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EXPERIMENTAL SYNTAX FOR BIOLINGUISTICS?

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LANGUAGE EVOLUTION (AND DEVELOPMENT)
BOILS DOWN TO THE EMERGENCE OF:

- RECURSIVE UNBOUNDED MERGE
- INTERFACES
- LEXICON

CF. FLN / FLB DICHOTOMY

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BIOLINGUISTICS:

- NATURALIZATION, OR BIOLOGIZATION, OF HUMAN LANGUAGE FACULTY (BIOSYNTAX, BIOSEMANTICS, ETC.)
 - DESIGN
 - DEVELOPMENT
 - EVOLUTION

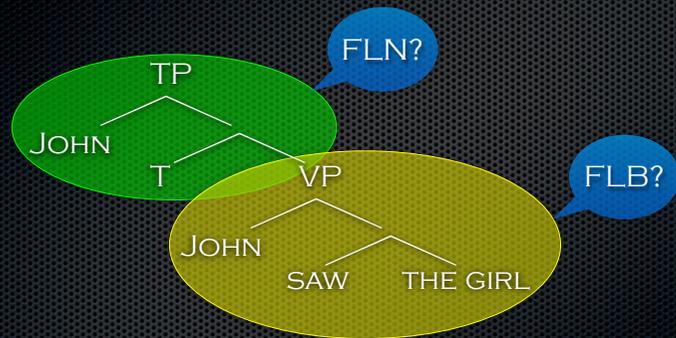
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REAL-TIME GRAMMAR (PHILLIPS' THESES):

- HUMAN LANGUAGE IS "IMPLEMENTATION DEPENDENT."
- GRAMMAR IS A REAL-TIME STRUCTURE BUILDING SYSTEM.
- DERIVATION PROCEEDS MOSTLY FROM LEFT (TOP) TO RIGHT (BOTTOM).

C. PHILLIPS & S. LEWIS. DERIVATIONAL ORDER IN SYNTAX:
EVIDENCE AND ARCHITECTURAL CONSEQUENCES.

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MISMATCH BETWEEN DERIVATIONS
AND PHYLOGENY/ONTOGENY?

GRAMMAR = PARSER?

- COMPETENCE
 - WHAT A COGNITIVE SYSTEM COULD ACHIEVE WITH UNBOUNDED RESOURCES
- PERFORMANCE
 - WHAT IT CAN ACHIEVE WHEN IT IS SUBJECT TO REAL-LIFE RESOURCE LIMITATIONS

C. PHILLIPS & M. WAGERS. RELATING STRUCTURE AND TIME IN LINGUISTICS AND PSYCHOLINGUISTICS. OXFORD HANDBOOK OF PSYCHOLINGUISTICS.

MAJOR ISSUES:

- MISMATCH BETWEEN THEORETICAL AND PSYCHO-/NEURO-LINGUISTICS
- LACK OF COMPARATIVE METHODS
- MODULARITY AS AN END RESULT OF EVOLUTION & DEVELOPMENT

UNBOUNDED MERGE

"... UNBOUNDED MERGE IS NOT ONLY A GENETICALLY DETERMINED PROPERTY OF LANGUAGE, BUT ALSO UNIQUE TO IT."

"... FOR BOTH EVOLUTION AND DEVELOPMENT, THERE SEEMS TO BE LITTLE REASON TO SUPPOSE THAT THERE WERE PRECURSORS TO UNBOUNDED MERGE."

- N. CHOMSKY

PIRAHÃ: A LANGUAGE WITHOUT RECURSION?

