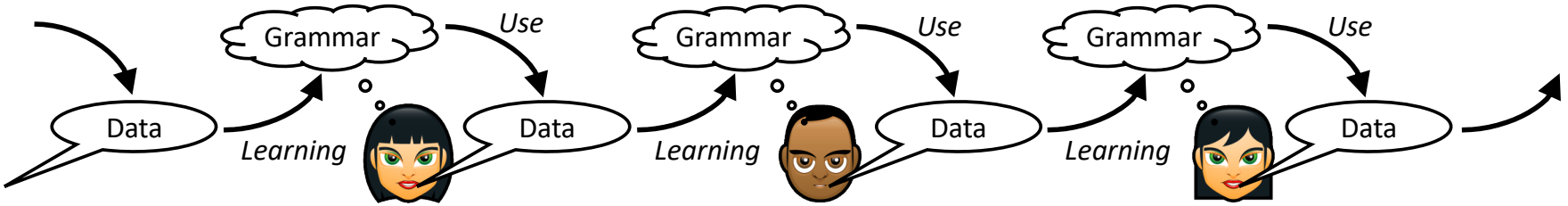
Origins and Evolution of Language
Week 2: Natural selection, adaptation, and the evolution of language

Kenny Smith
kenny.smith@ed.ac.uk

Tutorial allocation for late sign-ups

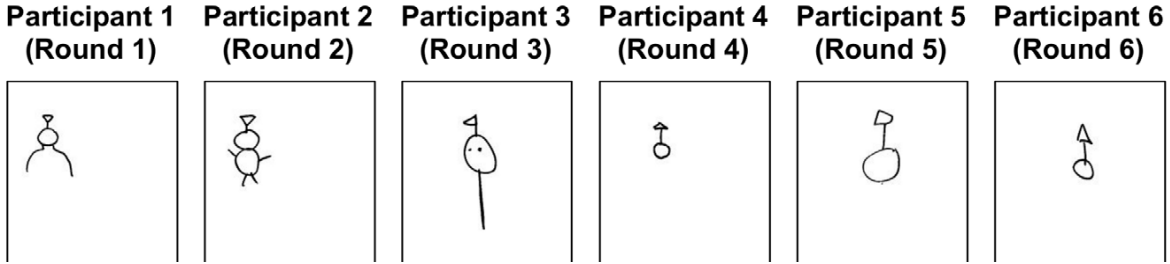
If you have not been allocated to a group, grab me in the break or email me asap – tutorials start this week!

Learning, use, and language design

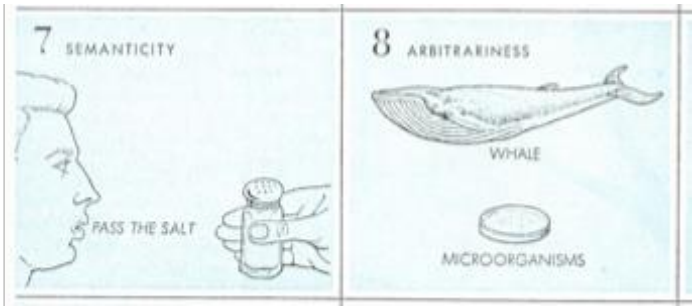


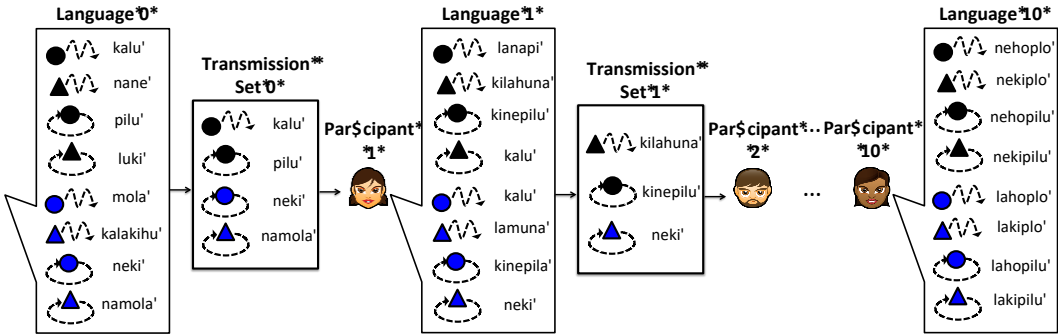
- Language is passed from person to person by **learning**
- People learn from language as it is **used in communication**
- Language **evolves** in response to its learning and use

Rather than us being adapted for language, language has adapted to us



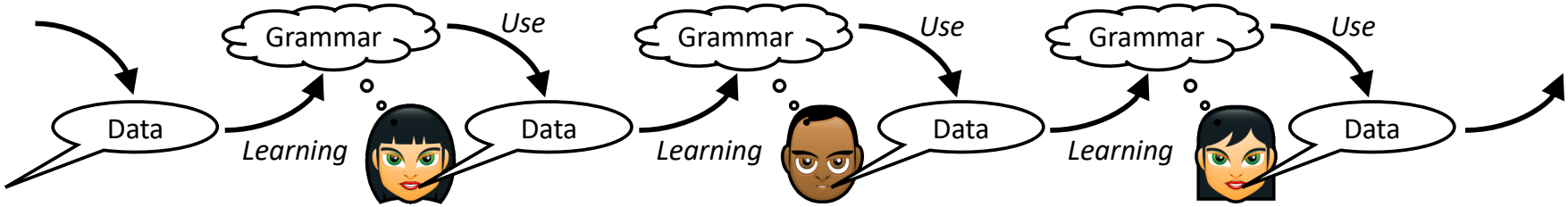
Caldwell, C. A., & Smith, K. (2012). Cultural evolution and the perpetuation of arbitrary communicative conventions in experimental microsocieties. *PLoS ONE, 7,* e43807.

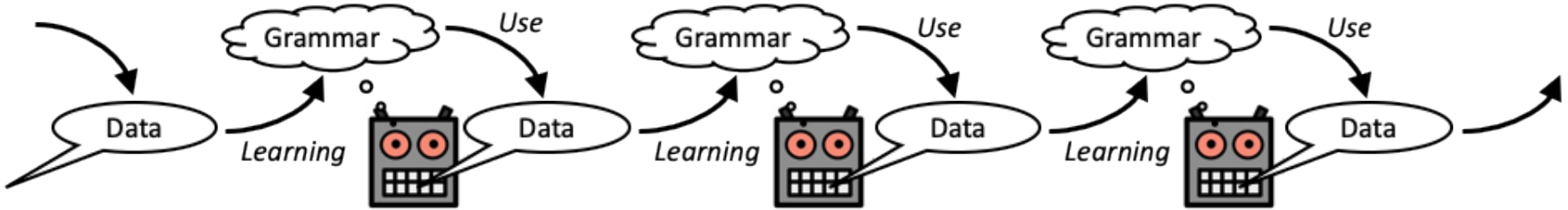




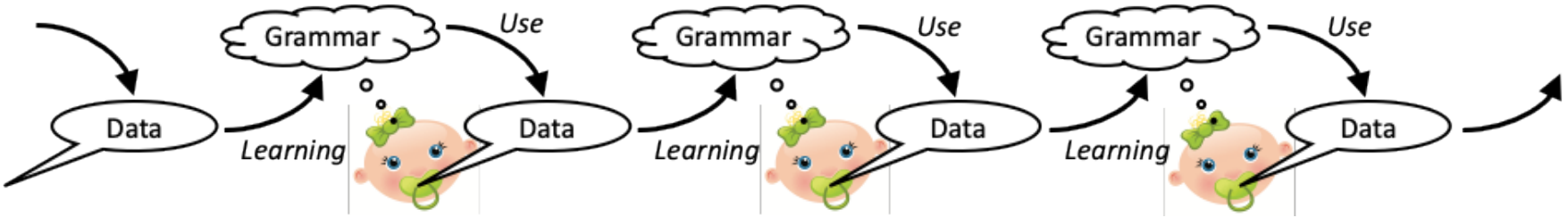
Kirby, S., Cornish, H., & Smith, K. (2008). Cumulative cultural evolution in the laboratory: an experimental approach to the origins of structure in human language. *Proceedings of the National Academy of Sciences, USA, 105,* 10681-10686.

