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From Pattern Language to Pattern Literacy: the Biosemiotic Underpinnings of "Patterning" and "Languaging".

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The key inquiry in this paper, to move the discussion forward on innovation and the future of Pattern Language, is about the relationship between patterns (and more precisely our capacities as humans to recognize and use patterns, aka 'patterning') and language (both in its form and in the processes involved, aka 'languaging'), in order to assess how each can be leveraged in understanding and communication, within and across domains. I dive here deep into the biological and bio-semiotic underpinnings of patterning and languaging, seeking to make a clear distinction between them. I explore the nature and "timeless properties" of patterns as signs and their role in the emergence of human cognition and language from an evolutionary perspective. In particular I examine their involvement in 'habit taking' and in the coordination of unselfconscious action and creative processes, such as evoked by Christopher Alexander.

This paper does not provide solutions or answers, it sets a foundation to show how the development of a pattern literacy around patterns seen as basic units for the coordination of action and the understanding of the world, beyond domain knowledge and linguistic divides, could bring new possibilities for the study and orientation of socio-ecological and socio-technological systems. This will open up opportunities to further explore how pattern languages could be understood and applied towards this objective, in order to actually realize their potential as lingua franca.

Categories and Subject Descriptors: **• Human-centered computing ~ Collaborative and social computing • Human-centered computing ~ Visualization** • Human-centered computing ~ Human computer interaction (HCI) **• Theory of computation ~ Semantics and reasoning • Computing methodologies ~ Knowledge representation and reasoning • Computing methodologies ~ Philosophical/theoretical foundations of artificial intelligence • Computing methodologies ~ Modeling and simulation**

General Terms: Human Factors, Design, Languages, Theory, Experimentation

Additional Key Words and Phrases: pattern literacy, semiotics, complex systems, pattern language, complex adaptive modeling, boundary objects, participatory inquiry, action research

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INTRODUCTION

This paper lays a foundation for earlier work where I provided some directions along which patterns and pattern languages could evolve to support systemic inquiry and design.

Since 2013, I have been reflecting on how pattern languages could be leveraged for systemic understanding and intervention, at the crossroads of Pattern Language and Systems Science/Systems Thinking practices and communities. I started exploring the idea of systemic pattern languages that could help navigate complexity, and enable adaptive modeling. I also introduced the idea of a Pattern Literacy, moving beyond Pattern Language, that could support Systems Literacy[1]. Patterns, from a systems science perspective, can be seen as a manifestation of systems at work -not only information systems, but broader systems, such as socio-technological systems (i.e. engineered systems 'in use') and socio environmental systems (humans and socio-technological systems in interaction with the environment)-, and therefore they are key to understanding how systems work and how they can be designed or changed. General Systems Theory's *isomorphisms*[2], which are forms that are meant to be found across disciplines to characterize broader systems processes, are nothing else than patterns, waiting to be discovered.

At Plop 2018, I raised[3] the question whether patterns and pattern languages were 'systemic' enough, in their configuration and the way they were used, to support systemic inquiry and design. I proposed to consider patterns more assertively in their broad definition, as mediators between objects or events in the world and the ways we represent and interpret them[4]. I examined why pattern languages were not so 'fit' for systemic inquiry and design, and suggested ways to configure them so that they became more so. The objective was to better focus on their observational and communicative aspects in the context of systemic inquiry and design, and to enable coordination of action across identity and knowledge boundaries, in order to better address the challenges[5] our societies are faced with. Christopher Alexander himself hoped that pattern languages would help to make the world a better place, but he recognized the failure of this endeavor[6].

Such questions have been raised in the Pattern Language community these past years. In particular Manns and Yoder[7] underlined the need to focus more on the process and community aspects involved in larger systemic processes, beyond the structural attributes of patterns. In a convergent way, Rebecca Wirfs-Brock has been bringing forward the role of patterns as heuristics for complex decision making and moving complex designs forward[8]. She stressed the need to enhance the usability and sustain the use of patterns and pattern languages in uncertain and changing conditions.

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[1] Presented at Plop, Purplsoc and ISSS in 2016 and 2017. Finidori, H. (2016). *Patterns That Connect: Exploring The Potential Of Patterns And Pattern Languages In Systemic Interventions Towards Realizing Sustainable Futures*. Paper presented at the 60th Annual Meeting of the International Society for the Systems Sciences - "Realizing Sustainable Futures", University of Colorado; Finidori, H., Borghini, S., & Henfrey, T. (2016). Towards a Fourth Generation Pattern Language: Patterns as Epistemic Threads for Systemic Orientation. In P. Baumgartner, T. Gruber-Muecke, & R. Sickinger (Eds.), *PURPLSOC. Pursuit of Pattern Languages for Societal Change. Designing Lively Scenarios in Various Fields.* (pp. 62-86). Berlin: epubli; Finidori, H., & Tuddenham, P. (2017). *Pattern Literacy in Support of Systems Literacy - An approach from a Pattern Language perspective.* Paper presented at the 24th Conference on Pattern Languages of Programs (PLoP), Vancouver (October 2017).

[2] Bertalanffy, L. v. (1968). *General System Theory*. New York: George Brazilier.

[3] Finidori, H. (2018). Configuring Patterns and Pattern Languages for Systemic Inquiry and Design. Paper presented at the Conf. on Pattern Lang. of Prog. 25, Portland, OR.

[4] Something Kohls had started to outline in his thesis, without pushing the idea further

[5] One can think, at the societal level, of health or addiction issues, criminality or conflicts, financial volatility, urban development, climate change and its consequences such as migration and droughts, or risks inherent to the development of artificial intelligence, cyber criminality or the development of big data exploitation, to name a few.

[6] Alexander, C. (1996). "Patterns in Architecture" presented at OOPSLA '96, October 8, San Jose, California. <bit.ly/1LnXvyP>[Retrieved 15 September 2015]

[7] At Plop 2017, Manns, M.L., Yoder, J.W., (2017). Patterns as Structure, Process and Community. HILLSIDE Proc. of Conf. on Pattern Lang. of Prog. 24 (October 2017), 22 pages.

[8] At Plop 2017, 2018 and 2019. Wirfs-Brock, R. (2017). Are Software Patterns Simply a Handy Way to Package Design Heuristics? 24th Conference on Pattern Languages of Programming (PLoP), PLoP 2017, Oct 23-25 2017, 15 pages; Wirfs-Brock, R. (2018). Traces, tracks, trails, and paths: An Exploration of Software Design Patterns and other Lesser Known Heuristics 25th Conference on Pattern Languages of Programming (PLoP), PLoP 2018, Oct 24-26 2018, 20 pages; Wirfs-Brock, R. and Kohls, C. (2019) Elephants, Patterns, and Heuristics 26th Conference on Pattern Languages of Programming (PLoP), PLoP 2019, Oct 7-10 2019, 15 pages.

We are indeed faced today with an ever-increasing complexity which involves a high interdependency of multidimensional factors to make sense of. The key difficulty is to coordinate action across knowledge, language and culture boundaries. This ever-increasing complexity requires us to look beyond the business as usual of rhetoric and our various talents for analyzing and synthesizing problems, and solving them. These are mainly based on language and symbolic reference, i.e. 'languaging'… an exercise where language focuses on itself in order to 'perfect' the accuracy or exactness of concepts conveyed, rather than on what constitutes 'shared' reality and experience. Focusing on language in itself is not enough nor quite helpful to cut across boundaries. I suggest here that 'patterning' as a process, by which living organisms recognize and use patterns, and which operates at a deeper level of cognition in making sense of organization and experience, is distinct from 'languaging'.

To move discussions forward on innovation and the future of Pattern Language, I explore in the present paper the relationship between 'patterning' and 'languaging', in order to better assess how each can be leveraged in understanding and communication, within and across domains.

This paper does not provide solutions or answers, rather, it sets a foundation to show how the development of a pattern literacy around patterns seen as basic units for the coordination of action and the understanding of the world, beyond domain knowledge and linguistic divides, could bring new possibilities for the study and orientation of socio-ecological and socio-technological systems. This will open up opportunities to further explore how pattern languages could be understood and applied towards this objective, in order to actually realize their potential as lingua franca. Ultimately, it is about finding out how pattern languages can help do more 'patterning', and less 'languaging'.

In the first section of this paper, I briefly describe the challenges we are faced with from a cognition and language perspective. In the second section, I examine how patterns as signs are key to life processes and biological exchanges, and what looking at evolution from a sign process and communication perspective rather than a strict survival and exchange of matter and energy perspective has brought to the knowledge of evolution. In the third section, I examine the co-evolution of cognition and language, as an evolutionary continuum, resulting from a history of micro- and macro-evolutions built upon the 'timeless' properties of patterns and their interpretation. In the fourth section, I examine the properties of human language and I draw the functional differences between patterning and languaging on the basis of Peircean distinctions of sign processes and Maturana's biology of cognition and language. I finally examine the divide between nature and culture, and the challenges it entails, and I propose directions for working at more elementary levels on patterns as basic components of sense-making and inquiry, so as to recreate our observational languages[9] in order to address systemic issues from different perspectives.

This work is part of a broader research in the context of my PhD on Pattern Literacy in Support of Systems Inquiry and Design.

1. - THE CHALLENGES WE ARE FACED WITH

There are several forms of complexity to deal with. One is detail complexity, characterized by an ever-increasing number of variables to compute and increasingly precise knowledge to master, which is produced at a fast pace. This type of complexity, which is merely 'complicated', is 'easily' solved with a greater degree of computer power, specialization and expertise. It is typically the type of complexity Pattern Languages [of Programs] seek to address, capturing the specialized knowledge of communities of practice, to make them more effective, sometimes creating bridges between specific branches or nuances of a shared practice and experience. The other kind of complexity is dynamic complexity, where factors of different nature are intertwined, with a significant degree of uncertainty and unpredictability in their reproducibility. This form of complexity is characterized by a high interdependency of multidimensional factors to make sense of, which involves bringing together a great number of radically different types of expertise, and the capacity to integrate them[10].

[9] Here I refer to comments of Critical Systems Thinker Ulrich, who saw Alexander's Timeless Way as a call for this 're-creation'. I show in my Plop 2018 paper that this has not quite been fulfilled.

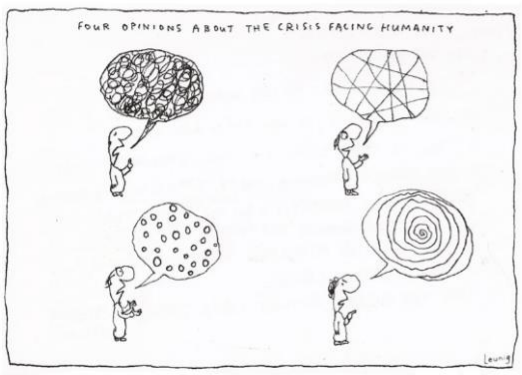
[10] Finidori, H. (2016). Patterns That Connect: Exploring The Potential Of Patterns And Pattern Languages In Systemic Interventions Towards Realizing Sustainable Futures. Paper presented at the 60th Annual Meeting of the International Society for the Systems Sciences - "Realizing Sustainable Futures", University of Colorado.