TI GÁI-SAI KÓ'OI HI KAHÁP-ÍÍ
I SAY-OLD.INFO KÓ'OI HE LEAVE-INTENTION
'I SAY, KÓ'OI WILL LEAVE.' (PARATAXIS)

D. L. EVERETT. 2005. CULTURAL CONSTRAINTS ON GRAMMAR AND COGNITION IN PIRAHÃ. CURRENT ANTHROPOLOGY 46.

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- UNBOUNDED, RECURSIVE MERGE: COMPETENCE
- CROSS-LINGUISTIC VARIATIONS: PERFORMANCE

"... THE SPEAKERS OF THIS LANGUAGE AREN'T MAKING USE OF A CAPACITY THAT THEY SURELY HAVE, A NORMAL SITUATION; PLENTY OF PEOPLE THROUGHOUT HISTORY WOULD DROWN IF THEY FALL INTO WATER. NOTHING MUCH FOLLOWS EXCEPT FOR A QUESTION AS TO WHY THEY HAVEN'T MADE USE OF THESE CAPACITIES."

N. CHOMSKY 2008. HUMAN NATURE AND THE ORIGINS OF LANGUAGE. RADICAL ANTHROPOLOGY 2.

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- "RECURSION IS A THEORETICAL ARTIFACT."

D. BICKERTON 2009. RECURSION: CORE OF COMPLEXITY OR ARTIFACT OF ANALYSIS. IN T. GOVÓN & M. SHIBATANI EDS. SYNTACTIC COMPLEXITY: DIACHRONY, ACQUISITION, NEUROCOGNITION, EVOLUTION. JOHN BENJAMINS.

- **RECURSIVE MERGE:**
 - MERGE APPLIES TO ITS OWN OUTPUT.

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- "WORKING MEMORY CAPACITY MAY ... BOTH ENABLE AND CONSTRAIN SYNTACTIC COMPLEXITY."

D. M. TUCKER ET AL. 2009. NEURAL MECHANISMS OF RECURSIVE PROCESSING IN COGNITIVE AND LINGUISTIC COMPLEXITY.

- DOES A THEORY OF RECURSIVE MERGE HAVE TO FORMULATE WM LIMITATIONS?
 - MAXIMUM NUMBER OF A VERB'S ARGUMENTS, CENTER-EMBEDDED RELATIVE CLAUSES, MULTIPLE POSSESSIVES, ETC.

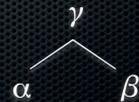
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RECURSIVE MERGE:

- CORE MERGE: $(\alpha, \beta) \rightarrow \{\alpha, \beta\}$

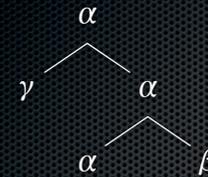


- LABEL: $\{\alpha, \beta\} \rightarrow \{\gamma, \{\alpha, \beta\}\}$, WHERE $\gamma = \alpha$ OR β



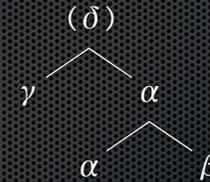
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LOCAL LABEL



→ ENDOCENTRICITY

NONLOCAL LABEL NO LABEL



→ EXOCENTRICITY

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- LABEL = MOVE = MERGE

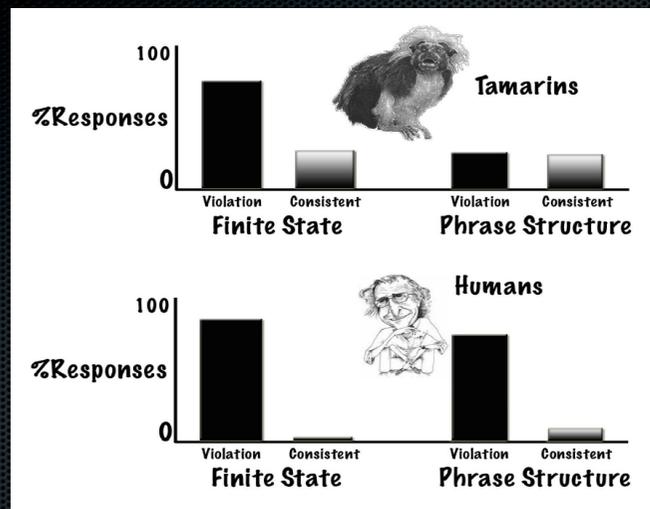
- EXTERNAL MERGE: $\{\alpha, \beta\} \rightarrow \{\gamma, \{\alpha, \beta\}\}$, WHERE γ IS EXTERNAL TO α AND β

