‘Speaking Brains’
Collective Papers on AI, Neuro-circuity and Basal Ganglia Grammar

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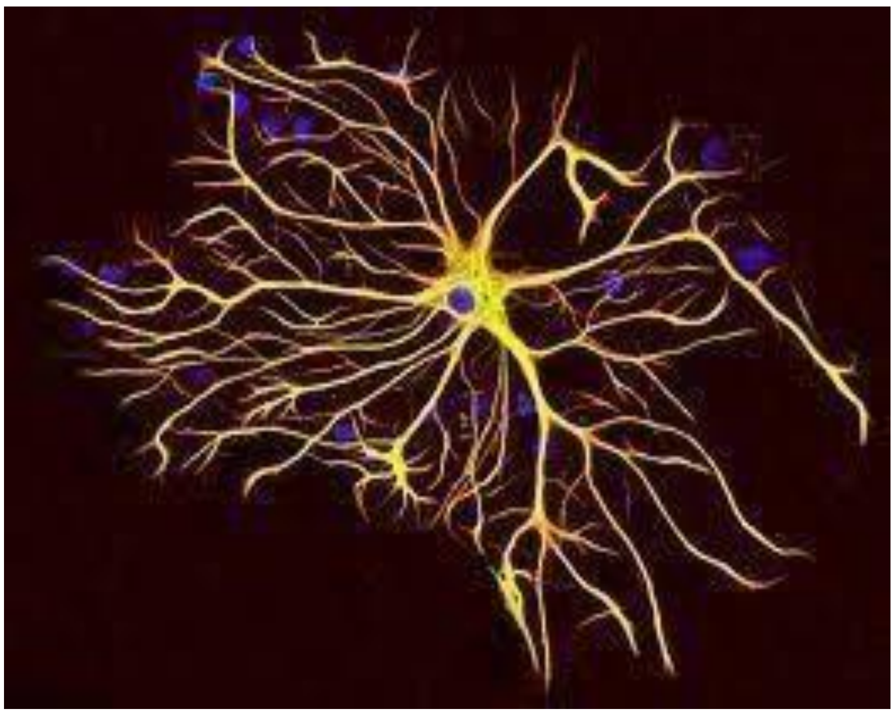

Preface

In a 1995 book entitled *Speaking Minds,* editors Peter Baumgartner and Sabine Payr put together a fascinating series of interviews with twenty of the most eminent cognitive scientists of the twentieth century. Out of these interviews emerged just how deep-seated and explicitly contentious animosities ran between some of these great minds, and showcased just how it was inevitable that two camps on AI would eventually splinter. Like two emerging phoenixes out of the cognitive ashes of unfulfilled promises, this Janus-headed monster would take on almost religiously zealous overtones and contempt for one another, as both sides would attempt to explain away the other's respective shortcomings in what was at the time thought of as an emerging field which held so much promise for future AI. While the interviews in 1995 seemed new and nuanced by today's standards, the debates themselves have much earlier antecedents dating back to pioneers such as Donald Hebb ('neurons which fire together wire together'), and pre-war brilliant polymaths such as von Neumann and Turing himself (the Turing Test)—all of whom fostered the famous post-war debates between Marvin Minsky and Frank Rosenblatt (classmates from the same Bronx High School of Science). The debates can be articulated in one fell swoop—namely, (i) whether AI and Cognitive Science (which would lead to deep learning, and our current Chat-GPT) should try to emulate the actual inner neurological architecture of the human brain, whereby 'human *learning*' arises from a *singular mode* of neuronal binary/**digital** activity, (the nature of which is heavily reliant upon brute-force notions such as *locality, frequency* and *weighted strengths)*, or (ii) whether the brain's architecture—as was then and still is today so impervious to our complete understanding—should be modeled not based on its poorly understood neuronal architecture, but rather modeled on its computational performance and outcomes for such capacities as logic, *reasoning, cause-and-effect*. These latter processes are uniquely human and seem rather **analog** in nature, as they give rise to symbolic rule-based procedures of language and 'human *understanding*'. The Singular vs Dual Mechanism Model debates are currently ongoing in the field. These papers amount to some of my thoughts on the topic. The following links are pulled from *informal working papers and squibs and* represent some of my thoughts are the current state of a potential AI-to-Natural Language Interface. The last three papers (Section III), particularly 'Why Move?', attempts to capture this AI to Natural Language interface regarding developmental stages of child syntax.

This informal e-book is organized into three sections:
Section I 'The Neuro Basis for Language', Section II 'Recursive Grammars', and
Section III 'Child Language Acquisition'.

*Papers, Squibs and Essays on the topic can all be found on my academia site: https://csun.academia.edu/josephgalasso

Contents

Section I: The Neuro Basis for Language.

