## 母語獲得とは

- 生まれつき備わっている普遍文法が、各個別環境に応じた具現化を起こすこと
- 古典的な意味での「学習」ではない
  （類推、模倣、暗記、統計的学習、刺激般化、等）

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- Language Growth（発生、成長）
- Language Acquisition（獲得）
- Language Learning（学習、習得）？

2

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## "Learning by Forgetting"

- 幼児の脳内には複数の異なる文法が設定済みであり、選択的過程を経てターゲットの文法に収束する。
- アポトーシス（プログラム細胞死）
- シナプスの過剰生成と刈り込み
- 神経ダーウィニズム

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## Medial-*Wh*

(1) Who do you think who Grover wants to hug? (4;9)

(2) Who do you think who's in there, really, really, really? (4;6)

(3) What do you think what Cookie Monster eats? (5;5)

(4) What do you think what the baby drinks? (3;3)

4

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## German

(1) Was glaubst du [ dass Hans ___ gekauft hat ]?
what believe you [ that Hans ___ bought has ]?
"What do you think that John bought?"

(2) Was glaubst du [ was Hans ___ gekauft hat ]?
what believe you [ what Hans ___ bought has ]?
"What do you think what John bought?"

5

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## French

(1) *Qui crois-tu [ que ___ viendra ]?
who believe you [ that ___ will come ]?
"Who do you believe that will come?"

(2) Qui crois-tu [ qui ___ viendra ]?
who believe you [ who ___ will come ]?
"Who do you believe who will come?"

6

## Irish

(1) Deir siad [ goN shileann an t-athair [ goN phosfaidh Sile ]]
say they [ that thinks the father [ that will-marry Sheila him ]]
"They say that the father thinks that Sheila will marry him."

(2) Cn fear aL deir siad [ aL shileann an t-athair [ aL phosfaidh Sile ___ ]]
which man aL say they [ aL thinks the father [ aL will-marry Sheila ___ ]]
"Which man aL do they say [ aL the father thinks [ aL Sheila will marry ___ ]]

## 連続循環移動
Successive-Cyclic Movement

(1) What do you think Cookie Monster eats?

(2) you think [ Cookie Monster eats what ]?

(3) you think [ what Cookie Monster eats what ]?

(4) [ what do you think [ what Cookie Monster eats what ]]?

◉ **幼児文法は、当該言語の大人の文法とは異なっていても、人間言語から逸脱したものではない。**

◉ **人間として生まれた以上、人間言語でないものが脳内に生じる余地は最初からない。**

## 深層の普遍性・表層の多様性

◉ **共時的** Synchronic **変化**

◉ **通時的** Diachronic **変化**

◉ **発達的** Developmental **変化**

**すべて**UG**の可変領域内での変動**

"When we think we are learning something, we are only discovering what already has been built into our brains."

M. S. Gazzaniga *Nature's Mind: The biological roots of thinking, emotions, sexuality, language and intelligence*.

**「学習をしなければ歌う能力は身につかないが、だからといってなんでも学ぶというわけではない…いつ、どんなことを学ぶかは、遺伝的に組み込まれている …」**

**中村桂子『生命科学』講談社学術文庫**

## 母語獲得の臨界期 Critical Period


http://si.unm.edu/bern_2003/autumn/aut_tl/tl.html

## *That-trace 効果

(1) Who do you think that John met __?
(2) Who do you think John met __?

(3) * Who do you think that __ met John?
(4) Who do you think __ met John?

*(asterisk)はその文が非文法的、つまり当該文法によっては生成不可能であることを示す

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(1) I said (that) John came.

(2) 太郎が来た *(と) 言っただろ

(3) 太郎が来た (て) ゆうたやろ

## Recursion (回帰性・再帰性)

- There is no longest sentence.

