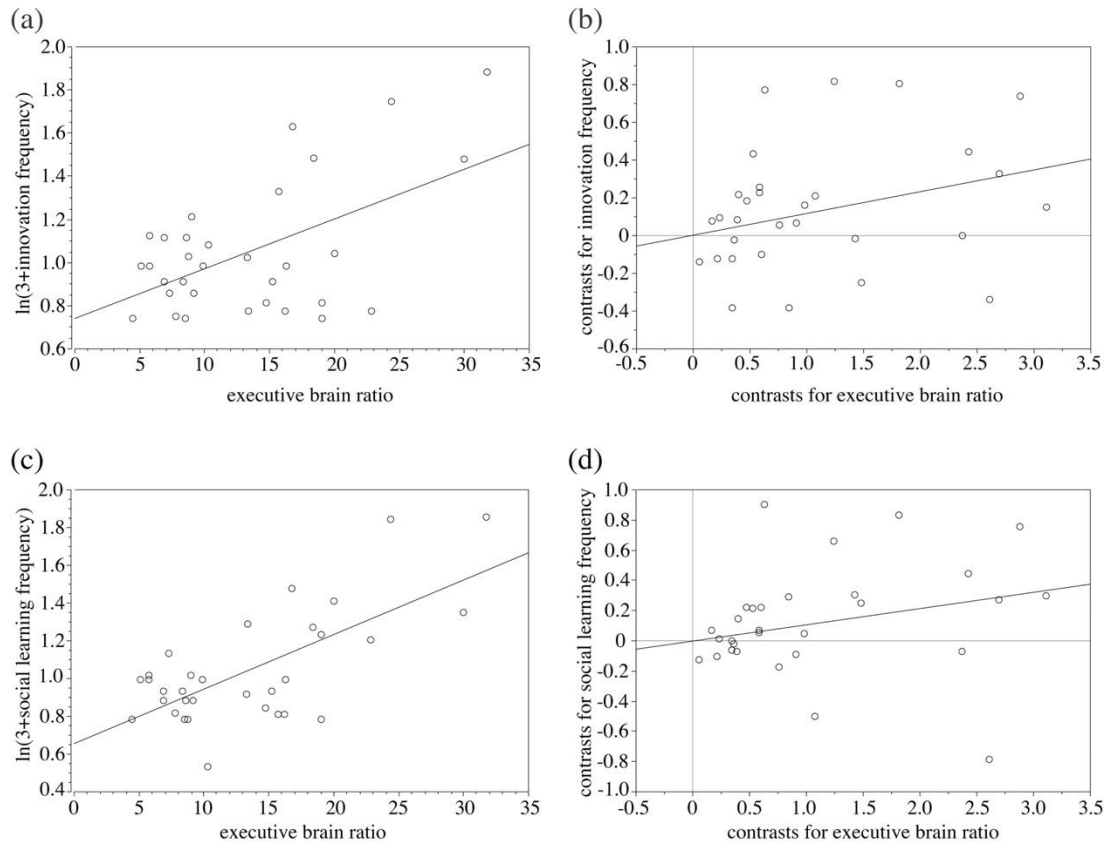


Neocortex size and group size



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



Technology, art, 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



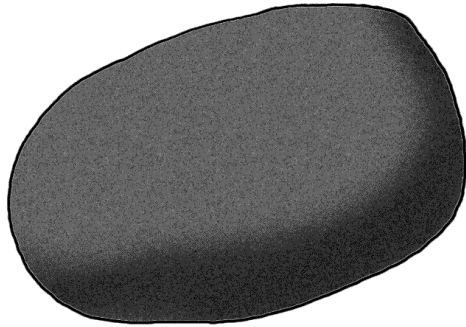
Oldest known
stone tools

Image Copyrights: Acheulean, Lomekwian tools © MPK-WTAP;
Oldowan tool © Turkana Basin Institute.