Pattern Languages have often been proposed as Lingua Franca[11] for such an endeavor. How they can be developed and used in contexts where these differences may seem irreconcilable is a key question. Even within cohesive domains of practice, Rebecca Wirfs-Brock[12] challenges the actual ability that pattern language users have to find and assess the right patterns and patterns languages to use, and the levels to which to apply them in uncertain and changing conditions. Taking patterns of software programming as an example, she claims that the many pattern collections and pattern languages available, without effective ways to curate them, may become overwhelming, which may put the scaling and sustainability of pattern language practice into question.

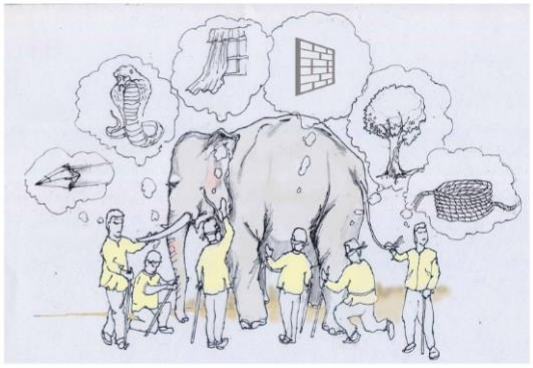
The challenge is that there often is no higher order vantage point to look from to coordinate the variety of expertise available in relation to the intricacy and possibly volatile nature of the problematiques in focus. Knowledge likely to be applied isn't curated and integrated fast enough, and there aren't many possible ways to do so. Pattern languages for architecture or human action are grounded in place or community of practice, so successful applications may be found there. With systemic problem solving or design, however, there is usually no co-location or easily trackable co-occurrence of experience that allows to ground the coherence of a response.

The construction of shared languages and understandings which transcend cultural and knowledge differences have not proven effective to date. Entangled issues that require transdisciplinary and systemic knowledge are often assumed to be solved through dialogue or discourse -i.e. languaging. It is commonplace to see parties trying to agree and even to fabricate a common ground at the onset, prior to discussion, with shared visions, values, vocabularies, or in short, by extracting or creating common reference. But the key foundations of incommunicability and incommensurability in language and paradigm, and perspective / worldviews which accompany the integration of different forms of knowledge are often overlooked. Mainly, in my opinion, because solutions are sought through a "culture" angle rather than a "nature" one[13], using languaging rather than patterning.

Reconciling and communicating across languages or paradigms is not a new topic. Incommunicability and difference in perspectives have been illustrated in several ways, using different types of metaphors or analogies. The Tower of Babel Myth is one of them, which presents language and its confusion as a curse rather than a blessing.



Four opinions about the crisis facing Humanity



The Fable of the Elephant

Discussions around the increasing political and identity polarization we are currently experiencing, which is a contemporary illustration of the Babel Myth, seem to show that divides are amplifying.

[11] Erickson, T. (2000). Lingua Francas for Design- Sacred Places and Pattern Languages (paper for DIS 2000). Paper presented at the DIS 2010; Reiners, R. (2013). An Evolving Pattern Library for Collaborative Project Documentation. (PhD), RWTH Aachen University.
[12] Wirfs-Brock (2017), ibid.
[13] The nature vs culture debate in anthropology opposes what is socially constructed to what is biologically acquired, or in other words the innate and the nurtured. The debate is particularly ferocious among linguists about language.

On April 23, 2019, Bruno Latour tweeted[14]:

> "Analysts are still scratching their heads about the brutalisation of politics, the spread of fake news and the lack of search for compromise and common ground. But they miss the obvious cause: there is no "common ground", people no longer live on the same planet."[15]

Politics is a case in point. This phenomenon of increased fragmentation and entrenchment can be found in numerous contexts, including Science[16]. It is not 'just' a question of language and translation, or finding the 'better truth' or vantage point, "aligning" worldviews or making a "synthesis". The Fable of the Elephant shows how perceived reality is context or perspective dependent. Fragmentation in language, and culture which comes with it, add to the fragmentation in knowledge.

The common mistake made by trying to 'talk each other into' alignment or shared visions, values or languages, comes from the view that language can describe an external world as well as internal states that everyone can refer to[17]. This view tends to conflate language as the unique human-wide communication capability, innately acquired through evolution, with language as a system of signs, culturally acquired through shared experience within shared contexts or milieus, available as many instances of the former[18]. It assumes that by focusing on language itself as a mode of consensual coordination -languaging as per Maturana[19]-, a sign system and commensurate systems of values and an ongoing tacit understanding, can be opportunistically constructed to reflect a common shared perceptual reality. Such endeavor works quite effectively within cohesive contexts / milieus of shared experience, and can work temporarily across boundaries. It usually doesn't 'stick' however across boundaries because there is no grounding in shared experience, and little shared history of practice and collective habit taking to make coordination effective and persistent in the long run.

In addition, a desire to collaborate across disciplines or domains of interaction does not imply a desire to unify these and align visions, pathways and priorities, to necessarily reach a consensus. Forms of agency / action logics are not interchangeable[20].

How different sign and interpretation systems can be made complementary and how they can be connected and made coherent without local loss of identity and effectiveness are the questions I will try to address in this paper.

To answer these questions, I dive deeper into the biological and bio-semiotic underpinnings of patterning and languaging, seeking to make a clear distinction between them and to understand how each can be leveraged in communication within and across domains. I explore the nature and "timeless properties" of patterns as signs and their role in the emergence of human cognition and language from an evolutionary perspective. In particular I examine their involvement in 'habit taking' and in the coordination of unselfconscious action and creative processes, such as evoked by Christopher Alexander[21]. The focus is essentially on the 'observational' and 'inquiry' aspects of patterns [22].

The fact that patterns, in their extended definition, are omnipresent should not deter us and lead us to think that if everything is a pattern, nothing actually is… on the contrary. I will show how patterns seen as signs and basic

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[14] https://twitter.com/BrunoLatourAIME/status/1120939140923760641

[15] Since I wrote the first draft of this paper in April 2019, we have seen how politics became even increasingly brutal, and how planets have been diverging further. This statement was prescient!

[16] The broadening divide even in the scientific assessment of the Covid19 pandemic is another illustration.

[17] Winograd, T., and Flores, F. (1987). Understanding Computers and Cognition, Addison Wesley, New York; Mingers, J. (1991). The Cognitive Theories of Maturana and Varela. Systems Practice, 4(4), 319-338.

[18] This statement applicable to natural language, as I intend here, is also valid for formal or disciplinary languages, such as mathematics or other modeling languages.

[19] Maturana, H. R. (1988). Reality: The Search for Objectivity or the Quest for a Compelling Argument. The Irish Journal of Psychology, 9(1), 25-82.

[20] Finidori & al (2016). Towards a 4th generation Pattern Language…Ibid

[21] Alexander, C. (1964). Notes on the synthesis of form. London: Oxford University Press. p.33. Alexander refers to the unselfconscious ways of vernacular cultures where "there is little thought about architecture or design as such"

[22] As opposed to patterns as tools for intentional design

units for the coordination of action can be used for the study of living systems[23] and for providing insights on ways to understand the world and design sustainable[24] systems.

The following two sections may seem quite remote from the everyday concerns of pattern writers and users, but I believe this foundational knowledge is essential to understanding how to better bring patterns and pattern languages to solving systemic issues.

2. SIGNS AT THE CENTER OF LIFE PROCESSES AND EVOLUTION

> *"The most pronounced feature of organic evolution is not the creation of a multiplicity of amazing morphological structures, but the general expansion of 'semiotic freedom', that is to say the increase in richness or 'depth' of meaning that can be communicated"*
>
> Hoffmeyer[25]

2.1 Why look at patterns from a biosemiotic perspective?

Signs are the basic units of life[26], and the basic units for the study of living systems[27].

Biology is not only about the organization of molecules and physical exchange or chemical transformation of energy and matter[28]. All living things whether cells, fungi, plants, animals, or humans, and more broadly, all self-organizing systems[29], whether socio-environmental and socio-technological, are sign producers and interpreters. These sign processes constitute semiosis.

Hoffmeyer describes a living system as a "sophisticated network of semiotic controls whereby biochemical, physiological and behavioral processes become tuned to the needs of the system across various levels"[30], and I will add scales. Even the simplest systems possess real semiotic competences, not only the language speaking self-conscious human beings that we are. Their self-organizing cooperative processes are semiotic and communicative[31].

All organisms "create, understand, act upon, exchange and, ultimately, know the world and make their livings in it through the use of signs"[32]. Cognition is involved here in more or less complex forms. As a biological phenomenon, it manifests through "effective action or successful behavior"[33]. It is what takes place in living systems so they can "operate effectively and successfully in a given domain". Maturana defines cognition as coordination of action. Semiosis plays a key role in this coordination.[34]

Processes, which involve signals as mediators ensuring 'optimal performance of organisms' via interaction with cues present in dynamic situations[35], are characterized as semiotic. Hoffmeyer suggests that organisms that are

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[23] Living systems should be understood here as socio-environmental systems, which encompass biological systems and social systems in interaction. Alexander defines living structures, not as structures of living creatures, but as the character of what we perceive as 'nature': the general morphological character which natural phenomena have in common. NOO Book2, p18.
[24] I define sustainable systems as systems that are viable and do not produce harmful externalities or unintended consequences.
[25] Hoffmeyer, J. (1996). Signs of Meaning in the Universe. Bloomington: Indiana University Press. p.61
[26] Hoffmeyer, J. (1995). The semiotic body-mind. In Tasca, N. (ed.), *Essays in Honor of Thomas A. Sebeok*, 367–383.
[27] Brier, S. (2006). Biosemiotics. *Encyclopedia of Language & Linguistics,* 31–40.
[28] Hoffmeyer J. (2008) Semiotic Scaffolding Of Living Systems. In: Barbieri M. (eds) Introduction to Biosemiotics. Springer, Dordrecht
[29] As long as they involve undeterministic parts -such as human systems.
[30] Hoffmeyer ibid p.1. See also Pattee, H. H. (1996). The Physics of Symbols and the Evolution of Semiotic Controls. Paper presented at the Workshop on Control Mechanisms for Complex Systems: Issues of Measurement and Semiotic Analysis, Las Cruces, New Mexico.
[31] Brier, S., Donacheva, A., Fuchs, C., Hofkirchner, W., & Stockinger, G. (2004). Towards a New Foundation of Information-, Cognitive- and Communication-Science. Paper presented at the Fuschl Conversations: Foundations of Information Science (IFSR).
[32] Favareau, D. F. (2015). Creation of the relevant next: How living systems capture the power of the adjacent possible through sign use. Prog Biophys Mol Biol, 119(3), 588-601 - quote p.593, referring to Peirce.
[33] Maturana, H. R. (1978). Cognition. In P. M. Hejl, W. K. Köck, & G. Roth (Eds.), Wahrnehmung und Kommunikation (pp. 29-49). Frankfurt: Peter Lang. p30
[34] Surprisingly there is little connection between the work of biosemioticians and the work of Maturana and his colleagues and followers.
[35] Hoffmeyer J. (2008), ibid

more able to interpret and create a variety of 'cues' in their environment have an evolutionary advantage.