“To what extent do these results depend on the fact that these people already have a language?”



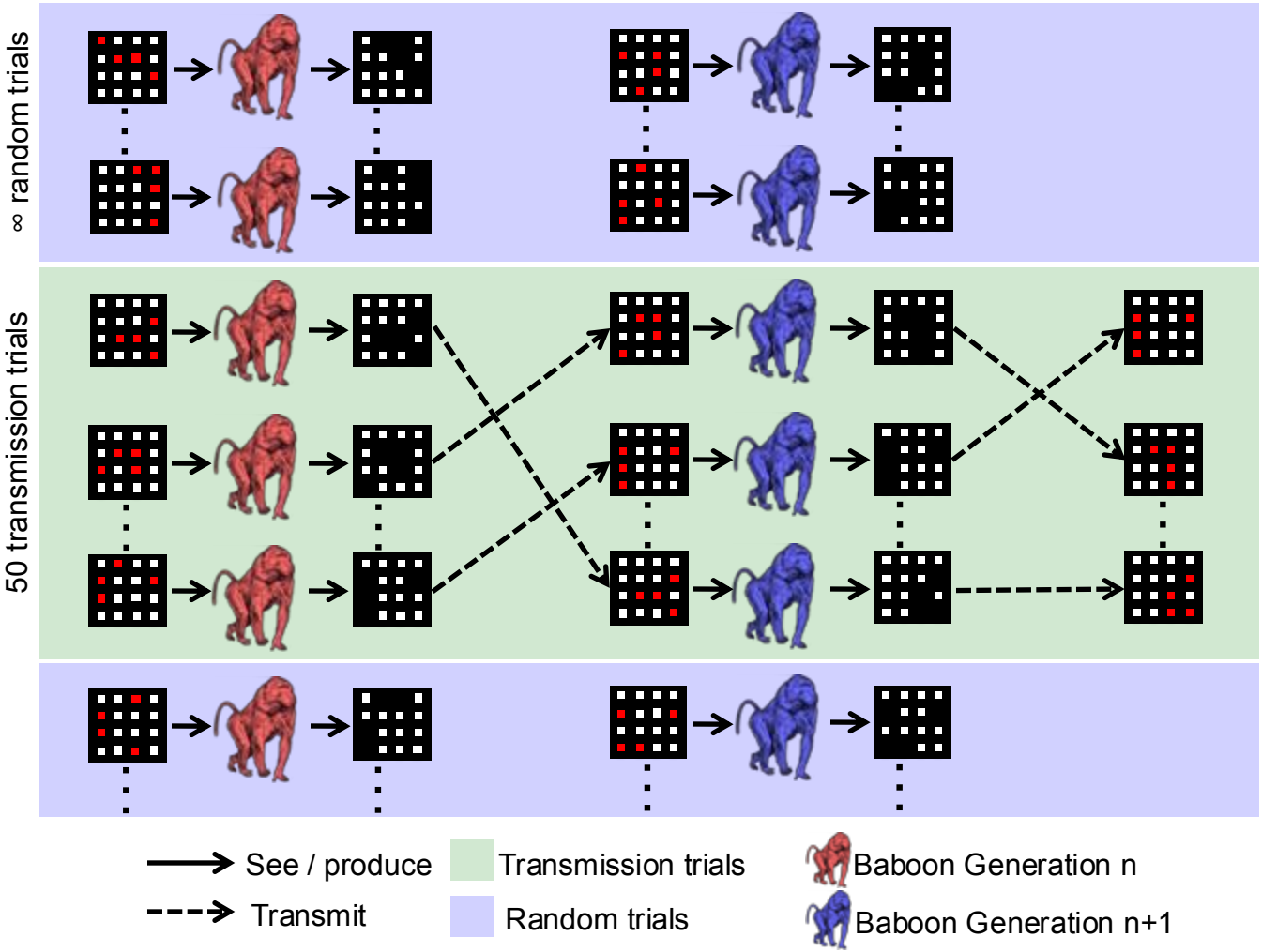


Methods taught in Simulating Language (Semester 2)



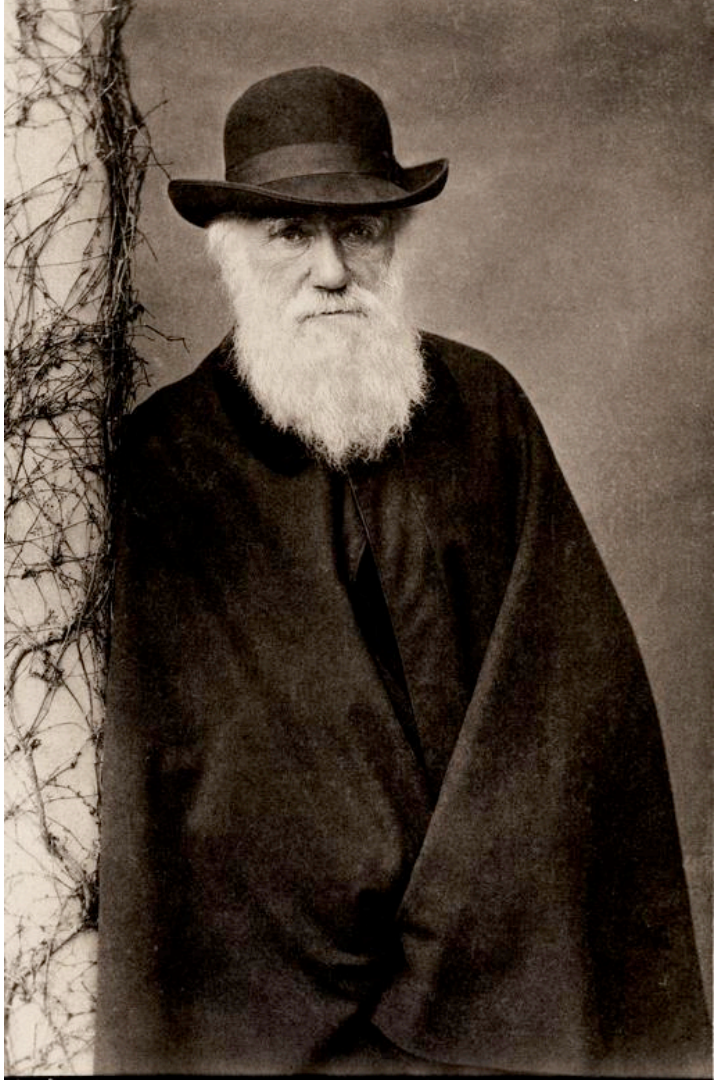
Raviv, L., & Arnon, I. (2018). Systematicity, but not compositionality: Examining the emergence of linguistic structure in children and adults using iterated learning. *Cognition, 181,* 160-173.

Claidière, N., Smith, K., Kirby, S., & Fagot, J. (2014). Cultural evolution of a systematically structured behaviour in a non-human primate. *Proceedings of the Royal Society B, 281,* 20141541.


