Biolinguistic Minimalism and Language Evolution

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"... an evolutionary novelty may result from the combination of two pre-existing parts with unrelated functions."
- M. Ridley

"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

Original Function vs. Current Utility

- Language as a tool for communication is an exaptation of language for thought.
- 'Current language with some function' is an exaptation of 'original language with no function.'
The functions of the components that jointly constituted the language faculty later in the hominin evolution may have had nothing to do with the current or original function(s) of language.

Animal communication may have only an indirect bearing on language evolution.

Organization

Part I: Conceptual Issues
Part II: Recursion in Minimalist Syntax
Part III: Towards a Comparative Study

Part I
Conceptual Issues

Biolinguistics:

Naturalization (or biologization) of human language faculty
Biosyntax
Biosemantics, etc.
**Minimalist Program:**

- Minimization of UG by reduction to natural laws (“the third factor”).
- Perfection, Optimality, Economy, Simplicity, and elegance in nature and language (as a natural object)
- Methodological Naturalism
- Strong Minimalist Thesis

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**Wiring optimization can relate neuronal structure and function**

Both L. Cheruv, David M. Hof, and Omri O. Chokkanda

Edited by C. Steven, 1996 issue for��ular voice (2005). We consider the structure of neural pathways in the brain as a complex system of interconnected neuronal networks. The optimization of neuronal structure and function is critical for the efficient processing of information.

**The physicist’s problem is the problem of ultimate origins and ultimate natural laws. The biologist’s problem is the problem of complexity.**

- R. Dawkins
Biolinguistic Minimalism

...tries to explain the Design, Development and Evolution of human language in terms of things simple enough to be handed over to physics.

"The presumption of perfection in language seems unwarranted and implausible"
- A. Kinsella & G. Marcus

"Evolution is often more about alighting on something that happens to work than what might in principle work best or most elegantly; it would be surprising if language, among evolution’s most recent innovations, was any different."
- G. Marcus

"Your theory of language evolution depends on your theory of language"
- R. Jackendoff

...and on your theory of biological evolution, too.

Furthermore, your theory of language depends on your theory of language evolution and biological evolution.

Language evolution is an instance of biological evolution.

If your theory of biological evolution does not explain language evolution, then it needs a serious reconsideration.
Logical Problem of Language Acquisition (Plato’s Problem)

Explanatory Adequacy

Logical Problem of Language Evolution (Darwin’s Problem)

Evolutionary Adequacy

Modern Synthesis (Neo-Darwinism)

- Adaptationist
- Natural Selection as the First Resort
- Gradualist
- Functionalist
- Genetic Determinism

Expanded Synthesis (Neo-Neo-Darwinism)

- Non-adaptationist
- NS as the Last Resort
- Punctuated Equilibrium (saltationist)
- Formalist
- Epigenetic View
- Language as a Spandrel

Against Hyper-Selectionism (Ultra-Darwinism)

“Natural selection can only function within a ‘channel’ of options afforded by natural law…”

“… the whole process of evolution is shaped by physical processes … yielding many properties that are casually attributed to selection.”

“Darwin … taking explicit note of a range of possibilities, including non-adaptive modifications and unselected functions determined from structure…”

- N. Chomsky

“Suppose that some ancestor, perhaps about 60,000 years ago, underwent a slight mutation rewiring the brain, yielding Merge. Then he or she would at once have had available an infinite array of structured expressions for use in thought (planning, interpretation, etc.), gaining selectional advantages transmitted to offspring, capacities that came to dominate, yielding the dramatic and rather sudden changes found in the archeological record.”

- N. Chomsky
Arrival of the Fittest

Survival of the Fittest

Physical Channel

Selectional Pressure

Non-adaptationist Formalism

Adaptationist Functionalism

Natural selection shapes the character for a current use.

<table>
<thead>
<tr>
<th>APTATION</th>
<th>ADAPTATION</th>
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<tbody>
<tr>
<td>A character, previously shaped by natural selection for a particular function, is co-opted for a new one. (preadaptation)</td>
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| EXAPTATION |
| A character whose origin cannot be ascribed to the direct action of natural selection (a non-adaptation) is co-opted for a current use. |

D’Arcy Thompson:

Physical constraints on growth and form, morphological transformation

Alan Turing:

Chemical basis of morphogenesis
Reaction-Diffusion Model

C. Waddington:

Canalization, Genetic Assimilation

S. Kauffman:

Self-organization, Auto-evolution

Figure 2. Peacock with a highly ornamented tail which, like the male quail’s tail, evolved by female choice. If some “eyes” are removed from its tail, it becomes less attractive to peahens. It is hard to imagine how such an enormous encumbrance would be compatible with escape from predators, and indeed further enlargement of the tail may have been constrained by natural selection.
"We want to see how ... the forms of living things, and of the parts of living things, can be explained by physical considerations, and to realise that in general no organic forms exist save such as are in conformity with physical and mathematical laws."