Sebeok who studied communication in animals defines semiosis as the "capacity of a species to produce and comprehend the specific types of models it requires for processing and codifying perceptual input in its own way."[36]

The models Sebeok refers to I call patterns, the processing and codifying of perceptual input I call patterning, and the capacity to do so I call pattern literacy. Semiosis can be understood in this context as a multilayered and multidimensional pattern creation and 'pattern recognition' process which enables an organism's effective cognitive operation.

The question we can ask ourselves as humans is whether we currently leverage this semiotic capacity at its full potential at the systemic level.

The study of semiosis or sign processes has been constituted as a discipline called semiotics, which broadly comprises two schools distinguished by their position on the extent of the field of application of semiosis:

- Saussure and the structuralists[37], or the European school, limit semiosis to human language and linguistics, where the sign is necessarily part of a discourse and the product of a set of cultural rules or conventions. This school does not recognize signs that are not self-consciously intentional (such as emotional composure / gesture, pheromone / hormone, body stigmata / rash etc).

- Peircean semiotics, or the American school, on the other hand, recognize signification of non-intentional signs between humans and other living beings, among other living beings, as well as within and among cells and molecules, via sensorimotor elements and signs at molecular scales.

Biosemiotics, which can be seen as a branch of Peircean semiotics, anchors the process of semiosis beyond the divide between humans and the rest of the biosphere[38], upstream in evolutionary terms of human language and social communication. It studies sign processes in their embodied cognition dimension.

I examine in this paper the processes of patterning and languaging, and their outputs of pattern and language systems from a Peircean biosemiotic perspective. This allows to take an evolutionary perspective in which the human species is part of a continuum, and not a Deus ex-Machina, coming all equipped with extraordinary features.

2.2 Semiosis at the basis of life and evolution

With Peircean semiotics, a mediator is added to Saussure's signified/signifier association, bringing the 'observer' or 'agent' into the sign relationship. More than the study of sign systems and sign relations, Peircean semiotics focuses on sign processes which relate a sign system to cognition and action or behavior 'in the world'. The mediator - i.e. *interpretant,* in Peircean terms, absent in Saussure- is formed as a response triggered by the measurement or recognition of a signal or perturbation - i.e. *sign vehicle* or *representamen* in Peircean terms, signifier in Saussure-, as representation / expression or manifestation of a phenomenon or event - i.e. *object* in Peircean terms, signified in Saussure-.

The signs referred to here are patterns, as a form or processual instruction that triggers a reaction on another organism, generating other signs or patterns. They are the forms of perturbations that an organism can structurally operate with. Patterns can thus be seen as configurations of signals that an organism is structurally likely to cognize and recognize, and to act upon. Patterning is the capacity to recognize or generate such patterns.

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[36] Sebeok, T. A. (2001). Signs: An introduction to semiotics (2nd ed.). Toronto: University of Toronto Press; quoted by Kull, K. (2009). Biosemiotics: To Know, What Life Knows. Cybernetics And Human Knowing, 16(1-2), 81-88.
[37] Such as Eco, Foucault, Barthes, etc...
[38] As demonstrated in the work of Uexküll, Sebeok, Brier.

Every living organism has sensory surfaces (sensors) that are coupled with motor surfaces, capable of producing movement or effects (effectors). It is the organism's structure that specifies the perturbations an organism can operate under, and the changes it can be submitted to, while maintaining its identity and the integrity of its organization as evolution and history follow their course[39]. One can compare this to Alexander's concept of structure-preserving transformation[40]. The medium/perturbations themselves do not 'specify' nor 'order' or 'determine' changes in an organism, but they 'select' the pathways that a change can follow[41]. In other words, the medium determines the constraints under which an organism can continue to operate and undergo structural changes without disintegrating, and it makes the organism proactive and anticipatory so as to 'pre-structure' responses. The pathways and possible responses to perturbation are mediated by the semiotic process, with the degree of 'semiotic freedom'[42] it has acquired through evolution.

Semiosis is at play in a bird's mating dance to find its reproduction partner, in the tracks left on the ground by an ant to orient other colony members towards food sources, or in the concentration of sugar in the environment that sets an E.coli bacterium into motion. All these processes are the result of an 'inbuilt' anticipatory capacity, based on the generation and interpretation of signs at local contexts[43]. Signals may include sounds, odors, movements, colors, electric fields, waves of any kind, chemical signals, touch, etc. Peirce identified three categories of sign-relations: iconic, indexical and symbolic, that I will come back to later in this paper.

Sensor-effector coupling can occur within a boundary via symbiosis, or across boundaries via semiosis. Symbiosis and semiosis can be seen as one and the same process[44].

In single cells, the correlation occurs through metabolic transformations within the cell itself (first order coupling). Cells interpret molecules or changes in chemical substances as signs. For example, the rising level of oxygen in the blood triggers a heart response. An interpretant is formed as a context sensitive response to an event, and is influenced by the history the involved entity has gone through. This latter phenomenon can be characterized as learning. The most illustrative example is the nerve cell whose response changes even when submitted to the same event. In particular retinal ganglia in the eye have sophisticated pattern recognition capability which can anticipate and change responses dynamically[45].

Multicellular organisms have a variety of sensors and effectors co-operating among their parts (second order coupling). When the variety, distance, and possibilities for correlation are too broad, sensorimotor activity is mediated by a nervous system, which manages and prioritizes contradictory impulses and potential conflicts. The flatworm is the simplest organism with a nervous system.

Dynamic complexity arises when organisms with nervous systems enter in coupling with each other (individuals within or across species, societies, ecologies, socio-environmental and socio-technological[46] systems) resulting in recurrences and co-adaptation (third order coupling). Coordination of independent behavior in such third order couplings[47] takes place via a variety of interactions depending on sensory and motor "organs" of the organisms involved which each may be responsive only to specific signs or patterns: chemical, visual, auditory, gestural/postural, tactile etc… These patterns can be learned or instinctive. They result in reciprocal coupling and mutually triggered coordinated behavior that shape species, and the social entities that form themselves within them.

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[39] Maturana 1978, ibid; Brier et al. 2004, ibid.

[40] Alexander, C. (2002). The Nature of Order. Berkeley: The Center for Environmental Structure. Book 2, ch. 2 & 3.

[41] Maturana, ibid. Would that be akin to Alexander's unfolding of wholeness? The whole determines the shape of the parts? Starting from the whole to build the parts?

[42] Hoffmeyer, J. (2010). Semiotic freedom: an emerging force. In P. C. W. Davies & N. H. Gregersen (Eds.), Information and the Nature of Reality: From Physics to Metaphysics. (pp. 185-204). Cambridge, USA: Cambridge University Press.

[43] Hofmeyer, J (2008), Ibid.

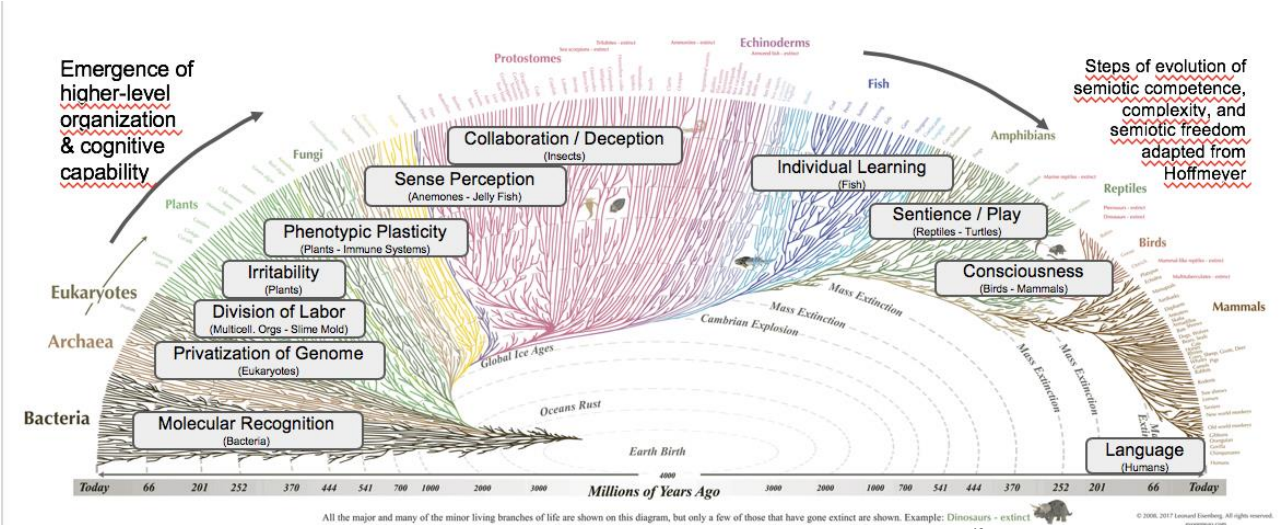
[44] Brier, S. (2006). Ibid.

[45] Hoffmeyer, J. (2008). Ibid; Schwartz, G., & Berry, M. J., 2nd. (2008). Sophisticated temporal pattern recognition in retinal ganglion cells. J Neurophysiol, 99(4)

[46] A socio-technological system can be understood as an extension of human cognitive and physical capability via technology.

[47] There is no 'natural' or a priori central nervous system to 'organize' things in such third order systems. There is an abundant literature on how this may or not be effectively constructed...

Hoffmeyer and Stjernfelt[48] see the complexification of these sensor-effector couplings as a result of evolutionary dynamics enabled by semiotic processes. They distinguished 11 steps of evolution of semiotic complexity, characterized by the acquisition of new semiotic competence and freedom, which correspond to the emergence of higher levels of organization and cognitive capability (See adaptation by the author of these steps onto Eisenberg's Tree of Life on Figure 1).



