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# The emergence of language as a function of brain-hemispheric feedback

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The Emergence of Language  
as a Function of  
Brain-Hemispheric Feedback

Eric Alexander La Freniere

A thesis submitted to the Graduate Faculty of

JAMES MADISON UNIVERSITY

In

Partial Fulfillment of the Requirements

for the degree of

Master of Science

School of Writing, Rhetoric, and Technical Communication

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## DEDICATION

For my mother—Bernadette Michelle-Marie La Freniere (1948-2012).

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Over the years, my closest friends—Gera Miles, Marc Chenault, Greg Conrow, and John Newman—encouraged me to finish my schooling (Newman: “It’s time to shit or get off the pot!”). I hope my scholarly efforts are worthy of their high estimations.

Without the support of my father—Jimmie La Freniere—it would have been even more difficult to complete my undergraduate and master’s degrees. He and my mother always believed in and loved me, even when I wandered along strange paths.

But the person who encouraged and supported me most is my best friend, wife, and muse—Meredith—who concocted delicious organic meals to keep me healthy, often read my febrile brain to sleep, listened to my cryptic rants, and provided insightful feedback and ideas. Truly, I am a lucky man!

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## ABSTRACT

This text posits the emergence of language as a function of brain-hemispheric feedback, where “emergence” refers to the generation of complex patterns from relatively simple interactions, “language” refers to an abstraction-based and representational-recombinatorial-recursive mapping-signaling system, “function” refers to an input-output relationship described by fractal algorithms, “brain-hemispheric” refers to complementary (approach-abstraction / avoidance-gestalt) cognitive modules, and “feedback” refers to self-regulation driven by neural inhibition and recruitment. The origin of language marks the dawn of human self-awareness and culture, and is thus a matter of fundamental and cross-disciplinary interest.

This text is a synthesized research essay that constructs its argument by drawing diverse scholarly voices into a critical, cross-disciplinary intertextual narrative. While it does not report any original empirical findings, it harnesses those made by others to offer a tentative, partial solution—one that can later be altered and expanded—to a problem that has occupied thinkers for centuries.

The research contained within this text is preceded by an introductory Section 1 that contextualizes the problem of the origin of language. Section 2 details the potential of evolutionary theory for addressing the problem, and the reasons for the century-long failure of linguistics to take advantage of that potential. Section 3 reviews the history of the discovery of brain lateralization, as well as its behavioral and structural characteristics. Section 4 discusses evolutionary evidence and mechanisms in terms of increasing adaptive complexity and intelligence, in general, and tool use, in particular.

Section 5 combines chaos theory, brain science, and semiotics to propose that, after the neotenic acquisition of contingency-based abstraction, language emerged as a feedback interaction between the left-hemisphere abstract word and the right-hemisphere gestalt image.

I conclude that the model proposed here might be a valuable tool for understanding, organizing, and relating data and ideas concerning human evolution, language, culture, and psychology. I recommend, of course, that I present this text to the scholarly community for criticism, and that I continue to gather and collate relevant data and ideas, in order to prepare its next iteration.

## 1.0 - INTRODUCTION

*The sign must “tell its story” before it can acquire a formal signification. In the resulting model of narrative as the constitution of the sign, the story is the generation of transcendence from immanence.*

-Eric Gans,<sup>1</sup> cultural anthropologist and philosopher of language

## 1.1 - TREE OF KNOWLEDGE

What does it mean to be human? We are flesh-and-blood animals, to be sure, but we have been variously defined as tool-using, artistic, meaning-making, story-telling, religious, rhetorical, ethical, rational, and self-aware. Since each of these traits depends upon, or at least involves language use, we are, most essentially: the ape that speaks.

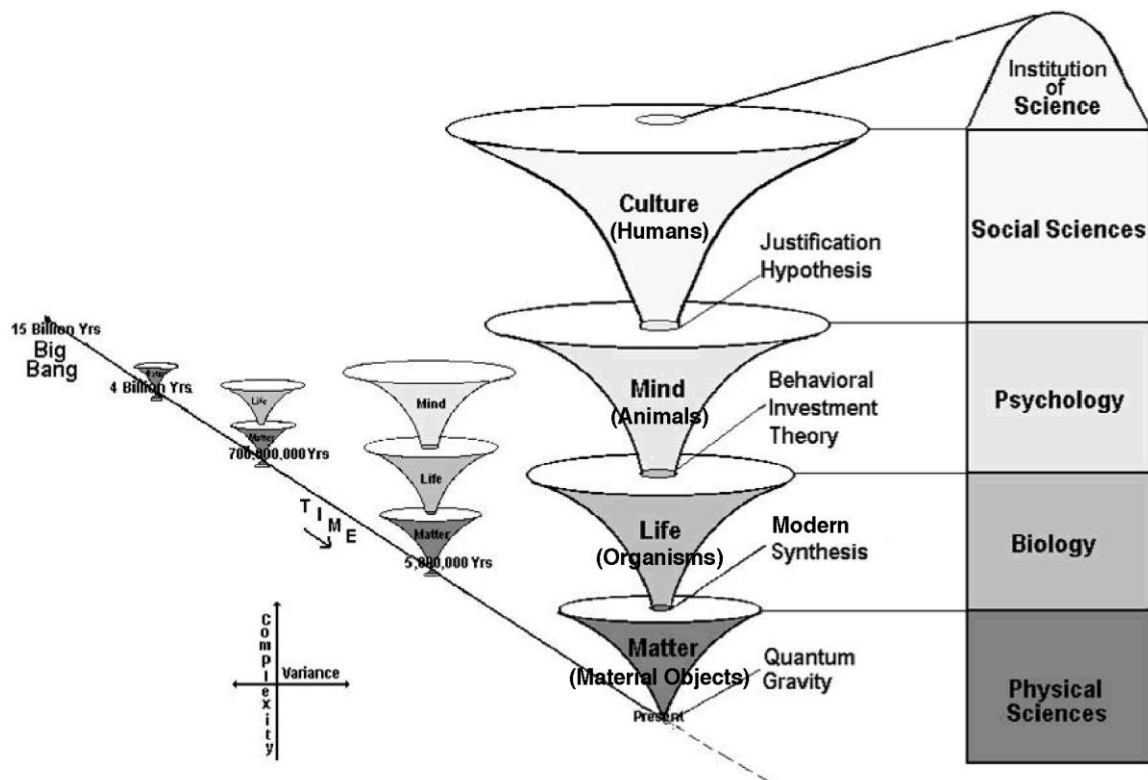
Where did language come from? If we can answer that question, we can better understand not only whence we came, but whither we are bound. However, that question, although much-addressed, remains unanswered. Indeed, the origin of language might be the hardest problem in science (Christiansen & Kirby, 2003); anyone hoping to not simply further polish that already-smooth nut through worried handling, but to crack it apart to get at its meat, must carefully contextualize it, and in light of that contextualization, choose from the disciplinary nut-cracking tools available.

Where is the problem of the origin of language situated? The Tree of Knowledge (ToK) model<sup>2</sup> developed by psychologist Gregg Henriques is useful here (see Figure 1).

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<sup>1</sup> From his electronic essay “Originary Narrative” (1997 / 1998).

<sup>2</sup> An outline of the ToK published in *Review of General Psychology* (2003), and two special issues of the *Journal of Clinical Psychology* focused on the system (2004 and 2005), as did a special issue of *Theory &*



**FIGURE 1. Tree of Knowledge (ToK) System (after “Tree of Knowledge System,” 2008).**

**This diagram illustrates the evolutionary emergence of four dimensions of cosmic complexity over time, as well as the hinge points between them and the class of sciences dealing with each.**

The ToK is a macro-evolutionary model intended to meta-theoretically encompass phenomena amenable to scientific investigation, in general, and to contextualize and organize the psychological sciences, in particular. Its scale is cosmic, its structure is nested, and it

... maps the pieces of the scientific puzzle in a novel way that connects Quantum Mechanics to Sociological processes and everything in between into a coherent whole. The most novel aspect of the ToK is its visuo-spatial depiction of knowledge as consisting of four dimensions of complexity (Matter, Life, Mind,

---

*Psychology* (2008). Most recently, Henriques elaborated his model into a book, *A New Unified Theory of Psychology* (2011).

and Culture) that correspond to the behavior of four classes of objects (material objects, organisms, animals, and humans), and four classes of science (physical, biological, psychological, and social). (Henriques, ToK FAQs)

Between the ToK's "dimensions of complexity" are what Henriques calls the "theoretical joint points" that address the moments of discontinuity before the emergence of novel properties—moments rather like the phase transitions that mark transformations between different states of matter in physics, or the paradigm shifts that mark transformations between different scientific models.

I will discuss such discontinuous change further in Section 5.1, but here it is enough to understand, in an admittedly simplified fashion, that a theory of Quantum Gravity (once achieved) would be a combination of quantum mechanics and general relativity that might explain the emergence of matter out of energy, that the Modern Synthesis (or "Neo-Darwinism") is a combination of evolutionary theory and genetics which might explain the emergence of life, that Behavioral Investment Theory is a combination of behavioral science and neuroscience which might explain the emergence of animal awareness, and that the Justification Hypothesis is a combination of psychology and sociology which might explain the emergence of culture and self-awareness.

According to Henriques, self-awareness "is an evolutionarily novel mental apparatus that functions to build justification narratives that legitimize actions and claims" and "is the language-based portion of one's mind that is narrating what is happening, why it is happening, and why one is doing what in that context." Furthermore, "the Justification Hypothesis posits that such justification narratives are evolutionarily

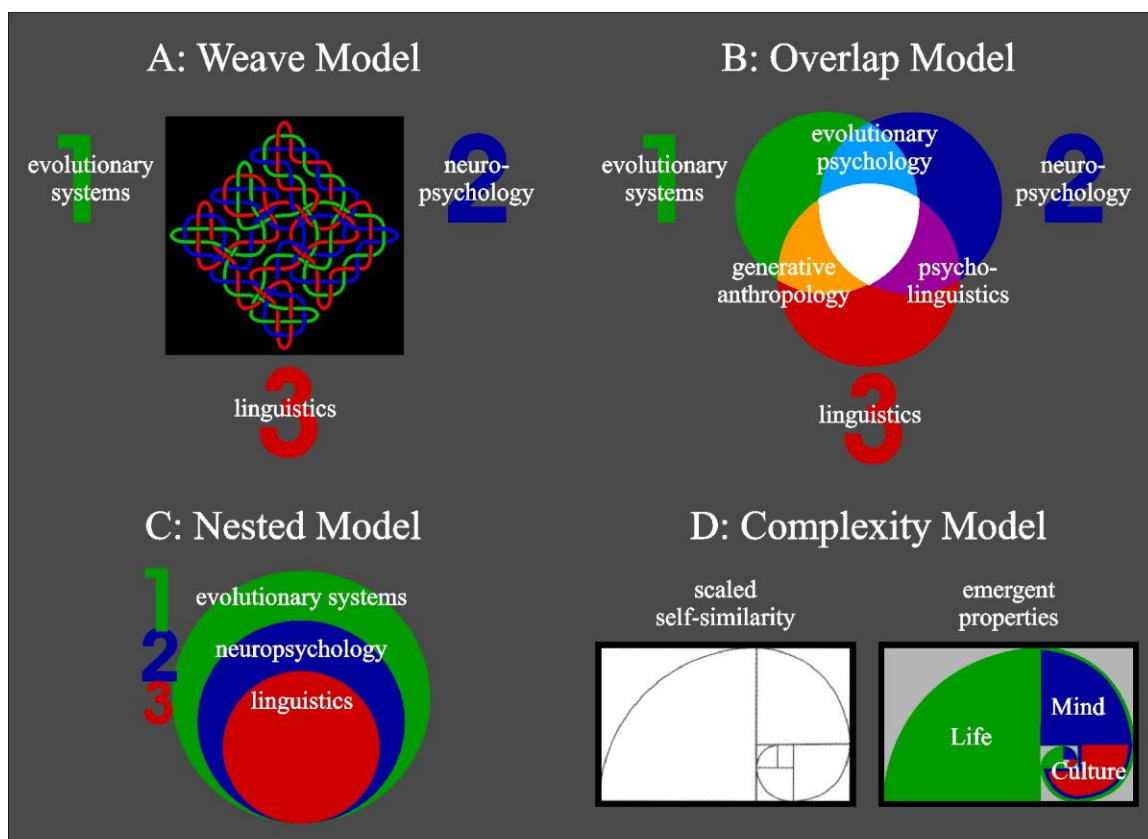
recent, emerging in close conjunction with the evolution of language in general.”

(Henriques, 2011, p.115)

So the problem of the origin of language can be narrowly situated at the very base of the joint point addressed by the Justification Hypothesis. And the disciplinary tools that can properly be brought to bear upon the nut of the problem—the acorn that, nested in the soil of animal awareness, has grown into the oak tree of culture and self-awareness—are those belonging to *evolutionary systems theory*, *neuropsychology*, and *linguistics*, where evolutionary systems theory constitutes a metanarrative or totalizing explanatory framework, neuropsychology addresses anatomy and physiology related to awareness, and linguistics addresses language as a signaling system capable of generating culture and self-awareness.

## 1.2 - SPIRAL OF EVOLUTION

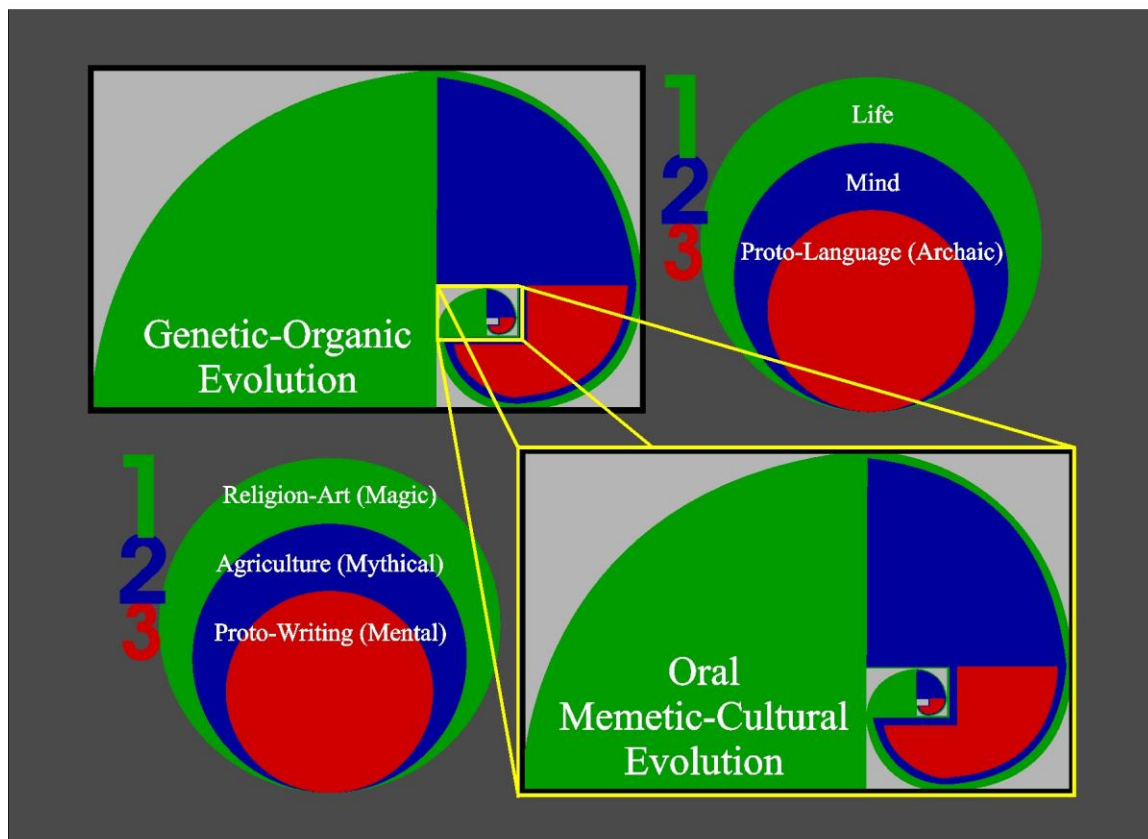
The relationships among those three primary disciplinary perspectives, employed in varying proportions throughout this text, can be visually modeled in different ways to provide insight into the problem of the origin of language. They can be simply interwoven (see Figure 2a) and draped over the problem to suggest its contours, but this tends to obscure a wealth of important details. Better, they can be overlapped (see Figure 2b) to emphasize cross-disciplinary contact zones—for example: evolutionary psychology, psycholinguistics, and generative anthropology—that might aid in understanding the problem. Best yet, they can be nested (see Figure 2c) to reflect the ontological underpinnings of the problem, so that evolutionary systems theory is treated architectonically in terms of complexity, mind is treated as an emergent property of life,



**FIGURE 2. Visual Models of Disciplinary Relationships.**

**These diagrams illustrate possible structural relationships among the three primary disciplinary perspectives employed throughout this text; the models are presented from least to most useful.**

and language is treated as an emergent property of mind. And if the nested model is represented in terms of scaled self-similarity (see Figure 2d), the emergent character of complexity is dramatically emphasized, as is the entropic fact that much less energy-space-time is available to each emerging dimension. Of course, if evolution traditionally relates to life, neuropsychology relates to mind, and linguistics relates to culture, then further involutions of this sequence denote the novel cultural structures that depend most proximally upon the origin of language.



**FIGURE 3. Emerging Oral Cultural Structures.**

**This diagram illustrates the relationship among Oral cultural structures and Gebser's structures of consciousness—a nesting made possible by the emergence of speech from organic evolution.**

A consideration of the oral structures of mimetic-cultural evolution in nested relation to the preceding structures of genetic-biological evolution (see Figure 3) suggests a technical distinction between proto-culture and culture proper, where the former marks a proto-human / proto-language phase transition between animal signaling systems and human speech—the point where genetic water begins to boil into mimetic steam. The evidence for as well as the nature and significance of proto-language will be discussed in Section 4.3, but here it is enough to note that the first true cultural structure to emerge was art-religion, followed by agriculture, then writing. It is likely that each of those novel structures simultaneously caused and was caused by changes in language corresponding to the evolution of self-aware consciousness. Indeed, the



structures of consciousness proposed by philosopher-linguist Jean Gebser (1905-1973) in his book *The Ever-Present Origin* (1986) can be applied to the structures of this emergent model so that the emergence of proto-speech and proto-culture roughly corresponds to the emergence of Archaic consciousness, art-religion to Magic consciousness, agriculture to Mythical consciousness, and writing to Mental consciousness.

Since it is proto-linguistic, Archaic consciousness is undifferentiated and pre-self-aware, and “can be likened to a dimly lit mist devoid of shadows.” Perhaps it might be compared developmentally to a toddler’s experience of the world, or mythically to Adam being limited to naming the animals in the Garden before he has eaten the fruit of the Tree of Knowledge of Good and Evil, that is, before he has acquired speech proper.

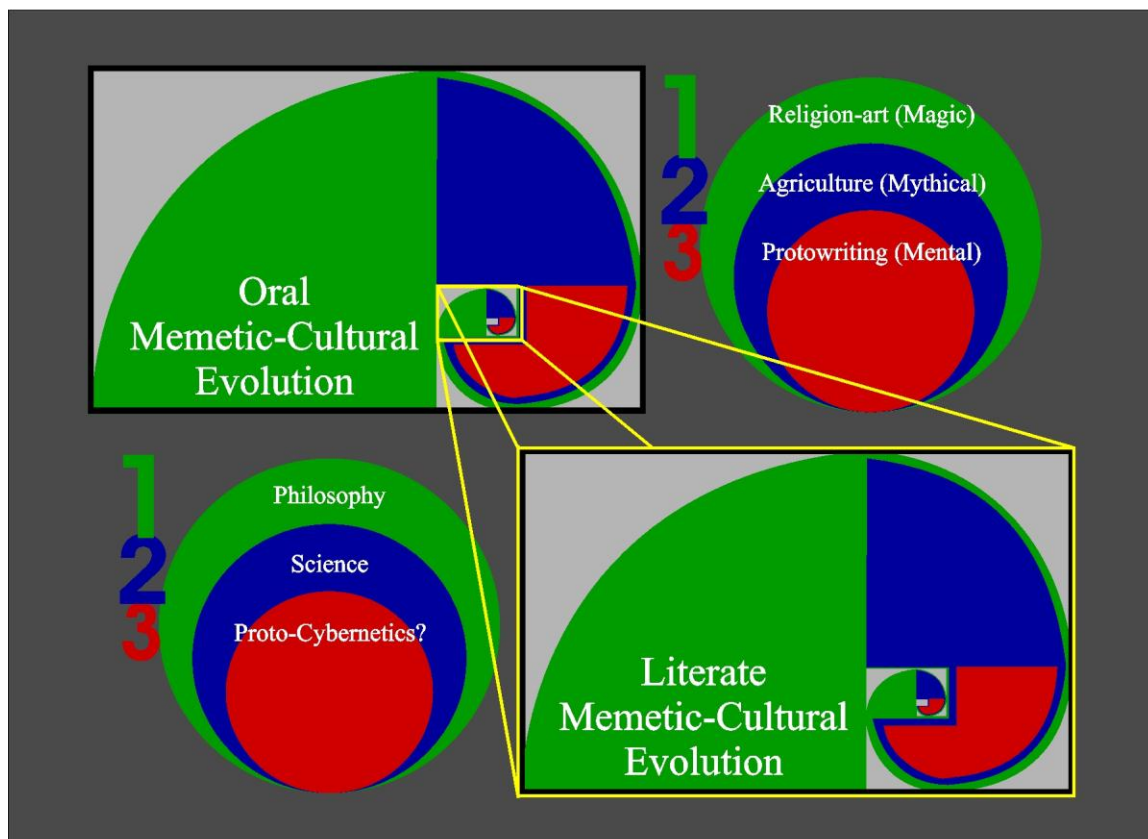
Magic consciousness, on the other hand, is linguistic; humanity has eaten the fiery fruit (or is making regular use of the fiery gift provided by another light-bearer who incurred divinely jealous wrath). And when speech starts to really divide the world, hunter-gatherers become aware of each other and especially of nature—and they use their newfound powers of symbolism not only to encompass and manipulate their world, but to express a primal sense of awe.

Starting with Mythical consciousness, though, speech becomes complex enough that human culture begins to displace nature as the center of concern in which the still-nascent individual remains embedded. Through increasingly skillful retelling, the dreams, inspirations, and actions of peoples in relation to their environments and especially each other are distilled into pedagogical-rhetorical narratives that organize and sustain agricultural societies.

And finally, Mental consciousness features the emergence of the perspectival, unified self, subjectively separated, as with a double-edged sword (the symbol of the intellect), from both nature and from other individuals. That separation was made possible by self-referential language, and made increasingly specialized and hierarchical societies possible—and unprecedented cruelty and greed, too.

### 1.3 - EVOLUTION BY ABSTRACTION

The next involution of the spiral, literate mimetic-cultural evolution (see Figure 4), is precipitated by the emergence of a novel information-processing system: writing. Actually, every turn of the spiral is precipitated by a novel information-processing



**FIGURE 4. Emerging Literate Cultural Structures.**

**This diagram illustrates the relationship among Literate and Oral cultural structures—a nesting made possible by the emergence of writing from cultural evolution.**

structure (Henrigues, 2011, 247-248), represented in these figures as a kind of hook that slingshots the evolving system into states of greater complexity against the pull of entropy, thus creating order out of chaos. Writing allows for the full flowering of Gebser's mental structure of consciousness, as expressed through the development of philosophy and science—and unprecedented alienation and anxiety, too.

What is the general relationship between speech and writing? They are both systems of abstraction, where “abstraction” here refers to the *removal or isolation of information for purposes of representation, recombination, and recursion*. For all its emotional immediacy, speech begins as an abstraction of perception—which is an abstraction of sensation, which is treated by any non-solipsistic episteme as an abstraction of an independently existing world—but speech is employed externally. Writing is an abstraction of speech, but that fourth-order abstraction is employed internally. While speech develops objective relationships with others, writing develops the self's relationship to itself. While speech builds group identity and cohesion, writing tends to enhance internal feedback or recursion, and heighten subjectivity. If “reflective thought is public or social conversation internalized” (Bruffee, 1984, p. 639), then writing is reflective thought polished and externalized.

Different forms of writing are related by their degree of abstraction. The image constitutes the most concrete form of writing (even paintings, petroglyphs, and photographs are abstractions), conveying a gestalt impression—a field of ideas. At one symbol per idea, pictographic writing is still somewhat concrete, but its symbols tend to become more abstract / less visually recognizable over time. Syllabic writing is abstract in that its symbols seek to represent moments of breath. Phonetic writing seeks to abstract

or encode every discernible uttered sound. And binary code seeks to reduce language to the simplest differences of pure information.

Speaking of binary code, the nature of the information-processing system that can slingshot us around the next turn of the evolutionary spiral remains unclear (as do the structures of the next “wave”), but an obvious possibility, given the place of science, is something involving computers and cybernetics. In his books *The Age of Intelligent Machines* (1990), *The Age of Spiritual Machines: When Computers Exceed Human Intelligence* (1999), and *The Singularity is Near: When Humans Transcend Biology* (2005), inventor and futurist Ray Kurzweil waxes lucidly but excitedly about such things as artificial intelligence, machine-human interface, and immortality—all to be precipitated according to an exponentially increasing “Law of Accelerating Returns.” And in his chapter titled “The Fifth Joint Point,” Henriques agrees that the next structures will likely be machine-mediated and meta- (or post- or trans-) human / cultural:

A pattern is apparent. Matter emerges out of Energy, Life emerges out of Matter, Mind emerges out of Life, and Culture emerges out of Mind. The natural question that follows is, what emerges out of culture? The sensible answer is MetaCulture. (2011, p. 247)

It is, however, uncertain that humanity will successfully negotiate the limits to growth that can obstruct such technological achievement. Simply put, our numbers and drive for artificial luxuries might have already placed too great a burden on the natural structures that precede and sustain our cultural structures (McKibben, 2012; Meadows, Meadows, & Rander, 2004).

Moreover, if the medium is related to the message, increasing abstraction might simply code for analysis as opposed to synthesis, hierarchy as opposed to equality, and self-involvement as opposed to community (Rossi, 2005). Hence we might witness the unfolding of a digital “paradise,” a virtual world written by human, machine, or cyborg programmers and most accessible to elect members of society. Disembodied subjects might eventually revel in crystalline isolation, basking in illusory relationships—all light, no substance—and anticipating the finest cog-and-gear assimilation into some post-human cloud mind (Cranford, 1996). The projected Word may triumphantly dwell in such blissful hyper-abstraction, until the real world upon which it depends collapses (Diamond, 2004).

It is interesting to note that Gebser identified a fifth, non-technologically-mediated structure in the “unfolding” of consciousness—a structure he called “integral” consciousness—which seems to involve some kind of superrational merging principle, or transcendence of dualism and perspective. But relatively few people have experienced more than flashes of such mystical states, and the language that describes it is difficult and even paradoxical, so its contours are necessarily vague.

In any case, across the linguistic-cultural evolution or unfolding of self-awareness *thus far* can be discerned a trajectory from immanence to transcendence, from embeddedness to separation, from implication to explication, from the concrete to the abstract, from orality to literacy, and from the image to the word. And although Gebser’s structures of consciousness are fundamentally different ways of experiencing reality that emerge in more or less discontinuous or quantum-like jumps, they are interconnected not

only in that all previous stages are found in subsequent ones, but in that the seeds of all subsequent structures are found in the current one.

That idea of what Gebser calls “latency” explains why he preferred “unfolding” over “evolution”—the latter term connotes both randomness and progress, whereas the former connotes the increasing “transparency” of a cosmic entelechy or intrinsic law normally hidden from us by our deictic frame (hence *The Ever-Present Origin*). If unfoldment is a deterministic but unpredictable revelation of what ultimately already is, then teleological questions are not simply projections of linguistic self-reference, but category mistakes. If we can move beyond both ego and error, perhaps a scientific pantheism can prevail, and we can cease to appeal to anything beyond energy.

However, the assumption of cosmic purpose, whether couched in religious or quasi-religious terms or simply left unstated (e.g. Behe, 2006), is of central importance to understanding the historical stultification of efforts to solve the problem of the origin of language. Inasmuch as essentially human behaviors are bound up in language-use, that stultification has blocked definitive solutions to the problems of the origins of self-awareness, culture, and our species. Conversely, we shall see, teleological assumptions have motivated and reinforced various strains of human exceptionalism, some more unabashedly unscientific than others.

## 2.0 - EVOLUTION AND LANGUAGE

*Absolute uniformity of atoms and forces would probably have led to the production of straight lines, true circles, or other closed curves. Inequality starts curves, and when growth is diverted from the straight path it almost necessarily leads to the production of that most beautiful of curves—the spiral.*

-Alfred Russel Wallace,<sup>3</sup> naturalist-explorer

## 2.1 - BAN ON ORIGIN

The 1859 publication of Charles Darwin's *The Origin of Species by Means of Natural Selection of the Preservation of Favoured Races in the Struggle for Life* forever altered the scientific world, and fanned the fires of the popular imagination into an uproar that still rages, over 150 years later. Essentially, Darwin proposed an elegant model involving adaptive feedback between species and their environments—a process that despite its simplicity could begin to explain the dizzying complexity of life on Earth. His gradualist theory of organic evolution by natural selection sparked an intellectual conflagration that, according to its supporters, promised to burn away the dross of superstition, and according to its detractors, threatened to consume the very foundations of faith itself (Desmond & Moore, 1991).

Darwin's dangerous idea (to use Daniel Dennett's phrasing) was initially contested even by many scientists, but the majority quickly recognized that the evidence

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<sup>3</sup> From a personal letter to Isaac Bickerstaffe (reprinted in 1912), as quoted on the back cover of T. A. Cook's *The Curves of Life: Being an Account of Spiral Formations and Their Application to Growth in Nature, to Science, and to Art* (1914).

presented in its favor was overwhelming and that its time had come. Consequently, there was a desire within then-differentiating scientific disciplines to treat evolution in more general terms. The attendees of the 1866 conference of the Linguistic Society of Paris, for example, were very much interested in the origin and evolution of language. The *Société* had been established only a couple of years previously, in 1864, but was an expression of a modern philosophical tradition that included thinkers such as political philosopher-sociologist Jean-Jacques Rousseau (1712-1778) and epistemologist-psychologist Étienne Bonnot de Condillac (1715-1780).

In his posthumously published “Essay on the Origin of Languages” (1781), Rousseau had hypothesized that humanity and language began in warm, southern environments, and then diffused to colder, northern environments. He had also suggested that primal language had a musical quality and exercised emotional, rather than rational, power (Rousseau, 2010). Earlier, Rousseau’s friend, Condillac, who held that language sublimated sensation into culture and compared ideas to harpsichord notes, had intimated in his “Essay on the Origin of Human Knowledge” (1746) that language has its roots in instinctive gesticulation, but was fully realized in vocal signification or meaning-making. He also hinted that that poetic myth had been a pre-rational rhetorical and pedagogical device that was superseded by the invention of writing, which while a more precise method of communication, is relatively lacking in vividness and emotional impact compared with speech (Condillac, 2001).

Unfortunately, such interesting guesswork was based upon scattered philological or anecdotal data, rather than upon the systematically collected results of rigorously developed scientific methodologies. Indeed, by the 1866 meeting of the nascent



Linguistic Society of Paris, such methodologies still did not exist, and the admixture of philosophical speculation regarding language and scientific longing regarding Darwinian theory apparently generated such a cacophony of scholarly controversy that the *Société* took the drastic step of indefinitely banning any further discussion of the origin and evolution of language! (Kenneally, 2007, p. 9).

Since science is predicated upon open communication and free inquiry, it would be interesting to know exactly what dramatic events transpired at that conference to elicit such a seemingly unscientific (re)action, but the details are elusive. The controversy must have been both intense and international since several years later, in 1872, the London Philological Society instituted an identical ban on the discussion of the origin and evolution of language (Kenneally, 2007, p. 22). Significantly, the previous year had seen the publication of Darwin's *The Descent of Man and Selection in Relation to Sex*, in which the author had compared the development of languages to organic evolution in ten different ways, after stating that "the formation of different languages and of distinct species, and the proofs that both have been developed through a gradual process, are curiously parallel" (Darwin, 1981, p. 59).

The ban within the discipline of linguistics held for over a century, during the greatest expansion of knowledge in history up to that point. Perhaps, though, an understanding of that situation is not too difficult. Beyond the science-reinforced, anxiety-inducing threats of human animality / mortality and a non-anthropocentric

cosmos,<sup>4</sup> and beyond the issue of initial methodological inadequacies and a dearth of data, two intertwining factors contributed to the development of a science that, eventually, did not even really require an active ban, but simply *no longer considered* the evolutionary origins or development of language. The first was an accumulating archeological record that did not seem to support the idea of humanity and language originating from geologically gradual processes, and the second was a synchronic theory of signs that precluded an evolutionary understanding of language. These factors are the subjects of the next two Sections.

## 2.2 - PROBLEMS WITH GRADUALISM

Darwinian gradualism was made possible by the idea of deep time pioneered in the West by geologist James Hutton (1726-1797). While the traditional Christian conception of time—beginning with Creation and ending with New Jerusalem—was measured in thousands of years, Hutton’s geological observations instead led him to conclude that “we find no vestige of a beginning, no prospect of an end” (Hutton, 2010, p. 90). His exponentially expansive understanding of time was measured in millions of years, leading one colleague to exclaim that “the mind seemed to grow giddy by looking so far into the abyss of time” (Playfair, 1805).

Gradual geological changes imply vast stretches of time, and the contemplation of such changes over such time inspired the theory of uniformitarianism, which is the idea

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<sup>4</sup> See the “Science and Society” chapters of Jason Colavito’s *Knowing Fear: Science, Knowledge, and the Development of the Horror Genre* (2008), as well as Part 1 of Eric La Freniere’s “An Awe-ful Integrity: The Science-Fiction Horror of H. P. Lovecraft” (2010).

that the laws of nature and the rates of natural change are constant, and that “the present is the key to the past.” Interestingly, the early Victorian scholar who coined the term “uniformitarianism” also coined the term “catastrophism” (Yeo, 1993, p. 101), which designates the idea that geological processes can trigger violently sudden transformations. But it was uniformitarianism, as presented by geologist Charles Lyell (1797-1875) in his massive and massively influential *Principles of Geology: Being an Attempt to Explain the Former Changes of the Earth's Surface, by Reference to Causes Now in Operation* (1830-33), which informed Darwinian gradualism. Not only had Darwin read the first volume of Lyell’s *Principles of Geology* while aboard the *Beagle*, but Lyell had befriended Darwin after the latter had returned to England, and had later encouraged Darwin to publish *The Origin of Species* when it had become known to them that Alfred Russel Wallace, another naturalist-explorer, was about to publish his own theory of evolution (Desmond & Moore, 1991).

The uniformitarian emphasis on constant rates of change by means of small, steadily building increments came to underlie Darwinian gradualism, and the longer the stretches of time considered in the archeological record, the more such rates of change seemed plausible in terms of biology as well as geology. However, as the nineteenth century bled into the twentieth, researchers examining evidence of prehistoric proto-humans and humans discovered that the data did not support the idea of a geological rate of change when it came to remains and artifacts. I will examine that evidence further in Section 4, but suffice to say here, the relative abruptness with which lithic technologies and art entered the archeological record was such that strictly Darwinian explanations were obviously inadequate—and since tools and art are the major archeological

indicators of culture, in general, and language-use, in particular, the archeological record seemed to offer little of value in terms of a gradual evolutionary origin of language.

Indeed, archeology seemed to indicate that language emerged somewhat miraculously, resulting in a historical situation that can be bookended by the words of two language experts, separated by nearly a hundred years.

The first was Max Muller (1823-1900), who held the chair of Philology at the University of Oxford. In 1873, Muller delivered three lectures to the Royal Institution, in which he criticized Darwinian theory by arguing that it could not accommodate the radical nature of human language:

My object is simply to point out a strange omission, and to call attention to one kind of evidence—I mean the evidence of language—which has been most unaccountably neglected, both in studying the development of the human intellect, and determining the position which man holds in the system of the world. (Muller, 1873, p. 77)

Muller forcefully stated that the idea that “man being the descendent of some lower animal, the development of the human mind out of the mind of animals, or out of no mind, is a mere question of time, is certainly enough to make me a little impatient” ( p. 82) and he pointed out that:

There is one specific difficulty which Mr. Darwin has not sufficiently appreciated . . . There is between the whole of the animal kingdom on the one side, and man, even in his lowest state, on the other, a barrier which no animal has ever crossed, and that barrier is—*Language*. (p. 154).

Nearly a hundred years later, in 1968, Noam Chomsky (b. 1928)—who authored the revolutionary *Syntactic Structures* (1957) and is now Professor Emeritus of the Department of Linguistics and Philosophy at MIT, published six of his lectures under the title *Language and Mind*. In that book, Chomsky argued that “human language appears to be a unique phenomenon.” Regarding Karl Popper’s idea that “the evolution of language passed through several stages, in particular a ‘lower stage’ in which vocal gestures are used for expression of emotional state, for example, and a ‘higher state’ in which articulated sound is used for the expression of thought” (p. 59), Chomsky objected that

[H]e establishes no relation between the lower and higher stages and does not suggest a mechanism whereby transition can take place from one stage to the next. In short, he gives no argument to show that the stages belong to a single evolutionary process. In fact, it is difficult to see what links these stages at all (except for the metaphorical use of the term “language”). There is no reason to suppose that the “gaps” are bridgeable. There is no more of a basis for assuming an evolutionary development of “higher” from “lower” stages, in this case, than there is for assuming an evolutionary development from breathing to walking; the stages have no significant analogy, it appears, and seem to involve entirely different processes and principles. (p. 59)

The linguist-philosopher was firm that language cannot be viewed in evolutionary terms:

There seems to be no substance to the view that human language is simply a more complex instance of something to be found elsewhere in the world. This poses a problem for the biologist, since, if true, it is an example of true ‘emergence’—the

appearance of a qualitatively different phenomenon at a specific stage of complexity of organization. ( p. 62)

Reading Chomsky here, we might be reminded of Darwin's (in)famous words from *The Origin of Species*:

To suppose that the eye with all its inimitable contrivances for adjusting the focus to different distances, for admitting different amounts of light, and for the correction of spherical and chromatic aberration, could have been formed by natural selection, seems, I freely confess, absurd in the highest degree. (p. 186)

Just as contemporary creationists frequently cite this passage out of context to claim that the eye is too complex a structure to have been produced by Darwinian evolutionary processes, Chomsky argued that language is too complex to have been produced by Darwinian evolutionary processes.

That comparison might seem harsh, but consider that Chomsky has presented his linguistic modules—his Universal Grammar (UG) and Language Acquisition Device (LAD)—as innate *without any discussion of how they came to be so*. In the absence of any natural explanation for the origin of a complex phenomenon, and in the presence of curiosity about the same phenomenon, supernatural or mythic “explanations” proliferate (e.g. gods and / or ancient astronauts). Science, of course, deals with neither incuriosity nor the supernatural.

It is true that evidence of language-use entered the archeological record with an abruptness that contraindicates gradualism. But what if there was an evolutionary mechanism other than gradualism that could explain that abruptness—a mechanism of natural selection that works catastrophically rather than uniformly? What if there was an

evolutionary bridge (or series of bridges) between the eyespot of a planarian and the human eye, or between the signaling systems of other animals and human language? In Section 4.3, I will examine such a mechanism and bridge(s), but first I must turn to the development of a synchronic theory of signs that, along with a strictly gradualist understanding of natural selection, precluded an evolutionary understanding of language.

### 2.3 - SIGNS ABOUT IDEAS

Language is a signaling system, and linguists are therefore concerned with signs, or units of meaning. The study of signs is called semiotics, and Ferdinand de Saussure (1857-1913) is considered the founder of semiotics, as well as one of the founders of twentieth-century linguistics. Saussure was a philologist with philosophical inclinations, and after his death, a group of his students collected, edited, and published notes from his lectures as *A Course in General Linguistics* (1916), a text that profoundly impacted not only linguistics, but a wide range of disciplines, including anthropology, sociology, psychology, philosophy, and literary criticism. However, in 1996, a manuscript in Saussure's own handwriting was discovered in a piece of his family's furniture, which resulted in the publication of *Writings in General Linguistics* (2002), a text which also includes his original lecture notes.

Scholars continue to compare and contrast *A Course* and *Writings*, but for our purposes the important thing is how Saussure defined the sign as “complex” or “dual,” that is, as a conjunction of a signifier (*signifiant*) and a signified (*signifié*). While common sense or scientific naiveté might suggest that a signifier could be something spoken (“The cat is on the mat”) and the signified could be something in the world (a cat

observed to be on a mat), for Saussure, the signified is always *an idea*: “there is no linguistic entity possible which would be directly accessible through the senses, because none exists apart from the idea which can be attached to it.” That position is philosophically sophisticated—and is perhaps not entirely incompatible with empiricism, at least of the Berkeleyan variety—but scientists might have some concern that Saussure abandoned the world, or at least any form of representationalism, for some kind of linguistic idealism. His *Writings* did nothing to alleviate such concern:

Does linguistics come face to face, as its primary and immediate object, with a readily defined object, a group of items perceptible to the senses, as is the case for physics, chemistry, botany, astronomy, etc.? In no way and at no time is this the case: linguistics is situated at the opposite extreme to those sciences which are able to take the data of the senses as their starting point.

Since, for Saussure, signs and meaning could never be about the world but only about ideas, then linguistics was more akin to abstraction-based logic or mathematics than it was to sensation-based biology or neurology—and curiosity about the evolution of language *simply evaporated*. The structural linguistics that followed from *A Course* broke even with historical considerations of language development, to consider language only as it exists at a given time; thus, structural linguistics is characterized as *synchronic* (“same time”), as opposed to *diachronic* (“across time”).

Such a historical-disciplinary development seems odd given that philology as Saussure knew it had been based on studies that showed languages as diverse as Hindi and Icelandic were derived from a common, extinct ancestor, now called Proto-Indo-European (PIE). But while researchers have connected PIE with other broad language



groups—which, in turn, might ultimately descend from a “Proto-World” language<sup>5</sup> that marks the beginning of culture, and even the origin of our species—Saussure insisted on a sharp division between linguistics and the study of natural systems:

. . . ‘A language is born, grows, weakens, and dies like any organic being.’ This sentence is absolutely typical of the conception, so widespread even among linguists that one wearies of fighting it, which leads directly to a definition of linguistics as a natural science. No, a language is not an organism, it is not a plant with an existence independent of humankind, it does not have a life of its own which leads to birth and death. Everything in the sentence that I quoted is wrong: a language is not an organic being, it does not of itself die, weaken, or grow, since it has no more a childhood than middle or old age, and it is not even born . . . (p. 102)

Although, as previously mentioned, Darwin had compared the development of language to organic evolution in *The Descent of Man*, it is doubtful that anyone had actually argued that language has “an existence independent of mankind.” Indeed, in *The Origin of Species*, the great naturalist had stated:

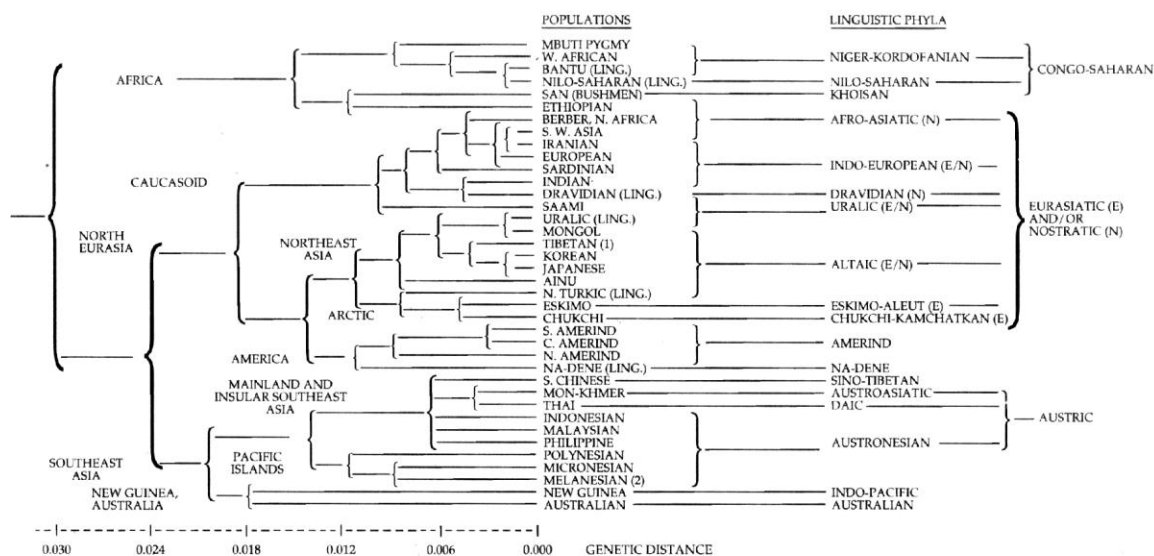
If we possessed a perfect pedigree of mankind, a genealogical arrangement of the races of man would afford the best classification of the various languages now spoken throughout the world; and if all extinct languages, and all intermediate and

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<sup>5</sup> For a discussion of the proposed Proto-World language, see “The Mother Tongue,” Chapter 2 of author-ethnologist Richard Rudgley’s *The Lost Civilizations of the Stone Age* (1999).

slowly changing dialects, were to be included, such an arrangement would be the only possible one.

This idea that there might be a significant diachronic relationship between human genealogy and language—as opposed to any alleged idea that language has “an existence independent of mankind”—has since been vindicated by comparisons of painstakingly acquired genetic and linguistic data (see Figure 5).