-D'Arcy W. Thompson

**Canalization**

- "DEVELOPMENT IS ROBUST TO CHANGES IN GENOTYPE AND ENVIRONMENT"

- "INDIVIDUALS ARE SOMEHOW BUFFERED, OR CANALIZED, AGAINST GENETIC AND ENVIRONMENTAL VARIATION."
  - J. E. Niven. Channelling evolution -- canalization and the nervous system.

**Evo-Devo**

- "A MAJOR RESEARCH PROGRAMME WHOSE FINDINGS PUT INTO QUESTION SOME CONCEPTS LYING AT THE CORE OF THE SYNTHETIC THEORY"

- "A 'REVOLUTION' IN BIOLOGY, ONE IN WHICH THE EXISTING GENETIC DETERMINISM WILL GIVE WAY TO A NEW CONCEPTUAL UNDERSTANDING OF THE COMPLEXITY OF LIVING ORGANISMS"

- "FOCUSED ON HOW CHANGES IN DEVELOPMENT BRING ABOUT EVOLUTIONARY CHANGES"

**Biolinguistic minimalism seeks a teleomatic explanation of the language design.**

- APPARENT GOAL-DIRECTEDNESS:
  - Teleology
  - Teleonomy
  - Teleomaticity

"Language is like a snowflake."
Main points made so far:

- Language evolution must be studied on the basis of a specific paradigm of evolutionary biology.
- Language evolution works as a useful tool for evaluating one’s view of biological evolution in general.
- Biolinguistic minimalism adopts the new paradigm of expanded synthesis and evo-devo.

Part II
Recursion in Minimalist Syntax

Human Language Faculty: Basic Design

From Proto-Language to Full Human Language
"A key component of FLN is a computational system (narrow syntax) that generates internal representations and maps them into the sensory-motor interface ... and into the conceptual-intentional interface."

"FLN comprises only the core computational mechanisms of recursion as they appear in narrow syntax and the mappings to the interfaces."

- Hauser, Chomsky & Fitch

Apparently, FLN should include:
- Recursive Syntax
- Recursive Mapping to the Interfaces
- The Lexicon

Core issues of language evolution boil down to the origins of these capacities.
NO CLEAR EVIDENCE FOR LANGUAGES THAT DEMONSTRABLY LACK RECURSION
  - B. Heine & T. Kuteva

RECURSION IS ABSENT IN PIRAHÄ.
  - D. Everett

MANy LANGUAGES HAVE NO, OR VERY CIRCUMSCRIBED RECURSION IN THEIR SYNTAX.
  - N. Evans & S. Levinson

RECURSION IS JUST A THEORETICAL ARTIFACT.
  - D. Bickerton

Syntactic Recursion = Recursive Merge

- REPRESENTATIONAL RECURSIVENESS:
  A CATEGORY APPEARS REPEATEDLY INSIDE A PHRASE OF THE SAME CATEGORY.

- DERIVATIONAL RECURSIVENESS:
  THE ELEMENTARY COMBINATORIAL OPERATION MERGE APPLIES RECURSIVELY TO ITS OWN OUTPUT.

(1) [John [ saw Mary ]].
   (DERIVATIONALLY RECURSIVE)

(2) [Bill [ thinks [John [ saw Mary ]]]].
   (REPRESENTATIONALLY RECURSIVE, TOO)

Pirahä: A Language without Recursion?

(1) ti gäi-säi kõ'oi hi kaháp-i'i
   I say-old.info Kõ'oi he leave-intention
   'I say: Kõ'oi will leave.' (parataxis)
   - D. L. Everett

"... the speakers of this language aren't making use of a capacity that they surely have ..."
  - N. Chomsky
“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

- Core-Merge: \((A, B) \rightarrow \{A, B\}\)

- Recursive Merge: \((C, \{A, B\}) \rightarrow \{C, \{A, B\}\}\)

Merge is triggered by the “Edge Feature.”

- Only lexical items have the EF.
- Only lexical items can undergo Merge.
- Recursive Merge is possible only when the EF remains visible to the computational system.

... But how did the EF evolve?

