



Faculty of Philosophy General Linguistics

Suptor & Somentice WiSe 2022/2022

Syntax & Semantics WiSe 2022/2023 Lecture 16: The Evolution of Syntax

20/12/2022, Christian Bentz



Note

The mock exam will be discussed in **Tutorial Week 9** (not Week 10). Week 10 and Week 11 will then be based on exercise sheets for semantic topics.

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Exam Registration

Make sure to sign up on ALMA for both the exam and the tutorial (if you need credits for it) by the **23rd of January**.

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Overview

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The Chomsky Hierarchy The Recursion Hypothesis The Merge Hypothesis The Minimalist Layers Hypothesis

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Vocal Communication Gestural Communication Thought

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Section 1: Introduction



Hominin Evolution





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

Bolhuis et al. (2014)

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

Bolhuis et al. (2014)



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

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... or does it?





"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)

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

Bolhuis et al. (2014)







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

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The Evolution of Visual Information Encoding





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

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How do we get from animal ... to modern day human communication ... language?





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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"



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Usage-Based Accounts: Language is Usage "Externalized Language"



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What is *Syntax*?



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

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The Chomsky Hierarchy



The Chomsky Hierarchy



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

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evolve?



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 aⁿbⁿ.

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

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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**.



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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. Shieber (1984). Evidence against the context-freeness of natural language.



Decision Algorithm

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



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Decision Algorithm: Some Problems

- A finite-state automaton (regular grammar) can generate aⁿbⁿ 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 aⁿbⁿ 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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The Recursion Hypothesis



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?

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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**.



Note: The *abⁿ* pattern here actually refers rather to higher level categories like parts of speech, than the actual surface string. See also issue raised above with regards to the Chomsky Hierarchy.

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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**.



Note: The *aⁿbⁿ* pattern here actually refers rather to higher level categories like parts of speech, than the actual surface string. See also issue raised above with regards to the Chomsky Hierarchy.

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The Merge Hypothesis



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?

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Merge

In minimalsim, 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**.



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What is Syntax? – The Merge Hypothesis



[...] the unified nature of human language arises from a shared, speciesspecific 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.

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Neural Correlates of Merge?

"The processing of $A^n B^n$ sequences activates Broca's area (BA 44), whereas $(AB)^n$ sequences activate the frontal operculum, a phylogenetically older cortical area than Broca's area. Note that A^{*n*}B^{*n*} sequences could, in principle, be processed without necessarily building hierarchically structured representations at all, by using a counting mechanism along with working memory that checks whether the same number of Bs follow the As. Such a process could in principle be at work in animals and humans."

Berwick et al. (2013), p. 93.





Neural Correlates of Merge?

"It has been reasoned that if the neural substrate of Merge is the same independent of the number of recursive applications, the single application of Merge should also recruit BA44 as part of Broca's area. [...] A recent study [...] investigated the computation Merge of a determiner phrase using a semantic-free determiner (the) and a semantic-free noun (bish) in an fMRI experiment and found activation in the most ventral portion of BA 44 (Zaccarella & Friederici 2015b)."

Friederici et al. (2017). Neurobiology of syntax as the core of human language.







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The Minimalist Layers Hypothesis





"The intent [of this monograph] is to show that syntax can be decomposed into **evolutionary primitives/layers** [...] My proposal is therefore that the capacity for **syntax evolved incrementally**, in stages, subject to selection pressures."

Progovac (2015). Evolutionary syntax, p. 1.

LJILJANA PROGOVAC

Evolutionary Syntax



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Minimalist Layers

In Minimalism there is a **hierarchy** of layers:

 $CP \succ TP \succ vP \succ VP/SC$ (1)

It is hypothesized that the capacity for syntax incrementally involved from the VP/SC (small clause) stage to the CP stage.

Progovac (2015). Evolutionary syntax, p. 9.





Internal Reconstruction

"Structure X is considered to be **primary** [in an evolutionary sense] relative to Structure Y if X can be composed independently of Y, but Y can only be built upon the foundation of X."

Progovac (2015). Evolutionary syntax, p. 9.

[VP/SC kiss Benjamin] \rightarrow [vP Peter [VP/SC kiss Benjamin]] \rightarrow [TP Peter will [vP Peter [VP/SC kiss Benjamin]]] \rightarrow [CP that [TP Peter will [vP Peter [VP/SC kiss Benjamin]]]]

Notes: The strike through notation is here used for indicating the trace of move. In the case of auxiliaries (will), it is here assumed that the subject has to move into the TP.

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Evolutionary Stages

In a nutshell, Progovac proposes **four evolutionary stages** of which one is *non-syntactic*, two are *proto-syntactic*, and one is *fully syntactic*.

- 0. **One-word stage** (no combinatorial power/no syntax)
- 1. Paratactic stage (proto-syntax)
- 2. Proto-coordination (proto-syntax)
- 3. **Specific functional category stage** (hierarchical/full syntax)

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The One-Word Stage

"[...] This stage is characterized by single words intended as complete utterances."