**FIGURE 5. Overlay of Genetic and Linguistic Data (after Cavalli-Sforza *et al.*, 1988, p. 6003). This diagram illustrates the general correspondence between the genetic derivation of human populations (Darwin’s “races of man”) and the distribution of language groups.**

Not only is Saussure’s independent-of-mankind straw man troubling from a scholarly point of view, but it is also puzzling given his own crucial distinction between *parole*, or language as it is actually spoken by persons, and *langue*, or language as an impersonal system of signs—that is, *langue as it exists apart from persons*. Leaving aside the possibility of psychological projection, however, we should note that Saussure’s desire to isolate linguistics from the natural sciences, in general, and from organic evolution, in particular, was so intense that he either failed to exercise due diligence with

respect to his understanding of Darwinian theory, or he engaged in willful (if eloquent) misrepresentation of the same:

The actual birth of a new language has never been reported anywhere in the world. We have seen new stars appear suddenly in the midst of the known constellations of the sky, and we have seen new islands rise up one day from the surface of the some sea, but we have never known a language which was not spoken the day before or which was not spoken in the same way the day before.

Here, if we but substitute “species” for “language,” and “did not exist” for “was not spoken,” the general form of this false argument stands revealed as being identical with that used by contemporary creationists to attack “Darwinism.”

#### 2.4 - SIGNS OF CHANGE

In 1976, evolutionary biologist Richard Dawkins argued in *The Selfish Gene* that, through language, evolution had transitioned from the merely genetic or organic to include the mimetic or cultural. Just as genes partake of materiality both literally as molecules, and figuratively as conveyers of information or meaning, “memes” (Dawkins coined the word, which has entered common parlance, that is, become a successful meme) also partake of materiality both literally as cultural artifacts, and figuratively as language-based and -transferred behaviors and ideas. And like genes, memes are subject to replication, recombination, mutation, and selective pressures—that is, language is an evolutionary system. Interestingly, Dawkins considered genes and, by implication, memes in somewhat viral and even teleological terms, as systems of information transfer

and transformation that use organisms as hosts or vectors—this is, as systems somewhat “independent of mankind.”<sup>6</sup>

Shortly thereafter—even though linguist John Lyons had asserted in his authoritative, two-volume *Semantics* (1977) that “there is no actual evidence from language” of its having “evolved from some non-linguistic signaling system”—self-described “street linguist” Derek Bickerton discussed in his *Roots of Language* (1981) the possibility of a “proto-language” or an evolutionary precursor to language proper. While it is unlikely that a single text ended linguistics’ more-than-century-long ban on the discussion of the evolutionary origin of language, *Roots* seemed to mark the beginning of a paradigm shift, where the language-related data that had been steadily accumulated by biologists, neurologists, psychologists, anthropologists, and ethologists had reached a point of self-organizing criticality, and a novel cross-disciplinary imperative or attractor emerged, forcing linguists to take heed.

However, that attractor needed time to stabilize due to disciplinary biases that impeded full commitment to the problem of the evolutionary origin of language; basically, a new generation of cross-disciplinary researchers has to construct their careers in terms of addressing the problem, which has long suffered a quixotic reputation. That process is ongoing, but some interesting partnerships and arguments have already occurred as scholars struggle to piece together and join sections of the puzzle at the center of all puzzles. For example, in “Natural Language and Natural Selection” (1990),

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<sup>6</sup> Writer William S. Burroughs plays with the idea of language as a virus in his novel *The Ticket That Exploded* (1962): “From symbiosis to parasitism is a short step. The word is now a virus” (p. 49).

psycholinguist Steven Pinker and cognitive psychologist Paul Bloom confronted Chomsky and evolutionary theorist Stephen Gould—who had been separately arguing that language is too complex to be anything other than a non-adaptive byproduct of evolution—by contending that the very complexity of language production and structure indicates its evolutionary centrality.

Then, in “The Faculty of Language: What Is It, Who Has It, and How Did It Evolve?” (2002), Chomsky collaborated with evolutionary biologists Mark Hauser and Tecumseh Fitch to point out that “developments in linguistics can be profitably wedded to work in evolutionary biology, anthropology, psychology, and neuroscience”—but mainly they argued for a distinction between “broad” and “narrow” senses of the language faculty, where the former refers to the sensory-motor, conceptual-intentional, and computational underpinnings of language, and the latter refers to its recursive, or nested, syntactical structure—Chomsky’s focus. Then, in “The Nature of the Language Faculty and Its Implications for the Evolution of Language” (2005), Pinker and cognitive linguist Ray Jackendoff argued against Chomsky, Hauser, and Fitch by pointing out that an arbitrary distinction that isolates syntactical recursion hampers a full understanding of the evolutionary bases of language—and that “recursion, though absent from other animals’ communications systems, is found in visual cognition, hence [it] cannot be the sole evolutionary development that granted language to humans.” Then, in “The Evolution of the Language Faculty: Clarifications and Implications” (2005), Chomsky, Hauser, and Fitch accused Pinker and Jackendoff of “blurring” their distinction, which led those two to “mischaracterize” an offered hypothesis and conduct “irrelevant” criticism of a “non-trivial endeavor . . . intended to help clarify misunderstandings and

aid interdisciplinary rapprochement”—and perhaps this line could have been lifted directly from that controversy-ridden, 1866 conference of the Linguistic Society of Paris:

Concerning evolution, we believe that Pinker and Jackendoff’s emphasis on the past adaptive history of the language faculty is misplaced. Such questions are unlikely to be resolved empirically due to a lack of relevant data, and invite speculation rather than research.

These important examples provide some sense of the individuals and issues, as well as the contentiousness involved in contemporary discussions relating to the origin of language (interestingly, both Fitch and Jackendoff have conducted research into the evolution of music, and Pinker specializes in visual cognition). These examples also might indicate that some remnant of the linguistics old guard is still working behind the scenes to thwart any diachronic or “adaptationist” attempt to address the problem.

I know first-hand that the attempt to relate language to biological evolution can be controversial. For example, when I first broached the subject with English professor and philosopher David Bleich, he maintained that “language was there as long as there was people” and “it’s wiser to decide that there’s no origin of language.” Regarding evolution in general, Bleich stated, “I don’t care about the origin of life” (Bleich, 2010). At another event, during which linguist Frank Arasanyin claimed that “language production is biocultural,” Bleich asked him, “Do you think it matters how language came about?” Arasanyin responded in the affirmative, stating that “to know where you are going, you should know where you are coming from; for me to put a step forward, I must know where my last step was.” To that, Bleich retorted, “But no one actually tries to find the origin, or stipulate it—it’s irrelevant.” Arasanyin disagreed, saying, “It’s part of academic

inquiry; it's also part of curiosity" (Arasanyin, 2011). On that point, I agree with Arasanyin.

Fortunately, we have two other primary disciplines besides linguistics to assist us: evolutionary theory and neuropsychology. And as the next Section shows, neuropsychology started to come into its own at about the same time that *The Origin of Species* was published.

### 3.0 - LANGUAGE AND THE BRAIN

*Again, I hear voices, I sort of lost touch with reality. Humming in my ears and a small feeling like a warning . . . Voices, the same as before. I was just losing touch with reality again.*

-20-year-old college student, while his right temporal lobe was being stimulated with a gentle electric current.<sup>7</sup>

### 3.1 – DISCOVERY OF LATERALIZATION

In the treatise titled “On the Sacred Disease,” it was recorded that the ancient Greek physician-teacher and pioneer of rational empiricism Hippocrates (460-377? BCE) maintained that epilepsy—or seizures driven by storms of electrical feedback within the brain—is not “any more divine or sacred than other diseases, but has a natural origin” (1959, p. 139). He was also said to have held that

Men ought to know that from the brain, and from the brain only, arise our pleasure, joys, laughter, and jests, as well as our sorrows, pains, griefs, and tears. Through it, in particular, we think, see, hear, and distinguish the ugly from the beautiful, the bad from the good, the pleasant from the unpleasant, in some cases using custom as a test, in others perceiving them from their utility. (p. 175)

Such observations led to the assertion that “the brain is the interpreter of consciousness” (p. 179). But while the treatise “Of Injuries of the Head” reported that patients who had

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<sup>7</sup> As quoted in Julian Jaynes’ book *The Origin of Consciousness in the Breakdown of the Bicameral Mind* (1976, p. 109).



received a wound or incision on one side of the head often exhibited seizures on the opposite side of the body (§13 and §19), and the treatise “Of the Epidemics” reported a case involving right-side seizures and paralysis associated with loss of speech abilities (Book 1, Section III, case xiii), the students of the father of Western medicine did not collate that data. Later, in his treatise “On Sleep and Sleeplessness,” Aristotle (384-322 BCE) designated the heart as the point where the mind interfaces with the body, and he claimed that the brain functions to cool the blood. Both the Hippocratic school and Aristotle may have been hindered in their understanding of the brain by a prohibition against dissection and the theory of humors, which involved harmony among four precious bodily fluids and their occult correspondences, and which survived even into the modern era to undergird the practice of bloodletting.

The physician-anatomist Herophilus of Alexandria (335-280 BCE) reinstated the brain as the seat of the mind, but he espoused the ventricular theory, which posited that brain functions are pneumatic, or air-based, and that the loci of cognition are situated along the brain’s midline, in the third ventricle. That theory may have reinforced the already-existing appeal of symmetry<sup>8</sup> to select against a theory of lateralization, or against even the recognition of data that might suggest such a theory. Under the first Ptolemaic pharaohs, Herophilus was permitted to conduct dissections of and experiments on living prisoners, and thereby discovered that sensory impulses travel into the spinal cord and brain, while motor impulses travel out of the brain and spinal cord. Later, the

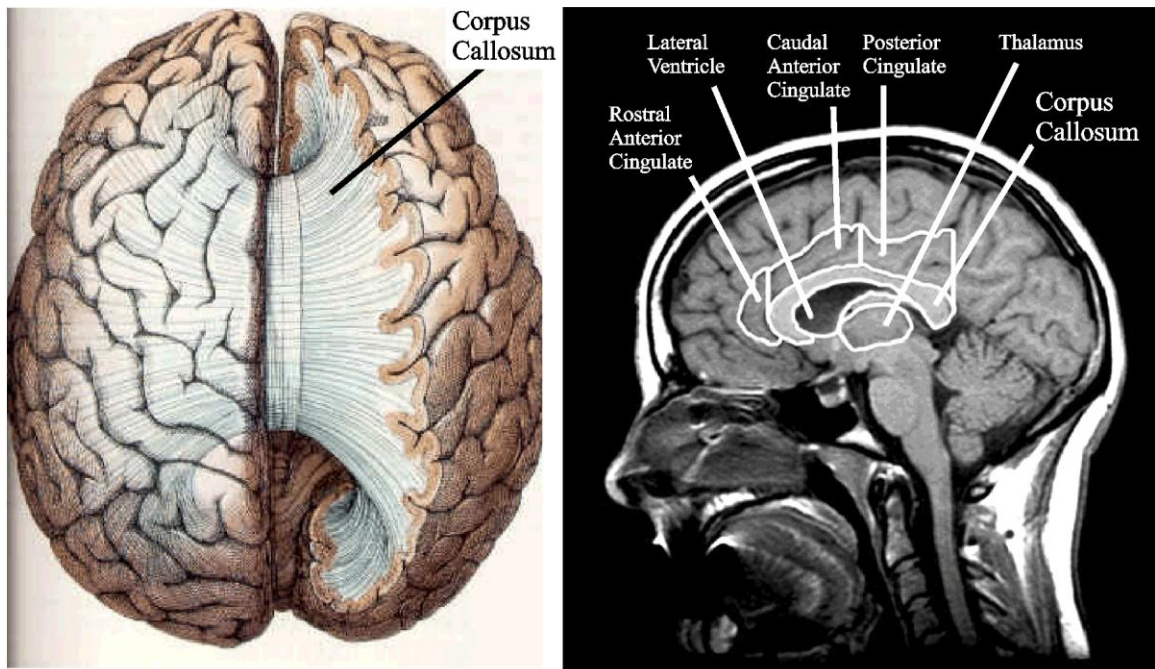
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<sup>8</sup> Symmetry seems universally considered a beautiful and desirable trait, and that cultural understanding is probably based ultimately upon its perceived indication of physical health in relation to courtship and mating.

Roman physician-anatomist Galen (129-209), a champion of ventricular theory who considered wounds to be “windows into the body,” also conducted live dissections as well as nerve ligation experiments on living prisoners in order to investigate how the brain controls the body’s muscles, but he failed to discern the contralateral nature of that control. The ventricular theory was elaborated by the Christian philosophers Nemesius (c. 390) and Augustine of Hippo (354-430), but with the collapse of classical culture, learning and knowledge went into a more-than-millennium-long general decline.

In the sixteenth century, the physician-anatomist and teacher Andreas Vesalius (1514-1564) began to question or at least qualify ventricular theory, and he reintroduced the practice of dissection—long banned under Christianity—in the context of a pedagogical theater, and he made empirical diagrams of human anatomy. Pioneering modern philosopher René Descartes (whose eventual distrust of the senses marks the split between philosophy and science) also held to a version of ventricular theory, although he proposed that brain functions are hydraulic, or liquid-based, and that the pineal gland—a pinecone-shaped midline structure attached to the posterior roof of the third ventricle—is the site of mind-body interface.

Then, in the seventeenth century, the English physician-anatomist Thomas Willis (1621-1675), a founding member of the Royal Society, focused his research on the brain, nerves, and muscles. He held the locus of crucial cognitive functions to be the corpus callosum (Latin for “tough body”): the thick, subcortical bundle of nerve fibers that connects the hemispheres of the cerebral brain and is nested within the cingulate cortex (see Figure 6). In fact, the corpus callosum is not only the largest commissure—or cross-hemispheric neural bridge—but it is by far the largest bundle of nerve fibers in the human



**FIGURE 6. The Corpus Callosum, Dorsal and Lateral Views (after “Dyslexia Symptoms,” 2006). These diagrams illustrate the structure and connectivity of the largest bundle of nerve fibers in the body and its nested relation to the cingulate cortex.**

body. It is estimated to contain 200-250 million highly myelinated (fat-insulated and conductive) axons or nerve cells, compared to about 1.5 million for each optic nerve and about 32,000 for the auditory nerve, and its cross-sectional area is about 700 square millimeters, compared with a few square millimeters for the optic nerve.

A century later, the French physician-anatomist Félix Vicq-d’Azyr (1746-1794), a member of the French Academy of Sciences, postulated that the corpus callosum served “to establish sympathetic communications between different parts of the brain”—namely, the brain’s hemispheres. Since “sympathetic communications” implies the existence of at least initial differences (or else information transfer would be unnecessary), the idea of a hemispheric bridge could have hinted at some kind of lateralization, that is, difference between the left and right hemispheres. But the appeal of symmetry prevailed, although

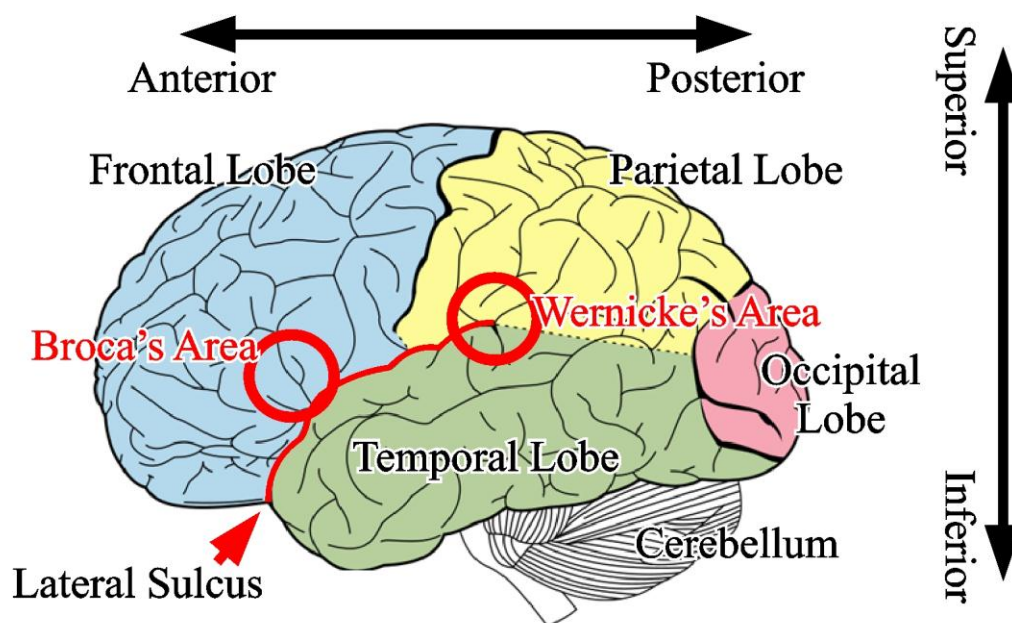
belief in it was strained, and here we might be reminded of how the appeal of the perfect circle hindered astronomy until Kepler's elliptical orbits.

For example, the Germanic neuroanatomist Franz Joseph Gall (1758-1828), member of the Royal Swedish Academy of Sciences and originator of phrenology, when presented with a case of amnesic aphasia—or defective recall of words for speech, with intact abilities of comprehension—following injury to the left frontal lobe, maintained that trauma to one hemisphere “upset the balance between the hemispheres, thus affecting the faculties on both sides.” In other words, Gall incorrectly postulated an early form of diaschisis—or damage across the brain—rather than question an unstated principle of symmetry.

However, in 1836, the French neuroanatomist Marc Dax (1771-1837) submitted notes to the French Academy of Sciences in which he claimed a link between aphasia—or impairment of language functions—and damage to only the left hemisphere (contralateral control was by then known through the study of the brain lesions of stroke-paralysis victims), but he died soon thereafter, and his work remained obscure.

Bolstered by phrenological thinking, and despite the rarity of ambidexterity, symmetry prevailed until a few years after the first printing of *The Origin of Species*, when Pierre Paul Broca (1824-1880)—the French neuroanatomist and anthropologist, subversive freethinker, and eventual lifetime member of the French Senate—published a short paper titled “Loss of Speech, Chronic Softening and Partial Destruction of the Anterior Left Lobe of the Brain” (1863). Broca reported on a recently deceased patient who had been only able to say “tan” for three decades, even though he could usually understand the speech of others. An autopsy performed on “Tan-Tan” revealed extensive

syphilitic damage: “a large cavity, capable of holding a chicken egg, and filled with serous fluid,” centering on “the middle part of the frontal lobe of the left hemisphere” (on the posterior section of the inferior frontal gyrus). There was no discernible damage across the brain, into the right hemisphere, and Broca concluded that “the lesion of the frontal lobe was the cause of the loss of speech.” The left hemisphere area identified by Broca would be named after him (see Figure 7), as would the expressive aphasia—or loss



**FIGURE 7. Left Hemisphere Language Centers.**

**This diagram illustrates the approximate loci of Broca's area and Wernicke's area relative to each other, the lobes of the cerebral cortex, and the left lateral sulcus.**

of speech and writing, with defective abilities of comprehension—resulting from its injury. Thus Broca (who may have read Dax) publicly announced the lateralization of language functions, and further research possibilities suggested themselves.

Most significantly, the Germanic neuropsychiatrist and anatomist Carl Wernicke (1848-1905) took advantage of the fact that wounds are “windows into the body” and that specific behavioral abnormalities can be correlated with specific damaged regions of the cerebral cortex (1874). One of his patients was a man who had suffered a stroke; the man

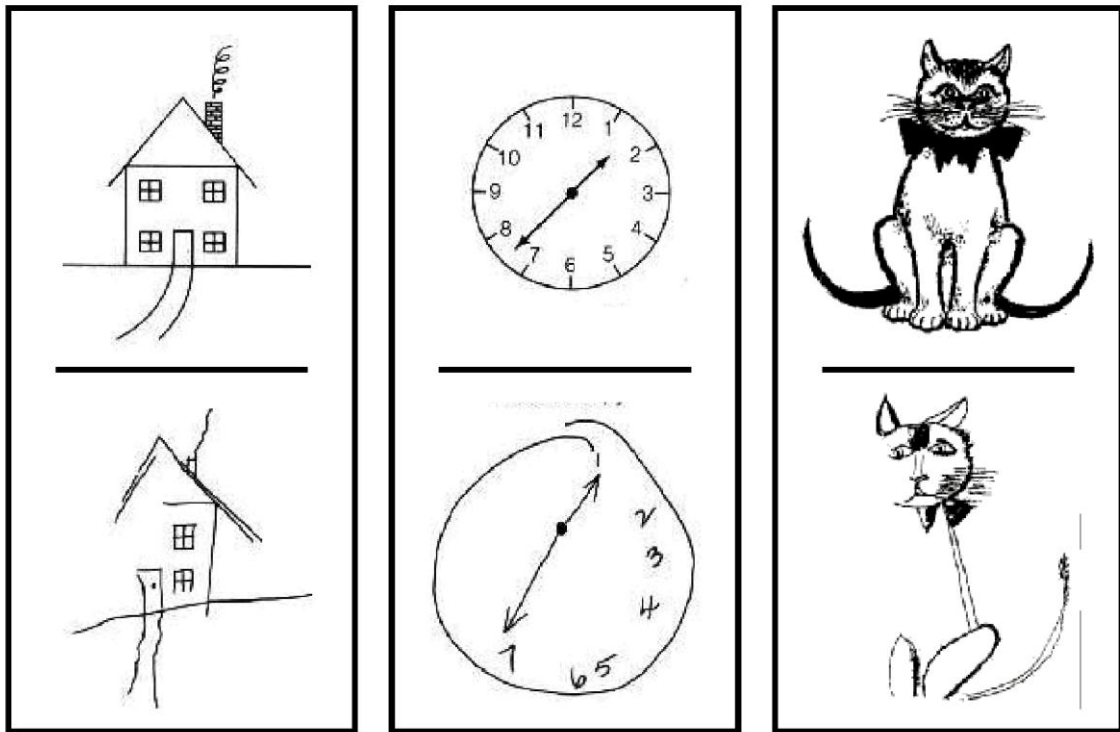
could speak, but the content of his speech was nonsensical, and he could not understand the speech of others. When the patient died, Wernicke performed an autopsy, and found a lesion on the left hemisphere of the man's cerebral cortex; the area of the lesion was posterior to Broca's area (on the posterior section of the superior temporal gyrus). This area identified by Wernicke would be named after him (see Figure 7), as would the receptive aphasia—or loss of comprehension, with defective abilities of speech and writing—resulting from its injury. Thus language was understood as having at least two correlative, left hemisphere loci along the lateral sulcus: one for grammar or speech (Broca's area), the other for semantics or understanding (Wernicke's area). The nascent theory of brain lateralization was thus reinforced.

Based on the emerging correlative methodology, other lateralized findings followed Broca and Wernicke's. For example, it was shown that damage to the posterior right hemisphere could result in spatial impairment (Jackson, 1876); damage to the left occipital cortex and the corpus callosum could result in alexia without agraphia—or loss of abilities to read, with intact abilities to write (Dejerine, 1892); damage to the left parietal lobe could result in apraxia—or loss of abilities to move purposefully (Liepmann 1905); and damage to the corpus callosum could prevent the left hand from executing verbal commands (Liepmann & Maas, 1907). Then, when research indicated that contralateral verbal movement-command reaction time was faster than ipsilateral, the difference was used to calculate the speed of information transfer across the corpus callosum (Poffenberger, 1912), and a concept of hemispheric interaction was proposed (Liepmann, 1912; Poffenberger, 1912), which further supported the concept of lateralized human language functions.

### 3.2 - DETERMINATION OF DIFFERENCES

Shortly after World War II, Juhn Wada (b. 1924), a Japanese-Canadian studying to become a neurosurgeon, published a report describing an elegant test for evaluating language lateralization prior to ablative surgery for epilepsy (1949). It had already been noted that speech lateralization was not entirely consistent; a minority patients of seemed right hemisphere “dominant” (lateralized) for speech, and fewer still seemed neither right nor left. A surgeon preparing to conduct a hemispherectomy needed to determine individual lateralization in order to best preserve speech and memory functions. Wada discovered that by introducing a sedative via cannula or catheter into either internal carotid artery of a still awake patient, the artery’s respective cerebral hemisphere could be temporarily anaesthetized. Using a series of language and memory tests, the functions of the non-sedated hemisphere could then be studied in isolation.

As expected, left hemisphere sedation usually impaired or eliminated speech and the understanding of speech, although the ability to sing was sometimes retained. Contralateral hemiplegia—or total paralysis of the arm, leg, and trunk on the side of the body opposite the anaesthetized hemisphere—was the rule (Broca, Wernicke, and others had observed it), as was profound hemispatial neglect—or loss of the ability to perceive stimuli on one side of the body (see Figure 8). Hemispatial neglect takes a variety of forms—with massive blindspots extending into even imaginary data such as memories, dreams, and hallucinations—but its victims usually have difficulty recognizing that anything is amiss. Various other unusual cognitive and affective behaviors also manifested under unilateral anesthetization, which suggested the idea of hemispheric



**FIGURE 8. Drawings Produced by Subjects with Hemispatial Neglect (after Thomas, 2010).**

**These diagrams illustrate the effects of hemispatial neglect on representation. The superior image of each pair was presented to a subject, who was asked to draw a copy of it, and the inferior image is the resulting image. The difficulty here is not one of sensation / the eye, but of perception / the brain.**

interaction via neural inhibition and its converse, recruitment. But the Wada test procedure is invasive and not without risk, and its effects last only a few minutes. It is a powerful diagnostic tool, but its value for research is limited; something else was needed.

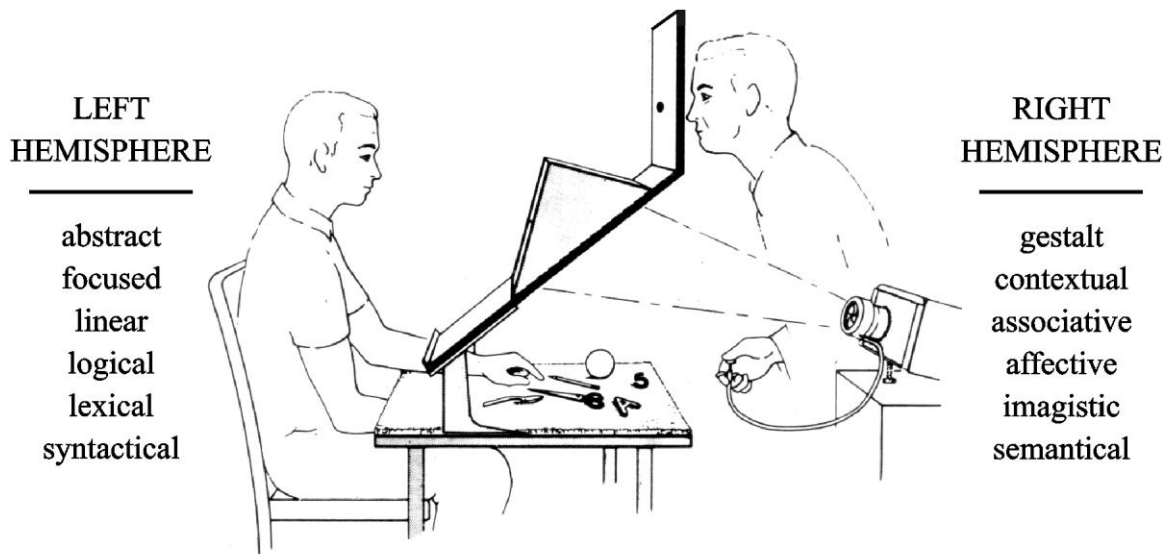
In the early 1960s, American neurobiologist Roger Sperry (1913-1994) began working with previously severe epileptics whose seizures had been curtailed by the surgical transection of the corpus callosum: so-called “split-brain” patients, their small commissures and subcortical structures remained intact. Sperry had previously researched brain plasticity (past a certain age, major neural pathways remain more or less fixed), and was very much interested in the mind-body problem at a time when behaviorism dominated the field. His controversial split-brain research with cats had already demonstrated that each hemisphere of the feline cortex was capable of independent



learning, but his research with human split-brain patients would eventually win him the Nobel Prize for Medicine (1981) and the National Medal of Science (1990).

Over the course of three decades, Sperry's research concentrated on teasing apart the cognitive differences between the hemispheres of the typical human brain. (Here, "typical" means the 97% of right-handers who exhibit left hemisphere lateralization for language functions; 3% of right-handers and 30% of left-handers exhibit either right hemisphere or bi-lateralization—and "handedness" has no single, agreed-upon operational definition). Through a series of clever experiments taking advantage of the fact that, in split-brain subjects, the left and right visual fields each provide sensory information only to the contralateral half of the cerebral cortex, Sperry, his protégé-colleague Michael Gazzaniga (b. 1939), and other researchers established that the left hemisphere specializes in relatively abstract-focused, linear-logical, lexical-syntactical cognitive functions, while the right hemisphere specializes in relatively gestalt-contextual, associative-affective, imagistic-semantic cognitive functions (Carlson, 2011, pp. 71-72; Bradshaw & Nettleton, 1981; Gazzaniga, 2002; Lovseth & Atchley, 2010; and Vigneau *et al.*, 2011).

For example, in an early experiment designed by Sperry and Gazzaniga (see Figure 9), the researcher made sure the split-brain subject fixed his eyes on a point on a screen, then the researcher flashed a word or image to one side of that point. The subject then attempted to say what the flashed stimulus had been, *and* reached under a partition with his left hand to select an object corresponding to it. Split-brain subjects typically could not say what a stimulus flashed to their left visual field had been, even though their left hand could select *or even draw* the corresponding object. That split-brain, word-



**FIGURE 9. Isolating Hemispheric Functions in Split-Brain Subjects (after Gazzaniga *et al.*, 1975). This diagram illustrates an experimental apparatus designed and used by researchers Roger Sperry and Michael Gazzaniga (see text for details), and it lists relative hemispheric cognitive traits.**

image-isolation effect could be ameliorated with practice and time, due to subject strategization and neural plasticity, but the experiment showed that while the right hemisphere does well with nouns and adjectives, it does poorly with verbs and syntax, and is not the seat of narrative self-awareness, but of some sort of separate and proto-linguistic mind or “implicit self” (Morin, 2002; Schore, 2010). And Gazzaniga reported that:

We then asked the left hemisphere, the only one that can talk, why the left hand was pointing to the object. It did not know, because the decision to point was made in the right hemisphere. Yet it quickly made up an explanation. We dubbed this creative, narrative talent the interpreter mechanism. (2002, p. 29)

That massive blindspot or seamless narrative effect could extend into more significant actions. For example, when Gazzaniga flashed to a subject’s isolated right hemisphere simple commands such as “walk around” or “laugh,” the subject would automatically

obey those commands—and when asked by the researcher to explain his behavior, would provide an easy rationalization such as “I am going to get a drink” or “Because you guys are so funny” (Henriques, 2011, p. 133).

It must be emphasized that differences based on left hemisphere lexical-grammatical versus right hemisphere imagistic-semantic cognitive specialization are generalizations; the concept of human brain lateralization denotes trends that vary across individuals and functions, presumably in accordance with genetic parameters, environmental factors, and neuro-developmental plasticity. Nevertheless, despite the almost overwhelming complexity of the brain itself, as well as the popular oversimplification of lateralization,<sup>9</sup> the data that denote hemispheric functional emphases are impressive. Laboratory experiments have consistently demonstrated that severed hemispheres yield separate, different minds or sets of behavior.

Before considering the structural hierarchy of lateralization, we should note the 1976 publication of a provocative, cross-disciplinary work by American psychologist Julian Jaynes (1920-1997): *The Origin of Consciousness in the Breakdown of the Bicameral Mind*. Like Sperry, whose split-brain research he prominently cites, Jaynes was interested in the mind-body problem, but Jaynes had a theory, albeit one that remains controversial. He recognized that the bulk of information transfer across the hemispheres occurs via the corpus callosum; however, he hypothesized that, in times past, information generated in the right hemisphere locus corresponding to Wernicke’s area had been

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<sup>9</sup> For an interesting critical review of the early popular misrepresentation of brain lateralization research, see Coren’s chapter titled “Psycho-Neuro-Astrology” (1993).

communicated across the anterior commissure to the left temporal lobe, where that information was interpreted as auditory-verbal hallucinations.<sup>10</sup>

Jaynes cited research spearheaded by Wilder Penfield (1891-1976), the Canadian neurosurgeon who co-created the somatic-sensory homunculus—research involving the experience of hazy voices, music, and images sometimes evoked by electrical stimulation of the posterior Section of the right superior temporal gyrus—and he also devoted entire chapters of *The Origin of Consciousness* to hypnosis and schizophrenia. In brief, Jaynes speculated that as recently as 1000 BCE the human mind had been “bicameral” (two houses on the same foundation), and that a non-subjective humanity had heard and obeyed without question the hallucinatory voices of the right hemisphere “gods.” There had been no opposition to those voices, because there had been no unitary self to mount opposition. With the evolution of sufficiently recursive metaphors, however, the multiplicity of voices was integrated into a single voice expressing the self and having its seat in the language loci of the left hemisphere. An anxiously stochastic humanity, Jaynes concluded, has longed for the lost voice(s) of certainty ever since.

### 3.3 - LEVELS OF LATERALIZATION

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<sup>10</sup> Interestingly, Gazzaniga singles out the anterior commissure in a discussion of differences in hemispheric communication between humans and other primates:

When this commissure is left intact in otherwise split-brain monkeys, the animals retain the ability to transfer visual information from one hemisphere to the other. People, however, do not transfer visual information in any way. Hence the same structure carries out different functions in different species. (2002, p. 28)

Evolution works by affecting hierarchically nested levels of organic structure, namely (from most implicit to most explicit), molecules, cells, tissues, and organs. We would expect functional lateralization to be accompanied by general structural lateralization, and that is exactly what we find. For example, on a molecular level, neurotransmitters, hormones, and neuropeptides and neuropeptidases are chemicals involved in neural development and potentiation—and they show asymmetric concentrations varying by species, environment, time of day, season, age, the female reproductive cycle, the sleep cycle, and in humans, psychological disorder (Ramirez *et al.*, 2004). On a cellular level, neurons have been shown to exhibit asymmetric localizations (for a comprehensive review, see Toga & Thompson, 2003), sizes (Hutsler & Gazzaniga, 1996), densities (Diaz, Pinto-Hamuy, & Fernandez, 1994), and dendritic branching morphologies (Seldon, 1981; Scheibel, 1985)—which, on a tissue level, generate left-right differences in circuit microarchitecture (Bianco *et al.* 2008), resulting most notably in the uniquely asymmetric minicolumn morphologies of the human planum temporale (Dorsaint-Pierre *et al.*, 2006).

The planum temporale is a roughly triangular area that, on the left hemisphere, is centered in Wernicke's area (Broca's area is located towards the other end of the left lateral fissure) and participates in the initial processing of incoming auditory information (Shapleske *et al.*, 1999). The tissues of the left planum temporale exhibit wider columns (Buxhoeveden *et al.*, 2001) with more neuropil space than the right (—resulting, on an

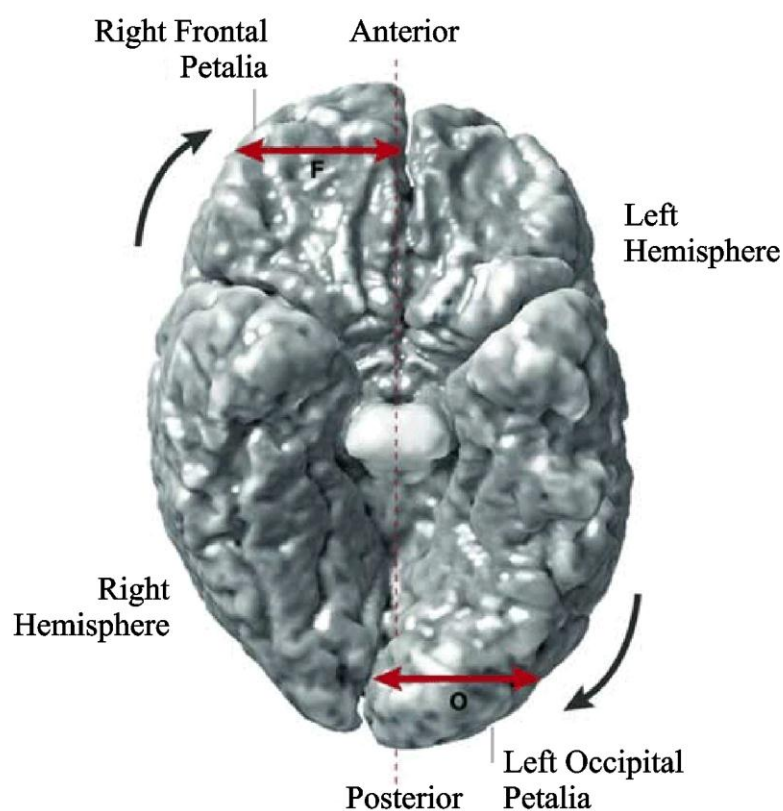
organ level, in the most significant asymmetry of any brain on the planet: in humans, *the left planum temporale can be up to five times as large as the right*.<sup>11</sup>

That massive asymmetry is the most prominent feature of Yakovlevian torque, which is named after its discoverer, the neuroanatomist Paul Yakovlev (1894-1983), and is a global anatomical twisting of the cerebral tissues such that the human brain's left occipital and right frontal lobes are wider and protrude farther than its right occipital and left frontal lobes (see Figure 10). That situation results in the left occipital lobe slightly crossing the midline so that the posterior interhemispheric fissure skews right, and the left lateral fissure is both lower and longer than the right—which effectively bunches extra neural tissue into the left planum temporale.<sup>12</sup> The distortion designated as Yakovlevian torque is so pronounced that the protruding left occipital and right frontal lobes produce differential petalia, or slight impressions upon the inner surface of the skull. Those differential petalia will be of interest in the next chapter, when we consider the fossilized remains of extinct hominid lines.

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<sup>11</sup> Interestingly, planum temporale minicolumn asymmetries are reduced in persons with schizophrenia, which affects the functions of the auditory cortex and the corpus callosum (Chance *et al.*, 2008).

<sup>12</sup> It is possible that the sometimes heightened language functions of hydrocephalic children (Pinker, 1994, p. 41) might be explained by exaggerated brain torque that further exaggerates the development of the already massively asymmetrical human planum temporale, whereupon are centered the abstract language functions.



**FIGURE 10. Yakovlevian Torque (after Toga and Thompson, 2003, p. 39).**

**This is an exaggerated, inferior view of the global anatomical distortion uniquely exhibited by the human brain. Note the widening and protrusion of the right frontal (F) and left occipital (O) lobes, the way the latter splays over the brain's midline, and the areas that generate petalia.**

### 3.4 - EVOLUTION OF LATERALIZATION

Once human brain lateralization was generally accepted and the unstated principle of symmetry relaxed, functional lateralization became something of a mark of distinction—evidence of humanity's privileged place along the *scala naturae*. Since speech is associated with reason and was also the first function recognized as lateralized, that recognition reinforced the already-existing tendency toward human exceptionalism, likely based on fear, in general, and fear of death, in particular (Becker, 1973). Obvious non-human lateralizations—for example, the fiddler crab's claws, the narwhal's tusk, and the flounder's eyes—made little difference; for nearly a century, researchers focused

solely on the asymmetry of the human brain, a trait often interpreted as the sign and the seal of our uniqueness.

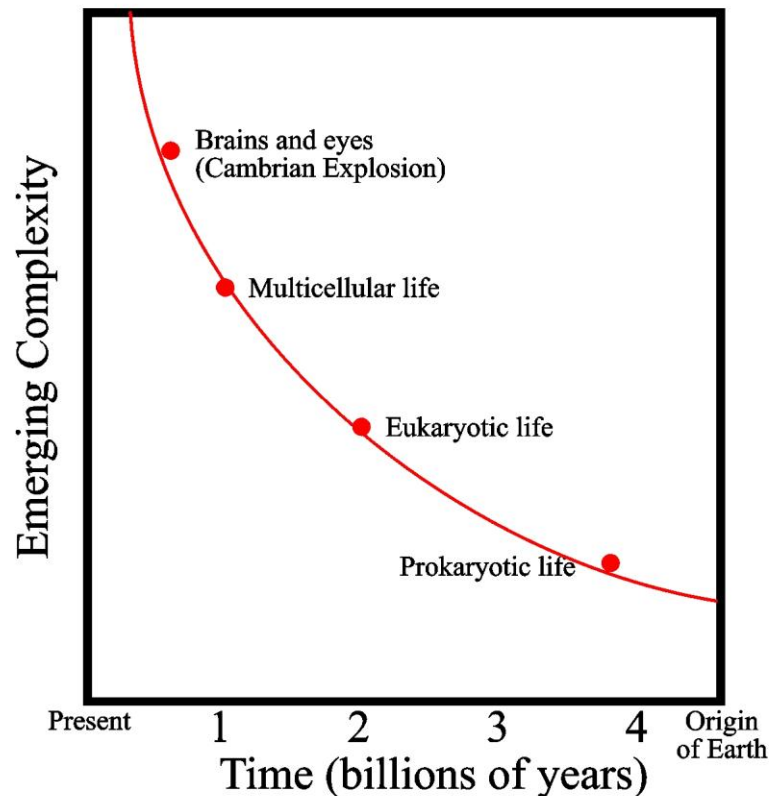
Over the past 30 years, however, researchers have been accumulating evidence of perceptual and cognitive lateralization in a wide variety of other chordates, from fish and frogs to lizards and domestic chickens to cats and chimpanzees. How did that occur?

Evolution is driven by adaptation, and by extending developmental-cognitive psychologist Howard Gardner's theory of multiple intelligences (2006, 2011), we may broadly define intelligence as adaptability, thus embracing such diverse examples as the negative phototropism of amoebae and the improvisational interactions of jazz musicians. While talk of evolutionary progress now seems naïve, we can still speak of increasing complexity, and it is apparent that increasing complexity means the emergence of novel forms of intelligence in response to selective pressures.

The geological pace of most of evolutionary history reflects corresponding geophysiological selective pressures (see Figure 11). Our Earth is estimated to be about 4.6 billion years old. Simple single-celled (prokaryotic) life seems to have been around for about 3.8 billion years—but nucleated (eukaryotic) life for only about the last two billion years. Multi-cellular life apparently emerged about a billion years ago, at which point something interesting happened: the primary selective pressures began to be *other organisms*. An evolutionary arms race or feedback loop ensued, with the deployment of various “arms” centering about developing nervous systems.

By just over 500 million years ago, brains had evolved, and the development of eyes and vision kicked off what biologists and archeologists call the “Cambrian explosion” (Parker, 2004 and Schwab, 2011), a rapid proliferation of organic complexity





**FIGURE 11. Emerging Complexity of Life Over Time.**

**This diagram illustrates the approximate curve of the emerging complexity of life. It treats complexity in terms of organic differentiation, and assumes equality among the stages shown.**

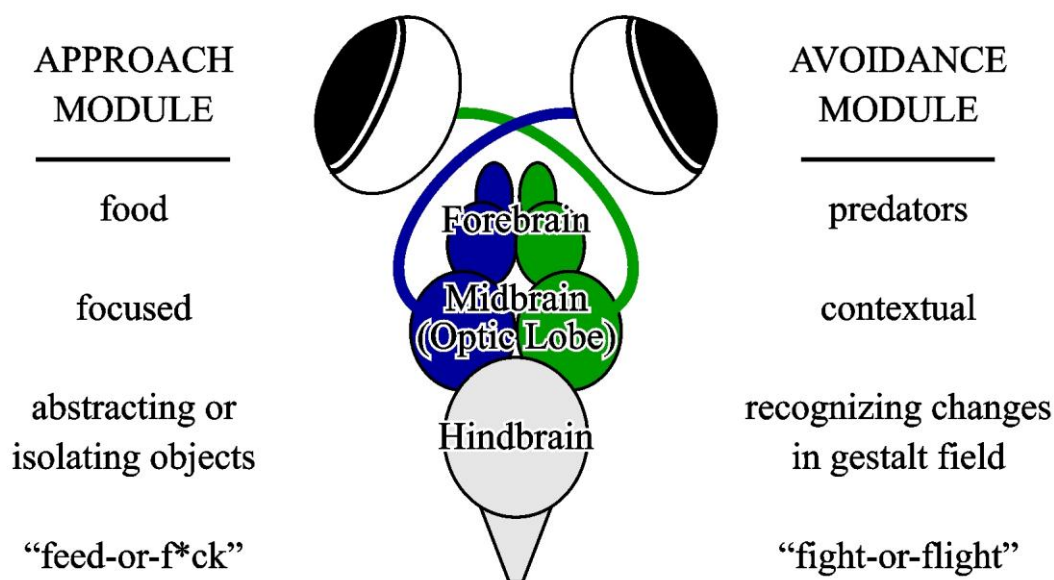
including the emergence of most of the major animal groups existing today—notably chordates, including the fish from which we eventually evolved. An interesting thing about fish, which have largely lateralized (as opposed to binocular) vision and no fore- or midbrain commissures, is that they exhibit lateralized behavior—that is, they engage their environment according to left-right preferences or fundamental cognitive modules corresponding to the halves of the fish brain.

Here “cognitive” is broadly defined as neural information-processing, and “modules” refers to the organization of such processing as described by philosopher and cognitive psychologist Jerry Fodor in his book *Modularity of Mind* (1983). According to Fodor, the brain has evolved innate structural-behavioral algorithms to solve different

adaptive problems. Those fixed functions operate irrespective of other cognitive systems, and cannot be bypassed; moreover, they are input-specific, with simple outputs that condition more flexible, higher-level cognitive systems.

In any case, fish typically respond more quickly when predators are first seen through one eye, and they find prey more efficiently when using the other eye. Brain lateralization differs by species in that individuals within shoaling species tend to share the same left-right preferences, while individuals within non-shoaling species show more variation in the direction of preference (Vallortigara, Rogers, & Bisazza, 1999). But in general, one eye and its contralateral half of the brain (since the optic nerves cross to connect each eye with the opposite side of the brain) perceive the environment in a more contextual fashion for what can be called “avoidance” perceptions and behaviors, while the other eye and half of the brain perceive the environment in a more focused fashion for what can be called “approach” perceptions and behaviors. We can say that the avoidance brain is neurologically geared towards recognizing changes in gestalt fields to generate more automatic “fight-or-flight” responses, while the approach brain is neurologically geared towards abstracting or isolating particular objects to generate more deliberative “feed-or-breed” responses (see Figure 12).

