EBERHARD KARLS
UNIVERSITÄT
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Faculty of Philosophy
General Linguistics

Syntax & Semantics WS2019/2020

Lecture 16: The Evolution of Syntax

16/12/2019, Christian Bentz

Overview

Section 1: Introduction

Fundamental Problem

> *"Language leaves no direct imprint in the fossil record."*

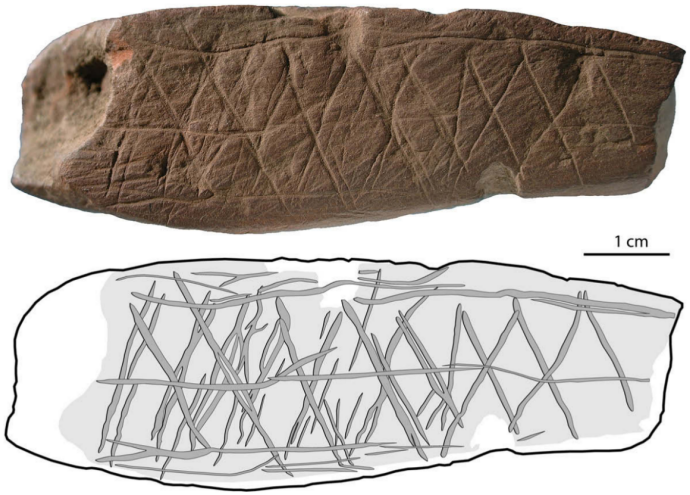
Bolhuis et al. (2014)

Fundamental Problem

"Language leaves no direct imprint in the fossil record."

Bolhuis et al. (2014)

... or does it?



Blombos Cave ca. 70 000 BP
Henshilwood et al. (2002)

Fundamental Problem

> *"Language leaves no direct imprint in the fossil record."*

Bolhuis et al. (2014)

... or does it?

Swabian Jura ca. 35 000 BP
Dutkiewicz et al. (2017)

Fundamental Problem

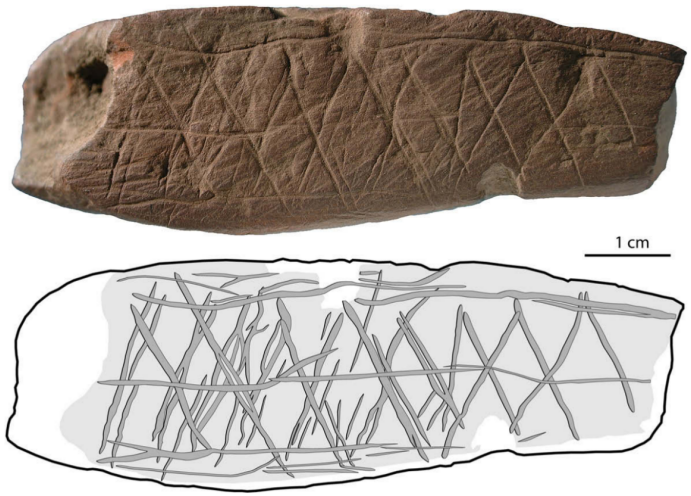
> *"Language leaves no direct imprint in the fossil record."*

Bolhuis et al. (2014)

... or does it?

Cueva de la pasiega ca. 16 000 BP
"La escritura"

How do we get from engravings...



Blombos Cave ca. 70 000 BP
Henshilwood et al. (2002)

... to the earliest forms of writing?

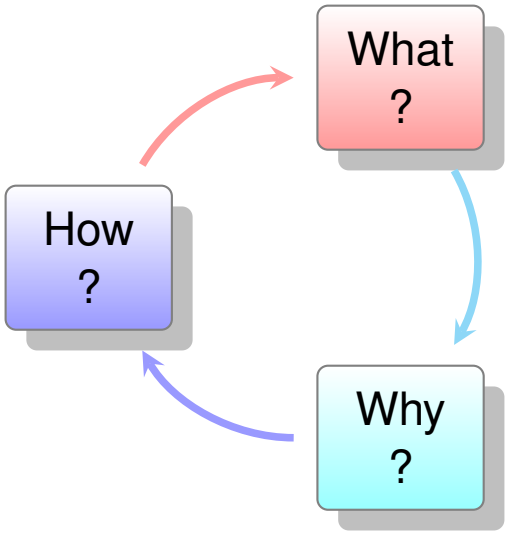
Sumerian Cuneiform ca. 5000 BP

How do we get from animal communication ...

... to modern day human language?

Three Interdependent Questions

1. **What** evolved, i.e. what is “language” in the first place?
2. **Why** did it evolve, i.e. did it have particular functions?
3. **How** did it evolve?



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Section 2: *What* is Syntax?

What is *Language*?

Generative Grammar: Language is Syntax “Internalized Language”

Noam Chomsky

Angela Friederici

Usage-Based Accounts: Language is Usage “Externalized Language”

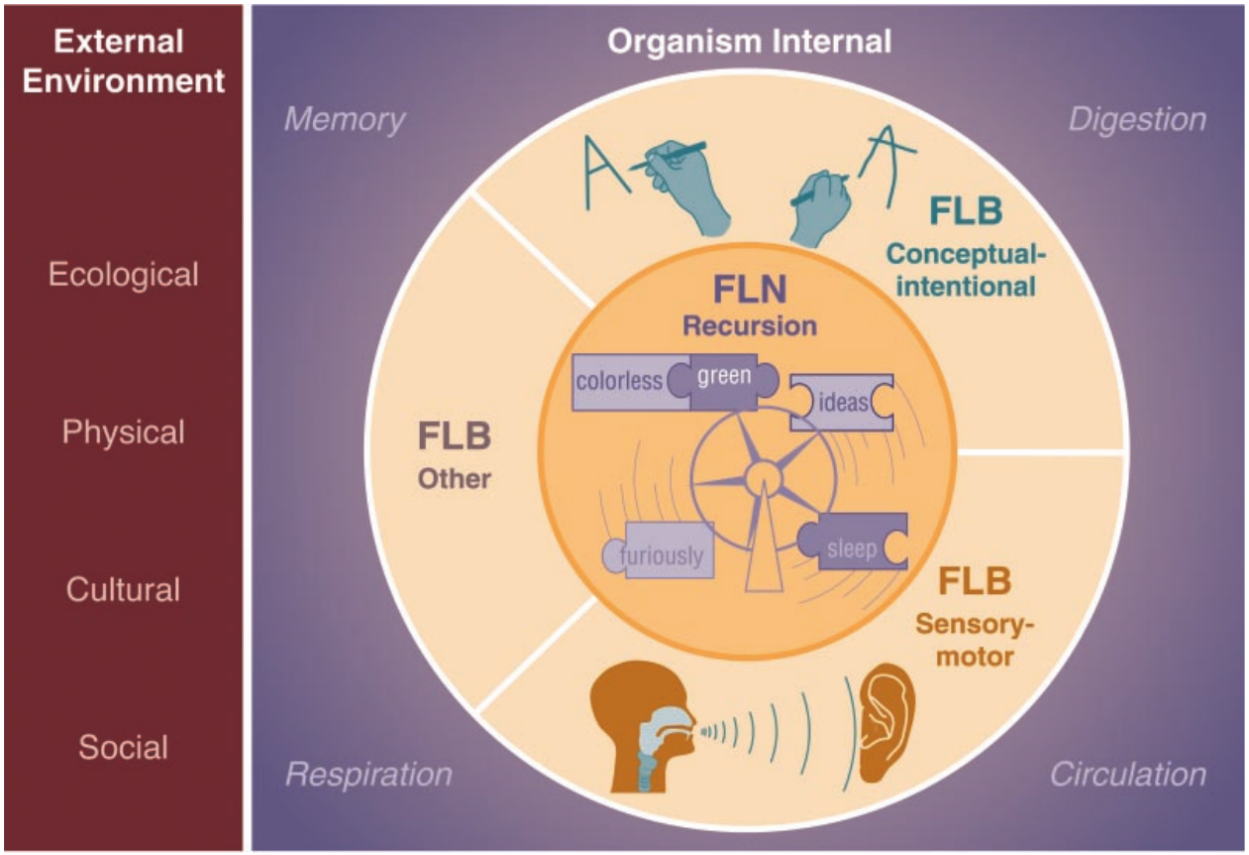
Joan Bybee

Morten Christiansen

What is *Syntax*?