Positioning of Hoffmeyer'& Stjernfelt's 11 steps onto Leonard's Eisenberg's Tree of Knowledge[49]. Adaptation by H. Finidori.

Figure 1: The evolution of cognitive capability and semiotic competence

Evolution is a process that saw the aggregation of single-cell and cooperating organisms into meta-cellular / more complex organisms creating new "lineages" operating with phenomenologies and sign systems, different than that of their component organisms, and the lineages that came before them. It is based on the development of semiotic possibilities or 'semiotic freedom', providing more choice for interpretation, and thus more choice for action. Natural selection can be seen as a result of this process. Organisms that are more able to generate and act upon multiple possibilities have an evolutionary advantage[50].

2.3 Actualization of possibilities and habit taking, key to adaptation

Semiosis is a learning process at play at different developmental and evolutionary time scales that ultimately shapes the structure of organisms. I examine here how semiosis operates, its role in adaptation and evolution, and the mechanisms by which semiotic competence, complexity and freedom are enhanced.

While living organisms are powered by metabolic energy, the coordination of behaviors they involve requires intricate systems of dynamic semiotic interactions. Signs come 'in between' energy and matter to orient behavior. At the most basic level this orientation ensures survival (food, reproduction, escape from predators). Adaptation, which operates through actualization of possibilities and habit-taking can be seen as a result of this process[51].

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[48] Hoffmeyer, J., & Stjernfelt, F. (2015). The Great Chain of Semiosis. Investigating the Steps in the Evolution of Semiotic Competence. Biosemiotics, 9(1), 7-29

[49] https://www.evogeneao.com/en/learn/tree-of-life ♥ 2008-2017 Leonard Eisenberg. All rights reserved

[50] Hoffmeyer, J. (2008). Ibid.

[51] Hoffmeyer, J. (2008). Ibid.

For Favareau[52], the semiotic process by which physical structures or events are transformed into signs plays a great role in moving to the next adjacent possible[53], and ultimately in adapting and evolving via a recursive process which in turn transforms physical structures. Favareau summarizes the sign process from a systems perspective as follows: The reception of a signal is a change (event) that sets up a number of possibilities for action (states for the system to move into next). The 'interpretant' is the process of measurement[54] which results in the actualization of one of several emergent possibilities and provides a signal for new acts of semiosis. The change in the system produced by one sign relation thus becomes the sign vehicle for a next sign relation. Signs prefigure possibilities, which are actualized or not. They are the manifestation of what comes in the present moment that can be actualized, in a relevant[55] and not just deterministic or stochastic way, through the negotiation of "simultaneous yet mutually exclusive action-taking possibilities"[56], making perception and action mutually constitutive. Through semiosis, organisms are able to remember and anticipate, and to communicate within the possibilities allowed by their structure. Hoffmeyer calls *semiotic freedom* the ranges of response possibilities or degree of choice a living system has within the constraints set by its given structure. By actualizing possibilities, organisms learn, individually and collectively.

The process enables the recursive reshaping of the immediately next adjacent possible that resembles improvisational comedy[57]: a moment to moment enfolding that does not follow predictable laws, but may be shaped by habit taking, as a result of the cumulative effects of actualizing possibilities through interpretation of signs.

Hoffmeyer sees habit taking as a recurrent act of interpretation; of formation of a mediating link between one regularity and another, where perception gives rise to possibilities which give rise to actualizations which give rise to habits - aka patterns, pushing the limits of possibilities further. "Habituation, in other words, is semiosis (sign activity) in its most general sense..." says Hoffmeyer[58]. Bateson evokes "internal patterning or redundancy" in the perception of certain events and objects which make other events and objects predictable to an observer (human or other organism), and suggest that the concept of redundancy could be a partial synonym of 'meaning'[59]. Such cumulative actualizations arising from emergent interactions, in turn generate higher order systems dynamics which channel "immediate-next-possibility" into prefigured possible pathways, exerting a top down organizing influence on lower order constituents[60]. This typically is a cybernetic process.

With Peirce & Kauffman, laws or habits are 'enabling' not 'entailing', fostering the 'propagation' of regularities that may thus be 'irreversibly canalized'[61]. These habits become patterns themselves, that shape further action.

The intricate networks of semiotic interactions that mediate and coordinate behavior can be seen as scaffolds[62] which ensure an organism's activity is 'tuned' to its needs. Semiotic processes are thus directly linked to the

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[52] Favareau, D. F. (2015). Creation of the relevant next: How living systems capture the power of the adjacent possible through sign use. Prog Biophys Mol Biol, 119(3)

[53] Favareau here refers to Stuart Kauffman's concept of adjacent possibles which he believes applies at the scales of biology and social systems altogether. Steven Johnson in the NYT article "the genius of the tinkerer" provides the most compelling definition of Kauffman's Adjacent possible: "The adjacent possible is a kind of shadow future, hovering on the edges of the present state of things, a map of all the ways in which the present can reinvent itself…" it "captures both the limits and the creative potential of change and innovation" ..."The strange and beautiful truth about the adjacent possible is that its boundaries grow as you explore them. Each new combination opens up the possibility of other new combinations."

[54] This includes recognition which is not necessarily 'quantitative'.

[55] Favareau proposes the idea of the 'relevant next' as a variation of Kauffman's adjacent possible framework, which takes into account the teleology of life, i.e. what maintains and reproduces life.

[56] Favareau (2015) ibid, referring to Kull, K. (2015). Semiosis stems from logical incompatibility in organic nature: Why biophysics does not see meaning, while biosemiotics does. Prog Biophys Mol Biol, 119(3). One can refer to Boyd's OODA loop here also.

[57] Favareau (2015) ibid, referring to Kauffman, S. A., & Gare, A. (2015). Beyond Descartes and Newton: Recovering life and humanity. Prog Biophys Mol Biol, 119(3), 219-244

[58] Hoffmeyer, J. (2008), ibid, p150.

[59] Bateson, G. (1972). Steps To An Ecology Of Mind - Collected Essays In Anthropology, Psychiatry, Evolution, And Epistemology. Northvale NJ: Jason Aronson Inc. pp 423 & 421

[60] Favareau and Kull, ibid.

[61] Favareau, ibid.

[62] Hoffmeyer (2008), ibid, defines semiotic scaffolding as operating by "assuring performance through semiotic interaction with cue elements that are characteristically present in dynamic situations such as the catching of prey, invading host organisms, or mating". It is a direct analogy with the support structures that help construction.

teleological property[63] of life (at the most basic level, striving for survival: feeding, escaping predation and reproducing).

One can thus understand semiosis as a multilayered and multidimensional pattern creation and 'pattern recognition' process, key to driving behavior and change at multiple levels and scales. Adaptive modeling comes to mind here[64], which underlies Christopher Alexander's lifelong quest and philosophy. This paper sets the first steps to understanding these processes and mechanisms and how they can be put to work in problem solving and design.

2.4 Cognitive Domains and Semiotic Niches: semiosis at the center of evolutionary dynamics

Sign relations encompass the whole domain of experience of an organism which constitutes its "umwelt" (von Uexküll, Sebeok[65]), "milieu" (Maturana & Varela[66]), or "lifeworlds" (Husserl[67]/ Habermas[68]): their perceived or experienced environment, distinct from their environment as a whole. The "semiosphere" or "significance sphere" is the whole shared sign universe all have access to -let's call this 'reality' as a whole. Organisms are however to an extent limited to the potential cues / signs that their sensing and interpretative capabilities, i.e. their system of 'interpretance'[69] allow -their perceived reality. In other words, organisms rely on the sign relations they have access to within this experiential world, and not on the whole of their external environment to coordinate their actions (eat, survive, etc). One can see the system of interpretance as the internal model[70] with which an organism constructs an understanding of its surroundings. This system of interpretance comprises the specific sets of sign detection and interpretation and sign relations it must master in order to survive and operate effectively. An organism's experiential world, the portion of 'reality' or part of the semiosphere it has access to, is its semiotic niche. The semiotic niche is a species' home[71].

Biosemiotics provides an understanding of the recursion that operates between modes of construction feeding into each other, linking the biological construct of cognitive systems, the cultural construct of sign / communication systems, and the social construct of structurally coupled agents interacting and co-evolving in a semiotic niche, reinforced by habit taking, as I described above. The recursion is illustrated in Figure 2 below.

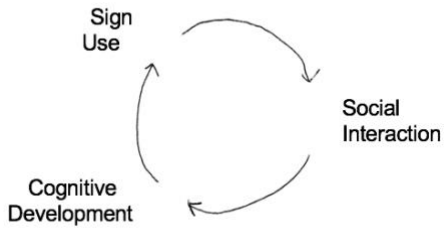

Figure 2: The semiotic recursion

[63] A teleological property of a system is one that explains its end or purpose, independently from whether it is intentionally designed or not.
[64] See here: Finidori, H., Borghini, S., & Henfrey, T. (2016). Towards a Fourth Generation Pattern Language: Patterns as Epistemic Threads for Systemic Orientation. In P. Baumgartner, T. Gruber-Muecke, & R. Sickinger (Eds.), PURPLSOC. Pursuit of Pattern Languages for Societal Change. Designing Lively Scenarios in Various Fields. (pp. 62-86). Berlin: epubli, where the authors point to the need for a pattern language that allows such adaptive modelling. I will add a sentence in this paragraph.
[65] The term first used by von Uexkuüll became a technical term in biosemiotics and beyond. See Kull, K. (2010). Umwelt and Modelling. In Cobley, P. (ed), The Routledge Companion to Semiotics. Abingdon, UK: Routledge.
[66] Maturana, H. R., & Varela, F. J. (1980). Autopoiesis and Cognition - The Realization of the Living. Dordrecht, Holland: D. Reidel Publishing Company.
[67] Husserl, E. (1954 (1970)). The Crisis of European Sciences and Transcendental Phenomenology: An Introduction to Phenomenological Philosophy". Evanston: Northwestern University Press.
[68] Habermas, J. (1987). The Theory of Communicative Action - Lifeworld and System: A Critique of Functionalist Reason (Vol. 2). Boston: Beacon Press.
[69] Hoffmeyer, J. (2008). The Semiotic Niche. Journal of Mediterranean Ecology, 9, 5-30.; Salthe, S. N. (2009). Inside / Outside. Biosemiotics, 2(2), 247-253
[70] Described by Sebeok, T. A. (2001). Signs: An introduction to semiotics (2nd ed.). Toronto: University of Toronto Press and Danesi, M. (2015). The Concept of Model in Thomas A. Sebeok's Semiotics. Paper presented at the New Semiotics. Between Tradition and Innovation.
[71] This is one of the 13 theses or biosemiotic principles set forth in Emmeche, C., Kull, K., & Stjernfelt, F. (2002). Reading Hoffmeyer, rethinking biology. Tartu: Tartu University Press. See also Hoffmeyer, J. (2008). The Semiotic Niche. ibid.