Similarly, domestic chicks have laterally-situated eyes, almost complete chiasmatic crossing of the optic nerves, and no corpus callosum; these natural split-brain subjects (cover an eye to isolate the ipsilateral hemisphere) were actually the first non-human animals strenuously studied for functional lateralization, and they continue to be fruitfully employed. A domestic chick’s normal feeding routine consists of pecking about for seed with its head tilted so that its right eye faces the ground and its left eye faces the sky.



**FIGURE 12. Approach and Avoidance Module-Halves of the Fish Brain.**

**This diagram illustrates the general structure of the lateralized fish brain and lists the relative targets and functions of the visual-cognitive modules corresponding to the halves of its mid- and forebrain.**

Experiments show that this arrangement allows for an efficient balance of seed-gathering and predator-detection behaviors: covering the right eye results in poor predator detection and even worse seed gathering, while covering the left eye results in poor seed gathering and even worse predator detection (Vallortigara & Regolin, 2006).

Why is there lateralization of the brain? According to Henriques’ Behavioral Investment Theory (BIT)—the first principle of which is *energy economics*—the animal mind is an epiphenomenon of the brain and evolved as “a decision-making system that calculates the value of the resources obtained and losses avoided, relative to the costs of spending the actions in the first place, the risks involved, and the value of other avenues of investment” (Henriques, 2011, p. 46). Inasmuch as the mind is a phenomenological mapping system, the most fundamental decision an animal can make is how to move in relation to landmarks—that is, approach or avoidance. The lateralized halves of the brain correspond to approach and avoidance modules that interact to determine the overall

movement of the organisms of which they are a part, and those vision-specific systems are the most fundamental and most influential cognitive modules possessed by animals, including humans.

The nature of the cognitive contest or feedback interaction between the approach and avoidance modules can be considered in terms described by economist George Zipf in his book *Human Behavior and the Principle of Least Effort* (1949). Zipf discovered an empirical relationship among words such that the second most commonly used word (“of”) in a given language occurs one-half as frequently as the first (“the”), the third (“and”) occurs one-third as frequently, the fourth occurs one-fourth, the fifth one-fifth, etc. In short, the frequency of any word is inversely proportional to its frequency rank—a fact that holds true across all tested languages. Zipf proposed that the observed high-frequency use of a small fraction of available words indicates that neither speakers nor hearers want to work any harder than necessary to reach understanding, and the process that results in the approximately equal distribution of their efforts leads to the highly skewed distribution of word frequencies.

I will revisit the principle of least effort in Section 5.3, when discussing the evolutionary emergence of word forms, but here it is enough to apply it to the animal mind vis-à-vis BIT and approach-avoidance modularity by modifying Zipf (as quoted by Henriques, 2011, p. 50) to state that an animal

will strive to solve [its] problems in such a way as to minimize the *total work* [it] must expend in solving both [its] immediate problems and [its] probable future problems. That in turn means that the [animal] will strive to minimize *the*

*probable average rate of [its] work expenditure* (over time). And in so doing [it] will be minimizing [its] effort.

Emerging forms of structural-behavior intelligence can be viewed in terms of maximizing energy efficiency as a general adaptive strategy. For example, while the unconnected halves of a fish brain allow for relatively discrete and less flexible interactions between the approach and avoidance modules (more inter-hemispheric competition than cooperation), the emergence of the corpus callosum among placental mammals—the earliest known example is 160 million years old—allows for relatively blended and more flexible interactions (more inter-hemispheric cooperation than competition), and we would expect evolution to take advantage of that trajectory. Indeed, biologist and early champion of Darwinian evolution Thomas Henry Huxley (1825-1895) commented that

[T]he appearance of the “corpus callosum” in the placental mammals is the greatest and most sudden modification exhibited by the brain in the whole series of the vertebrated animals—it is the greatest leap anywhere made by Nature in her brain work. For the two halves of the brain being once thus knit together, the progress of cerebral complexity is traceable through a complete series of steps, from the lowest Rodent, or Insectivore, to Man; and that complexity consists chiefly in the disproportionate development of the cerebral hemispheres . . . .  
(Huxley, 2001, p. 97)

And more recently, evolutionary neurologists have suggested that “the origin of the mammalian corpus callosum is related to the need to integrate the two topographic hemirepresentations of the sensory surface across the midline,” and that

Another important callosal function may have been bimanual coordination . . . [which] may have involved the corpus callosum at later stages of cortical evolution, after the topographic maps were already established and the cerebral cortex had begun to exert significant control in motor behavior. (Aboitiz & Montiel, 2003, p. 414)

“Bimanual coordination” will be discussed in terms of the avoidance and approach modules, as well as their derivatives, in the next Section.

The fundamental nature of the approach-avoidance behavioral binary—which underlies brain asymmetry, in general, and cerebral hemispheric lateralization, in particular—cannot be overemphasized. In their article “Approach and Avoidance Motivation” (2001), which introduced a special issue of *Educational Psychology Review* dedicated to goal theory, psychologists Andrew Elliot and Martin Covington stated: “We contend that approach-avoidance is not just an important motivational distinction, but that it is fundamental and basic, and should be construed as the foundation on which other motivational distinctions rest” (p. 74). The authors note that “one argument for the fundamental importance of the approach-avoidance distinction is that it has a long and rich history in intellectual thought.” They trace that history from the pleasure-pain dichotomy central to ancient Greek ethical hedonism and Benthamite utilitarianism to the formulations of James, Jung, Pavlov, Skinner, Maslow, and a host of other psychologists (pp. 74-76). The authors then note that

A second argument for the fundamental importance of the approach-avoidance distinction is its applicability across forms of animate life. That is, approach and

avoidance motivation is not only manifest in humans, but also in lower organisms as simple as the single-cell amoeba. (p. 76)

In particular, Elliot and Covington reference the work of animal psychologist Theodore Schneirla (1902-1968), who coauthored several books in his field, contributed many scientific papers, researched the behavior of army ants, and who

argued that organisms at all levels of complexity possess what he termed A-type (approach-type) mechanisms, which evoke approach reactions and facilitate food-getting, shelter-getting, and mating and W-type (withdrawal-type) mechanisms, which evoke withdrawal reactions and facilitate defense, huddling, flight, and protection in general. [Schneirla] proposed that the sophistication of these mechanisms varies considerably across species, with those of protozoa and other invertebrates being rudimentary and rigid, and those of higher organisms being more advanced and flexible. (p. 76)

The fact that non-chordates display approach-avoidance behaviors brings up the question of whether the structural underpinnings of those behaviors are homologous or analogous to those found among chordates (Martin & Jones, 2005). Are the brain-cognitive asymmetries found in chordates ultimately derived via evolutionary processes from asymmetries already found among non-chordates (homologous), or did the two lines evolve their respective approach-avoidance modules independently (analogous)? Given that researchers have found that approach-avoidance functions are lateralized in non-chordates as well as chordates (e.g. Heuts & Brunt, 2005), the former possibility is more likely. Additionally, the principle of parsimony suggests that structural-functional

asymmetry is an emergent property of nervous systems—a kind of biological law that immediately manifested and informed all subsequent evolutionary trajectories.

Elliot and Covington discuss “the hypothesis that approach and avoidance motivation are localized in different cerebral hemispheres” based on experiments that have demonstrated that resting hemispheric asymmetry in the prefrontal cortex is associated with motivation-based affective experience, such that relatively greater resting activity in the left prefrontal lobe is linked to approach-based positive affect, whereas relatively greater resting activity in the right prefrontal lobe is linked to withdrawal-based negative affect. (p. 81)

They also note that “this work produces interpretational difficulties” in that the “computation of asymmetry implies a single bipolar (reciprocal) continuum of cortical activation, which contrasts sharply with the prevailing view of approach and avoidance as largely independent motivational orientations” (p. 81). I have already mentioned that a brain with halves / fundamental modules massively connected by a corpus callosum—in effect, a parallel computer—could generate relatively blended, flexible approach-avoidance behaviors, and in Section 5.3 I will discuss the computational contours of the “single bipolar (reciprocal) continuum of cortical activation” within such a brain, and how that continuum relates to the emergence of language. First, though, I will consider the archeological evidence for language to determine what it reveals about the essence of that mapping-signaling system in light of brain lateralization.



#### 4.0 - ARCHEOLOGICAL EVIDENCE

*It has its birth in the earth, its strength it does acquire in the fire, and there becomes the true Stone of the ancient sages.*

-Arnald of Villanova, physician-chemist<sup>13</sup>

*Perhaps the low-level computer rather unexpectedly taught itself some new tricks and stole the show.*

-Frank Wilson, neurologist<sup>14</sup>

#### 4.1 - SETTING THE STAGE

At the latest, brain lateralization began with fish (~500 Ma), and it seems to have been passed down to all other chordates: amphibians (~360 Ma), reptiles (~300 Ma), and eventually mammals (~200 Ma) and birds (~150 Ma), the two lines that have the most complex brains. For half a billion years and through multiple mass extinctions, evolution wrung as much adaptability—as much intelligence—as possible out of the animal nervous system. Yet for virtually all that vast stretch of time, there is no evidence of tool use or culture, and thus no evidence of language.

What in the archaeological record constitutes evidence of language? There are two lines: the physical remains of proto- / humans, which provide evidence of physiological structures associated with language use, and the artifacts produced by proto- / humans, which provide evidence of production associated with language use.

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<sup>13</sup> As quoted in Charles Nicholl's book *The Chemical Theater* (1997, p. 86).

<sup>14</sup> From his book *The Hand: How Its Use Shapes the Brain, Language, and Human Culture* (1998, p.163).

Discussions of those lines of evidence are necessarily conjectural and complicated by the fact that the edges of the standard model of proto- / human physical and cultural evolution are in constant flux due to a steady stream of new and often surprising archeological data. Still, if we move in broad strokes, an evolutionary outline can be described in terms of a few key players.

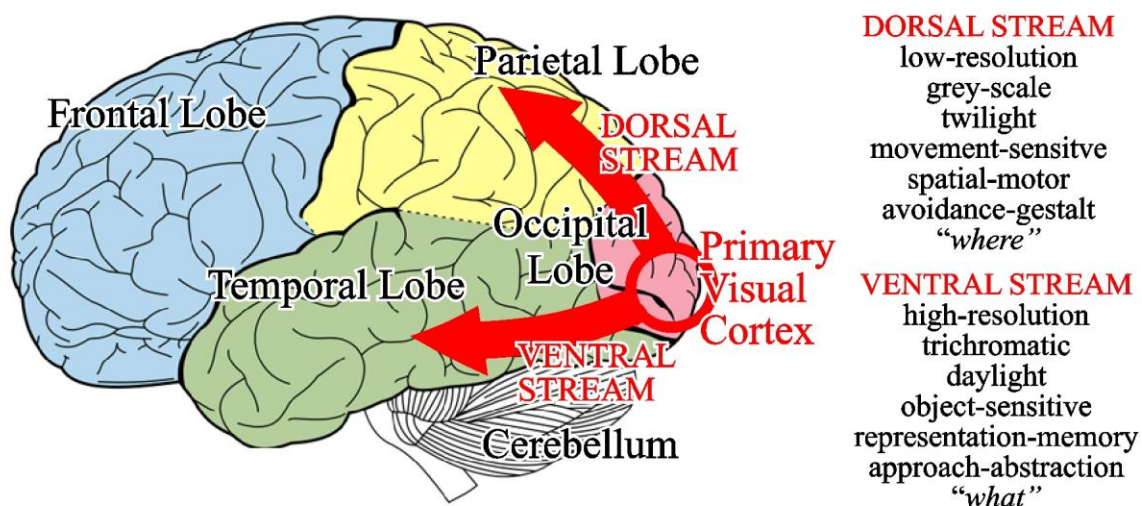
The currently available data suggests that, after the extinction event that wiped out the dinosaurs except for birds, some of our distant, placental-mammal ancestors took to the trees (e.g. *Plesiadapis tricuspidens*, ~60 Ma). There, they ate insects and evolved limbs for grasping branches and binocular vision for better determining depth and distance (e.g. *Teilhardina asiatica*, ~40 Ma). From those prosimians, herbivorous monkeys with partially opposable thumbs evolved, and later split into two main groups: New World and Old World. The latter group of monkeys (e.g. *Aegyptopithecus zeuxis*, ~30 Ma) evolved trichromatic vision and became day-active, and from them evolved the larger, tailless apes (e.g. *Proconsul africanus*, ~25 Ma). The apes split into the common ancestor of lesser apes such as gibbons (~15 Ma) and the common ancestor of greater apes, or hominids, such as orangutans (e.g. *Pierolapithecus catalaunicus*, ~13 Ma). The hominid line then split into the knuckle-walking, herbivorous ancestor of gorillas (~10 Ma) and the knuckle-walking, omnivorous common ancestor of chimpanzees and humans (e.g. *Sahelanthropus tchadensis*, ~7 Ma).

Note that, from the beginning of this evolutionary trajectory, the distinguishing characteristics of the mammalian brain—the cortex, or wrinkled outer layers that are loaded with excitatory pyramidal neurons and inhibitory interneurons, as well as the corpus callosum—was either already in place or was emerging. The result was a highly

networked brain, primed for neural oscillation-enabled sensory input, motor output, information transfer, and mapping (Fries, 2001; Varela, Lachaux, Rodriguez, & Martinerie, 2001). And that brain was fundamentally approach-avoidance lateralized, a fact which conditioned the unique evolution of the primate hand with significant consequences.

Note also that the evolution of trichromatic vision among Old World monkeys and apes involves the splitting of visual data into dorsal and ventral streams after its initial processing by the primary visual cortex within the occipital lobe (Rauschecker, 2012). On the one hand, the dorsal stream consists of relatively low-resolution grey-scale data more useful in twilight conditions, which feeds into the movement-sensitive spatial-motor systems of the parietal lobes. On the other hand, the ventral stream consists of a relatively high resolution mixture of grey-scale and trichromatic data more useful in daylight conditions, which feeds into the object-sensitive representation-memory systems of the temporal lobes. In terms of visual mapping, the dorsal stream is said to be involved in perceiving *where* objects are in relation to each other, and the ventral stream in recognizing *what* objects are and their shape, size, and color (Carlson, 2011, pp. 164 and 349). In that the visual data streaming into the temporal lobes is pre-filtered for approach-abstraction (*what*) rather than avoidance-gestalt processing (*where*), dorsal-ventral partitioning complemented and reinforced the evolution of brain lateralization (see Figure 13).

In any case, chimpanzees, like humans, are now known to have a larynx that, over the first two years of life, drops past the hyoid bone to a point between the pharynx and the lungs. It is probable that this relocation evolved with the knuckle-walking,



**FIGURE 13. Dorsal and Ventral Visual Streams.**

**This diagram illustrates the vectors of the dorsal and ventral streams of the human primary visual cortex. This partitioning occurred at the start of the hominid line and reinforced brain lateralization.**

omnivorous common ancestor of chimpanzees and humans, allowing for more complex vocalizations due to greater control of volume and pitch. Such signaling would have arisen in conjunction with increasing social cohesion that simultaneously created cooperative advantages—especially in terms of hunting, defense, and raising young—and generated tensions between the needs and desires of individuals and other individuals and hominid society—tensions that can be broadly considered in terms of approach-avoidance behaviors.

The earliest known hominin (*Orrorin tugenensis*, ~6 Ma), or split from the common hominid ancestor on the side believed to lead to humans, had a femur with characteristics that suggest partial bipedalism, but otherwise seems to have been a proficient tree-climber. Fossilized specimens of the genus *Ardipithicus* (~5.8-4.3 Ma), however, are different. With a cranial capacity of about 300-350 ml, or on the lower end of that of modern chimpanzees, *Ardipithicus* was likely an omnivore with reduced

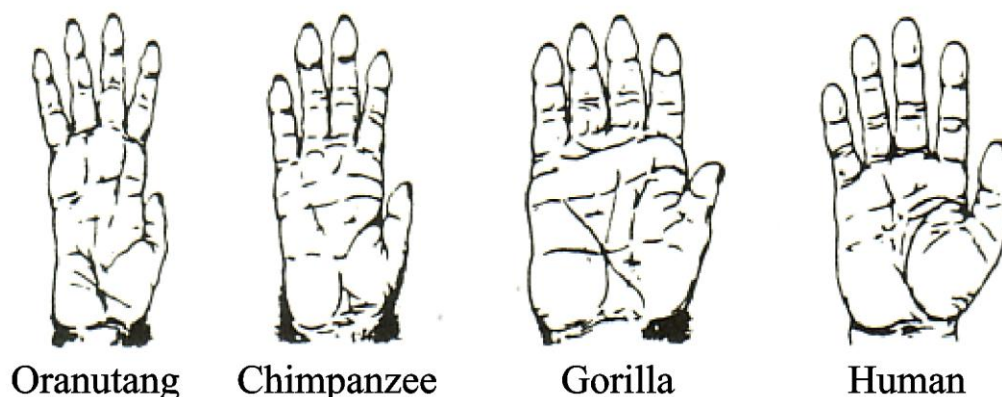
canines.<sup>15</sup> And its bowl-shaped pelvis, the angle of its foramen magnum (the opening at the base of the skull through which the spinal cord connects to the brain), and its thinner wrist bones all indicate an at least partially bipedal stance, where it would have stood just under 4 ft. tall. And although *Ardipithicus*' feet were still configured for grasping rather than long-distance walking, its novel stance might have been advantageous due to the way it freed its hands for manipulation. Whether or not that was the case—bipedalism might also have conferred benefits related to locomotion, sight, and even regulation of brain temperature (Falk, 2009)—the freed hands of this hominin line contributed to the evolution of the mid-level cognitive modules that enabled the emergence of language.

The next actor to take the prehistoric stage was the genus *Australopithicus* (~4-2.4 Ma), which included an omnivore-herbivore species range adapted for living on the savannah rather than in the forest, and is famously represented by the fossilized remains of “Lucy.” Although it still had the long arms of a tree-climber / knuckle-walker, this hominin had a spine, pelvis, and legs that indicate full bipedalism, and stood about 4-4½ ft. tall. *Australopithicus* had even more reduced canines than its apparent ancestor, *Ardipithicus*, and its cranial capacity of about 380-500 ml was between that of a modern chimpanzee and a gorilla.

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<sup>15</sup> In extant primates, male canines can be several times larger than female, and are used for defense, attack, and threat displays by males. Reduction of male canines suggests the development of other modes of conflict resolution, possibly mediated by sexual selection, where females prefer less threatening males. For example, bonobos use sex to resolve conflicts, and show less sexual dimorphism in terms of canine as well as general body size—and bonobo males show lower testosterone levels than chimpanzee males.

However, as researched by physical anthropologist Mary Marzke, the physical feature that really stands out here is the thumb, which is now long enough and positioned such that it can form a “three-jaw chuck” with the index and middle fingers, allowing for the focused and accurate manipulation of small objects (1983). Modern orangutans (brachiators) and chimpanzees and gorillas (knuckle-walkers) cannot form that manual configuration, since their thumbs are too short in relation to the rest of their hand (see Figure 14), but Marzke hypothesized that *Australopithicus*’ “grip could have been



**FIGURE 14. Hominid Hands (after Schulz, 1969, p. 58).**

**This diagram illustrates extant hominid hands. Only the human hand has a thumb long enough to be able to form a “three-jaw chuck” for focused and accurate manipulation of tools.**

exploited in the manipulation of small stone flakes and wood probes, and in the controlled manipulation of stone missiles” (p. 197). While full bipedalism in conjunction with the novel grip would have allowed for overhand stone-throwing (chimpanzees can manage an underhand toss), there is not and probably cannot be any evidence of that activity. But evidence of the focused and accurate manipulation of small stone flakes has surfaced:

While working in the Afar Region of Ethiopia, [archeologists] found fossilized bones bearing unambiguous evidence of stone tool use—cut marks inflicted while carving meat off the bone and percussion marks created while breaking the bones

open to extract the marrow. The bones date to roughly 3.4 million years ago.

(Heness, 2010)

There is little evidence that *Australopithicus* reshaped the stone tools it used; rather, they were likely tools of opportunity. Other animals also use tools of opportunity; for example, chimpanzees insert sticks to draw termites from their mounds and use rocks to crack open nuts (Trivedi, 2004),<sup>16</sup> otters use stones to dislodge and crack open mollusks (“Sea Otters,” n.d.), bottlenose dolphins have been observed to use conch shells to trap and eat small fish (“Ingenious Fishing,” 2011), and specimens of the veined octopus have been observed gathering coconut shells to assemble them into shelters—octopi are the only invertebrates known to use tools (Finn, Tregenza, & Norman, 2009). Birds are particularly intelligent when it comes to tool use. New Caledonian crows use sticks held in their beaks to extract ants from logs, and a laboratory specimen was observed to improvise a hooked wire tool with no prior training or experience (Winkler, 2002). Seagulls leave oysters at city intersections to be cracked open by passing cars (Henry & Anzar, 2006), and crows do the same with hard-shelled nuts (“Smart Crow,” 2010).

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<sup>16</sup> Researchers led by archeologist Julio Mercader have concluded that stones found in conjunction with chimpanzee remains from about 4.3 ka ago show signs of deliberate modification such as “bashing” and even “flaking” (Clarke, 2007), which if accurate, would place their creators alongside *Homo habilis* in terms of tool-making capacity. Additionally, wild chimpanzees have been observed sharpening the ends of sticks with their teeth and using the resulting “spears” to hunt for bush babies in tree hollows (Roach, 2007).

But the way in which *Australopithecus* used stone tools of opportunity was distinctive in that its thumb allowed it to bring focused and accurate force to bear, and its reconfigured, more flexible wrist also acted as a shock absorber. That ability to focus force with accuracy directly through a tool might have favored individuals with a penchant for finding stones with already-existing *edges and points* (that left cut and percussion marks on bones), causing proto-human tool use to foster a narrowing of attention, and thus approach-abstraction over gestalt-avoidance cognition. This possibility is supported by a study of *Australopithecus* cranial endocasts, which “show a distinct left-occipital, right-frontal petalial pattern” (101) suggesting “decidedly human rather than pongid [hominin rather than merely hominid] patterns of hemispheric asymmetry” (102)—in other words, signs of the Yakovlevian torque that figures into the oversized planum temporale of modern humans.<sup>17</sup> Although that study should be considered inconclusive due to its small sample size,<sup>18</sup> it is possible that *Australopithecus* was capable of rudimentary proto-linguistic abstraction and that it generated and passed down

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<sup>17</sup> There is evidence suggesting that *Orrorin* possessed a long thumb, if not a flexible wrist, before *Australopithecus* (Bower, 2010). There is, however, no evidence of regular tool use (and thus proto-language) so early in the hominin line—the cognitive capacity likely had not yet developed. But an early long thumb could have immediately started selecting for enhanced abstract cognition based on brain torque.

<sup>18</sup> As must the study “Morphology and Histology of Chimpanzee Primary Visual Striate Cortex Indicate That Brain Reorganization Predated Brain Expansion in Early Hominid Evolution” (2003). The primary striate visual cortex is the area at the root of the dorsal and ventral visual streams, and the study examines that area to “offer significant support for the hypothesis that the neurogenetic basis for brain reorganization was present in our early fossil ancestors (i.e., the australopithecines) prior to brain enlargement”—but its primary data was obtained from only two chimpanzees.



warning cries or other exclamations. But being essentially emotional signifiers, those simplest of word forms would have been insufficient to indicate any shift from BIT consciousness (which is essentially emotional) to Archaic consciousness, a position reinforced by the fact that other animals also engage in mimetic behaviors so rudimentary as to not be proto-cultural in the technical sense considered here.

#### 4.2 - DRAWING THE CURTAINS

The next actor to take the prehistoric stage is classified as the first true human: *Homo habilis*, or “handy-man,” famously discovered by the Leakey family at Olduvai Gorge in Tanzania. The Leakey family had previously discovered *Australopithecus* in the same area, and the two genera have adjacent time frames, where *Australopithecus* existed from about 4-2.4 Ma and *habilis* existed from about 2.4-1.4 Ma. Since there is no evidence of independent evolution for *habilis*, it appears that it emerged from an *Australopithecus* line—perhaps something like *A. sediba* (~2 Ma), which had a very sophisticated hand, or *A. garhi*, which might have reshaped stone tools (~2.5 Ma). *Habilis* apparently scavenged meat, and was hunted by giant cats. It remained short, with long arms, but its teeth were smaller and its face less prognathous than *Australopithecus*. The major anatomical difference, though, was its brain size: *habilis* had a 600-800 ml cranial capacity and thus a brain that was more than half again as large as that of *Australopithecus*, or at and surpassing the upper range of that of the modern gorilla. That difference marked the beginning of the process of “encephalization,” whereby the hominin cortex rapidly mushroomed as if it was caught up in some sort of evolutionary positive feedback loop.

The other major difference was the presence of a roughly reshaped assemblage of pounders, scrapers, and choppers referred to as the “Olduwan” toolkit or industry after the Olduvai Gorge (see Figure 15). But who started making this toolkit, and who was

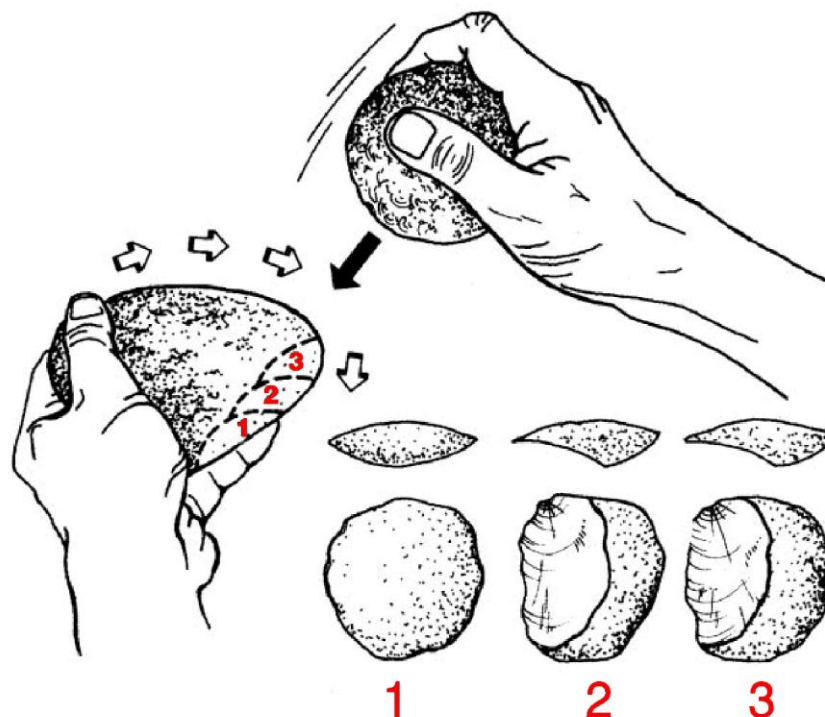


**FIGURE 15. “Olduwan Chopper,” 2011 (University of Missouri Museum of Anthropology). This diagram illustrates a typical Olduwan stone tool, which is unifacial and roughly worked.**

being so industrious? The oldest examples found so far date to 2.6 Ma, or 200k years before the earliest known specimen of *habilis*. Did something like *A. sediba* or *A. garhi* start the toolkit, and then hand it off (so to speak) to *habilis*? If so, then an *Australopithecus* species seems eligible for *Homo* status, and would be first in the human line. Such issues point to the limitations of our models, which are based on incredibly fragmentary data and artificially discrete categories; as the temporal window under consideration narrows, even a single new find can upset our evolutionary applecart. We must be willing to gather up our scattered apples, and prop up our cart as best we can—or maybe make a new cart, if our old one seems beyond repair.

In any case, the important thing to note here is that the Olduwan toolkit—which was produced for about a million years, from 2.6-1.7 Ma ago, and constitutes the beginning of the Lower Paleolithic era—is the first evidence of proto-culture and

Gebser's Archaic mind. Olduwan tools were fashioned by using a stone to remove flakes from another stone, or core (see Figure 16), and both the flakes and the core were used as



**FIGURE 16. Olduwan Production (after Schick & Toth, 1993, p. 141).**

**This diagram illustrates the flaked-stone technique involved in making an Olduwan handaxe. This process was likely first carried out by *habilis* after the emergence of the *Australopithicus* thumb.**

tools. This process involves a narrowing of attention into something like intention,<sup>19</sup> and can be described as the abstraction of flakes from a gestalt core. And if we think in terms of approach-abstraction / avoidance-gestalt brain lateralization or asymmetry, it is significant not only that endocasts of *habilis* crania show an impression of Broca's area, but that an analysis of Olduwan cores "reveals a preferential, clockwise rotation of cores

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<sup>19</sup> In his book *Love and Will* (1969), psychologist Rollo May treats intentionality as "the 'missing link' between mind and body" (p. 227), and states: "Intentionality is an imaginative attention which underlies our intentions and informs our actions" (p. 308).

during flaking” that is “a non-random pattern...consistent with that produced by right-handed toolmakers” (Toth, 1985, p.607).

The implication of this information is summed up nicely by neurologist Frank Wilson, in his book *The Hand: How Its Use Shapes Brain, Language, and Human Culture* (1998): “Handedness may be nearly as old and influential as bipedalism was in shaping human development and orienting our subsequent history.” One of Wilson’s major concerns is finding

an explanation of handedness that could be linked to the evolution of lateralized specialization of the brain, which is an important possibility to consider since it is now known that the left hemisphere (which exerts a powerful influence on the movement of the right arm) could provide the temporal precision needed for the kind of complex sequenced movements that the dominant hand seems especially suited for.

It is not difficult to recognize that the fundamental approach-abstraction and avoidance-gestalt modules were elaborated in relation to the dexterous hominin hand to rapidly evolve a holographic, novel, technical module, as evidenced by the Oldowan toolkit.

Wilson might as well be talking about *habilis* when he says:

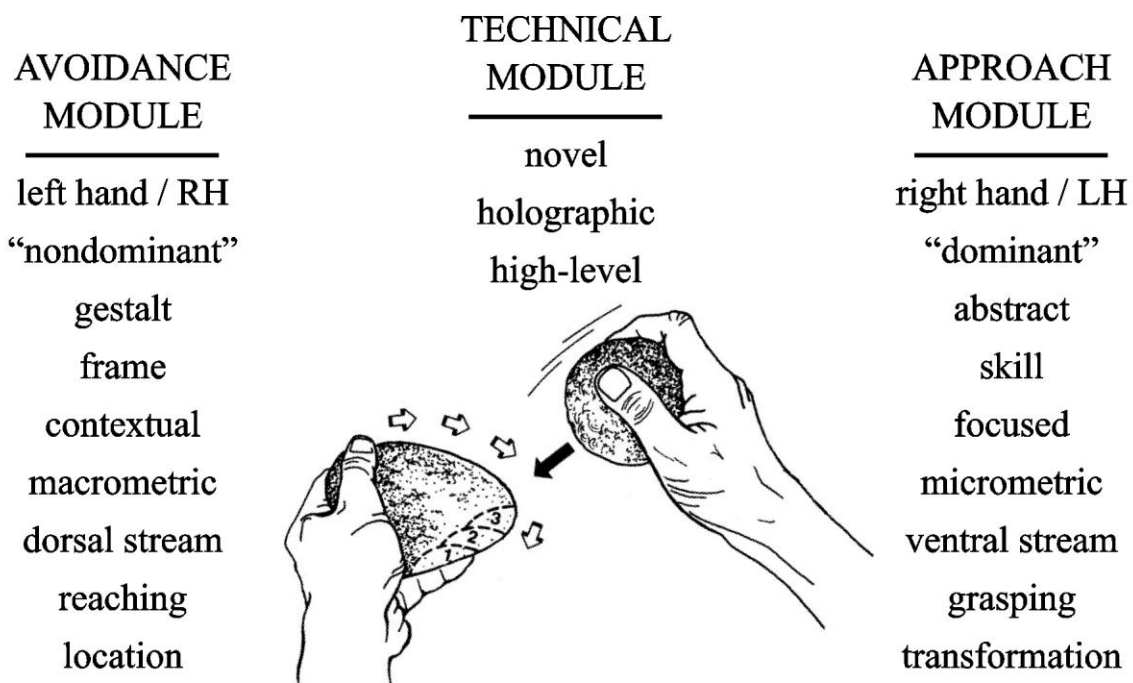
The spatial and temporal scales of movement of the two hands were different, the dominant being “micrometric” and the nondominant “macrometric” [and] “the nondominant hand (as when adjusting a piece of paper) “frames” the movement of the dominant hand: it sets and confines the spatial context in which the “skilled” movement will take place.

We should remember those dorsal and ventral visual streams evolved by the common ancestor of the great apes, a partitioning perhaps significant enough to constitute a restructuring of the fundamental modules. Indeed, in his book *The Cognitive Neuroscience of Action* (1997), cognitive neuroscientist Marc Jeannerod (1935-2011) speaks in terms of “parallel visual systems” and “another visuomotor model, no longer based on the modalities of visual coding of the movement, but rather on the modes of *representation* of the *goal* of the movement” (emphases added). Particularly for an animal with hands, “objects in space afford two main types of interactions, reaching and grasping.” And according to Jeannerod, the dorsal stream “deals with the extrinsic properties of these objects (their location in space with respect to the body, their velocity of motion, etc.),” and “its function is to transport the hand to the desired location in extrapersonal space,” while the ventral stream “deals with the intrinsic properties (like shape or size),” and “its function is to shape the hand with the purpose of manipulating, identifying, and transforming objects” (p.21).

In summing up the issues involved in the emergence of the hominin technical module it becomes apparent that it involves a sublimation of avoidance behavior by or in relation to approach behavior—a fact reflected in the terms “dominant” and “nondominant” (see Figure 17). That process was likely enabled by the prior emergence of what cognitive archeologist Steven Mithen refers to as Social Intelligence.<sup>20</sup> In his

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<sup>20</sup> Social evidence for avoidance sublimation might be found at the level of pronoun usage. When a person of lesser status communicates with a person of greater status, the former actually tends to use the word “I” with greater frequency because he is more self-conscious (Pennebaker, 2011, pp. 177-181). In other words,



**FIGURE 17. Hand-Brain Emergence of the Human Technical Module.**

**This diagram illustrates the general sublimation of the avoidance-gestalt module by or in relation to the approach-abstraction module to generate the high-level human technical module.**

book *The Prehistory of the Mind: The Cognitive Origins of Art and Science* (1999),

Mithen also uses Fodor’s theory of modularity and Gardner’s theory of multiple

intelligences to discuss possible relations among General Intelligence, Natural History

Intelligence, Social Intelligence, Technical Intelligence, and Language. For our purposes,

though, general intelligence can be considered in terms of the degree of flexibility in

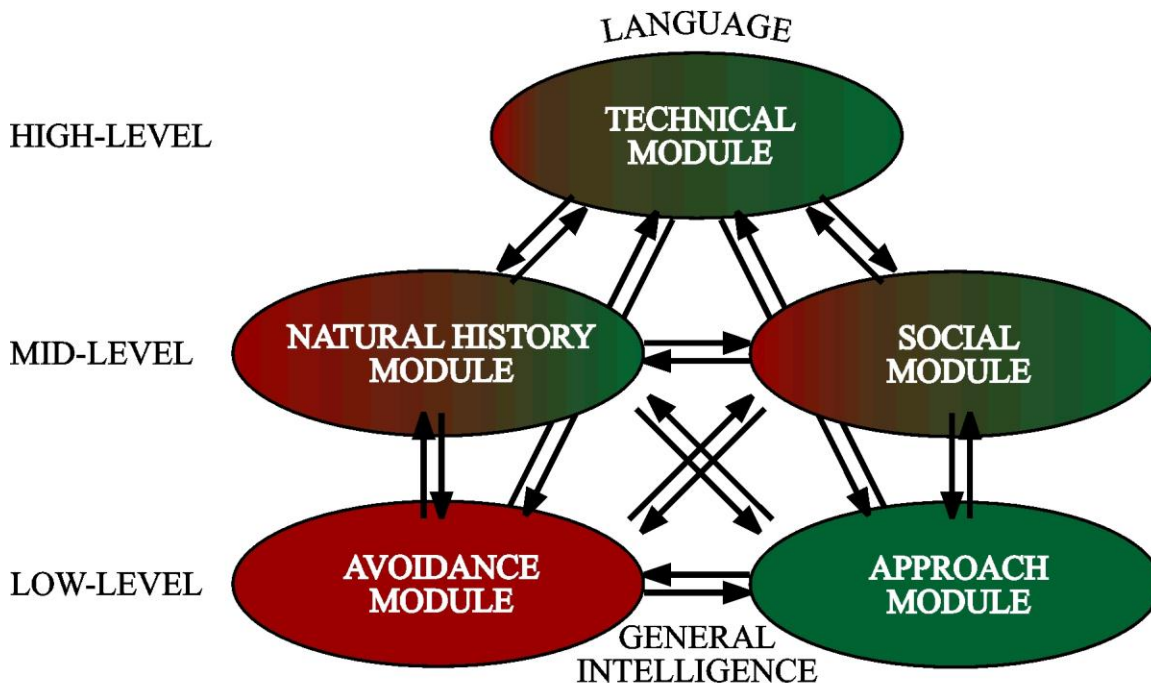
interactions between the low-level approach and avoidance modules, from which, given

enough flexibility, the mid-level natural history and social modules can emerge. And

given enough flexibility, those four modules can then interact to generate the high-level

part of him would rather run away or avoid the situation, but instead he asserts himself or approaches the situation.

technical module, from which, given enough flexibility, language can emerge as a form of technology—a tool (see Figure 18).



**FIGURE 18. Relationships Among Cognitive Modules and Language.**

**This diagram illustrates the relationship among human cognitive modules, where lines and arrows represent feedback loops, and red and green represent possible avoidance-approach ratios.**

As will be discussed in Section 5.1, this whole evolutionary trajectory is a nested hierarchy with feedback throughout—but the generation of the technical module, and thus language, is difficult to imagine without the tool-making flexibility provided by the hominin hand. Thus psychologist Lev Vygotsky points out in his book *Thought and Language* (1986) that

even before language comes *thinking in terms of tools*, i.e. the realization of mechanical connections and the invention of mechanical means for mechanical ends. To put it briefly, before the advent of speech, action comes to have *subjective meaning*; i.e. it becomes consciously purposive. (p. 81, emphases in original)

It should be stressed that this proto-linguistic, technical subjectivity described by Vygotsky is not self-aware consciousness, but “only” a sophisticated version of the mapping mind outlined by Henriques’ BIT. With *habilis*, tool-making is present, but language proper is not suggested, and in order to understand why that is the case—and move on to consider *Homo erectus*, *neanderthalensis*, and *sapiens*—I must first briefly consider the essential characteristics of language.

I have already noted that language is an information-processing system, mentioned Dawkins’ concept of memes and mimetic evolution, and I have discussed signs as units of meaning. Although I have left the nature of signs an open question that will be addressed in Section 5.2, here I will define language as *a mapping-signaling system that allows for the social-mimetic construction and processing of information-meaning through representation, recombination, and recursion*. Here, put simply:

- *Representation* is the use of sounds, words, and phrases to designate referents.
- *Recombination* is the joining of sounds, words, or phrases to generate novel words, phrases, and simple and compound sentences.
- *Recursion* is the nesting of simple and compound sentences to generate novel complex sentences.

While I have couched these definitions in easily recognizable terms, they describe a general pattern of linguistic evolution that is anchored in experience of both the natural world and society, but becomes increasingly complex and eventually self-referential through a process of iterative abstraction.



As a species, *habilis* was social, and it was capable of abstractions through which it was able to represent its natural world in such a way that it was able to reshape stone. But the Oldowan toolkit remained unchanged *for hundreds of thousands of years*. That lack of novelty over a timespan so vast as to be only vaguely conceivable in normal human scales clearly indicates only rudimentary recombinatorial capacity—to say nothing of recursion and self-awareness—and thus indicates a lack of language proper. As already suggested, with *habilis*, we are likely looking at proto-language and proto-culture based largely on instinctive abstractions and generating a cusp-Archaic consciousness still very much bounded by genetic evolution and an innately neural-algorithmic technical module.

I say “largely” because here there is the possibility of contingency-based abstraction—or concept formation—that allowed for novel, on-the-fly representations of percepts, that is, the first nouns (and noun-adjectives, immediately thereafter). Other animals use instinctive, neural-algorithmic, module-based abstractions for purposes of mapping and signaling—that is, representation, as in the famous example is the vervet monkey, which uses specific alarm calls to signal the presence of specific predators (Seyfarth, Cheney, & Marler, 1980). Did *habilis* have something more? Did it have contingency-based representation, if not substantial recombination or recursion? The regular and transmitted *making* of even simple tools is a goal-oriented behavior that suggests intention and meaning based on a rewiring of the brain’s capacity for abstraction, as suggested by the impression of Broca’s area in *habilis*. That, combined with the static toolkit and absence of art, is why I suggest that *habilis* possessed proto-language, proto-culture, and cusp-Archaic consciousness.

The situation with the next actor to take the prehistoric stage, *H. erectus*, was quite different from that of *habilis*. There is evidence of *erectus* going back 1.9 Ma in Africa, 1.8 Ma in west Asia, and perhaps 1.7 Ma in east Asia, so its point of origin is uncertain. Some have argued for a line of hominin descent in Asia (Begun, 2003; Raghaven, Groves, & Pathmanathan, 2003), but the standard model has *erectus* leaving Africa to seed Europe and Asia with the *Homo* line. If *erectus* emerged in Africa, than it might have split from *habilis*, or been derived from a common ancestor such as *Ardipithicus* or *Australopithecus*. There is evidence of its survival in Asia until at least 100 ka (Anton, 2003, p. 131), which indicates overlapping timeframes with both *neanderthalensis* and *sapiens*. Standing at just under 6 ft. tall, *erectus* had longer legs and shorter arms than *habilis*—proportions similar, in fact, to ours. It also had a flatter face, smaller teeth, and at 850-1200 ml, a cranial capacity half again larger than that of *habilis*.

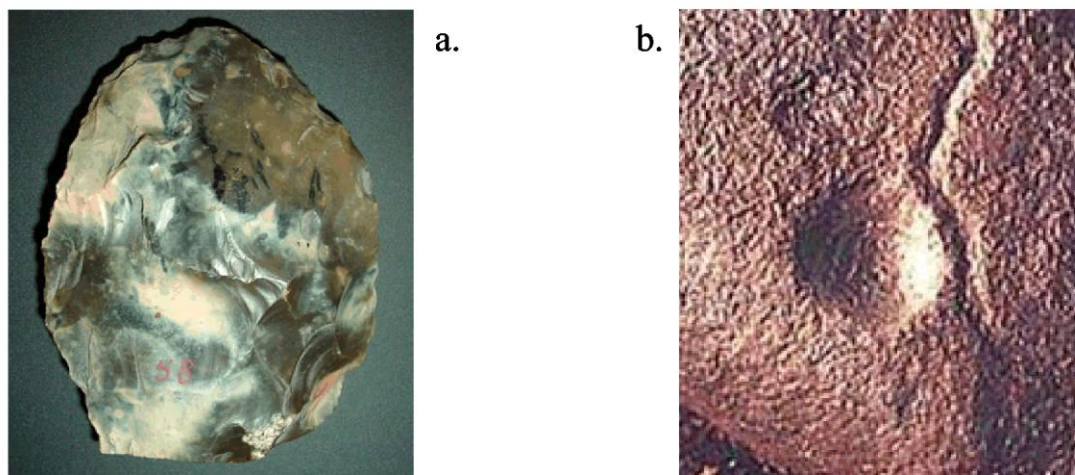
That continued rapid growth in brain size was likely the phylogenetic equivalent of “if you build it, then they will come,” where the thing being “built” was the hand, and the “they” was the brain that supported the technical module. But the linear “if-then” construction doesn’t take into account feedback, which allows for nonlinear growth (as will be discussed in Section 5.1). In other words, bipedalism (e.g. *Ardipithicus*) allowed for the evolution of a manipulative hand (e.g. *Australopithecus*), which allowed for the evolution of the technical module and tool-making (e.g. *habilis*), which allowed for the evolution of a bigger brain with a technical module more tightly wired to handedness (e.g. *erectus*), which allowed for the evolution of a bigger brain with a technical module more tightly wired to handedness (e.g. *neanderthalensis*), etc. That feedback loop

constitutes a phylogenetic illustration of a strong version of Vygotsky, Leont'ev, and Luria's activity theory, which basically states that "the things we make make us."

But in nature, there are no isolated systems or feedback loops. The activity of the evolving technical module allowed for a better tool kit, but it also fed into the natural history and social modules both directly, and indirectly through the approach and avoidance modules. The general effect here would have been an increasing emphasis on the approach-abstraction function and the increasing sublimation of the avoidance-gestalt function. Hence we find evidence that *erectus* was an active hunter, as well as the first hominin to leave Africa to settle across Asia and Europe. Those activities required not just greater technical skill, but enhanced social cohesion and understanding of the natural world. All of those functions fed back into each other through the evolving dexterous-hand / big-brain system, which placed a premium on right-hand focus and accuracy and left-brain focus and abstraction. And significantly, endocasts of *erectus* crania clearly show the left-occipital / right-frontal petalia that indicate Yakovlevian torque.

