



Modern Human Origins

Adaptive and Non-Adaptive Theories of Language Evolution

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10 January 2018, Lecture 8, Bentz



Readings for Lecture 8

Christiansen MH, and Kirby S. 2003. Language evolution. Oxford: Oxford University Press. pp. 1-15.

Pinker S, and Jackendoff R. 2005. The faculty of language: what's special about it? *Cognition* 95(2):201-236.

Fitch WT. 2010. The evolution of language. Cambridge: Cambridge University Press. pp. 73-143.

Course websites

<https://moodle02.zdv.uni-tuebingen.de/course/view.php?id=1932>

http://www.christianbentz.de/teaching_humanOrigins2017.html



Introduction

Language evolution: the hardest problem in science?

Christiansen & Kirby (2003)



Fundamental problem:

“Language leaves no direct imprint in the fossil record.”

Bolhuis et al. (2014)

Theories of language evolution are often (inevitably?) more speculative than theories of human evolution based on archaeological and palaeoanthropological evidence.

Société de Linguistique de Paris

ART. 2. - La Société n'admet aucune communication concernant, soit **l'origine du langage** soit la création d'une langue universelle.

Société de Linguistique de Paris. Statuts de 1866.



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

or

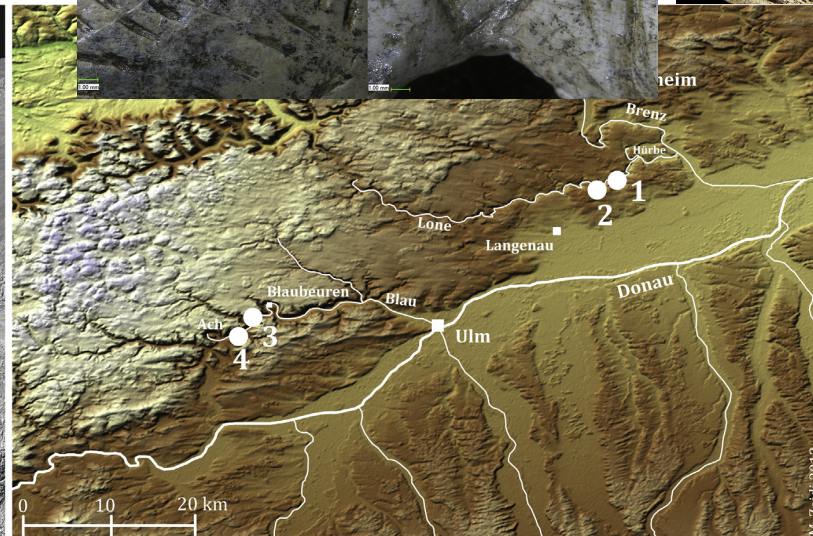
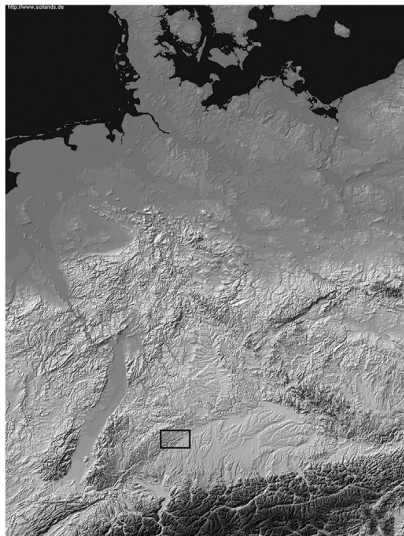
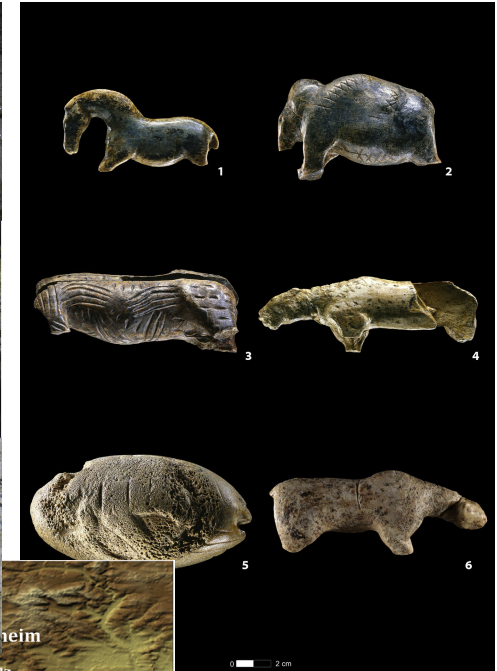
... does it?





There is an abundance of abstract signs in the Upper Palaeolithic (ca. 40 000 to 10 000 years ago) of Europe.

Example:
Finds of art objects in the Swabian Jura

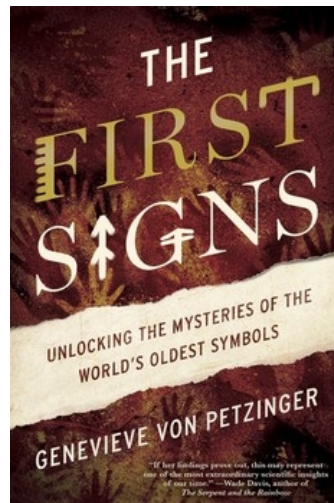


Dutkiewicz,
Wolf & Conard
(2017)



There is an abundance of abstract signs in the Upper Palaeolithic (ca. 40 000 to 10 000 years ago) of Europe.

Example:
Abstracts signs in cave art



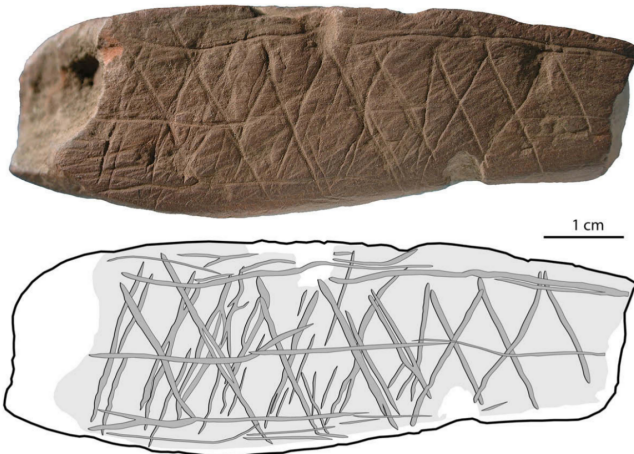
“The Inscription”
Cueva de la Pasiega,
Spain (ca. 18000 BC)





How do we get from...

engravings



Blombos Cave (South Africa) ca. 70 000 BCE



writing



Sumerian Cuneiform (Mesopotamia) ca. 3000 BCE





How do we get from...

Animal communication

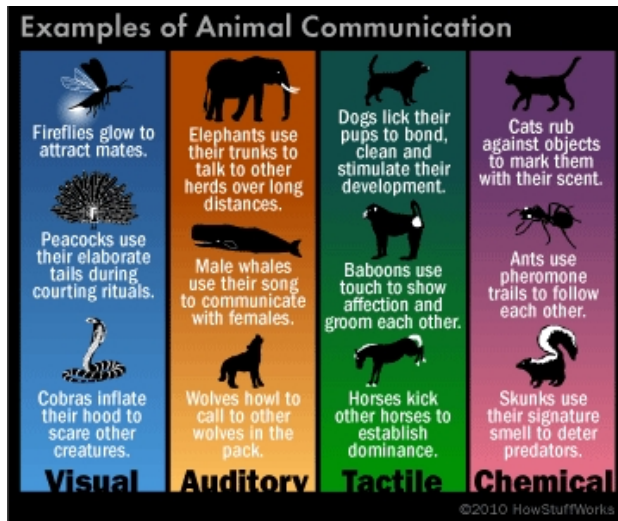


Human language





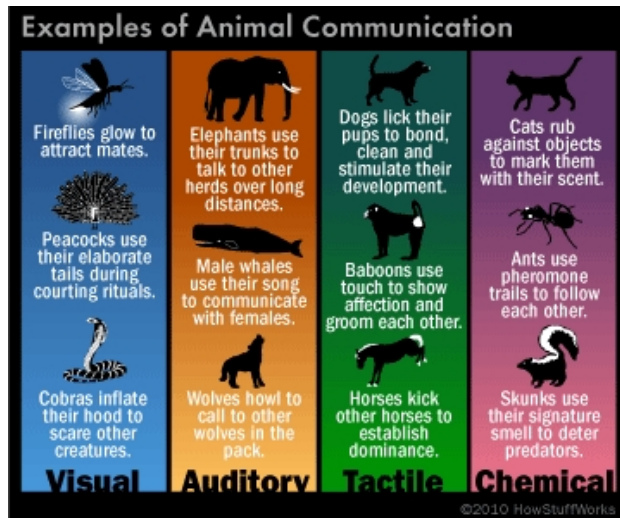
What's the difference, and when did it arise?