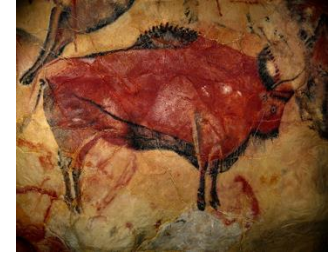


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Mousterian
0.3 MYA – 40KYA



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



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

DEVELOPMENT OF STONE TOOL TECHNOLOGY IN EASTERN AFRICA

Location of
Lomekwi 3 site



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2.5

3.0

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MAJOR EVENTS



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Homo erectus appears
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Cooler, dryer climate
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Oldest known
Homo fossils



Oldest known
stone tools

Image Copyrights: Acheulean, Lomekwian tools © MPK-WTAP;
Oldowan tool © Turkana Basin Institute.



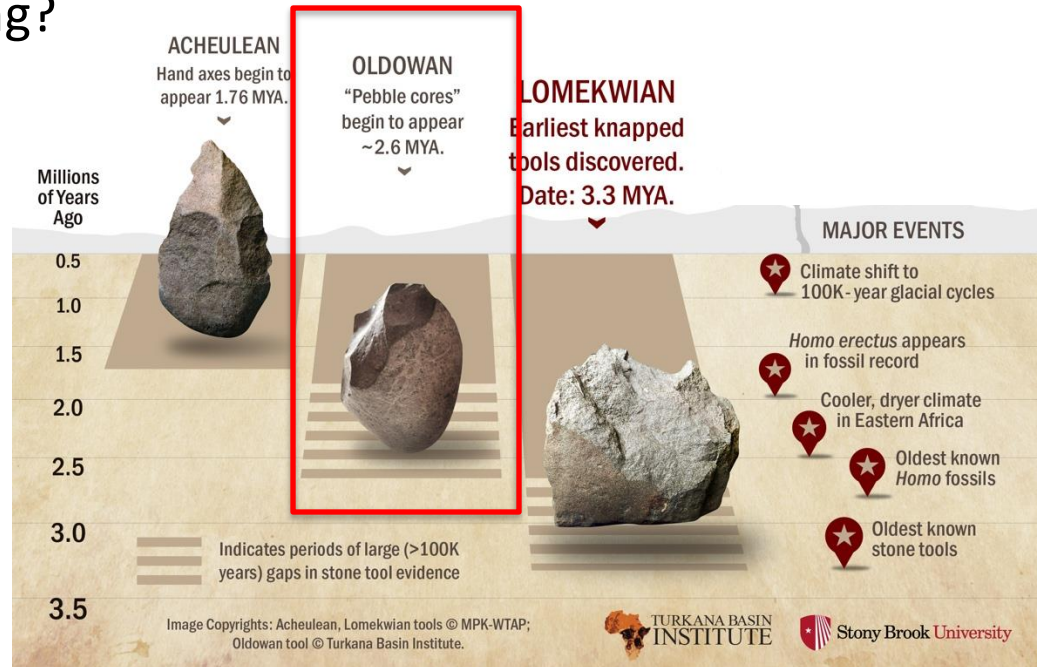
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This week's tutorial: tools and language

How did individuals acquire these skills?