- INTERNAL MERGE: $\{\alpha, \beta\} \rightarrow \{\gamma, \{\alpha, \beta\}\}$, WHERE γ IS INTERNAL TO α OR β

- LABEL: $\{\alpha, \beta\} \rightarrow \{\gamma, \{\alpha, \beta\}\}$, WHERE γ IS α OR β

LABEL = STRICTLY LOCALIZED VERSION OF INTERNAL MERGE (MOVE)

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R. TINCOFF AND M. D. HAUSER, 2006. COGNITIVE BASIS FOR LANGUAGE EVOLUTION IN NONHUMAN PRIMATES. ENCYCLOPEDIA OF LANGUAGE & LINGUISTICS, 2ND ED.

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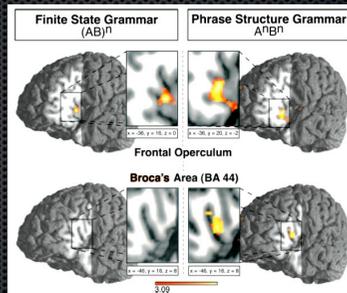
TWO NEURONAL CIRCUITS FOR PROCESSING SYNTACTIC COMPLEXITY

- FINITE STATE GRAMMAR ((AB)^N):

VENTRAL PREMOTOR CORTEX (VPMC, BA6) & DEEP FRONTAL OPERCULUM (FO)

- PHRASE STRUCTURE GRAMMAR (A^NB^N):

BA44/45 (BROCA'S AREA) & POSTERIOR PART OF SUPERIOR TEMPORAL GYRUS (STG)



A. D. FRIEDERICI & J. BRAUER. 2009. SYNTACTIC COMPLEXITY IN THE BRAIN.

VPMC/FO PHYLOGENETICALLY OLDER THAN BROCA'S AREA

SYNTAX

- AS A SINGLE COMPUTATIONAL MODULE
- AS A SET OF DISTINCT COMPUTATIONAL MODULES

PROTO-LANGUAGE TO FULL LANGUAGE

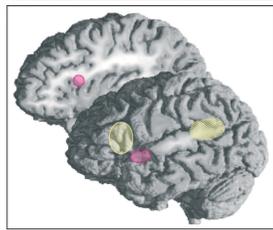


- "ONCE YOU HAVE MERGE, YOU HAVE MOVE, TOO."
- (CORE) MERGE AND MOVE ARE SUBSERVED BY DIFFERENT BRAIN AREAS.
- (CORE) MERGE IS PHYLOGENETICALLY OLDER THAN MOVE.

Table 2

The neurological distribution of formal syntactic operations

Syntactic operation	Impaired in Broca's aphasia?	Main loci of activation in fMRI
LEX	No	?
MERGE	No	?
MOVE _{XP}	Yes	L-IFG, R-STG, L-STG
MOVE _V	No	L-SFG, L-MFG
BIND	No	R-MFG, L-SFG, L-OG



A schematic view of the main areas activated during syntactic processing. Pink areas (frontal operculum and anterior STG) are involved in the build-up of local phrase structures, the yellow area (Broca's area, BA 44/45) supports the computation of dependency relations between constituents of a sentence, and the striped area (posterior STG/STG) is involved in integration processes, possibly involving syntactic and syntax-relevant lexical information.

Y. GRODZINSKY & A.D. FRIEDERICI. 2006. NEUROIMAGING OF SYNTAX AND SYNTACTIC PROCESSING. CURRENT OPINIONS IN NEUROBIOLOGY 16.