The Acheulean industry associated with *erectus* also shows the effects of that premium on right-hand focus and accuracy. The oldest examples are African—although the toolkit takes its name from a French village where it was first discovered—and go back about 1.8 Ma, and the last scattered examples go back about 200 ka. The most prevalent Acheulean tool is the flaked-stone hand axe, a tear-shaped, pear-shaped, or ovoid core held in the hand for piercing, cutting, and scraping (see Figure 19a). This tool comes in various sizes, is bifacial, and shows an attention to symmetry that might be more than merely functional (Mithen, 1999, p. 116), especially when considered in conjunction with wide-ranging evidence of what can be considered *erectus* proto-art:

petroglyphs in the form of apparently non-representational cupules or circular depressions (see Figure 19b), sometimes with traces of mineral pigments that suggest representational intent (Bednarik, 2011, 62-67).<sup>21</sup>



**FIGURE 19. “Acheulean Handaxe,” 2011 (University of Missouri Museum of Anthropology) and Possible Proto-Art (Bednarik, 2011, p. 65) fashioned by *Erectus*.**

**These diagrams illustrate a typical hand axe (a), which is bifacial and worked for symmetry, and an apparently non-utilitarian cupule with a meandering line (b), hammered into a stone wall.**

But the use of fire by *erectus* is the most novel and abstract behavior in the history of life on Earth up to that point, especially if that fire was started from scratch. Much has been written on the importance of the mastery of fire in terms of cooking food and providing light, protection, warmth, and a center for communication (e.g. Burton, 2009; Wrangham, 2009). While the specific *erectus* behaviors involved in the generation or

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<sup>21</sup> The so-called “Venus of Berekhat Ram” (found in the Golan Heights and dated to at least 230 ka ago) and the “Venus of Tan-Tan” (found in Morocco and dated to 300-500 ka ago) are stone objects possibly reshaped by *erectus*, but they remain ambiguous. It has been suggested that *erectus* set up stones about 180 ka ago at the end of the Wonderwerks Cave in South Africa to modify its acoustic and visual properties (Chazan & Horwitz, 2009), and the same site has provided evidence for the earliest use of fire by *erectus*, dated to about 1 Ma ago.

preservation of fire must have been taught and were therefore proto- / cultural-mimetic, the instinctive and distinctive human fascination with fire—at least until the point of mastery (Fessler, 2006)—is the product of a hominin brain, in general, and technical module, specifically, rapidly expanding towards phase transition criticality. Not only was the fascination with fire an extreme instance of the sublimation of avoidance behavior by or in relation to approach behavior, but I submit that in terms of abstraction, fire was a game-changing tool that not required and reinforced the use of hands, but created its own evolutionary feedback loop. It is unlikely *erectus* would have been able to travel so far and adapt to ice age environments without it.

And speaking of traveling so far, *erectus* might have constructed seaworthy watercraft to populate Flores about 800-900 ka and Crete about 150 ka, since their tools have been found and dated at those island locations and others as well. Of course, if such activity occurred, it must have been intentional and cooperative, and would have required communication both representational and recombinatorial—and likely somewhat recursive. Paleo-art expert Robert Bednarik is especially keen on “The Maritime Dispersal of Pleistocene Humans” (2002) and its implications:

The entire destiny of humanity was decided around a million years ago, when hominids made a conscious decision to entrust themselves, their very existence, to a contraption they themselves had built, and to seek their future in an unknown land.... Aspects of “modern human behavior” as defined by this model had existed in South-east Asia for the best part of a million years, and included language and symbolic production. Complex social systems and technologies must certainly have been available to the seafarers, because without them it would

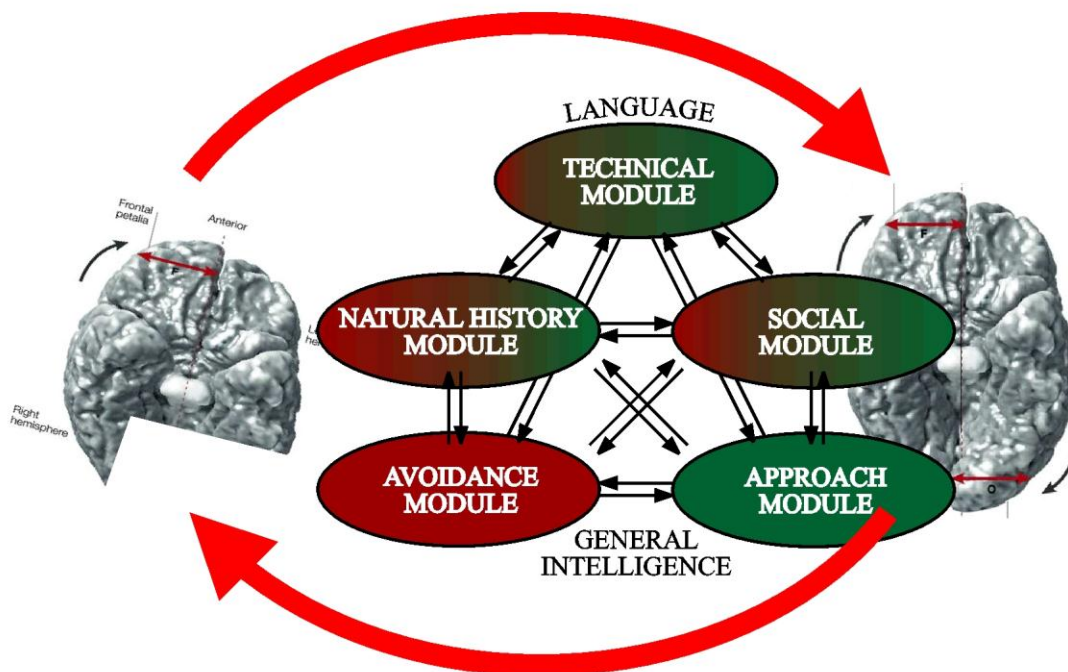
have been entirely impossible to organise and execute such courageous exploits.... For such a colonisation effort to be successful, it had to have a minimum number of male and especially female participants of reproductive age, perhaps around a dozen individuals. To transport a number of humans and their supplies, a vessel of certain minimum requirements needed to be constructed, and to do this with stone tools involved a considerable investment of effort and material. Common sense tells us so, but it does not provide any further details.

But there is no direct evidence of such composite construction—indeed, there is no evidence that *erectus* fashioned anything recombinatorial at all. Its stone tools, for example, were apparently hand-held, not hafted, since none are “waisted” for hafting or show hafting wear; its wooden spears had sharpened, fire-hardened points; and it did not seem to have projectile weapons. Moreover, Bednarik fails to address the facts that other large animals managed such migrations, and that successive ice ages lowered global sea levels enough to nearly connect both Flores and Crete with mainland.

Still, the fabrication of tools with an eye towards symmetry, the leaving of non-utilitarian marks on stone and the probable use of pigmentation, the use and probable making of fire, and the migration of groups across varied environments—those activities all suggest the use of language. However, there is no evidence of *erectus* religion; as noted, their proto-art was apparently non-representational. That implies a lack of inner life or subjectivity born of only rudimentary linguistic recursion. It seems that big-brained *erectus* had most of the qualifications for language: contingency-based abstraction allowing for regular social representation, limited recombination of vocalizations, and perhaps rudimentary recursion. Hence, the novel behavior requiring

sequential attention and cooperation—although the Acheulean hand axe, like the Olduwan chopper-scrapers, remained essentially unchanged for *hundreds of thousands of years*. So why only limited recombination and rudimentary recursion? Why does it seem that *erectus* was locked into Gebser’s Archaic consciousness?

Two possible answers come to mind. The simplest answer is insufficient processing power based on brain size and connectivity, where *erectus* was likely able to *abstract nouns through time* to derive verbs (and verb-adverbs immediately thereafter), but was unable to derive function words to allow for anything beyond simple sentences; basically, another evolutionary iteration of the hand-brain positive feedback loop (Roby-Brami *et al.*, 2012) involving the hominin technical module (see Figure 20) was needed to move beyond content words. The more complicated answer might have to do with



**FIGURE 20. Hand-Brain Positive Feedback Loop.**

**This diagram illustrates the iterative evolutionary process whereby the hominin hands, newly freed by full bipedalism, reinforced already-existent lateralizations, which reinforced handedness, etc. The overall trajectory is increasing manual coordination, brain lateralization and size, and intelligence.**

limitations in expression, where the hominin vocal apparatus had not changed significantly since the common ancestor with chimpanzees, so *erectus* still lacked the vocalization capacity required by speech, and was consequently limited to gestural communication. However, modern sign language can generate recursion, and congenitally deaf people think recursively in sign language using the same areas of the brain associated with thinking in speech, so the first answer is the more likely of the two.

Here, it is important to elaborate upon the distinction between content and function words. In his book *The Unfolding of Language: An Evolutionary Tour of Mankind's Greatest Invention* (2005), mathematician-linguist Guy Deutscher points out that “most words we use, like ‘table,’ ‘kick,’ ‘walk,’ or ‘rabbit,’ have a simple solid meaning, so they are often called ‘content words’” (p.26)—nouns and verbs and their derivatives. But there are also ‘function words,’

a group of words in language whose meaning really is quite a lot less obvious.

These are the ‘grammatical words’ such as *a, the, of, so, that, which, or, than...* conjunctions, prepositions, articles, and so on. But there is one basic property that is common to all of them all: they cannot boast their own independent meaning. They don’t refer to objects, actions or properties, or to any other concepts that can be imagined in their own right. (p. 26)

As was discussed in Section 2.3 and will be discussed again in Section 5.2, Saussurian or structuralist sign theory does not recognize that words can have “independent meaning” because it does not recognize that words can refer to anything other than each other. Section 5.2 will also discuss the idea that exclamations have such heavy emotional



content, and are so dependent on situational context, that they can be treated as proto-words rather than words proper.

In any case, the next actor to take the prehistoric stage was not lacking in the brain-size department. With a cranial capacity of about 1300-1700 ml, *neanderthalensis* had a brain almost half again as large as that of *erectus*. And again, that expansion occurred so rapidly in evolutionary terms that the hand-brain positive feedback loop involving the hominin technical module is implicated. *Neanderthalensis* ultimately emerged from *erectus* about 400 ka ago, and lived across Europe and into the Levant until as late as 24 ka ago. The novel artifacts associated with *neanderthalensis* constitute the Mousterian industry, and are found as early as 300 ka ago and as late as 30 ka ago, thus delineating the Middle Paleolithic. Here, the iconic tool was the Levellois point, which had actually been a minor component of the Olduwan and Acheulean industries of the Lower Paleolithic.

A Levellois point (see Figure 21), is made by knocking a flat Section from the end of a stone core to make a striking platform, then trimming flakes from the edge of the



**FIGURE 21. “Levellois Flake,” 2011 (University of Missouri Museum of Anthropology). This diagram illustrates the typical Mousterian tool, most frequently fashioned by *neanderthalensis*.**

core in the shape of the final point, then knocking the striking platform so that the final point with its edges already trimmed was dislodged from the core. Depending on its exact size and shape, a Levellois point can be used as a scraper, knife, or spear point. Of course, the manufacture of such a tool—the multi-step abstraction of a stone point from a gestalt core—requires careful attention to materials, a careful plan of action, and the careful application of force. And while *habilis* and *erectus* had crafted the Levellois point in limited quantities—presumably because of the relative difficulties involved, compared with a chopper-scraper or hand axe—*neanderthalensis* made it the tool of choice. That choice required *neanderthalensis* to have a well-developed mapping system and to be able to engage in complex abstract representation, abilities that likely carried over into its signaling system—which was, nevertheless, still proto-linguistic.

I say that despite the fact that many assume that since *neaderthalensis* “lived 250,000 years or more in the harshest climates experienced by primates, not just humans” (Alper, 2003), it must have made and worn clothing—although *erectus* also migrated through ice age environments—and there is evidence that *neaderthalensis* made hafted, composite tools (Mithen, 1996, p. 122), so its recombinatorial abilities were qualitatively better than those of *erectus*. Moreover, there is evidence suggesting *neaderthalensis* proto-religion and proto-art, and therefore limited recursion, even before the introduction of, and coexistence with, *sapiens* about 40 ka—namely, there are what appear to be simple burials (e.g. at Shanidar Cave in Iraq, dated to 60-80 ka ago, and Qafzeh Cave in Isreal, dated to about 90 ka ago), and there are cave paintings.

While the burials found do not unambiguously include grave goods (Mithen, 1996, pp. 135-136), their apparent deliberateness—bodies are more often found in mass

deposits, or sometimes butchered (Viegas, 2010b)—suggests a developing theory of mind based on the “mind-reading” function of the social module. The intensification of that function went hand-in-hand with the emergence of technical-linguistic abstraction, which fed back into the mid- and low-level modules to allow for an increased sense of sympathy and altruism, as evidenced by *neanderthalensis* remains that show signs of survival and healing after crippling sickness and injury. Such survival would have been unlikely without social assistance. Previously, the natural world, social, and technical modules were not as well-developed, and the tendency would have been to eventually shun, leave behind, or otherwise avoid a sick or crippled individual. With the unfolding of proto-language, however, such low-level avoidance responses were sublimated into increasingly complex proto-cultural approach responses.

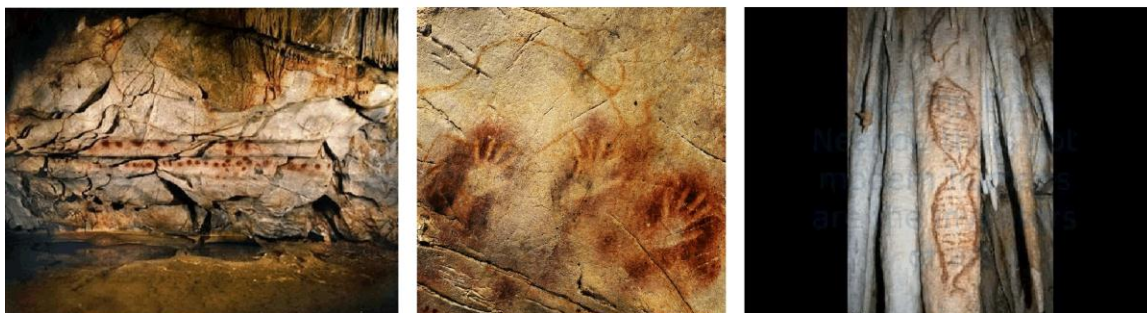
The flip side of a developing theory of other minds based on the “mind-reading” function of the social module as enabled by unfolding but still limited proto-linguistic recursion is a developing theory of self. Neuroscientist Vilayanur Ramachandran (b. 1951) puts it like this:

It was almost certainly a two-way street [a positive feedback loop] with self-awareness and other-awareness enriching each other in an auto-catalytic cascade that culminated in the fully human sense of self. You say you are being “self-conscious” when really you mean being conscious of someone being conscious of you. (Thagard, 2007).

Similarly, psychiatrist and brain imaging specialist Marco Iacoboni states, “The self and the other are just two sides of the same coin. To understand myself, I must recognize myself in other people” (Slack, 2007). This understanding is in keeping with the ideas

expressed by philosopher Emmanuel Levinas in his book *Totality and Infinity: An Essay on Exteriority* (1961), where the recognized Other is the mirror of the self, the ground of ethics, and the gateway to religion; the emerging self was and is bound up in reflection, responsibility, and reification (the projection and concretization of abstractions)

With the possibility of *neanderthalensis* proto-art, we could have evidence of limited reflection and reification. Researchers have recently redated fifty sections of prehistoric cave painting in eleven Spanish caves such as Altamira, and determined that the oldest layers—consisting of geometric shapes and the blown-pigment outlines of hands—might have been created by *neanderthalensis* 35-40 ka ago (see Figure 22). Those

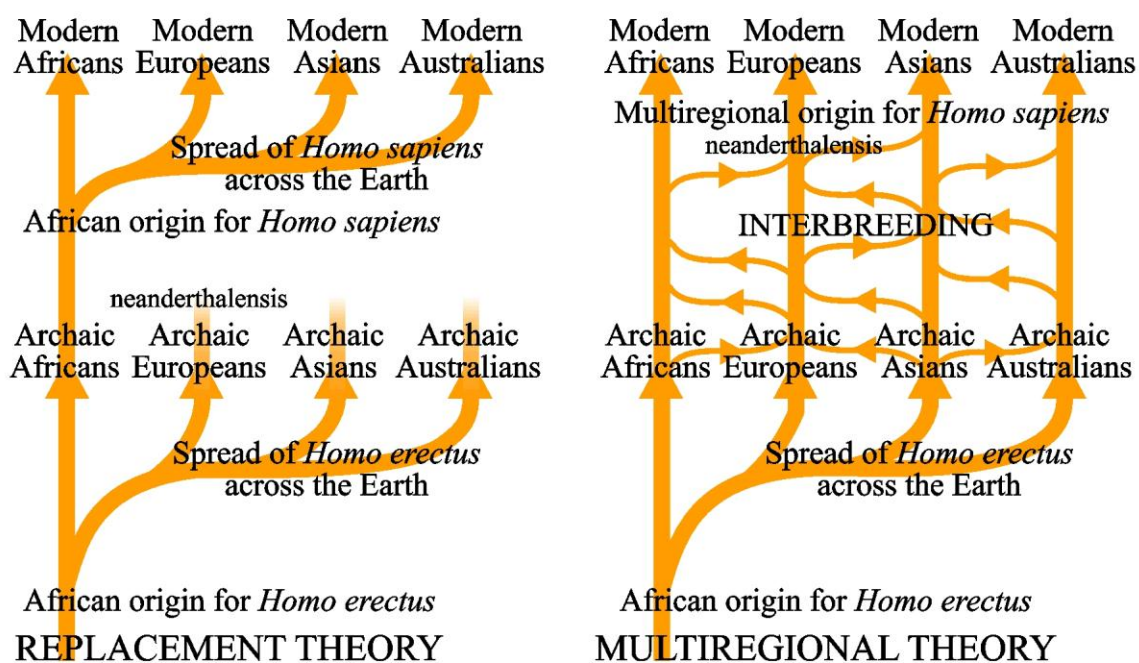


**FIGURE 22. Possible *Neanderthalensis* Cave Painting (“Europe’s Oldest Known Art,” 2012; Borenstein, 2012; and “First Neanderthal Cave Paintings,” 2012, respectively).**

geometric shapes are probably representations of the abstraction function itself, centered in the left-hemisphere approach module and manifested through the handed technical module. And interestingly, those *hands* are probably the earliest known representations of self-reflection, although *neanderthalensis* would have arrived at that point only during the final approximately 5% of its duration, and never had the chance to move beyond it—for it seems the hominin brain-expansion experiment came to an end with them. The future of neural information-processing would reside not so much in massive size as in highly plastic connectivity.

### 4.3 - STARTING THE PLAY

Of course, the next actor to take the prehistoric stage was *sapiens*, or we modern humans. But what exactly was the relationship between *neanderthalensis* and *sapiens*? The standard model partakes of the Out of Africa or Replacement Theory (see Figure 23a), which posits that *sapiens* emerged probably from *erectus* exclusively in Africa, and then



**FIGURE 23. Replacement (a) and Multiregional (b) Theories.**

**These diagrams illustrate the two major, competing theories for the origin and dispersal of humanity (time not represented to scale). Note the situations of *erectus* and *neanderthalensis* within each.**

spread into Asia and Europe (Cann, Stoneking, & Wilson, 1987; Stringer & Andrews 1988). According to this view, *neanderthalensis* was descended from the earlier migration of *erectus* from Africa, so when African *sapiens* later began streaming into Europe, the two lines confronting each other would have been different species—and *sapiens* wound up replacing *erectus* through resource competition, disease introduction, and / or killing and predation. An alternative scenario is described by Multi-Regional Theory (see Figure

23b), which posits that *sapiens* emerged with variation across widely dispersed populations of *erectus* in Africa and Eurasia (Wolpoff, Zhi, & Thorne, 1984). According to this view, *sapiens* had no single origin point, but was an emergent property of an interbreeding network established by *erectus*, and existed alongside other post-*erectus* transitional forms (e.g. *ergaster*, *antecessor*, *heidelbergensis*)—including *neanderthalensis*, with which it was similar enough to produce viable offspring, making the two lines different subspecies on the same species spectrum. That theory is supported by genetic evidence indicating *neanderthalensis* ancestry (1-4% contribution) among modern human populations across Eurasia. While neither Replacement Theory nor Multi-Regional Theory can account for all the fossil, genetic, artifact, and linguistic data, the former is currently considered more inclusive.<sup>22</sup>

In any case, the oldest *sapiens* remains are typically held to be from Ethiopia, and go back about 200 ka ago.<sup>23</sup> Further remains going back to about 125 ka ago have been found on the Arabian Peninsula, and in India going back to about 70 ka ago. From India, *sapiens* could have moved into southeast Asia / Malaysia / Indonesia (*Sunda*), and then into New Guinea / Australia / Tasmania (*Sahul*)—which were joined land masses during heavy glaciation—by about 55 ka ago. In Europe, *sapiens* might have been present as

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<sup>22</sup> For a forceful critique of the Replacement Theory and a statement of the Multi-Regional Theory, see Bednarik's "The Expulsion of Eve," Chapter 2 of his book *The Human Condition* (2011).

<sup>23</sup> Although at Qesem Cave in Israel, researchers recently discovered *sapiens* teeth that might go back to about 200-400 ka ago, which suggests a southwest Asian origin for modern humanity (Hershkovitz *et al.*, 2011)

early as about 45 ka ago, and that presents a problem, since its presence among and influence upon *neanderthalensis* cannot be unambiguously disentangled.

For example, that earliest cave painting in Spain might have been inspired by contact with *sapiens*, or might have been produced by an unknown *sapiens* population. Similarly, a stone and bone “mask” (four inches tall and wide, and crude enough that some researchers consider it a natural or modified natural object) found on the banks of the Loire in France has been hailed as *neanderthalensis* art—and it has been dated to about 35 ka ago, which is within the *sapiens* window in Europe (Amos, 2003). The upshot of this uncertainty is that it compounds our uncertainty regarding *neanderthalensis* proto-linguistic capacity. A brain half-again as large as *erectus*’ suggests a qualitative jump—something beyond content words. Function words such as prepositions and conjunctions would have allowed for grammatical sophistication, enabling recombinatorial communication and tool-making (e.g. hafting). Moreover, there is fossil evidence that the hyoid bone in *neanderthalensis* had descended relative to the skull to connect the musculature of the tongue and the larynx, which would have enabled even more complex vocalizations (remember, the hominid larynx had already descended relative to the hyoid bone). Even so, biophysical studies suggest that *neanderthalensis* had a voice that was high-pitched, sharp, and nasal relative to *sapiens*, and that it would have been capable of only slower speech with a smaller number of phonemes. How, then, would complex proto-language have been possible?

In his book *The Singing Neanderthals: The Origins of Music, Language, Mind, and Body* (2005), Steven Mithen presents a diverse body of evidence to theorize that *neanderthalensis* communicated via what he calls a “HMMMM” proto-music / language:

a signaling system that was *holistic* (composed of blended signals), *manipulative* (of emotional states and thus behavior), *multi-modal* (using vocalizations, expressions, gestures, and movements), *musical* (temporally controlled, rhythmic, and melodic) and *mimetic* (transmitted through imitation). Such a proto-music / language could have helped overcome limitations to vocalization, and its right-hemisphere emphases suggest a transitional signaling system, where abstract meaning is still very much conveyed by prosody and grounded in affect, as in song and poetry. Moreover, after noting a lack of symbolic representation among *neanderthalensis* artifacts, Mithen claims that it did not possess symbolic thought. I agree, and submit that symbolic thought is born of a critical degree of recursion, where a self-referential mind begins to reify its own thoughts and imaginings and project them upon the world—and that moment constitutes the beginning of art-religion. For all its sophistication, *neanderthalensis* apparently lacked the final level of recursion necessary for symbolism, self-awareness, true Magical consciousness, and language / culture proper.

So why did *neanderthalensis* linger at the threshold of Gebser's Magical consciousness? Here, it is important to note that the emergence of proto-linguistic abstraction within the hominin line, as evidenced by data ranging from the opportunistic use of stones by *australopithicus* to the making of compound tools and simple burials by *neanderthalensis*, did not happen instantly but in gradual and probably non-discrete stages (see Table 1). Granted, we now know that those stages are measurable in “only” hundreds of thousands, rather than tens of millions, of years—that is, their pace was literally glacial, rather than geological—but they occurred gradually enough to “show that the stages belong to a single evolutionary process” (*contra* Chomsky, in Section 2.2).



HOMININ / ~DATES (~CRANIAL CAPACITY)	NOVELTY	Representational Abstraction	Recombinatorial Abstraction	Recursive Abstraction	WORD FORMS	CONSCIOUS- NESS
<i>Orrorin</i> / 6.6-5.7 Ma (?)	possible bipedalism	—	—	—	—	BIT (emotions)
<i>Ardipithicus</i> / 5.8-4.3 Ma (300-350 ml)	partial bipedalism	—	—	—	—	BIT (emotions)
<i>Australopithicus</i> / 4-2.4 Ma (380-500 ml)	bipedalism & thumb	*	—	—	exclamations (holophrases)	BIT (emotions)
<i>H. habilis</i> / 2.4-1.4 Ma (600-800 ml)	tool-making (proto-culture)	**	*	—	nouns & adjectives	BIT- Archaic
<i>H. erectus</i> / 1.9 Ma-100 ka (850-1200 ml)	migration & fire-use	***	**	*	verbs & adverbs	Archaic
<i>H. neanderthal.</i> / 400-28 ka (1300-1700 ml)	clothing & burials	***	***	**	conjunctions & prepositions	Archaic- Magical
<i>H. sapiens</i> / 200 ka-present (1200-1500 ml)	art-religion (culture)	***	***	***	pronouns (metawords)	Magical

**TABLE 1. Stages of (Proto-)Language / Culture and Consciousness.**

**This diagram illustrates proposed relationships among factors relating to the emergence of language, with a gradation from proto-language/culture (green) towards language / culture proper (red), and a degree of abstraction chart where “\*” indicates rudimentary, “\*\*” limited, and “\*\*\*” regular.**

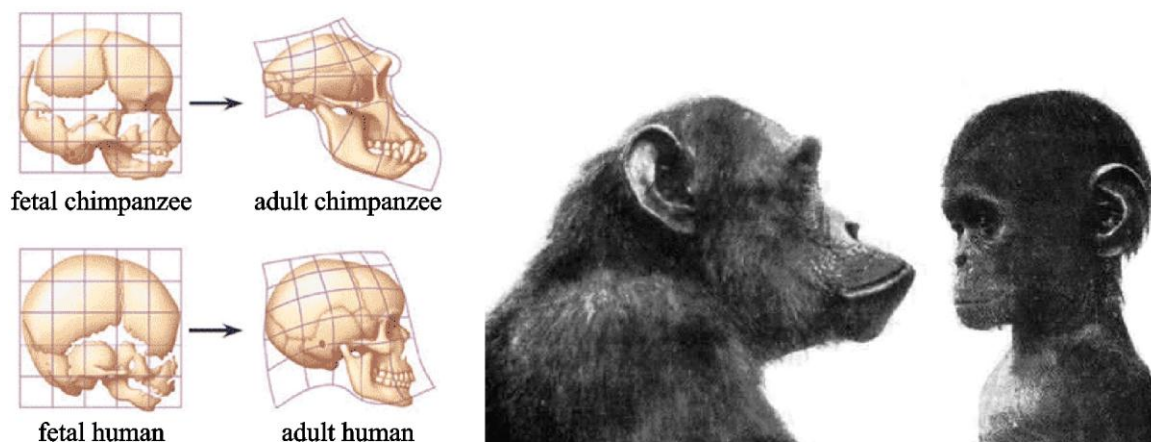
It is *not* “difficult to see what links these stages” (degrees of tool use and, by implication, communicative complexity increasing within a phylogenetic line) because it is *not* the case that “the stages have no significant analogy” (they are analogous in that they all make use of abstraction) or “involve entirely different processes and principles” (they involve mapping, signaling, and activity by means of representation, recombination, and / or recursion). Moreover, there is *every* “reason to suppose that the ‘gaps’ are bridgeable” because intermediary remains and artifacts are constantly being discovered, and they *do* form “a basis for assuming an evolutionary development of ‘higher’ from ‘lower’ stages” (or cognitive modules), and we *can* “suggest a mechanism whereby transition can take place from one stage to the next” (the hand-brain positive feedback loop involving the hominin technical module).

According to the Modern Synthesis, such a mechanism must have a genetic component, and while natural selection operating on random mutations over hundreds of thousands of years cannot explain the relatively rapid rate of hominin evolution—hence the century of confusion caused by Darwinian natural selection in light of proto-human archeology—a hand-brain positive feedback loop operating upon a few key genes might account for the speedy change. Regulator genes, which control the expression of other genes, including other regulator genes in feedback loops or cascades, through activation and repression, are the obvious candidates here (Valentine & Campbell, 1975). For example, modern humans and chimpanzees are very similar in terms of genetic sequence, but their differences include information that codes for regulator genes involved in the developmental growth of the brain (Evans, 2006; Tang, 2006; Somel *et al.*, 2009); those small initial differences in genotype are amplified within a complex phylogenetic system to make for large differences in eventual phenotype. Regulator genes are the genotypic mechanism “whereby transition can take place from one stage to the next” through *allometry* (differing positions and proportions within and among body regions and parts) controlled by *heterochrony* (differing rates in the timing and duration of morphogenic events). The most fundamental or embedded regulator genes are the *Hox* genes, which correspond to and control the relative positions and proportions of animal body regions and parts. *Hox* genes determine overall somatic axis and orientation in everything from sea anemones to humans, and they are highly conserved (Shubin, 2008, pp. 107-115). It might be objected that regulator genes do not directly relate to language—which is the case—but since language function follows brain form, that objection is moot.

The corresponding phenotypic mechanism can be discerned as the trajectory of the hominin line evolving via the general strategy known as *neoteny* (“new stretch”), where the adult form of a line maintains and elaborates characteristics that were previously found only in pre-adult forms—a kind of childhood writ large. Evolutionary biologist Stephen Gould describes the situation in his book *The Panda’s Thumb: More Reflections in Natural History* (1980):

Humans are neotenic—we have evolved by retaining juvenile features of our ancestors. Our large brains, small jaws, and a host of other features ranging from distribution of bodily hair to ventral pointing of the vaginal canal, are consequences of eternal youth.... By the time we became upright as *A. afarensis* [the earliest known species of *Australopithecus*], the game was largely over, the major alteration of architecture accomplished, the trigger of future change already set. The later enlargement of our brain was anatomically easy. We read our larger brain out of the program of our own growth, by prolonging rapid rates of fetal growth to later times and preserving, as adults, the characteristic proportions of a juvenile primate skull. And we evolved this brain in concert with a host of other neotenic features, all part of a general pattern. (p. 133)

Thus we humans can be viewed as fetal chimpanzees (see Figure 24), the difference being that the chimpanzee line remained knuckle-walkers after the split with our common ancestor; we are “chimps have little hair and walk upright...just a third species of chimpanzee, along with the pygmy chimp of Zaire [the bonobo] and the common chimp of the rest of tropical Africa” (Diamond, 1992, p. 2). It was full bipedalism that radically liberated the hominin hand and made the hand-brain positive feedback loop possible, thus



**FIGURE 24. *Sapiens* as Neotenic Chimpanzees (after “AP Chapter 24,” 2012 and Naef, 1926).**

**These diagrams illustrate allometric changes between fetal and adult skulls, and provide photographs of an adult and infant chimpanzee for comparison. The adult human skull resembles that of the fetal chimpanzee, and the infant chimpanzee resembles a human more than the adult chimpanzee.**

allowing for rapid evolution through the mechanism(s) of regulator genes and neoteny.

And the raw material upon which those processes worked was an already lateralized and highly connected primate brain.<sup>24</sup>

The general effect of neoteny within the hominin line was to increase the size and processing power of the association cortices (Rapoport, 2009), where complex sensory-motor processing and decision making events take place, but it also involved lengthening periods of childhood growth and dependency, where proto-human groups were required to cooperate for child-rearing purposes or face extinction. The fetalization of the hominin line created ever-larger windows of neuro-developmental plasticity, through which vulnerable young brains continued to form synaptic networks in response to natural and,

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<sup>24</sup> The chimpanzee brain exhibits a larger left planum temporale, although that asymmetry is not as pronounced as in humans (Gannon *et al.*, 1998; Spocter *et al.*, 2010), and chimpanzee crania do not exhibit asymmetric petalia (Zilles *et al.*, 1996). However, wild chimpanzees do show population-level right handedness for tool use (Lonsdorf & Hopkins, 2005).

increasingly, social stimuli. Thus neoteny did not simply create larger and more flexible brains, but it also dramatically conditioned the social matrices in which they developed after birth. Since the technical module evolved out of the natural history and social modules (which evolved out of the approach and avoidance modules), proto-language (which was a product of the technical module) was communication *about* nature and society. But as both the somatic and proto-cultural structures surrounding proto-language evolved, communication became more and more about social webs of reciprocity and agreement, especially over issues of proto-linguistic representation. In other words, human ancestors *simultaneously* became increasingly proto-linguistic, neotenic, and social—or, as biologist-mathematician Martin Nowak states in this book

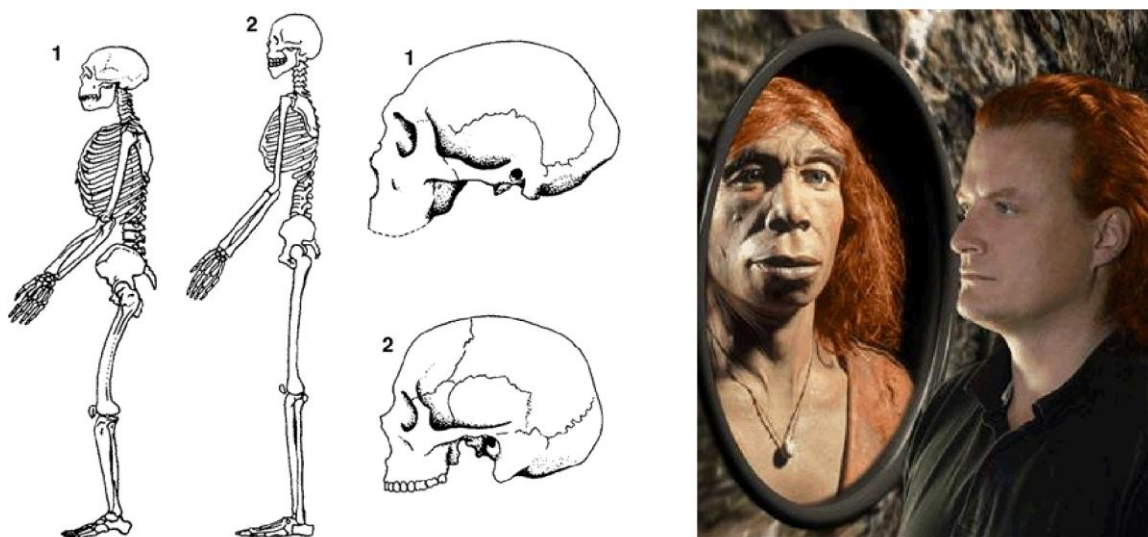
*SuperCooperators: Altruism, Evolution, and Why We Need Others to Succeed* (2011):

[L]anguage, brainpower, and society became intertwined in a three-way dance. What resulted as each component moved in step with one another was coevolution, a spiral toward more and more social complexity as language allowed for even more manipulation and deception, and ever more collaboration and cooperation too. Thanks to the new invention of widespread indirect reciprocity, coevolution bootstrapped the evolution of the social brain .... (p. 187)

So we might say that, within the hominin line, manual manipulation and social manipulation co-evolved as two sides of the same big-brain coin.

From that point of view (and assuming a straight line of descent with “missing links”), *Ardipithicus* was a neotenic derivative of *Orrorin*, *Australopithicus* was a neotenic derivative of *Ardipithicus*, *habilis* was a neotenic derivative of *Australopithicus*, *erectus* was a neotenic derivative of *habilis*, and *neanderthalensis* was a neotenic

derivative of *erectus*—as was *sapiens* (Montagu, 1989; Thiessen, 1995).<sup>25</sup> Indeed, the morphological differences between *neanderthalensis* and *sapiens* can be framed in neotenic terms such that the former exhibited less “retardation” (DeBeer, 1940) of adult features than the latter (see Figure 25). Adult *neanderthalensis* were relatively squat,



**FIGURE 25.** *Sapiens* as Neotenic *Neanderthalensis* (from Weber, 2008 and “Ancient DNA,” 2007).

heavy-boned, and barrel-chested, with massive muscles, powerful hands and feet, and a long, low, thick skull with a prominent brow ridge, protruding jaw, and a large nose and teeth. Adult *sapiens* are relatively willowy, thin-boned, slightly built, with reduced muscles, delicate hands and feet, and a large, round, thin skull with a negligible brow ridge, flat face, and a small nose and teeth.

But while *neanderthalensis* had a slightly larger cranial capacity than *sapiens*—1300-1700 ml compared to 1200-1500 ml, respectively—dental evidence indicates that it matured at a faster rate (Mayell, 2004), that is, “Neanderthals Lived Fast, Died Young”

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<sup>25</sup> Although Bednarik argues that *neanderthalensis* and *sapiens* should be considered “robust” and “gracile” variations, respectively, of the same species.

(Viegas, 2010a). Those facts suggest a neotenic trade-off, where a slightly larger final brain size generated less adaptability or intelligence than did further delays in the rate of maturation. If we consider neoteny as Zipf's principle, thermodynamic efficiency, and using the simplest route and the materials available applied to hominin evolution, then the larger, more energy-intensive *neanderthalensis* brain was less valuable than the smaller *sapiens* brain made more plastic through heterochronic regulation—or in information-processing terms, raw power was less important than prolonged flexibility for forming neural pathways in response to mimetic conditioning. Indeed, since the evolution of the hominin technical module, of which language is a product, was bound up in neuro-developmental plasticity and mimetic conditioning, we might say that the technical module *is* neuro-developmental plasticity. That is, it depends upon open and responsive, as opposed to genetically preset, neural circuitry. And extreme neuro-developmental plasticity is what allowed *sapiens* to develop language and culture proper, and to outperform physically hardier *neanderthalensis*.

The FoxP2 gene is a meta-regulatory gene involved in the evolution of language (MacAndrew, 2003; Zimmer, 2011) by modulating neuro-developmental plasticity as well as other downstream targets (Spiteri *et al.*, 2007; Vernes *et al.*, 2007). FoxP2 is thought to be highly conserved—different versions have been implicated in bat and cetacean echolocation, songbird song, and alligator and fish vocalization (Scharff & Haesler, 2004; Webb & Zhang, 2005)—and mutations in the human version are known to cause severe language and speech impairment (Lai *et al.*, 2001; MacDermot *et al.*, 2005). Presumably, selective pressures could work upon such a pivotal gene to induce adaptive changes, too. But sequencing studies indicate that *neanderthalensis* had the same version

of FoxP2 as modern humans (Kraus *et al.*, 2007), which suggests that it was necessary but not sufficient for the emergence of language proper (Benítez-Burraco *et al.*, 2008).

Other than handedness, what factors drove evolution toward big brains and neurodevelopmental plasticity? In his book *Reason and Wonder: A Copernican Revolution in Science and Spirit* (2011), mathematician-philosopher Dave Pruett notes that

Hominids have not always sported such disproportionately large brains. Within a relatively short period—a mere three million years—the brains of our ancestors quadrupled in size. It is now widely accepted that our brains grew of necessity, so that humans could adapt to the one constant of existence—change. The period of bulging brains coincides conspicuously with the onset of a succession of ice ages. During the epoch of ice, on a cycle of roughly 100,000 years, glaciers periodically buried one quarter of the globe. Brain capacity was *the* adaptation most beneficial for human ancestors to cope with severe climate oscillations. (p. 280)

If a succession of ice ages constituted the major factor behind the emergence of the hominin big brain and thus language, then why is there so much genetic and linguistic variation in Africa, which was never glaciated, and from which *sapiens* emerged, according to the Out of Africa or Replacement Theory? I submit that there is so much African variation because there was less population movement and thus less genetic and linguistic reshuffling *due precisely to a lack of glaciation*. Given more stable environments, proto- / humans were more likely to stay put, to not mate with outsiders, and to elaborate their own proto- / cultural traditions—to segregate into relatively isolated populations. The issue of human emergence then becomes a question of which is more crucial for evolution: diversity (Out of Africa or Replacement Theory) or novelty (Multi-



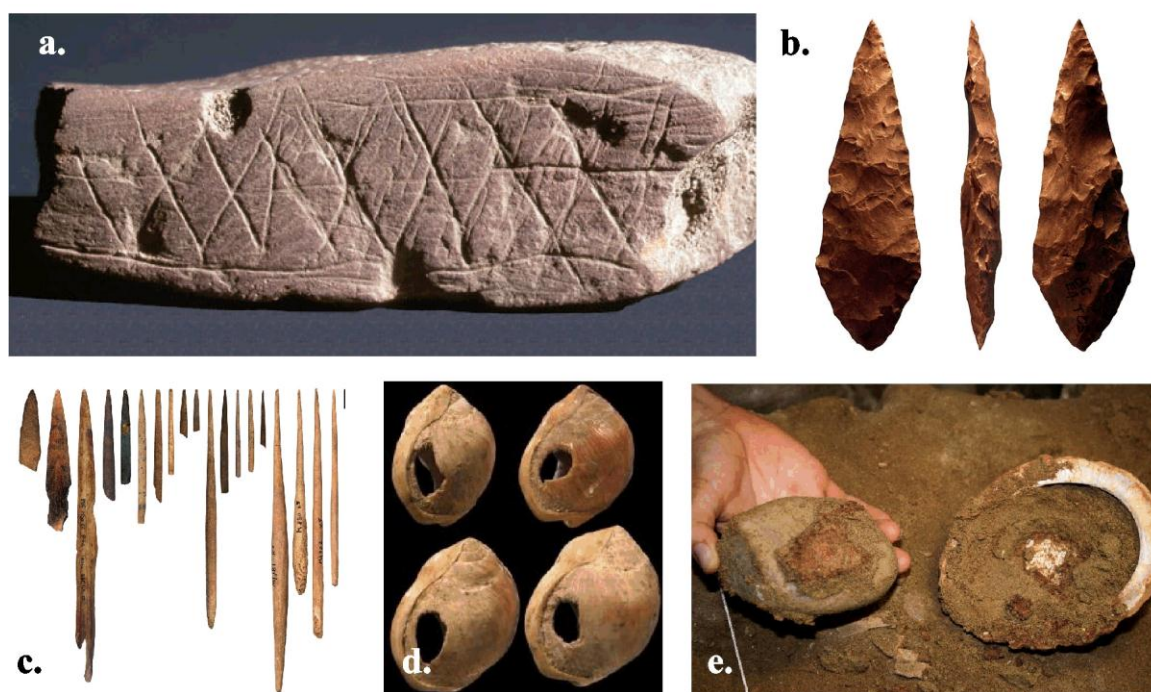
Regional Theory). While diversity is a sign of environmental stability or sustainability, novelty *is* emergence, which is the essence of evolution.

Does the archeological evidence support the idea that ice age emergency drove modern human emergence? Recently, there has been a push to emphasize evidence of non-European novelty in terms of dawning art-religion. For example, in his essay “The First Stirrings of Creation” (1998), Bednarik argues:

Art as such did not appear suddenly, but developed gradually with the cognitive evolution of humans. By the time that the famous cave art of France and Spain was being produced, art traditions are thought to have been well established at least in southern Africa, the Levant, eastern Europe, India and Australia, and no doubt in many other regions that have yet to be examined adequately. (p. 4)

Bednarik goes on to state, “The oldest known rock art was produced in India two or three hundred thousand years ago. It consists of cup marks and a meandering line hammered into the rock of a sandstone cave” (p. 5)—a reference to the *erectus* proto-art mentioned earlier (see Figure 19b)—and then says, “At about the same time, simple line markings were made on a variety of portable objects (bone, teeth, ivory and stone) which have been found at the camp sites of early humans” (p. 5). Since the earliest *sapiens* remains are dated to about 200 ka ago, the “early humans” executing “simple line markings” must have been *erectus* or *neanderthalensis*. Bednarik continues, stating: “Sets of bunched engraved lines first appear in central and eastern Europe; they developed into distinctive arrangements that can be recognized as motifs such as zigzags, crosses, arcs and sets of parallel lines” (p. 5).

The earliest such abstract markings have since been found in Blombos Cave, South Africa: crosshatching scratched into pieces of ochre found in association with finely flaked bifacial blades, polished bone tools, small shell beads, and probable pigment-mixing containers (abalone shells), all variously dated to 70-100 ka ago (see Figure 26a-e), with evidence of (shell)fishing going back about 140 ka ago. The blades



**FIGURE 26. Blombos Cave Artifacts.**

**Piece of ochre with crosshatch markings (a: “Abstract Engravings,” 2002), pressure-flaked blades (b: “Blombos Cave,” 2012), polished bone points (c: Backwell, d’Errico, & Wadley, 2008), small shell beads (d: “Blombos Cave,” 2012), and possible shell pigment-mixing bowl (e: “Blombos Cave,” 2012).**

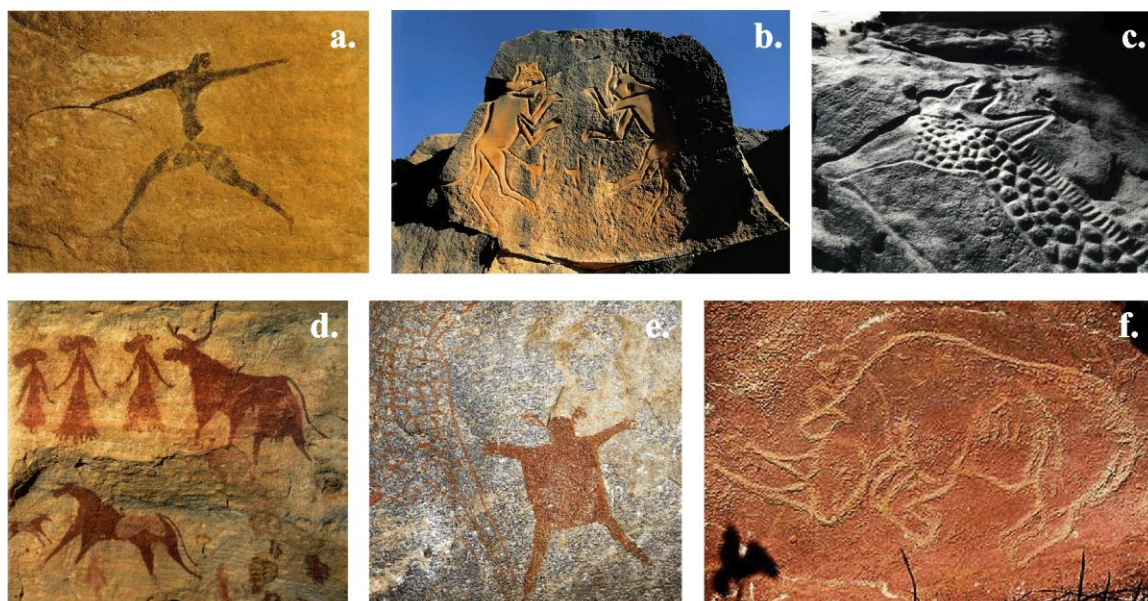
are delicate and more advanced (pressure flaking technique) than other tools made about the same time, as are the bone tools (nonexistent in Europe for tens of thousands of years). The ochre hatch marks are possibly incidental and are, in any case, non-representational. And of course, fishing is utilitarian. Interestingly, the women of the traditional Himba people of Namibia (just west of South Africa) still use ochre not just to

ornament themselves, but to protect themselves from the sun—and they wear shell-bead anklets to warn away snakes (“Himba People,” 2012).