Three important questions:

- 1) **What** evolved, i.e. what is “language” in the first place?
- 2) **Why** did it evolve, i.e. did it have particular function(s)?
- 3) **How** did it evolve, e.g. suddenly via mutation, gradual, etc.?





Question 1: What is „language“?





Question 1: What is „language“?



a) The sounds,
graphemes and signs
we see and hear



Question 1: What is „language“?



b) our mental
capacity to process
sounds, graphemes
and signs



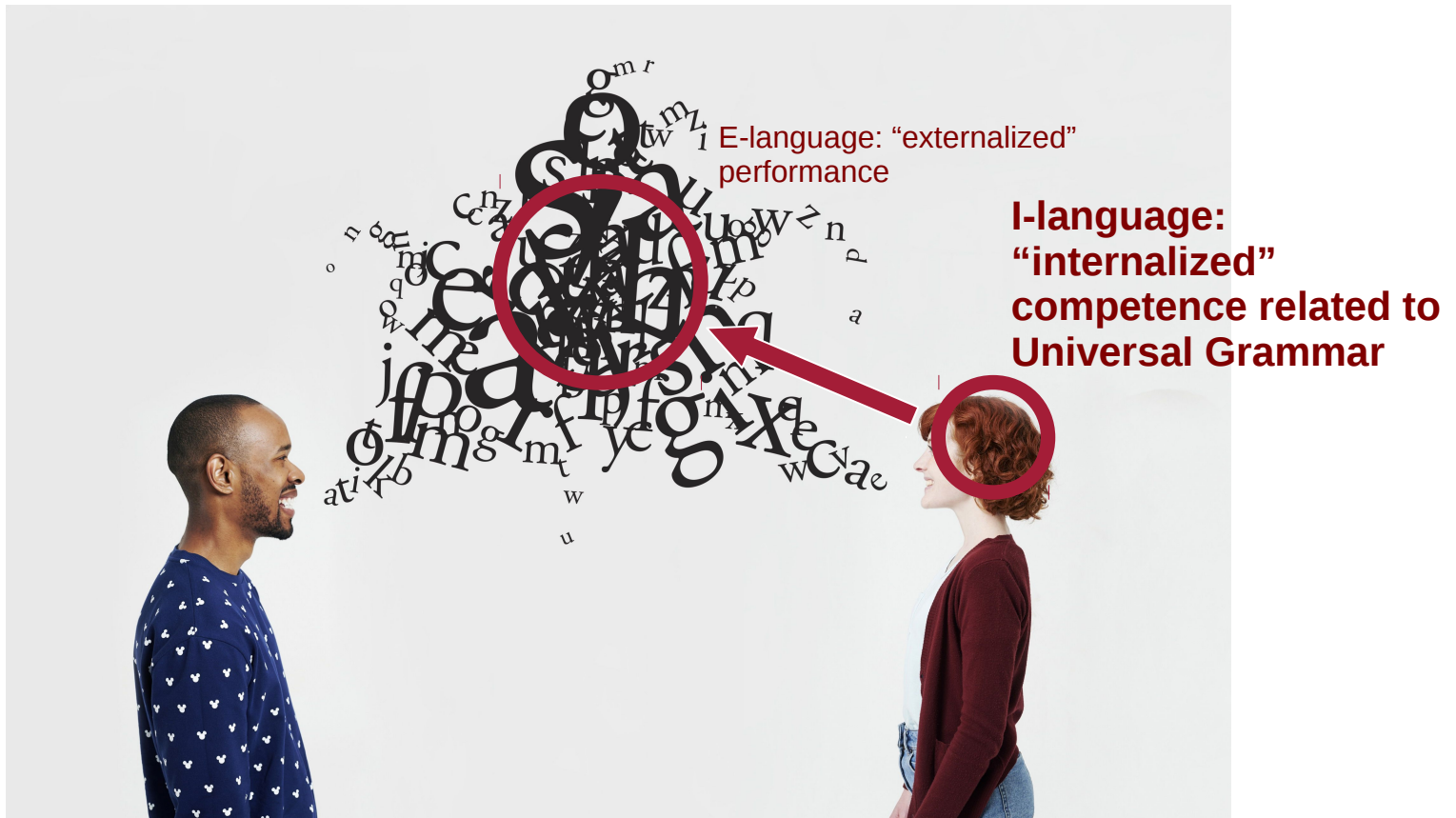
Question 1: What is „language“?



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



Generative answer: I-language



Chomsky (1965). Aspects of the theory of syntax.

Chomsky (1986). Knowledge of language: it's nature, origin and use.



Question 2: Why did it evolve?

- Vocal communication

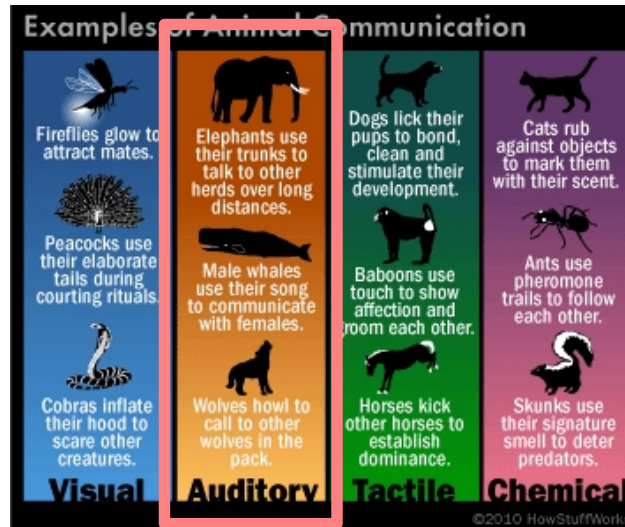
- Gestural communication

- Social bonding (grooming)

- Gossiping

- Thinking

- No function (?)



Christiansen & Kirby (2003)
Chapter 14 by Philip Lieberman
Chapter 2 by Steven Pinker



Question 2: Why did it evolve?

Alarm calls, e.g. in Vervet monkeys

- Vocal communication

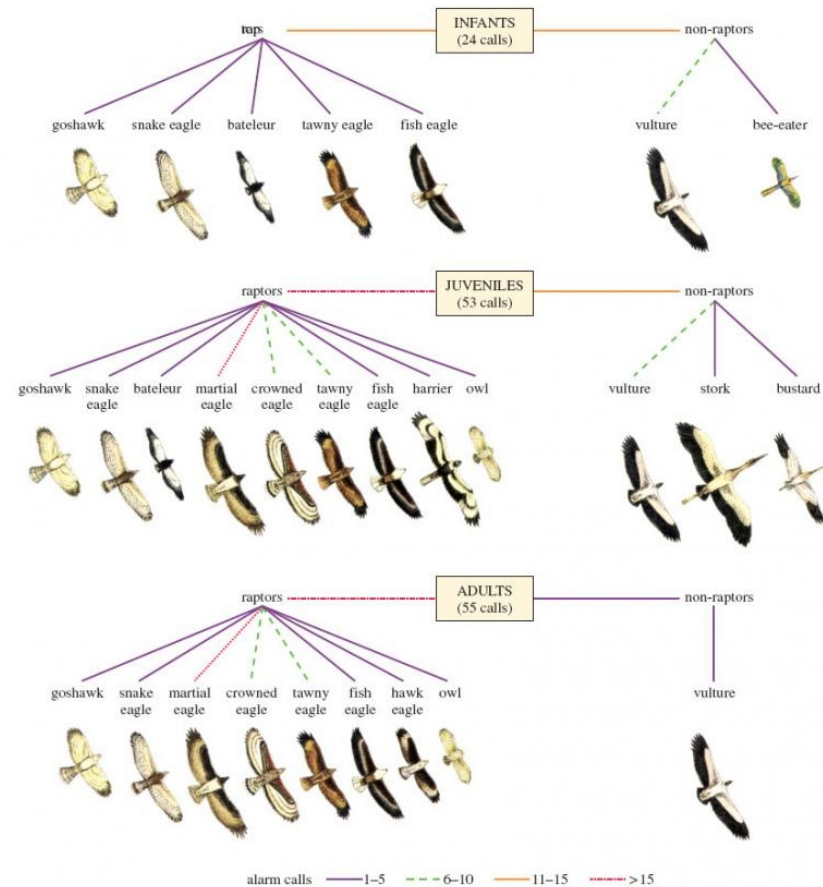
- Gestural communication

- Social bonding (grooming)

- Gossiping

- Thinking

- No function (?)



Gould, J.L. & Gould, C.G. (1999). *The Animal Mind*. Scientific American Library.