∞ random trials
50 transmission trials
See / produce
Transmit
Transmission trials
Random trials
Baboon Generation n
Baboon Generation n+1

From last week

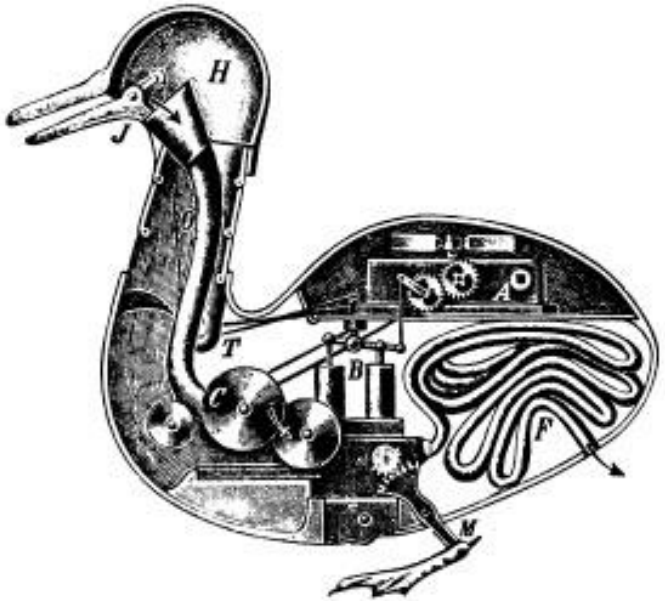
- Language is just like any other adaptive feature of an organism's biology
- It's an **innate** feature of the human mind
- It evolved by natural selection under pressure for communication



Plan for today

- **Natural selection and adaptation**
  - Heritable variation in fitness
- Homology and analogy
- Language as an adaptation

Design in life

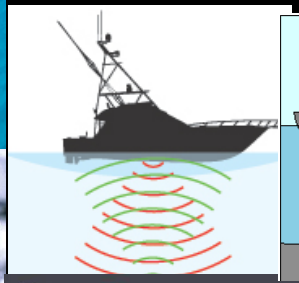


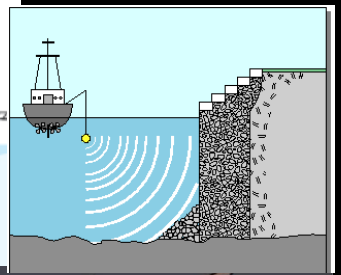
https://en.wikipedia.org/wiki/Digesting_Duck

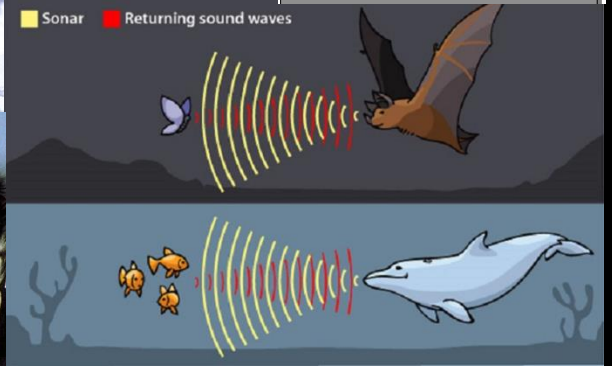
Living things are remarkably competent

- They are self-sustaining, reproducing, autonomous, deal with hostile, changing environments, …
- Designing a machine to do any of these things is currently beyond us

Design in life







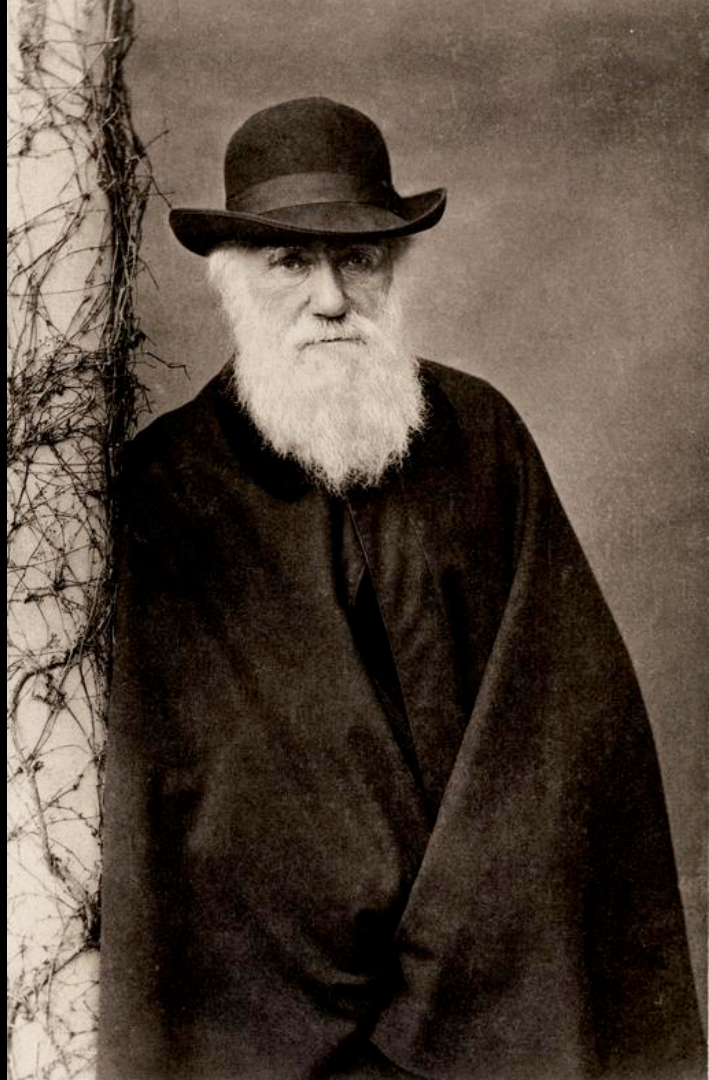
Adaptations

- "'design' in life – those properties of living things that enable them to survive and reproduce in nature." (Ridley, 1996, *Evolution*, p. 5)
- "An adaptation is a characteristic that enhances the survival or reproduction of organisms that bear it" (Futuyama, 2009, *Evolution,* p. 279)
- "The process whereby the members of a population become better suited to some feature of their environment through change in a characteristic that affects their survival and reproduction" (Futuyama again, same page)
- "a characteristic that has evolved by natural selection" (Futuyama again, same page)

Evolution by natural selection

"Owing to this struggle for life, any variation, however slight and from whatever cause proceeding, if it be in any degree profitable to an individual of any species, in its infinitely complex relations to other organic beings and to external nature, will tend to the preservation of that individual, and will generally be inherited by its offspring. The offspring, also, will thus have a better chance of surviving, for, of the many individuals of any species which are periodically born, but a small number can survive. I have called this principle, by which each slight variation, if useful, is preserved, by the term of Natural Selection"

(Darwin, 1859/1965, *On the Origin of Species*, p. 61)



