

Cognition, Language & Communication'13

MSc Brain & Cognitive Science, UvA
track Cognitive Science

Jelle Zuidema
Institute for Logic, Language & Computation
zuidema@uva.nl

What's so special about humans?



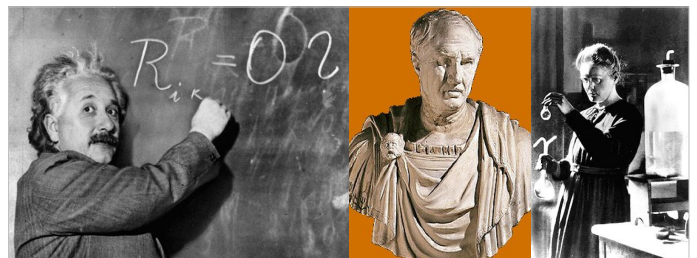
Humans and chimpanzees are [...] very similar in their proteins, on the average, but vastly different in the sizes of their brains and their ability to write books about each other.

(Richard Lewontin, 1998, p. 117)



Outline

- Intro
 - 'Humanness'
 - Human origins
 - Human evolution
 - Is language the key?
- Practicalities
 - Schedule, literature
 - examination



Human cognition

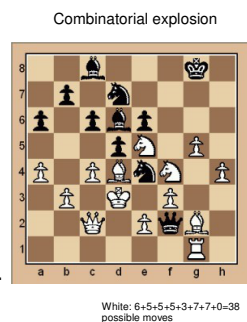
- Thought & reasoning
- Number cognition, Mathematics
- Consciousness
- Music (beat/rhythm, harmony)
- Naïve physics, proportional reasoning
- Spatial cognition
- Social cognition
- Tool use, technology
- Art

Human communication

- Innate nonverbal signals (laughing, crying, smiling, ...)
- Language
 - Function: Statements (compositionality), imperatives, questions, irony, ambiguity, plausible deniability, metalinguistic, expressive, emotive use
 - Form: Duality of patterning, recursive/hierarchical
 - Acquisition: Learned, culturally transmitted
- Altruistic/honest/cooperative
 - Gricean maxims: quality, quantity, relevance, manner

Human cognition

- Compare Machine Intelligence
 - Chess, Go
 - Planning
 - Navigation
 - Language
- Compare Animal Intelligence
 - Kluge Hans
 - Selfrecognition
 - Developmental studies, T.o.M.



Human Origins - timeline

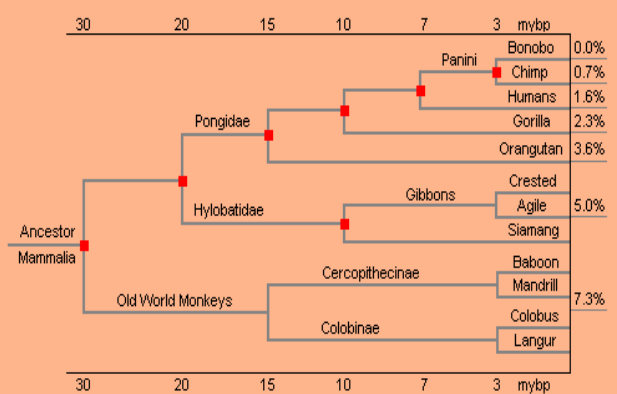
- Genetic data: primate family tree
 - Tool use
 - Communication, Vocal learning
 - Cultural transmission
- Fossil record: hominin family tree
 - Tool use
 - Control over fire
 - Art, symbols
 - Rituals
- Human family tree