To my mind, the Blombos artifacts, while modern human in origin, do not provide unambiguous evidence of art-religion (although pigment-mixing containers are, of course, suggestive); they are likely the products of cusp-Magical consciousness. However, the discovery of South African “stone points” with traces of blood, bone, and plant-based glue, and dated to about 64 ka ago—apparently the earliest arrow heads (Gill, 2010)—provides evidence of advanced tool-making in the form of projectile weapons (meta-tools), which suggests something more than limited recursive abstraction. Africa’s earliest *dated* representational art is comprised of a handful of animal images painted on stone slabs discovered in the Apollo 11 Cave (thus named because the discovery occurred on the day of the first moon landing) in Namibia and dated to 23-25 ka ago. But that is likely to change, since Africa actually has myriad rock art traditions (e.g. Figure 27a-f), some of which have so far resisted dating due mainly to situational and / or weathering factors:

[E]vidence of the earliest rock art is notoriously difficult to confirm, but its tradition is not—from desert to forest to savanna, we see a vast display of spectacular rock art, both paintings and engravings, depicting a staggering array of subjects.... As more rock art is discovered, and dating techniques become more sophisticated, greater light is shed on the thoughts, beliefs, joys and fears of our African ancestors. (“African Rock Art Archive,” 2012)

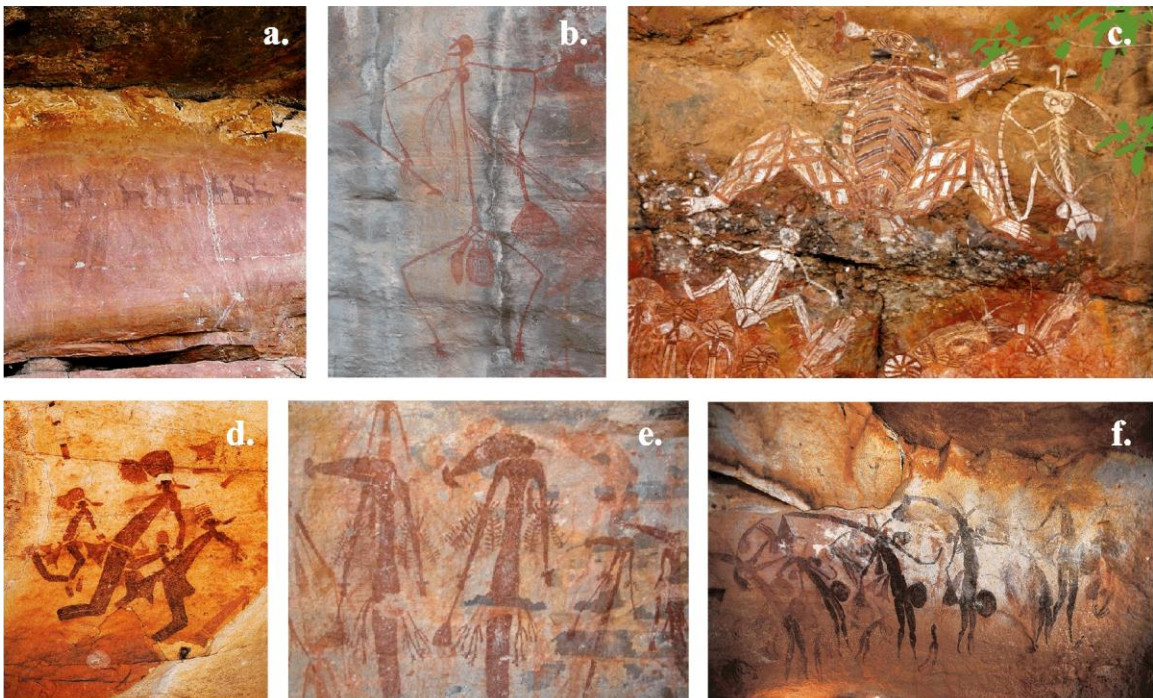
On the other hand, a large body of evidence for the early emergence of Australian art-religion is already dated, as outlined in *The Bone Readers: Science and Politics in*



**FIGURE 27. African Rock Art Traditions (“African Rock Art Archive,” 2012).  
Examples from Algeria (a), Libya (b), Niger (c), Chad (d), Tanzania (e), and South Africa (f).**

*Human Origins Research* (2009), by geochronologist Claudio Tuniz, radiocarbon dating expert Richard Gillespie, and science journalist Cheryl Jones. For example, the rock faces of the Ubirr region in northern Australia have been continuously painted and repainted by the Australian aborigines from about 40 ka ago to the present, and depict non-indigenous species (e.g. Figure 28a). In the *Dynamic Figure* tradition the Ubirr rock paintings depict stick-like human(oid) figures engaged in hunting and other activities (e.g. Figure 28b), and in the so-called *X-Ray* tradition, they depict more naturalistic figures—including extinct animals—with quasi-internal features showing (e.g. Figure 28c). The most sacred site at Ubirr is the traditionally women-only path or “songline” traced by the Rainbow Serpent as she moved across the world, singing its rocks, plants, animals, and people into existence during the Dreamtime or creation. We are on Magical ground here, although it is difficult to disentangle what came earlier from what came later (e.g., most of the Ubirr rock paintings are from about 2 ka ago).





**FIGURE 28. Australian Rock Art Traditions (“African Rock Art Archive,” 2012).  
Examples from Ubirr site in north (a-c) and Gwion Gwion tradition in west (d-f).**

Interestingly, the Australian aborigines say their ancestors had nothing to do with the distinctive Gwion Gwion or Bradshaw (the native and colonial names, respectively) rock painting tradition of western Australia (e.g. Figure 28d-f), the remains of which encompass an estimated 100,000 sites spread over 50,000 square kilometers and depict human(oids) wearing clothing and ornaments, as well as non-indigenous and extinct plants and animals. The Gwion Gwion rock paintings have been dated to at least 17 ka ago, although they are possibly much older (accurate dating is thwarted by pigment-invading bacteria and fungi); indeed, it must be in reference to the Gwion Gwion rock paintings that Bednarik states, “In Australia, some specimens of rock art may be up to 60,000 years old, as old as the human occupation of the continent itself,” before noting in reference to traditions like those found at Ubirr, “and hundreds of sites contain examples which are thought to predate the cave art of western Europe” (1998, p. 5).

So it is Australia—due perhaps to ecological and historical flukes of preservation—that seems to have the earliest known, full-fledged, and unambiguous traditions of art-religion that indicate the emergence of Magical consciousness, language proper with regular nested or recursive features, culture proper, and primal justification narratives still very much grounded in the natural history module as well as the social module. Thus, in her collection of lectures titled *True Stories* (2000), historian-anthropologist Inga Clendinnen observed that the earliest inhabitants of Australia

developed steeping thought-structures—intellectual edifices so comprehensive that every creature and plant had its place within it. They travelled light, but they were walking atlases, and walking encyclopedias of natural history.... Detailed observations of nature were elevated into drama by the development of multiple and multi-level narratives: narratives which made the intricate relationships between these observed phenomena memorable. (p. 132)

Starting about 40 ka ago, the situation of *sapiens* in Europe was shaping up similarly to that of *sapiens* in Australia. Until recently, archeologists referred to that European situation as “The Upper Paleolithic Revolution” or “The Creative Explosion”—terms describing an expansion of novelty which actually took a little while to transition from the *neanderthalensis* Mousterian toolkit (300-30 ka ago) into what have been designated the Châtelperronian (~35-29 ka ago), Aurignacian (~32-26 ka ago), and Gravettian (~28-22 ka ago) cultural complexes, whose dates vary depended upon location. But those revolutionary / explosive terms are sometimes no longer used, or their meaning has been expanded to include items such as 250 ka-old *erectus* proto-art (cupules). To my mind, the loss of those terms to what seems like political correctness

obscures the fact that—again, due perhaps to ecological and historical flukes of preservation—in Europe we have a uniquely broad body of evidence for the emergence of modern human culture. Without going into detail or considering order of appearance, the novel cultural complexes snowballed new stone tool techniques and shapes, as well as the use of hitherto unexploited materials such as bone and antler, novel tool types such as awls and needles (the presence of clothing is now assured), personal ornamentation such as pendants and bracelets, and the making of the spear thrower and probably the bow and arrow, ropes and nets, wind instruments and possible calendric devices, unambiguous burials with grave goods, and elaborate cave art and portable sculpture (see Figure 29).



**FIGURE 29. Upper Paleolithic European Cultural Artifacts (a: Conard & Bolus, 2002; b: “La musique dans la préhistoire,” 2012; c: Curry, 2010; d: Balák, 2012; e: “Oldest Lunar Calendar,” n.d.).**

The rate of the introduction of these novelties over a period of about 20 ka is unprecedented, and it implies re-regulation of the highly lateralized technical module. Extreme neuro-developmental plasticity developed via neoteny would have left the

technical module open to prolonged mimetic conditioning, providing a basis for culture proper. Re-regulation would have affected the cerebral cortex, and especially the left hemisphere and the corpus callosum, allowing for the emergence of language proper. The particulars of that process and crucial word from resulting from it will be discussed in Section 5.3, but here it is important to recognize exactly how intertwined the emergence of culture and language were, as evidenced by symbolic art-religion, the hallmark of Magical consciousness.

Here, we are concerned with the elaborate cave art and portable sculpture of the Upper Paleolithic, which constitute a long-lasting iconography with two foci: large animals (and humans in relation to them), and the female body.<sup>26</sup> These images (see Figure 30) are the most concrete form of writing, a system of symbols through which language—as yet *indistinguishable to itself* from the natural world and a society fraught with approach and avoidance experiences and emotions—was reified and projected. Magical consciousness is described by philosopher Ernst Cassirer in his book *Language and Myth* (1946):

At this point, the word which denotes...thought content is not a mere conventional symbol, but is merged with its object in an indissoluble unity. The conscious experience is not merely wedded to the word, but is consumed by it. Whatever has been fixed by a name, henceforth is not only real, but is Reality.

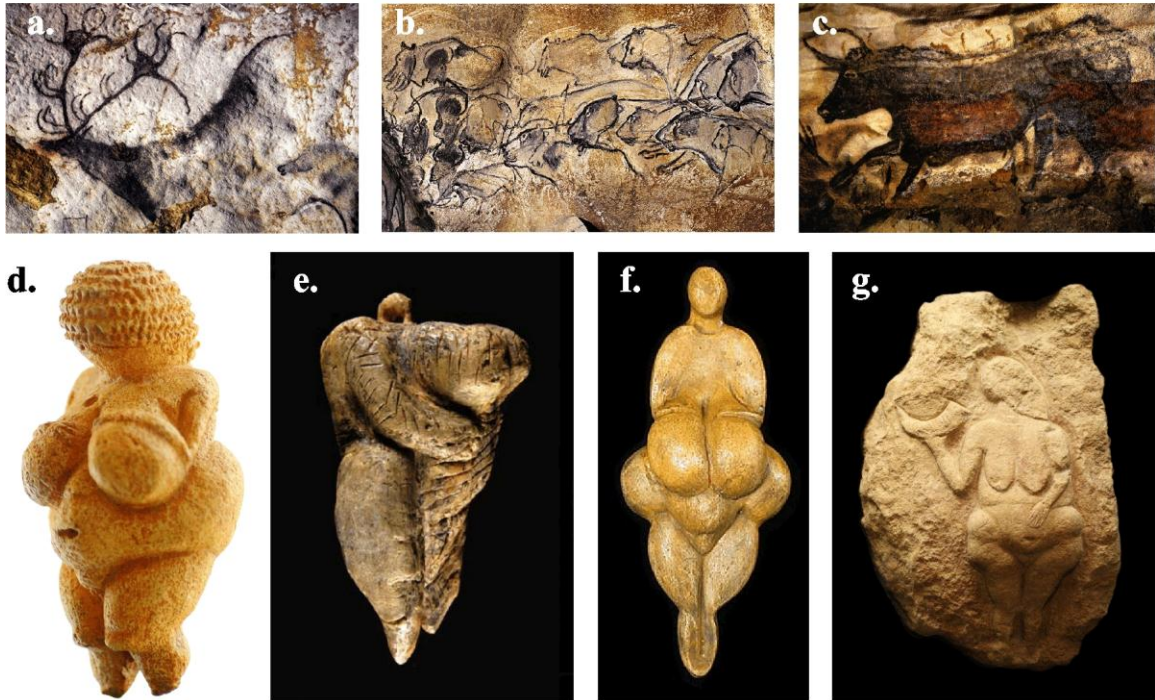
The potential between “symbol” and “meaning” is resolved; in place of a more or

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<sup>26</sup> The earliest representational art may be vaginal images engraved into cave walls and dated to about 37 ka, which may predate the earliest images of animals (Balter, 2012).



less adequate “expression,” we find a relation of identity, of complete congruence between “image” and “object,” between the name and the thing. (p. 58)



**FIGURE 30. The Two Primal Foci: Big Beasts and Big Breasts (a-c: “France Rock Archive,” 2012; d: “Venus of Willendorf,” 2004; e: “Venus of Hohle Fels,” n.d.; f: “Venus of Lespugue,” 2004; g: “Venus of Laussel,” 2008).**

There is but a single step from Magical consciousness to sympathetic magic, as practiced by the manual projection of the reified word upon a cave wall or a chunk of ivory.

And that moment was nested within and recapitulated during the transition from Magical conscious to Mythic consciousness, where the manual projection of the reified word was eventually expressed in abstract writing—a system of symbols through which language *began to distinguish itself* from the natural world and a society fraught with approach and avoidance experiences and emotions, thus laying the foundation for Mental consciousness, or self-awareness proper (which is itself a reification and a projection).

But a full consideration of the Neolithic and the ages of metal are outside the scope of this text. Suffice to say that

Language and myth stand in original and indissoluble correlation with one another, from which they both emerge but gradually as independent elements. They are two diverse shoots of the same stem, the same impulse of symbolic formulation, springing from the same basic mental activity, a concentration and heightening of sensory experience. In the vocables of speech and in primitive mythic figurations, the same inner process finds its confirmation: they are both resolutions of an inner tension, the representation of subjective impulses and excitations in definite objective forms and figures ( p. 88)

That “concentration and heightening of sensory experience” and “inner tension...of subjective impulses and excitations” is generated fundamentally by the interplay of the approach and avoidance modules, where wonder + dread = awe. And “the representation” of primal awe “in the vocables of speech and in primitive mythic figurations” is the beginning of art-religion.

The two foci of primal European culture are asymmetric in that big beasts represented more the avoidance-dread side of awe and the natural world module—after all, it was dangerous to stumble upon a bear, to hunt elk or bison, or to be stalked by a great cat. The female body (or big breasts), on the other hand, represented more the approach-wonder side of awe and the social module—after all, it was advantageous to have a generous mother, to be favored by a woman, or to nurture new life through cooperation. In his essay “On the Problem of the Venus Statuettes in the Eurasian Upper Paleolithic,” anthropologist Franz Hancar explains the origin of the Great Mother:

The psychological background of the idea derives from the feeling and recognition of women, especially during her periods of pregnancy, as the center and source of an effective magical force.... And from the point of view of the history of thought these...Venus figurines come to us as the earliest detectable expression of that undying ritual idea which sees in Woman the embodiment of the beginning and continuance of life, as well as the symbol of the immortality of that earthly matter which is itself without form, yet clothes all forms.<sup>27</sup>

And that valorization of the approach-wonder side of awe and the social module fed into the development of ever-more abstract language through cultural-mimetic evolution, leading eventually to complex syntactical-symbolical constructions and civilization, where the Great Mother became the Great Goddess.<sup>28</sup>

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<sup>27</sup> As translated by comparative mythologist Joseph Campbell in his book *The Masks of God: Primitive Mythology* (1960), p.314.

<sup>28</sup> For an examination of the transition from Great Mother to Great Goddess, see chapters 6 and 7 of philosopher-psychologist Ken Wilber's book *Up From Eden: A Transpersonal View of Human Evolution* (1981).

## 5.0 - FEEDBACK AND CONTINGENCY

*. . . Mighty things from small beginnings grow.*

-John Dryden, poet<sup>29</sup>

*Physicists like to think that all you have to do is say, these are the conditions, now what happens next?*

-Richard Feynman, physicist<sup>30</sup>

## 5.1 - SCIENCE OF SCIENCES

In this Section, I work to focus the lines of evidence discussed thus far into a unified argument for the emergence of language as a function of brain hemispheric feedback. Those lines of evidence relate to linguistics, neuropsychology, and evolution. But as mentioned in the introductory Section, the concept of evolutionary change must be expanded beyond biology into general evolutionary systems theory. And while Henriques' ToK and my nested spiral variation thereof are applications of such an architectonic, here I am particularly indebted to geologist Lynn Fichter.

That indebtedness might seem odd if one asks, "What has geology to do with evolution?" But remember that Darwin read Lyell's *Principles of Geology* while voyaging on the *Beagle*, and Lyell later encouraged Darwin to publish *The Origin of Species*. Moreover, the line of disciplinary influence came full circle with the formulation during the 1970s of the Gaia hypothesis by chemist James Lovelock, with developmental assistance from biologist Lynn Margulis, most famous for her contributions to

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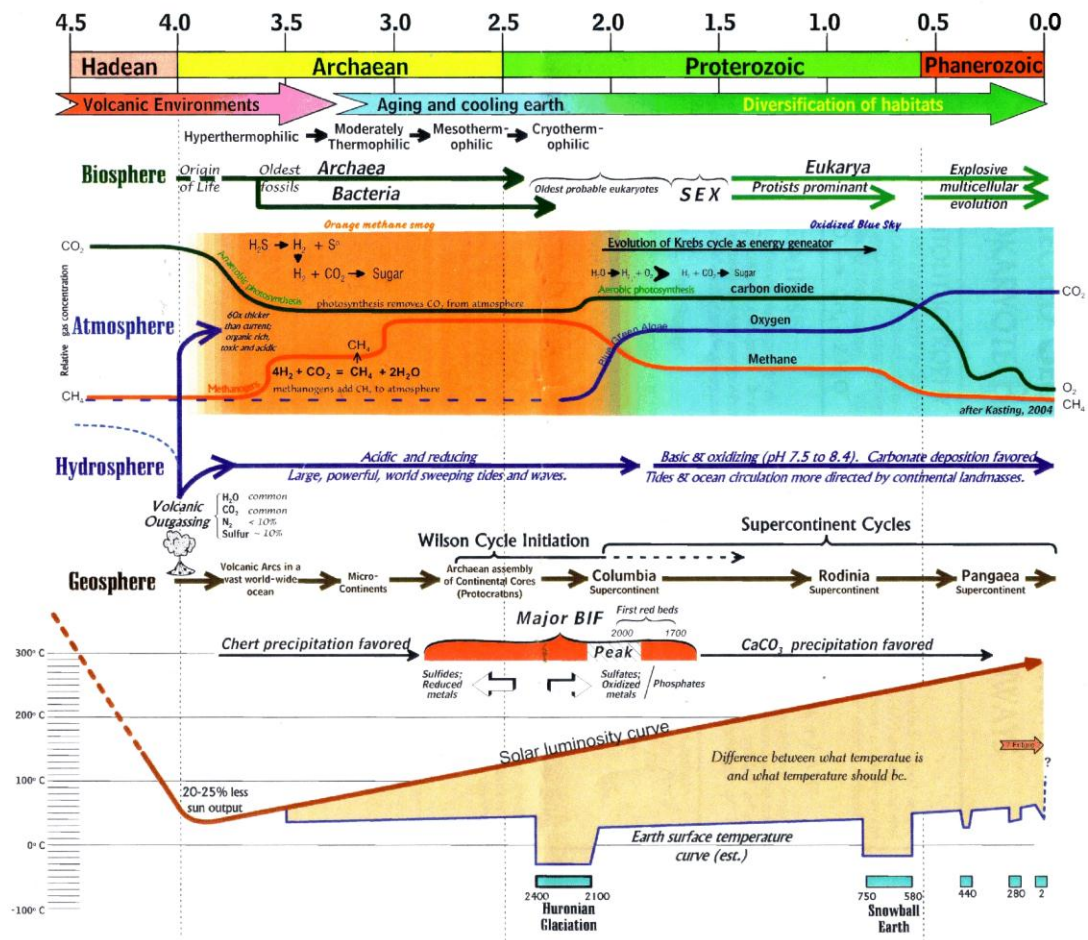
<sup>29</sup> From *The Poetical Works of John Dryden, Volume 1* (1909, p. 40).

<sup>30</sup> As quoted in James Gleick's *Chaos: Making a New Science* (1987), p. 9.

endosymbiotic theory (where she postulated that mitochondria and chloroplasts developed from proteobacteria and cyanobacteria, respectively). Since that hypothesis has been supported by empirical studies and it has made useful predictions, it is now considered Gaia theory, and it views the entire Earth—hence “Gaia,” the Earth Mother of titans, gods, and humanity from Greek mythology—as a living organism, an emergent property generated by feedback loops permeating and connecting its geosphere, atmosphere, hydrosphere, and biosphere, as well as the Sun and outer space. Geologists like Fichter do not treat the geosphere in isolation, nor do they treat it synchronically; rather, they speak in terms of “geophysiology,” and think of the Earth as a set of interlocking networks (see Figure 31) evolving over time in ways fundamentally deterministic but ultimately unpredictable—that is, as “chaotic” dynamical systems.

The Course Information website for the ENVT 200: Environmental Systems Theory (formerly Evolutionary Systems Theory) class taught by Fichter and colleague Steve Baedke notes that “Evolutionary Systems is non-disciplinary and interdisciplinary. Its subject matter belongs to no department, yet its concepts and ideas pervade every discipline” (Fichter , 2011b) Furthermore, its Course Description web page states that

Evolutionary Systems are rooted in complex systems, complex systems are rooted in complexity theory, complexity theory is rooted in chaos theory, and chaos theory is rooted in non-equilibrium thermodynamics. The study of Evolutionary Systems seeks to explain how complex system such as the geochemical systems, organisms, ecosystems, and economies organize, grow, and evolve by bottom-up processes, that is, without central planning or control. (Fichter, 2011a)



**FIGURE 31. Interlocking Geophysiological Systems (from Fichter, 2011).**

**This is a page from one of the many handouts provided in Lynn Fichter and Steven Baedke's class, ENVT 200: Environmental Systems Theory.**

In Section 5.3, I shall argue that the complex mapping-signaling system we call “language” evolved as an epiphenomenon of bottom-up processes within a neurobiological system functioning according to non-equilibrium thermodynamics. But first I must review and make relevant the basics of complexity theory and chaos theory, in this Section, as well as delineate a theory of signs, in Section 5.2.

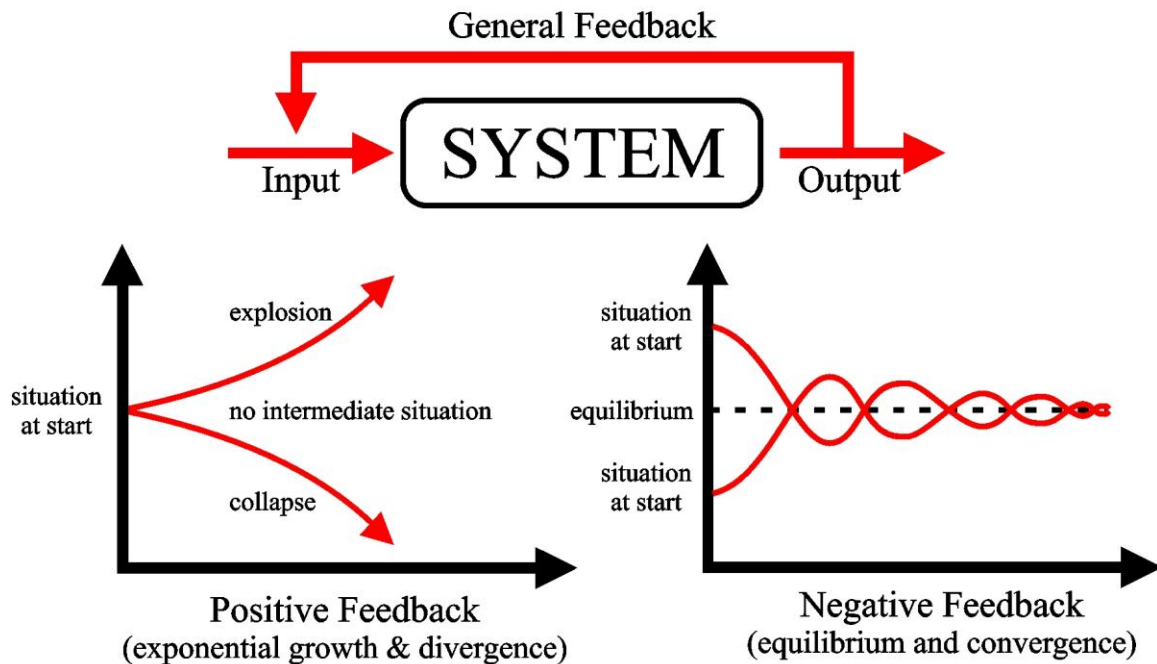
If we understand complexity science as “the study of the phenomena which emerge from a collection of interacting objects” (Johnson, 2007, pp. 3-4), and recognize that all the sciences involve collections of interacting objects, then we can see why

complexity science has been called “the science of sciences” (Clippinger, 1999, p. 1). Indeed, theoretical physicist Jules Henri Poincaré (1854-1912) was investigating the three-body problem in celestial mechanics—he was trying to predict the motions of the Earth, Moon, and Sun based on their gravitational interactions—when he discovered that the behavior of such a system was deterministic but unpredictable (Barrow-Green, 1996), thus laying the foundations for chaos theory.

What exactly does that mean, “deterministic but unpredictable”? Like classical physics, chaos science deals with natural dynamical systems, and since the underlying order of natural systems is *determined* by intrinsic cosmic principles or natural laws, they are deterministic. However, classical physics limits its treatment of change by modeling it only in linear terms, where “there is a constant correspondence between one variable and another,” resulting in “a straight line on a graph” (Fichter, “A Glossary”). For example, Newton’s law of gravity states that every point-mass in the universe attracts every other with a force that is directly proportional to the product of their masses and inversely proportional to the square of the distance between them. That law allows for the relatively simple prediction of a stable state within a two-body system—for example, the Earth and the Moon. However, when the distant but massive Sun is thrown into the equation, equilibrium behaviors within the newly complicated system become hopelessly unpredictable because positive feedback generates nonlinear perturbations (Barrow-Green, 1996) and novelty, that is, emergent properties.

The terms in that last bit have begun to enter common usage, and I have been employing them throughout this thesis, but now it is time to define and relate them.

In brief, *feedback* is recursive behavior, and comes in two varieties (see Figure 32): positive feedback is “when the output of a system is fed back into the system

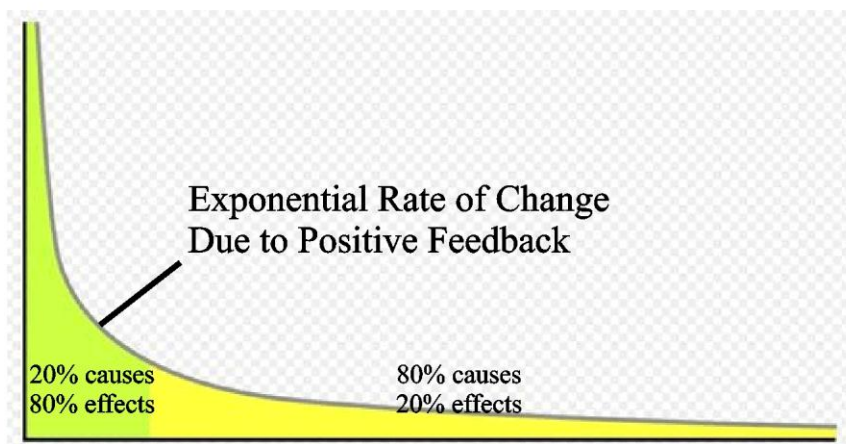


**FIGURE 32. Feedback: General, Positive, and Negative.**

resulting in out of control amplification of the effect”—the hominin hand-brain positive feedback loop is a prime example, as is the expression of the FoxP2 meta-regulatory gene—and negative feedback is “when the output of a system, fed back into the system, tends to dampen or regulate the effect” (Fichter, “A Glossary”)—as when socialization or the use of fire sublimated avoidance responses into an approach responses. Both forms of feedback recursively generate temporary disequilibria before establishing stable states, before generating temporary disequilibria before establishing stable states, etc. (kind of an order-chaos yin-yang, which is a good way to envision complexity), although an unregulated positive feedback loop leads to explosion and / or collapse, and a negative feedback loop tightens to eventually establish permanent equilibrium.



*Nonlinear* effects are generated by “a system where one variable varies irregularly with respect to another variable” due to positive feedback—and “most of the interesting things in this universe are not linear, or predictable. They are nonlinear and unpredictable, but produce the vast majority of the great complexity and order that we observe all around us” (Fichter, “A Glossary”). A nonlinear dynamical system driven by positive feedback generates a distinctively dramatic, exponential rate of change known as a *power law curve* (see Figure 33), which is reminiscent of Kurzweil’s Law of



**FIGURE 33. Power Law Curve.**

Accelerating Returns. Interestingly, any segment of such curve is proportional to any other segment of that curve; this property is referred to as the *scale invariance* of the equation that describes the curve. Also, the distribution of effects under a power law curve is disproportionate such that about 80% of them come from about 20% of the causes; this property is referred to as the *Pareto principle*, and it is an indication of the instabilities that lead to sudden transformations in complex systems: avalanches, phase transitions, tipping points—emergent properties. The buildup to such novelty is characterized by increasing instability, and the moment of transformation itself is referred

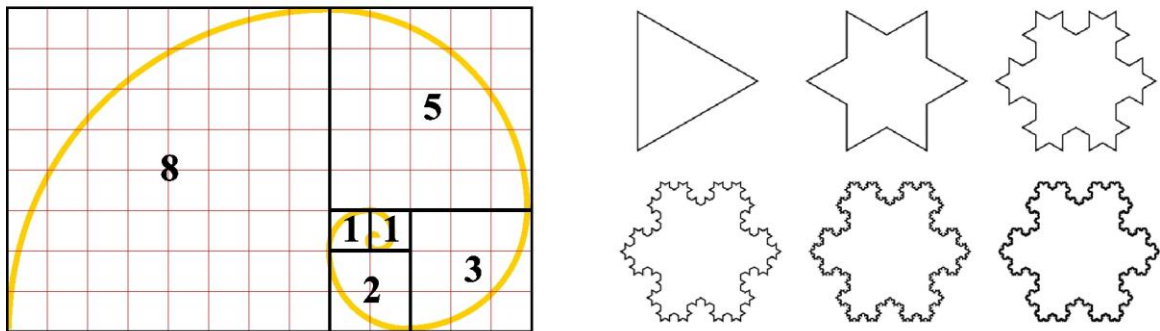
to *as self-organized criticality*, where the novel state emerging is more stable than the one immediately preceding it.

Finally, *emergence* distinguishes complexity in the technical sense (novelty) from complexity in the ordinary sense (complicated), and is the generation of relatively complex (in both senses) patterns from relatively simple interactions, where that generation is synergistic—that is, the novelty of its effects is greater than the sum of its causes. To reiterate and elaborate: an emergent property is “an outcome which is the result of all the individual components interacting but which cannot be found in any one of those components,” and it is “a complex outcome emerging from the action of simple rules” (Fichter, “A Glossary”).

Just as classical physics works to quantify or model linear systems, chaos science works to quantify or model nonlinear systems. But before the development of sufficiently powerful computers, the number crunching involved in modeling nonlinear systems was beyond daunting: it was prohibitive (Briggs, 1992, p. 47). Which explains why Poincaré’s discovery was largely ignored—a sleeping dragon—in favor of “good enough” classical physics, until 1960, when MIT mathematician-meteorologist Edward Lorenz (1917-2008) was using a Royal McBee LPG-30 to model weather systems (Maugh, 2008). He unexpectedly found that if he rounded his input to the nearest thousandth, his output became not merely similar, but completely different (Briggs, 1992, p. 15-17, 56-60). Lorenz decided to focus upon that phenomenon with computer assistance—to awaken Poincaré’s dragon—and thus modern chaos science was born with the principle of *sensitive dependence on initial conditions* at its heart. Indeed, in 1972, Lorenz presented a paper titled “Predictability: Does the Flap of a Butterfly’s Wings in Brazil set off a

Tornado in Texas?”—thus inspiring the popular phrase denoting the founding principle of chaos science: *The Butterfly Effect*.<sup>31</sup>

Mathematical models of feedback systems can be graphically represented in terms of the trajectories of their states through  $n$ -dimensional *phase space* (Gleick, 1987, pp. 49-52) The simplest feedback systems are merely iterative and, strictly speaking, linear (completely regular in progression), so their trajectories do not exhibit true novelty, but are limited to a scaled self-similarity akin to the scale invariance of the power law curve. Examples include the golden ratio—made by drawing circle-arcs to connect the opposite corners of tiled squares whose sides are successive numbers in length (where each number is the sum of the previous two)—and the Koch snowflake—made by dividing the sides of an equilateral triangle into three equal segments with further equilateral triangles and continuing that process to infinite crenulation. These examples (see Figure 34) are of the most elementary kinds of feedback or recursion, which underlie many natural forms



**FIGURE 34. Linear Feedback or Recursion: Golden Ratio and Koch Snowflake.**

**These diagrams illustrate the behavior of dynamical systems that are merely iterative and completely regular in their progression, thus generating scaled self-similarity without true novelty.**

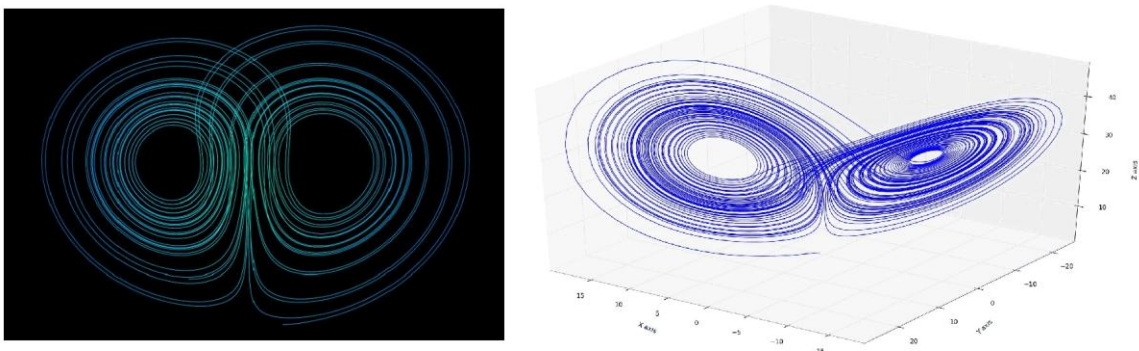
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<sup>31</sup> This choice might have, in turn, been inspired by fiction writer Ray Bradbury (1920-2012), whose 1952 short story “A Sound of Thunder” features the image of a crushed butterfly as a symbol for small initial differences snowballing catastrophically through time.

(e.g. the nautilus shell and the snowflake). They are often treated as icons of recursion, in general, and chaos science, in particular, even though they do not exhibit emergent properties, that is, complexity.

Nonlinear feedback systems, on the other hand, exhibit both scaled self-similarity and emergent properties. Poincaré’s investigations into the three-body problem had invigorated the rarified study of complex system dynamics, as exemplified by the work of mathematician Gaston Julia (1893-1978), who during the first part of the twentieth century envisioned exotic structures composed of differential equations unfolding in phase space—the *Julia set*, in particular. But, again, it wasn’t until sufficiently powerful computers were available that the field really became accessible.

In 1963, Lorenz handed three linked equations—derived from a simplified topological model of atmospheric convection—to a UC Santa Cruz graduate student who configured an old analog computer to run them. That student became the first person to view an unfolding *Lorenz attractor* (see Figure 35), a self-similar positive feedback loop that swirls diachronically about two asymptotic poles, where the synergistic outputs of the linked equations drop towards a bounded infinity determined by the structures of the



**FIGURE 35. Nonlinear Feedback or Recursion: Lorenz Attractor.**

**These diagrams illustrate the phase signature of three equations linked by nonlinear feedback. On the left is a straight-on “owl’s mask” view, and on the right is an oblique 3-dimensional view.**

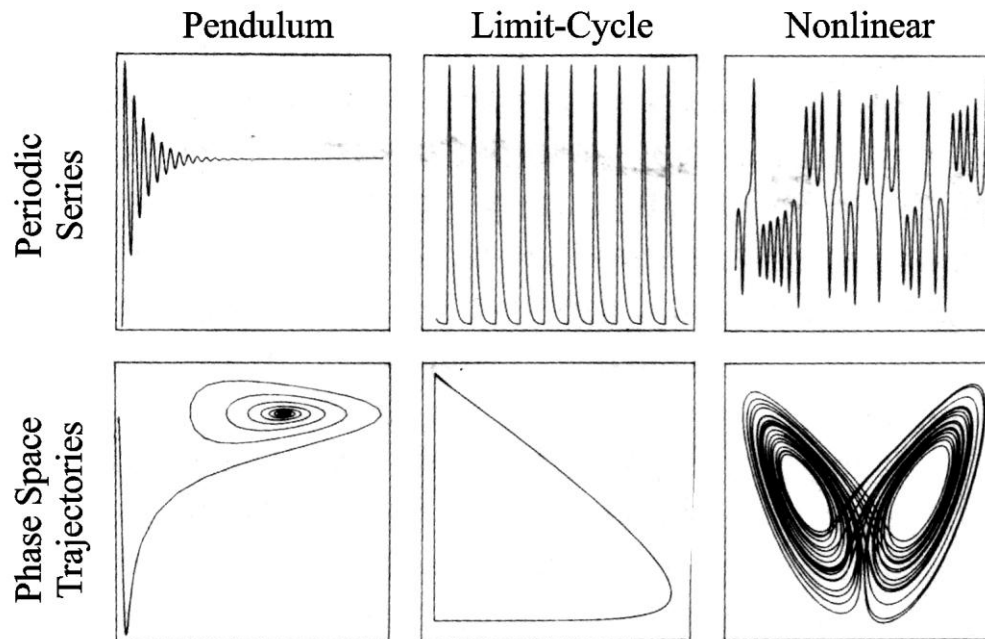
equations themselves. In his book *Chaos: Making a New Science* (1987) journalist-author James Gleick describes the student's viewing situation:

He spent several nights in the basement, watching the green dot of the oscilloscope flying around the screen, tracing over and over the characteristic owl's mask of the Lorenz attractor. The flow of the shape stayed on the retina, a flickering, fluttering thing.... It seemed to have a life of its own. It held the mind just as a flame does, by running in patterns that never repeat. (p. 246)

Since it is a nonlinear system, the Lorenz attractor not only never repeats itself, but it is sensitive to initial conditions so that *any* difference in input results in usually rapid topological divergence. Thus there are infinite variations on the theme described by the Lorenz attractor's equations, and the exact characteristics of each variation can never be known *a priori*—that is, the outputs are emergent and unpredictable, and can only be determined empirically.

The Lorenz attractor is emblematic of dynamical systems because it is a *bistable system*, where its two poles represent states of thermodynamic stability separated by interlocking vortices of thermodynamic instability. Most dynamical systems are bistable in that their extremes consist of two low-energy (stable) states separated by a maximum-energy barrier that must be overcome in order to transition from one state to the other. Overcoming that barrier (i.e. getting to *phase transition criticality*) requires the input of activation energy, and that process of overcoming can be regulated by external factors to create a switching mechanism for the system. Additionally, internal regulation of switching by *hysteresis*, or modifications to a system's sensitivity due to cause-and-effect time lags, is common.

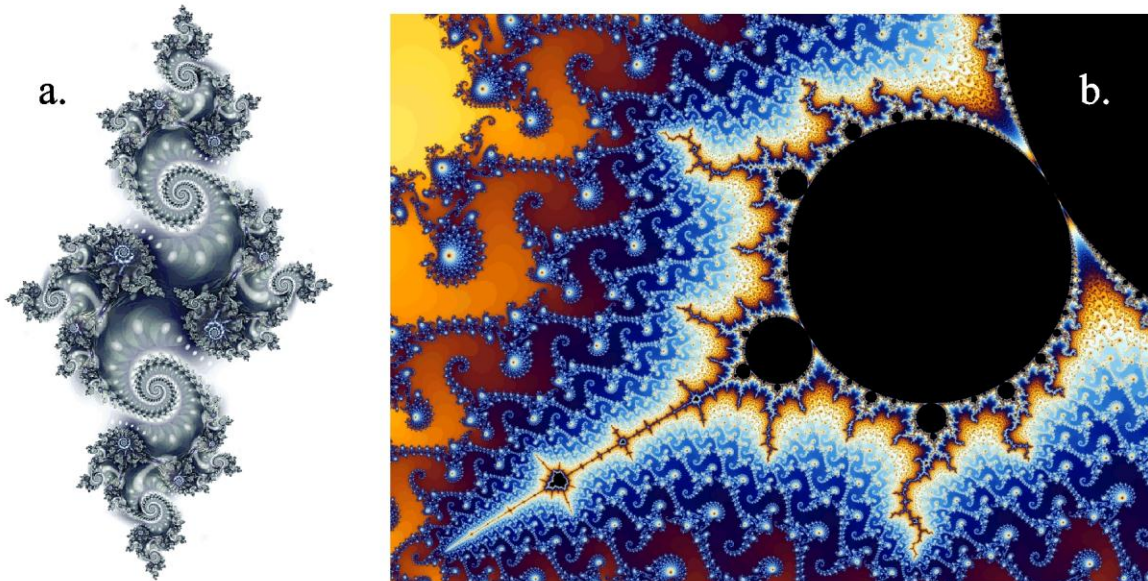
There are three basic types of dynamical systems, and their long-term bistable oscillations can be illustrated as both periodic series and phase space trajectories (see Figure 36). The first type is a *pendulum* system that has a point attractor, and is



**FIGURE 36. Three Basic Types of Dynamical Systems (after Gleick, 1987, p. 50).**

characterized by decreasing oscillations between its two low-energy states, leading eventually to complete stability—at which point the system is no longer really dynamical. The second type is a *limit-cycle* system that also has a point attractor, but is characterized by circular oscillations between its two low-energy states, creating complete stability—a repetitious dynamic made possible by the regular input of energy. The third type is a *nonlinear* system built on positive feedback (such as the Lorenz attractor), and is characterized by oscillations of infinite value among its emergent low-energy states, creating chaotic stability and bounded novelty made possible by the regular input of energy. Nonlinear or chaotic attractors have a special name: they are called *strange attractors*.

Of course, the Lorenz attractor is by no means the only algorithm built on positive feedback and made hauntingly visible with computer graphics. The Julia set mentioned earlier is another such attractor (see Figure 37a)—but the most famous strange attractor must be the Mandelbrot set (see Figure 37b), named for mathematician Benoit



**FIGURE 37. Two Strange Attractors: Julia Set (a: from Carnielli, 2010) and Mandelbrot Set (b: from Beyer, 2005).**

Mandelbrot, who first plugged its equation into a computer in 1979, and watched it unfold within phase space. Gleick describes the moment:

Then Mandelbrot turned his attention to a simple mapping that was particularly easy to program. On a rough grid, with a program that repeated the feedback loop just a few times, the first outlines of disks appeared.... To the right and left of the main disks, hints of more shapes appeared. In his mind, he said later, he saw more: a hierarchy of shapes, atoms sprouting smaller atoms ad infinitum. And where the set intersected the real line, its successively smaller disks scaled with a geometric regularity.... That encouraged him to push the computation further,



refining those first crude images, and he soon discovered dirt cluttering the edge of the disks and also floating in the space nearby.... To his surprise the growing messiness was the sign of something real. Sprouts and tendrils spun languidly away from the main island. Mandelbrot saw a seemingly smooth boundary resolve itself into a chain of spirals like the tails of seahorses. The irrational fertilized the rational. (p.223)

It was an apotheosis, and Mandelbrot became a prophet of chaos. He coined the term *fractal*—"broken, irregular"—specifically to describe the structures generated by nonlinear dynamical systems (although the term is also used to encompass simple recursive structures, such as the golden ratio and the Koch snowflake, that exhibit scaled self-similarity). And Mandelbrot wrote a book called *The Fractal Geometry of Nature* (1982), in which he laid out the foundations for the postmodern science of chaos that could begin to model the messiness of the cosmos (e.g. see Wolfram, 2002)—which is to say, the vast majority of natural things, including living and evolving systems.<sup>32</sup>

*Most* evolving systems are nonlinear dynamical systems, so they exhibit chaotic oscillations, power behaviors, and emergent properties. This explains why

From a human perspective, evolutionary change is not linear; it is exponential in time.<sup>33</sup> The pace of evolution accelerates at a fantastic clip. Peering backwards at the evolutionary panorama from the vantage point of the steep rise at its current

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<sup>32</sup> For a video overview of fractals and their nigh-universal applicability, see the NOVA documentary *Fractals: The Hidden Dimension* (Schwarz & Jersey, 2009).

<sup>33</sup> Movement through space also has an exponential or fractal quality, as seen in *Powers of Ten: A Film Dealing with the Relative Size of Things in the Universe and the Effect of Adding Another Zero* (Eames &



epoch, humans find it tempting to conclude that we are evolution's end point and its ultimate purpose. (Pruett, 2012, p. 186)

But if we avoid teleological projection, and understand evolution not only in neo-Darwinian terms, but as “any process that leads to increases in complexity, diversity, order, and / or interconnectedness” (Fichter, 2010, p.59), then we can see that evolutionary systems are working against entropy. In thermodynamic as well as informational terms, evolutionary systems are necessarily open, and here on Earth, they ultimately receive their energy from the Sun or from the planet's core.