Chomsky (1965). Aspects of the theory of syntax.
Chomsky (1986). Knowledge of language: it’s nature, origin, and use.

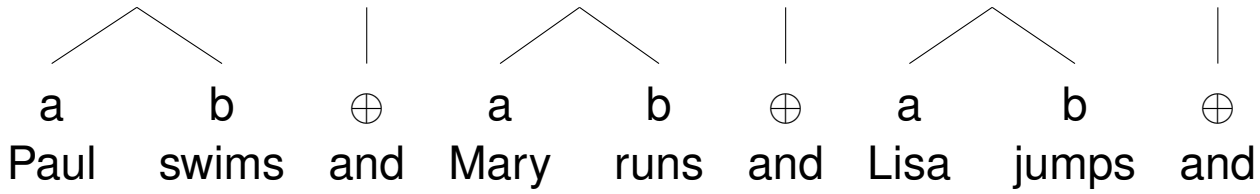
What is *Syntax*? – The Recursion Hypothesis



Hauser, Chomsky & Fitch (2002). The faculty of language: What is it, who has it, and how did it evolve?

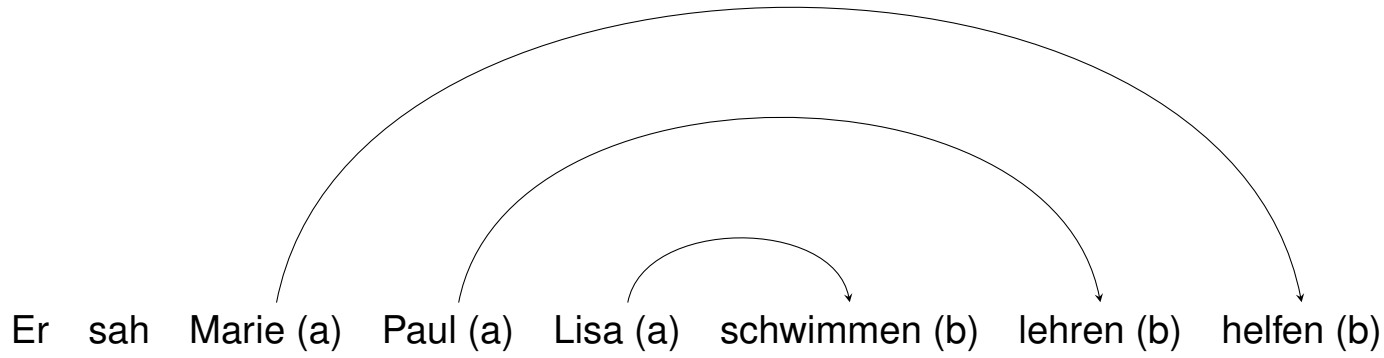
Types of Recursion: Tail Recursion

Tail recursion is a process whereby the same string of symbols (e.g. *ab*) (could be terminals or non-terminals in PSG terminology) is just appended to the end of itself, such that we get a string of the form $(ab)^n$, where n is potentially infinite. This is the "simple" way to **discrete infinity**.

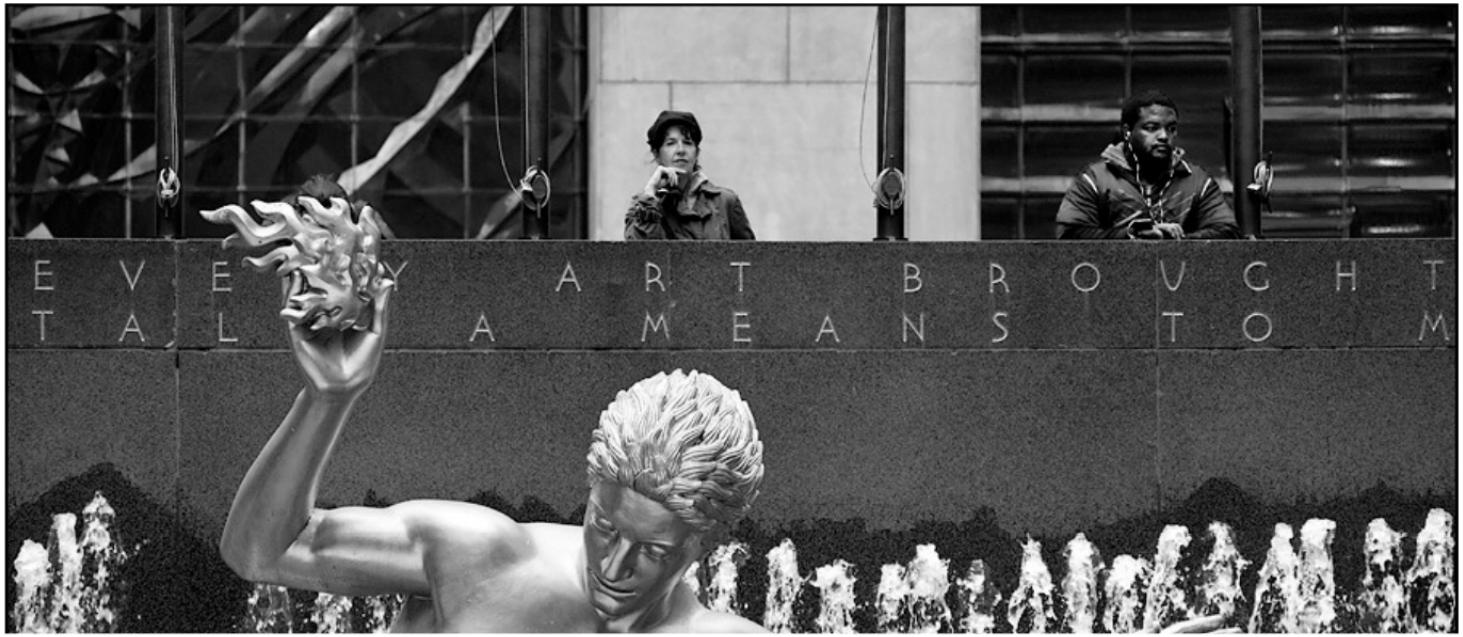


Types of Recursion: “True” Recursion

“True” recursion is a process whereby a potentially infinite number *n* of instances of a symbol is followed by the same number of another symbol, such that we have $a^n b^n$. This is the “hard” way to **discrete infinity**.