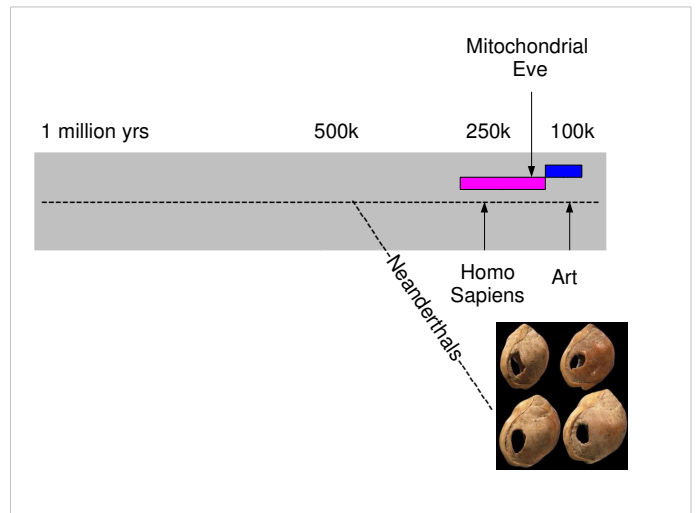
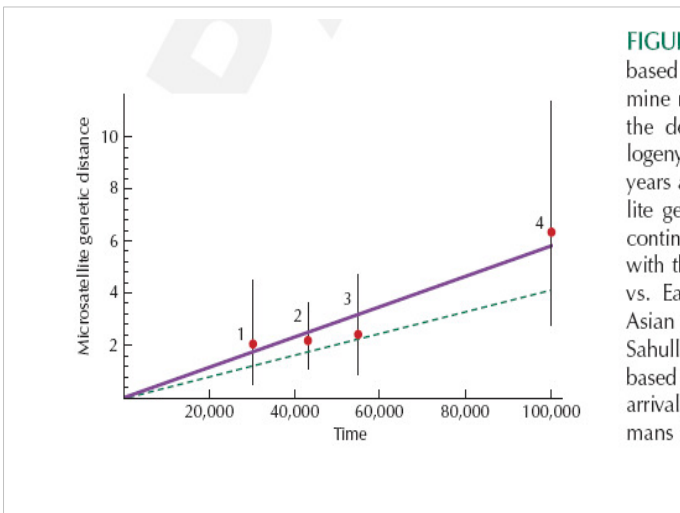
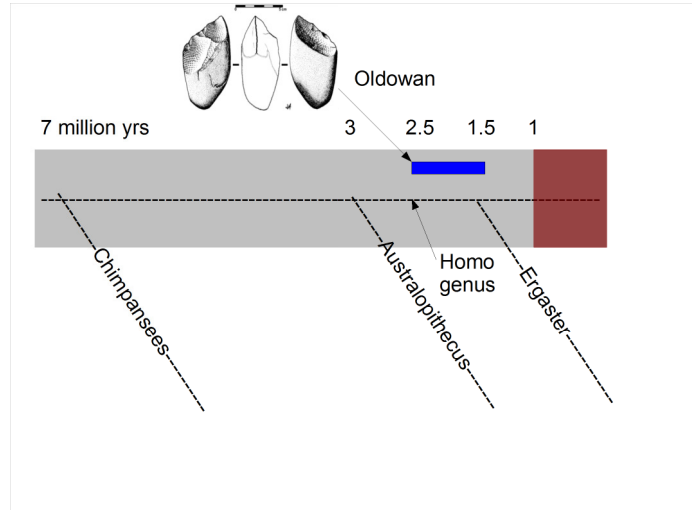