According to Fichter, there are “at least three distinct mechanisms, or theories of evolution: elaboration, self-organization, and fractionation,” where

Elaborating evolution begins with a seed, an ancestor, or a randomly generated population of agents (individual interacting units, like birds in a flock, sand grains in a ripple, or individual units of friction along a fault zone) and evolves by generating and randomly mutating, a large diversity of descendants which are evaluated by an external fitness function; those that do not measure up are selected out. (Fichter, 2010, p. 59)

This is the most familiar evolutionary mechanism, since Darwinian natural selection or “survival of the fittest” is a biological case of elaboration, which proceeds according to the “General Evolutionary Algorithm: 1) differentiate, 2) select, 3) amplify, 4) repeat” (p. 60). On the other hand,

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Eames, 1968). This classic short includes an explicit nod to scaled self-similarity on a cosmic scale:

“Notice the alternation between great activity and relative inactivity” (5:15).

Self-organizing evolution begins with an initial state of random agents that through the application of simple rules of interaction among the agents (e.g. an algorithm, or chemical / physical laws) evolves a system of ordered structures, patterns and / or connections without control or guidance by an external agent of process. That is, the system pulls itself up by its own bootstraps—a.k.a. Local Rules leads to Global Behavior” (p. 60)

Examples of this evolutionary mechanism are “widespread, common, and diverse, and technically belong to the realms of chaos” (p. 60), which are modeled theoretically using fractal mathematics and strange attractors such as the Lorenz attractor and the Julia and Mandelbrot sets. And finally,

Fractionating evolution begins with a complex parent which is physically or chemically divided into fractions through the addition of sufficient energy because of differences in the size, weight, valence, reactivity, etc. of the component particles. Because fractionating systems follow chemical / physical laws, it is possible to predict (calculate) the evolutionary path of the system, and its end state. (p. 61)

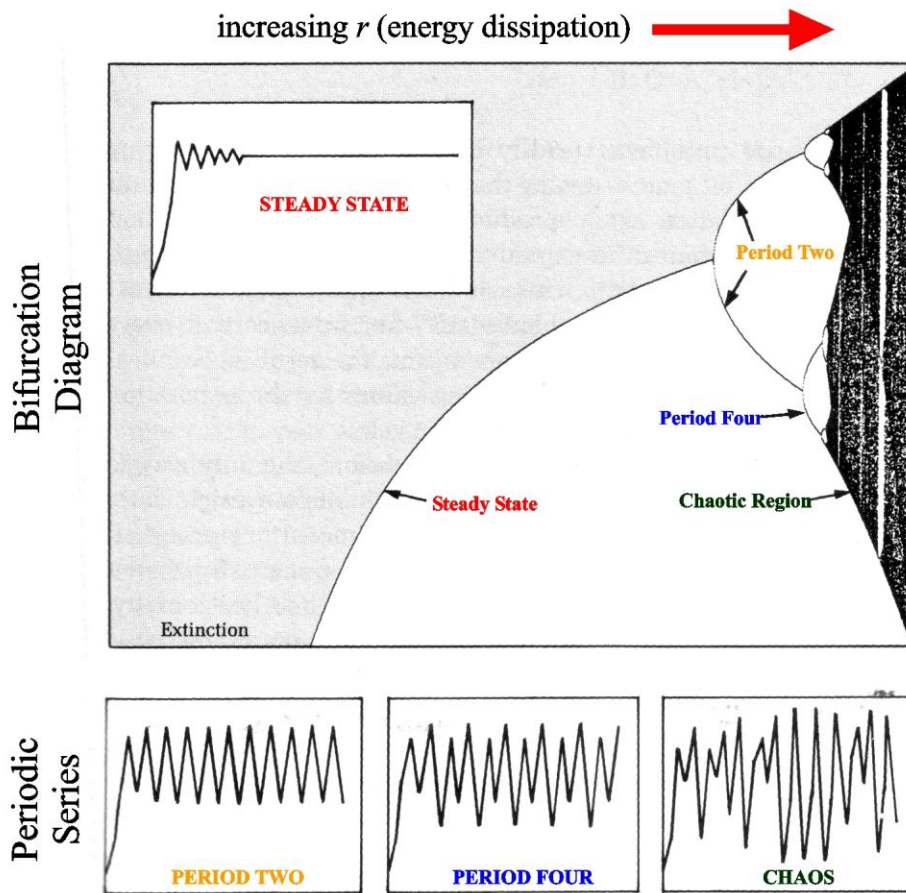
This evolutionary mechanism is associated with inorganic systems, “including the compositional evolution of the atmosphere and oceans, and the evolution of rocks” (p. 61), but it does not involve positive feedback or produce nonlinear effects such as chaotic oscillations, power law behaviors, and emergent properties.<sup>34</sup>

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<sup>34</sup> Although a visit to the Hall of Minerals at the National Museum of Natural History in Washington, D.C. might make you think that the Earth is capable of emergent properties.

Understanding the origin of language requires an understanding of emergent properties, in particular, and evolutionary systems, in general. For example, the hominin hand-brain positive feedback loop can be viewed as an example of elaborating evolution, while the meta-regulatory system that underlies neoteny can be viewed as an example of self-organizing evolution (Misteli, 2009; Törönen *et al.*, 1999; Tucker, 2002, pp.57-58). Those two mechanisms intertwined over hundreds of thousands of years, and the resulting positive feedback generated emergent proto-linguistic / cultural systems that were themselves both elaborative and self-organizing, and might also have fractionating components—although diachronic linguistics emphasizes elaboration, and synchronic linguistics emphasizes self-organization.

The general pattern of emergence created by nonlinear systems can be described thermodynamically as a bifurcation diagram (see Figure 38), where periodic series are modified so that their horizontal time axis becomes  $r$ , a measure of the amount of energy being dissipated by the system. As  $r$  increases, the bistable system—represented in the modified series as a single curve—becomes increasingly unstable. Eventually, a point of self-organizing criticality is reached, and the curve bifurcates as a *novel low-energy state emerges*, through which energy is more efficiently dissipated. If  $r$  continues to increase, each arm of the newly bifurcated system becomes increasingly unstable, and eventually reaches its own point of self-organizing criticality, thus generating further bifurcation and novelty-emergence. That iterative process—called *period doubling to chaos*—is modified by changes in  $r$  and by the recursive algorithm that bounds the system, and it can continue *ad infinitum* to produce a strange attractor with scaled self-similarity throughout. Thus novelty and emergence can be considered in the most abstract, thermodynamic

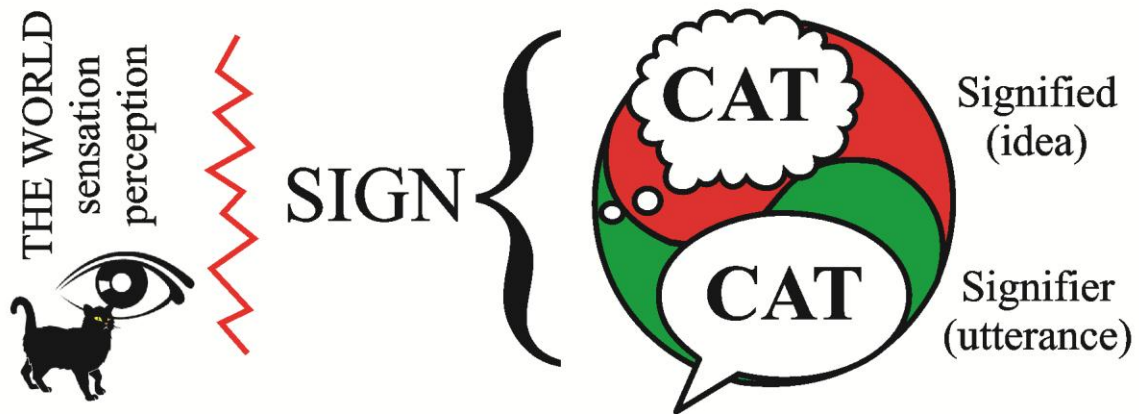


**FIGURE 38. Period Doubling to Chaos: Generator of Emergent Properties (after Gleick, 1987, p. 71).**

terms, which can be applied towards understanding the evolutionary emergence of language.

## 5.2 - THEORY OF SIGNS

Here, I must backtrack and elaborate in order to approach unification. As discussed in Section 2.3, Saussure's theory of signs holds that the linguistic sign is a conjunction of a *signifier* or speech itself—the "utterance"—and the *signified* or an idea, a situation which has the effect of cutting language off from perception, sensation, and the world (see Figure 39). Thus, for Saussure and the structuralists that followed him, language is a purely self-referential web of meaning, a system of floating abstractions



**FIGURE 39. Saussurean Theory of Signs.**

**This diagram illustrates the dyadic relationship between the *signifier* and the *signified* within the Saussurian sign system, which is isolated from experience.**

defined not in any positive terms, but only in terms of relational differences. But is that position justified? Is it not similar to the “revelation” that the words in the dictionary might be defined only in relation to each other? Can ideas be grounded in anything but other ideas? No, yes, and yes. I maintain that ideas, to varying degrees, *must* be grounded in sensation and perception—that the mind is embodied (e.g. see Lakoff & Johnson, 1999)—and that claims to the contrary are ultimately variations on the sophomoric theme of “How can I be sure that what I’m calling ‘red’ is the same thing you’re calling ‘red’?” (The answer, of course, is that our eyes work basically the same way—except when they do not, in which case the exception underscores the rule).

It is worth considering that while the students who compiled their lecture notes into *A Course in General Linguistics* were certain in defining the sign as an utterance-idea dyad, Saussure’s own notes, later compiled into *Writings in General Linguistics*, offer no explanation for that definition. Indeed, his text problematizes the issue, and then trails off after dramatic flourishes and when explanations seem forthcoming—as in the

following extended quotation, which retains its original paragraph breaks, emphases, and capitalization:

*Langue* has a physical side and a psychological side. But the unforgivable error which is found in every paragraph of the grammars is the belief that the psychological side is an *idea*, while the physical side is the *sound*, the *form*, the *word*.

Things are rather more complicated than that.

It is not true, indeed it is extremely false to imagine there to be a distinction between the sound and the idea. These are in fact inseparably one in our minds.

The distinction . . . [trails off]

Thus we have on one side a *word* (physical entity), on the other side its meaning (psychological entity). *Langue* has a physical side and a psychological side. For students of language the meaning of this common sense truth has to be perfectly clear: otherwise there is no way of knowing what belongs in the physical domain and what belongs in the psychological domain.

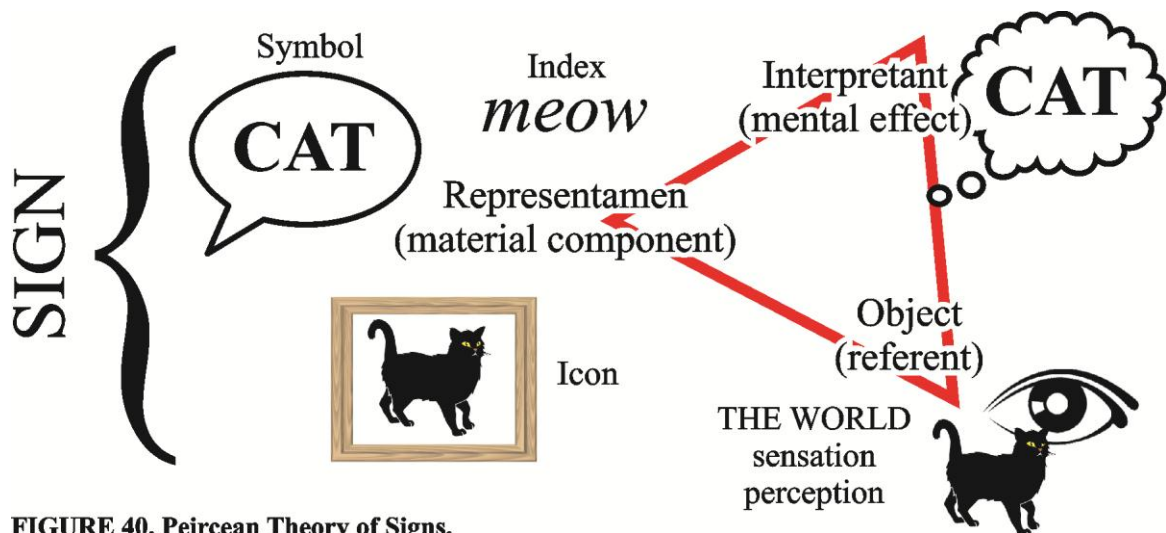
The traditional, straightforward distinction is perfectly disastrous, for it eliminates any hope of rational study of language by presuming that the psychological side is simply the IDEA or signification, while the physical side . . . [trails off] (p. 41)

It is thus difficult to really understand or grapple with Saussure's theory of signs.

However, we can note that his reference to the "rational study of language" implies a Cartesian longing for certainty through reduction to structures best apprehended

mathematically—a longing manifested by the post-Saussurian positivist-structuralist tribe within the social sciences, of which Chomsky is now chieftain.

A more useful understanding of signs was offered by American scientist-philosopher Charles Peirce (1839-1914), who was greatly admired by his friend and benefactor, the psychologist-philosopher William James. Roughly, Peirce treated the process of signification in triadic terms, where the *representamen* is the material component of the sign (e.g. the word “cat,” spoken aloud), the *object* is that to which the *representamen* refers (e.g. a cat), and the *interpretant* is the effect produced upon the mind (e.g. the concept “cat”) by the *representamen* (see Figure 40). This system has the



**FIGURE 40. Peircean Theory of Signs.**

**This diagram illustrates the triadic relationship among the *representamen*, the *interpretant*, and the *object* within Peircean sign system, and it also differentiates iconic, indexical, and symbolic signs.**

advantage of linking language to experience through the *object*, but its details were overly complicated and poorly explained, and it does not provide an account of concept-formation, so it places the horse (*interpretant*) of signification before its cart (*representamen*).

That last problem is likely a cause or effect of Peirce’s doctrine of “infinite semiosis,” where *representamen* exist only in relation *interpretants*, which in turn

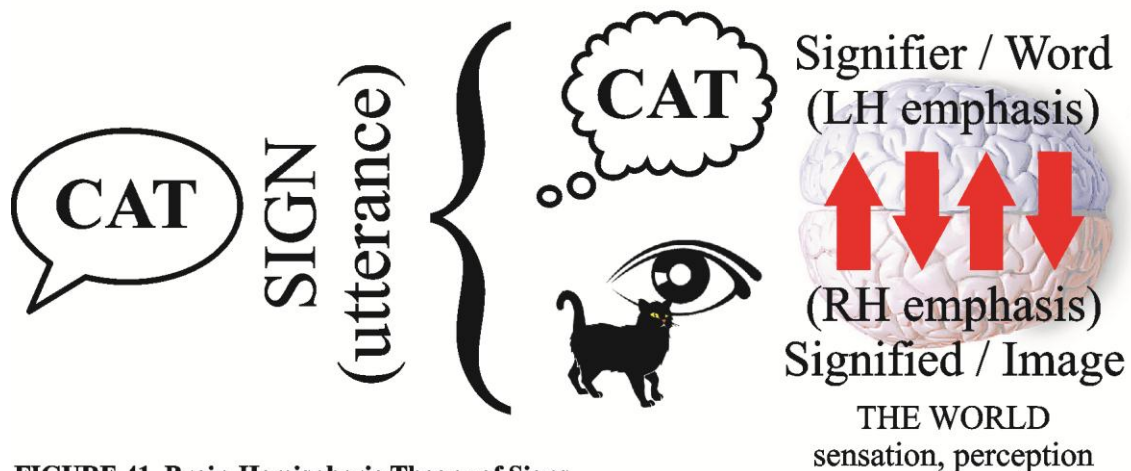
become *representamen* themselves. The resulting chain of linguistic signification (is it recursive, or merely reiterative?) supposedly has no beginning or end (...horse, cart, horse, cart...), and here Peirce seems to forget about his *object* and agree with Saussure that words can refer only to ideas, which are generated by words, which can refer only to ideas, etc. Here, we might object that “unlimited semiosis is only a potential, of course, since at one point the necessities of practical life demand that the interpretation stops” (Atkins, 2010)—but what remains after interpretation? Perhaps only the right hemisphere knows, given that Gazzaniga locates his “interpreter mechanism” in the left.

Peirce also famously argued that the *representamen-object* relation comes in three basic types: the icon, the index, and the symbol. If the relationship is based on similarity (e.g. a painting of cat), it is iconic; if the relationship is based on causality (a heard “meow”), it is indexical; and if the relationship is arbitrary (the word “cat”), it is symbolic. Peirce recognized that these categories are not hard-and-fast, and did much to elaborate upon their interpenetrations, but for our purposes it is important to note that the ability to engage in one form of signification suggests the ability to engage in the other forms. For example, Herring gull chicks instinctively peck at a patch painted on a stick, because the patch resembles the one found on their mothers’ beaks (Ten Cate, 2008). That behavior simultaneously partakes of iconic signification (the stick and beak patches are similar), indexical signification (peck patch, get fed), and symbolic signification (the patch can be modified, and still elicit pecks)—but that behavior is instinctive rather than contingency-based. There is no concept formation involved, and therefore the behavior is non-linguistic.



In any case, the theory of signs I offer here takes into account the evolutionary lateralization of the brain, especially in regards to the hominin hand-brain feedback loop or activity pump, and thus the fact that the brain is thoroughly intertwined with the rest of the body (e.g. bipedalism allowed for an opposable thumb), resulting in embodied cognition and embodied mind. The structuralist theory of signs, on the hand, seems influenced by the Cartesian idea of the brain suspended in a vat by an inscrutable demon.

My theory is simply this: the *sign* is the “utterance,” the *signifier* is a left-hemisphere “word,” and the *signified* is a right-hemisphere “image” (see Figure 41). The



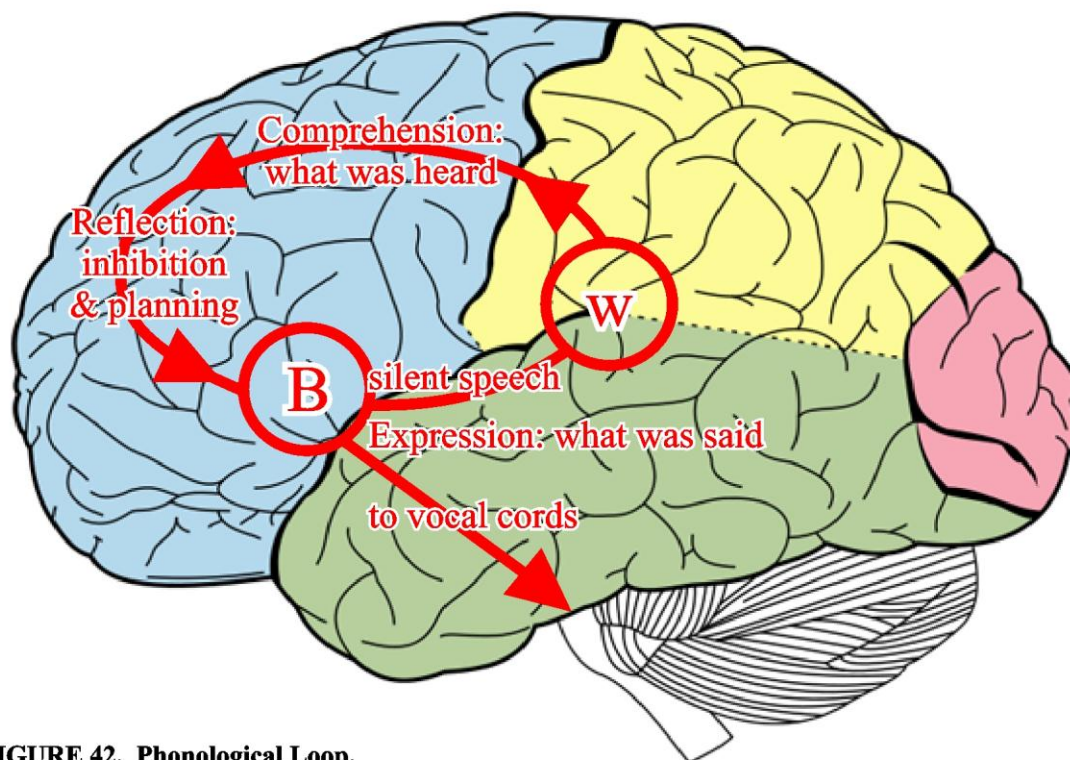
**FIGURE 41. Brain-Hemispheric Theory of Signs.**

**This diagram illustrates the feedback relationship between the abstract *word* and the gestalt *image* within the Brain-Hemispheric sign system, which is connected with experience and the world.**

“utterance” is a sign because language is a signaling system. It makes no sense to treat the utterance as a *component* of the sign, as structuralism does; rather, the utterance itself constitutes a semiotic complex—the vocal sign—and speech is a series of vocal signs.

The *signifier* or left-hemisphere “word” is a contingency-based abstraction or concept, and has its neurological bases in the “phonological loop” (Baddeley, 1993) that operates primarily across the superior longitudinal fasciculus, a bi-directional bundle of nerves that in the left hemisphere connects premotor / motor areas near Broca’s area with

the auditory association cortex, which overlaps with Wernicke's area (see Figure 42). As neuropsychologist Neil Carlson puts it in his *Foundations of Behavioral Neuroscience* (2011), "thinking in words probably involves two-way communication between the speech areas and surrounding association cortex" (p. 392), and



**FIGURE 42. Phonological Loop.**

**This diagram illustrates the path taken by verbal information across the superior longitudinal fasciculus. That information is processed by language functions (W = Wernicke's area / Comprehension and B = Broca's area / Expression) and executive (Reflection) functions.**

the connection between Wernicke's area and Broca's area appears to play an important role in short-term memory of words and speech sounds that have just been heard. Presumably, the rehearsal of such information can be accomplished by "talking to ourselves" inside our head without having to say anything aloud. Imagining ourselves saying the word activates the region of Broca's area, whereas imagining that we are hearing it activates the auditory association area of the temporal lobe. (p. 390)

That typically subvocal “rehearsal” of utterances used to signify that which is signified, or to refer to that which is referenced, is essential to contingency-based abstraction or concept-formation, whereby a series of referents with perceived common qualities are lumped together through reiteration. Thus, the phonological loop provides the necessary but not sufficient left-hemisphere component of language. (And its “two-way communication” also underlies the entirety of Saussurean sign theory, as well as Peirce’s infinite semiosis).

The *signified* or right-hemisphere “image” begins as emotionally impactful gestalt data, and has its neurological bases in the perception and memory circuits of the occipital and temporal lobes, which are “activated by categories such as animals, tools, cars, flowers, letters and letter strings, faces, bodies, and scenes.” In particular, “a relatively large region of the ventral stream of the visual association cortex, the lateral occipital cortex (LOC), appears to respond to a wide variety of objects and shapes,” and “special face-recognizing circuits are found in the fusiform facial area (FFA) located in the fusiform gyrus on the base of the temporal lobe” (Carlson, 2011, p. 167). Significantly, the occipital cortex is asymmetrically activated, such that the right hemisphere responds more to “global” (gestalt) stimuli and the left hemisphere responds more to “local” (abstract) stimuli (Han *et al.*, 2001). Additionally, while the FFA “of the right hemisphere has the ability to quickly recognize unique configurations of people’s eyes, noses, lips, and other features of their faces even when the differences between two people’s faces are very similar” (Carlson, 2011, p. 403), in experiments “the most selective region included the left anterior fusiform cortex, which was activated only by actual [written or

visually represented] words” (pp. 402-403) and has thus been designated the “visual word-form area.”

The tendency here is such that abstract-technological imagery (especially writing) is left-shifted, while gestalt-organic imagery (especially faces) is right-shifted, and that tendency extends to subcortical structures: “In general, pictures or spatial information activates the right hippocampal formation, and verbal information activates the left hippocampal formation” (Carlson, 2011, p. 364). Moreover, there is a link between deficits associated with imagistic lateralization and gender, since as “the human brain is a sexually dimorphic organ” in which “the two hemispheres of the women’s brain appear to share functions more than those of men’s brains do” (p. 261), and “the behavioral characteristics of people with autistic spectrum disorders appear to be exaggerations of the traits that tend to be associated with males.” Men are four times more likely than women to be on the autistic spectrum, in general, and nine times more likely to have Asperger’s disorder, in particular, and “the lack of interest in or understanding of other people as reflected in the response of the autistic brain to the sight of the human face,” with “little or no activity in the fusiform face area of autistic adults looking at pictures of human faces (p. 480). The “extreme male brain” (Baron-Cohen, 2002) emphasis on abstraction might be partially innate, since “even at 1 day of age, baby boys prefer to watch a moving mobile and baby girls prefer to look at a human face,” and it might have a pre-hominin basis, since “young vervet monkeys showed the same sexually dimorphic preferences in choice of toys that children do: Males tend to play with a car and a ball, whereas females preferred to play with a doll and a pot” (Carlson, 2011, p. 260).

My point here is that while lateralization deficits can lead to language dysfunction, the left-hemisphere abstract word (*signifier*) needed to be properly balanced with or framed by the right-hemisphere gestalt image (*signified*) for language to emerge—and after the emergence of language, such a balance or framing must be maintained to avoid dysfunction on an individual or cultural level. After all, the right-hemisphere contribution to language is nothing less than the gestalt grounding of meaning through the affective evaluation (BIT) of approach-and-avoidance situations already filtered through the natural history and social cognitive modules: “[T]he image...determines what might be called the current behavior of any organism or organization. The image acts as a field. The behavior consists in gravitating toward the most highly valued part of the world” (Boulding, 1956, p. 155). In short, the right-hemisphere-emphasized image sets the initial conditions for language—which like all nonlinear dynamical systems, exhibits sensitivity to initial conditions.

The grounding function of the image includes contextualization by vocal intonation and prosody, which “is a special function of the right hemisphere, undoubtedly related to the more general role of this hemisphere in musical skills and the expression and recognition of emotions” (Carlson, 2011, p. 394; see also Joseph’s chapter “Right Hemisphere Language,” 2000). Interestingly, people with William’s syndrome speak lyrically, enjoy music and singing, engage faces and eyes, and are overly emotional, friendly, and trusting (“1 of 2 Williams Syndrome,” 2011). Those behaviors suggest that William’s syndrome is the right-hemispheric (Bogdanov & Solonichenko, 1997) opposite

of autism (Brock, Einav, & Riby, 2008; Byrnie, 2010), where the former might be associated with left-hemispheric deficits, and the latter, with right.<sup>35</sup>

Although language has evolved beyond percept-based or concrete forms of speech, even the most deliberately abstract concepts (e.g. as within strict monotheism or theoretical physics) are signaled with an imagistic component. Indeed, as sound, expression, and gesture, speech is inevitably imagistic, and as visible sign, so is writing. Thus, in *Writing and Difference* (1967), philosopher Jacques Derrida asserts “an animality of the letter which assumes the forms of the letter’s desire, anxiety, and solitude” (p. 88) and, even more inscrutably:

The animality of the letter certainly appears, at first, as *one* metaphor among others...But above all it is metaphor *itself*, the origin of language as metaphor in which Being and Nothing, the conditions of metaphor, the beyond-metaphor of metaphor, never say themselves. Metaphor, or the animality of the letter, is the primary and infinite equivocality of the signifier as Life. (pp. 88-89)

Here, I take Derrida to mean that proto-language required the comparative grouping of images by perceived similarity (concept formation), and that such comparisons created primal metaphors, where one image stood for or against another—as evidenced by therianthropic cave art, for example. Abstraction thus allowed for metaphor, which ruptured the unity of Archaic consciousness and formed the basis of symbolic thought,

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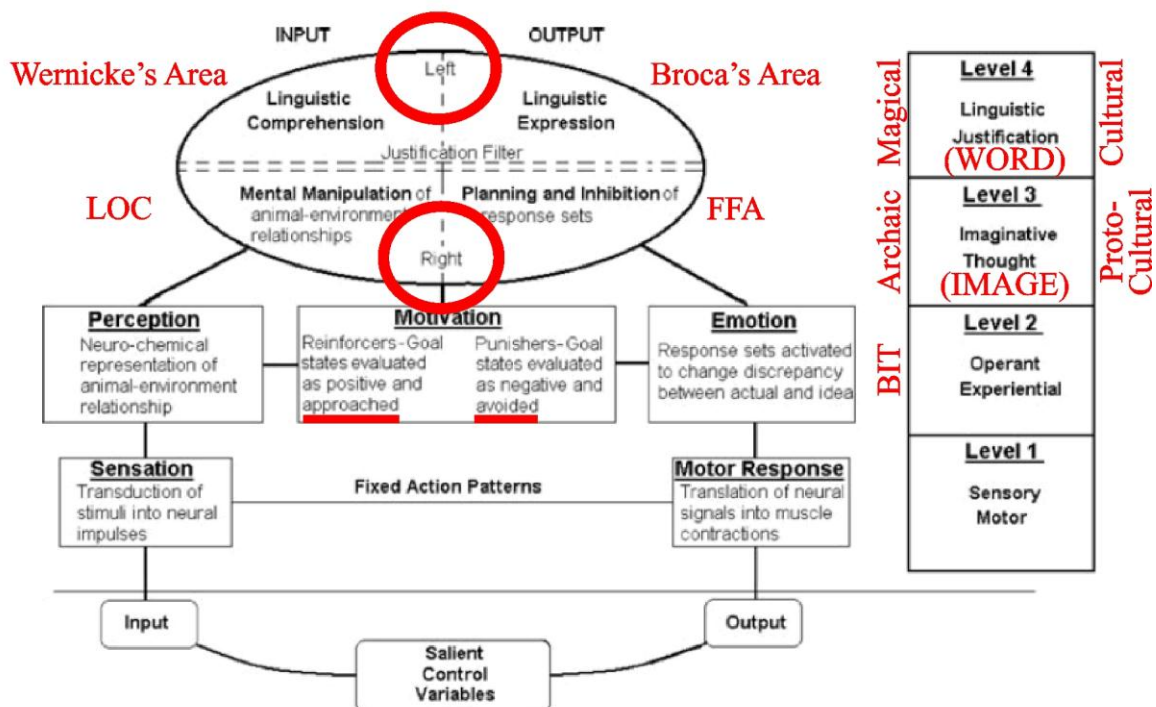
<sup>35</sup> This possibility is reinforced by the fact that Williams syndrome is also associated with “a specific deficit of dorsal stream function” (Adkinson *et al.*, 1997)—that is, the stream that emphasizes avoidance-gestalt visual processing (see Figure 13).

through which humanity lives and moves and has its being—or as philosopher-historian Mircea Eliade states in *Images and Symbols: Studies in Religious Symbols* (1952):

Symbolic thinking . . . is consubstantial with human existence, and it comes before language and discursive reason. The symbol reveals certain aspects of reality—the deepest aspects—which defy any other means of knowledge. Images, symbols, and myths are not irresponsible creations of the psyche; they respond to a need and fulfill a function, that of bringing to light the most hidden modalities of being. (p.12)

It is important to establish a scientific context for these phenomenological claims.

For example, Henriques' Architecture of Human Mind model (see Figure 43) is brain-lateralized (see circles)—although Henriques does not emphasize lateralization or extend



**FIGURE 43. Henriques' Word-Image "Architecture of Human Mind" (after Henriques, 2011, p. 71). This diagram (red information added) illustrates a brain-lateralized model of mind, where the left-hemisphere Linguistic Comprehension and Expression functions are centered in Wernicke's and Broca's areas, respectively, and Imaginative Thought, in the right-hemisphere LOC and FFA.**

it to approach-avoidance considerations (underlined)—and it stresses the importance of Imaginative Thought, which is equivalent to Gebser’s Archaic consciousness (just as Linguistic Justification is equivalent to at least Magical consciousness, and Operant-Experiential mind is equivalent to BIT consciousness). In this model, we can clearly see how the linguistic functions operate fundamentally upon imagistic input before they get caught up in their own phonological-conceptual positive feedback loop. In other words, the image and the imagination precede the word and narration—claims to the contrary (e.g. “In the beginning was the Word”) are revisionist and / or the product of an interpreter-effect blind spot—and the image remains nested within the word such that the word “transcends but includes” (Wilber, 1995, p.59) the image. The gestalt image provides the foundation for abstract metaphor and symbolic meaning, and cannot be removed without reducing “meaning” to a set of empty relations.

Henriques’ Architecture of Human Mind model is empirically grounded and therefore valuable, but it makes sense to directly examine cognitive research that focuses on image-word differences such as degrees of abstraction and brain lateralization. The following extended discussion focuses critically on two such studies to consider and evaluate their theoretical frameworks, methodologies, and analytical techniques.

First, in their article “Dissociating Verbal and Nonverbal Conceptual Processing in the Human Brain” (2006), Thierry and Price explain how they used differential stimuli in conjunction with functional neuroimaging to investigate how brain function is localized during verbal and nonverbal conceptual processing. The authors define conceptual processing as “access to long-term memory representations of meaningful objects (concrete or abstract), the retrieval of their functional properties, and the



mechanisms by which these properties are assessed / compared / related prior to a decision” (p. 1018).

According to a literature review, both verbal and nonverbal conceptual processing—everything from categorization, comprehension, reading for meaning, pictures of objects, and environmental sounds—induce left-hemisphere-lateralized neural activation. However, “there is also evidence for verbal / nonverbal functional dissociations at both the perceptual and conceptual levels” (p. 1018). For example, subjects with pure word deafness and dyslexia have difficulties with auditory-spoken or visual-written verbal tasks relative to nonverbal tasks (left-hemisphere deficiencies?), and subjects with auditory agnosia without aphasia or visual problems have difficulties with nonverbal tasks relative to auditory-spoken or visual-written verbal tasks (right-hemisphere deficiencies?). There is also research showing greater right-hemisphere activation in response to images and greater left-hemisphere activation in response to words, but that research failed to “exclude the contribution of perceptual confounds” (p. 1025).

Based on these data, the authors hypothesize that “verbal and nonverbal access to meaning may be neuro-anatomically segregated” (p. 1018). That is, even though conceptual processing is a generally left-hemisphere-lateralized function, it might exhibit differences in lateralization depending on its perceptual content. Such differences may exist not just between the processing of verbal versus nonverbal stimuli, but also between the processing of visual-written versus auditory-spoken verbal stimuli.

In a previous study, the authors had compared the processing of spoken words (e.g. “cow mooing”) and environmental sounds (e.g. cow mooing), and they had found

that “left anterior temporal activation was greater for spoken words than sounds and, conversely, right posterior superior temporal activation was greatest for sounds” (p. 1019). Here, the authors combine that previous data with the results of their latest research to test their hypothesis and fill a research gap: “Functional imaging evidence for a verbal / nonverbal dissociation is implied when the results from the verbal and nonverbal studies are compared in either the auditory modality or the visual modality. However, no clear double dissociation between verbal and nonverbal conceptual processing has yet been demonstrated when perceptual differences are controlled.” (p. 1019)

This study involved 24 male native speakers of English, half of whom were presented with visual verbal and nonverbal stimuli (text and mute video images), and the other half with auditory verbal and nonverbal stimuli (speech and environmental sounds). Meaningless control stimuli were also presented to establish a neuroimaging baseline, and all subjects were required to perform two conceptual tasks—simple categorization (animal or not animal) and more difficult sequence interpretation (ordered or disordered)—on each stimulus. In both the visual and auditory groups, the effect of task on reaction times and error rates was significant ( $p < .001$ ), where sequence interpretation  $>$  categorization  $>$  baseline, but there was no effect of stimulus type (verbal or nonverbal) on either reaction times or error rates.

In terms of neuroimaging, as expected, meaningful stimuli “independent of sensory modality and independent of verbal status revealed a shared network in the left hemisphere” (p. 1023). However, greater activation of specific areas of the left hemisphere was observed for verbal stimuli in both the visual and auditory groups, and

greater activation of specific areas of the right hemisphere was observed for nonverbal stimuli in both the visual and auditory groups ( $p < .05$  corrected for entire brain). In the visual group, there was also a specific left-hemisphere area that was activated by “visual words more than all other conditions,” although the authors state that they were unable to “exclude the contribution of perceptual confounds within each modality” (p. 1025). In general, the data indicated that “a left versus right verbal / nonverbal functional double dissociation is observed irrespective of sensory modality, which implies that the effects originate at the conceptual, not perceptual level” (p. 1026), and did not disconfirm their experimental hypothesis.

This study seems well-designed to accomplish its goal, which is to tease apart the differences in the location and intensity of brain activation during both categorization and sequence interpretation processing of both verbal and nonverbal stimuli presented in both auditory and visual modalities. However, the theoretical construction and discussion of the study might have been improved had the research model been more nuanced than a straight conceptual-versus-perceptual binary. Conceptual processing might exhibit degrees of left-right difference in lateralization across a conceptual (left)-perceptual (right) *spectrum*. The root problem here may relate to the author’s definition of conceptual processing, which seems to relate to linguistic abstraction, but has no imagistic component (this despite “concrete or abstract”). It is more reasonable to expect that verbal concepts are not entirely abstract, but are more or less rooted in perceptual experience. For example, “cow” might activate areas more associated with visual processing than “honesty,” although the later term may also conjure visual associations. It

should be noted that the study seemed to account for this possibility, since it used only concrete-perceptual words (animals) as verbal stimuli.

In statistical terms, the study used Z-scoring to normalize PET scan measurements across the entire brain, as well as *t*-tests to generate *p*-values / evaluate the significance of difference among activation responses to stimuli. The Z-scoring seems reasonable, but the *t*-test approach is probably too simple given the unknown and probably complex nature of the relationships among the different variables being investigated. The study assumes relationships among the variables based on differences rather than associations (no correlation or regression analysis), and treats those relationships as simple rather than complex (no ANOVA). This can be viewed as a chicken-or-the-egg modeling problem, where researchers are trying to establish the nature of the variable relationships, but in order to do so must use statistical tools that assume particular relationships. In any case, the simple *t*-test feels too much like a leap of faith; I would have liked to have seen a discussion of a more complex statistical treatment of the relationships among the variables. Of course, the use of *t*-tests was necessitated by the unknown population standard deviations and the small sample sizes ( $n = 12$ ). The next study should increase those sample sizes ( $n = 30+$ ) to allow for more sophisticated analyses and understanding.

Second, in their article “An Image is Worth a Thousand Words: Why Nouns Tend to Dominate in Early Word Learning” (2010), McDonough *et al.* explain how they used statistical analyses of already-existing data to investigate why nouns are learned earlier than verbs. Their analyses centered on data gathered using the MacArthur-Bates Communicative Development Inventory: Words and Sentences (CDI), “a widely used

instrument that asks parents to report when their children *produced* a word by checking it off from a list” (p. 183).

After noting that “nouns tend to appear before verbs...across the globe,” the authors state that verbs require “that children perceptually abstract the invariants of an action across multiple exemplars that show wide variation” (p. 181) and that “nouns are generally (though not always) more imageable and easier to see as distinct separate entities than those represented by verbs.” The authors define imageability as “the ease with which a concept evokes a mental image,” and they speculate that ease of learning might be explained not “by the *linguistic* phenomenon of form class [noun versus verb], but by a *conceptual* distinction between what these word classes tend to label.” In short, the authors hypothesize that, if nouns tend to have more concrete referents than verbs and “imageability is highly correlated with concreteness,” then “imageability may play a role in word acquisition” (p. 182).

A literature review conducted by the researchers provided some support for their hypothesis. For example, adult subjects asked to guess words spoken by mothers on silent, child-interaction videos were “far more successful at guessing the nouns than the verbs,” and word imageability was a significantly better predictor of word identifiability than word class. Word imageability was also a significant predictor of successful naming of actions and objects by young (three- and five-year old) children (p. 182). Moreover, parents rated nouns more imageable than verbs, and reported that their children learned more imageable words earlier. The authors note, however, that prior-research limitations included dependence on the memory of subjects, age scales too wide to differentiate

among very young subjects, and a dearth of studies relating to the imageability of verbs in particular (p. 183).

In their current study, the authors compare previously gathered subject imageability ratings for words with CDI word-acquisition data, after noting that parent-reported CDI data have a .61 median correlation with laboratory data. There were 76 nouns and 44 verbs that appeared in both the imageability study and the CDI study, and those overlapping words provided a basis for statistical analyses. It was first determined that, on average, nouns are acquired at a significantly younger age and have significantly higher imageability ratings ( $p < .001$ ). Additionally, the CDI age of word acquisition correlated significantly with imageability for all words ( $p < .001$ ) and for nouns and verbs alone ( $p < .001$  and  $.02$ , respectively).

The authors then applied hierarchical multiple regression, where the CDI age of word acquisition was the dependent variable, and word class (noun = 1, verb = 2) and imageability ratings were the independent variables. First, they controlled for word class, and determined that it accounted for 11% of the variance of the dependent variable ( $p < .001$ ), and that the effects of imageability on the CDI age of word acquisition showed normal distribution, so it was unnecessary to transform the variables. Then, they conducted regression analysis, which showed that word class and imageability ratings correlated significantly with each other and with the CDI age of word acquisition, and that imageability rating accounted for another 11% of the variance of the independent variable ( $p < .001$ ). In short, “word class and imageability rating together accounted for 22% of the variance of the CDI words’ age of acquisition,” and results showed that when

holding imageability rating *or* word class is held constant, nouns are acquired 1.63 *or* 2.31 months earlier than verbs, respectively.

The authors conclude that “the imageability rating not only predicts CDI age of acquisition above and beyond a word’s form class, but its predictive power also exceeds that of the word’s form class using the current data set” (p. 185). Further, they speculate that “the early dominance of nouns may not be simply a function of form class. Rather it may have a conceptual explanation—highly imageable words may be easier to learn” (p. 186).

On the whole, this statistical study of already existing data seems well-conceived. The only thing that might be a problem is directly related to the measurement technique employed in the Communicative Development Inventory. That instrument provides the dependent variable for the current study: the age of word acquisition, *as provided by parents*. As previously mentioned, McDonough *et al.* discuss (1) that prior research limitations included dependence on the memory of subjects and (2) that parent-reported CDI data have a .61 median correlation with laboratory data. That correlation is not significant enough to be the foundation for complex statistical analyses, which means that this study suffers from a research limitation similar to that discussed by the authors. The CDI is an established index, but it is not without controversy (e.g. Feldman *et al.*). An alternate way to conduct the current study would be to base it entirely on word acquisition data obtained in a more controlled, laboratory environment. That solution would be more expensive and time-consuming, but it would yield more solid results.

I have dwelt on these two studies to show not only how they are consistent with the brain-hemispheric theory of signs—the first study indicates the verbal (LH)-

nonverbal (RH) lateralization of visual-written and auditory-spoken stimuli (see also Kateb *et al.*, 2002), while the second indicates that words are more easily learned if they have a more imagistic component (see also Casasanto, 2003)—but to show that such studies need to be approached cautiously, with an awareness of their particular limitations. Science is provisional due to both incomplete data and imperfect methodologies.

### 5.3 - EMERGENCE OF LANGUAGE

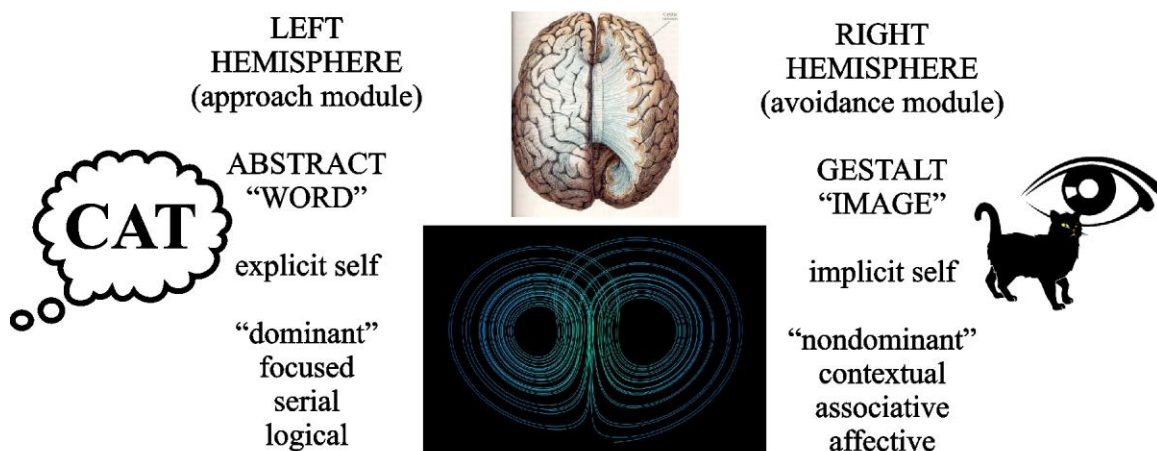
Among other things, the following items have already been discussed: the general pattern of brain lateralization as approach-avoidance modularity, hominin handedness and neotony and their contributions to extreme brain lateralization and neuro-developmental plasticity, the evolution of nonlinear systems through feedback, and the sign as abstract word-gestalt image dyad. We are now in position to understand the emergence of language as a function of brain-hemispheric feedback by using complexity and chaos concepts in a strictly qualitative fashion, being careful to avoid the mathematical enthusiasm that has been called “The Cult of the Golden Ratio” (Martin Gardner, 1994).

First, a Lorenz attractor can be used to neurologically model language as a complex dynamical system swirling about the word and image poles of the linguistic sign (see Figure 44).<sup>36</sup> This bistable system has two low-energy states centered within the

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<sup>36</sup> This model is conceptually extrapolated from computer modeling of cells firing within a human olfactory bulb, as a particular scent prompts their self-organizing behavior. The resulting neurological strange attractor (a unifocal vortex) might provide a basis for the memory of that scent (Briggs, 1992, p. 128).