CATEGORY-SPECIFIC DEFICITS: NOUN-VERB DISSOCIATIONS

DISTINCT NEURAL SUBSTRATES FOR VERBAL AND NOMINAL MORPHOSYNTAX

- V: FRONTO-PARIETAL CIRCUIT
- N: FRONTO-TEMPORAL CIRCUIT

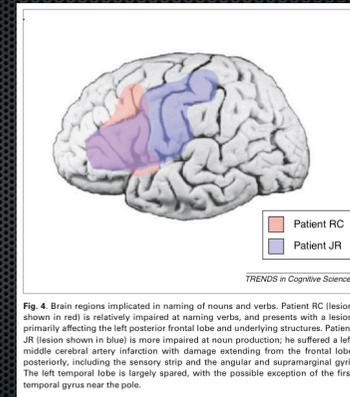
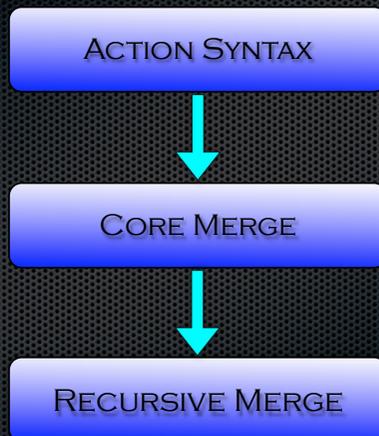


Fig. 4 Brain regions implicated in naming of nouns and verbs. Patient RC (lesion shown in red) is relatively impaired at naming verbs, and presents with a lesion primarily affecting the left posterior frontal lobe and underlying structures. Patient JR (lesion shown in blue) is more impaired at noun production; he suffered a left middle cerebral artery infarction with damage extending from the frontal lobe posteriorly, including the sensory strip and the angular and supramarginal gyri. The left temporal lobe is largely spared, with the possible exception of the first temporal gyrus near the pole.

A. CARAMAZZA & K. SHAPIRO, 2004. THE REPRESENTATION OF GRAMMATICAL KNOWLEDGE IN THE BRAIN.

EXAPTIVE EVOLUTION OF RECURSIVE MERGE



- FRONTAL CORTEX IMPLICATED IN ALL (REGULAR AND IRREGULAR) MORPHOSYNTACTIC PROCESSES (CONTRA ULLMAN ET AL.)
- THE LEXICON NEED NOT BE DIVIDED INTO GRAMMATICAL CATEGORIES.

(1) MARY TALKED TO BILL, BUT SUZY WILL NOT (TALK TO BILL).

TALKED = TALK + ED

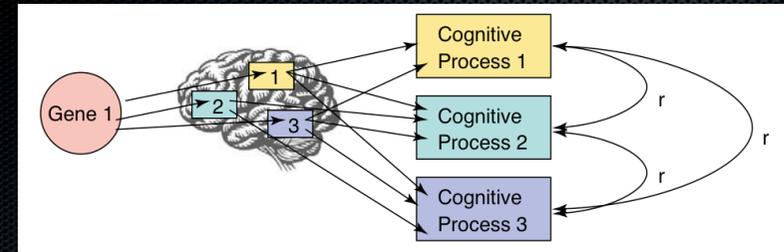
(2) MARY WROTE TO BILL, BUT SUZY WILL NOT (WRITE TO BILL).

WROTE = WRITE + ED

DISTINCT NEURAL MECHANISM FOR LEXICAL AND SYNTACTIC CAUSATIVES IN JAPANESE

T. ITOH ET AL. 2007.

- (1) LC: JOHN-NI TV-WO MISERU (SHOW)
- (2) SC: JOHN-NI TV-WO MISASERU (LET WATCH)



Mechanism 3

A gene influences several areas of the brain, and each area affects several cognitive processes

Y. KOVAS & R. PLOMIN 2006. GENERALIST GENES: IMPLICATIONS FOR THE COGNITIVE SCIENCES. TRENDS IN COGNITIVE SCIENCES 10.

- DISTINCT NEURAL CIRCUITS DO NOT JUSTIFY DISTINCT THEORETICAL MODULES, BUT CALL FOR A MORE ELABORATE THEORY OF THE DESIGN, DEVELOPMENT AND EVOLUTION OF A SINGLE MODULE.