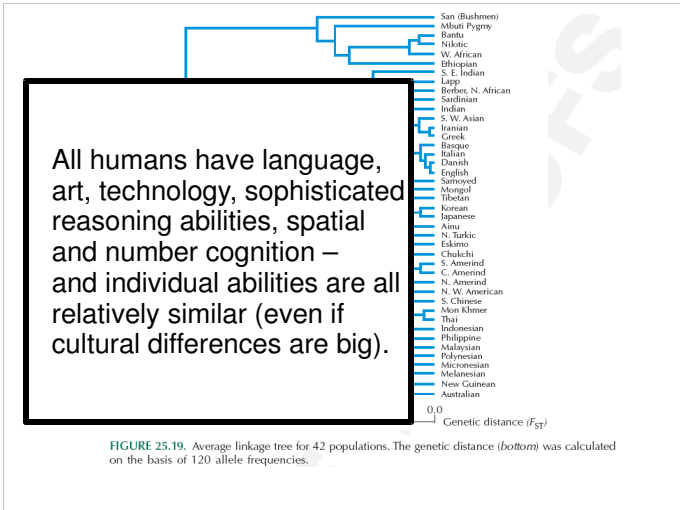
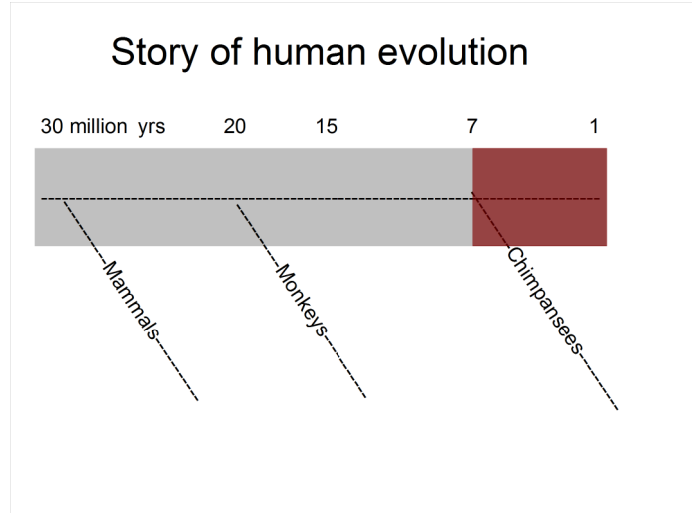
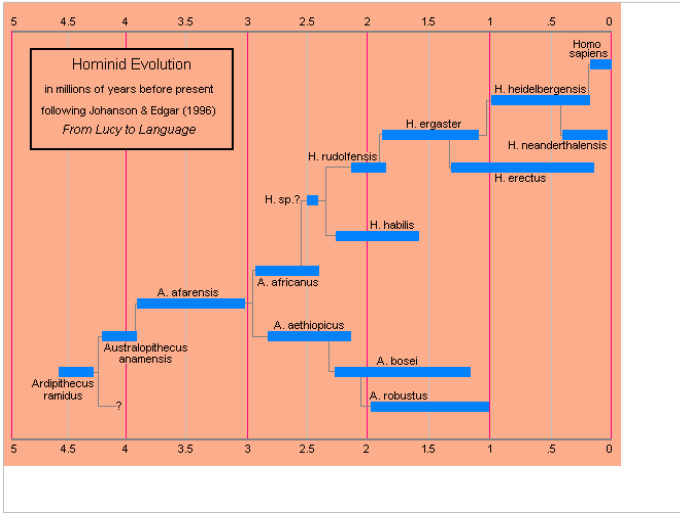
Human communication