What is *Syntax*? – The Merge Hypothesis

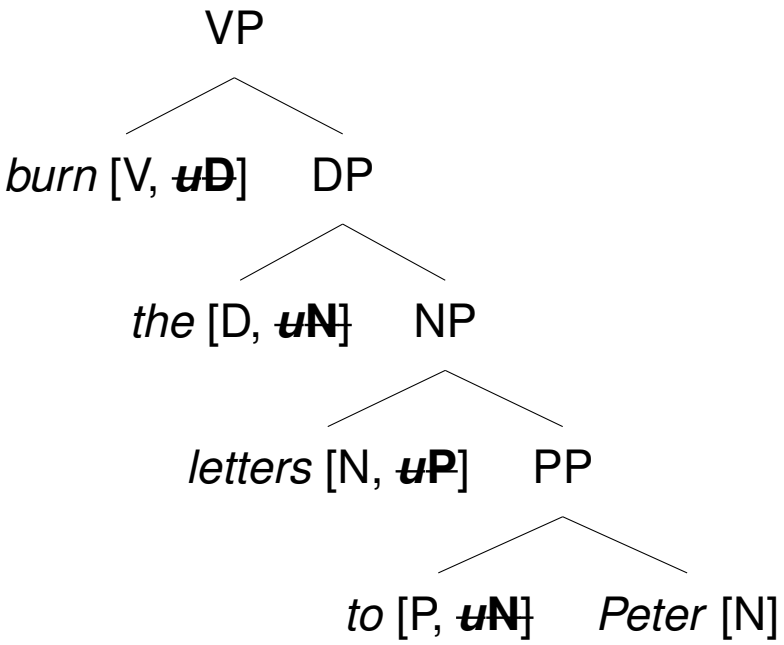


simplest speculation about the evolution of language. Within some small group from which we are all descended, a rewiring of the brain took place in some individual, call him *Prometheus*, yielding the operation of unbounded Merge, applying to concepts with intricate (and little understood) properties.

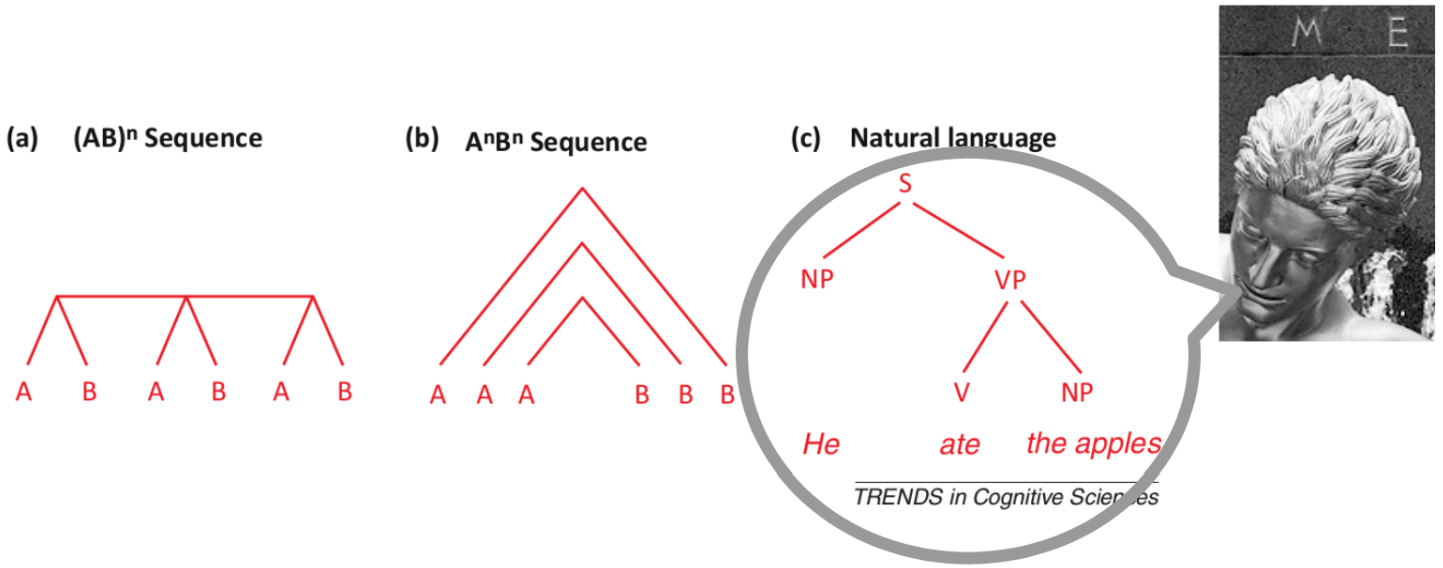
Chomsky (2005). Some simple evo devo theses: how true might they be for language?

Merge

Note that in the examples above we have implicitely assumed that the tree is binary. This naturally derives from the fact that there is always only **one uninterpretable categorial feature in each node** which has to be feature checked and deleted. The operation which combines exactly two elements to a complex phrase is called **merge**.



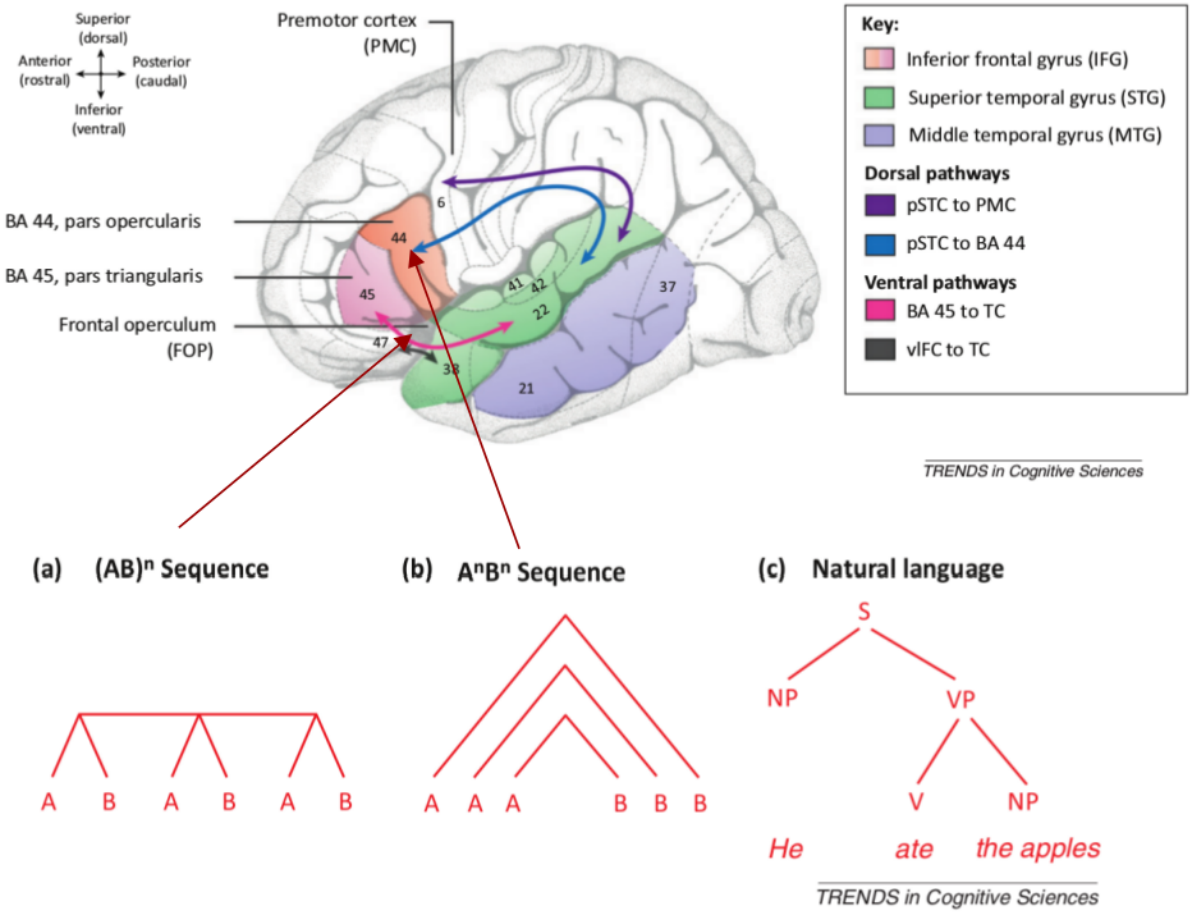
What is *Syntax*? – The Merge Hypothesis



[...] the unified nature of human language arises from a shared, species-specific computational ability. This ability has identifiable correlates in the brain and has remained fixed since the origin of language approximately 100 thousand years ago.