... that John knows [ that Bill knows [ that Mary knows [ that Jane knows [ that I love you ]]]]

同じものを無限に埋め込んでいくことができる。
→言語の無限の創造性
cf. 回帰関数 recursive function

## What is one longest word in English?

SMILES

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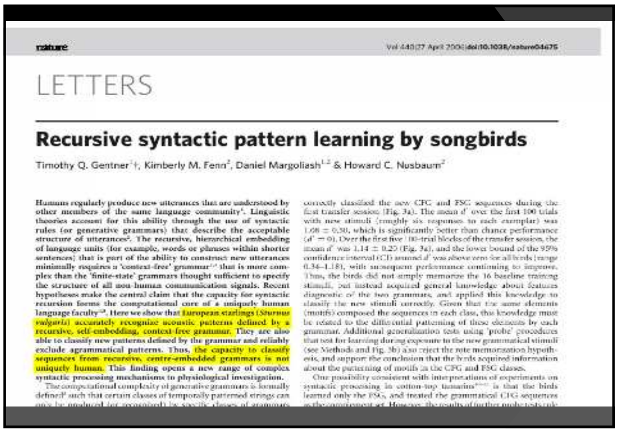
- 回帰性がシンタクスの根幹であり、人間言語の唯一の固有特性だと考えられる
- 回帰性の起源 → 人間言語の起源へ



nature Vol 440|27 April 2006|doi:10.1038/nature04675

LETTERS

# Recursive syntactic pattern learning by songbirds

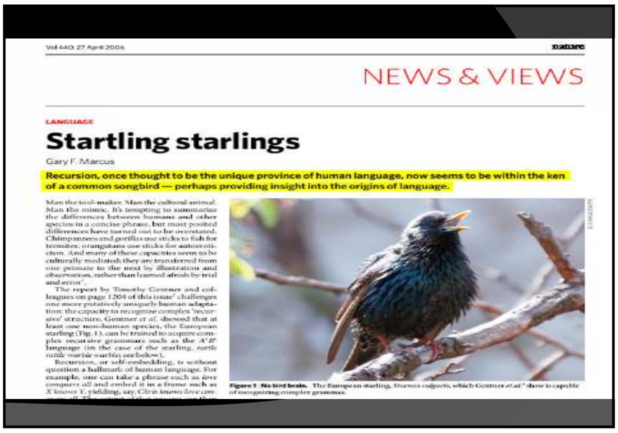
Timothy Q. Gentner[1]†, Kimberly M. Fenn[2], Daniel Margoliash[1,2] & Howard C. Nusbaum[2]

Humans regularly produce new utterances that are understood by other members of the same language community[1]. Linguistic theories account for this ability through the use of syntactic rules (or generative grammars) that describe the acceptable structure of utterances[2]. The recursive, hierarchical embedding of language units (for example, words or phrases within shorter sentences) that is part of the ability to construct new utterances minimally requires a 'context-free' grammar that is more complex than the 'finite-state' grammars thought sufficient to specify the structure of all non-human communication signals. Recent hypotheses make the central claim that the capacity for syntactic recursion forms the computational core of a uniquely human language faculty. Here we show that European starlings (*Sturnus vulgaris*) accurately recognize acoustic patterns defined by a recursive, self-embedding, context-free grammar. They are also able to classify new patterns defined by the grammar and reliably exclude agrammatical patterns. Thus, the capacity to classify sequences from recursive, centre-embedded grammars is not uniquely human. This finding opens a new range of complex syntactic processing mechanisms to physiological investigation.

The computational complexity of generative grammars is formally defined such that certain classes of temporally patterned strings can ...

correctly classified the new CFG and FSG sequences during the first transfer session (Fig. 3a). The mean d' over the first 100 trials with new stimuli (roughly six responses to each exemplar) was 1.08 ± 0.30, which is significantly better than chance performance (d' = 0). Over the first five 100-trial blocks of the transfer session, the mean d' was 1.14 ± 0.20 (Fig. 3a), and the lower bound of the 95% confidence interval (CI) around d' was above zero for all birds (range 0.34–1.18), with subsequent performance continuing to improve. Thus, the birds did not simply memorize the 16 baseline training stimuli, but instead acquired general knowledge about features diagnostic of the two grammars, and applied this knowledge to classify the new stimuli correctly. Given that the same elements (motifs) composed the sequences in each class, this knowledge must be related to the differential patterning of these elements by each grammar. Additional generalization tests using 'probe' procedures that test for learning during exposure to the new grammatical stimuli (see Methods and Fig. 3b) also reject the rote memorization hypothesis, and support the conclusion that the birds acquired information about the patterning of motifs in the CFG and FSG classes.

One possibility consistent with interpretations of experiments on syntactic processing in cotton-top tamarins is that the birds learned only the FSG, and treated the grammatical CFG sequences ...