*CHI: what you do with the pencil ?
 *URS: oh # you sharpen it .
 *CHI: sharpen it # with what ?
 *URS: with the pencil sharpener .
 *CHI: and do what ?
 *CHI: d(o) you wan(t) me +...
 *CHI: # you do it .
 *URS: I'll show you how .
 *CHI: what I taking out ?
 *CHI: take out ?
 *CHI: I trying to take out a pencil .
 *CHI: can I take de [: the] pencil apart ?
 *URS: you can't take it apart # no .
 *CHI: take dis [: this] apart # dis [: this] one ?
 *URS: no .
 *CHI: turn it ?
 *URS: yes .
 *CHI: turn it and take apart ?
 *URS: no # just turn it and sharpen the pencil .

Childes/Brown corpus: Adam 3;2.21

Genetic Change Over Time (millions of years) Among the Primates







Can we assess the evolutionary plausibility of massive modularity, intelligence-first, and language-first scenarios?

What has happened?

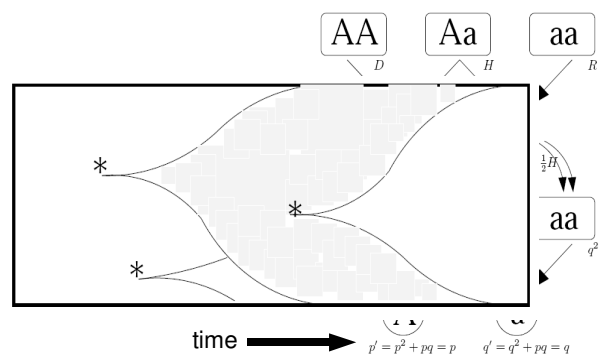
- Earliest evidence for some (very limited) aspects of 'humanness' 2.5My BP
- Last common ancestor all humans:
 - 140Ky-290Ky BP (mtDNA)
 - 70Ky BP (Ychromosome)
- Between 2.5My and 100,000 years BP something very significant has happened in hominin evolution!

Yes - Evolutionary considerations provide important constraints on plausible scenarios

Three scenarios

- “Language-first scenario”: humans discovered language, and language made us smart
- “Intelligence-first scenario”: human intelligence increased and affected many other human cognitive traits (once it reached a threshold)
- “Massive modularity scenario”: human specific traits are modules, evolved one by one under selection pressure of savannah life

Evolution



Genome data

- Chimp-human genome comparison: 98% in common, but still 35 million single nucleotide substitutions (half in human lineage);
- 600 genes strong positive selection in those lineages (immune system, transcription factors)
- 6 chromosomal regions show evidence of strong selection, including region of FOXP2 and CFTR (sweat, cholera)

Requirements for plausible scenarios

- Explain how such a radical new phenotype can be based on relatively few genetic changes
 - (1) Common causes
 - (2) Hidden potential
- Explain how the unusual circumstances needed for the evolution of social traits can be sustained
 - (3) Self-enforcing dynamic

Limited time argument

- Implausible to assume very many *selected* genes for each uniquely human trait
 - 100,000 yrs ~ 4,000 generations, 2My ~ 80,000 gens
 - Population size N : 10,000 (estimate for 12,000 y BP)
 - Fixation time ~ $2N$ generations ~ 4 selective sweeps (if consecutive as in asexual reproduction)
 - but: evidence for recent selection on $\approx 1,800$ human genes (last 50Ky; Hawks et al, 2007, *PNAS*)
 - but: "strong evidence of positive selection unique to the human lineage is thus limited to a handful of genes" - (Chimp sequencing consortium 2005)

Scenario

- Hominin and chimp lineages diverged 7My ago; Hominins gradually adapted to a niche that required upright posture, running, larger groups, more cooperation & more politics
- About 200Ky ago, Anatomically Modern Humans crossed a threshold (cooperativity), where it became possible for combinatorial language to culturally evolve and adapt to its learners.
- Language then became available as a representational system and unlocked the potential for "higher cognition" in many domains.
- These new abilities created new, fierce selection pressures for even better cognitive abilities.

Social traits argument

- Most uniquely human traits are 'unusual', social traits in evolution because their benefits are *for or dependent on* the social group.
- E.g., evolution of language, communication, music, cooperativity, social cognition etc. all pose coordination and altruism problems:
 - Kin selection / Social evolution theory
 - Frequency dependent selection
- Require unusual circumstances; implausible to simply assume a prolonged selection regime favoring social traits

Things to investigate

- Language must be built on mechanisms shared with other animals, require only few language-specific adaptations but be qualitatively different
 - Comparative biology of language processing
 - Properties of language
 - Evolution of language
- Language must be able to adapt to language learners in a process of cultural evolution
- Language must be involved in many (if not all) other human-specific cognitive abilities, such as reasoning, music, mathematics, consciousness

Mo 9/9 L1: Communication, Language & Evolution
Hockett (1960), Fitch & Hauser (2003), Assignment 0

Th 12/9 L2: Design Features, Chomsky Hierarchy
Chomsky (1957): pp11-48, Assignment 1

Mo 16/9 Discussion I, L3: Generativism, Nativism-Empiricism
Chomsky (1967)

Th 19/9 Computer lab 1: Processing, webexperiments
Assignment 2

Mo 23/9 L4: Usage-based Grammar, Connectionism, Prob Ling
Tomasello (2000), Abney (1996)