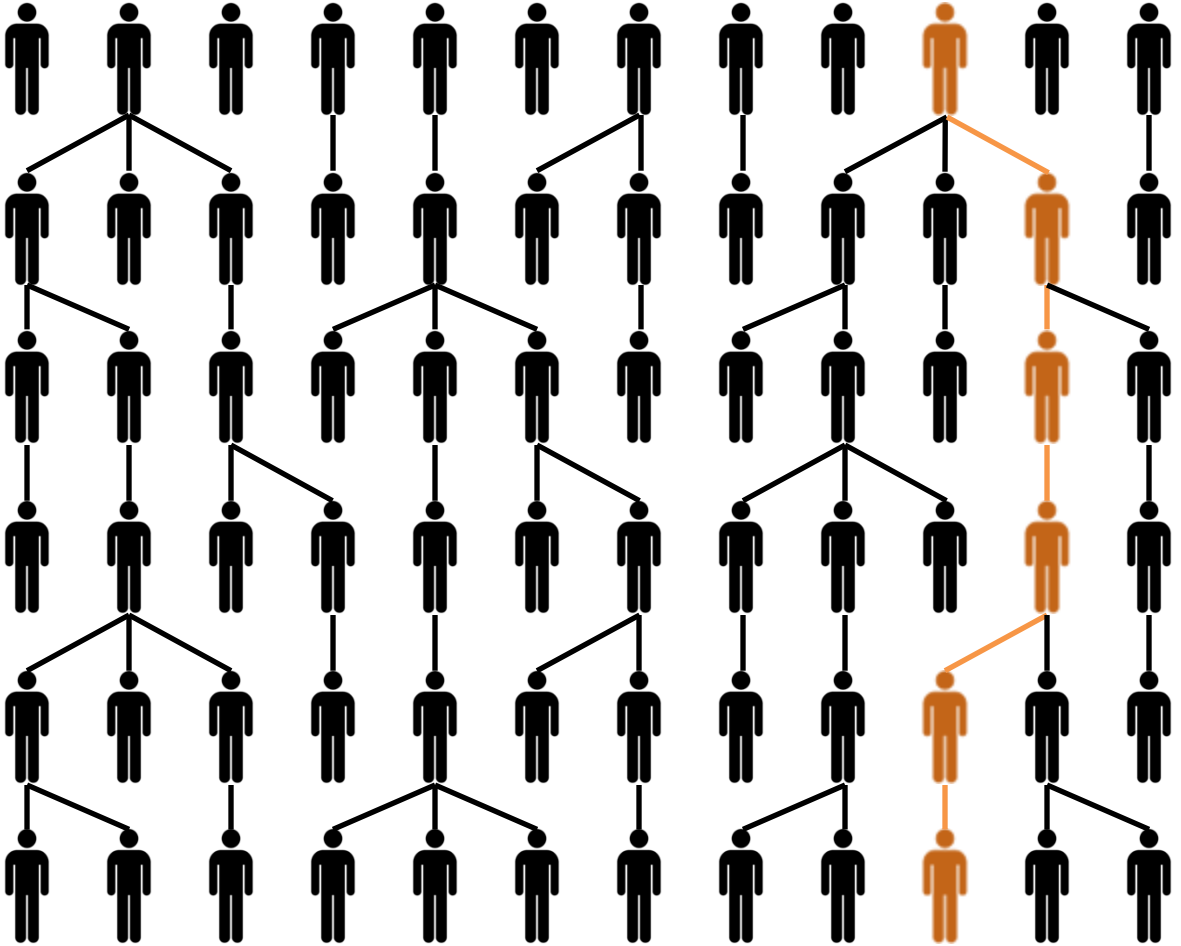
Evolution by natural selection

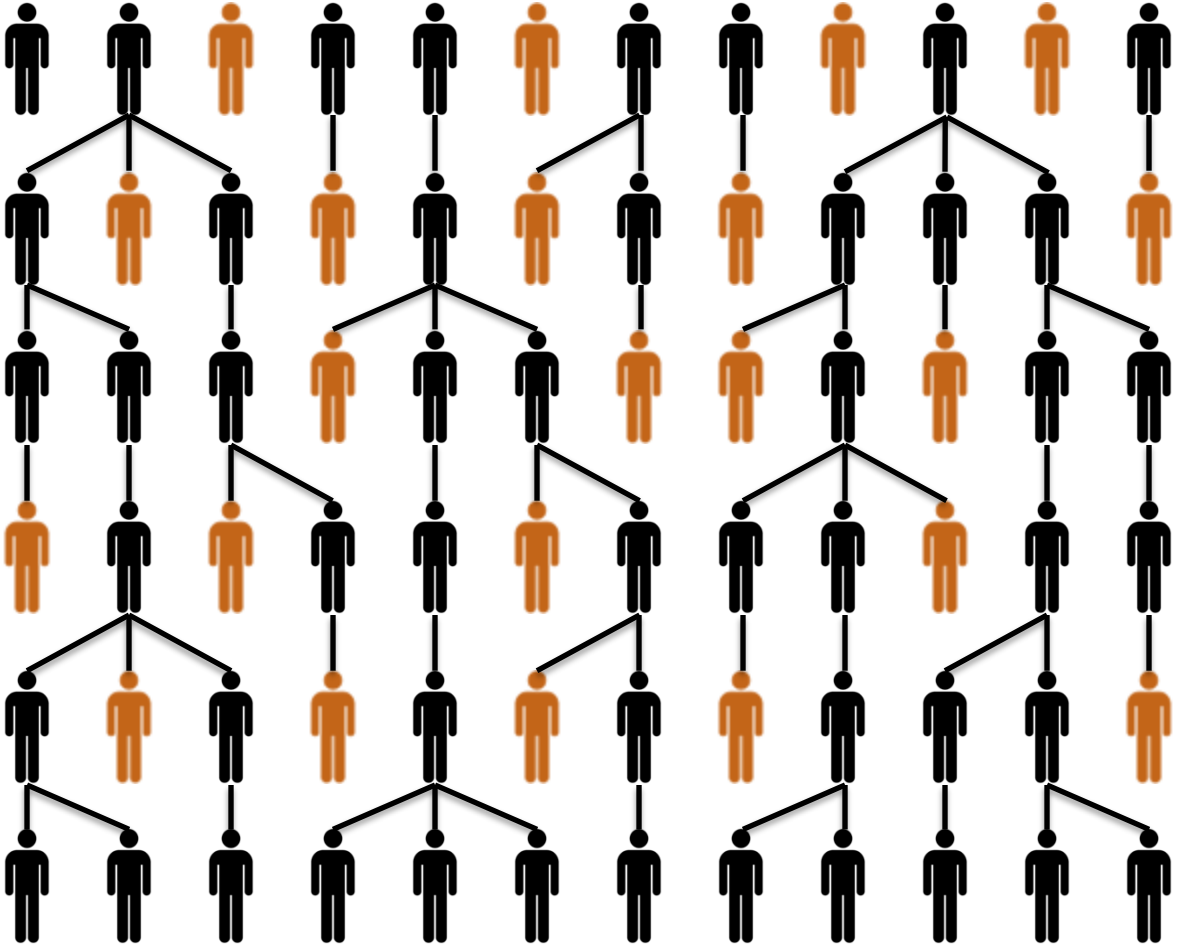
"Natural selection is easiest to understand, in the abstract, as a logical *argument*, leading from premises to conclusion…