<https://www.youtube.com/watch?v=q8ZG8Dpc8mM>

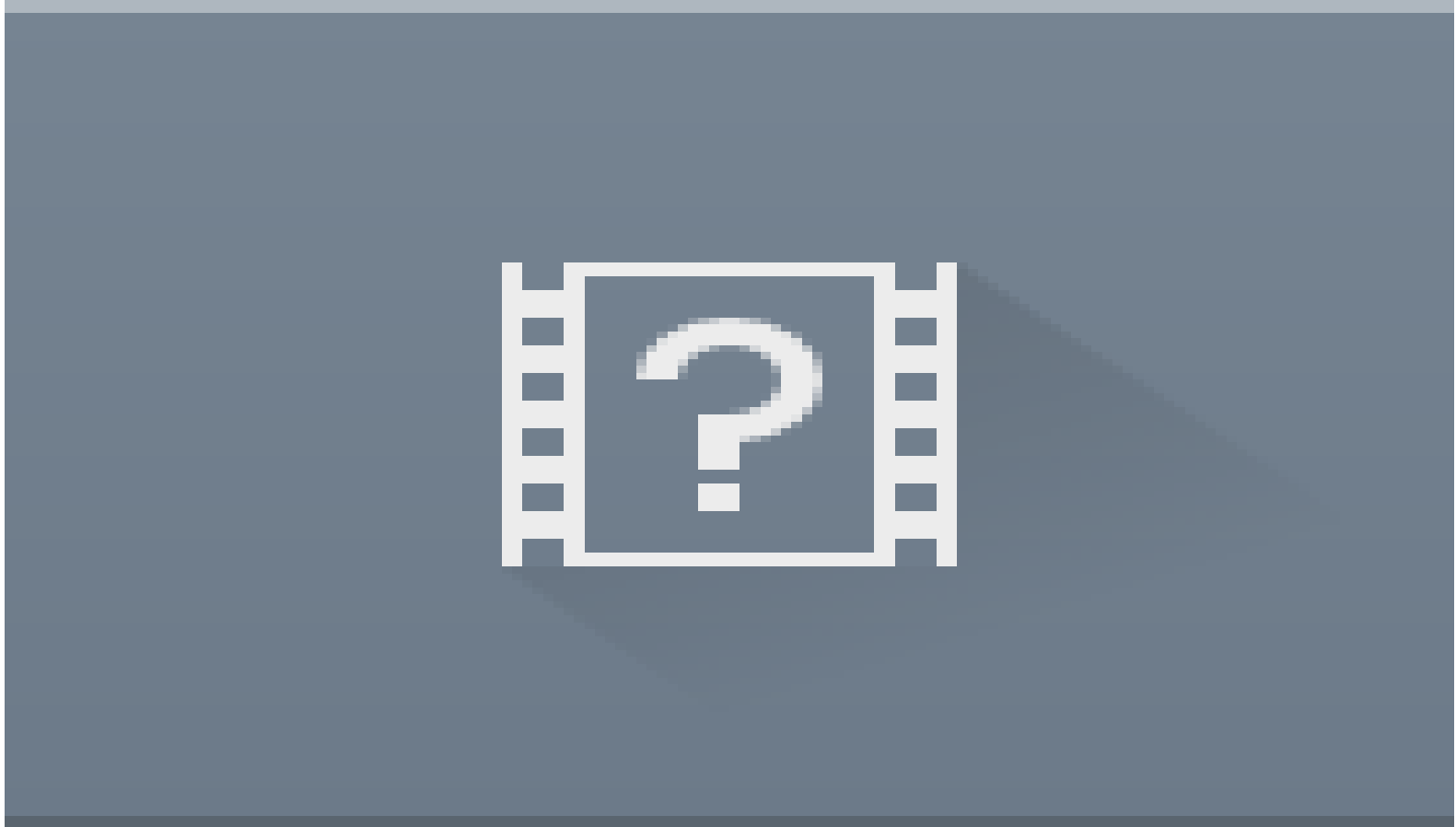


Question 2: Why did it evolve?

- Vocal communication
- **Gestural communication**
- Social bonding (grooming)
- Gossiping
- Deception
- Thinking
- No function (?)



Christiansen & Kirby (2003)
Chapter 10 by Michael A. Arbib
Chapter 11 by Michael C. Corballis



<https://www.youtube.com/watch?v=NBFBbFcixRY>



Question 2: Why did it evolve?

- Vocal communication

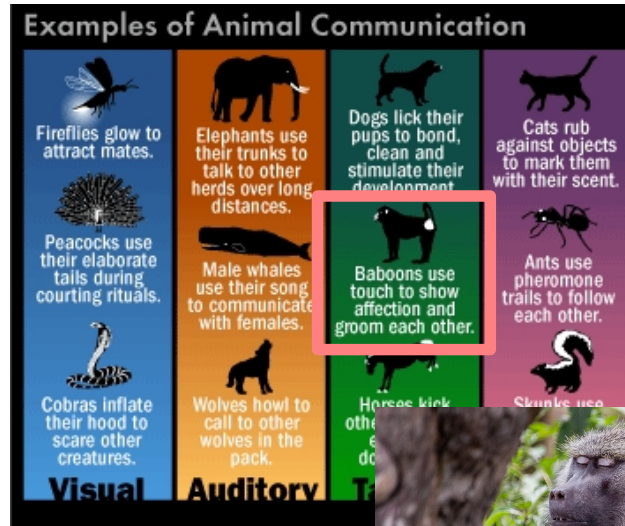
- Gestural communication

- **Social bonding (grooming)**

- Gossiping

- Thinking

- No function (?)

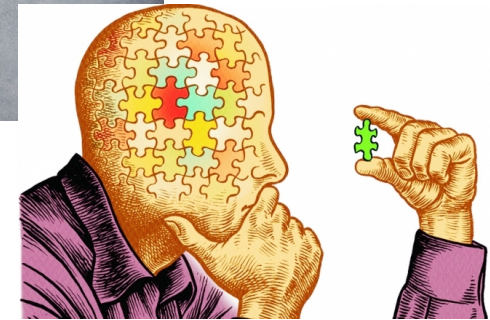


Christiansen & Kirby (2003)
Chapter 12 by Robin Dunbar



Question 2: Why did it evolve?

- Vocal communication
- Gestural communication
- Social bonding (grooming)
- Gossiping
- **Thinking**
- No function (?)



... language is not properly regarded as a system of communication. It is a system for 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).

Cited in Pinker & Jackendoff 2005, p. 223



Question 2: Why did it evolve?

- Vocal communication
- Gestural communication
- Social bonding (grooming)
- Gossiping
- Thinking
- **No function (?)**