This recursion operates at the individual and collective level among individuals of similar structure and across them. History of recurring interactions among structurally coupled organisms and their environment[72] lead to "structural congruence"[73]. This congruent structural coupling generates through time what Maturana and Varela call a structural drift, the co-adaptation and co-evolution of coupled organisms. The "fitting" operates through two processes: ontogeny at an organism's development level and phylogeny at a species' evolution level through the integration of changes in the intrinsic organization of an organism (DNA).

From an evolutionary perspective two timescales are involved: macro and micro evolution[74].

Macroevolution is to be considered beyond the species scale, at the geological scale. It jumps from one local optimum to another, and produces discontinuous and non-directed diversifications of species, which follow no necessity. These are the ones identified in fossils. Hoffmeyer's 11 steps in the evolution of semiotic competence (Figure 1) correspond to macro structural changes in organisms.

Microevolution and adaptation happen "in between". They occur through rapid evolution before stabilization and evolution of a species. They are gradual and directed, with each generation improving over the previous one, following the recursion described in Figure 2. One can relate them to the 'structural drifts' described above. Micro-evolutions may appear as stagnation of a species at the scales of evolutionary time as they are not captured in fossils.

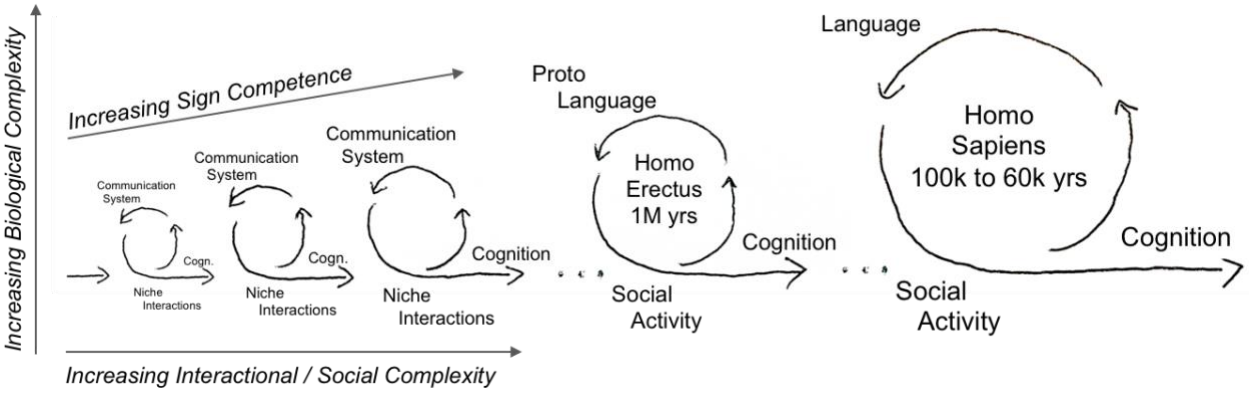

Figure 3: Semiotic niches and evolutionary dynamics

Figure 3 above illustrates evolutionary dynamics integrating micro and macro evolutions and showing successive recursions and semiotic steps which form new semiotic niches. Each cycle represents a macro-evolution from the previous. Hoffmeyer's 11 steps follow similar recursive cycles. Within each semiotic niche, increased cognitive/semiotic competences (biology) enhances the sign systems (culture), enabling more complex interactions (social). Such micro- co-evolution generates out of equilibrium conditions and new evolutionary pressures, which lead to further cognitive improvements at each generation, and further recursions, bringing a semiotic niche to a higher level of complexity, generating new lineages with whole new sets of sign systems, cognitive structures and social interaction. These adaptations become first epigenetically and then genetically integrated.

Biosemiotics allow a bio-constructivist perspective that links nature and culture in a continuum -not necessarily gradual and incremental, i.e. linear- of nested and/or forked micro and macro evolutions.

[72] Maturana prefers to refer to it as 'milieu'.
[73] Maturana, H. R., & Varela, F. J. (1987). The tree of knowledge: the biological roots of human understanding Boston: Shambhala Publications.
[74] Dessalles, J.-L. (2007). Why we talk. Oxford: Oxford University Press. Referring to Monod, J. (1970). Le Hasard et la Nécessité. Paris: Seuil; and Gould, S. J. (1980). The Panda's Thumb. New York: Norton.

Human evolution in general and language in particular followed this recursive pattern as I will describe further in the next section.

3. THE CO-EVOLUTION OF COGNITION AND LANGUAGE

Much attention has been placed on the study of language as the factor of difference between humans and other species. A variety of disciplines are involved in explaining the origin of language, which have been working in silos: evolutionary biology, paleoanthropology, ethology, genetics, linguistics, cognitive linguistics, neuroscience. They are now cooperating at broader scales.

Language represents a huge breakthrough for the human species. Sometimes, however, it is credited for what it is not or cannot bring about.

3.1 The emergence of Language: Chance or Necessity? Nature vs Culture?

Discussions on the origins, nature and potential of language have fueled many wars[75] in the past decades, particularly among linguists, mainly around the question of whether language was the result of a sudden macro-mutation that set a whole new lineage apart from existing primate species (chance) or whether it was the outcome of a continuous adaptation (necessity). Other controversies revolve around whether it is a social construct or an innate code that helps humans represent the (their?) world.

Responses are more complex than settling for one end of an either/or duality. There is now a consensus in the linguistic community on the fact that human language appeared in two steps[76], following the recursive evolutionary dynamics illustrated in figure 3, starting from existing primate communication with Homo Erectus 1 million years ago. The question over whether language is a social construct or an innate biological function, is partly addressed above, in the cybernetic cycle where nature, culture and social interaction feed back into each other (Figures 2 and 3). This cycle applies to human language as it does to sign processes and communication systems of other living forms, as outlined in Hoffmeyer's steps in the evolution of semiotic complexity (Figure 1). The question of nature versus culture is further discussed throughout this paper, and in particular in the distinctions between patterning and languaging, and within language itself, between language as cognitive and communication capability and language as system of signs.

3.2 Convergence of Newly Acquired Capacities

A number of factors, capacities, causes have been invoked to explain the evolution of cognition and the emergence of human language in Homo Sapiens. These factors, which converge, rather than compete, are contextual, physiological, social, and cognitive.

In terms of context: geological changes (due to rifts), wildfires (due to cosmic activity) and climate events (causing changes in vegetation), which occurred before or at the beginning of the paleolithic era, may have isolated or pushed some groups of proto-humans away from forests, leading them to venture onto the open savanna areas and into caves for shelter. This involved more running and less climbing, more exposure to predators, and therefore pressures to adapt to different habitat, climate conditions, food sources and dangers[77].

Physiologically: running freed hands for carrying things and led to the adoption of bipedalism which caused a lowering of the pharynx and the formation of the larynx, ultimately making it possible to articulate sounds.

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[75] Described in Harris, R. A. (1993). The linguistics wars. New York: Oxford University Press; and Bickerton, D. (2014). More than Nature Needs. Cambridge: Harvard University Press; and 'in action' in Piattelli-Palmarini, M. (Ed.) (1980). Language and Learning: The Debate between Jean Piaget and Noam Chomsky. Cambridge: Harvard University Press.

[76] Which steps these are and their period of occurrence still remain subject to debates.

[77] See among others Calvin, W.H. (1990). The ascent of mind. New York: Bentam

Smaller hips, which were naturally selected for running faster, gave an evolutionary advantage to premature children, born with smaller heads, but with 'unfinished' more malleable/plastic brains[78].

In terms of social activity, many correlations have been suggested as foundational, which all concurred to the cognitive and physiological development of the human species, epitomized in language[79]:

- arranging objects with the development of the retina, and visual spatial organization[80];
- throwing stones and spears, with the mobilization of neurons in parallel[81];
- building and handling tools and resulting planning and execution skills, with changes in the organization of the brain[82];
- coordination of information on extractive foraging and protection against predators, with communication coordination capability[83];
- uttering alarm calls and pooling knowledge practice, with sound articulation[84];
- grooming used as 'group massage' and the communications and rituals around it, with the development of social 'conversation' and social bonding[85];
- mimetic capacity, with reciprocity and reflectivity[86];
- seeking trust as political advantage through argumentation and validation, with syntax and logical connections[87]...

In terms of cognition: the upright position and intensification of social activity allowed the increase in size and connectivity of human brains, which in turn allowed more neural connections, the coordination of more varied precision activities, and an interconnection of brain functions, which enhanced cognitive capacity. In addition, premature births and the "unfinished" plastic brains that this entailed, with part of the development of the brain taking place ex-utero, enhanced human learning capability and adaptability to new conditions.

3.3 Evolutionary dynamics

We saw earlier, when referring to evolutionary dynamics that micro-evolutions are not visible in fossils, and may appear as stagnation of a species at the scales of time as they are not captured in fossils.

This is why many of the factors listed above can only be connected to and inferred from fossils but cannot clearly be explained and causally related to human evolution. In particular, the order in which these factors played out is difficult to establish. There are very little paleo archaeological elements to help explain and document the evolution of human cognition and language, and to know what different lineages of humans were capable of at different periods of the paleolithic. It is likely that different groups evolved similar capabilities at different paces.

Evolution of the human species in general, and language in particular, is the produce of microevolutions at the interplay of chance and necessity, as results of combinations of the various new capabilities listed above. Necessity is a driver at the micro-level, where out of equilibrium conditions create new pressures and open up possibilities for adaptation, as well as opportunities for "new niches", such as for example freeing hands fostered the development and perfecting of the use of tools and weapons. Eventually these micro-evolutions and adaptations converge towards an evolutionary "innovation", that becomes visible at the scale of time, as macroevolution. Language is such a macroevolution, that we humans are a living proof of, resulting from a set of microevolutions.