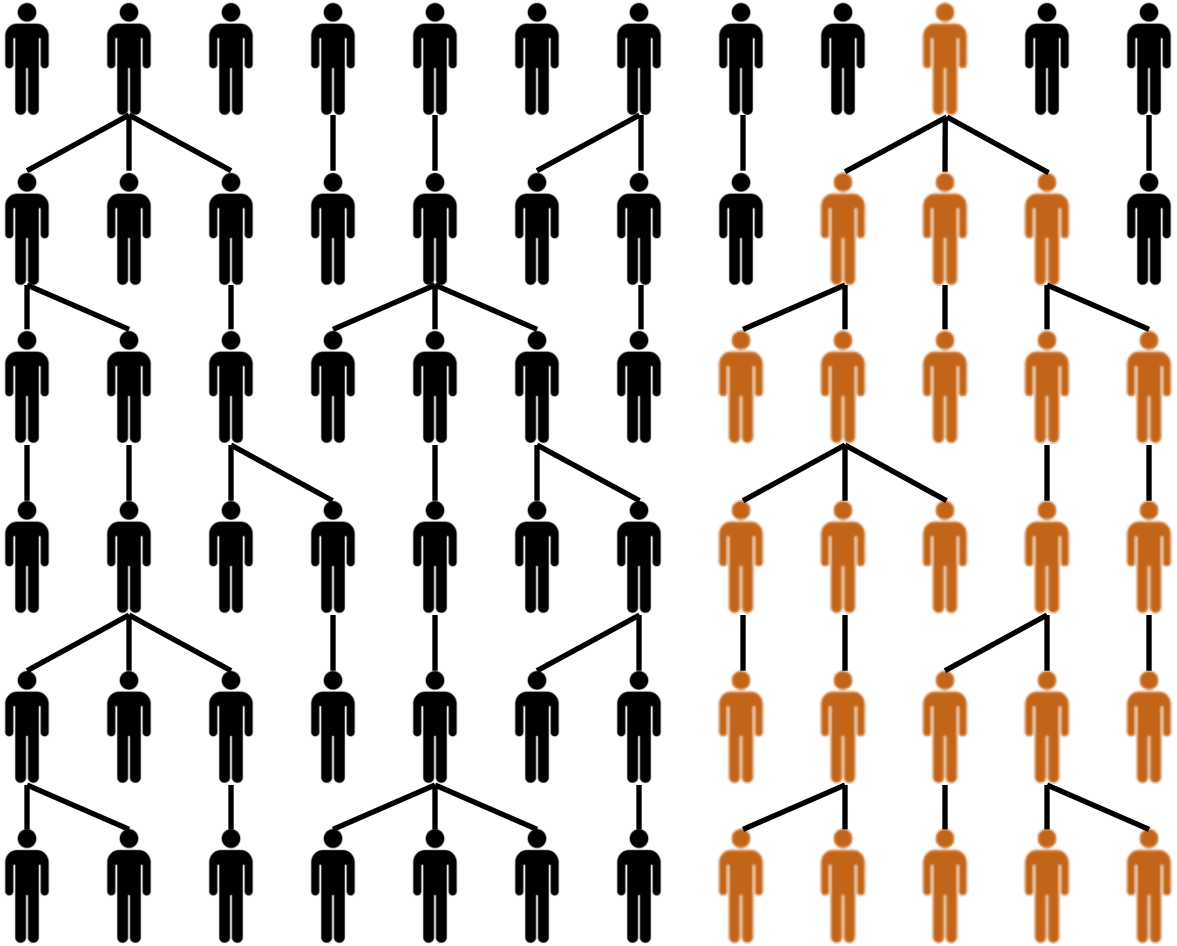
1. Reproduction. Entities must reproduce to form a new generation.
2. Heredity. Offspring must tend to resemble their parents: roughly speaking, "like must produce like."
3. Variation in individual characters among members of a population. …
4. Variation in the *fitness* of *organisms* according to the state they have for a heritable character. … individuals in the population with some characters must be more likely to reproduce (i.e. have higher fitness) than others

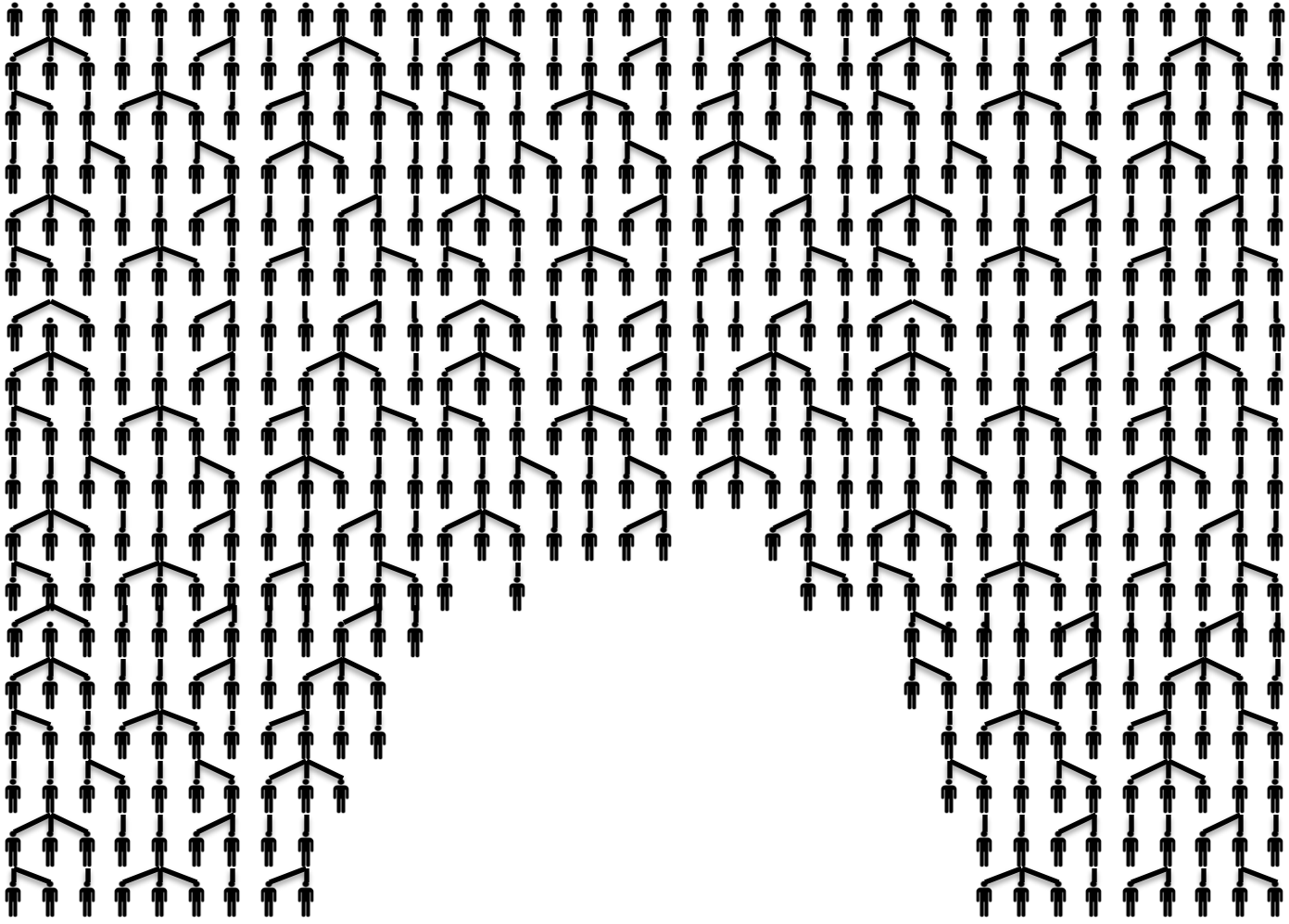
If these conditions are met, for any property or species, natural selection *automatically* results. If any conditions are not met, natural selection does not result. … When all four conditions apply, the entities with the property conferring higher fitness will leave more offspring, and the frequency of that type of entity will increase in the population" . (Ridley, *Evolution,* p. 71-72)