	Qal	Niphal	Piel	Pual	Hiphil	Hophal	Hithpael
Perf. 3ms	קָטַל	נִקְטַל	קָטַל	קִטְּלָה	הִקְטִיל	הִקְטִיל	הִתְקַטַּף
3fs	קָטְלָה	נִקְטְלָה	קָטְלָה	קִטְּלָה	הִקְטִילָה	הִקְטִילָה	הִתְקַטְּפָה
2ms	קָטַלְתָּ	נִקְטַלְתָּ	קָטַלְתָּ	קִטְּלָתָּ	הִקְטִילְתָּ	הִקְטִילְתָּ	הִתְקַטַּפְתָּ
2fs	קָטַלְתְּ	נִקְטַלְתְּ	קָטַלְתְּ	קִטְּלָתְּ	הִקְטִילְתְּ	הִקְטִילְתְּ	הִתְקַטַּפְתְּ
1cs	קָטַלְתִּי	נִקְטַלְתִּי	קָטַלְתִּי	קִטְּלָתִי	הִקְטִילְתִּי	הִקְטִילְתִּי	הִתְקַטַּפְתִּי
3cp	קָטְלוּ	נִקְטְלוּ	קָטְלוּ	קִטְּלוּ	הִקְטִילוּ	הִקְטִילוּ	הִתְקַטְּפוּ
2mp	קָטַלְתֶּם	נִקְטַלְתֶּם	קָטַלְתֶּם	קִטְּלַתֶּם	הִקְטִילְתֶּם	הִקְטִילְתֶּם	הִתְקַטַּפְתֶּם
	קָטַלְתִּין	נִקְטַלְתִּין	קָטַלְתִּין	קִטְּלַתִּין	הִקְטִילְתִּין	הִקְטִילְתִּין	הִתְקַטַּפְתִּין
	נִקְטְלוּ	נִקְטְלוּ	נִקְטְלוּ	נִקְטְלוּ	נִקְטְלוּ	נִקְטְלוּ	נִתְקַטְּפוּ
	תִּקְטַל	תִּקְטַל	תִּקְטַל	תִּקְטַל	תִּקְטַל	תִּקְטַל	תִּתְקַטַּף
	תִּקְטְלֶנּוּ	תִּקְטְלֶנּוּ	תִּקְטְלֶנּוּ	תִּקְטְלֶנּוּ	תִּקְטְלֶנּוּ	תִּקְטְלֶנּוּ	תִּתְקַטְּפוּ
	תִּקְטְלִי	תִּקְטְלִי	תִּקְטְלִי	תִּקְטְלִי	תִּקְטְלִי	תִּקְטְלִי	תִּתְקַטְּפִי
	אֶקְטַל	אֶקְטַל	אֶקְטַל	אֶקְטַל	אֶקְטַל	אֶקְטַל	אֶתְקַטַּף
	אֶקְטְלוּ	אֶקְטְלוּ	אֶקְטְלוּ	אֶקְטְלוּ	אֶקְטְלוּ	אֶקְטְלוּ	אֶתְקַטְּפוּ
	תִּקְטְלֶנּוּ	תִּקְטְלֶנּוּ	תִּקְטְלֶנּוּ	תִּקְטְלֶנּוּ	תִּקְטְלֶנּוּ	תִּקְטְלֶנּוּ	תִּתְקַטְּפוּ
	תִּקְטְלוּ	תִּקְטְלוּ	תִּקְטְלוּ	תִּקְטְלוּ	תִּקְטְלוּ	תִּקְטְלוּ	תִּתְקַטְּפוּ
	נִקְטַל	נִקְטַל	נִקְטַל	נִקְטַל	נִקְטַל	נִקְטַל	נִתְקַטַּף
	הִקְטִיל	הִקְטִיל	הִקְטִיל	הִקְטִיל	הִקְטִיל	הִקְטִיל	הִתְקַטַּף
	הִקְטִילִי	הִקְטִילִי	הִקְטִילִי	הִקְטִילִי	הִקְטִילִי	הִקְטִילִי	הִתְקַטְּפִי
	הִקְטִילוּ	הִקְטִילוּ	הִקְטִילוּ	הִקְטִילוּ	הִקְטִילוּ	הִקְטִילוּ	הִתְקַטְּפוּ
	הִקְטִילְנָה	הִקְטִילְנָה	הִקְטִילְנָה	הִקְטִילְנָה	הִקְטִילְנָה	הִקְטִילְנָה	הִתְקַטְּפוּ
	הִקְטִילוּ	הִקְטִילוּ	הִקְטִילוּ	הִקְטִילוּ	הִקְטִילוּ	הִקְטִילוּ	הִתְקַטְּפוּ
	הִקְטִילְנָה	הִקְטִילְנָה	הִקְטִילְנָה	הִקְטִילְנָה	הִקְטִילְנָה	הִקְטִילְנָה	הִתְקַטְּפוּ
	הִקְטִילוּ	הִקְטִילוּ	הִקְטִילוּ	הִקְטִילוּ	הִקְטִילוּ	הִקְטִילוּ	הִתְקַטְּפוּ
	הִקְטִילוּ	הִקְטִילוּ	הִקְטִילוּ	הִקְטִילוּ	הִקְטִילוּ	הִקְטִילוּ	הִתְקַטְּפוּ
	הִקְטִילוּ	הִקְטִילוּ	הִקְטִילוּ	הִקְטִילוּ	הִקְטִילוּ	הִקְטִילוּ	הִתְקַטְּפוּ
	הִקְטִילוּ	הִקְטִילוּ	הִקְטִילוּ	הִקְטִילוּ	הִקְטִילוּ	הִקְטִילוּ	הִתְקַטְּפוּ
Adv.	קָטְלוּ	קָטְלוּ	קָטְלוּ	קָטְלוּ	קָטְלוּ	קָטְלוּ	קָטְלוּ
Part. Act.	קָטֹל	קָטֹל	קָטֹל	קָטֹל	קָטֹל	קָטֹל	קָטֹל
Pass.	קָטוּל	קָטוּל	קָטוּל	קָטוּל	קָטוּל	קָטוּל	קָטוּל

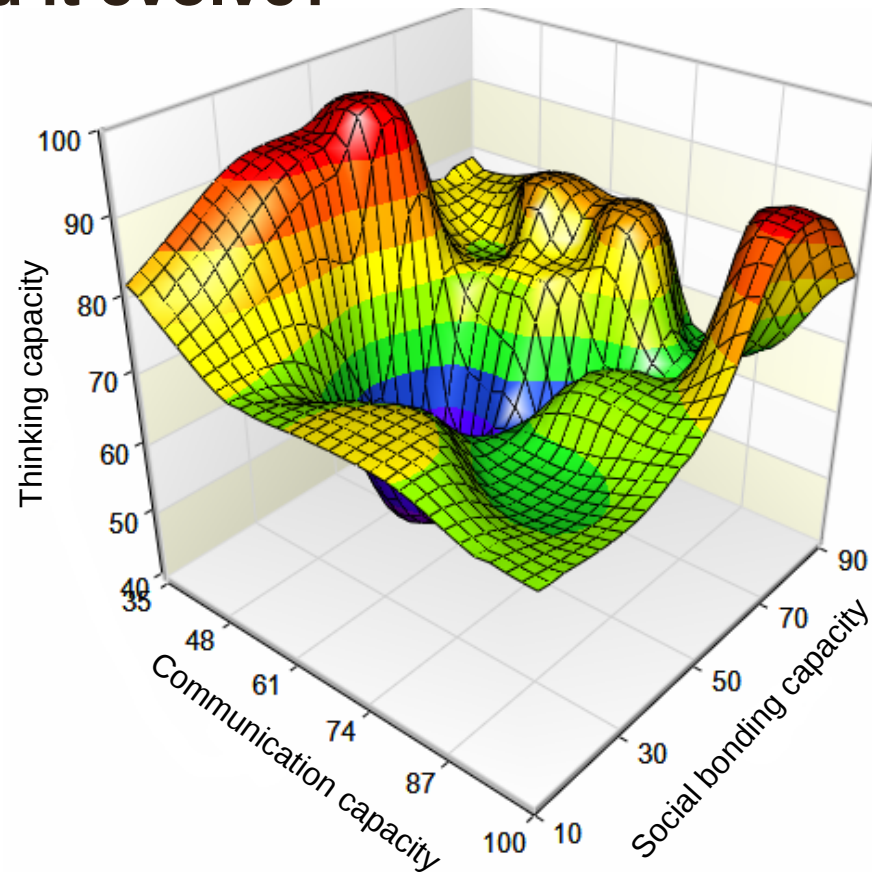
Language design as such appears to be in many respects “**dysfunctional**,” yielding properties that are not well adapted to the function language is called upon to perform. ... What we seem to discover are some intriguing and unexpected features of language design ... [which are] unusual among biological systems of the natural world (Chomsky, 1995, p. 162).

Cited in Pinker & Jackendoff 2005, p. 223



Question 2: Why did it evolve?

- Vocal communication
- Gestural communication
- Social bonding (grooming)
- Gossiping
- Thinking
- No function (?)

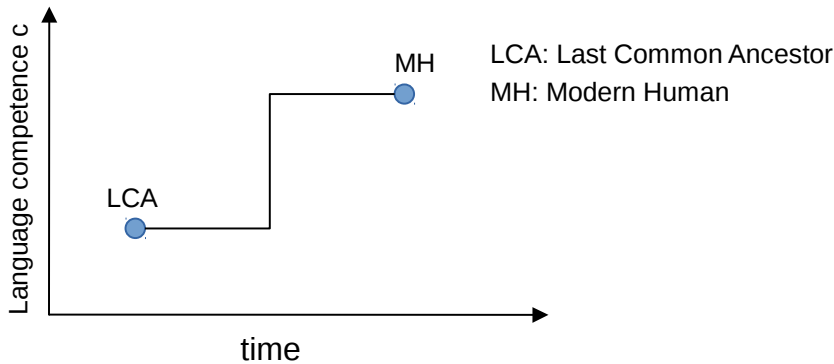


Does there have to be an either/or answer? Or is it possible that language is located in a multidimensional design space with trade-offs between different functions?

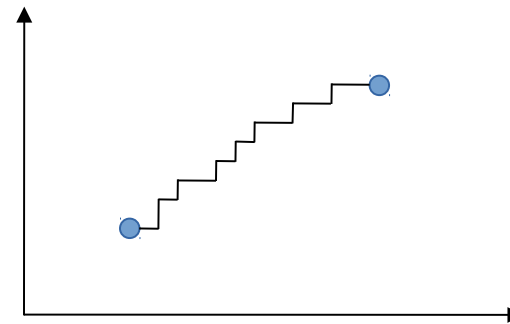


Question 3: How did language evolve?