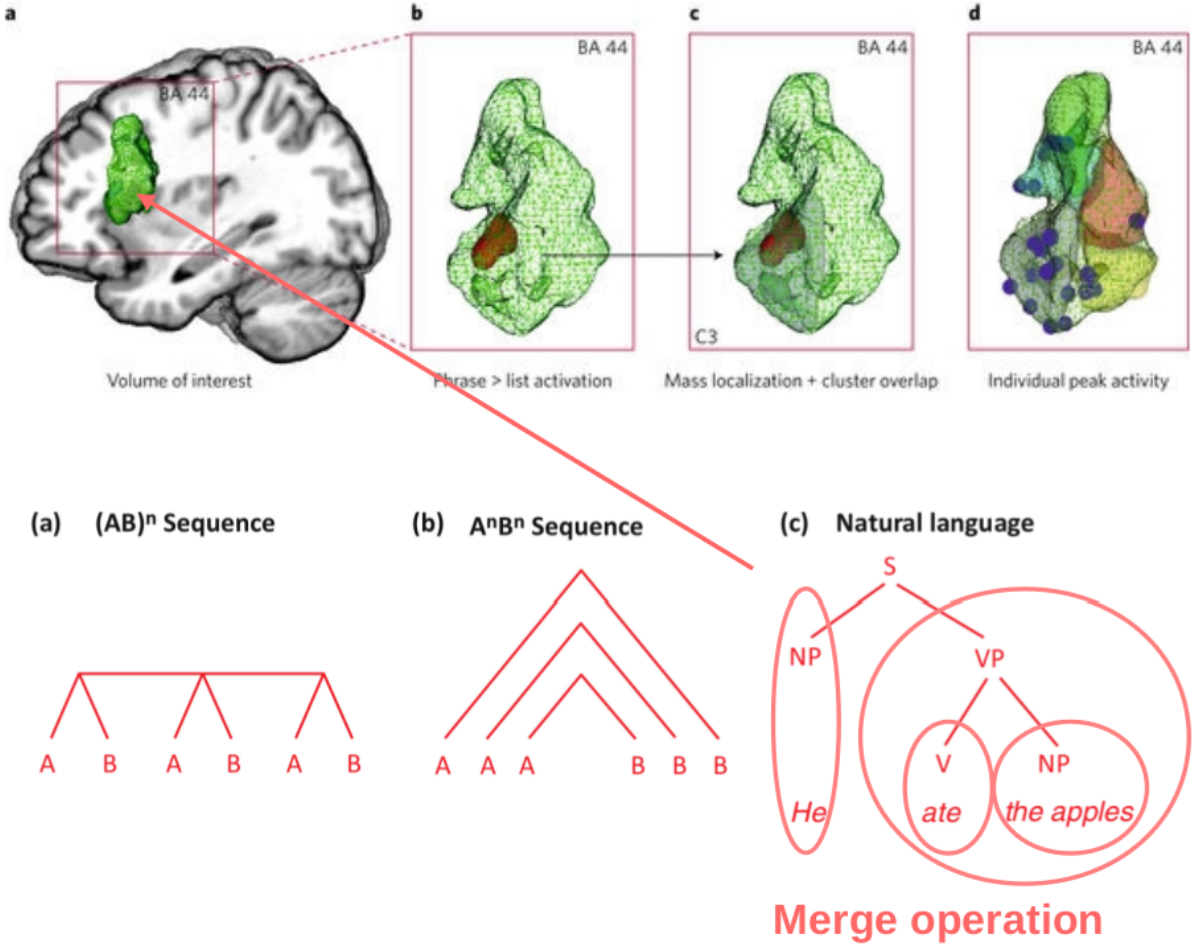
Berwick et al. (2013). Evolution, brain, and the nature of language.

Neural Correlates of Merge?



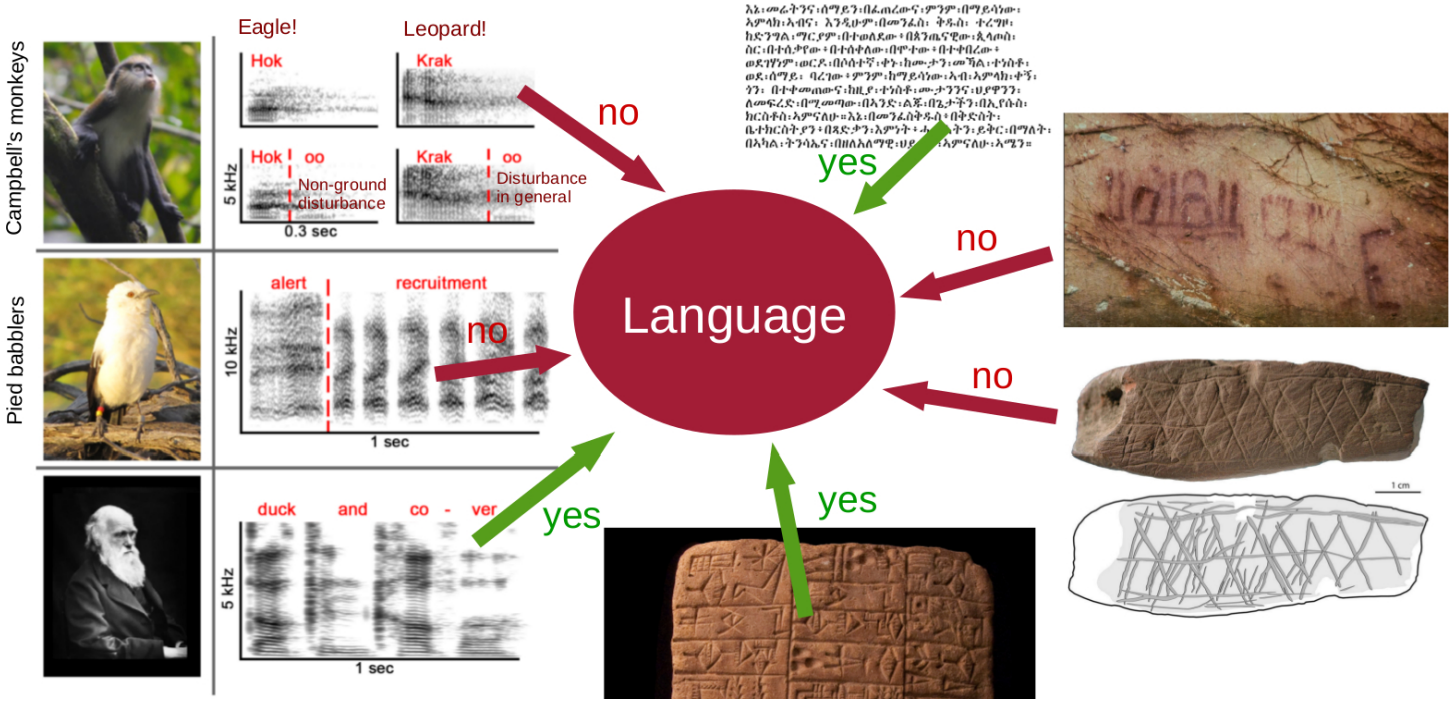
Berwick et al. (2013). Evolution, brain, and the nature of language.