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

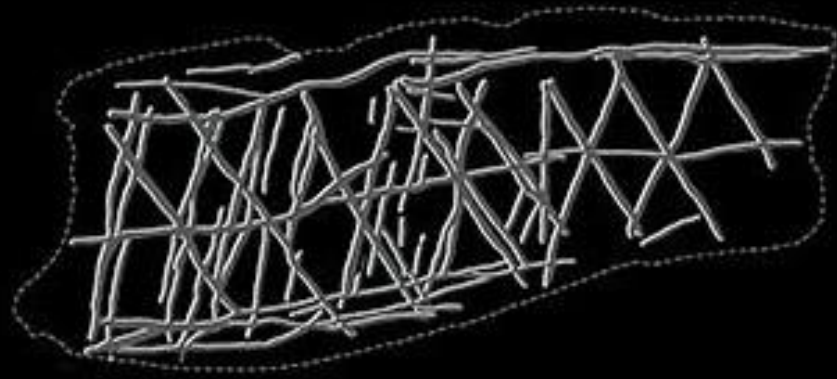




Blombos cave, South Africa

d







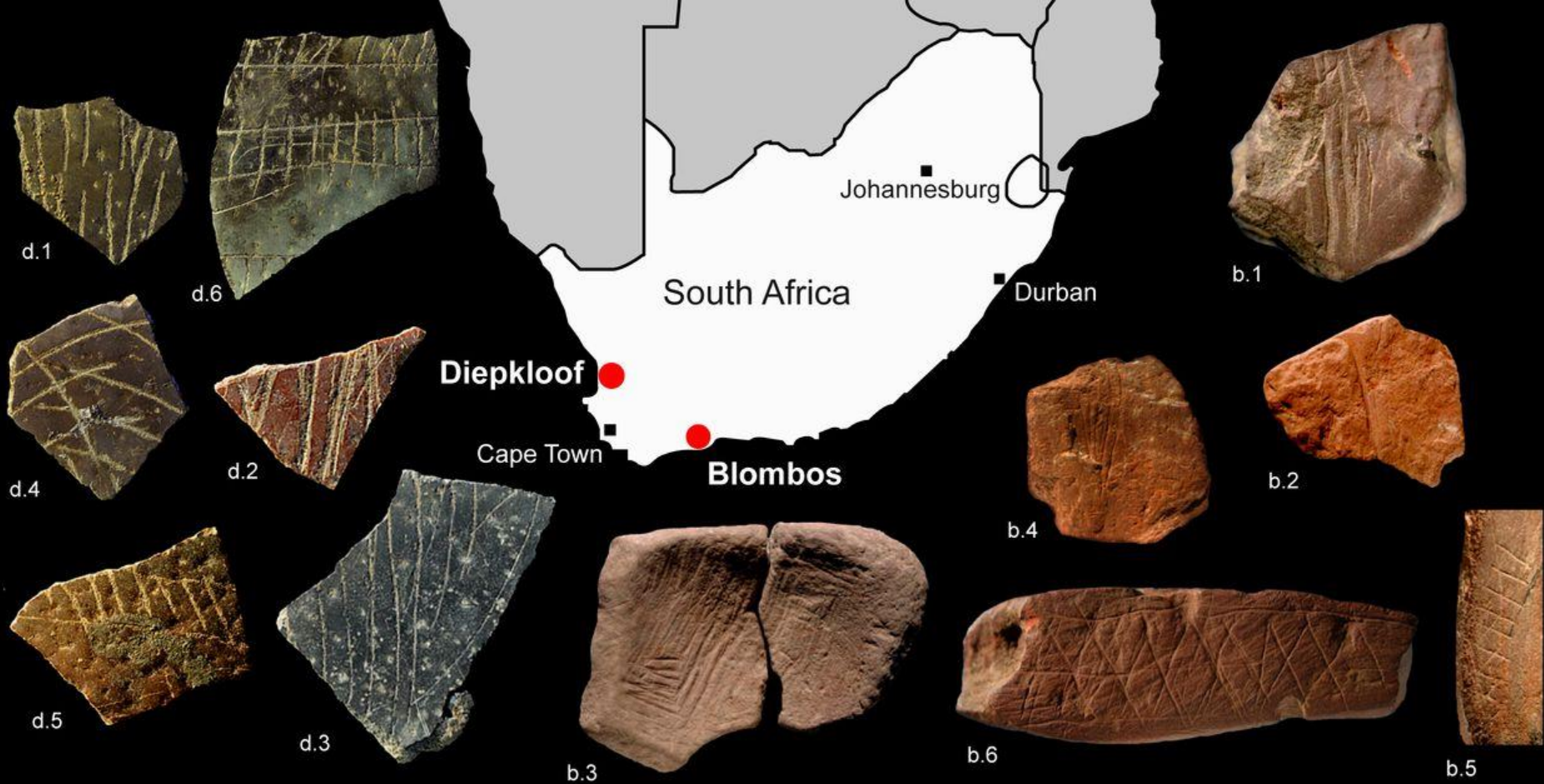
From Henshilwood, C.S. *et al.* (2018) An abstract drawing from the 73,000-year-old levels at Blombos Cave, South Africa. *Nature*, 562, 115–118.