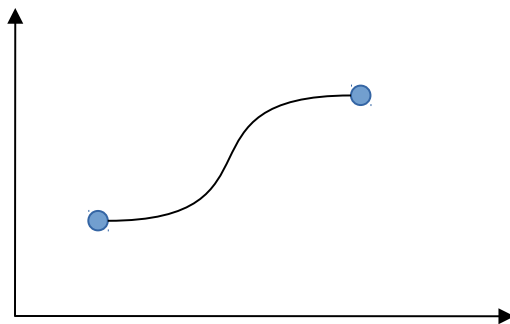
Sudden big jump (saltation)



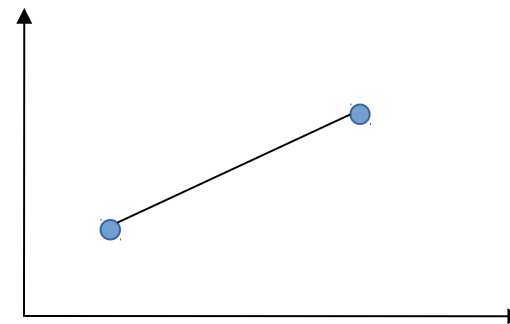
Small jumps (gradual, stepwise)



Continuous change with sudden spurts (variable rate)



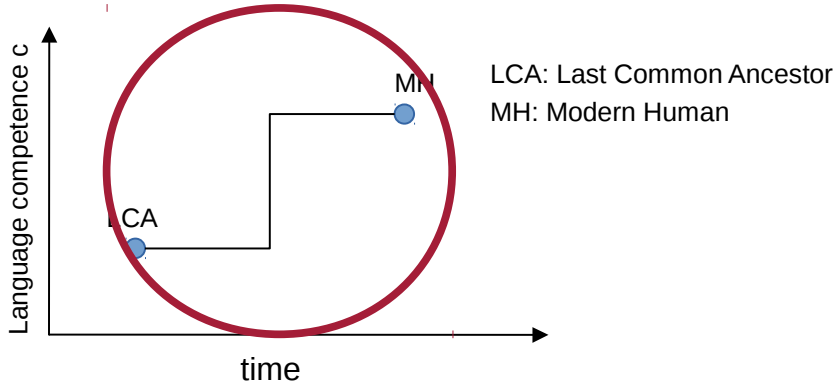
Continuous change (constant rate)



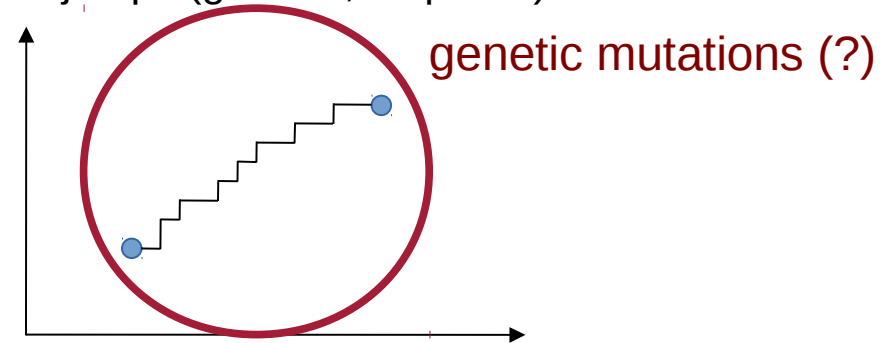


Question 3: How did language evolve?

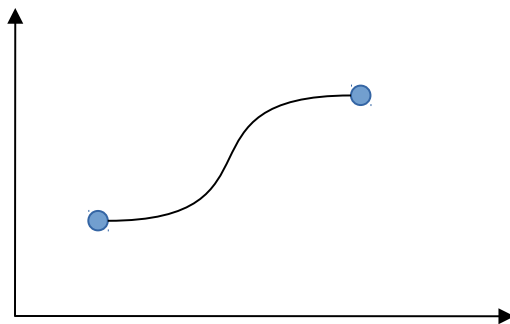
Sudden big jump (saltation)



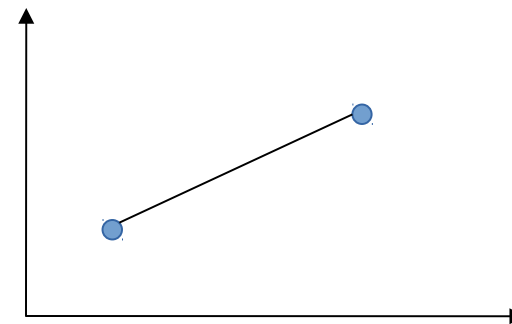
Small jumps (gradual, stepwise)



Continuous change with sudden spurts (variable rate)



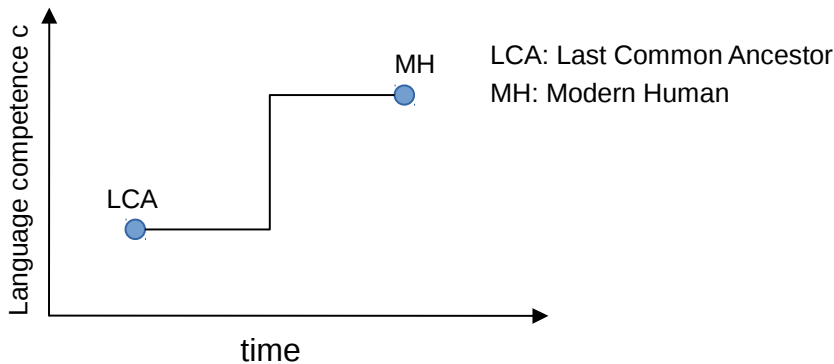
Continuous change (constant rate)



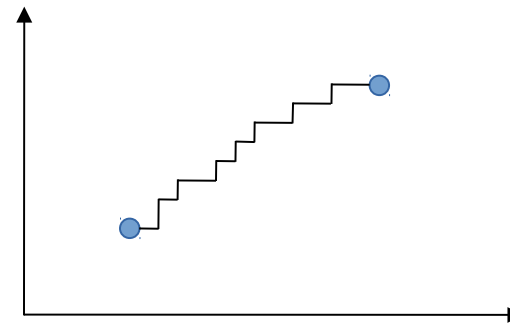


Question 3: How did language evolve?

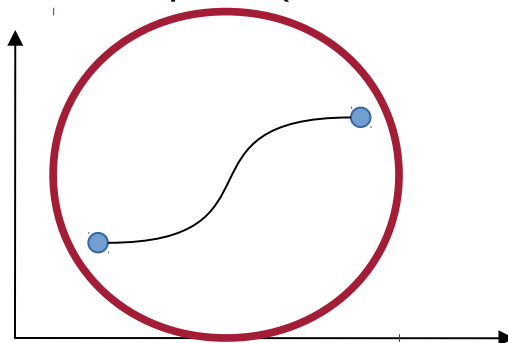
Sudden big jump (saltation)



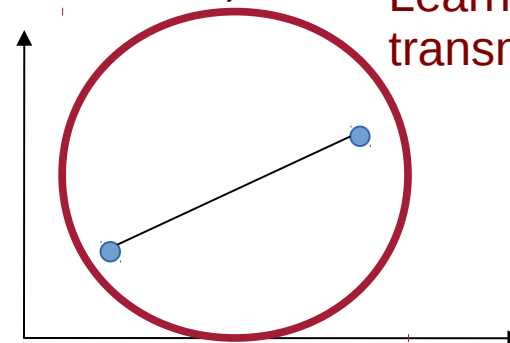
Small jumps (gradual, stepwise)



Continuous change with sudden spurts (variable rate)



Continuous change (constant rate)



Learning and cultural transmission (?)



Saltation vs. Graduation

The Saltational Account

The Gradual Account

The Co-Evolution Account



The Saltational Account

- What is language?

A human specific cognitive ability to process “infinite discreteness”, i.e. recursion (called operation Merge within the Minimalist Program)

- Why did it evolve?

Potentially independent of communication, e.g. for number cognition and/or navigation

- How did it evolve?

Most likely via a sudden mutation (saltation), not necessarily with any adaptive advantage

SCIENCE'S COMPASS  • REVIEW

REVIEW: NEUROSCIENCE

The Faculty of Language: What Is It, Who Has It, and How Did It Evolve?

Marc D. Hauser,^{1*} Noam Chomsky,² W. Tecumseh Fitch¹

OPEN ACCESS Freely available online

 PLOS | BIOLOGY

Essay

How Could Language Have Evolved?

Johan J. Bolhuis^{1,2*}, Ian Tattersall³, Noam Chomsky⁴, Robert C. Berwick⁵

¹ Cognitive Neurobiology and Helmholtz Institute, Departments of Psychology and Biology, Utrecht University, Utrecht, The Netherlands, ² Department of Zoology and Sidney Sussex College, University of Cambridge, Cambridge, United Kingdom, ³ Division of Anthropology, American Museum of Natural History, New York, New York, United States of America, ⁴ Department of Linguistics and Philosophy, MIT, Cambridge, Massachusetts, United States of America, ⁵ Department of Electrical Engineering & Computer Science and Brain and Cognitive Sciences, MIT, Cambridge, Massachusetts, United States of America

Hauser, Chomsky & Fitch (2002).

Christiansen & Kirby (2003). Chapter 9 by Hauser and Fitch.

Bolhuis, Tattersall, Chomsky & Berwick (2014).



The Saltational Account

- What is language?