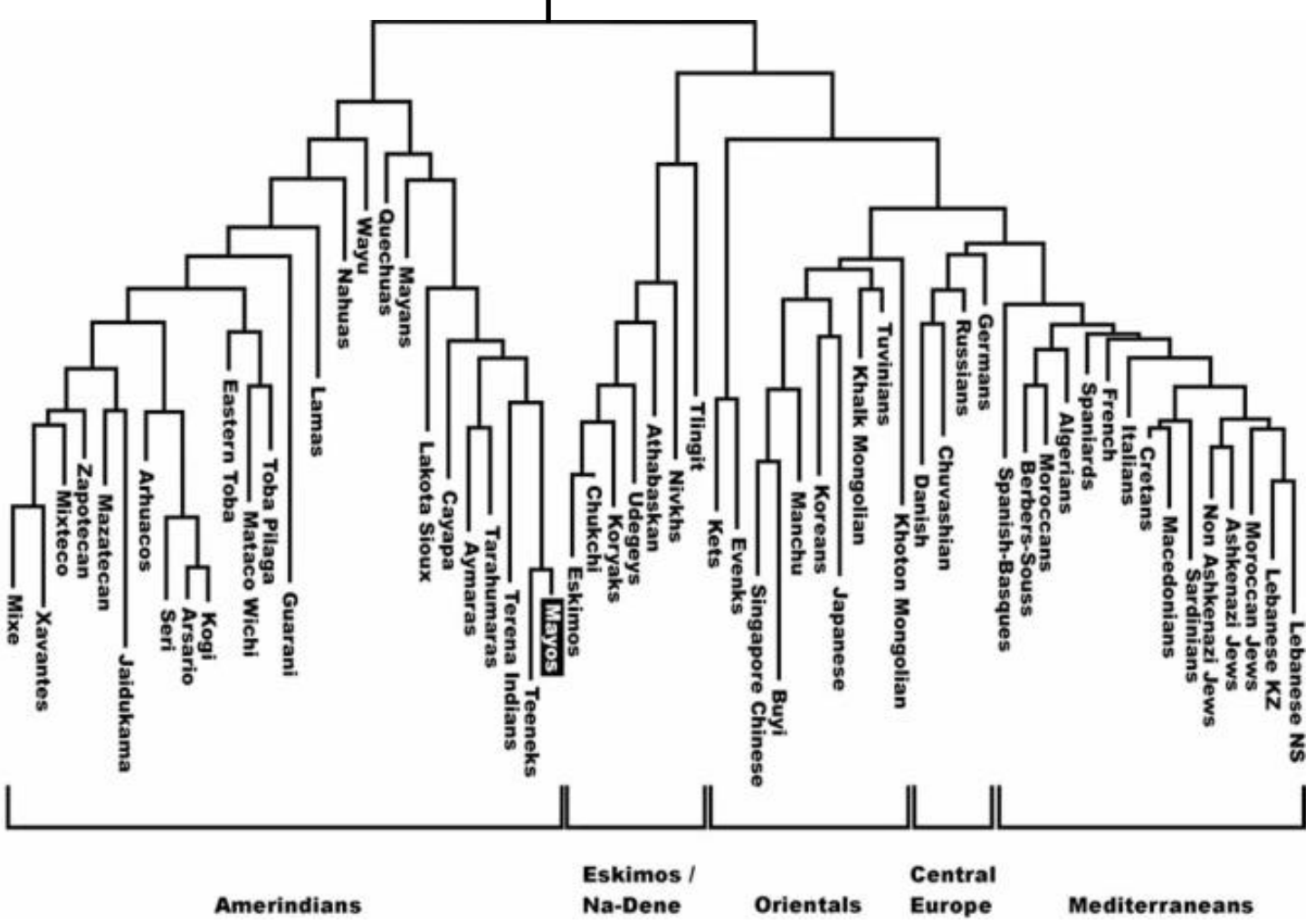
https://www.youtube.com/watch?v=plVk4NVIUh8