“evidence for modern cognition at c. 77–55 ky. In particular, we highlight the shell beads and engraved ochres from Blombos Cave as being examples of artifacts with clear symbolic meaning. A number of authors have previously suggested that the Blombos ochre pieces and the marine shell beads equate with information being stored outside of the human brain ... and that the transmission and sharing of the symbolic meaning of these items must have depended on “syntactical” language” (Hensholwood & Dubreuil, 2009, p. 60-61)

Henshilwood, C.S. & Dubreuil, B. (2009). Reading the artefacts: Gleaning language skills from the Middle Stone Age in southern Africa. In R. Botha & C. Knight (Eds.), *The Cradle of Language* (pp. 41-60). Oxford: Oxford University Press.

“We argue that the capacity to represent how an object appears to another person ... enables the invention of symbolic artifacts like beads and engraved ochres, but also of other artifacts whose symbolic component remains contentious, such as bone tools, bifacial points, and engraved ostrich egg shell. Because recursion is essential to articulate in language [this] kind of meta-representations ..., we predict that the presence of syntactic language can now confidently be “read” from some of the Blombos artifacts. ” (Henshilwood & Dubreuil, 2009, p. 61)

Henshilwood, C.S. & Dubreuil, B. (2009). Reading the artefacts: Gleaning language skills from the Middle Stone Age in southern Africa. In R. Botha & C. Knight (Eds.), *The Cradle of Language* (pp. 41-60). Oxford: Oxford University Press.



Tylén, K., Fusaroli, R., Rojo, S., Heimann, K., Fay, N., Johannsen, N. N., Riede, F., & Lombard, M. (2020). The evolution of early symbolic behavior in *Homo sapiens*. *Proceedings of the National Academy of Sciences*, 117, 4578-4584.