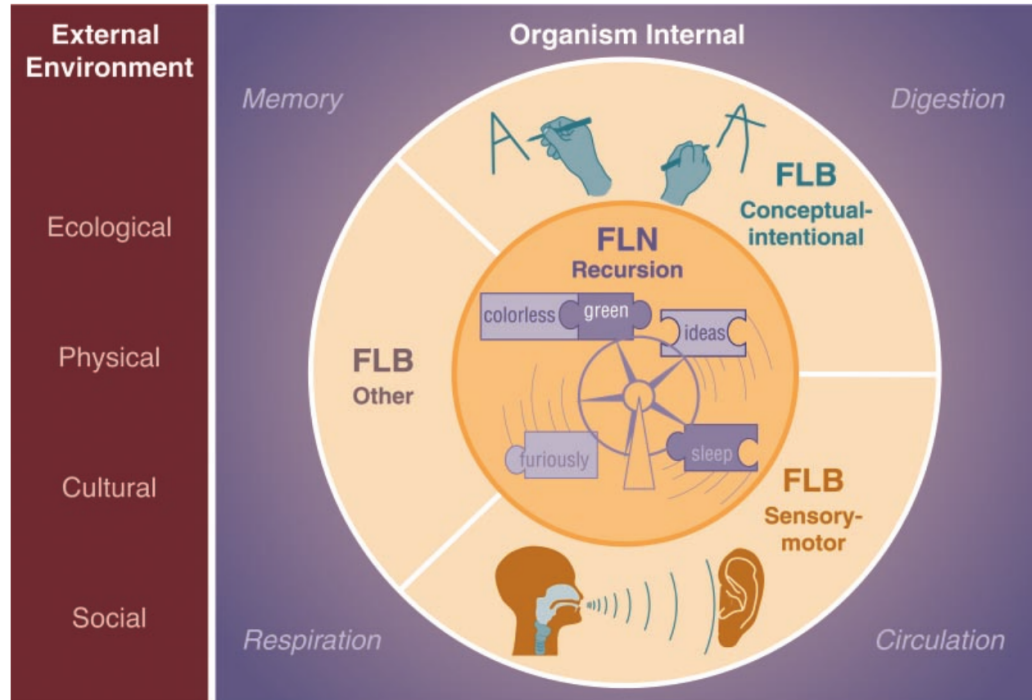
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Most likely via a sudden mutation (saltation), not necessarily with any adaptive advantage



FLB: Faculty of Language in a **B**road sense, i.e. not human and/or language specific

FLN: Faculty of Language in a **N**arrow sense, i.e. human *and* language specific

Hauser, Chomsky & Fitch (2002).



The Saltational Account

- What is language?

A human specific cognitive ability to process “infinite discreteness”, i.e. recursion (called operation Merge within the Minimalist Program)

- Why did it evolve?

Potentially independent of communication, e.g. for number cognition and/or navigation

- How did it evolve?

Most likely via a sudden mutation (saltation), not necessarily with any adaptive advantage

The easy way to discrete infinity:

Domain-general example of “tail” recursion:

$(ab)^n$, where n is potentially infinite;
ab, abab, ababab, etc.

Language example: Coordination

$$\begin{array}{c} a \quad b \\ \diagdown \quad / \\ \end{array}$$
 Paul swims

$$\begin{array}{c} a \quad b \\ \diagdown \quad / \\ \end{array} \quad \text{and} \quad \begin{array}{c} a \quad b \\ \diagdown \quad / \\ \end{array}$$
 Paul swims and Mary runs

$$\begin{array}{c} a \quad b \\ \diagdown \quad / \\ \end{array} \quad \text{and} \quad \begin{array}{c} a \quad b \\ \diagdown \quad / \\ \end{array} \quad \text{and} \quad \begin{array}{c} a \quad b \\ \diagdown \quad / \\ \end{array}$$
 Paul swims and Mary runs and Isa jumps

etc.



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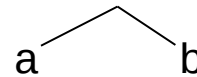
Most likely via a sudden mutation (saltation), not necessarily with any adaptive advantage

The difficult way to discrete infinity:

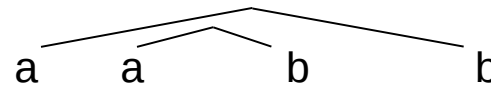
Domain-general example of “true” recursion:

$a^n b^n$, where n is potentially infinite;
ab, aabb, aaabbbb, etc.

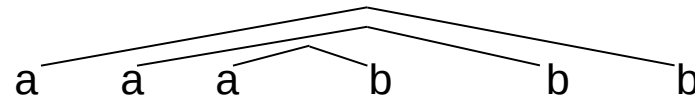
Language example:



Er sah Marie schwimmen



Er sah Marie Paul schwimmen lernen



Er sah Marie Paul Isa schwimmen lernen helfen



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RESEARCH ARTICLE

A Corpus Investigation of Syntactic Embedding in Pirahã

Richard Futrell^{1*}, Laura Stearns¹, Daniel L. Everett², Steven T. Piantadosi³, Edward Gibson¹

¹ Department of Brain and Cognitive Sciences, Massachusetts Institute of Technology, Cambridge, MA, United States of America, ² Dean of Arts and Sciences, Bentley University, Waltham, MA, United States of America, ³ Department of Brain and Cognitive Sciences, University of Rochester, Rochester, NY, United States of America



Language without recursion?

“Our analysis has failed to find strong support for syntactically embedded structures in Pirahã. We emphasize that any conclusions that can be drawn from this corpus evidence must be highly tentative, due to the difficulty of working with a language whose speakers are so difficult to access, as well as the computational challenges of characterizing linguistic complexity.”

Futrell, Stearns, Everett, Piantadosi & Gibson (2016).



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“The quality of language that makes it unique does not seem to be so much its role in communicating directives for action” or other common features of animal communication, Jacob continued, but rather “its role in symbolizing, in evoking cognitive images,” in “molding” our notion of reality and yielding our capacity for thought and planning,” [...]

Jacob (1982) cited in:
Chomsky (2005). Three factors in language design.

“A complex train of thought can be no more carried out without the use of words, whether spoken or silent, than a long calculation without the use of figures or algebra”

Charles Darwin cited in:
Bolhuis et al. (2014)



The Saltational Account

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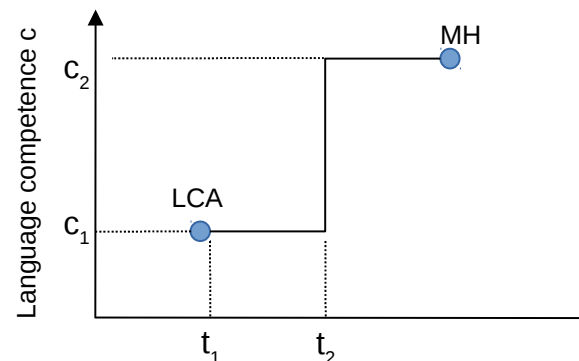
- How did it evolve?

Most likely via a sudden mutation (saltation), not necessarily with any adaptive advantage

“The simplest account of the “Great Leap Forward” in the evolution of humans would be that the brain was rewired, perhaps by some slight mutation, to provide the operation Merge, at once laying a core part of the basis for what is found at that dramatic “moment” of human evolution” [...]

Chomsky (2005). Three factors in language design.

Sudden big jump (saltation)



In Bolhuis et al. (2014) the point in time t is speculated to be around 200 000 to 80 000 years ago based on the appearance of modern Homo sapiens and the earliest symbolic finds in Blombos cave (South Africa)



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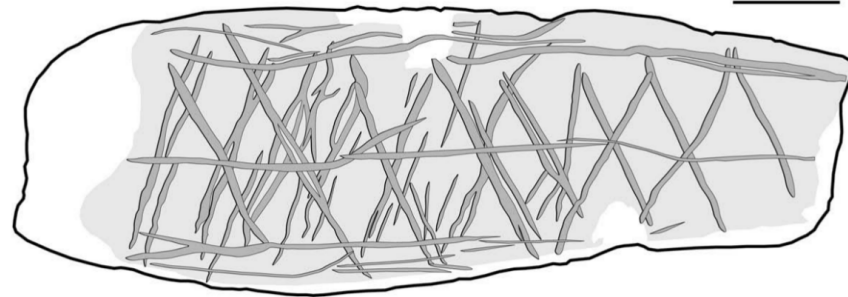
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Think about it...



Does this represent “discrete infinity”, “tail recursion”, or “true recursion”?



The Gradual Account

- What is language?

A toolbox of different cognitive abilities specific to humans and language (FLN)

- Why did it evolve?

Most likely as an adaptation for more explicit communication of complex propositions

- How did it evolve?

Gradually via several mutations and selection (here called discrete graduation)

BEHAVIORAL AND BRAIN SCIENCES (1990) 13, 707–784
Printed in the United States of America

Natural language and natural selection

Steven Pinker^a and Paul Bloom^b

^aDepartment of Brain and Cognitive Sciences, Massachusetts Institute of Technology, Cambridge, MA 02139 and ^bDepartment of Psychology, University of Arizona, Tucson, AZ 85721

Electronic mail: ^asteve@psyche.mit.edu and ^bbloom@rvax.ccit.arizona.edu

Pinker & Bloom (1990)
Pinker & Jackendoff (2005)



The Gradual Account

- What is language?