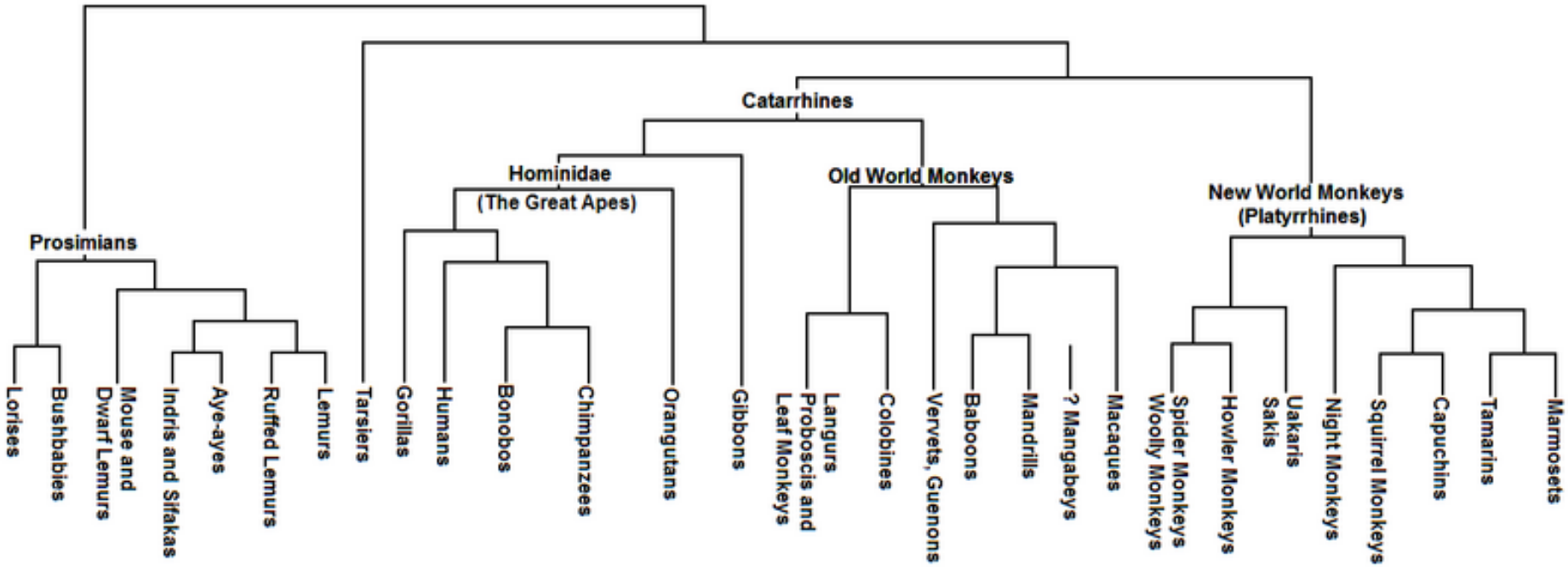


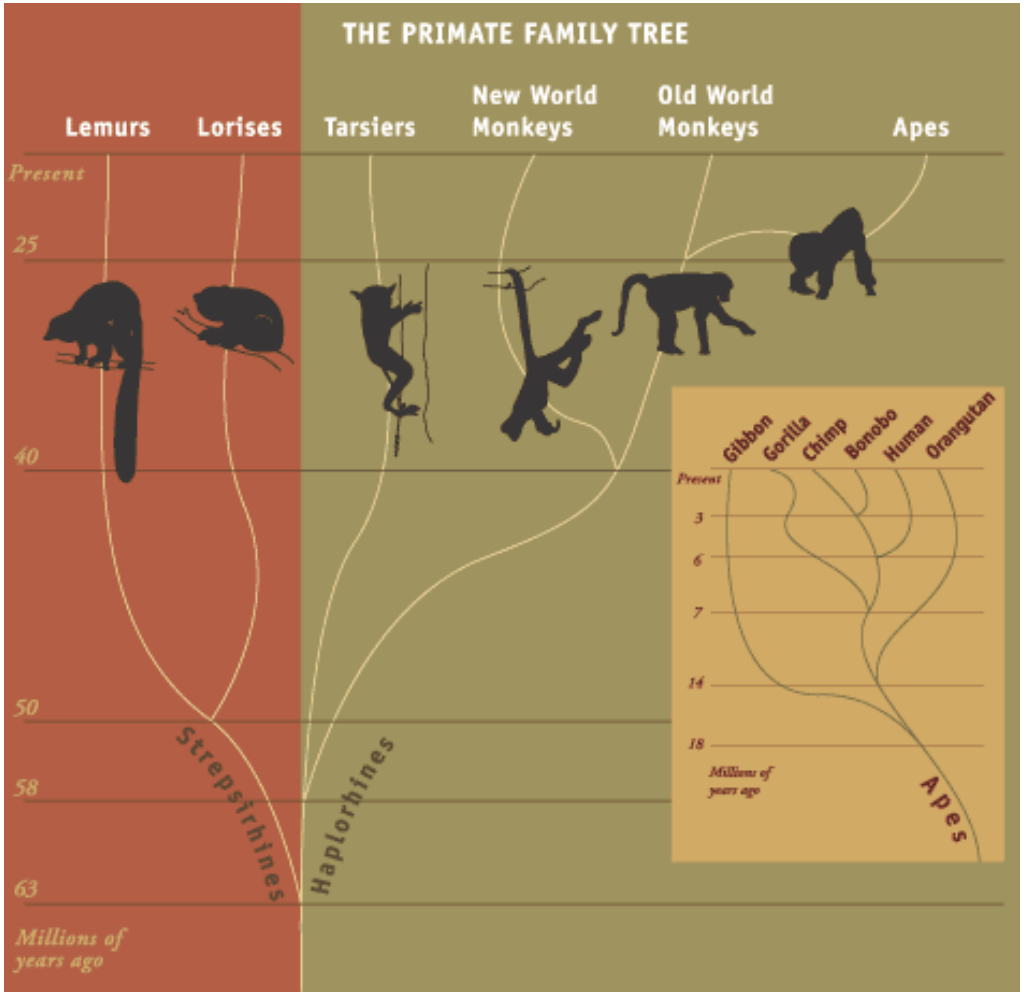




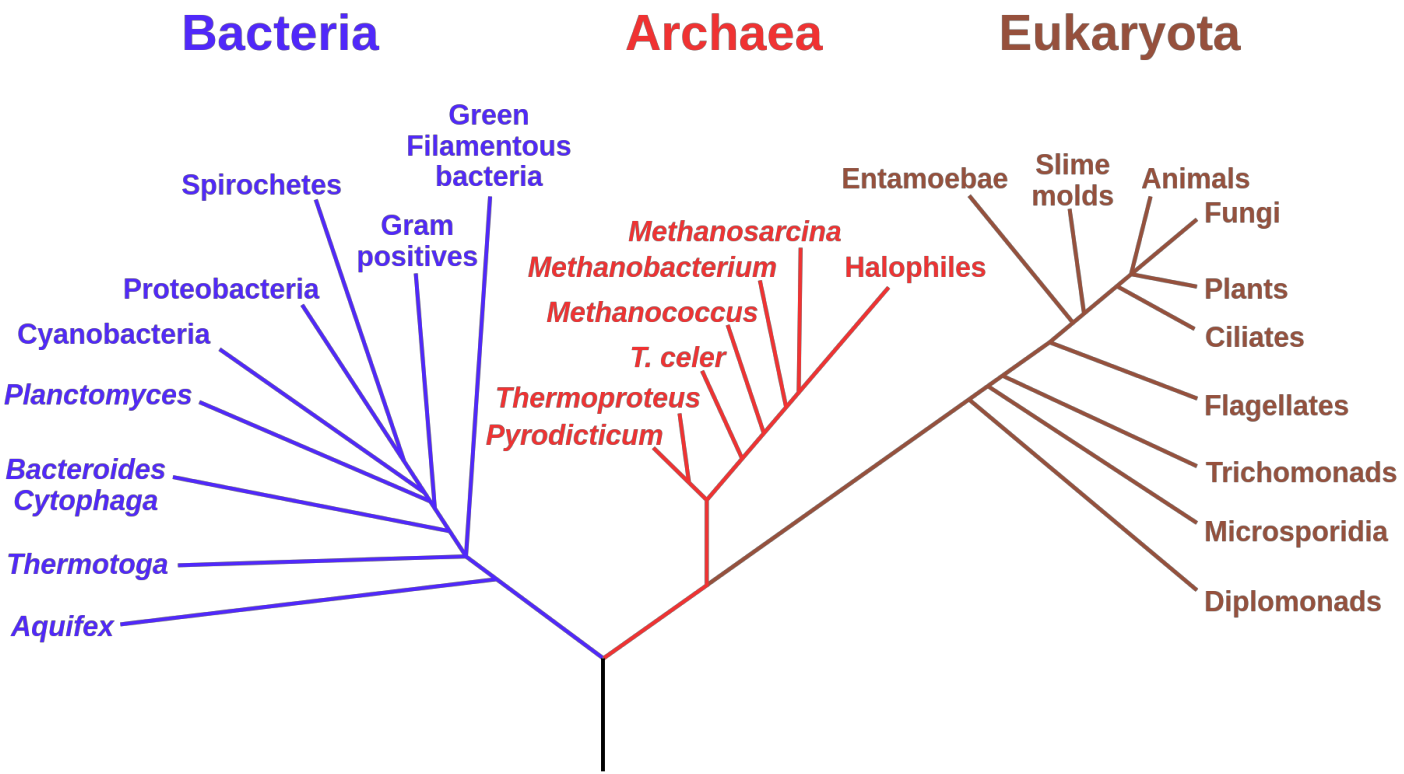


From Arnaiz-Villena et al. (2007). HLA Genes in Mayos Population from Northeast Mexico. *Current Genomics. 8.* 466-475.


Prosimians
Lorises
Bushbabies
Mouse and Dwarf Lemurs
Indris and Sifakas
Aye-ayes
Ruffed Lemurs
Lemurs
Tarsiers
Catarrhines
Hominidae (The Great Apes)
Gorillas
Humans
Bonobos
Chimpanzees
Orangutans
Gibbons
Old World Monkeys
Langurs Proboscis and Leaf Monkeys
Colobines
Vervets, Guenons
Baboons
Mandrills
? Mangabeys
Macaques
New World Monkeys (Platyrrhines)
Spider Monkeys Woolly Monkeys
Howler Monkeys
Uakaris Sakis
Night Monkeys
Squirrel Monkeys
Capuchins
Tamarins
Marmosets