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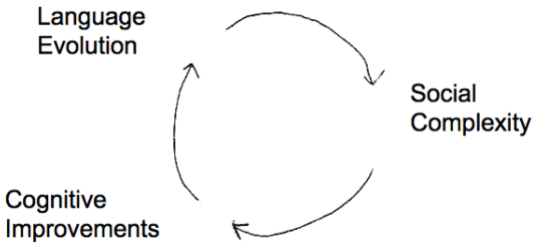
[78] Aiello, L. C. (1996). Terrestriality, Bipedalism and the Origin of Language. Proceedings of the British Academy, 88, 269-289.
[79] Most are cited in Dessalles (2007), op. cit.
[80] Gregory, R.L. (1970). *The Intelligent Eye* (1970), London: Weidenfeld and Nicolson.
[81] Calvin, W.H. (1991). The throwing Madonna. Lincoln: iUniverse.com
[82] Leroi-Gourhan, A. (1993 (1964)). Gesture and Speech: The MIT Press.
[83] Bickerton, D. (2009). Adam's Tongue: How Humans Made Language, How Language Made Humans. New York: Hill and Wang.
[84] Lieberman, P. (2007). The Evolution of Human Speech: Its Anatomical and Neural Bases. Current Anthropology, 48(1).
[85] Dunbar, R. I. M. (2010). Coevolution of neocortical size, group size and language in humans. Behavioral and Brain Sciences, 16(4), 681-694.
[86] Donald, M. (1998). Mimesis and the Executive Suite: missing links in language evolution. In James R. Hurford, M. Studdert-Kennedy, & C. Knight (Eds.), Approaches to the Evolution of Language: Social and Cognitive Bases: Cambridge University Press.
[87] Dessalles own theses.

From what is examined in earlier sections, one can extrapolate that human cognition as coordination of action evolved from the ability, in the primates that came before us and our whole lineage, to generate, interpret and associate an increasing number and types of signs within the limits and constraints of what biology had endowed us with in terms of sensorimotor capacity[88]. This occurred by jumping from moment to moment into what Favareau called the 'relevant next' from one adjacent possible to the next, creating new contexts and possibilities, eventually leading to language.

To understand, however, how language emerged from all these factors of microevolution, we need to understand the evolutionary pressures that led to language as we know it, and the biological necessity for language[89]. Language did not come "in one piece", as the "big bang" suggested by Noam Chomsky. Language is not a macromutation. It is not however the result of a gradual incremental process, as some breakthroughs did occur.

3.4 A Bootstrapping Process

Paleoanthropologists, ethologists and cognitive linguists agree that breaking from animal communication occurred via exaptation -a new capacity made available for a new use, with no necessary evolutionary pressure for this capacity or use-, by social selection, and by collective learning (Bickerton). Language and cognition co-evolved thanks to a bootstrapping effect (result of the recursion described in figures 2 and 3) which linked together the evolution of language, social complexity and cognitive improvement, starting with cognition[90]. A new capability enabled by any of the factors mentioned earlier generated possibilities for new types of activities. When a certain limit was reached, a new need emerged, which created an evolutionary pressure, which in turn took advantage of another transformation etc....



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It is now broadly assumed that human language emerged iteratively in two significant steps, first as an analog symbolic referential sign system, then organized as a digital structuring system. The first step, moving from pre-language to proto language, was made necessary by a pressure to handle and communicate more complex concepts for local effectiveness in everyday action[91]. The second step was triggered by a need for clarity and verifiability of argumentation especially as narration was 'displaced' in space and time and risks of inconsistency increased (Dessalles). Both were triggered by a need for new modes of representation and expression that could 'collapse' information and make it more 'stable' and reproducible, as it was becoming more significant in volume and more complex[92].

4. PATTERNING AND LANGUAGING

4.1 The Emergence of Language: From a Pragmatic to a Symbolic System

[88] I include cognition and speech capability here.
[89] A need described in Dessalles; Bickerton, op. cit.
[90] Bickerton; Dessalles, op. cit.
[91] Bickerton, op. cit.
[92] Dessalles, op. cit.

The human symbolic lexical system, the first step to language as we know it, appeared as a form of extension of memory, that allowed to 'store', associate and manipulate more cognitive material. This new 'practice' enabled more areas of the brain to be connected, opening up in turn possibilities for additional microevolutions in cognitive capacities. This operated a shift from a form of communication which was mainly inferential, directly connected and connectable to a phenomenon and its perception, to a form of communication increasingly evocative, detached from sensorimotor activity.

The new ability most likely evolved from the pre-language call-out system, while bodily expressions were still in high use. It all probably started from a rudimentary combination of gestures/sign language and grunts/cries /sounds, entailing a significant amount of emotional signaling, such as primates use nowadays, directly interpretable, which constituted a pragmatic inferential sign system. The lexical system and the uttering of words came together with a drive to produce clearer sounds for better intelligibility, the articulation of which was made possible with the transformation of the larynx.

Over time, proto-humans had acquired proficiency in building scenic representations of day-to-day situations. These representations were useful mainly for warning or coordinating action in context, to serve the immediacy of the experience, using all the newly acquired capabilities, and in particular the development of the vocal tool. Good observers were socially rewarded for being on the lookout, able to protect the group from dangers[93]. At this stage of pre-linguistic inferential communication, the main difference with other primates was in cognitive ability, manifested in an enhanced coordination of immediate action and ability to concomitantly interpret and verify signals. Sebeok called this pre-language the primary modeling system.

In parallel, increases in capacity of the human nervous system enabled access to memories, focus on longer thoughts, and the production of more complex associations. This opened up possibilities for referring to past or possible future events, and later led to the development of storytelling and planning. To 'free' cognitive capacity, for precision and accuracy, and engage in reflective thought, things and events needed to be referred to, or evoked, in simpler and more repeatable and verifiable ways than replaying scenic representations each time. This created the evolutionary pressure that led to a first breakthrough characterized by the use of symbolic forms, such as words or signs encapsulating whole concepts, used as 'shortcuts' to facilitate interpretation. This was the stage of symbolic referential communication, where people started to systematize and stabilize shared ways to designate things, which Sebeok called the secondary modelling system.

Referring to the practice of pattern language, the naming of patterns follows similar motivations: to create an easy way/ a handle to 'retrieve' patterns. The pattern itself is a "collapse" of complexity or simplification of complexity in reference to Herbert Simon's near decomposable system[94]. The problem we currently have however with pattern language[95] is that we still lack a way to mobilize pattern language in immediate adaptive ways. [96]

Seen from a biosemiotics perspective, one can refine the notion of referential system in relation to patterns. In particular, Peirce[97] distinguished three forms of referential associations, or types of references. This approach provides the basis for a continuity between nature and culture, from the unicellular organism, to multicellular living organisms, which can be extended to social and socio-technological systems[98].

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[93] Dessalles; Bickerton, op. cit.
[94] Simon, H. A. (1962). The Architecture of Complexity. The American Philosophical Society, 106(6), 467–482.
[95] Described in Finidori et al 2016 and Finidori 2018 op. cit, and also mentioned by Wirfs-Brock, R. (2017). Are Software Patterns Simply a Handy Way to Package Design Heuristics? Paper presented at the 24th Conference on Pattern Languages of Programming (PLoP)
[96] Using pattern languages usually involves going back to the shelf and using patterns that have been captured and stored for later use: 'frozen' patterns, which may with time become disconnected from their initial purpose because they are not tacitly embedded in practice. The 'frozen' nature of pattern sets is especially noticeable when they are enclosed with proprietary IP as Alexander's *A Pattern Language* patterns have been#. What I seek to foster in my research is the development of a capability to muster patterns as needed, as in a literacy… I advocate here the development of a 'pattern language literacy' or 'patterning literacy', which would add practice and mastery to pattern language as expert knowledge tool, based on an understanding and mirroring of the way semiosis works, with 'patterning' being used as a method of coordination of action just as languaging is and has been.
[97] CP 2.274 in Peirce, C. S. (1994). The Collected Papers of Charles Sanders Peirce.
[98] Luhmann, N. (1995 (1984)). Social Systems: Stanford University Press; Brier, S. (2008). Cybersemiotics: why information is not enough! Toronto: University of Toronto Press

The first form of referential association is iconic, based on similarity. The second is indexical, based on associations and correlations. The third is symbolic, based on social convention.

Barbieri[99] and Deacon[100] describe each of these referential forms in a manner that is quite relevant to a pattern perspective[101]:

- Iconic associations establish a similarity link between a sign and an object. They are at the foundation of pattern recognition and mental categories, the basic tools of perception by which we recognize for example different species of animals, or different types of clouds. They are also the basic means by which something is 're-presented', i.e. presented to the senses anew, so that they can be re-cognized, i.e. summoned into thought again.

- Indexical associations establish a physical or temporal link between a sign and an object. They allow to infer, or point to something from the existence of something else. They are the basic tools of anticipation. The form of a cloud can help us infer the type of rain, a pheromone leads the ant to the food source, smoke is an indicator of fire, etc.

- Symbolic associations establish a conventional link between a sign and an object. They are the basic tools for imagination and abstraction. Flags, religious artifacts, numbers, names of objects, projects, imaginary objects are the produce of social conventions.

We saw earlier that to survive and thrive, all living organisms relied on communication systems based on signs. Humans as a produce of evolution are therefore 'equipped' with the three types of referential systems.
The use of icons and indexes is shared by all living organisms, in more elaborate forms when mediated by nervous systems. The inferential communication I evoked earlier in this section as constituting pre-language, innate and specific for each species or type of organism, was essentially based on iconic and indexical references; the 'primary modelling system' thanks to which any organism adapts to its environment and evolves[102].

A few authors endow all organisms with some form of symbolic system[103]. But all agree that what makes the 'real' difference is that humans are the only species to massively and systematically use symbolic sign systems. This is a key attribute of language that only humans have, in distinction from communication relying on pragmatic sign systems, that all organisms have, in more or less elaborate form[104].

With symbolic reference, the sign-relations used to communicate, initially denotative and inferential (iconic, figurative, literal, and indexical, pointing to) that mirrored perception and enabled direct interpretation, were complemented with connotative and referential ones (evocative and symbolic), disconnected from sensorimotor activity[105].

Symbols are arbitrary signs that are socially acquired, and intrinsically 'detached' from meaning and experience. The connection with meaning comes from naming and categorizing perceptual and abstract/'rational' concepts via usage, adoption/convention -metastabilization of form-, and from learning collectively, forming a code that all members of a 'society' share[106]. We will see later the nuances and the implications. What is sure is that the

[99] Barbieri, M. (2010). On the Origin of Language. Biosemiotics, 3(2), 201-223.
[100] Deacon, T. W. (1997). The symbolic species: the co-evolution of language and the brain. New York: W. W. Norton & Company.
[101] Barbieri however does not acknowledge interpretative semiosis in cells and the continuity in the semiotic evolution between cells and organisms equipped with nervous systems. He promotes the idea of 'code semiosis' for simple organisms.
[102] Sebeok, Thomas A.; Danesi, M. (2000). The Forms of Meaning: Modeling Systems Theory and Semiotic Analysis. Berlin: Mouton de Gruyter; Brier, S. (2008). The Paradigm of Peircean Biosemiotics. Signs, 2, 20-81.
[103] See Barbieri, M. (2009). A Short History of Biosemiotics. Biosemiotics, 2(2), 221-245. A few examples of symbolic associations have been reported in animals. Pattee for example suggests that cells are governed by a symbolic system via the genetic code, but none of these can point to a constituted symbolic communication as humans have. Pattee, H. H. (1996). The Physics of Symbols and the Evolution of Semiotic Controls. Paper presented at the Workshop on Control Mechanisms for Complex Systems: Issues of Measurement and Semiotic Analysis, Las Cruces, New Mexico.
[104] Deacon in The Symbolic Species outlines the fact that most research tries to look for animal language by looking for the features of human language in animal communication, but to him comparing communication, which is cognition related, and language which is 'external' to cognition is a 'fausse route'.
[105] Bickerton, and Dessalles, op.cit.;
[106] Symbolic communication is the sole focus of Saussurean semiotics, the domain of Eco,

'shortcuts' and the increased capacity in cognitive processing provided by this sign system highly increased possibilities for enhanced communication and social interaction, both in quantity and in kind.