Suppose in a language C’s EF is always erased once satisfied, the language will have no clausal embedding – a situation compatible with the Pirahã facts.
(1) EF invisible

(2) EF visible

(3) Recursive Merge applies

Labeling

Label (the, dog) = {the, dog}
Label {the, dog} = {the, {the, dog}}

Core-Merge + Label = Recursive Merge

Only Label, not Recursive Merge, belongs to FLN.
Core-Merge is not unique to language.

... But how did Label evolve?

N. Fukui: Label = Embed

Merge defines a Base Set \{A, B\} to which subsequent operations may apply.
Embed takes one member of this BS (A) and forms a union of this member and the BS.
Embed (A, \{A, B\}) = A \cup \{A, B\} = \{A, \{A, B\}\}
- LABEL = Recursive Merge
- Merge (C, {A, B}) = {C, {A, B}}
- LABEL (A, {A, B}) = {A, {B, C}}

No need to seek the origin of Label independently of Merge.

To the extent that Move = Internal Merge, Label is a strictly local version of Move.

Merge (C, {A, B}) = {C, {A, B}}:
1. External Merge, where C is external to A and B.
2. Internal Merge, where C is internal to A or B.
3. Label, where C is A or B.

Label always gives rise to Endocentricity.

But what about exocentric compounds?

   building-gen high-low-nom problem is “The height of the building is the problem.”

Root compounding

Exocentric compounds are in fact endocentric.

1. A+A→N
2. √ + √ + N→N

Diagram:
```
      N
     /\N
    /  \N
   /    \N
  /      \N
 /        \N
√TAKAI 'HIGH'

√HUKI 'LOW'
```
Evolution of the generative lexicon

Syntax (recursive Merge) generates words. (Distributed Morphology)

Lexical category = categorizer + root

$V + \sqrt{\text{DESTROY}} = \text{destroy}$

$N + \sqrt{\text{DESTROY}} = \text{destruction, etc.}$

The issue of whether proto-language was holophrastic or synthetic is largely irrelevant.

Word-like elements of proto-language (proto-words) could exist in the absence of syntax, providing materials to be combined later to form full words.

Syntactic Nature of 'Lexical' Verbs

1. a. John gave Mary a book.
   b. [VP John V [VP Mary V a book]]
   c. [John CAUSE [Mary HAVE a book]]

2. a. John gave a book to Mary.
   b. [VP John V [VP a book V to Mary]]
   c. [John CAUSE [a book GO-to Mary]]
Evidence from Developmental Data

CAUSE (2;0.4) ≥ HAVE (2;0.7) ≥
Double Obj verbs (2;1.6) ≥
GO (2;4.0) ≥ Dative Obj verbs (2;4.9)

- J. Viau

Merge in verb acquisition

“No verb is an island.”
“Children start to use Merge already with their very first word combinations.”

- A. Ninio

Children start to use Merge already with their very first words.

Three-Layered Split VP

```
       VP1
      /   \
     Agent  V
       \
        V1
       /   \
      Causer V  \
          /  \
         V2  \
            /  \
           V3  \
              Theme
```

cf. [x DO [x CAUSE [y BECOME ... ]]]

- Mapping to the C-I interface becomes straightforward.
- “Syntax carves out lexical and phrasal semantics.”
- The evolution of the C-I interface and the lexicon depends on the evolution of recursive syntax.
- Merge is at the root of human intelligence.

- Core-Merge + Label = Recursive Merge

- Core-Merge + Recursion = Recursive Merge

Given that Label is already an instance of recursive Merge, where does its recursiveness come from? (EF is not an answer; it can only be a necessary condition.)

- General Recursive Capacity was extended to Core-Merge in the human brain to yield recursive Merge.
“ALL CREATURES ARE ENDOwed WITH RECURSIVE MOTOR MACHINERY AS PART OF THEIR STANDARD OPERATING EQUIPMENT.”

“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

Main points made so far:

- Merge, subsuming both Move and Label, is the elementary computational device of human language.
- The uniquely human Recursive Merge evolved from the combination of Core-Merge and general recursive capacity, neither of which is unique to human language.
- The origins of these capacities, and the process of their combination, are the key issues of language evolution.

Part III
Towards a Comparative Study

Tools and Language: Action to Syntax

- Broca’s area: common neural substrate for hierarchical organization in action and language
- Mirror neurons: for goal-directed manual action and language
Gestural origin of syntax (?)

cf. M. Corballis: “Speech evolved from manual gestures.”
I. Pairing Strategy

Core-Merge

THE  BOY

II. Pot Strategy

Pot-Merge:

JOHN  SAW  MARY

III. Subassembly Strategy

Sub-Merge:

THE  BOY SAW  MARY
- **Pot-Merge:**
  - Merge (A, B):
    - A attracts B, forming \{A, B\}=A.
  - Merge (A, C):
    - A attracts C, forming \{\{A, B\}, C\}=A.