Engravings



Original
Outlines



Experimental
Stimuli

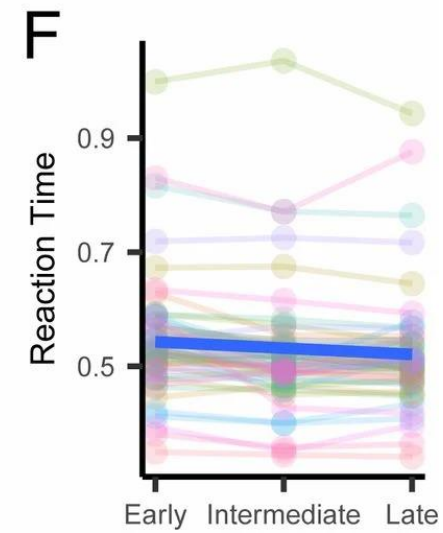
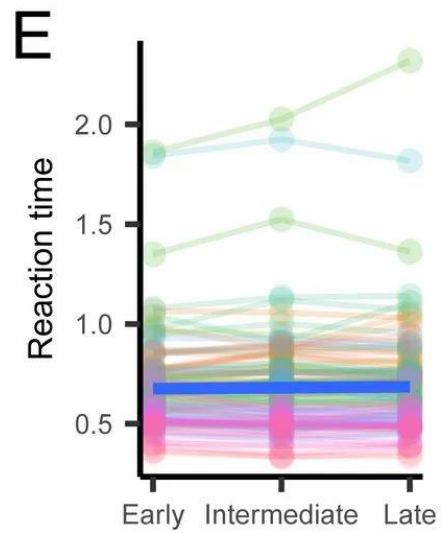
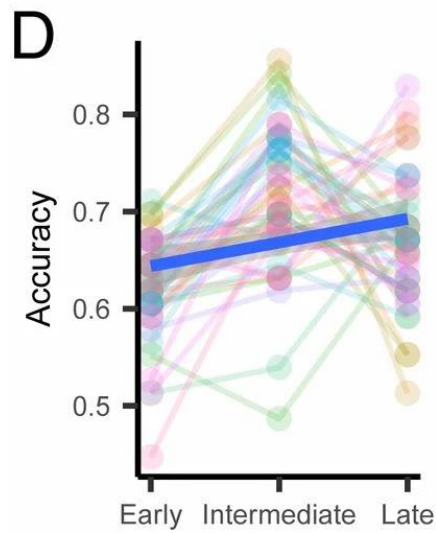
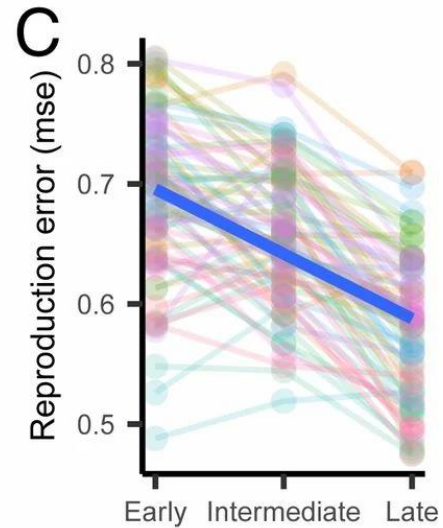
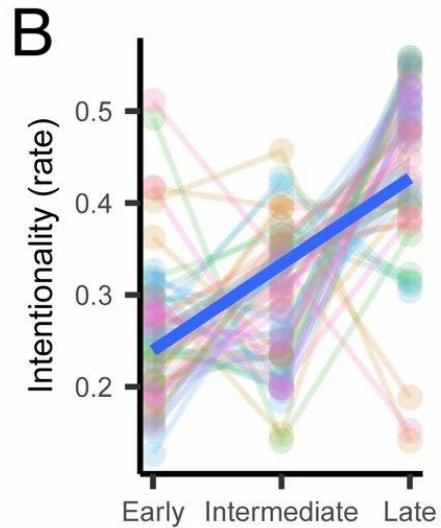
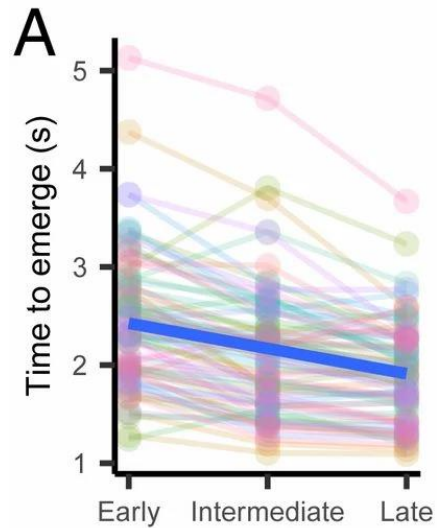


Early

Intermediate

Late

Tylén, K., Fusaroli, R., Rojo, S., Heimann, K., Fay, N., Johannsen, N. N., Riede, F., & Lombard, M. (2020). The evolution of early symbolic behavior in Homo sapiens. *Proceedings of the National Academy of Sciences*, 117, 4578-4584.



“Our findings support a view of the engravings as products of a cumulative cultural development toward more complex patterns with increasingly structured and symmetric line crossings, which make them more salient to the human eye, more recognizable as intentionally made, easier to reproduce from memory, and easier to recognize as belonging to a specific group. These properties have been shown to make symbolic forms easier for the visual system to process (56) and are found to be associated with human aesthetic preferences (28, 57, 58) and modern orthographic systems (59). In other words, they track Middle Stone Age H. sapiens becoming increasingly skilled in producing engravings that resonate with the human cognitive system in effective ways.” (Tylén et al., 2020, p. 4582)

Tylén, K., Fusaroli, R., Rojo, S., Heimann, K., Fay, N., Johannsen, N. N., Riede, F., & Lombard, M. (2020). The evolution of early symbolic behavior in Homo sapiens. *Proceedings of the National Academy of Sciences*, *117*, 4578-4584.