1. Basal Ganglia Grammar

What follows is a brief research statement of what I think may be a neural 'common-denominator' behind all these inner-workings leading to language — namely, 'the *Basal Ganglia'* (BG), a subcortical region of the brain not dissimilar to what we know and find of the *insular cortex*, which serves as a switchboard-like operator for all inputs coming in from different regions of the brain, to be sorted and allocated — the accumulation of which leads to the manifestation of language (see e.g., Liebermann 2002/2006). Foremost in importance among these BG inner-workings is the ability for *movement.* For example, in Parkinson's disease we see BG neurological impairment leading not only to loss of *physical* 'noisy' movement control (Huntington's dance), but also to deficits in *mental* movement (so-called 'silent' movement) related to (syntactic) movement-based processes such as long-distance dependences exhorted by the brain/mind (i.e., hierarchical long-distant co-indexing which goes well beyond linear-ABABABA grammars, See Galasso 2023a). (Some of the best studies of such loss of mental, silent movement comes from Broca's Aphasia (BA) subjects who show loss of syntactic movement capabilities.3 Regarding the latter (silent mental movement) there may be similar maturation factors at play in the emergence of early child language syntax) (The Silent-Unspoken 'language of thought' is a perfect example of such silent movement (see Moro's Lecture)).

https://www.academia.edu/104605907/Basal_Ganglia_Grammar_The_Neuronal_Substrate_as_Common_Denominator_Interface_for_Language

2. The Basal Ganglia, Astrocyte-Ca^{2+} Neuronal -Circuit and Artificial Intelligence.

The most compelling evidence to date for involvement of the Basal Ganglia (BG) (Basal Ganglia Grammar) in natural language comes to us from theoretical *movement operations* (nested dependency, distant binding and trace-theory). This implication of BG overlaps with well-established evidence showing Broca's involvement with movement. Dual pathways are a marked characteristic of BG insofar that in cascading down-stream neural networks, both direct as well as indirect paths affect admixed neuronal populations from multiple cortical areas. A tentative proposal may suggest that any notion of duality at the subcortical level may have the ability to simulate what we know of local vs distant binding dependencies as found in Dual Mechanism Model accounts of natural language.

https://www.academia.edu/107999360/The_Basal_Ganglia_Astrocyte_Ca_2_Neuronal_Circuit_and_Artificial_Intelligence_Real_Requirements_towards_AI_Transformer_to_Natural_Language_Interface_A_Dual_Mechanism_Account

3. **Squibbing against continuity in AI**

The fact that the brain is made up of neurons doesn't tell us much about the underlying representational mode upon which human thought is delivered, nor does it account for whether there are analogs to computer-software procedures as found in Artificial Intelligence (AI). The arguments herein contrast two types of neuronal delivery systems (local v distant, serial v parallel) in determining how short-term memory (hippocampus) tethers to 'local-domain' connectionist models, while long-term memory (cortex) tethers to 'distant-domain' symbolic models: thus, any putative interface which seeks to model the human global thought-process must require a hybrid model. The dual distinction, while model-based on serial v parallel neuronal processing, may provide insights into human language and cognition—for instance, we now know that Cortico-Hippocampal interplay (distant-to-local) shapes representational context in the brain. Hippocampal-Neural-net models (such a connectionist multilayer-perceptrons) seem to play an important role in the 'correlation' of local, frequency-based representations ('words')—whereby such 1-1 correlations can be readily captured by statistics—while Cortico-Symbol-manipulation is crucial to a deeper 'understanding' in spawning the necessary distant and recursive implementation which defines human language ('rules'). Another way to juxtapose these two distinct systems is to speak about the role 'Items' vs 'Categories' play in human language and thought—the former Item being advanced by brute-force statistics which promote 'local domain' correlations, while the latter Categories promote 'distant-domain' understand—such as logical inferences, causal relations and abstract knowledge. We believe the human mind to be uniquely defined by the latter categorical manner—viz., human thought is representational in nature, abstract in variable usage, and hierarchically recursive. We certainly know that much more goes on beneath what meets the eye in human understanding: broad understanding is certainly much more than the sum of its narrow parts. Any well-designed AI wishing to simulate human thought must capture these unique prerequisites.

https://www.academia.edu/103248724/Squibbing_Against_Continuity_Claims_in_Artificial_Intelligence_Why_We_Cant_Get_There_From_Here_The_Pursuit_of_Recursive_Neurons