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NEWS & VIEWS

LANGUAGE

# Startling starlings

Gary F. Marcus

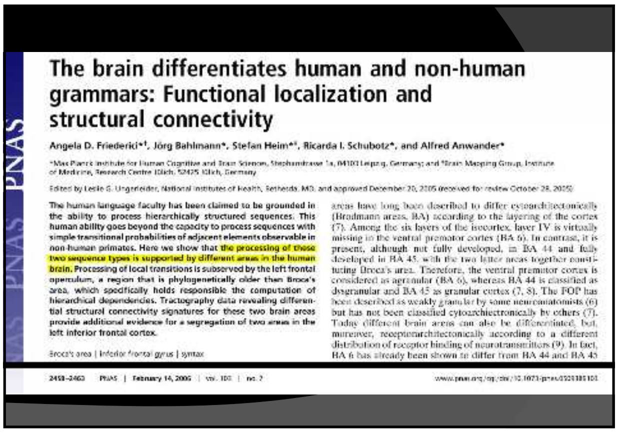
**Recursion, once thought to be the unique province of human language, now seems to be within the ken of a common songbird — perhaps providing insight into the origins of language.**

Man the tool-maker. Man the cultural animal. Man the mimic. It's tempting to summarize the differences between humans and other species in a concise phrase, but most posited differences have turned out to be overstated. Chimpanzees and gorillas use sticks to fish for termites, orangutans use sticks for autoeroticism. And many of these capacities seem to be culturally mediated: they are transferred from one primate to the next by illustration and observation, rather than learned afresh by trial and error.

The report by Timothy Gentner and colleagues on page 1204 of this issue challenges one more putatively uniquely human adaptation: the capacity to recognize complex 'recursive' structure. Gentner et al. showed that at least one non-human species, the European starling (Fig. 1), can be trained to acquire complex recursive grammars such as the $A^nB^n$ language (in the case of the starling, rattle rattle warble warble; see below).

Recursion, or self-embedding, is without question a hallmark of human language. For example, one can take a phrase such as *love conquers all* and embed it in a frame such as *X knows Y*, yielding, say, *Chris knows love conquers all*. ...

**Figure 1 | No bird brain.** The European starling, *Sturnus vulgaris*, which Gentner et al. show is capable of recognizing complex grammar.



PNAS

# The brain differentiates human and non-human grammars: Functional localization and structural connectivity

Angela D. Friederici*†, Jörg Bahlmann*, Stefan Heim*†, Ricarda I. Schubotz*, and Alfred Anwander*

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Edited by Leslie G. Ungerleider, National Institutes of Health, Bethesda, MD, and approved December 20, 2005 (received for review October 28, 2005)

The human language faculty has been claimed to be grounded in the ability to process hierarchically structured sequences. This human ability goes beyond the capacity to process sequences with simple transitional probabilities of adjacent elements observable in non-human primates. Here we show that the processing of these two sequence types is supported by different areas in the human brain. Processing of local transitions is subserved by the left frontal operculum, a region that is phylogenetically older than Broca's area, which specifically holds responsible the computation of hierarchical dependencies. Tractography data revealing differential structural connectivity signatures for these two brain areas provide additional evidence for a segregation of two areas in the left inferior frontal cortex.

Broca's area | inferior frontal gyrus | syntax

areas have long been described to differ cytoarchitectonically (Brodmann areas, BA) according to the layering of the cortex (7). Among the six layers of the isocortex, layer IV is virtually missing in the ventral premotor cortex (BA 6). In contrast, it is present, although not fully developed, in BA 44 and fully developed in BA 45, with the two latter areas together constituting Broca's area. Therefore, the ventral premotor cortex is considered as agranular (BA 6), whereas BA 44 is classified as dysgranular and BA 45 as granular cortex (7, 8). The FOP has been described as weakly granular by some neuroanatomists (6) but has not been classified cytoarchitectonically by others (7). Today different brain areas can also be differentiated, but, moreover, receptorarchitectonically according to a different distribution of receptor binding of neurotransmitters (9). In fact, BA 6 has already been shown to differ from BA 44 and BA 45

2458–2463 | PNAS | February 14, 2006 | vol. 103 | no. 7 www.pnas.org/cgi/doi/10.1073/pnas.0509389103