Th 27/9 Computer lab 2: data-analysis with R
Assignment 3

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Mo 30/9 Discussion II, L4: Artificial Language Learning
Saffran et al.'96; Marcus et al.'98, Fitch & Hauser'04

Th 3/10 Guest Lectures: Rule vs. statistical learning
Assignment 4: Research Proposals

Mo 7/10 L5: Iterated Learning
Christiansen & Chater (2008), Zuidema (2003)

Th 10/10 L6: Evolution of Language
Pinker (2010), Zuidema (2013), Spelke (2003)

Mo 14/10 Discussion III, Miniproject presentations 1 & 2

Th 17/10 Presentations 3 & 4, L7: Origins of Human Cognition

Mo 21/10, 1pm, Miniproject reports due

What is it? Who has it? And how did it evolve?



Cognition, Language & Communication'12

Lecture 1b: Animal Communication & Natural Language

Jelle Zuidema
Institute for Logic, Language & Computation
zuidema@uva.nl

Unique "Design Features"?

(Hockett, 1960, etc; reviewed in Smith'03)

DISPLACEMENT: Language can be used to communicate about things in places, times or even possible worlds removed from the actual communicative act. (Burling, Hudson, O'Grady et al., Trask)

COMPOSITIONAL SEMANTICS: The meaning of an expression (excluding idioms and irregulars) is a function of the meaning of its parts and the way in which they are combined (Cann 1993; Krifka 2001).

ARBITRARINESS: Typically, the form of a signal is arbitrarily related to its meaning. (Fromkin & Rodman, Hudson, O'Grady et al., Trask)

CULTURAL TRANSMISSION: Language is learned (in some sense to some degree) by language users from other language users, as opposed to being genetically transmitted. (Burling, Fromkin & Rodman, Hudson, O'Grady et al., Trask)

DISCRETENESS: The units of a language are distinguished from each other categorically, as opposed to grading into one another. (Burling, O'Grady et al.)

STIMULUS FREEDOM: Language users can potentially produce any signal they want at any time, and are not bound to producing a signal only when the appropriate stimulus is present. (Fromkin & Rodman, O'Grady et al., Trask)

DUALITY OF PATTERNING: Small numbers of meaningless elements (phonemes in spoken languages) are combined to form large numbers of meaningful elements (words). (Burling, Hudson, O'Grady et al., Trask)

OPEN-ENDEDNESS / RECURSION: An expression of a particular type can be a subpart of a larger expression of that type (see e.g. Burling (1992), Haegeman (1994), Hudson (2000)). Recursiveness allows the creation of an infinite number of utterances.

Unique "Design Features"?

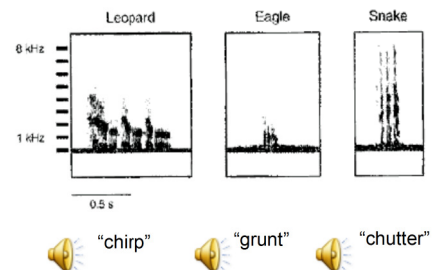
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- ~~Compositionality~~
- Arbitrariness
- Cultural transmission
- Discreteness
- Stimulus freedom
- Duality of Patterning
- Open-endedness, Recursion

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Vervet monkey alarm calls

(Struhsaker'67; Seyfarth, Cheney & Marler'80; squirrels: Sherman'77)



Bee dance

(von Frisch'65, '74)