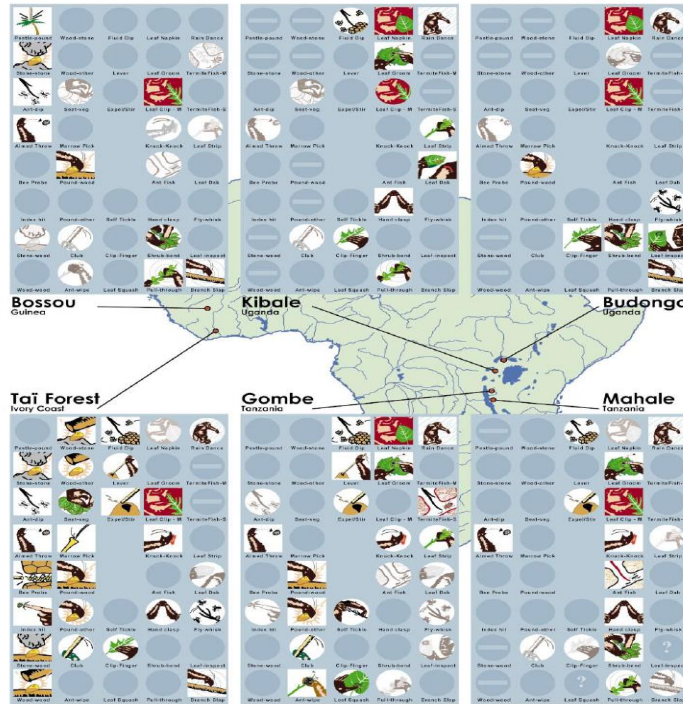
“there was also evidence that they evolved to become easier to remember and reproduce (Experiment 3), suggesting they have been subject to adaptive pressures for learnability. Similarly, the later patterns were easier to recognize as belonging to the same archeological site compared to the earlier patterns (Experiment 4). This suggests that the engravings were part of a cultural practice—a style—in which they were reproduced, transmitted, and learned within a social group” (Tylén et al., 2020, p. 4582)

Tylén, K., Fusaroli, R., Rojo, S., Heimann, K., Fay, N., Johannsen, N. N., Riede, F., & Lombard, M. (2020). The evolution of early symbolic behavior in *Homo sapiens*. *Proceedings of the National Academy of Sciences*, *117*, 4578-4584.

“We found no evidence that the engraved patterns became increasingly discriminable within the two archeological sites. This suggests that the patterns were not under adaptive pressure to evolve affordances for a referential function linked to semantic contents.” (Tylén et al., 2020, p. 4582)

Tylén, K., Fusaroli, R., Rojo, S., Heimann, K., Fay, N., Johannsen, N. N., Riede, F., & Lombard, M. (2020). The evolution of early symbolic behavior in *Homo sapiens*. *Proceedings of the National Academy of Sciences*, *117*, 4578-4584.