4.2 Syntax as spatiotemporal mapping

The second and final breakthrough came with syntax, which enables the translation of referential relationships into reliable and reproducible spatiotemporal, contextual, relations[107]. The mental operation of conceptualizing a spatial relation is also qualitatively different from perception and reference. It is 'based' on perceptions, but is not 'perceptual in nature'.

The expression of scenic representations and referential associations prevalent in proto language were most probably initially organized in unstructured sequential ways which didn't have much to do with syntax, but rather resembled pidgin languages[108]. The need at some point arose to construct 'predicates' in ways that could support argumentation, i.e. that were more systematic and reproducible. This is the stage of argumentative communication, which gives an evolutionary advantage to the construction of valid arguments and detection of inconsistency.

The preciseness of discourse and argumentation depends on the capacity to render the organization of objects of experience in space and time, in order to best describe events, whether in the past, present or future.

Syntax enables the construction of a predicate (the expression of an action, state, or quality) of a situation by segmenting it in different referential frames, and putting these back together. It provides ways of expressing relations between objects, locations, properties within each frame of reference / thematic segments[109]. The theme is the entity that moves within its reference context, in relation to a point of reference, and to the other elements in relation with its trajectory.

This helps keep track of the relative positions (separateness, inclusion, proximity) and trajectories of things despite the fact that we are constantly changing focus and attending different objects whose situation in time or space change as well, allowing better constructs and justification through argumentation.

It is most probable that the capacity to optimize the expression of spatiotemporal and contextual relations arose from the practice of this optimization. Grammars as systematic logical structures are the result of this process. And so is our capability for logical reasoning.

The syntactic ability is innate to humans and therefore 'universal' -at the scale of humans…-. It is however more of a combinatorial capability, that can help to effectively and efficiently render organization and movement in space and time, than a set of underlying universal structural rules embedded in our minds such as Chomsky proposed with Universal Grammar[110]. Such combinatorial capability lets grammars self-organize in finding the best paths and organization in any given time and location (Bickerton), and to evolve, together with lexical systems, as locally socially developed and refined cultural tools.

At the heart of this combinatorial capability, are core innate pre-linguistic knowledge systems we humans are born with. Recent work with infants in developmental psychology (Spelke & Kinzler) have identified five, but there may be more. These core knowledge systems give us an ability to recognize and process percepts, i.e. objects of perception:

- forms and their relations of length and angles;
- quantity, numbers, and their arithmetic relations;
- objects and their motions;

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[107] Dessalles op.cit; George, L., & Mark, J. (1980). The Metaphorical Structure of the Human Conceptual System. Cognitive Science, 4(1980), 195-208; Jackendoff, R. (1999). Possible stages in the evolution of the language capacity. TRENDS in Cognitive Sciences, 2(7), 272-279.
[108] Bickerton op. cit.
[109] Dessalles, Jackendoff op. cit, citing Gruber, J.S. (1965). Lexical structures in syntax and semantics. Amsterdam: North Holland.
[110] Actually, Chomsky's initial 'error' seems to have been that he conflated a capability (combinatorial of spatio-temporal elements and predicates and optimization in finding the best paths) and its instantiation in an organization system, i.e. tool. See Dehaene, S. (2014). Consciousness and the Brain. New York, NY: Penguin Books; and the talk by Stanislas Dehaene - D'où proviennent nos intuitions mathématiques? at the IHES in 2016.

- agents and their goal directed actions;
- places, and their relations of distance and direction.

Our inferences are made from the combination of these percepts. Lakoff also identified similar innate schemas that we build both our physical motions and our metaphors upon. These core knowledges that are further developed as infants learn help make sense of organization in space and time, and its associated outcomes, and help us orient ourselves within it.

Other mammals also have all or part of these knowledge systems, but what we humans have that other animals don't is a unique capacity to recognize, assemble, and envision configurations from across these independent systems, building them up into increasingly complex symbolic structures, as our mind / body develops. This pre-linguistic associative capability may have been what Chomsky called 'universal grammar'[111], found at the basis not only of natural languages, but of all types of our cognitive encoding and decoding systems, or the languages or codes we may use.

Deacon defines language as:

> "a mode of communication based upon symbolic reference (the way words refer to things) and involving combinatorial rules that comprise a system for representing synthetic logical relationships among these symbols. Under this definition, manual signing, mathematics, computer "languages," musical compositions, religious ceremonies, systems of etiquette, and many rule-governed games might qualify as having the core attributes of language."[112]

All these languages involve an embodied, i.e. tacit, knowledge and practice, and therefore a degree of mastery in execution, which constitutes literacies. Pattern language as imagined and developed by Alexander has been claimed as one of these also. I however contend that unlike the languages listed above, pattern languages as theorized and practiced today does not broadly result from and generate literacies. Few pattern languages are configured to be learned and exercised for being performed unselfconsciously, as something mastered, 'known', 'understood' such as martial arts, music or fighter jet piloting[113]... Neither of these languages or disciplines are performed mainly through conscious reflection, and by 'looking up' their components as they are being used[114].

4.3 Human Language: a blend of Analogue Symbolic Reference and Digital Combinatorial Representation

The analogue composition of sensory motor components producing perceptual prototypes, or schema[115], initially manifested through combination of gestures and sounds, found their final expression through digital combinatorial mechanisms of recursion. Language as we know it is characterized by a double articulation -aka dual patterning[116] - materialized by a:

- Combinatorial of phonemes/syllables that produce lexical references - words[117]
- Combinatorial of morphemes/words that produce syntactic structures - sentences[118]

Such combinatorial mechanisms allow constant rearrangement of discrete elements into meaning. They make use of finite resources to produce infinite meaning[119] -like chemistry and genetics. Each can be seen as a source of universality, allowing greater levels of abstraction, symbolism and detachment from 'physical' reality and embodied experience …

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[111] Bickerton, D. (2014). op. cit. provides a good account of the evolution of Chomsky & followers on Universal Grammar.
[112] Deacon (1997), op. cit. p.41
[113] Need to work this idea/sentence. See if I keep this here or elsewhere. Maybe I should define literacy somewhere at the beginning.
[114] There is a difference in airplane piloting for example between a fighter jet in combat and a procedure or checklist a commercial pilot goes through in case of an incident.
[115] Lakoff, G. (2014). Mapping the brain's metaphor circuitry: metaphorical thought in everyday reason. Front Hum Neurosci, 8.
[116] Hockett, C. F. (1990). The Origin of Speech. Scientific American, 203, 88-111.
[117] Hockett, ibid. These probably emerged with symbolic reference, as part of the primary modeling system
[118] Chomsky, N. (2002). Syntactic Structures. Berlin: Mouton de Gruyter.
[119] Chomsky quotes von Humboldt' "infinite use of finite means," in Chomsky, N. (2016). On the Evolution of Language: A Biolinguistic PerspectiveNoam Chomsky interviewed by C. J. Polychroniou. September 24, 2016.

Language is the integration of two new features / functionalities, which made humans distinct from any other species:

- An analogue function based on signs, which gradually moved from a Pragmatic Inferential System to an increasingly Symbolic Referential System.[120]
- A digital function based on combinatorial of discrete elements which evolved from simple linear associations to increasingly complex nested syntactic structures.[121]

Language is therefore not a unitary phenomenon[122]. It is both an analog and a digital mechanism, which combines symbolic meaning with combinatorial logic.

This combinatorial capability which is the essence, with symbolic reference, of human language fulfils the need for new modes of "organization"/ "structuration" of knowledge: a more complex code to render the conceptual ideas and relationships brought by the construction of new dimensions of meaning, in ways separate from the perceptual world.

Deacon sees language as a code to translate and share key attributes of individual idiosyncratic memories and mental images, i.e. the product of 'embodied cognition' as coordination of action. The detachment from direct experience allows individuals to "supply their own indexical and iconic mnemonics in order to reground these tokens in new iconic and indexical representations during the process of interpretation"[123]. Or in other words mental representations and emotional experience of a same event or object may differ, while its "symbolic understanding" is shared, providing a "subjective distance" that enables a "representational freedom to thought processes" that are not available with direct recall or imagining of experience[124]. The regrounding can however only occur when there exists a prior history of tacit grounding that enables the rebuilding of a reference architecture

The two facets or dimensions of language are often conflated, or one of them takes the primacy on the other and becomes the only prevailing attribute of language. Much of the attention has been dedicated to syntax and logical construction, while the implications of the symbolic aspects often reduced to the lexicon, have been neglected, in particular when it comes to attempting to understand each other across knowledge, language and/or cultural boundaries.

5. BRIDGING THE DIVIDE

5.1 Language: A Blessing Or A Curse?

[120] See Section 4.1 above.
[121] See section 4.2 above.
[122] Bickerton, D. (2016). Roots of language. Berlin: Language Science Press.
[123] Deacon, T. (1997). op. cit. p451.
[124] I am not quite in agreement with this. I am not sure that it is the 'understanding' that is shared. "understanding' is embodied. I would suggest that it is the assumption of the understanding and its commonality that is shared.

So how well are we using these extraordinary capacities that enable us to create and express ourselves with quasi infinite possibility?

One may say that language is the result of the human species' semiotic evolution, which developed through structural couplings of the third order, from interactions among humans and with their milieu. It developed first using iconic and indexical, i.e. pragmatic, associations that enable any organism to make sense of and adapt in its own environment. Iconic and lexical associations are inherent to cognition and necessary for survival and evolution, as part of 'nature', and are species dependent. Then symbolic reference came into play, which in Deacon's terms[125] 'offloaded' a 'large fraction of our communicative capacity' 'onto social transmission'. A totally different story, which enabled the exponential development of collective habit taking that we know as culture, which is group or context dependent. We still kept our capacity for pragmatic / inferential reference, but our natural, biological, 'embodied cognition' capabilities and grounding have somewhat been obscured by our propensity and skills to manipulate concepts that may be detached from perceived reality.