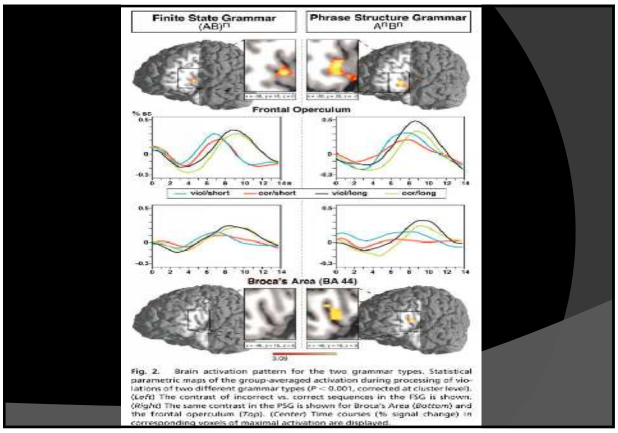
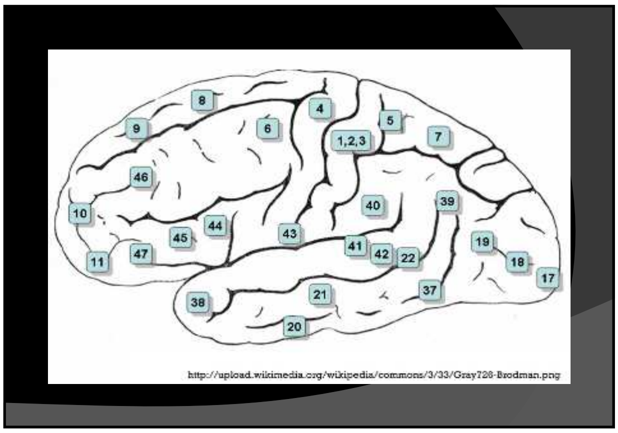



Fig. 2. Brain activation pattern for the two grammar types. Statistical parametric maps of the group-averaged activation during processing of violations of two different grammar types ($P < 0.001$, corrected at cluster level). (*Left*) The contrast of incorrect vs. correct sequences in the FSG is shown. (*Right*) The same contrast in the PSG is shown for Broca's Area (*Bottom*) and the frontal operculum (*Top*). (*Center*) Time courses (% signal change) in corresponding voxels of maximal activation are displayed.

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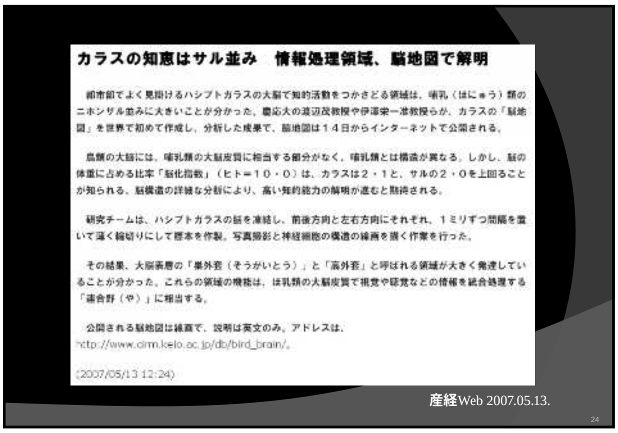

# カラスの知恵はサル並み　情報処理領域、脳地図で解明

都市部でよく見掛けるハシブトカラスの大脳で知的活動をつかさどる領域は、哺乳（ほにゅう）類のニホンザル並みに大きいことが分かった。慶応大の渡辺茂教授や伊澤栄一准教授らが、カラスの「脳地図」を世界で初めて作成し、分析した成果で、脳地図は１４日からインターネットで公開される。

鳥類の大脳には、哺乳類の大脳皮質に相当する部分がなく、哺乳類とは構造が異なる。しかし、脳の体重に占める比率「脳化指数」（ヒト＝１０・０）は、カラスは２・１と、サルの２・０を上回ることが知られる。脳構造の詳細な分析により、高い知的能力の解明が進むと期待される。

研究チームは、ハシブトカラスの脳を凍結し、前後方向と左右方向にそれぞれ、１ミリずつ間隔を置いて薄く輪切りにして標本を作製。写真撮影と神経細胞の構造の線画を描く作業を行った。

その結果、大脳表層の「巣外套（そうがいとう）」と「高外套」と呼ばれる領域が大きく発達していることが分かった。これらの領域の機能は、ほ乳類の大脳皮質で視覚や聴覚などの情報を統合処理する「連合野（や）」に相当する。

公開される脳地図は線画で、説明は英文のみ。アドレスは、
http://www.cirm.keio.ac.jp/db/bird_brain/。

(2007/05/13 12:24)

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