Neural Correlates of Merge?

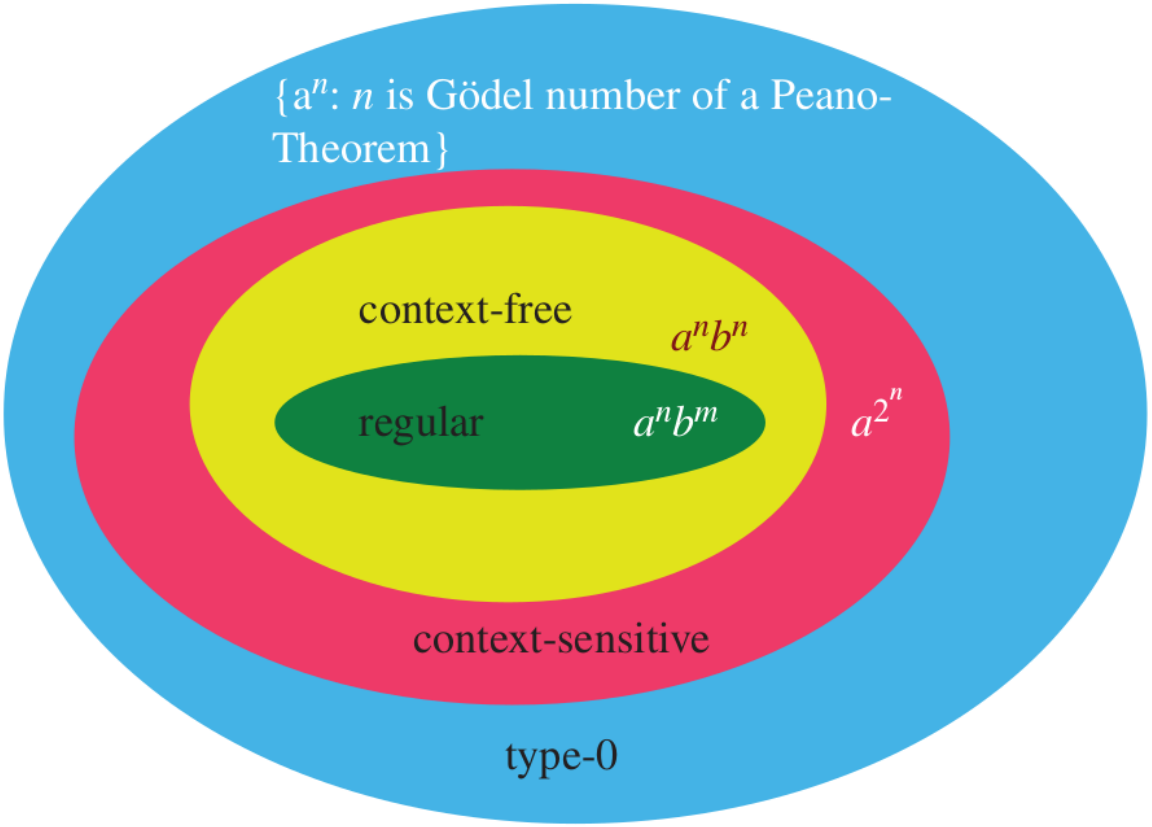


Friederici et al. (2017). Language, mind, and brain.

Is there an empirical way of deciding what is human language and what not?



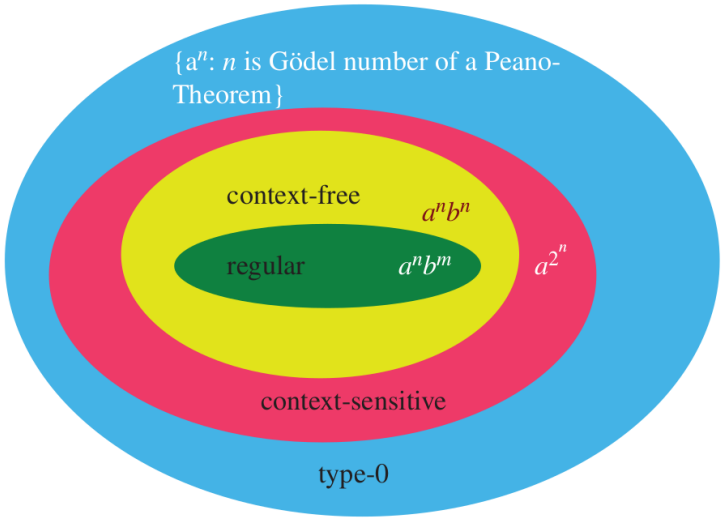
The Chomsky Hierarchy



Chomsky (1956). Three models for the description of language.
Jäger & Rogers (2012). Formal language theory: refining the Chomsky hierarchy.

Regular languages

are generated by a **finite state automaton**, aka Markov process.



Example of a regular grammar to generate strings of the type $a^n b^m$:

Rules:

1. A → aA
2. A → aB
3. B → bB
4. B → b

Generating a string:

apply rule 1: aA
apply rule 1: aaA
apply rule 2: aaaB
apply rule 3: aaabB
apply rule 4: aaabb

Note: Upper case letters (e.g. A) are *non-terminal* symbols, lower case letters are *(pre)terminal* symbols.

Chomsky (1956). Three models for the description of language.
Jäger & Rogers (2012). Formal language theory: refining the Chomsky hierarchy.

Context-free languages are generated by a **push down stack**.

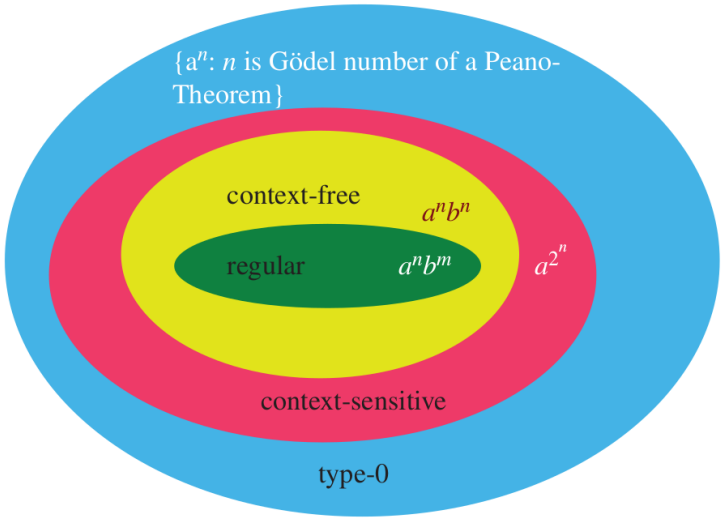
Example of a context-free grammar to generate strings of the type $a^n b^n$:

Rules:

1. S $\rightarrow$ aSb
2. S $\rightarrow \epsilon$

Generating a string:

apply rule 1: aSb
apply rule 1: aaSbb
apply rule 2: aabb

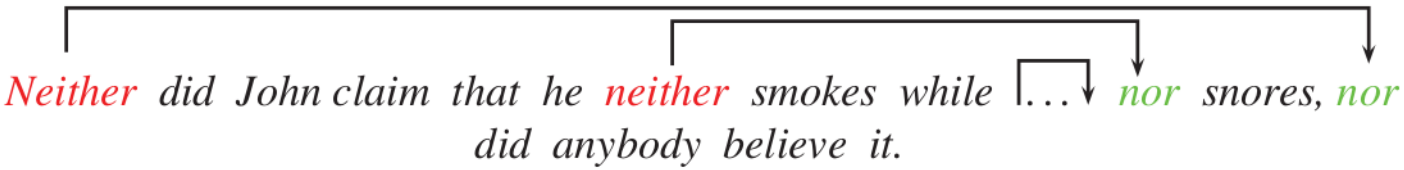


Chomsky (1956). Three models for the description of language.
Jäger & Rogers (2012). Formal language theory: refining the Chomsky hierarchy.