As groups scattered and individuated independently from one another, they evolved different lexical and syntactic systems, each as described by Dave Gray[126] with their own self-sealing logics -i.e. their own kind of 'cultural' operational closure, and their own paradigms and sign systems. Each group generated its own variety in the symbols they could produce and learn both in terms of form and content, and in the rules they used to combine them. This is how the Eskimos end up with 250 words to say snow or for different shades of white[127], or how in a specific Australian Aboriginal language, objects are positioned according to their absolute position (North, South, West, East) rather than their relative one (in front, behind, left, right)[128]. Some variations are more subtle, with similar words or symbols meaning radically different things to different people -take freedom and equality for example.... The upside is that we humans gained in effectiveness when communicating within our respective niches, determined by physical proximity to start with, and then as history unfolded, formed around disciplinary, domain related, epistemological, ontological proximity, or the 'social objects' that brought people together. The downside is that we lost, through habit taking and 'con-formation' -i.e. shaping with, together-, a large part of our capacity to understand each other across the boundaries of these domains.

In this context, we can wonder whether language, mainly in its symbolic dimension, is a blessing or a curse. It is interesting to note that in French there are two words for language. One is *langage* that reflects a cognitive capacity, a competence -which Chomsky called Internal language, I-language. The other is *langue* which is the cultural form in which this capacity is expressed or performed -which Chomsky called External language, E-language[129]. *Langage* as capacity is unique/universal to all humans. *Langues* as sign systems, and systems of rules, are the multiple instances of *langage* as a capacity.

[125] Schilhab, T., Stjernfelt, F., & Deacon, T. (Eds.). (2012). The Symbolic Species Evolved: Springer.
[126] Gray, D. (2016). Liminal Thinking: Create the Change You Want by Changing the Way You Think. Brooklyn: Two Waves.
[127] This may well be widely exaggerated if not an anthropological hoax, but it still illustrates the variety...
[128] Boroditsky, L. (2011). How Language Shapes Thought. Scientific American (February 2011).
[129] Chomsky, N. (1997). Language and Problems of Knowledge. Teorema, XVI/2, 5-33.

At the species evolution level (phylogenetic), we humans have biologically evolved an "innate" function of *langage* that we all share in common, and makes us uniquely human. We all have cognitive and languaging abilities reflected in our capacity to associate symbolic references in infinite forms of combinatorial that enable us to model and express the way we see the world and interact with it in logical and effective ways, whichever language or *langue* we may locally use.

At the individual development level (ontogenetic), humans, through learning and praxis, have socially acquired and reproduced a variety of systems of communication and learned behaviors. They developed different *langues* that fit specific niche contexts, and reflect a shared, and more or less cohesive because co-evolved, way of seeing the world.

Our language capacity -*langage*- enables us to learn, invent, mediate, come together, be effective as social groups. It is the blessing.

This *langage* competence or capacity can only however be exercised using a *langue*. Our languages in praxis -*langues*- or conventional codes, enclose us in self-sealing logics that hinder our capacity to communicate beyond our learning environments or 'milieus'. This is the curse, epitomized long ago in the old testament with the Babel Tower myth which illustrates the confusion and scattering of the languages, imposed by God to humans as a punishment for trying to elevate themselves to the heights of heaven[130]...

In particular it is a curse in a time when humanity needs to come together to solve increasingly complex sustainability and social issues. This is where I believe pattern literacy and pattern languages can help as tools for inquiry and design, by reconnecting us with our "patterning" ability, our 'patterning instinct'[131], which underpins our languaging one.

To assess how pattern language can fulfil this role, two questions come to mind. One is: how much 'languaging' is involved in the form and practice of pattern language? Naming and making explicit for reuse what is implicit in action is by essence a form of languaging. Christopher Alexander grasped the difference between patterning and languaging, and this very issue when he eluded naming the ultimate quality, QWAN, with preciseness, preferring to define it through the patterns that generate the experience of this quality. This leads to the second question: how can the languaging part of pattern language form and practice be self-consciously reduced to a minimum; how can we 'free' patterns and pattern languages from unnecessary 'languaging' element, so that pattern language can effectively help us turn languaging into patterning[132]?

5.2 Ways Forward

Being aware that our divergences come partly from culturally constructed but biologically determined ontogenetic processes could help us reconnect the natural and the cultural, by focusing on the 'natural ground' that we phylogenetically share, manifested in the continuity of the semiotic process. This can be done through enhancing our ability as humans to interpret the world using iconic and indexical references, i.e. patterns, rather than symbolic ones, and ultimately using patterns as connectors or mediators of our various symbolic systems[133]. In other words, this means reconnecting with our 'patterning' ability that underpins our 'languaging' one.

Patterning and languaging are distinct. The error made by 'talking each other into' alignment or shared visions, values or languages, comes from the view that language is representational and denotative, i.e. pointing out to an

[130] Or so says the 'common' interpretation.
[131] My definition of 'patterning' and 'patterning instinct' which I have used in several presentations to designate a capacity to discern, recognize, create or mobilize patterns is broader than Jeremy Lent's in "patterning instinct" which to me does not really address this instinct but rather addresses the historical patterns that arise through history and evolution. Lent, J. (2017). The Patterning Instinct – A Cultural History of Humanity's Search for Meaning. Amherst, NY: Prometheus Books.
[132] Terms coined by Hans Wegener my shepherd thanks!
[133] See my ISSS 2018 presentation Patterns as mediators of multiple realities.

external world all can refer to, rather than seeing it as a social action to coordinate our activity[134] (Winograd & Flores 1987; Mingers 1991). For Maturana, the process of languaging involves focusing on language forms and behaviors themselves as objects of coordination. It is a meta-process, which occurs effectively among structurally coupled observers. He defines linguistic behavior as the consensual coordination of action, and languaging as the recursion of it, i.e. the consensual coordination of the consensual coordination of action. In other words, language focusing on itself for preciseness and effectiveness rather than on a 'shared' reality. It is difficult in this context to cut across the boundaries of a social group's co-constructed self-sealing logic.

How can we get out of this predicament? There is a whole potential to discover, by exploring and distinguishing further the processes of patterning and languaging, and by relating our different ways of perceiving and evoking a shared reality, and ultimately re-constructing the signs -the patterns- that are at the foundation of our symbolic representations. How Pattern languages can help us do that optimally is the question I bring to the Pattern Language community.

Let's go back to our three referential systems from a pattern and pattern language perspective.

Earlier in this paper I mentioned symbolic reference as providing the "subjective distance" that enables a "representational freedom to thought processes", and its detachment from the perceptual world. Symbolic reference and language seem to be the epitome of the separation of nature and culture when seen outside the bubbles of specific constructed worlds.

The three systems of reference or types of sign-relations are not however completely detached or mutually exclusive. There is some hope! A sign can be an icon, an index or a symbol depending on the level of interpretation and the interpretative process at play. Deacon described the hierarchical aspect of referential associations and interpretation, where more complex associations are built from simpler ones, reflecting a prior competence in identifying relations. Indexes are composed of iconic relations (i.e. based on similarity), and symbols are composed of indexical relations (i.e., based on association in space and/or time). He suggests that symbolic competence is based on an ability to produce interpretant responses that come from an infrastructure of more basic iconic and indexical interpretants.

This can be seen in infant development, where children first associate things iconically (they recognize individual attributes of Papa, Mama etc), then they relate them (they connect sets of iconic attributes as pointing to Papa), then they build more sophisticated iconic metaphors relating similar things (they recognize papa on a photograph), and later invoke more abstract or symbolic concepts and form full syntactic sentences (they name Papa, and ask him to tell a story).

To grasp a symbol, according to Deacon, requires a competence in making prior indexical and iconic associations. Memories of past experiences that repeat are icons of each other, which bring other associations into play. Past experiences of fire for example, generate iconic references that through cumulative effect consolidate the indexical references that associate smoke to flames to fire when seen or evoked independently. Our everyday behaviors and decisions are responses developed from day-to-day interpretation and from what we associatively learn from the recurrences and associations we encounter. Our interpretive processes of symbols summon indexical and iconic relations to assess new stimuli, whether they be icons (direct sensorial stimuli), indexes (indicators) or symbols (concepts). This is an implicit, unselfconscious process. Similar to the timeless way evoked by Christopher Alexander[135], by which vernacular cultures built their environment.

Going one step further, Deacon suggests that symbols, then, could be explained by describing what 'makes' the symbolic interpretant (i.e. the context-sensitive response that the symbol as sign triggers). This would require to explain the production of corresponding iconic and indexical interpretants (i.e. patterns), and how they are 're-coded' to produce higher forms[136]. This is done 'naturally' and implicitly when the symbolic code is shared. I

[134] Mingers, J. (1991). The Cognitive Theories of Maturana and Varela. Systems Practice, 4(4), 319-338; citing Winograd, T., and Flores, F. (1987). Understanding Computers and Cognition, Addison Wesley, New York.
[135] Alexander, C. (1979). The timeless way of building. New York: Oxford University Press.
[136] Something Robert Rosen touched upon in his "Modelling Relation".

believe that doing it explicitly, i.e. by cracking open our semiotic and interpreting processes in participatory ways[137], and by looking for and analyzing patterns and patterning processes, we would help improve communication among humans, in particular to cross different kinds of knowledges and forms of expression and understanding. Some ways of doing this, and tapping in the potential of patterns have been described in Finidori 2016, Finidori et al 2016, and Finidori 2016[138].

6. CONCLUSION

A way out of the Babel Curse, rather than waiting for the Pentecost[139] -though evolutionary pressures may be leading us there…- would be to work across boundaries on our processes of patterning, in a way that distinguishes rather than amalgamates patterning (as the association of intrinsic basic iconic and indexical units of our cognition and I-language) and languaging (our symbolic and cultural expressions of it, used as consensual coordination of action); to relate our different ways of perceiving and evoking shared realities and experiences. It is about working on what unites us at the most basic level of embodied cognition, rather than at the higher levels of values and culture.

We are at a time where we need a breakthrough similar to what brought us human language. Working on the development of a pattern literacy and systemically oriented pattern languages would help us get there.

Many thanks to my shepherd Hans Wegener, whose editing insights helped me clarify my rendering of this complex topic.

[137] Indigenous knowledge and forms of pattern based expression can help. See Sand Talk. I will read on further

[138] Actually this paper is the 'underpinning' for the papers I wrote earlier, where I offer in more detail some directions into which patterns and pattern languages can evolve.

[139] Note that Pentecost is not about coming back to the imperialism of one language or lingua franca, but rather reaching unity in diversity and reversing the babel curse in reversing "any hostility that *may have* arisen in the wake of linguistic confusion". See http://theologicalmisc.net/2016/05/pentecost-reversal-babel/