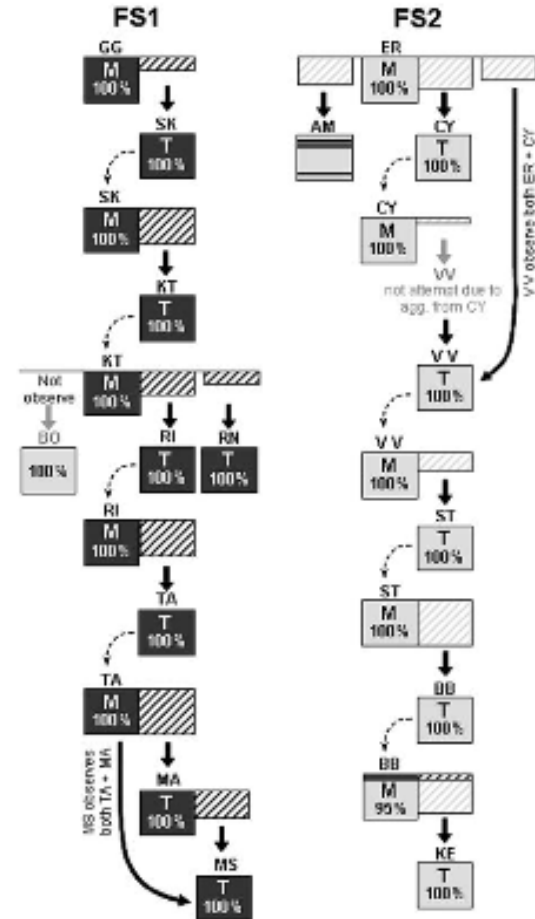
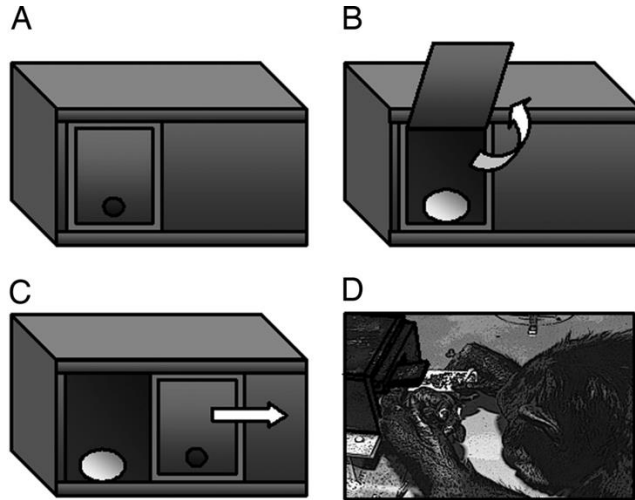
Social learning and culture in chimpanzees



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.

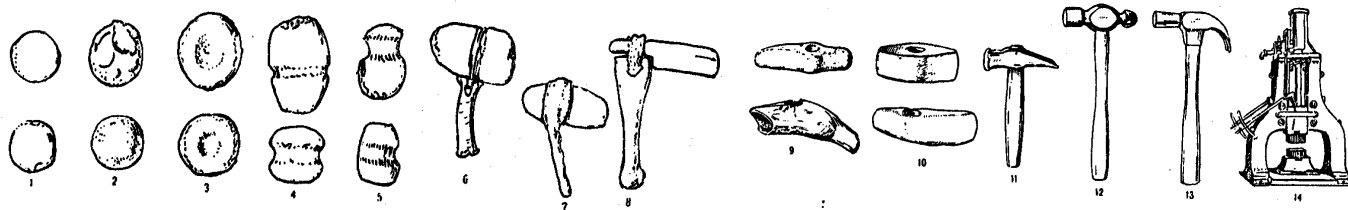
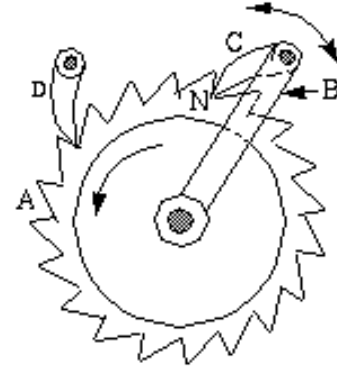
Social learning and culture in bumblebees (!)



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?

“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.

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)

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.

Summary of today

- Human evolution
 - Bushy, not linear
 - Rapid evolution of brain size
 - Evolution of technology and art, The Great Leap Forward
- Social learning, art and tool use, and language
 - What can be inferred from the archaeological record?
 - Are there better methods than just guessing?

Next up

- Tutorial
 - Inferring language from tool use / material culture?
- Next lecture: vocal learning, comparative psychology of language learning