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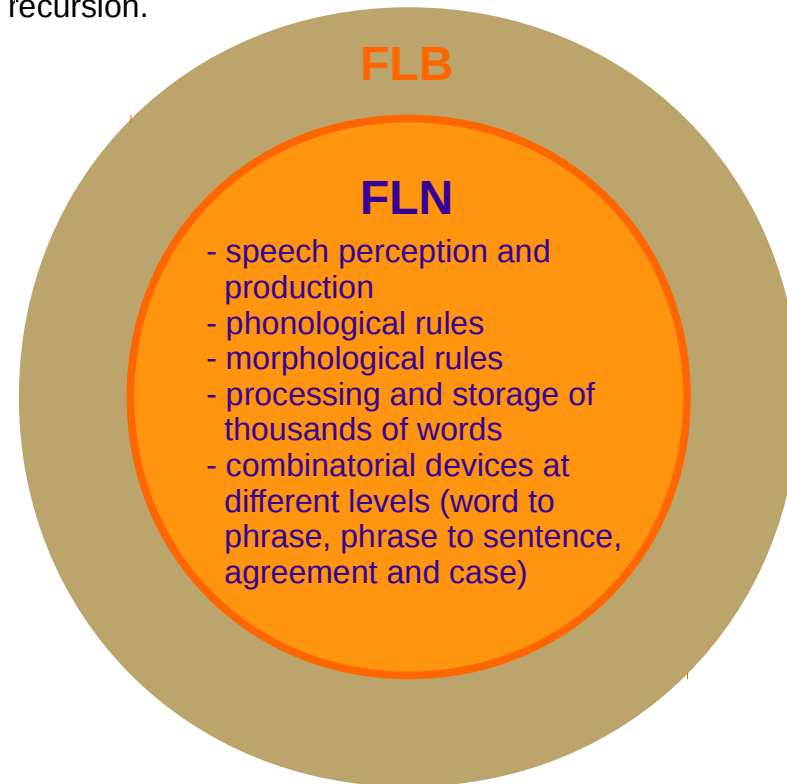
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“Language” is mainly the FLN – in agreement with Hauser, Chomsky and Fitch (2002). However, the FLN is much richer, i.e. contains many more human and language specific properties, not just some form of recursion.



Pinker & Jackendoff (2005)



The Gradual Account

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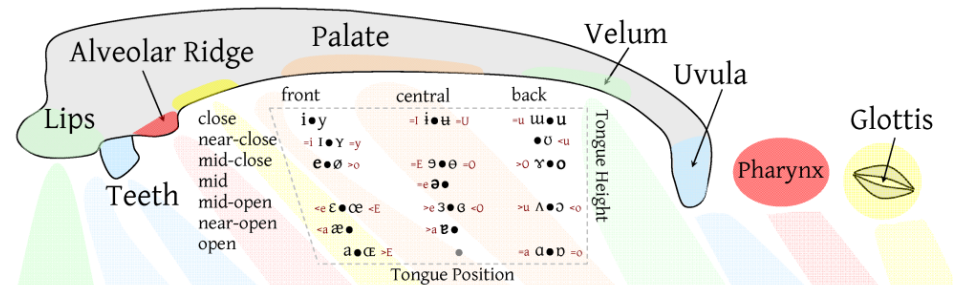
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Example: Speech perception and production



CONSONANTS	Bilabial	Labiodental	Dental	Alveolar	Post-alveolar	Retroflex	Palatal	Velar	Uvular	Pharyngeal	Glottal
Plosive	p b		t̪ t̪ʃ d̪ d̪ʃ	t d		t̠ t̠ʃ d̠ d̠ʃ	c	k g	q		ʔ
Nasal		m	n̪ n̪ʃ	n		ɳ	ɲ	ŋ	ɴ		ɴ
Trill				r							
Flap				r̠							
Fricative	ɸ β	f v	θ ð	s z	ʃ ʒ	ʂ ʐ	ç	x	χ	ħ	ʕ
Lateral Fric.				ɬ ɮ							
Lateral Appr.				l			ʎ	ʟ			
Approximant	ʍ w	ʋ		ɹ		ɻ	j	ɰ			
Vowel (above)								u			
								e			
								ə			
								o			
								a			
Implosive		ɓ		ɗ			ɟ	ɠ	ʄ		
Click	ǀ ǂ		ǃ		ǁ						

Lateral flap: ɬ ɮ. Other symbols: ʎ pʰ h ɲ c ʎnc p̣ p̣l ṭ ṭʃ ẹ ẹḷ ṃ ṃḷ ʃ̣ ṭʃ̣

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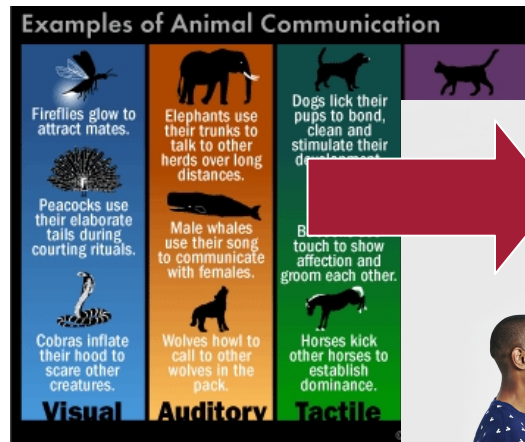
As an adaptation for more explicit communication of complex propositions

- How did it evolve?

Gradually via several mutations and selection (here called discrete graduation)

“Moreover the design of language – a mapping between meaning and sound – is precisely what one would expect in a system that **evolved for the communication of propositions**. We cannot convey recipes, hunting techniques, gossip, or reciprocal promises by “manner of walking or style of clothes or hair,” because these forms of behavior lack grammatical devices that allow propositions to be encoded in a recoverable way in details of the behavior.”

Pinker and Jackendoff (2005), p. 224.





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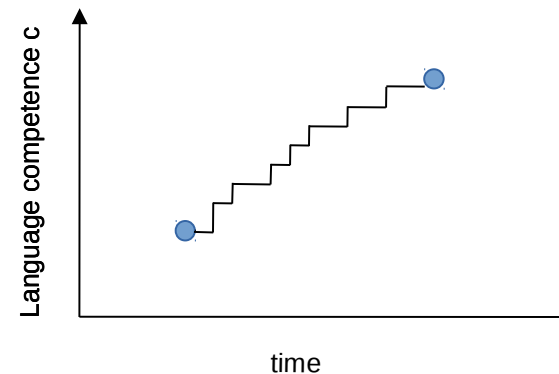
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“[...] the language faculty evolved gradually in response to the adaptive value of more precise and efficient communication [...]. Gradual emergence implies that later stages had to build on earlier ones in the contingent fashion characteristic of natural selection [...]”

Pinker and Jackendoff (2005), p. 223.

Small jumps



Pinker & Jackendoff use the terms “piecemeal” and “gradually”, this could probably also be called “stepwise”. Strictly speaking this is still different from a continuous evolution, as it involves discrete mutations that might be selected for.



The Co-Evolution Account

- What is language?

The empirical sounds, graphemes and signs produced and used by a speaker, hearer, or signer population

- Why did it evolve?

As a communicative and social tool (similar to the gradual account)

- How did it evolve?

In a continuous co-evolution of the human brain and the empirical usage data

BEHAVIORAL AND BRAIN SCIENCES (2008) 31, 489–558
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doi:10.1017/S0140525X08004998

Language as shaped by the brain

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<http://www.psych.cornell.edu/people/Faculty/mhc27.html>

Nick Chater

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Language Is a Complex Adaptive System: Position Paper

The "Five Graces Group"

Clay Beckner

University of New Mexico

Nick C. Ellis

University of Michigan

Richard Blythe

University of Edinburgh

John Holland

Santa Fe Institute; University of Michigan

Joan Bybee

University of New Mexico

Jinyun Ke

University of Michigan

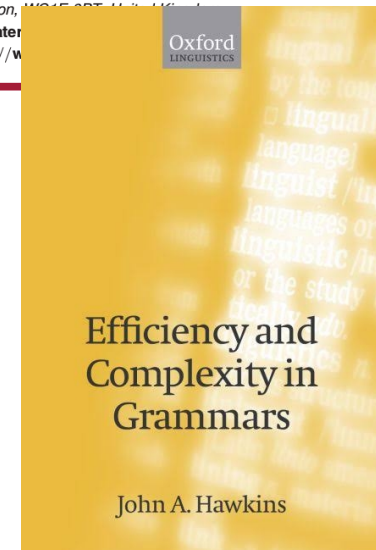
Morten H. Christiansen

Cornell University

Diane Larsen-Freeman

University of Michigan

Christiansen & Kirby (2003). Chapter 15.
Hawkins (2004)
Christiansen & Chater (2008)
Beckner et al. (2009)





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We propose [...] to invert the perspective on language evolution, shifting the focus from the evolution of *language users* to the evolution of *languages*.