The Non-Regularity of Natural Languages

"English is not a finite-state language, and we are forced to reject the theory of language under discussion [i.e. language as a Markov process] [...]"

Chomsky (1956). Three models for the description of language.

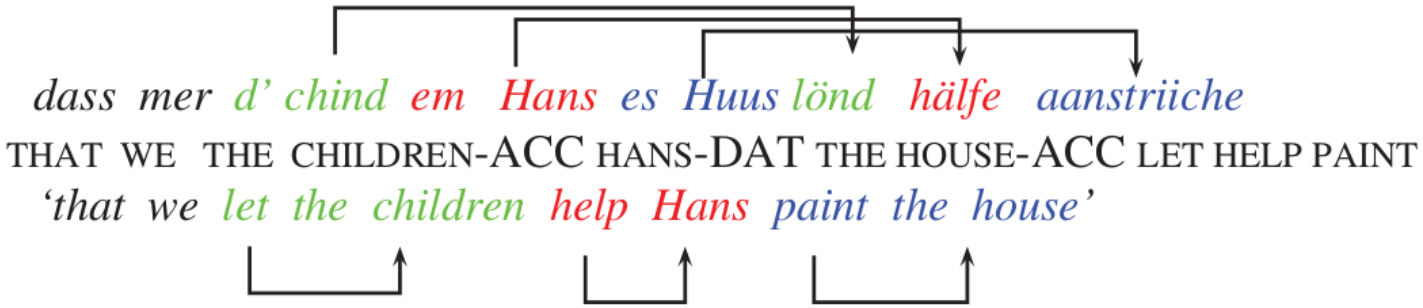


Note: The structure here is aabb, more generally this could be extended to $a^n b^n$.

Jäger & Rogers (2012). Formal language theory: refining the Chomsky hierarchy.

The Context-Sensitivity of Natural Languages

It was later shown that natural languages might also display structures that cannot be generated by context-free grammars. Hence, it is assumed that languages are **mildly context-sensitive**.

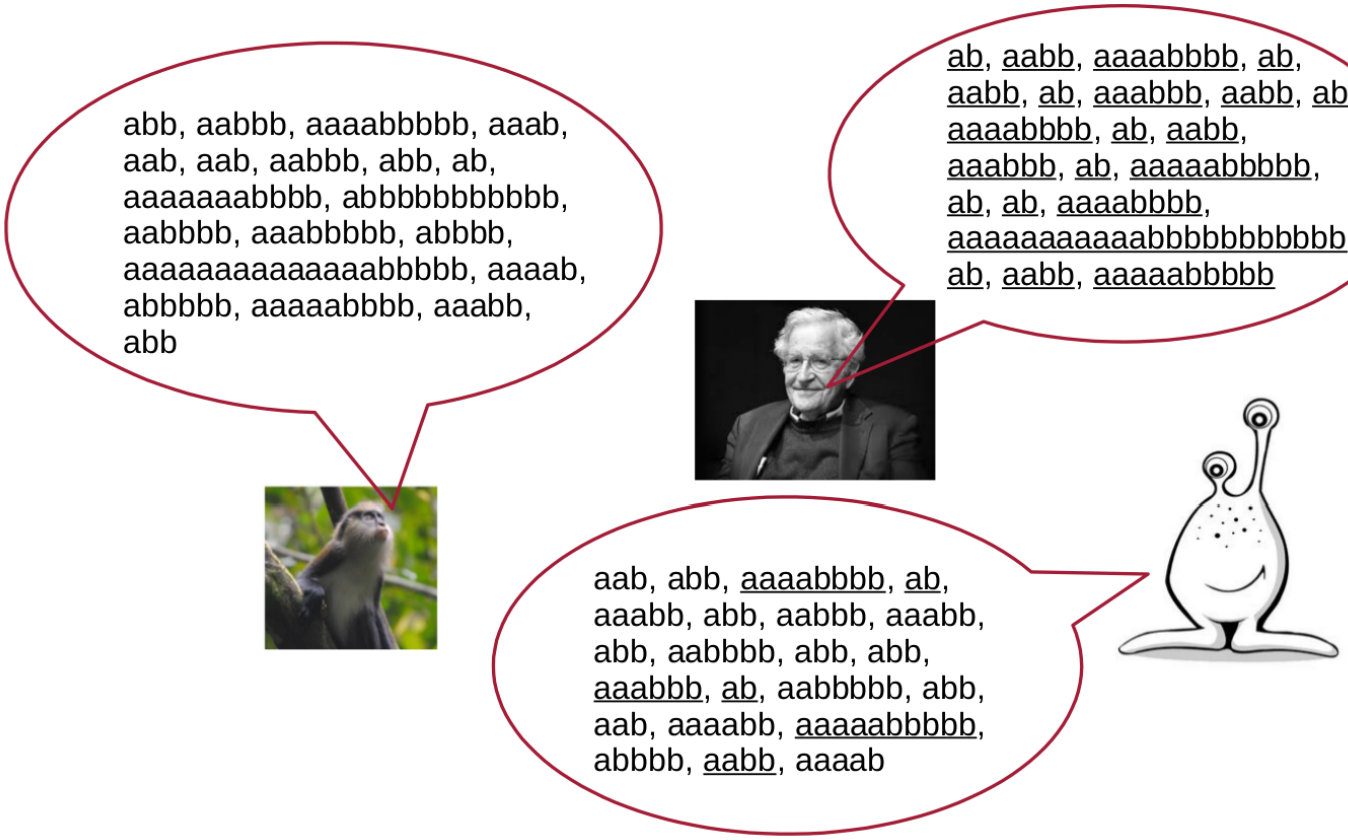


Note: The structure in the Swiss German example is abcabc, while for the English translation it is aabbcc.

Jäger & Rogers (2012). Formal language theory: refining the Chomsky hierarchy.

Decision Algorithm

Is there a way of identifying human language purely based on empirical data?



Decision Algorithm: Some Problems

- A finite-state automaton (regular grammar) **can generate** $a^n b^n$ sequences (either coincidentally or by implementing a simple counter).
- The argument that language is not a finite-state automaton is based on the assumption of **potentially infinite dependencies** (n). However, empirical data are always finite.
- In natural languages, there can be **intervening symbols** as in the example above (*neither* ... *neither* ... *nor* ... *nor*).
- In natural languages, the structural property of $a^n b^n$ does not necessarily refer to **"surface" properties** of the string (e.g. sequences of characters or phonemes), but higher order structures such as NP (noun phrase) or VP (verb phrase).