**FIGURE 44. Emergence of Language as a Word-Image Lorenz Attractor.**

**This diagram illustrates the bistable, recursive relationship between the *word* and the *image*—a relationship rooted in the fundamental modules of a brain hyper-lateralized by handedness. This nonlinear system is sensitive to initial conditions, unpredictable, and it generates novel outputs.**

cerebral hemispheres, and separated by the maximum-energy barrier centered within the corpus callosum. Overcoming that barrier requires the input of activation energy, and that process of overcoming is regulated by the language system’s internal hysteresis (bottom-up organization) and by an external switching prompts (top-down organization) centering on the cingulate cortex, which wraps around the corpus callosum (see Figure 6) and projects into both the cortex and into subcortical structures. The cingulate cortex apparently evolved as a substantially audition-based interface between the vision-based, relatively approach-oriented and cognitive functions of the cortex and the scent-based, relatively avoidance-oriented and emotional functions of the limbic. And it is worth noting that the anterior or angular cingulate cortex emphasizes attentional-motivational / executive functions system (Devinsky, Morrell, & Vogt, 1995; Paus, 2001), while the posterior cingulate cortex underlies and projects directly into the primary auditory cortex, Wernicke’s area, and the angular gyrus—and into the areas of the corpus callosum associated with those structures.

Here it must be noted that, just as the hemispheres of the cerebral cortex are approach-avoidance lateralized, so are subcortical structures such as the amygdala and hippocampus. This suggests that the emergence of more complex or “higher” brain structures in order to generate greater intelligence—that is, flexibility or adaptability in terms of more nuanced approach-abstraction (and thus learning and risk-taking) behaviors—follows a fractal curve. In humans, then, the left neomammalian complex (cortex) is more approach-oriented than the right, and the *entire* neomammalian complex is more approach-oriented than the paleomammalian complex (limbic system). Similarly, the left paleomammalian complex is more approach-oriented than the right, and the *entire* paleomammalian complex is more approach-oriented than the reptilian complex, which is itself lateralized. The implication of this scaled self-similarity is that the right side of each brain evolutionary level has more in common with the previous level than does the left (e.g. the right hemisphere is more emotional than the left, and the limbic system is very emotional), and that the right side might act as a kind of bridge between the two levels—which conjures a spiral image not inconsistent with the twisting motion involved in Yakovlevian torque.

In any case, probably the best way to appreciate the auditory nature of the switching function carried out by the cingulate cortex within the Lorenz attractor of the emerging linguistic sign is by considering the arguments set forth by cognitive scientist Mark Changizi in his book *Harnessed: How Language and Music Mimicked Nature and Transformed Ape to Man* (2011). Changizi points out that “vision excels at answering the questions ‘What is it?’ [ventral stream] and ‘Where is it’ [dorsal stream] but not ‘What happened?’” (p. 33). On the one hand: “Vision is not ideal for sensing events because

events have trouble visually outshouting all the showy nonevents.” On the other hand: “Audition excels at ‘What’s happening’ sensing a signal only when there’s an event” (p. 34). The question of whether or not “an event” has occurred, is occurring, or is about to occur is, of course, a matter of concern for the fundamental approach and avoidance modules, which accords with Changizi’s claim that “if there is a ‘core grammar’ to nature, then this core would have been a highly steady invariant over our evolutionary history, and would thus have been a strong shaper of our visual and auditory systems” (p. 18).

So switching back and forth between the approach and avoidance modules across the corpus callosum is best controlled by audition, which evolved to pay attention to and evaluate nature’s fundamental sounds to determine what sort of events are underfoot. And according to Chanziri, “most events we hear are built out of just three fundamental building blocks: hits, slides and rings” (p. 35), and “hits, slides, and rings are, therefore, nature’s primary phonemes. They are a consequence of how solid physical objects interact and vibrate” (p. 37). The main claim of *Harnessed* is that language is a signaling system of complex vocalizations that evolved to take advantage of an already-existing attentional and motivational system, in general, and—I maintain—the cingulate cortex switch, in particular. This explains why “*human speech sounds like solid-object physical events*” (p. 19, original emphasis), where “language’s hit, slides, and rings, are respectively, plosives, fricatives, and sonorants” (p. 38).

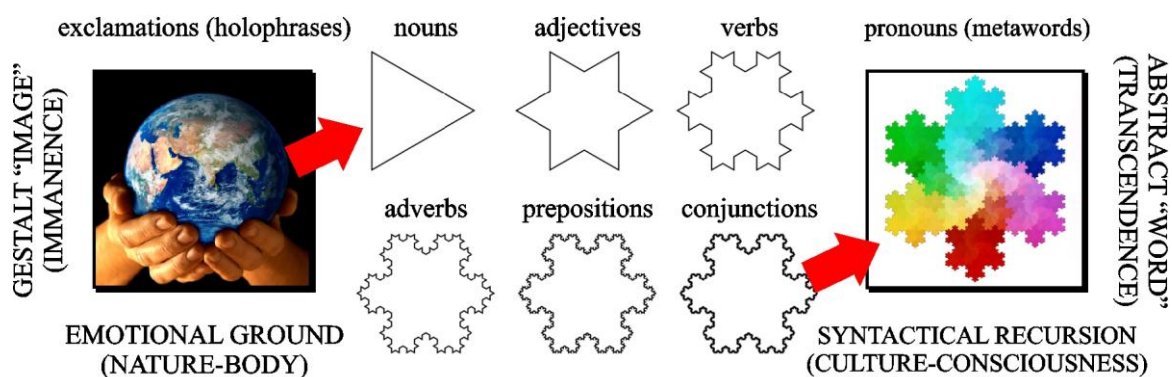
Interestingly, Changizi also points out that the way phonemes are put together follows patterns found in solid-object physical events: “Language’s most universal structure above the level of phonemes—the syllable—has its foundation, then, in

physics” (p. 69). Moreover, “words are not only approximately the size of solid-object physical events—i.e., having several interaction sounds—words also take the amount of time for a typical event” (p. 75). It is worth noting here that, inasmuch as “language carves at nature’s joints” (p. 56), it is *not* entirely arbitrary, as claimed by Saussure and his followers.

Changizi extends his argument by stating that “*music sounds like humans moving and behaving (usually expressively)*” (p. 19, original emphasis). This explains why music can be so moving, both literally and emotionally: “To emote literally means to move or prepare for action” (Maxwell and Davidson, 2007, p. 1113), and music takes advantage of a system and a switch that evolved to pay attention to and evaluate natural events, in general, and human movement, in particular. Of course, that system describes the mid-level natural history and social modules, which evolved out of the low-level avoidance and approach modules; thus, “culture learned how to package language and music so that they fit right into our brains. Culture learned how to harness us” (p. 22).

Here it is worth considering Goldenberg’s hypothesis (2009) that, as components of an integrative system designed to track events in space, the left hemisphere emphasizes the relatively micrometric-categorical (fine) perception and production of phonemes and tongue movements (28-40 Hz range), while the right hemisphere emphasizes the relatively macrometric-coordinate (coarse) perception and production of syllabic rate and jaw movements (3-6 Hz frequency). I would add that the left hemisphere likely specializes in vowels, while the right hemisphere specializes in consonants, in accordance with proto-human linguistic capacity (Best, 1986, p. 47; “In the Beginning was the Vowel,” 2001).

If phonemes and the phonemic structure of syllables and words have their basis in a complex dynamical nervous system (bottom-up organization) interacting with auditory environmental inputs (top-down organization), does that fully explain the emergence of language? It does not—it “only” explains the phonological properties of speech and inadvertently provides a better understanding of the cingulate cortex switch that regulates the strange attractor of linguistic emergence. In order to understand the nature, order, and criticality of the novelties generated by that chaotic system, the issues of brain lateralization and abstract versus gestalt cognition must be addressed. For example, the emergence of word forms or parts of speech out of brain-hemispheric feedback can be modeled as a Koch snowflake (see Figure 45), where exclamations are treated as



**FIGURE 45. Emergence of Word Forms as Koch Snowflake.**

**This diagram illustrates the crystallization of word forms as a fractal curve, where abstraction feeds back upon itself to generate recombination from representation, then recursion from recombination. The general movement is from immanence to transcendence, from gestalt *image* to abstract *word*.**

holophrases that establish the ground of linguistic emergence, and pronouns are treated as metawords that allow for full syntactical recursion. Let us first address the exclamation—typically considered a simple or coarse word form—because the beginning is a good place to start.

When it comes to applying developmental models to evolutionary scenarios, we are reversing Haeckel's already-provisional formulation "ontogeny recapitulates phylogeny," so we must be doubly careful. However, it is difficult not to make certain extrapolations when Linguist David Crystal tells us in his book *How Language Works: How Babies Babble, Words Change Meaning, and Languages Live or Die* (2005) that

The earliest stage of grammatical development hardly seems like grammar at all, since only single words are involved—utterances such as *Gone, More, Dada,* and *Bye-bye*.... The 'one-word' stage is usually most noticeable between twelve and eighteen months. But to talk about it solely in terms of 'words' is misleading. In many respects, these early utterances function as if they were sentences.... For example, one child uses the word *dada* in three different ways: as she heard someone approach outside, she said *Dada?*, with a rising intonation; as she saw it was indeed daddy, she said *Dada*, with a triumphant, falling intonation; and then she said *Da-da!*, with an insistent, level intonation, with her arms outstretched. (pp. 254-255)

Note that Chanziri tells us that a "rising pitch...suggests...that events are coming your way" (p. 80), while a "falling pitch means the object is directing itself less and less towards you" (p. 83)—and he points out that "people overlay the sterile solid-object event sound of speech with emotional overtones. We add intonation, a pitch-like property...[and] these prosody-related emotional overtones turn Steven Hawking computer voice speech into regular human speech" (p. 99). Crystal continues:

At a later stage in development, these three functions would be called a *question*, *statement*, and *command*. At this stage, these utterances do not have a distinctive

grammatical form, but the use of prosody and gesture conveys the force of these sentence types nonetheless. In such cases, many scholars describe them as *one-word sentences*, or *holophrases*. (p. 255)

I suggest that proto-language was hinted at—possibly among *Australopithicus* (Table 1)—by contingency-based exclamations that amounted to holophrases.<sup>37</sup> Here, the exact meaning of the left-hemisphere “word”—question, statement, or command?—was profoundly modulated by its right-hemisphere imagistic component, or “intonation” and “prosody and gesture.” In other words, the manner in which an abstracting signal was differentiated from its gestalt field was determined by the perceived intensity and frequency (audition) of its emotional-auditory activation energy. Again, we must be careful not infer too much from a developmental situation that is embedded within an already-existing cultural matrix—that would be an unforgivable error—but it seems reasonable to conclude that, as contingency-based abstraction, the exclamation is a

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<sup>37</sup> In asserting that language evolved from contingency-based exclamations or holophrases, I am supported by researchers such as Wray (1998, 2000) and Kirby (2002), but I am in opposition to researchers such as Tallerman (2007) and Heine & Kuteva, whose arguments essentially boil down to:

[W]e are not aware of any diachronic evidence to the effect that such a segmentation process can commonly be found in language change. New grammatical categories do not *normally* arise via the reinterpretation of complex, unanalyzed propositions; accordingly, we consider this hypothesis to be less convincing for reconstructing language evolution . . . (2007, p. 26, emphasis added)

For a single-volume intertextual discussion of this topic, see *The Emergence of Protolanguage: Holophrasis vs Compositionality* (Arbib & Bickerton, Eds., 2010).

standardized representation (contingency-based abstraction) of an emotional-situational state (gestalt).

My own view is that such primal holophrases were so bound up in their contextual fields that they did not even indicate proto-language, but that view is not arbitrary or dismissive. Rather, I think that, in terms of signaling, the *pre-language* of the exclamation established the emotional ground for the glacially gradual emergence of syntactical recursion, the crystallization of language from protolanguage, and the movement (for better or worse) of immanent nature and body towards transcendent culture and consciousness. In his book *The Genesis of Syntactic Complexity: Diachrony, Ontogeny, Neuro-Cognition, Evolution* (2009), linguist-writer Thomas Givon states of his subject that “at least theoretically, one could go in two directions,” which he describes as:

- **Expansion (analysis):** Start from an undifferentiated holistic signal and then reanalyze it as a composite of morphemes (a word) or of words (a clause).
- **Combination (synthesis):** Start from the small units (morphemes, words) and then build up the word or clause combinatorially. (p. 8, emphases in the original)

Both “directions” were likely required, where proto-language emerged from the pre-linguistic holophrase through left-hemisphere analysis, and then proto-language gradually evolved into language proper through inter-hemispheric and inter-personal positive feedback loops of right-hemisphere (gestalt) synthesis and left-hemisphere (abstraction)



analysis.<sup>38</sup> But crucially, the primal exclamation established the mechanism of contingency-based abstraction or concept formation by means of the left-hemisphere phonological loop made possible through neoteny and torque-related cerebral reorganization.

Language involves contingency-based representation, then recombination, and then recursion, where more abstract and complex concepts can be formed for mapping and signaling purposes at each of those levels, stages, or scales. Animals have innate or phylogenetic concepts—instincts—that they use to negotiate the world. Presumably, humans also have such innate or phylogenetic concepts or “archetypes” (Jung, 1981), which can be treated as transcendent attractors in a sort of hermetic, “as-above-so-below” fashion. But the formation and communication of novel concepts is proto- / cultural behavior, and since language is mimetic, rather than genetic, it is non-instinctive. Note that there *are* animals that seem capable of rudimentary representational pre-language or contingency-based exclamations in the wild (e.g. chimpanzees), which suggests *Australopithecus*-level BIT consciousness and pre-culture, as evidenced by the use of tools of opportunity. And especially with human assistance, there are animals (Koko the gorilla, Nim Chimpsky the chimpanzee, and Alex the African Grey parrot) that seem capable of *habilis*-level proto-linguistic abstraction: limited contingency-based representation (nouns and adjectives, with perhaps a few verbs) and rudimentary recombination (phrases, with perhaps a few simple sentences).

Interestingly, male songbirds use contingency-based recombinatorial and recursive signaling to attract mates, and ornithologists refer to songbird “culture”

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<sup>38</sup> See Henriques, 2011, p. 124 for a diagram of what this process might look like.

(Rowlett, 2011) despite the fact that birdsong has no apparent referential base or representational function, and should therefore be described as *para*-linguistic. Female songbirds are “simply” attracted to the emergent properties of nonlinear birdsong as a perceived function of male fitness, which suggests that females possess their own complex algorithms for evaluating birdsong strange attractors (Sasahara & Ikegami, 2007). Human music also exhibits nonlinear or fractal properties (Joyce, 2012) and may be viewed as *para*-linguistic. Language-making, like all tool-making, is novel and interesting precisely because it is *not* instinctive, and proto-linguistic tool-making—which is mimetic and proto-cultural, as opposed to genetic and instinctive—is novel and interesting for the same reason.

The understanding of language as a mapping-signaling system involving contingency-based abstraction or on-the-fly concept formation is contrary to Steven Pinker’s eponymous thesis in his book *The Language Instinct: How the Mind Creates Language* (1994). The claim that language is “innate” or “instinctive” among humans is, I think, overstated and / or careless. It is based primarily on the poverty of the stimulus argument, which asserts that it must be impossible for children to learn the rules of their native languages so quickly without those rules being somehow instinctive—an argument that fails to consider the extreme neuro-developmental plasticity that is humanity’s defining evolutionary heritage. Pinker bolsters his claim that language is innate with the examples of a child-centered transition from a pidgin to a creole and the spontaneous emergence of signing among a community of deaf children—but in both cases the children in question had already been exposed to language and its effects, that is, culture.

Thus Pinker is likely inferring too much evolutionary information from a developmental situation that is embedded within an already-existing cultural matrix.

Pinker's examples can be explained in terms of developing neural circuits, already set in adults, that encode an emerging "consistent grammar" (p. 25) and allow for a "grammar explosion" (p. 33). Those circuits are part of a highly mimetic-adaptive technical module that forms in response to natural history and social stimuli. Moreover, the nonlinear language systems resulting from their formation are composed of multi-level networks (Ferreira *et al.*, 2006; Kello & Beltz, 2009; Steyvers & Tenenbaum, 2005) that exhibit power law effects such as scale invariance, self-organizing criticality (e.g. pidgin to creole), and Zipf and Pareto behaviors—for example, where the least communicative effort is achieved by differentiating rules or words, selecting about 20% of them to do about 80% of the work, amplifying those rules or words, then repeating (e.g. rapid deaf community).

Here, we should consider Partha Niyogi's section on "Gradualism versus Abruptness (or the S-Shaped curve)" in *The Computational Nature of Language Learning and Evolution* (2006), where he quotes earlier researchers when discussing "the S-shaped nature of [linguistic] change while introducing the notion of community (population) and the possibility of change being actuated by children (learning)" (p. 29):

"A given change begins quite gradually; after reaching a certain point (say, twenty percent), it picks up momentum and proceeds at a much faster rate and finally tails off slowly before reaching completion. The result is an S-shaped curve . . . . (Bailey, 1973, 77)"

That self-organizing, critical “twenty percent” is an example of Pareto behavior—and with further energy input (perhaps due to a population), the stable logistic system represented by an S-shaped curve proceeds by period doubling to chaotic bifurcation (Fichter, “But First: What is Chaos?”)

In any case, there is no reason to treat the brain as a steady-state computer with genetically preset linguistic algorithms (determined, no doubt, by a linear translation of the human genome). Due to the hand-brain feedback loop and meta-regulatory neoteny, humans have inherited a very large, plastic, and well-connected brain with a powerful technical module. Language is a socially constructed product of that technical module; it is a tool, not an instinct. Pinker’s desire to declare language an instinct clashes with his own common sense: first he states that “language is no more a cultural invention than is upright posture” (p. 5), then he refers to “ordinary speech” as “a technology” (p. 15). Perhaps he is making a Saussurean distinction between *langue* and *parole*? We do not know, but the technical module involves the most plastic circuitry in the brain, and due to sensitivity to initial conditions, the rapid development of its abstract cognitive potentials depends crucially upon early cultural immersion and mimesis. The stages of language acquisition are well-known, as are the effects of missed developmental windows (Penfield & Roberts, 1959; Lenneberg, 1967).<sup>39</sup> Pinker’s assertion that language “is not something that parents teach their children” (6), his claim that the wug test does not

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<sup>39</sup> See also the work of language acquisition specialists Elizabeth Bates (1947-2003), Anat Ninio (b. 1944), and Catherine E. Snow (b. 1945). For specific defenses of relatively empirical emergentism / criticisms of relatively theoretical (in)nativism—a split that might reflect brain hemispheric-cognitive preferences—see Cowrie (1999), Scholz & Pullum (2006), and Ramscar & Gitcho (2007).

measure mimetic language acquisition but instead provides a “demonstration that normal children do not learn language by imitating their parents” (38), and his complaint that “many parents...think that mothers provide children with implicit lessons” (p. 28) are understandable only in ideological terms. If, unlike the children in his favorite poverty-of-the-stimulus examples, a human child did somehow grow up entirely apart from culture—à la the Wild Boy of Aveyron—he or she would no more be able to speak than craft a Levellois point. But Pinker is well aware that recovered feral children “are permanently incapable of mastering the full grammar of the language” (p. 296), and that “despite intensive training and impressive gains in other spheres, [their] syntax is bizarre” (p. 298), so his claim that “your parents need not bathe you in language or even command a language” (p. 43) is nonsensical.

It is precisely the grammar and syntax of language—the rules for abstract representation, recombination, and recursion—that Chomsky has claimed are instinctive. As previously mentioned, his Universal Grammar (UG) and Language Acquisition Device (LAD) have been presented as innate without any discussion of how they came to be so. On the one hand Chomsky seems eager to link linguistics with the discovery of the genetic code, presumably because such a move might provide additional relevancy and legitimacy, but on the other hand, he seems uninterested in evolutionary theory because of its diachronic concerns, which conflict with Saussurean-structuralist synchronic concerns. As a result of that contradiction, one of the greatest living thinkers has been unable to come to grips with the modern evolutionary synthesis (at least so far as language goes), and has instead made statements such as “there is nothing useful to be

said about behavior or thought at the level of abstraction at which animal and human communication fall together” (p. 60), which are apparently intended to stymie discourse.

There was never any significant evidence for Chomsky’s UG or LAD. Indeed, I cannot determine why they were ever considered theories, or even hypotheses, given the lack of suggestions for testability / falsifiability.<sup>40</sup> The obvious thing to do would be to conduct a comparison of the world languages to determine whether or not a UG can be discerned, but for some reason such a comparison was not attempted until 2011, when a group of researchers at the Max Planck Institute for Psycholinguistics...found that word-orders in languages from different language families evolve differently. The finding contradicts the common understanding that word-order develops in accordance with a set of universal rules, applicable to all languages. Researchers have concluded that languages do not primarily follow innate rules of language processing in the brain. Rather, sentence structure is determined by the historical context in which a language develops. Linguists want to understand how languages have become so diverse and what constraints language evolution is subject to. To this end, they search for recurring patterns in language structure. In spite of the enormous variety of sounds and sentence structure patterns, linguistic chaos actually stays within certain limits: individual language patterns repeat themselves. For example, in some languages, the verb is placed at the beginning of the sentence, while with others it is placed in the middle or at the end of the

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<sup>40</sup> Here, computational linguist Geoffery Sampson (b. 1944) is most consistent and dogged in his criticism of Chomsky’s UG (1979, 1980a, 1997), and he also presents of strong defense of empirical linguistics (2001), in general, and “Popperian language acquisition,” in particular (1980b).

sentence. The formation of words in a given language also follows certain principles. (“Weak Evidence for Word-Order Universals,” 2011; originally reported in Dunn, Greenhill, Levinson, & Gray, 2011)

While this study disconfirms the idea of a UG, it supports the idea that languages are fundamentally—that is, at the level of grammar as well as word formation—complex dynamical systems. Every language can be viewed as an unfolding strange attractor defined by its own grammatical “equations,” with emergent properties based on sensitivity to initial conditions. And evolutionarily related languages have similar grammars and thus similar fractal forms, where “in spite of the enormous variety of sounds and sentence structure patterns, linguistic chaos actually stays within certain limits: individual language patterns repeat themselves.” Of course, the converse is also true: less evolutionarily related languages have less similar grammars and thus less similar fractal forms.

A lack of UG does not mean that even the most distant languages would be completely dissimilar. The evolutionary history of the human organism presumably sets biosemiotic boundaries on what sorts of grammatical variations are possible, in both physiological-phenomenological terms and in terms of neural-algorithmic plasticity (cf. the theoretical biology and comparative psychology of Jakob von Uexküll). The former can include factors such as sensory and perceptual limitations and the nature of events themselves, where for example, “stuff happens” or “happening stuff” (noun-verb or verb-noun). But such boundaries might be insignificant and / or unimaginable in principle.

Interestingly, Chomsky approvingly quotes the naturalist-explorer Alexander von Humboldt (1769-1859) regarding “that constant and unvarying system of processes

underlying the mental act of raising articulated structurally organized signals to an expression of thought” and “a recursively generated system, where the laws of generation are fixed and invariant, but the scope and the specific manner in which they are applied remain entirely unspecified.” Chomsky himself talks about language’s “deep and surface structure” and “transformational operations,” and “the new field of mathematical linguistics” (p. 62)—and he mentions “one possible direction for future research...of highly abstract principles and structures that determine the character of human mental processes” (p. 63). But he fails to discuss, or even name, that direction of research. It might have been computational linguistics, which arose from cybernetics and artificial intelligence studies, or it might have been L-systems, the equations used by biologist Aristid Lindemayer to model the development of plants. In 1968—the year *Language and Mind* was published—Chomsky used the latter for modeling syntax, but he applied the equations sequentially, rather than simultaneously as Lindemayer did, and he thus missed their feedback or nonlinear characteristics (“L-Systems,” n.d). Still, Chomsky talks about “a fairly small number of features that can be specified in absolute, language-independent terms [that] appear to provide the basis for the organization of all phonological systems” (p. 65), “cyclic ordering,” “infinite generative capacity,” and “the abstract structure of the various patterns that appear at various stages of derivation” (p. 66)—language that sounds vaguely fractally. But Mandelbrot would not coin the word *fractal* until 1975, and the Lorenz attractor was only a half-decade old. Moreover, even if Chomsky had known about complex dynamical systems, there is no reason to think he would have treated language in anything but synchronic, non-evolutionary terms. Likely, the most he would have done with fractals is somehow use them to prop up his UG idea.



In order to understand the full significance of the greatest challenge to Chomsky's UG, though, we must return to the model of language crystallization as a Koch snowflake, where contingency-based exclamations set the pre-linguistic ground (*Australopithicus*). The first true word form to emerge—that is, the first word form to be more abstract-approach lateralized than gestalt-avoidance lateralized—is the noun, which establishes the proto-linguistic ground of referential representation. Likely, the sequential use of nouns was the most rudimentary form of recombination, and laid the groundwork for the emergence of adjectives and phrases (*habilis*). The most rudimentary form of recursion was the abstraction of the verb from temporal-iterative considerations of a-noun-nced objects, which laid the groundwork for the emergence of adverbs, and allowed for simple sentences, regular representation, and better if still limited recombination (*erectus*). Better if still limited recursion was made possible by the abstraction of relational-locational signifiers such as conjunctions and prepositions, which allowed for regular recombination and compound sentences (*neanderthalensis*). And the abstraction of self-referential pronouns, or the first metawords, allowed for regular recursion and complex sentences, and thus the emergence of language proper (*sapiens*).

I recognize that the emergence of regular recursion and language proper—and the difference between *neanderthalensis* and *sapiens*—is a lot to put upon the shoulders of the humble pronoun, although it is really no more than I have burdened exclamations with. It is true that the idea first came to me while reading from *Mine, All Mine: A Book About Pronouns* (1999), by Ruth Heller (1923-2004), “a children's author and graphic artist known for her use of bright color and detail in both geometric design and the representation of creatures, plants, patterns, and puzzles” (“Ruth Heller,” 2010):

Pronouns take the place of nouns so we don't have to say "Mike said Mike walked Mike's dogs today. Mike walked Mike's dogs a long, long way." How boring what we say would be without the PRONOUNS *his* and *he*. King Cole would call for King Cole's pipe. King Cole would call for King Cole's bowl and fiddlers three. On and on...it makes me yawn. It's awkward and wordy. The rhythm is gone. Pronouns make our language flow.

This caused me to consider how pronouns allow for easier linguistic nesting or embedding—that is, recursion—and complex sentences. Then I realized that pronouns are words that do nothing but refer to other words—that is, they are metawords. Such signifiers are abstractions of abstractions that encourage enhanced abstraction across all word forms and point to self-reference, as exemplified by the pronoun *I*.<sup>41</sup>

A quick survey of pronoun theory ("Pronoun," 2012) did not turn up anything particularly interesting, although I learned that pronouns have been classified as:

- "indicative words" (Karl Brugmann, Karl Bühler, Uriel Weinreich)
- "indexes" or "indicators" (Charles Sanders Peirce, William Edward Collinson)
- "words with changeable signification" (Adolf Noreen)
- "moveable identifiers" (Otto Jespersen, Roman Jakobson)

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<sup>41</sup> Interestingly, children with Williams syndrome show significantly delayed development in the use of pronouns, and their deficits in grammatical "raising," or linguistic recursion / embedding, often last into adulthood (Joffe & Varlokosta, 2007).

- “updating” or “means of transferring from language to speech” (Charles Bally, Émile Benveniste)
- “words of subjective-objective lexical meaning” (Alexey Peshkovsky)
- “word remnants” or “substitutes” (Lev Shcherba, Leonard Bloomfield, Zellig Harris)
- “represents” (Ferdinand Brunot)
- “survivals of special part of speech” (Viktor Vinogradov)

The problem with these structuralist-formalist classifications is that they are largely synchronic; at most, some of them hint at linguistic evolution. It wasn't until reading *The Origin of Language: Tracing the Evolution of the Mother Tongue* (1994) by linguist Merritt Ruhlen (b. 1944) that I understood the possible evolutionary importance of pronouns. Among other things, Ruhlen discusses the breakthroughs made and difficulties faced by linguist Joseph Greenberg (1915-2001), whose work revolutionized language classification systems *based significantly on pronominal patterns*. First, from 1949-1954, Greenberg used mass comparison of words to discern fundamental similarities across 1000+ African languages, which allowed him to group them into just four major families. Those fundamental differences were not just pronominal, but they were primarily so, and the most fundamental differences were across the first-person pronouns *I* and *you* (pp. 36 & 91). Later, in his book *Language in the Americas* (1987), Greenberg did essentially the same thing with hundreds of Native American languages, grouping them into three major families based primarily on first-person pronominal differences (pp. 86-93)—an much-contested move recently supported by genetic data that suggests “at least three distinct waves” of Asian migration into the New World (Gibbons, 2012, p. 144).

Greenberg's American conclusions were prefigured and likely inspired by the pronominal work of linguists Alfred Trombetti and Edward Sapir (Ruhlen, p. 87), but he nonetheless knew how those conclusions would be received: "I am . . . well aware that what is attempted in this work runs against the current trends in Amerindian work and will be received in certain quarters with something akin to outrage'." He was correct; for example, one Americanist urged his colleagues to "shout down" *Language in the Americas* without having read it (p. 90), and another declared that its author's "avowed values are subversive and should be explicitly argued against'." Ruhlen recounts how "a noted physical anthropologist, not involved in this debate . . . characterized the reactions to Greenberg's book as 'hysterical'," and maintains that "the kind of verbal abuse that has recently been directed at Greenberg is usually reserved for religious heretics rather than scholars with new ideas" (p. 91).

For our purposes, the take-away from this linguistics controversy is two-fold. First, in regard to the one of the counterclaims, made by Americanists defending the status quo, that Native American languages share pronominal patterns due to ubiquitous pronominal *borrowing*, Ruhlen points out: "It is well known in linguistics that pronouns are almost never borrowed, and such promiscuous borrowing, among many different groups, as the Americanists propose is simply unheard of in the linguistic literature" (pp. 92-93). The conservation of pronominal patterns—that is, the relative infrequency of pronominal borrowing—points to both the antiquity of pronouns and to their centrality in the emergence of language proper, that is, a signaling system that includes regular recursive abstraction. Second, in regard to the Americanists making the counterclaims, Ruhlen points out: "In practice, if not in their theoretical pronouncements (like the Indo-

Europeanists, whom they so studiously emulate), these scholars are strictly creationist. An evolutionary answer, plausible or not, is simply not acceptable” (p. 93). The Americanist historical-comparative status quo is a product of Sausurrean structuralism, and cannot abide anything other than synchronic interpretations of linguistic data—interpretations that vigorously avoid considerations of evolutionary possibilities.

Here, the obvious move is to examine a language that exhibits pronominal borrowing (an exception to the rule) to see if and how it might otherwise be unusual. It turns out that the most unusual language that exhibits pronominal borrowing—and perhaps the most unusual language, period—is *Pirahã*. And the controversy surrounding that tongue is fierce, on-going, and involves Noam Chomsky and his followers.

*Pirahã* is spoken by a group of only few hundred hunter-gatherers living in the Amazonian interior, who refer to themselves as “the straight ones” and anyone speaking another language as having a “crooked head” (Everett, 2005a, p. 234). The principle ethnographer of the *Pirahã* people has been linguist Daniel Everett (b. 1951), who presented his research in a *Current Anthropology* article titled “Cultural Constraints on Grammar and Cognition in *Pirahã*: Another Look at the Design Features of Human Language” (2005a) and in his book *Don’t Sleep, There Are Snakes: Life and Language in the Amazonian Jungle* (2008). Everett came among the *Pirahã* people in 1977, as a Christian missionary with his family, and initially studied their language to convert them. However, over about a decade, he became fluent in their language, and his experiences among them wore down and eventually eliminated his faith. As he worked to become a linguist, Everett became increasingly interested in understanding the *Pirahã* people on their own terms.

The most unusual aspect of the Pirahã language, according to Everett, is that *it lacks syntactical recursion*: “It is the only language known without embedding (putting one phrase inside another of the same type or lower level, e.g., noun phrases in noun phrases, sentences in sentences, etc.)” (2005a, p. 622). Limited semantical recursion seems possible, if awkwardly so, through the use of interrelated simple and compound sentences (p. 629), but the linguistic nesting that characterizes complex sentences is absent. And significantly, “Pirahã has the simplest pronoun inventory known. It also appears that all its pronouns were borrowed recently” from a nearby but unrelated language group.<sup>42</sup> The Pirahã people prefer not to use pronouns—Everett notes that “this reduced role for pronouns is striking” (p. 628)—and without regular recursion, their language is necessarily less abstract than others, and their culture is necessarily less complex than others; for example (p. 622):

- Pirahã is the only language known without number, numerals, or a concept of counting.
- It also lacks terms for quantification such as “all,” “each,” “every,” “most,” and “some.”
- It is the only language known without color terms.
- It has no perfect tense.
- It has perhaps the simplest kinship system ever documented.

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<sup>42</sup> Indeed, “the Pirahã language is not demonstrably related to any living language” (2008, p. 28), which, when combined with the lack of regular recursion, suggests that it might be an isolate recently evolved from a band of linguistically immature child survivors of warfare, disease, or some other tragedy.

- It has no creation myths—its texts are almost always descriptions of immediate experience or interpretations of experience.
- Pirahã in general express no individual or collective memory of more than two generations past.
- They do not draw, except for extremely crude stick figures representing the spirit world that they (claim to) have directly experienced.

The art-religion aspect of this culture is interesting in that *there really is none*.

The closest thing to art not prompted by outsiders is when the Pirahã people “make necklaces from seeds, home-spun cotton string, and teeth, feathers, beads, beer can pull-tabs and / or other objects, that show little symmetry and are very crude and unattractive compared with the artifacts of other . . . groups in the region”—but “these are decorative only secondarily, their primary purpose being to ward off the evil spirits they see almost daily” (2005b, p. 30). And relations with these mundane “spirits” constitute the sum total of their religious life:

The Pirahãs, I learned, have no concept of a supreme or creator god. They have individual sprits, but they believe they have seen these spirits, and they believe they see them regularly. When we looked into it, we saw that these aren’t invisible spirits that they’re seeing. They are entities that take on the shape of things in the environment. They’ll call a jaguar a spirit, or a tree a spirit, depending on the kinds of properties that it has. Spirit doesn’t really mean for them what it means for us, and everything they say they have to evaluate empirically. (2008, p. 134)

This hallucinatory (from our perspective) animism smacks of psycholinguistic reification-projection and pre-Mental consciousness or Julian Jaynes' bicameral mind, and I submit that “everything they say they have to evaluate empirically” is a gentle statement of just how concrete-bound the Pirahã people are in their thinking—it could easily have been written that “they cannot think except in terms of more or less immediate experience or concrete terms.” Indeed, Everett elsewhere gives a blunter assessment of the limiting effects of the Pirahã language on the lives, experiences, and narratives of its speakers:

Grammar and other ways of living are restricted to concrete, immediate experience (where an experience is immediate in Pirahã if it has been seen or recounted as seen by a person alive at the time of telling), and immediacy of experience is reflected in immediacy of information encoding—one event per utterance. (2005a, p. 621)

The former missionary tries to smooth over any possible political incorrectness (it does not matter)<sup>43</sup> while clarifying some important points:

No one should draw the conclusion from this paper that the Pirahã language is in

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<sup>43</sup> For example, a researcher at the Max Planck Institute for Psycholinguistics, commenting immediately after Everett's *Current Anthropology* article, stated:

Having made the Pirahã sound like the mindless bearers of an almost subhumanly simple culture, Everett ends with a paean to “this beautiful language and culture” with “so much to teach us.” As one of the few spokespersons for a small, unempowered group, he surely has some obligation to have presented a more balanced picture throughout. (2005a, p. 638)

The scientific meaning of the phrase “a more balanced picture” is never explained.



any way “primitive.” It has the most complex verbal morphology I am aware of and a strikingly complex prosodic system. The Pirahã are some of the brightest, pleasantest, most fun-loving people that I know. The absence of formal fiction, myths, etc. does not mean that they do not or cannot joke or lie, both of which they particularly enjoy doing at my expense, always good-naturedly. Questioning Pirahã’s implications for the ‘design features of human language’ is not at all equivalent to questioning their intelligence or the richness of their cultural experience and knowledge. (2005, p. 621)

The emphatic disavowal of the possibility that Pirahã is a relatively simple or “primitive” language is in keeping with Pinker’s assertion that there can be “no such thing as a Stone Age language” (p. 14). The problem for Pinker, though, is that the Pirahã tongue exhibits profound lexical-grammatical (left-brain) simplicity on every level from the phonemic up, and that its richness lies precisely in its prosodic-semantic (right-brain) “singing-Neanderthal” qualities:

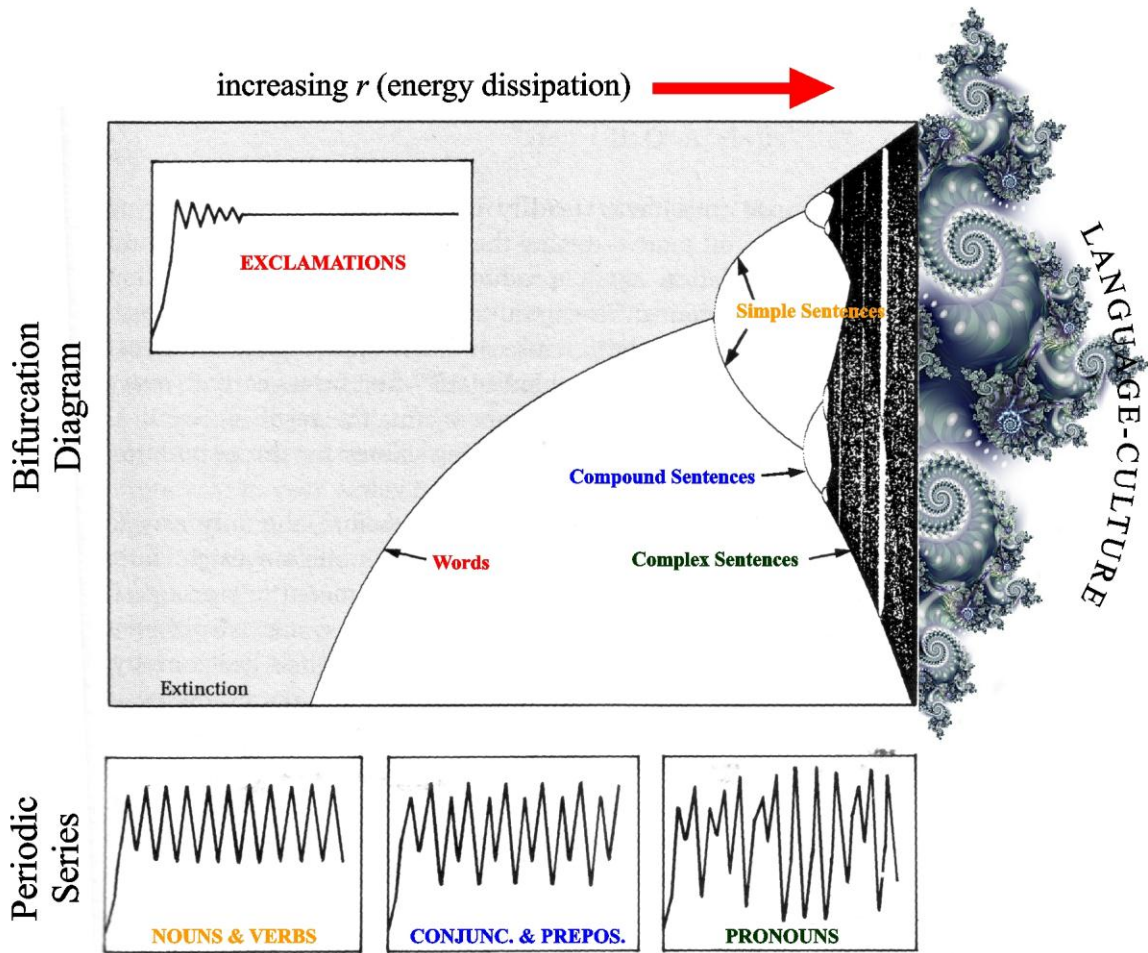
The phonemic inventory of Pirahã women is the smallest in the world, with only seven consonants and three vowels, while the men’s inventory is tied with Rotokas and Hawaiian for the next-smallest inventory, with only eight consonants and three vowels . . . . The Pirahã people communicate almost as much by singing, whistling, and humming as they do using consonants and vowels . . . . Pirahã prosody is very rich, with a well-documented five-way weight distinction between syllable types. (2005, p. 622)

The absence of formal fiction and myth implies a lack of regularly recursive consciousness, and is such an unusual cultural characteristic (what other culture has no

story-telling tradition?) that it cannot be entirely offset by the abilities to joke or lie—abilities that indicate a theory of *other* minds, or limited recursion. A theory of *one's own* mind, or self-reference, goes hand in hand with the ordinary use of (especially first-person) pronouns and the presence of regular syntactical recursion.

Of all the “design features of human language,” regular syntactical recursion is the most crucial, because Chomsky has declared syntactical recursion the *sine qua non* of language. But because Chomsky is a linguistic creationist—that is, he refuses to consider how language might have emerged more or less gradually—he thinks of language as being an all-or-nothing proposition, like an on-off switch: one day there was no language or anything like it, and then the next day language existed with regular syntactical recursion. But according to the model developed within this thesis, language emerged as a nonlinear dynamical system, a positive feedback loop swirling about word-image / approach-avoidance poles, where each word form and corresponding stage, segmentation, or articulation of grammatical complexity was an emergent property (see also Wildgen, 2008). It can allow that the emergence of regular syntactical recursion through pronoun usage represented the flowering of language proper, and at the same time acknowledge the proto-linguistic structures that preceded it.

Finally, a bifurcation diagram can be used to show how language evolved as an adaptive system of energy dissipation (see Figure 46)—after all, “the human brain is only about 2 percent of the weight of the body, but it consumes about 20 percent of the energy in the body at rest” (Brown, 2000, p. 156)—resulting in a strange attractor capable of generating recursive syntactical structures such as “I Am Who I Am” and “I think,



**FIGURE 46. Emergence of Grammar as Bifurcation Diagram.**

therefore I am.” Thus Gebser’s Mental consciousness and culture proper evolved reiteratively from a simple mapping-signaling system.

Finally, in closing, we should note two things. First, the BBC documentary *The Grammar of Happiness* (2012) reviews Daniel Everett’s lifework, and shows how his efforts have so displeased the linguistic establishment—and Noam Chomsky, in particular—that he has been banned from further contact with the Pirahã people, who are his good friends (see also Pullum, 2012 and Schuessler, 2012). Moreover, the Brazilian government has simultaneously taken unprecedented steps to intervene in their previously isolated lives, introducing them to television and schools, and effectively disrupting their

culture. It appears Pirahã is now an endangered tongue, and the chance to study it in order to better understand the evolution of language is quickly disappearing. This is a sad state of affairs for both the Pirahã people and science, and serves only to protect academic dogmatism based on willful ignorance. In *The Grammar of Happiness*, researchers subject recordings of Pirahã to computer analysis, and find no evidence of syntactical recursion. That finding clearly threatens Chomsky's UG idea, which features nesting or embedding.

Second, the connection between pronouns and vowels needs to be explored, where the most abstract word forms might have been enabled by precise phonemic control. The left-hemisphere functions involved here are implicated in the emergence of art-religion / culture and other- and self-awareness—that is *you* and *I*.

## REFERENCES

- 1 of 2 Williams Syndrome - Sunny Personalities [ABC 6-10-2011]. (2011). YouTube.  
Retrieved from [youtube.com / watch?v=-VL5kMSgLIw](https://www.youtube.com/watch?v=-VL5kMSgLIw)
- Aboitiz, F. & and Montiel, J. (2003). One hundred million years of interhemispheric communication: the history of the corpus callosum. *Brazilian Journal of Medical and Biological Research*, 36, 409-420.
- Abstract engravings show modern behavior emerged earlier than previously thought. (2002). Retrieved from [nsf.gov/od/lpa/news/02/pr0202.htm](https://www.nsf.gov/od/lpa/news/02/pr0202.htm)
- “Acheulean Handaxe.” (2011). University of Missouri Museum of Anthropology.  
Retrieved from [anthromuseum.missouri.edu/minigalleries/handaxes/1980-1009-handaxe-acheulean.shtm](https://anthromuseum.missouri.edu/minigalleries/handaxes/1980-1009-handaxe-acheulean.shtm)
- African rock art archive. (2012). The Bradshaw Foundation. Retrieved from [bradshawfoundation.com / africa / index.php](https://www.bradshawfoundation.com/africa/index.php)
- Amir, Y., Harel, M., Malach, R.. (1993). Cortical hierarchy reflected in the organization of intrinsic connections in macaque monkey visual cortex. *Journal of Comparative Neurology*, 334, 1, 19-46.
- Amos, J. (2003). Neanderthal “face” found in Loire. BBC News. Retrieved from [news.bbc.co.uk / 2 / hi / science / nature / 3256228.stm](https://www.bbc.co.uk/2/hi/science/nature/3256228.stm)
- Ancient DNA Reveals That Some Neanderthals Were Redheads. (2007). *ScienceDaily*.  
Retrieved from [sciencedaily.com/releases/2007/10/071025143311.htm](https://www.sciencedaily.com/releases/2007/10/071025143311.htm)
- Anton, S. C. (2003). Natural history of Homo erectus. *Yearbook of Physical Anthropology*, 46, 126-170

- AP chapter 24: The origin of species. (2012). Quia. Retrieved from  
[quia.com / jg / 1577798list.html](http://quia.com/jg/1577798list.html)
- Arasanyin, F. (2011). Transformation of language aims. Lecture. JMU WRTC.
- Arbib, M. A., & Bickerton, D. (Eds.). (2010). *The Emergence of Protolanguage: Holophrasis vs Compositionality*. Amsterdam: John Benjamins.
- Atkin, A. (2010). Peirce's theory of signs. Stanford Encyclopedia of Philosophy.  
 Retrieved from [plato.stanford.edu / entries / peirce-semiotics /](http://plato.stanford.edu/entries/peirce-semiotics/)
- Atkinson, J., King, J., Braddick, O., Nokes, L., Anker, S., & Braddick, F. (1997). A specific deficit of dorsal stream function in Williams syndrome. *Neuroreport*, 8, 71919-71922.
- Australian rock art archive. (2012). The Bradshaw Foundation. Retrieved from  
[bradshawfoundation.com/bradshaws/index.php](http://bradshawfoundation.com/bradshaws/index.php)
- Balák, L. (2012). The era of the great European cultures of the Northern-type hunters.  
 Retrieved from [anthropark.wz.cz/gravetta.htm](http://anthropark.wz.cz/gravetta.htm)
- Balter, M. (2012). Engravings of female genitalia may be world's oldest cave art. AAAS.  
 Retrieved from [news.sciencemag.org / sciencenow / 2012 / 05 / engravings-of-female-genitalia.html](http://news.sciencemag.org/sciencenow/2012/05/engravings-of-female-genitalia.html)
- Baron-Cohen, S. (2002). The extreme male brain theory of autism. *Trends in Cognitive Sciences*, 6, 248-254.
- Becker, E. (1973). *The denial of death*. New York: The Free Press.
- Bednarik, R. G. (1998). The first stirrings of creation. *UNESCO Courier*, April, 4-9.
- Bednarik, R. G. (2011). *The human condition*. New York: Springer.
- Begun, D. R. (2003). Planet of the apes. *Scientific American*, August, 74-83.

