A Comparative Approach on the Faculty of Syntax:
Towards an Operative Definition of Language
Are nonhuman animals rational?

How did language evolve?

Are humans the only “linguistic” species?
What is language?
Methodology of inquiry

A. Focus on a core constitutive trait of the ability of language:

“Syntax”

meaning from the greek “syntaxein”:

connect different elements according to structural rules.
The faculty of language (broad sense)

B. Apply a comparative approach on the **phylogenetic evolution of language syntax**

- Core cognitive operations shared among animal species
- Species-specific traits of human language
The evolution of the ability to recognize syntactic structures
The faculty of language

Comparative approach on the **phylogenetic evolution of language syntax**

- core cognitive operations shared among animal species
- species-specific traits of human language

- brief review of the current state of art of the literature
- critics
- alternative hypothesis / research question
We hypothesize that FLN [faculty of language narrow sense] only includes recursion and is the only uniquely human component of the faculty of language.
strings are embedded within other strings of the same kind, creating complex **hierarchical structures** and **long-distance dependencies**.

Do animals have the ability to process recursive structures?
Theory of formal language: a comparative approach
Chomsky hierarchy

- illimited
- context-dependent grammar
- context free grammar
- finite state grammar
Perception of phono-syntactical patterns: the chomskyan paradigm

A^nB^n
(and/or recursive structures)

context free grammar

finite state grammar

(AB)^n

n times
Finite State grammars

$AB^n$

This is the rat that ate the malt that lay in the house that Jack built

$a_1$ $b_1$ $a_2$ $b_2$ $\ldots$ $\ldots$

as many As as Bs

$n$ times
Context free grammars

$$A^n B^n$$

"the cheese that the mouse that the cat chased ate is in John’s house"

\[
A^n B^n
\]

a1 the cheese $\rightarrow$ b1 is in John’s house
a2 that the mouse $\rightarrow$ b2 ate
a3 that the cat $\rightarrow$ b3 chased
Do animals have the ability to process context free grammars?

How can we test it?

Using shapes, colors and sounds
Finite State grammars

\[ AB^n \]

\[ a_1 b_1 \quad a_2 b_2 \quad \ldots \quad \ldots \]

Examples in the acoustic domain

ba nu di do mi ka

Context free grammars

\[ A^n B^n \]

\[ a_1 \quad \rightarrow \quad b_1 \]

\[ a_2 \quad \rightarrow \quad b_2 \]

\[ a_3 \quad \rightarrow \quad b_3 \]

la no yo mo bi gu
grammars were matched for acoustic features: A and B stimulus classes were spoken by different speakers, a female and a male.
Recursive syntactic pattern learning by songbirds

Timothy Q. Gentner¹†, Kimberly M. Fenn², Daniel Margoliash¹² & Howard C. Nusbaum²
Fig. 1. Tree structure for (a) center-embedded recursion, and (b) double iteration.

- double iteration
- subitation
- no structural dependence
Figure 1. Strategies to check whether sentences are members of the formal languages $a^n b^n$ and $(ab)^n$ (see text for details).
Songbirds possess the spontaneous ability to discriminate syntactic rules

Kentaro Abe¹,² & Dai Watanabe¹,³
Abe, K., Watanabe, D., 2011
2.2. Material

They were tested with learning devices equipped with a touch screen and a food dispenser. The main innovation of the test equipments is that the baboons participated at will, as they had a 24-h access to the computers from the outdoor enclosure, where they live in a social group (see Fagot & Bonté, 2010, for a detailed description of the testing apparatus). Twelve shapes (e.g. Δ, Φ, ⁰, Γ, Σ, Ω, *, _VERTEX, ζ, &, λ) were used to create six arbitrary pairs of stimuli, hereafter noted a₁b₁, a₂b₂, ..., a₆b₆. A different set of 10 neutral shapes served as visual distractors (ς, ζ, ς, ς, ζ, ζ, ζ, ζ, ζ, ζ).
finite state grammar
context-free grammar
context-dependent grammars
illimited grammars


The faculty of language: comparative studies on nonhuman species:

process structural dependencies
quantify and compare
subitation

$A^nB^n$

$AB^n$
The faculty of language: comparative studies on nonhuman species:

process structural dependencies
quantify and compare
subitation

Ability to process “perceptual syntax”

$AB^n$    $A^nB^n$
Is the ability to process perceptual patterns a pre-requisite for humans’ faculty of language?

\[ AB^n \quad A^nB^n \]
Perceptual syntax

Propositional syntax

patterns ruled by logical, morphological connections

patterns in the perceptual domain
What’s the difference?

- recognizing a language - perceptual syntax

- understanding a propositional syntax

1) elements that have internal logical dependencies

2) linked to external objects (existent or not): meanings
The indexical power is distributed, so to speak, in the relationships between words.

Symbolic reference derives from combinatorial possibilities and impossibilities [...].

Deacon T., The Symbolic Species, 1997
Hypothesis

Humans are the only species able to categorize the units of a pattern going beyond its perceptual characteristics:

- combine different elements within a network of combinatorial logical relationships
- link them to a referential state of affairs.
Humans can associate a combinatorial pattern to a structural combination among external objects or categories of objects.

\[(2+6) : 3 - 5 = \ldots\]
New suggested methodology for a comparative approach

Address the ability of nonhuman animals to

a) process simple perceptual patterns with internal dependencies between the elements

b) refer these basic structures to a pattern of external objects of reference

what makes a species-typical human linguistic expression out of a pattern of perceptual stimuli

zoon logikon
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Questions or comments?

Thank you!