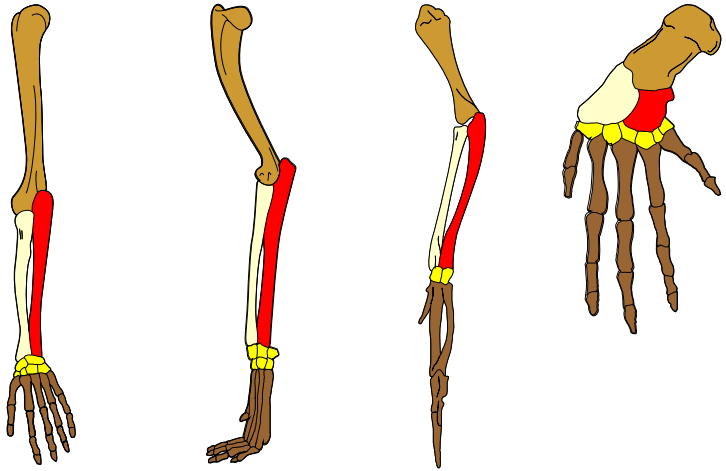


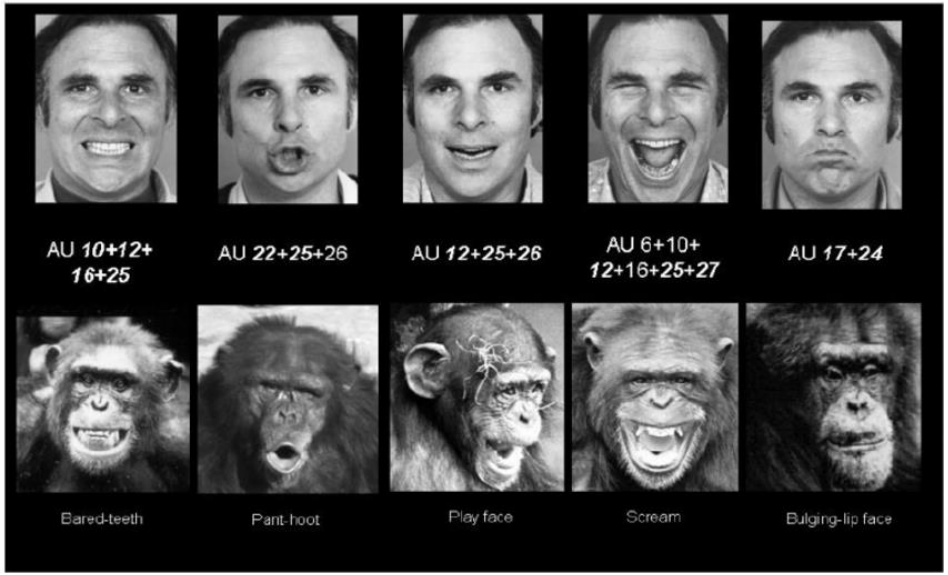
http://www.daviddarling.info/images/primate_family_tree.gif



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

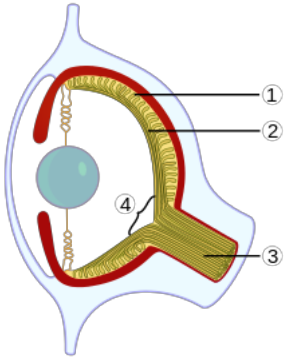
Homology

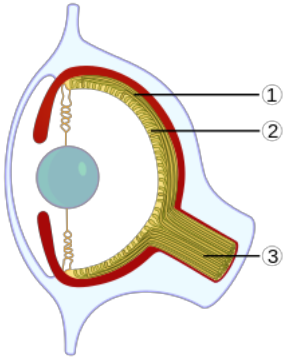




From Parr, L. A., &, Waller, B. M. (2006). Understanding chimpanzee facial expression: insights into the evolution of communication. *SCAN, 1,* 221-228.

Convergent evolution





Language as an adaptation?

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- It's an **innate** feature of the human mind
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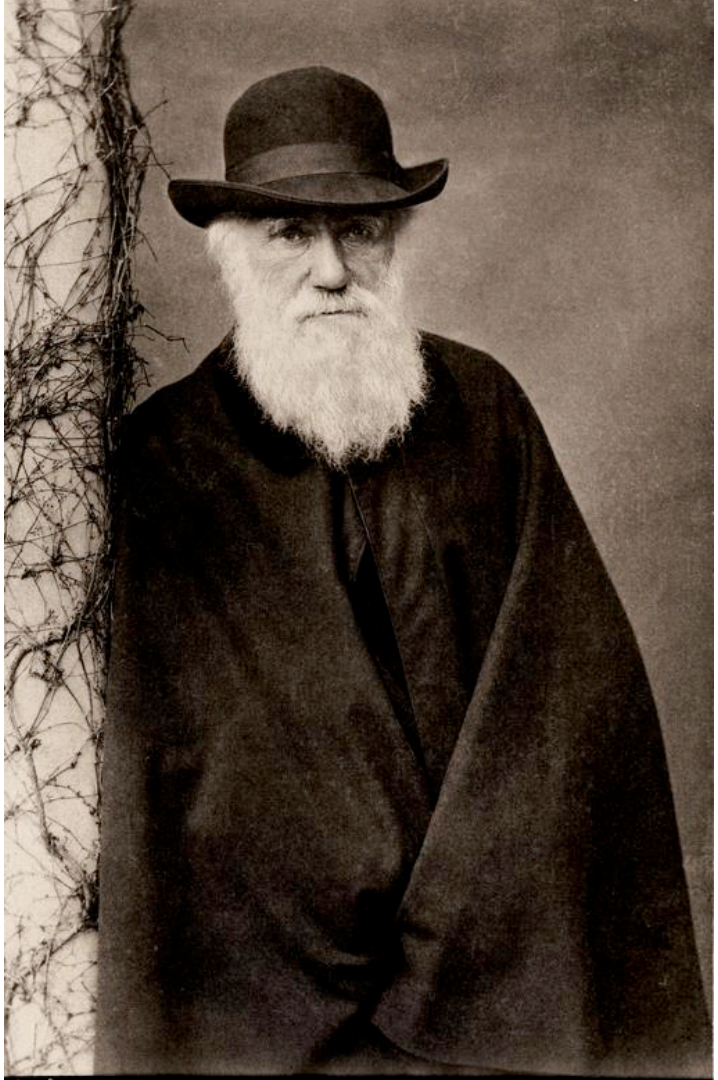

A tool for the communication of knowledge and internal states

The core of the argument (from Pinker & Bloom, 1990)

"We will suggest that language shows signs of design for the communication of propositional structures over a serial channel.

The propositions in [human thought] are relational structures whose symbols pertain to people, objects, and events, the categories they belong to, their distribution in space and time, and their causal relations to one another … The causal relations governing the behavior of other people are understood as involving their beliefs and desires, which can be reconsidered as relations between an individual and the proposition that represents the content of that belief or desire"

Pinker, S., & Bloom, P. (1990). Natural language and natural selection. *Behavioural and Brain Sciences, 13,* 707-784.
Lengthy quote is from p. 712-713

The core of the argument (from Pinker & Bloom, 1990)

"We would want to be able to

- *refer to individuals and classes,*
- *to distinguish among basic ontological categories (things, events, places, times, manners, and so on),*
- *to talk about events and states, distinguishing the participants in the event or state according to role (agents, patients, goals),*
- *to talk about the intentional states of ourselves and others*
- *to express distinctions of truth value, modality (necessity, possibility, probability, factivity)*

Pinker, S., & Bloom, P. (1990). Natural language and natural selection. *Behavioural and Brain Sciences, 13,* 707-784.
Lengthy quote is from p. 712-713

The core of the argument (from Pinker & Bloom, 1990)

- *to comment on the time of an event or state, including both its distribution over time (continuous, iterative, punctate) and its overall time of occurrence*
- *to encode an unlimited number of predicates, arguments, and propositions*
- *to be able to use the same propositional content within different speech acts; for instance, as a question, a statement, or a command.*
- *to focus or to put into the background different parts of a proposition, so as to tie the speech act into its context of previously conveyed information and patterns of knowledge of the listener. ”*

Pinker, S., & Bloom, P. (1990). Natural language and natural selection. *Behavioural and Brain Sciences, 13,* 707-784.
Lengthy quote is from p. 712-713

Summary

- Adaptation & natural selection
  - A consequence of heritable variation in fitness
  - Similarity due to common ancestry (homology)
  - Convergent evolution and analogy
- Language as a biological adaptation

Next up

- Tutorials
  - Attendance recorded and compulsory
  - Know where you are going
  - Take a look at the exercise in advance (less intensive prep this week than usual)
- Next week's lecture: intention and structure in animal communication