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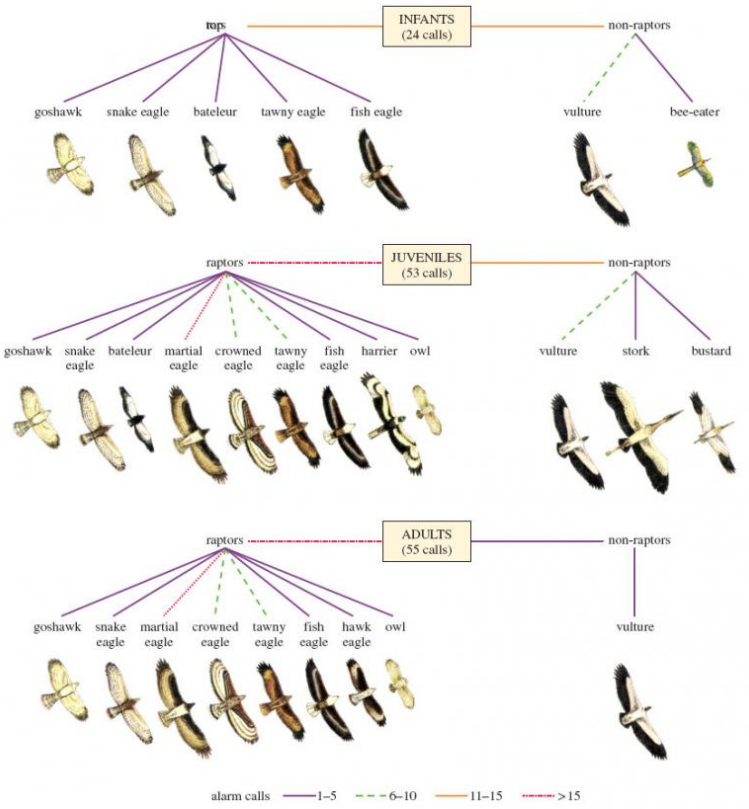
Section 3: *Why* did Syntax evolve?

Vocal Communication

It is often assumed that human (spoken) language is an extension to **vocal communication** found in other animals.

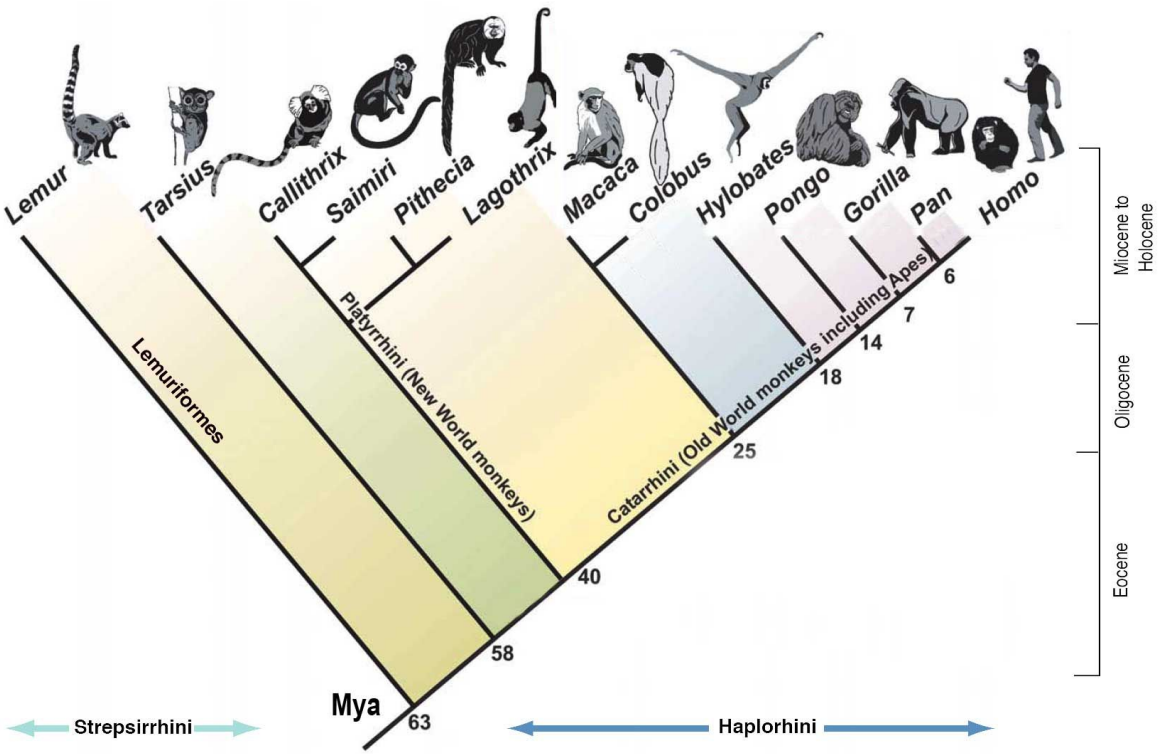
Seyfarth et al. (1980). Vervet monkey alarm calls: semantic communication in a free-ranging primate.

Seyfarth et al. (1980). Monkey responses to three different alarm calls: evidence of predator classification and semantic communication.



Vocal Communication

Problem: While more distant relatives (e.g. New World monkeys) indeed use sometimes complex vocal communication, our closest relatives (i.e. Apes) don't.



Gestural Communication

Due to this inability of our closest relatives to use complex vocal communication, it is also investigated whether gestural communication in apes reflects a predecessor of human language.

Koko, a female gorilla, learned approximately 1000 words in American Sign Language (ASL).

Kanzi, a male Chimpanzee, learned approximately 500 symbols, and was able to combine these to sentences using a keyboard.

Thought

"[...] language is not properly regarded as a system of communication. It is a **system of expressing thought**, something quite different. It can of course be used for communication, as can anything people do – manner of walking or style of clothes or hair, for example. But in any useful sense of the term, communication is not the function of language, and may even be of no unique significance for understanding the functions and nature of language. (Chomsky, 2000b, p. 75)"

Chomsky cited in Pinker & Jackendoff (2005), p. 223.

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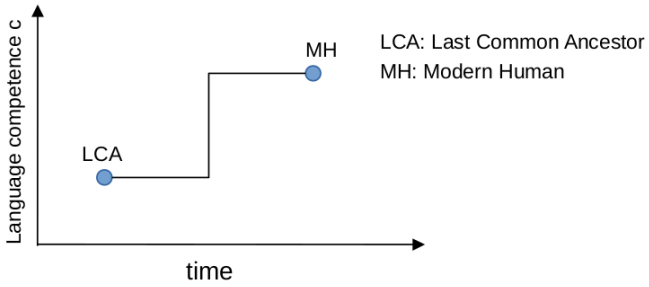
Section 4: *How* did Syntax evolve?

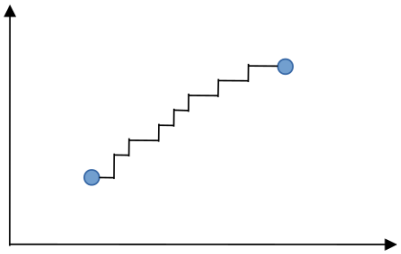
Evolutionary Models

There are several different models for the evolution of Language/Syntax depending on whether **adaptation** is supposed to play a role, and whether **discrete** or **continuous** changes are assumed:

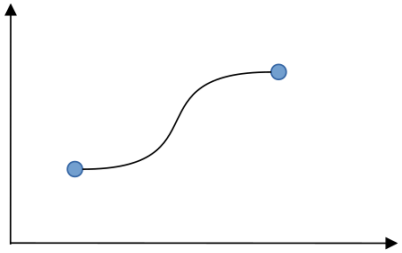
Sudden big jump (saltation)



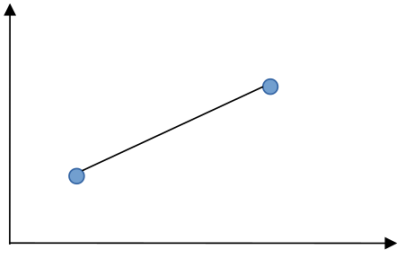
Small jumps (gradual, stepwise)



