Experimental Syntax for Biolinguistics?

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Experimental Syntax for Biolinguistics?

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Biolinguistics:
- Naturalization, or biologization, of human language faculty (biosyntax, biosemantics, etc.)
- Design
- Development
- Evolution

Language evolution (and development) boils down to the emergence of:
- Recursive Unbounded Merge
- Interfaces
- Lexicon

cf. FLN / FLB dichotomy

Language evolution (and development) boils down to the emergence of:

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).

**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**

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**Major Issues:**

- **Mismatch between Theoretical and Psycho-/Neuro-Linguistics**
- **Lack of Comparative Methods**
- **Modularity as an end result of evolution & development**

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**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?

I say-old.info Kó’oi he leave-intention
"I say. Kó’oi will leave." (parataxis)


- 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."


- "Recursion is a theoretical artifact."
- Recursive Merge:
  - Merge applies to its own output.

"Working memory capacity may ... both enable and constrain syntactic 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.
Recursive Merge:

- **Core Merge**: $(\alpha, \beta) \rightarrow \{\alpha, \beta\}$

- **Label**: $(\alpha, \beta) \rightarrow \{\gamma, \{\alpha, \beta\}\}$, where $\gamma = \alpha$ or $\beta$

Label = Move = Merge

- **External Merge**: $(\alpha, \beta) \rightarrow \{\gamma, \{\alpha, \beta\}\}$, where $\gamma$ is external to $\alpha$ and $\beta$

- **Internal Merge**: $(\alpha, \beta) \rightarrow \{\gamma, \{\alpha, \beta\}\}$, where $\gamma$ is internal to $\alpha$ or $\beta$

- **Label**: $(\alpha, \beta) \rightarrow \{\gamma, \{\alpha, \beta\}\}$, where $\gamma$ is $\alpha$ or $\beta$

Label = strictly localized version of Internal Merge (Move)
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).

vPMC/FO phylogenetically older than Broca’s Area.


Syntax

- As a single computational module
- As a set of distinct computational modules

"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.
**Category-Specific Deficits: Noun-Verb Dissociations**

**Distinct neural substrates for verbal and nominal morphosyntax**

- **V**: frontal-parietal circuit
- **N**: frontal-temporal circuit

**Table 2**
The neurological distribution of formal syntactic operations

<table>
<thead>
<tr>
<th>Syntactic operation</th>
<th>Broca’s aphasias?</th>
<th>Main loci of activation in fMRI</th>
</tr>
</thead>
<tbody>
<tr>
<td>LEX</td>
<td>No</td>
<td>?</td>
</tr>
<tr>
<td>MERGE</td>
<td>No</td>
<td>?</td>
</tr>
<tr>
<td>MOVEبرش</td>
<td>Yes</td>
<td>L-SFG, R-STS, L-STS</td>
</tr>
<tr>
<td>MOVEلى</td>
<td>No</td>
<td>L-SFG, L-MFG</td>
</tr>
<tr>
<td>BIND</td>
<td>No</td>
<td>R-MFG, L-SFG, L-OG</td>
</tr>
</tbody>
</table>

**Exaptive Evolution of Recursive Merge**

- **Action Syntax**
- **Core Merge**
- **Recursive Merge**

**Distinct neural substrates for verbal and nominal morphosyntax**

- **V**: frontal-parietal circuit
- **N**: frontal-temporal circuit

**Fron**
- **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)

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.”


Mechanism 3
A gene influences several areas of the brain, and each area affects several cognitive processes

"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

Three phases for the evolution of the mind

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
I. Pairing Strategy

Merge (Nut, Anvil) → \{Nut, Anvil\}

Merge (Hammer, \{Nut, Anvil\}) → \{Hammer, \{Nut, Anvil\}\}

II. Pot Strategy

Pot-Merge:

John

Saw

Mary

Subassembly Strategy

Sub-Merge:

The

Boy Saw

Mary
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."


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.
References
Greenfield, P. 2006. Implications of mirror neurons for the ontogeny and phylogeny of cultural processes: The examples of tools and language. In M. A. Arbib ed. Action to Language via the Mirror Neuron System. CUP.