MODULAR ARCHITECTURE OF THE MIND

- "DESCENT-WITH-MODIFICATION MODULARITY"
(AS OPPOSED TO "SUI GENERIS MODULARITY!")
- "CURRENT COGNITIVE MODULES ... SHAPED BY EVOLUTIONARY CHANGES FROM ANCESTRAL COGNITIVE MODULES."

G. F. MARCUS, 2006. COGNITION 101.

"EVOLUTION HAS RECRUITED FOR LANGUAGE PURPOSES BRAIN STRUCTURES THAT PERFORMED OTHER FUNCTIONS IN NON-HUMAN PRIMATES."

- T. W. DEACON

"LANGUAGE CAN BE VIEWED AS A NEW MACHINE THAT EVOLVED INITIALLY IN THE SERVICE OF COMPLETELY DIFFERENT FUNCTIONS."

- E. BATES

TOOLS AND LANGUAGE: ACTION TO SYNTAX

- BROCA'S AREA: COMMON NEURAL SUBSTRATE FOR HIERARCHICAL ORGANIZATION IN ACTION AND LANGUAGE

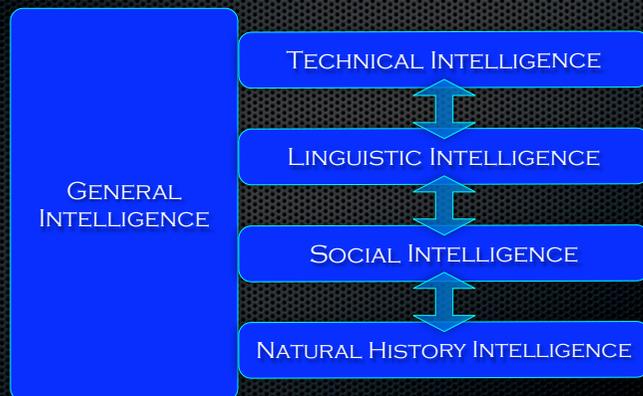
P. GREENFIELD 1991.

- MIRROR NEURONS: FOR GOAL-DIRECTED MANUAL ACTION AND LANGUAGE

P. GREENFIELD 2006.

■ THREE PHASES FOR THE EVOLUTION OF THE MIND

S. MITHEN 1988. THE PREHISTORY OF THE MIND.



HAMMER

NUT

ANVIL

MERGE (NUT, ANVIL) → {NUT, ANVIL}

MERGE (HAMMER, {NUT, ANVIL}) →

{HAMMER, {NUT, ANVIL}}



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II. POT STRATEGY



POT-MERGE:



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I. PAIRING STRATEGY



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  graph TD
    A[ ] --- B[THE]
    A --- C[BOY]
  
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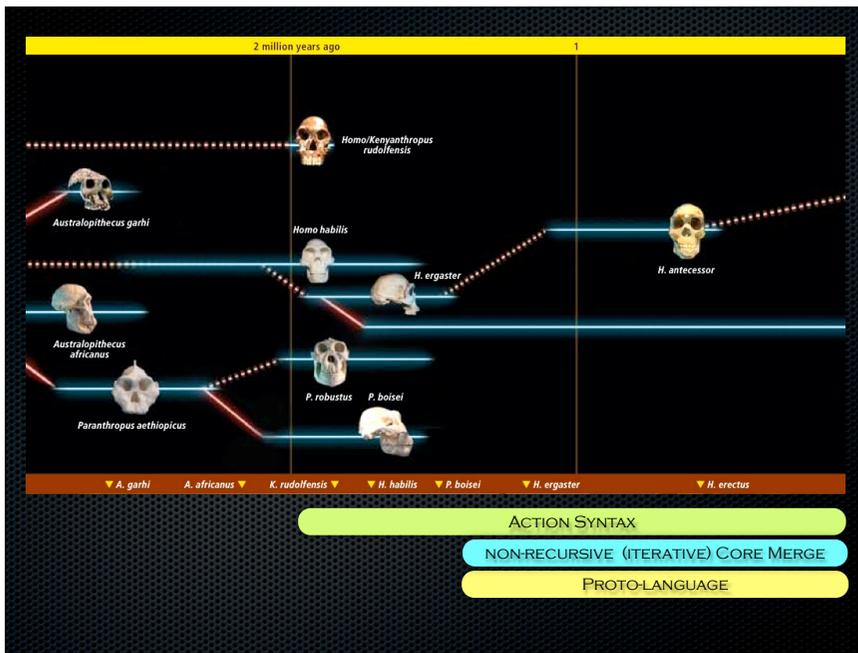
SUBASSEMBLY STRATEGY