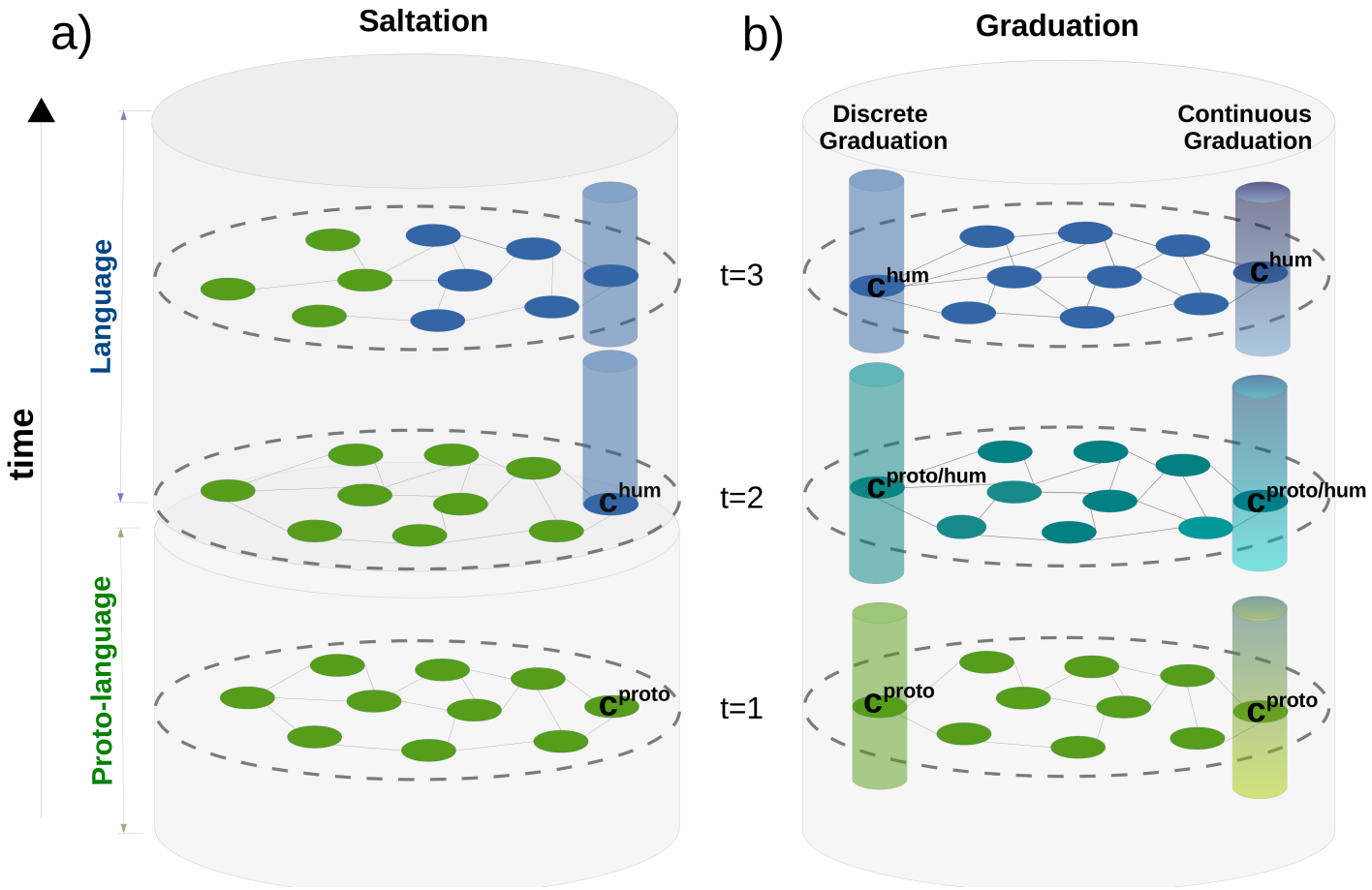
Continuous change with sudden spurts (variable rate)



Continuous change (constant rate)



Evolutionary Models



Evolutionary Models

Decisive Question: Is language learning more like *growing a wing* or more *like learning to play chess*?

Saltational Account

Gradual Account

Co-evolution Account

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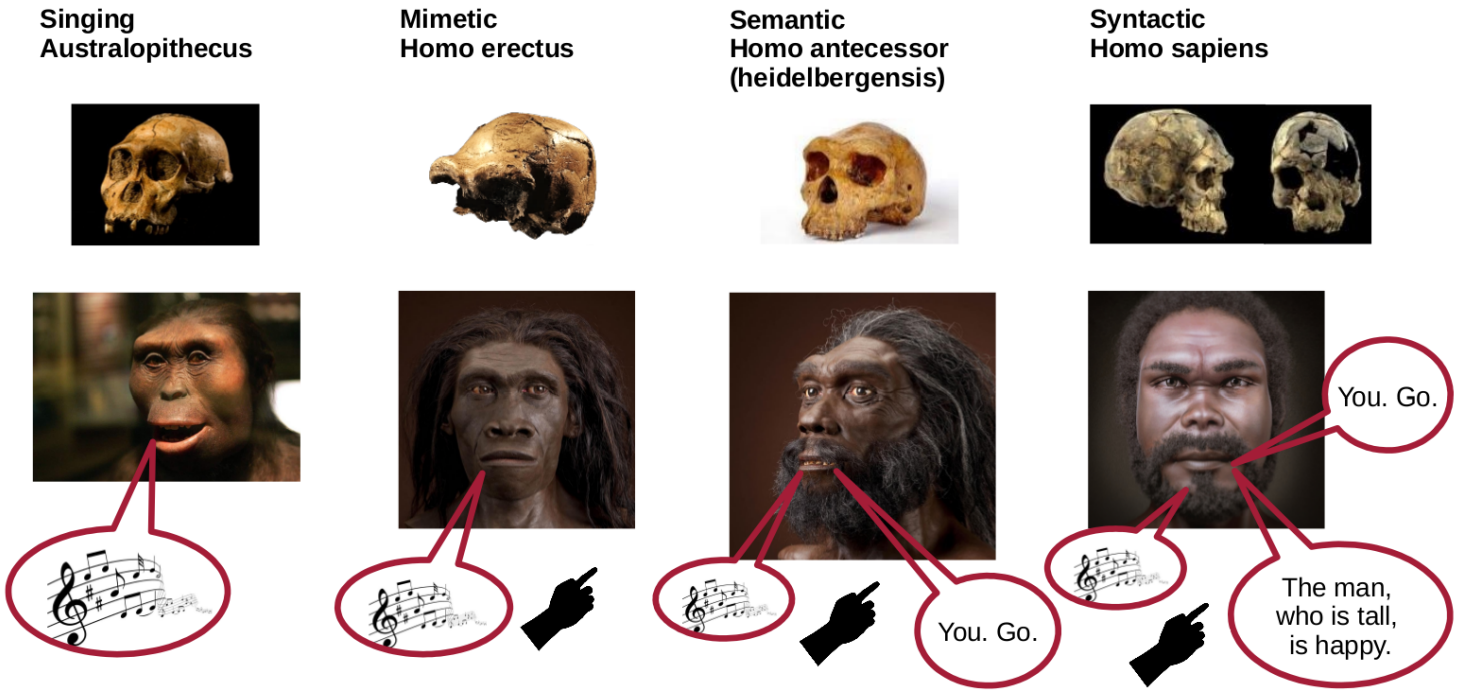
Section 5: When did Syntax evolve?

Who was Prometheus?



Fitch (2017). Empirical approaches to the study of language evolution.

Section 6: References

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Thank You.

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