Progovac (2015). Evolutionary syntax, p. 33.

- (1)Run!
- Snake! (2)
- Out! (3)

Notes: Just as in the case of animal alarm calls, these might have different meanings, and provoke different reactions by the hearers. Run! might be more appropriate when there is a danger that you can actually outrun, while Snake! might rather provoke taking a higher position.

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The Paratactic Stage (Proto-Syntax)

"[...] the proposal is that first "sentences" were **paratactic** (not hierarchical, not headed) combinations of a **verb with just one argument** [...] The claim is that such structures are still found across various constructions in present day languages, "**living fossils**" of this stage of grammar."

Progovac (2015). Evolutionary syntax, p. 33.

- (4) Him retire?!
- (5) Me first!
- (6) Problem solved.
- (7) kill-joy, pick-pocket, rattle-snake, etc.

Notes: According to Progovac, while in the first three examples, there are more complicated morphosyntactic phenomena involved (i.e. case, participles and headedness), the **exocentric compound** examples are probably the closest to a very early evolutionary stage where not even a head can be determined.

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The Proto-Coordination Stage (Proto-Syntax)

"This is the stage in which, in addition to prosody, a **conjunction/linker provides all-purpose segmental glue to hold the utterance together**. [...] This stage is still arguably syntactically flat/non-hierarchical [...] The proposal is that the meaningless linkers/proto-conjunctions, best approximated by the conjunction of the type *and* in present-day languages, were among the first functional categories [...] "

Progovac (2015). Evolutionary syntax, p. 13.

- (8) Duck and cover!
- (9) Ich (**und**) Angst haben! (German)
 - I (**and**) fear have 'Me afraid?!'
- (10) 'napiši mat-im eql-um-ma (Akkadian) soul.of land-GEN field-NOM-CONJ
 'The soul of the land is the field'

Notes: This is called the **proto-merge stage**, as there is now explicit marking by the linker that two elements are merged.

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Specific Functional Category Stage

"In this **hierarchical stage**, in addition to prosody and to segmental glue, **specific functional categories** become available, providing specialized syntactic glue for constituent cohesion, including tense particles and subordinators/complementizers."

Progovac (2015). Evolutionary syntax, p. 13.

- (11) Peter will kiss Benjamin. (TP)
- (12) I believe that Peter will kiss Benjamin. (CP)

Notes: Progovac does not further distinguish evolutionary stages between the TP and CP, these are rather collapsed here. Once merge is possible given feature checking, both tense markers and complementizers are possible. Section 1: Introduction

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Evolutionary Progression and Selection

Progovac argues that for each transition from one stage to another there might have been **selection pressure** in terms of more efficient/explicit communication.

Progovac (2015). Evolutionary syntax, p. 17.

- (13) Apple. Eat. Ka. Go. (One-word stage)
- (14) Apple eat. Ka go. (Paratactic two-word stage)
- (15) Apple eat and Ka go. (Proto-coordination stage)
- (16) Ka ate the apple and went. (Specific functional category stage).

Notes: It could be argued that ambiguity in the utterances is reduced from stage to stage. Interestingly, Progovac (2019, p. 17) argues that the ability to fantasize about absurd and unrealistic situations (e.g. *The apple ate Ka and went*) hinges upon the existence of higher level syntax, i.e. consituent order, tense, case. Without these, the pragmatic interpretation (Ka is the eater) would always win out in interpretation.

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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.



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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.



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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. Section 1: Introduction

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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:



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Evolutionary Models







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



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Section 5: When did Syntax evolve?



Who was Prometheus?



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





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Why do we talk?

Language evolution, language learning, language processing, artificial language learning, animal communication.



https://www.dailymotion.com/video/x40jndd

Section 1: Introduction



Is the man who is tall happy?

Interviews with Noam Chomsky about language.



https://www.youtube.com/watch?v=cv66xFD7s7g

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The Grammar of Happiness

About the allegedly non-recursive language of the Pirahã.



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https://www.youtube.com/watch?v=5NyB4flZHeU



Kata Kolok

Short introduction to the Kata Kolok Sign language.



https://www.youtube.com/watch?v=PwXBwV1YJ-s

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Die Sprache der Wale

Trying to understand Orca songs using deep learning (in German).



https://www.3sat.de/wissen/wissenschaftsdoku/die-sprache-der-wale-102.html

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Vom Schreiben und Denken

On how writing was invented (in German).



https://www.youtube.com/watch?v=sQy-Q_psTJ0

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The Linguists

On language documentation and endangerement.



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https://www.youtube.com/watch?v=HInOD7VrCdY (trailer)





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References

Berwick, Friederici, Chomsky, & Bolhuis (2013). Evolution, brain, and the nature of language. *Trends in Cognitive Sciences*, Vol. 17, No. 2.

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Thank You.

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