SUB-MERGE:



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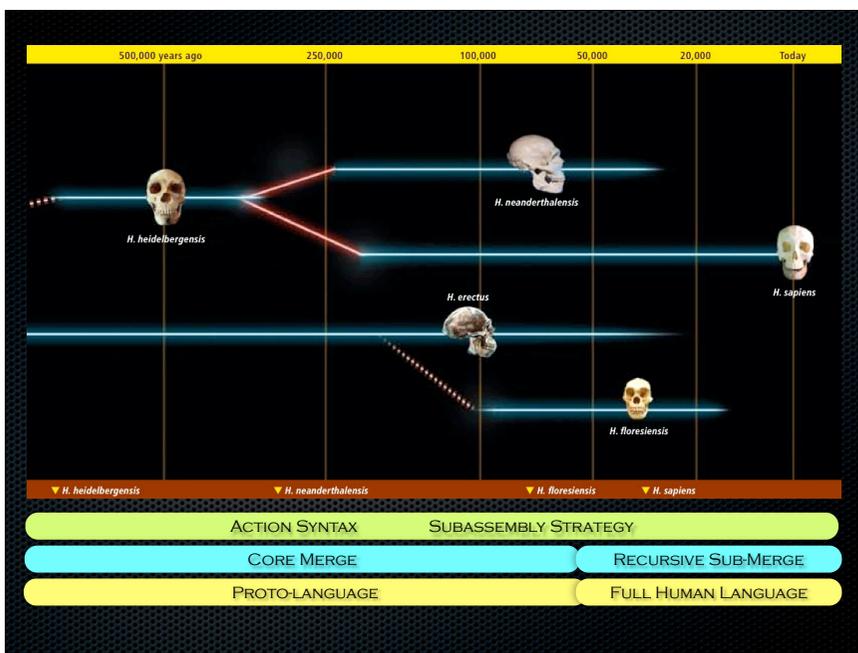
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FOUR KEY INGREDIENTS OF "HUMANIQUENESS"

- GENERATIVE COMPUTATION
 - PROMISCUOUS COMBINATION OF IDEAS
 - MENTAL SYMBOLS
 - ABSTRACT THOUGHT
- "... A CRITICAL STEP IN ACQUIRING OUR OWN DISTINCTIVE BRAND OF THINKING WAS NOT THE EVOLUTION OF RECURSION AS A NOVEL FORM OF COMPUTATION BUT THE RELEASE OF RECURSION FROM ITS MOTOR PRISON TO OTHER DOMAINS OF THOUGHT."

M. HAUSER 2009. ORIGIN OF THE MIND. SCIENTIFIC AMERICAN. SEPT. 2009.

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- THE TRANSITIONS
 - FROM DOMAIN-GENERAL TO DOMAIN-SPECIFIC, AND VICE VERSA
 - FROM CORE MERGE TO RECURSIVE SUB-MERGE
- EXPERIMENTAL SYNTAX FOR BIOLINGUISTICS NEEDS A CROSS-MODULAR COMPARATIVE METHOD.

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THANK YOU!

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