[...] linguistic adaptation allows for the evolution of increasingly expressive languages that can nonetheless still be learned and processed by domain-general mechanisms.

Christiansen & Chater (2008), p. 497





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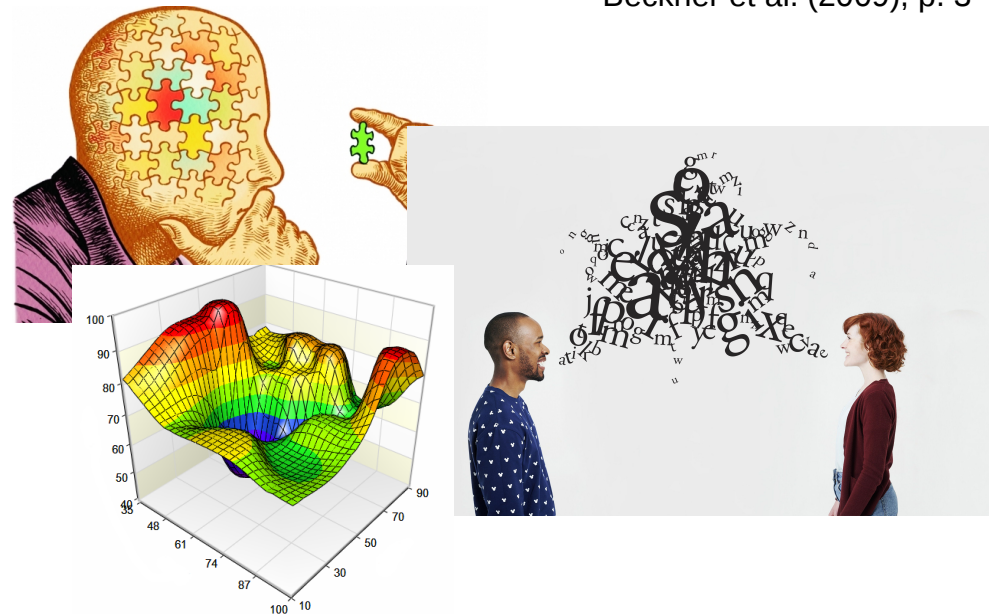
- How did it evolve?

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Language is used for **human social interaction**, and so its origins and capacities are dependent on its role in our social life [...]

To understand how language has evolved in the human lineage [...] we need to look at the combined effect of many **interacting constraints**, including the structure of thought processes, perceptual and motor biases, cognitive limitations, and socio-pragmatic factors.

Beckner et al. (2009), p. 3





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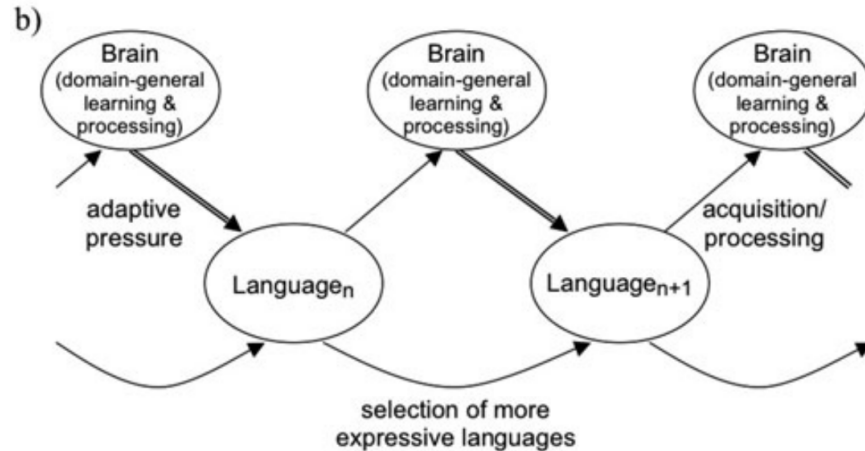
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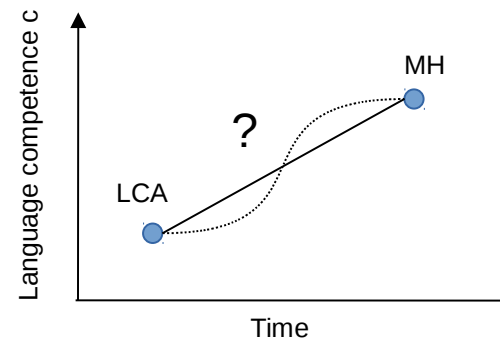
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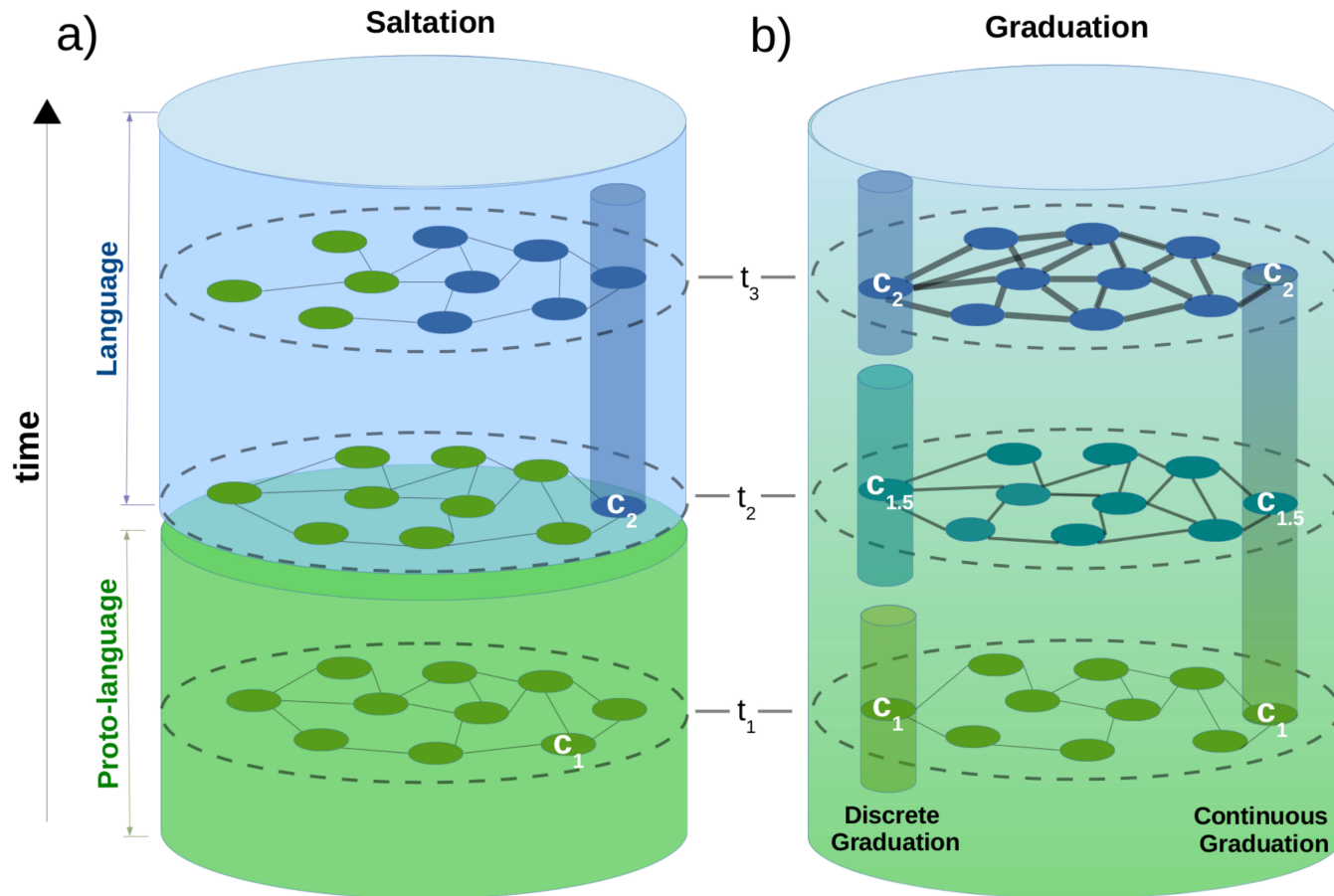
Christiansen & Chater (2008)

Continuous change with or without sudden spurts





Summary: Models of Language Evolution



Bentz (2018) Adaptive languages: An information-theoretic account of linguistic diversity.



Summary: Models of Language Evolution

Is language more like growing a wing or more like learning to play chess?



Saltational Account

Gradual Account

Co-evolution Account





Contact:



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