- **Sub-Merge:**
  - Merge (A, B):
    - A attracts B, forming \{A, B\}=A.
  - Merge (A, C):
    - C attracts A, forming \{\{A, B\}, C\}=C.

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**Swedish: barn bok klub:**

```
  barn
   /\      /
  bok  klub
       /\    /
      BARN KLUB
```

**English: child book club:**

```
  child
   /\      /
  book  club
       /\    /
      CHILD CLUB
```

- T. Roeper & W. Snyder

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**Potential Problem:**

If 'book' and 'child' are syntactically complex, right-branching compounding already requires Sub-Merge.

```
  [n √ child] [n √ book] club
```

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**Root Compounding**

```
  N
     √ barn
    /
    N
     √ bok
    /
    N
     √ klub
```

```
  N1
   /\    /
  N2   KLUB
     /
     barn
```

```
  N2
   /\    /
  N1   bok
     /
     barn
```
- Given that a lexical category is syntactically complex, merger of lexical categories always takes place in the form of Sub-Merge.

- It was the emergence of Sub-Merge that gave rise to full human language.

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**Action**

- **Pairing Strategy**
- **Pot Strategy**
- **Subassembly Strategy**

**Syntax**

- **Core-Merge**
- **Pot-Merge**
- **Sub-Merge**

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

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The human language faculty has been viewed as a de novo integration of independent structural and functional systems. The human ability goes beyond the capacity to process sequence and simple transformational patterns of an infinite number of possible sentences. How could this be? How could the processing of natural language be so fundamental? Here, we show that the processing of natural language is a biologically based, independent cognitive system that is responsible for conceptualization, coding, and communication of novel concepts. The brain must have evolved in a process that is not supported by the evolutionary tree of our species. This hypothesis is consistent with the idea that the human language faculty is a de novo integration of independent structural and functional systems. It is also consistent with the idea that the human language faculty is a de novo integration of independent structural and functional systems. This hypothesis is consistent with the idea that the human language faculty is a de novo integration of independent structural and functional systems.
Two Neuronal Circuits for Processing Syntactic Complexity

- **Finite State Grammar (A^B^n):**
  - Ventral Premotor Cortex (vPMC, BA6) & Deep Frontal Operculum (FO)
- **Phrase Structure Grammar (A^B^n):**
  - BA44/45 (Broca’s Area) & Posterior Part of Superior Temporal Gyrus (STG)

vPMC/FO phylogenetically older than Broca’s Area.

- A. D. Friederici & J. Brauer

Core-Merge is phylogenetically older (and ontogenetically earlier) than Sub-Merge.

Ph(r)asal movement is a form of Sub-Merge, a later innovation than Core-Merge.

Move for externalization (communication).

Transfer as Sub-Merge?
(recursive mapping to the(171,879),(501,975)

Phase = derivational chunk
“THE DISPERSION OF HUMANS OVER THE WORLD MUST POST-DATE THE EVOLUTION OF LANGUAGE, SINCE THERE IS NO DETECTABLE DIFFERENCE IN BASIC LANGUAGE CAPACITY AMONG CONTEMPORARY HUMANS.”

- N. CHOMSKY

FiguRE 15.7. Populated time spans and relationships of hominid species.

S. MITHEN 1988. THE PREHISTORY OF THE MIND.

GENERAL INTELLIGENCE

TECHNICAL INTELLIGENCE

LINGUISTIC INTELLIGENCE

SOCIAL INTELLIGENCE

NATURAL HISTORY INTELLIGENCE

THREE PHASES FOR THE EVOLUTION OF THE MIND

S. MITHEN 1988. THE PREHISTORY OF THE MIND.

MECHANISM 3

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

Main points made so far:

- Syntax evolved from manual action.
- Sub-Merge is the recursive engine of human syntax, a combination of pot-Merge and Subassembly strategy of action grammar.
- The fact that the Merge-based derivational model makes this kind of comparative study possible demonstrates the advantage of adopting minimalist syntax for evolutionary studies of language.
- It also shows that evolutionary linguistics and theoretical linguistics are tightly connected.

“To create is to recombine.”
- F. Jacob

“To create is to Merge.”
- A generative biolinguist