Section II: Recursive Grammars

4. **ABABABA-Grammars.**

Recursive embedding as part of the language faculty has recently become the one essential ingredient in establishing the definition of what constitutes 'human language'—namely, recursion: that quintessential phenomenon which separates animal communication from human language, stage-1 child utterances from full adult syntax, MERGE operations over MOVE, and human-abstract rules found in the human mind vs Deep-Learning/AI algorithms: Why child stage1 cannot discriminate between the expressions 'boat-house' vs 'house boat' (the former a kind of house, the latter a kind of boat); Why regular rule formations such as the prosaic plural {s} as found in English remain productive over an array of nonce (never-heard-before) items, and why irregulars must rather be memorized (via reinforcement: Stimulus & Response); Why Move operations provoke a non-frequency-driven recursion of the [[ ]] type, while Merge relies on frequency of item for brute memorization. Some argue that recursion is a recently adapted byproduct of a newly emergent human brain, perhaps having arisen as recently as 40KYA (thousand years ago), and perhaps the one feature which gave Cro-magnum an edge-up (in software) over Neanderthal. The following paper examines some basic issues surrounding the theme 'Recurrent vs Recursive' within a maturational/developmental progression: viz., syntax, long-distant dependency, and recursive design whereby algorithmic computation {x+y=z} governs grammar, as opposed to frequency-driven adjacency (x=x) as found in platforms of artificial intelligence.

https://www.academia.edu/108466141/The_Recursive_Linguistic_Mind_Recurrent_ABABABA_Grammars_Recursion_and_a_Note_on_Child_Syntax_1

5. **A Note on Artificial Intelligence and the critical recursive implementation: The lagging problem of 'background knowledge'**

Most historians of the Cognitive Revolution consider the now historic 1956 MIT IRE Conference 'Transactions on Information Theory' to be the conceptual origin of the revolution. It was at this conference that three of the most important papers in the emerging field of AI would be read: (i) George Miller's Human memory and the storage of information (coupled with an earlier 1955 paper The magic number seven, plus or minus two: Some limits on our capacity for processing information). (ii) Allen Newell & Herbert Simon's paper The logic Theory Machine: A complex Information processing system. (iii) Noam Chomsky's paper Three models for the description of language. But it would not be long before splits would occur in the very defining of AI. For some, let's call them the AI-soft crowd, despite the ever-growing consensus that the brain really did not function like a computer after all, (as was earlier suggested by the naïve 'brain is computer' metaphor of the time), the AI-soft crowd, against the push-back, were content to go their own way and see just how far they could actually push their learning algorithms in solving 'real-world' problems (eventually using Bayesian networks). Most early cognitive scientists of this time—while now at least partially acknowledging and accepting the fact that what they were doing was indeed not real 'human intelligence' modeling—would nonetheless remain undeterred from learning about how to improve upon these non-human-like networks. One AI-soft champion that stands out here would be Frank Rosenblatt and his Perceptron model for visual learning (1959-1962).
https://www.academia.edu/104606120/A_Note_on_Artificial_Intelligence

Section III. Child Language Acquisition: The Maturation of Recursive Structures.

6. **Why Move?**
One of the leading questions burning in the minds of most developmental linguists is: To what extent do biological factors such as brain maturation play a role in the early stages of syntactic development? The theoretical framework 'Merge over Move' is applied here to the earliest observable stages of child syntax, a stage-1 which demonstrates a complete absence of movement operations owing to a complete lack of INFLectional morphology. The data in the paper support claims for a Non-INFLectional stage-1.
https://www.academia.edu/108466152/Why_Move_Preliminary_Thoughts_and_Overview_How_Merge_over_Move_informs_Early_Child_Syntax

7. **Remarks on a Minimalist Approach to Early Child Syntax.**

The working hypothesis in this paper is that the young children's syntactic parsers are initially unable to advance (MOVE) a morpho-syntactic utterance, both at PF (phonology form) and at LF (logical form) up the syntactic tree (whereby MOVEment would thus save the derivation from being sent off immediately to early semantic transfer). A pervasive deficiency of recursive movement is not just a surface-level PF deficit, but is also found at interpretation. Hence, as a metaphor for this lack of movement (both at PF and LF), children's early utterances are indeed semantically frozen deep within the prosaic trappings of the bottom portion of the tree (namely, within the base-generated VP phrase) and are thus sent immediately to spell-out. In this paper, I propose an initial 'merge-only' stage of child syntax which can account for a rather wide spectrum of implications leading to the impoverished state of early child syntax. Using Chomsky's current Minimalist Program (MP) framework, I adopt a 'Merge over Move' hypothesis as a developmental sequence thus accounting for the cited mixed word order, lack of inflection, and misreading of syntactic compounds found in the data.

(PDF) Remarks on a Minimalist Approach to Early Child Syntax | joseph galasso - Academia.edu

8. **Oxford Bibliographies: 'The Acquisition of Possessives'**

Developmental Pragmatics - Linguistics - Oxford Bibliographies