- Behe, M. J. (2006). *Darwin's black box: The biochemical challenge to evolution* (2<sup>nd</sup> ed.). New York: Simon & Schuster.
- Benítez-Burraco, A., Longa, V. M., Lorenzo, G., & Uriagereka, J. (2008). Also sprach Neanderthalis . . . or did she? *Biolinguistics*, 2, 2, 225-232.
- Best, C. T. (1986). The emergence of cerebral asymmetries in early human development: a literature review and a neuroembryological model. Retrieved from [haskins.yale.edu/SR/SR088/SR088\\_02.pdf](http://haskins.yale.edu/SR/SR088/SR088_02.pdf)
- Beyer, W. (2005). File:Mandel zoom 08 satellite antenna.jpg. Retrieved from [commons.wikimedia.org/wiki/File:Mandel\\_zoom\\_08\\_satellite\\_antenna.jpg](http://commons.wikimedia.org/wiki/File:Mandel_zoom_08_satellite_antenna.jpg)
- Bianco, I. H., Carl, M., Russell, C., Clarke, J. D. W., & Wilson, S. W. (2008). Brain asymmetry is encoded at the level of axon terminal morphology. *Neural Development*, 3, 9. Retrieved from [neuraldevelopment.com / content / 3 / 1 / 9 /](http://neuraldevelopment.com/content/3/1/9/)
- Bickerton, D. (1981). *The Roots of Language*. Ann Arbor, MI: Karoma.
- Backwell, L., d'Errico, F., & Wadley, L. (2008). Middle Stone Age bone tools from the Howiesons Poort layers, Sibudu Cave, South Africa. *Journal of Archaeological Science*, 35, 6, 1566-1580.
- Bleich, D. (2010). Thoughts on the materiality of language. Lecture. JMU WRTC.
- Blombos cave. (2012). Retrieved from [mannaismayaadventure.com/2012/02/01/blombos-cave/](http://mannaismayaadventure.com/2012/02/01/blombos-cave/)
- Bogdanov, N. N. & Solonichenko, V. G. (1997). Williams syndrome as a model of genetically determined right-hemisphere dominance. *Neuroscience and Behavioral Physiology*, 27, 3, 264-7.
- Borenstein, S. (2012). Cave art suggests that Neanderthals weren't such Neanderthals,

after all. Retrieved from [csmonitor.com/Science/2012/0615/Cave-art-suggests-that-Neanderthals-weren-t-such-Neanderthals-after-all-video](http://csmonitor.com/Science/2012/0615/Cave-art-suggests-that-Neanderthals-weren-t-such-Neanderthals-after-all-video)

Boulding, K. (1956). *The image: Knowledge in life and society*. Ann Arbor: University of Michigan Press.

Bower, B. (2010). Ancient Hominids Had Human-Like Grip. Discovery News. Retrieved from [news.discovery.com/history/ancient-hominids-thumbs.html](http://news.discovery.com/history/ancient-hominids-thumbs.html)

Bradshaw, J. L. & Nettleton, N. C. (1981). The nature of hemispheric specialization in man. *Behavioral and Brain Sciences*, 4, 51-63.

Briggs, J. (1992). *Fractals: The patterns of chaos*. New York: Simon & Schuster.

Broca, P. (1863). Localisations des fonctions cérébrales: Sièges de la faculté du langage articulé. *Bulletin de la Société d'Anthropologie*, 4, 200-208.

Brock, J., Einav, S., & Riby, D. (2008). The other end of the spectrum? Social cognition in Williams syndrome. In T. Striano & V. Reid (Eds.), *Social Cognition: Development, Neuroscience and Autism*. Oxford, UK: Wiley-Blackwell.

Brown, G. (2000). *The energy of life: The science of what makes our minds and bodies work*. New York: Simon and Schuster.

Bruffee, K. A. (1984). Collaborative learning and the 'conversation of mankind.' *College English*, 46(7) 1984, 635-652.

Byrne, F. (2010). The brain's language processing in Williams syndrome and Autism. Psychology Today. Retrieved from [psychologytoday.com / blog / brain-sense / 201008 / the-brains-language-processing-in-williams-syndrome-and-autism](http://psychologytoday.com/blog/brain-sense/201008/the-brains-language-processing-in-williams-syndrome-and-autism)



- Burroughs, W. S. (1992). *The ticket that exploded*. New York: Grove Press.
- Buxhoeveden, D. P., Switala, A. E., Litaker, M., Roy, E., Casanova, M. F. (2001).  
Lateralization of minicolumns in human planum temporale is absent in nonhuman primate cortex. *Brain, Behavior, and Evolution*, 57, 6, 349-58.
- Campbell, J. (1960). *The Masks of God: Primitive Mythology*. London: Martin Secker & Warburg Ltd.
- Carlson, N. (2011). *Foundations of behavioral neuroscience* (8<sup>th</sup> ed.). Boston: Pearson.
- Carnielli, L. M. (2010). Fractal: Conjunto de Julia. DrGEN.com.ar. Retrieved from [drgen.com.ar/2010/10/fractales-naturaleza-imagenes/julia\\_set/](http://drgen.com.ar/2010/10/fractales-naturaleza-imagenes/julia_set/)
- Casasanto, D. (2003). Hemispheric specialization in prefrontal cortex: effects of verbalizability, imagability, and meaning. *Journal of Neurolinguistics*, 16, 361-382.
- Cavalli-Sforza, L. L., Piazza, A., Menozzi, P., Mountain, J. (1988). Reconstruction of human evolution: Bringing together genetic, archeological, and linguistic data. *Proceedings of the National Academy of Sciences*, 85, 6002-6006.
- Chance, S. A., Casanova, M. F., Switala, A. E., & Crow, T. J. (2008). Auditory cortex asymmetry, altered minicolumn spacing and absence of ageing effects in schizophrenia. *Brain*, 131, 3178-3192
- Chomsky, N. (2002). *Language and mind* (3<sup>rd</sup> ed.). Cambridge, MA: Cambridge University Press.
- Chomsky, N. (2002). *Syntactic Structures* (2<sup>nd</sup> ed.). New York: Mouton de Gruyter.
- Christiansen, M. H. & Kirby, S. (2003). Language evolution: The hardest problem in

- science? In Christiansen, M. & Kirby, S. (Eds.), *Language evolution* (pp. 1-15).  
Oxford: Oxford University Press.
- Clendinnen, Inga. (2000). *True stories*. Sydney: ABC Books.
- Clippinger, J. H. III. (1999). Order from the bottom up: Complex systems and their management. In John Henry Clippinger (Ed.) *The biology of business: decoding the natural laws of enterprise* (pp. 1-30). San Francisco: Jossey-Bass.
- Colavito, J. (2008). *Knowing fear: Science, knowledge, and the development of the horror genre*. Jefferson, NC: McFarland & Company.
- Conard, N. J. & Bolus, M. (2003). Radiocarbon dating the appearance of modern humans and timing of cultural innovations in Europe: new results and new challenges. *Journal of Human Evolution*, 44, 3, 331–371.
- Condillac, E. B. D. (2001). *Essay on the origin of human knowledge*. (H. Aarleff, Trans.).  
Cambridge, UK: Cambridge University Press.
- Cook, T. A. (1979). *The curves of life: Being an account of spiral formations and their application to growth in nature, to science, and to art*. New York: Dover.
- Coren, S. (1992). *The left-hander syndrome: The causes and consequences of left handedness*. New York: Random House.
- Cowie, F. (1999). *What's Within? Nativism Reconsidered*. New York: Oxford University Press.
- Cranford, M. (1996). The Social trajectory of virtual reality: Substantive ethics in a world without constraints. *Technology in Society*, 18, 79-92.
- Crow, T. J. (2000). Schizophrenia as the price that homo sapiens pays for language: a resolution of the central paradox in the origin of the species. *Brain Research*

*Reviews*, 31(2-3):118-29.

- Curry, A. (2010). Fate of the cave bear. Retrieved from  
 smithsonianmag.com/history-archaeology/Fate-of-the-Cave-  
 Bear.html?c=y&page=2
- Darwin, C. R. (1981). *The descent of man: And selection in relation to sex*. Princeton, NJ:  
 Princeton University Press.
- Darwin, C. R. (2009). *The origin of species: By means of natural selection of the  
 preservation of favoured races in the struggle for life*. New York: Penguin.
- De Beer, G. (1940). *Embryos and ancestors*. Oxford, UK: Oxford University Press.
- Dejerine, J. (1892). Contribution à l'étude anatomoclinique et clinique des différentes  
 variétés de cécité verbale. *Mémoires de la Société de Biologie*, 4, 61-90.
- Derrida, J. (1980). *Writing and difference*. Chicago: University of Chicago Press.
- de Saussure, F. (2002). *Writings in general linguistics*. Oxford, UK: Oxford University  
 Press.
- Desmond, A. & Moore, J. (1991). *Darwin: The life of a tormented evolutionist*. New  
 York: W. W. Norton and Company.
- Devinsky, O., Morrell, M. J., & Vogt, B. A. (1995). Contributions of anterior cingulate  
 cortex to behavior. *Brain*, 118, 279-306.
- Diamond, J. (2005). *Collapse: How societies choose to fail or succeed*. New York:  
 Penguin.
- Dorsaint-Pierre, R., Penhune, V. B., Watkins, K. E., Neelin, P., Lerch, J. P., Bouffard,  
 M., & Zatorre, R. J. (2006). Asymmetries of the planum temporale and Heschl's  
 gyrus: relationship to language lateralization. *Brain*, 129, 1164-1176.

Dryden, J. (1909). *The poetical works of John Dryden, volume 1* (Bliss Perry, Ed.). New York: Houghton Mifflin.

Dunn, M., Greenhill, S. J., Levinson, S. C., Gray, R. D. (2011). Evolved structure of language shows lineage-specific trends in word-order universals. *Nature*, 473(7345), 79-82.

Dyslexia symptoms and PTSD—is there a connection? (2006). Retrieved from [ibiblio.org/rcip/dyslexia](http://ibiblio.org/rcip/dyslexia).

Eames, C. & Eames, R. (1968). Powers of ten: A film dealing with the relative size of things in the universe and the effect of adding another zero. YouTube. Retrieved from [youtube.com/watch?v=OfKBhvDjuy0](http://youtube.com/watch?v=OfKBhvDjuy0)

Eliade, M. (1991). *Images and symbols: Studies in religious symbols*. Princeton, NJ: Princeton University Press.

Elliot, A. J. & Covington, M. V. (2001). Approach and avoidance motivation. *Educational Psychology Review*, 13, 2, 73-92.

Europe's oldest known art—Neanderthals were cave artists. (2012). Retrieved from [ikono.org/2012/06/europes-oldest-known-art-neanderthals-were-cave-artists/](http://ikono.org/2012/06/europes-oldest-known-art-neanderthals-were-cave-artists/)

Everett, D. L. (2005a). Cultural constraints on grammar and cognition in Pirahã: Another look at the design features of human language. *Current Anthropology*, 46, 4. 621-646.

Everett, D. L. (2005b). Cultural constraints on grammar and cognition in Pirahã: Another look at the design features of human language (with appendices). Retrieved from [sil.org/americas/brasil/publcns/anthro/PHGrCult.pdf](http://sil.org/americas/brasil/publcns/anthro/PHGrCult.pdf)

Everett, D. L. (2008). *Don't sleep, there are snakes*. New York: Random House.

- Feldman, H. M., Dollaghan, C. A., Campbell, T. F., Kurs-Lasky, M., Janosky, J. E., Paradise, J. L. (2000). Measurement properties of the MacArthur Communicative Development Inventories at ages one and two years. *Child Development, 71*(2), 310-322.
- Fichter, L. (n.d.). But first: What is chaos? JMU Department of Geology and Environmental Science. Retrieved from [jmu.edu / geology / ComplexEvolutionarySystems / ChaosTheory.htm](http://jmu.edu/geology/ComplexEvolutionarySystems/ChaosTheory.htm)
- Fichter, L. (2010). Expanding evolutionary theory beyond Darwinism with elaborating, self-organizing, and fractionating complex evolutionary systems. *Journal of Geoscience Education, 58*, 2, 58-64.
- Fichter, L. (n.d.). A glossary of terms and concepts associated with non-equilibrium thermodynamic systems. JMU Department of Geology and Environmental Science. Retrieved from [jmu.edu/geology/evolutionarysystems/pdf/glosschaos00.pdf](http://jmu.edu/geology/evolutionarysystems/pdf/glosschaos00.pdf)
- Finn, J. K., Tregenza, T., & Norman, M. D. (2009). Defensive tool use in a coconut carrying octopus. *Current Biology, 19* (23), R1069-R1070
- First Neanderthal cave paintings discovered in Spain? (2012). Retrieved from [theheritagetrust.wordpress.com/2012/02/14/first-neanderthal-cave-paintings-discovered-in-spain/](http://theheritagetrust.wordpress.com/2012/02/14/first-neanderthal-cave-paintings-discovered-in-spain/)
- Fitch, W. T., Hauser, M. D. & Chomsky, N. (2005). The evolution of the language faculty: clarifications and implications. *Cognition, 97*, 179–210.
- Fodor, J. (1983). *The modularity of mind: An essay on faculty psychology*. Cambridge, MA: MIT Press.

- Fries, P. (2001). A mechanism for cognitive dynamics: neuronal communication through neuronal coherence." *Trends in Cognitive Science*, 9, 10, 474-480.
- Gannon, P. J., Holloway, R. L., Broadfield, D. C. & Braun, A. R. (1998). Asymmetry of chimpanzee planum temporale: Humanlike pattern of Wernicke's brain language area homolog. *Science*, 279: 220- 222.
- Ganz, E. L. (1997 / 1998). Originary narrative. *Anthropoetics: The Electronic Journal of Generative Anthropology*, 3(2). Retrieved from [anthropoetics.ucla.edu / ap0302 / narrative.htm](http://anthropoetics.ucla.edu/ap0302/narrative.htm)
- Gardner, H. E. (2011). *Frames of Mind: The theory of multiple intelligences* (10<sup>th</sup> Anniversary Ed.). New York: Basic Books.
- Gardner, H. E. (2006). *Multiple intelligences: New horizons*. New York: Basic Books.
- Gardner, M. (1994). Notes on a fringe-watcher: The cult of the golden ratio. *Skeptical Inquirer* 18, 243-47.
- Gazzaniga, M. S., Risse, G. L., Springer, S. P., Clark, E., & Wilson, D. H. (1975). Psychologic and neurologic consequences of partial and complete commissurotomy. *Neurology*, 25, 10-15.
- Gazzaniga, M. S. (2002). The split brain revisited. *Scientific American*. Retrieved from [utdallas.edu / ~otoole / CGS / R5.pdf](http://utdallas.edu/~otoole/CGS/R5.pdf)
- Gebser, J. (1986). *The ever-present origin*. Athens, OH: Ohio University Press.
- Gibbons, A. (2012). Genes suggest three groups peopled the New World. *Science*, 337, 144.
- Givon, T. (2009). *The Genesis of Syntactic Complexity: Diachrony, Ontogeny, Neuro Cognition, Evolution*. Amsterdam: John Benjamins.

- Gladwell, M. (2007). *Blink: The Power of Thinking Without Thinking*. New York: Time Warner.
- Goldenberg, G. Apraxia and the parietal lobes. *Neuropsychologia*, 47, 1449-1459.
- Han, S., Weaver, J. A., Murray, S. O., Kang, X., Yund, E. W., Woods, D. L. (2002). Hemispheric asymmetry in global / local processing: effects of stimulus position and spatial frequency. *NeuroImage*, 17, 1290-1299.
- Hauser, M. D., Chomsky, N., Fitch, W. T. (2002). The faculty of language: What is it, who has it and how did it evolve? *Science*, 298, 1569-1579.
- Heine, B., Kuteva, T. (2007). *The Genesis of Grammar: A Reconstruction*. New York: Oxford University Press.
- Heller, R. (1999). *Mine, all mine: A book about pronouns*. New York: Penguin.
- Henriques, G. R. (2011). *A new unified theory of psychology*. New York: Springer.
- Henriques, G. R. (Ed.). (2004). Special issue: Defining psychology: Articles and commentaries on a new unified theory (part 1). *Journal of Clinical Psychology*, 60, 12, 1203-1315.
- Henriques, G. R. (Ed.). (2005). Special issue: Defining psychology: Articles and commentaries on a new unified theory (part 2). *Journal of Clinical Psychology*, 61(1), 1-139.
- Henriques, G. R. (Ed.). (2008). Special issue: The tree of knowledge system. *Theory & Psychology*, 18(8), 731-863.
- Henriques, G. R. (N.D.). ToK FAQs. Retrieved from [psychweb.cisat.jmu.edu / ToKSystem / other%20research.htm](http://psychweb.cisat.jmu.edu/ToKSystem/other%20research.htm)
- Henriques, G. R. (2003). The tree of knowledge system and the theoretical unification of

- psychology. *Review of General Psychology*, 7, 150-182.
- Henry, P-Y. & Anzar, J-C. (2006). Tool-use in Charadrii: Active bait-fishing by a Herring Gull. *Waterbirds*, 29, 2, 233-234.
- Hershkovitz, I., Smith, P., Sarig, R., Quam, R., Rodríguez, L., García, R., Arsuaga, J-L., Barkai, R. & Gopher, A. (2011). Middle Pleistocene dental remains from Qesem Cave, Israel. *American Journal of Physical Anthropology*, 144, 4, 575-592.
- Heuts, B. A. & Brunt, T. (2005). Behavioral left-right asymmetry extends to arthropods. *Behavioral and Brain Sciences*, 28, 4, 601-602.
- Himba people. (2012). K2studio.sk. Retrieved from [k2studio.sk / en / expedicie / himba](http://k2studio.sk/en/expedicie/himba)
- Hutton, M. D. J. (2010). *Theory of the earth*. New York: Classic Books International.
- Huxley, T. H. (2001). *Man's Place in Nature*. New York: Random House.
- Ingenious fishing method may be spreading through dolphins. (2011). Murdoch University. Retrieved from [media.murdoch.edu.au / ingenious-fishing-method-dolphins](http://media.murdoch.edu.au/ingenious-fishing-method-dolphins)
- Innocenti, G. M., Ansermet, F., Parnas, J. (2003). Schizophrenia, neurodevelopment and corpus callosum. *Molecular Psychiatry* (2003) 8, 261-274.
- In the Beginning Was the Vowel. (2010). BBC News. Retrieved from [news.bbc.co.uk / 2 / hi / world / monitoring / media\\_reports / 1480303.stm](http://news.bbc.co.uk/2/hi/world/monitoring/media_reports/1480303.stm)
- Jackendoff, R. & Pinker, S. (2005). The nature of the language faculty and its implications for the evolution of language. *Cognition*, 97, 211-225
- Jackson, J. H. (1876). Case of large cerebral tumour without optic neuritis and with left hemiplegia and imperception. *Royal London Ophthalmic Hospital Reports*, 8, 434-444.



- Jaynes, J. (1976). *The origin of consciousness in the breakdown of the bicameral mind*. Boston: Houghton Mifflin.
- Jeannerod, J. (1997). *The cognitive neuroscience of action: Fundamentals of cognitive neuroscience*. Cambridge, MA: Blackwell.
- Joffe, V. & Varlokosta, S. (2007). Patterns of syntactic development in children with Williams syndrome and Down's syndrome: evidence from passives and wh questions. *Clinical Linguistics and Phonetics*, 21, 9, 705-27.
- Johnson, N. (2007). *Simply complexity: A clear guide to complexity theory*. Oxford, UK: Oneworld.
- Joseph, R. (2000). *Neuropsychiatry, neuropsychology, and clinical neuroscience: Emotion, evolution, cognition, language, memory, brain damage, and abnormal behavior* (2<sup>nd</sup> ed.). New York: Lippincott Williams & Wilkins.
- Joyce, C. (2012). Nature has a good beat, but can you dance to it? National Public Radio. Retrieved from [npr.org / 2012 / 02 / 21 / 147180161 / nature-has-a-good-beat-but-can-you-dance-to-it](http://npr.org/2012/02/21/147180161/nature-has-a-good-beat-but-can-you-dance-to-it)
- Jung, C. G. (1981). *The archetypes and the collective unconscious (collected works of C. G. Jung Vol. 9 Part 1)*. (R.F.C Hull, Trans.). Princeton, NJ: Princeton University Press.
- Khateb, A., Pegna, A. J., Michel, C. M., Landis, T., Annoni, J. M. (2002). Dynamics of brain activation during an explicit word and image recognition task: an electrophysiological study. *Brain Topography*, 14, 3, 197-213.
- Kello, C. T. & Beltz, B. C. (2009). Scale-Free Networks in Phonological and

- Orthographic Wordform Lexicons. In I. Chitoran, C. Coupé, E. Marsico, & F. Pellegrino (Eds.) *Approaches to Phonological Complexity*. New York: Walter de Gruyter.
- Kenneally, C. (2007). *The first word: The search for the origins of language*. New York: Penguin.
- Kirby, S. (2002). Learning, bottlenecks and the evolution of recursive syntax. In Ted Briscoe (Ed.) *Linguistic evolution through language acquisition: formal and computational models*. Cambridge, MA: Cambridge University Press.
- Krause, J., Lalueza-Fox, C., Orlando, L., Enard, W., Green, R. E., Burbano, H.A., Hublin, J. J., Hänni, C., Fortea, J., de la Rasilla, M., Bertranpetit, J., Rosas, A., & Pääbo, S. (2007). The derived FoxP2 variant of modern humans was shared with Neandertals. *Current Biology*, 17, 21, 1908-12.
- Kuperberg, G. R. (2010). Language in schizophrenia Part 1: an Introduction. *Language and Linguistics Compass*, 4(8): 576-589.
- Kurzweil, R. (1990). *The age of intelligent machines*. Cambridge, MA: MIT Press.
- Kurzweil, R. (1999). *The age of spiritual machines: When computers exceed human intelligence*. New York: Penguin.
- Kurzweil, R. (2005). *The singularity is near: When humans transcend biology*. New York: Penguin.
- La Freniere, E. A. (2010). An awe-ful integrity: The science-fiction horror of H. P. Lovecraft. Madison Writing Awards. Retrieved from [jmu.edu / mwa / docs / 2010b / lafreniere.pdf](http://jmu.edu/mwa/docs/2010b/lafreniere.pdf)
- Lakoff, G. & Johnson, M. (1999). *Philosophy in the flesh : The embodied mind and its*

*challenge to Western thought*. New York: Perseus Books.

Lai, C. S. L., Fisher, S. E., Hurst, J. A., Vargha-Khadem, F., Monaco, A. P. (2001). A forkhead-domain gene is mutated in a severe speech and language disorder.

*Nature*, 413, 6855, 519-23.

La musique dans la préhistoire. (2012). Retrieved from

[hominides.com/html/dossiers/musique-prehistoire.php](http://hominides.com/html/dossiers/musique-prehistoire.php)

Lenneberg, E. (1967). *Biological foundations of language*. Hoboken, NJ: Wiley.

“Levallois Flake.” (2011). University of Missouri Museum of Anthropology. Retrieved from [anthromuseum.missouri.edu/minigalleries/handaxes/74-18-handaxe-levallois.shtm](http://anthromuseum.missouri.edu/minigalleries/handaxes/74-18-handaxe-levallois.shtm)

Levinas, E. (1979). *Totality and infinity: An essay on exteriority*. New York: Springer.

Liepmann, H. (1905). Die linke hemisphäre und das handeln. *Münchener Medizinische Wochenschrift*, 49, 2375-2378.

Liepmann, H. & Maas, O. (1907). Fall von linksseitiger agraphie und apraxie bei rechtsseitiger lähmung. *Zeitschrift für Psychologie und Neurologie*, 10, 214-227.

Liepmann, H. (1912). Zur lokalisation der hirnfunktionen mit besonderer Berücksichtigung der beteiligung der beiden hemisphären an den gedächtnisstörungen. *Zeitschrift für Psychologie*, 63, 1-18.

Lovseth, K. & Atchley, R. A. (2010). Examining lateralized semantic access using pictures. *Brian & Cognition*, 72, 2, 202-209.

L-Systems: Some History of L-Systems. (n.d.). Yale. Retrieved from

[classes.yale.edu / fractals / introfrac / initgen / lsystems / LSysHist.html](http://classes.yale.edu/fractals/introfrac/initgen/lsystems/LSysHist.html)

Lyell, C. (1830-1833). *Principles of geology: Being an attempt to explain the former*

*changes of the Earth's surface, by reference to causes now in operation* (3 vol.).

London: Murray.

- MacDermot, K. D., Bonora, E., Sykes, N., Coupe, A.M., Lai, C. S., Vernes, S. C., Vargha-Khadem, F., McKenzie, F., Smith, R.L., Monaco, A.P., Fisher, S.E. (2005). Identification of FoxP2 truncation as a novel cause of developmental speech and language deficits. *American Journal Human Genetics*, 76, 6, 1074-80.
- Marzke, M. W. (1983). Joint functions and grips of the *Australopithecus afarensis* hand, with special reference to the region of the capitate. *Journal of Human Evolution*, 12, 197-211.
- Martin, M. & Jones, G. V. (2005). Constraints from handedness on the evolution of brain lateralization. *Behavioral and Brain Sciences*, 28, 4, 603-604.
- Maugh, T. H. II. (2008). His computer riddle led to chaos theory. Retrieved from [articles.latimes.com/2008/apr/18/local/me-lorenz18](http://articles.latimes.com/2008/apr/18/local/me-lorenz18)
- Maxwell, J.S., Davidson, R. J. (2007). Emotion as motion: asymmetries in approach and avoidant actions. *Psychological Science*, 18, 12, 1113-1119.
- Mayell, H. (2004). Neanderthals were fully developed by age 15, experts say. National Geographic News. Retrieved from [news.nationalgeographic.com/news/2004/04/0428\\_040428\\_neandertals.html](http://news.nationalgeographic.com/news/2004/04/0428_040428_neandertals.html)
- Mayer, R. E., & Wittrock, M. C. (1996). Problem-solving transfer. In D. C. Berliner & R. C. Calfee (Eds.), *Handbook of Educational Psychology* (pp. 47-62). New York: MacMillan.
- MacAndrew, A. (2003). FOXP2 and the evolution of language. Retrieved from [evolutionpages.com/FOXP2\\_language.htm](http://evolutionpages.com/FOXP2_language.htm)

- McCrea, S. M. (2010). Intuition, insight, and the right hemisphere: Emergence of higher sociocognitive functions. *Psychology Research and Behavior Management*, 2010, 3, 1-39.
- McDonough, C., Song, L., Hirsh-Pasek, K., Golinkoff, R. M. & Lannon, R. (2010). An image is worth a thousand words: why nouns tend to dominate in early word learning. *Developmental Science*, 14(2), 181-189.
- McGrew, W. C. & Marchant, L. F. (1997). On the other hand: Current issues in and metaanalysis of the behavioral laterality of hand function in nonhuman primates. *Yearbook of Physical Anthropology*, 40, 201-232.
- McKibben, B. (2012). Global warming's terrifying new math. Rolling Stone. Retrieved From [rollingstone.com / politics / news / global-warmings-terrifying-new-math-20120719](http://rollingstone.com/politics/news/global-warmings-terrifying-new-math-20120719)
- Meadows, D. H., Meadows, D. L., & Randers, J. (2004). *Limits to growth: The thirty-year update*. White River Junction, VT: Chelsea Green.
- Misteli, T. (2009). Self-organization in the genome. *Proceedings of the National Academy of Sciences*, 106, 17, 6885-6886.
- Mithen, S. (1996). *The prehistory of the mind: The cognitive origins of art and science*. New York: Thames and Hudson.
- Montagu, A. (1989). *Growing young*. Granby, MA: Bergin & Garvey Publishers.
- Morin, A. (2001). The split-brain debate revisited: On the importance of language an self recognition for right hemispheric consciousness. *Journal of Mind and Behavior*, (22)2, 207-218.

- Muller, F. M. (1873). Lectures on Mr. Darwin's philosophy of language. In *Eclectic Magazine of Foreign Literature, Science, and Art*, 18. (W. H. Bidwell, Ed.). New York: E. R. Pelton. 75-88, 148-163, 257-275.
- Naef, A. (1926). Über die Urformen der Anthropomorphen und die Stammengeschichte des Mensenschädels. *Die Naturwissenschaften*, 14, 445-452.
- Niyogi, P. (2006). *The computational nature of language learning and evolution*. Cambridge, MA: MIT Press.
- Oldest lunar calendar on Earth. (n.d). Retrieved from [environmentalgraffiti.com/featured/oldest-lunar-calendar/15204](http://environmentalgraffiti.com/featured/oldest-lunar-calendar/15204)
- “Olduwan Chopper.” (2011). University of Missouri Museum of Anthropology. Retrieved from [anthromuseum.missouri.edu/minigalleries/handaxes/1985-0235-handaxe-oldowan.shtm](http://anthromuseum.missouri.edu/minigalleries/handaxes/1985-0235-handaxe-oldowan.shtm)
- Parker, A. (2004). *In the blink of an eye: How vision sparked the big bang of evolution*. New York: Perseus Books.
- Paus, T. (2001). Primate anterior cingulate cortex: where motor control, drive and cognition interface. *Nature Reviews Neuroscience*, 2, 6, 417–424
- Penfield, W. & Roberts, L. (1959). *Speech and brain mechanisms*. Princeton, NJ: Princeton University Press.
- Pinker, S. (1994). *The language instinct: How the mind creates language*. New York: HarperCollins.
- Pinker, S. & Bloom, P. (1990). Natural language and natural selection. *Behavioral and Brain Sciences*, 13, 707–784.
- Playfair, J. (1805). Scaling Siccar Point. *Transactions of the Royal Society of Edinburgh*,

5(3).

Poffenberger, A.T. (1912). Reaction time to retinal stimulation with special reference to the time lost in conduction through nerve centres. *Archives of Psychology*, 23, 1-73.

Pruett, D. (2012). *Reason and wonder: A Copernican revolution in science and spirit*. Santa Barbara, CA: ABC-CLIO, LLC.

Pullum, G. (2012). The rise and fall of a venomous dispute. Retrieved from [chronicle.com/blogs/linguafranca/2012/03/28/poisonous-dispute/](http://chronicle.com/blogs/linguafranca/2012/03/28/poisonous-dispute/)

Raghavan, P., Groves, C., Pathmanathan, G. (2003). Homo erectus—was our stone age mechanical engineer an indigenous species of Asia? Yes! He was a product of “evolution in isolation.” *Journal of the Anatomical Society of India*, 52(1), 16-19.

Ramirez, M., Prieto, I., Vives, F., Gasparo, M., Alba, F. (2004). Neuropeptides, neuropeptidases and brain asymmetry. *Current Protein and Peptide Science*, 5, 497-506.

Ramscar, M. & Gitcho, N. (2007). Developmental change and the nature of learning in childhood. *Trends in Cognitive Science*, 11, 7, 274-9.

Roach, J. (2007). Chimps use “spears” to hunt mammals, study says. National Geographic News. Retrieved from [news.nationalgeographic.com/news/2007/02/070222-chimps-spears.html](http://news.nationalgeographic.com/news/2007/02/070222-chimps-spears.html)

Roby-Brami, A., Hermsdörfer, J., Roy, A. C., Jacobs, S. (2012). A neuropsychological perspective on the link between language and praxis in modern humans. *Philosophical Transactions of the Royal Society B: Biological Sciences*, 367, 1585, 144-60.

- Rossi, M. A. (2005). Extending our reach into nothingness: Why technology can't fix character. Retrieved from [spectacle.org / 0305 / rossi.html](http://spectacle.org/0305/rossi.html)
- Rousseau, J-J. (2010). *Essay on the origin of languages and writing related to music*. (J. T. Scoty, Ed. & Trans.). Lebanon, NH: University Press of New England.
- Rowlett, J. (2011). Communication systems with and without language. Lecture. JMU WRTC.
- Rudgley, R. (1999). *The Lost Civilizations of the Stone Age*. New York: Simon and Schuster.
- Ruhlen, M. (1994). *The origin of language: Tracing the evolution of the mother tongue*. New York: John Wiley and Sons.
- Sampson, G. (1979). What was transformational grammar? *Lingua*, 48, 355-78.
- Sampson, G. (1980a). *Schools of linguistics: competition and evolution*. New York: HarperCollins.
- Sampson, G. (1980b). Popperian language-acquisition undefeated. *British Journal for the Philosophy of Science*, 31, 63-67.
- Sampson, G. (1997) *Educating Eve: The "language instinct" debate*. New York: Bloomsbury.
- Sampson, G. (2001). *Empirical Linguistics*. New York: Bloomsbury.
- Sasahara, K. & Ikegami, T. (2007). Evolution of birdsong syntax by interjection communication. *Artificial Life*, 13, 259-277.
- Scharff, C., Haesler, S. (2004). An evolutionary perspective on FoxP2: strictly for the birds? *Current Opinions in Neurobiology* 15, 6, 694-703.
- Scheibel, A. B., Paul, L. A., Fried, I., Forsythe, A. B., Tomiyasu, U., Wechsler, A., Kao,



- A., Slotnick, J. (1985). Dendritic organization of the anterior speech area. *Experimental Neurology*, 87, 1, 109-117.
- Scholz, B. & Pullum, G. (2006). Irrational nativist exuberance. In R. J. Stainton (Ed.) *Contemporary Debates in Cognitive Science* (pp. 59-80). Malden, MA: Blackwell.
- Schore, A. N. (2010). The right-brain implicit self: A central mechanism of the psychotherapy change process. In J. Petrucelli (Ed.) *Knowing, Not-Knowing and Sort-of-Knowing: Psychoanalysis and the Experience of Uncertainty* (pp. 177-202). London: Karnac Books.
- Schulz, A. (1969). *The life of primates*. West Sussex, UK: Littlehampton Book Services.
- Schuessler, J. (2012). How do you say ‘disagreement’ in Pirahã? Retrieved from [nytimes.com/2012/03/22/books/a-new-book-and-film-about-rare-amazonian-language.html?pagewanted=all](http://nytimes.com/2012/03/22/books/a-new-book-and-film-about-rare-amazonian-language.html?pagewanted=all)
- Schwab, I. (2011). *Evolution’s witness: how eyes evolved*. New York: Oxford University Press.
- Schwarz, M. & Jersey, B. (Directors). (2009). *Fractals: The hidden dimension*. YouTube. Retrieved from [youtube.com/watch?v=s65DSz78jW4](http://youtube.com/watch?v=s65DSz78jW4)
- Schick, K. D. & Toth, N. (1993). *Making silent stones speak: Human evolution and the dawn of technology*. New York: Simon & Schuster.
- Sea otters, *Enhydra lutris*. (n.d.). MarineBio. Retrieved from [marinebio.org/species.asp?id=157](http://marinebio.org/species.asp?id=157)
- Seldon, H.L. (1981). Structure of human auditory cortex. I. Cytoarchitectonics and dendritic distributions. *Brain Research*. 229, 277-294.

- Seyfarth, R. M., Cheney, D. L., & Marler, P. (1980). Monkey responses to three different alarm calls: evidence of predator classification and semantic communication. *Science* 210: 801-803.
- Shapleske, J., Rossell, S. L., Woodruff, P. W. R., David, A. S. (1999). The planum temporale: a systematic, quantitative review of its structural, functional and clinical significance. *Brain Research Reviews*, 29, 26–49
- Shubin, N. (2008). *Your inner fish: A journey into the 3.5 billion-year history of the human body*. New York: Random House.
- Slack, G. (2007). I feel your pain: New proof of "mirror neurons" explains why we experience the grief and joy of others, and maybe why humans are altruistic. But don't call us Gandhi yet. Salon.com. Retrieved from [salon.com / news / feature / 2007 / 11 / 05 / mirror\\_neurons /](http://salon.com/news/feature/2007/11/05/mirror_neurons/)
- Smart crow uses cars to crack nuts in Akita, Japan near Senshu Park (2010). YouTube. Retrieved From [youtube.com / watch?v=NenEdSuL7QU](http://youtube.com/watch?v=NenEdSuL7QU)
- Spiteri, E., Konopka, G., Coppola, G., Bomar, J., Oldham, M., Ou, J., Vernes, SC., Fisher, S. E., Ren, B., Geschwind, D. H. (2007). Identification of the transcriptional targets of FoxP2, a gene linked to speech and language, in developing human brain. *American Journal of Human Genetics*, 81, 6, 1144-57.
- Stanovich, K. E., West, R. F., Toplak, M. E. (2010). Contaminated mindware: Thinking biases of the cognitive miser. *Rotman Magazine*, Winter, 16-21.
- Stanovich, K. E., West, R. F., Toplak, M. E. (2011). Individual differences as essential components of heuristics and biases research. In K. Mantelov, D. Over, & S.

- Elqayam (Eds.), *The science of reason* (pp. 355-396). New York: Psychology Press.
- Steyvers, M., Tenenbaum, J. B. (2005). The Large-Scale Structure of Semantic Networks: Statistical Analyses and a Model of Semantic Growth. *Cognitive Science*, 29, 41-78.
- Tallerman, M. (2007). Did our ancestors speak a holistic protolanguage? *Lingua*, 117, 3, 579-604.
- Ten Cate, C. (2008). Niko Tinbergen and the red patch on the herring gull's beak. *Animal Behaviour*, 77, 4, 785-794.
- Thagard, P. (2007). I feel your pain: Mirror neurons, empathy, and moral motivation. *Journal of Cognitive Science*, 8, 109-136.
- Thierry, G. & Price, C. J. (2006). Dissociating verbal and nonverbal conceptual processing in the human brain. *Journal of Cognitive Neuroscience*, 18:6, 1018-1028.
- Thiessen, D. D. (1995). *Bittersweet destiny: The stormy evolution of human behavior*. Piscataway: Transaction Publishers.
- Thomas, N. J. T. (2010). Representational Neglect. Stanford Encyclopedia of Philosophy. Retrieved from [plato.stanford.edu / entries / mental-imagery / representational-neglect.html](http://plato.stanford.edu/entries/mental-imagery/representational-neglect.html)
- Toga, A. W., Thompson, P. M. (2003). Mapping brain asymmetry. *Nature Reviews Neuroscience*, 4, 37-48.
- Törönen, P., Kolehmainen, M., Wong, G., Castrén, E. (1999). Analysis of gene expression data using self-organizing maps. *FEBS Letters*, 451, 21, 142-146.

- Tree of Knowledge System. (2008). Wikipedia. Retrieved from  
[en.wikipedia.org/wiki/Tree\\_of\\_Knowledge\\_System](http://en.wikipedia.org/wiki/Tree_of_Knowledge_System)
- Trivedi, B. (2004). Chimps shown using not just a tool but a “tool kit.” National Geographic News. Retrieved from  
[news.nationalgeographic.com/news/2004/10/1006\\_041006\\_chimps.html](http://news.nationalgeographic.com/news/2004/10/1006_041006_chimps.html)
- Tucker, D. M. (2002). Embodied meaning. In T. Givón & B. Malle (Eds.), *The evolution of language out of pre-language* (51-82). Philadelphia, PA: John Benjamins North America.
- Tuniz, C., Gillespie, R., Jones, C. (2009). *The bone readers: Science and politics in human origins research*. Walnut Creek, CA: Left Coast Press.
- Valentine, J. W. & Campbell, C. A. (1975). Genetic regulation and the fossil record: Evolution of the regulatory genome may underlie the rapid development of major animal groups. *American Scientist*, 63, 6, 673-680.
- Vallortigara, G. & Regolin, L. (2006). Animal brain lateralization: Cognitive, ontogenetic, and phylogenetic aspects. *Cognition, Brain, Behavior*, 10, 187–210.
- Vallortigara, G., Rogers, L. G., Bisazza, A. (1999). Possible evolutionary origins of brain lateralization. *Brain Research Reviews*, 30, 164-175.
- Varela, F., Lachaux, JP., Rodriguez, E., Martinerie, J. (2001). The brainweb: phase synchronization and large-scale integration. *National Review of Neuroscience*, 2, 4, 229-239.
- The Venus of Hohle Fels. (n.d.). Retrieved from [donsmaps.com/hohlefelsvenus.html](http://donsmaps.com/hohlefelsvenus.html)
- Venus of Lespugue. (2004). Retrieved from [en.wikipedia.org/wiki/Venus\\_of\\_Lespugue](http://en.wikipedia.org/wiki/Venus_of_Lespugue)
- Venus of Laussel. (2008). Retrieved from

arthistorypart1.blogspot.com/2008/01/venus-of-laussel-marquay-bas-relief-of.html

Venus of Willendorf. (2004). Retrieved from

en.wikipedia.org/w/index.php?title=Venus\_of\_Willendorf&offset=20110420042424&limit=500&action=history

Vernes, S. C., Spiteri, E., Nicod, J., Groszer, M., Taylor, J. M., Davies, K. E.,

Geschwind, D. H., Fisher, S. E. (2007). High-throughput analysis of promoter occupancy reveals direct neural targets of FoxP2, a gene mutated in speech and language disorders. *American Journal of Human Genetics*, 81, 6, 1232-50.

Viegas, J. (2010a). Neanderthals lived fast, died young. Discovery News. Retrieved from

news.discovery.com / history / neanderthals-aging-maturity-development.html

Viegas, J. (2010b). Prehistoric people ate each other, bones show. Discovery News.

Retrieved from

news.discovery.com/history/cannibalism-early-humans-bones-101213.html

Vigneau, M., Beaucousin, V., Hervé, P. Y., Jobard, G., Petit, L., Crivello, F., Mellet, E.,

Zago, L., Mazoyer, B., Tzourio-Mazoyer, N. (2011). What is right-hemisphere contribution to phonological, lexico-semantic, and sentence processing? Insights from a meta-analysis. *Neuroimage*, 54, 1, 577-93.

Vygotsky, L. (1986). *Thought and language*. Cambridge, MA: MIT Press.

Wada, J. (1949). A new method for the determination of the side of cerebral speech

dominance: A preliminary report of the intra-carotid injection of sodium amytal in man. *Igaku to Seibutsugaki*, 14, 221-222.

Wallace, A.R. (N.D.). A personal letter to Isaac Bickerstaffe regarding spirals (reprinted

by permission in the latter's article "Some Principles of Growth and Beauty" on page 946 of the 11 May 1912 number of *The Field*). Retrieved from  
[people.wku.edu / charles.smith / wallace / S695.htm](http://people.wku.edu/charles.smith/wallace/S695.htm)

Weak Evidence for Word-Order Universals: Language Not as "Innate" as Thought?

(2011). ScienceDaily. Retrieved from

[sciencedaily.com / releases / 2011 / 04 / 110414065107.htm](http://sciencedaily.com/releases/2011/04/110414065107.htm)

Webb, D. M., Zhang, J. (2005). FoxP2 in song-learning birds and vocal-learning mammals. *Journal of Heredity*, 96, 3, 212-6.

Weber, G. (2008). Toba Volcano 5: Through the Bottleneck. Retrieved from

[andaman.org/BOOK/originals/Weber-Toba/ch5\\_bottleneck/textr5.htm](http://andaman.org/BOOK/originals/Weber-Toba/ch5_bottleneck/textr5.htm)

Wernicke, C. C. (1874). *Der aphasische symptomkomplex*. Breslau: Franck & Weigart.

Wilber, Ken. (1995). *Sex, ecology, and spirituality: The spirit of evolution*. Boston:

Shambhala Publications.

Wilber, Ken. (1981). *Up from Eden: A transpersonal view of human evolution*. New

York: Anchor Books.

Wildgen, W. (2008). Semiotic Hypercycles Driving the Evolution of Language.

*Axiomathes*, 18, 1, 91-116.

Winkler, R. (2002). Crow Makes Wire Hook to Get Food. National Geographic News.

Retrieved from

[news.nationalgeographic.com / news / 2002 / 08 / 0808\\_020808\\_crow.html](http://news.nationalgeographic.com/news/2002/08/0808_020808_crow.html)

Wray, A. (2000). Holistic utterances in protolanguage: the link from primates to humans.

In Chris Knight, Michael Studdert-Kennedy, and James R. Hurford (Eds.) *The evolutionary emergence of language: Social function and the origins of*

*linguistic form*. Cambridge, MA: Cambridge University Press.

Wray, A. (1998). Protolanguage as a holistic system for social interaction. *Language and Communication*, 18, 1, 47-67.

Yeo, R. (1993). *Defining science: William Whewell, natural knowledge, and public debate in Victorian Britain*. Cambridge, UK: Cambridge University Press.

Zilles, K., Dabringhaus, A., Geyer, S., Amunts, K., Qu, M., Scheicher, A., Gilissen, E., Schlang, G. & Steinmetz, H. (1996). Structural asymmetries in the human forebrain and the forebrain of non-human primates and rats. *Neuroscience and Biobehavioral Reviews*, 20, 593-605.

Zimmer, C. (2011). The language fossils buried in every cell of your body. Retrieved from [discovermagazine.com / 2011 / oct / 08-the-brain-language-fossils-buried-in-your-cells / article\\_view?b\\_start:int=1&-C=](http://discovermagazine.com/2011/oct/08-the-brain-language-fossils-buried-in-your-cells/article_view?b_start:int=1&-C=)