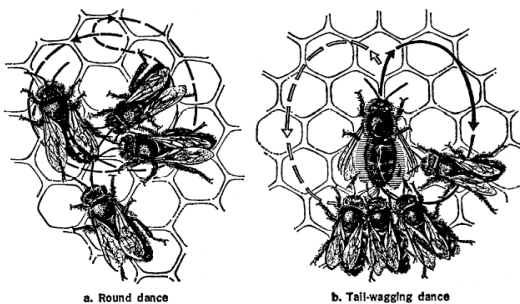
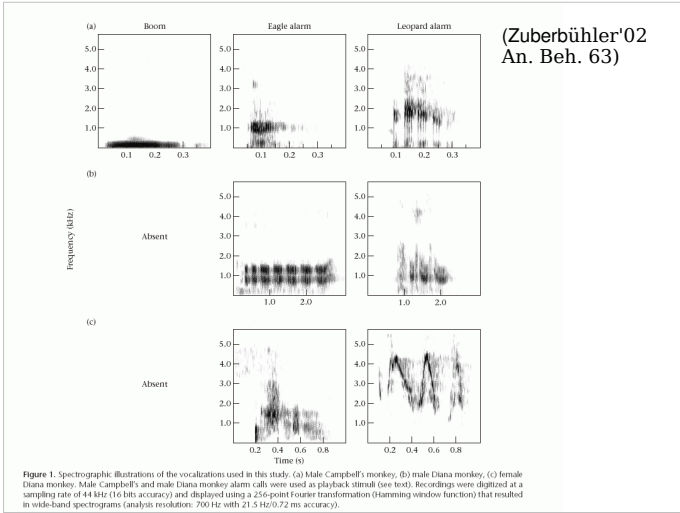


Fig. 1. Running curve of the bee (a) during round dance and (b) during tail-wagging dance. Bees that follow the dancer take in information.

von Frisch'74, *Science* 4152:664

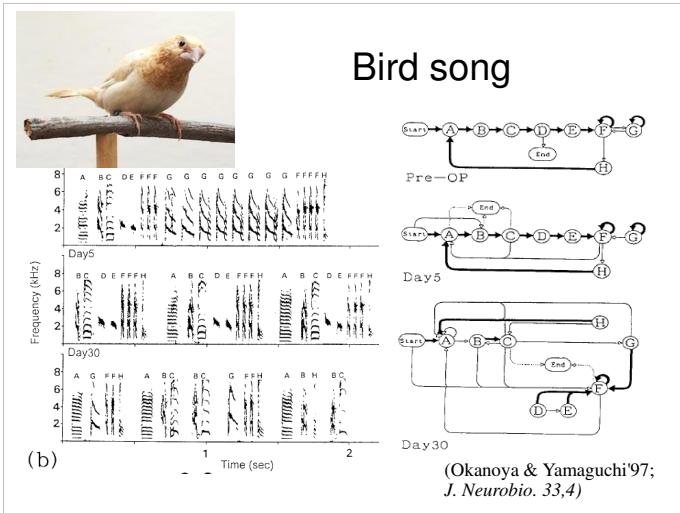
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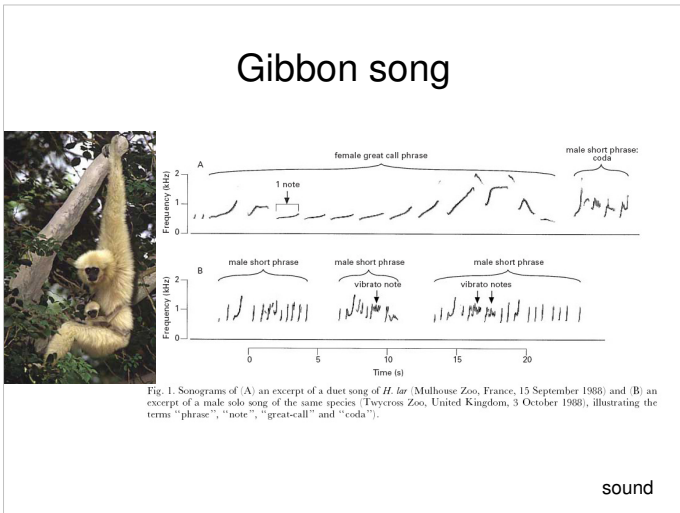
Vocal learning

Hoover, the talking seal



Unique "Design Features"?

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Next class

- Duality of Patterning
- Hierarchical Phrase-structure
- Recursion
- Chomsky Hierarchy
- Read Hockett (1960) & Fitch & Hauser (2003)
- Take part in a webexperiment (check email)

sound