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 of 'languaging' involved), 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**

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INTRODUCTION

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 each other in and 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 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[3]. 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 patterns and pattern languages as they were traditionally considered and 'practiced' by the pattern community 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.

This paper does not provide new answers or solutions, it lays in more details the scientific background for this earlier work where I provided some directions along which patterns and pattern languages could evolve to support systemic inquiry and design. I invite the reader, eager for more 'applied' reflections, to read the papers referenced above[9]. This work is part of a broader research in the context of my PhD on Pattern Literacy in Support of Systems Inquiry and Design.

I trust that the present paper will clarify the intent behind my earlier work and my journey, and help better understand it as it challenges some of the precepts current in the pattern community. In particular it suggests that patterns are much more that an elegant solution to a problem, and it bridges the concept of pattern with a small 'p' -the general concept of a pattern-, with that of the pattern with a capital 'P', as self-ascribed by the pattern community, -the design pattern or Alexandrian pattern-[10].

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[1] Presented at Plop, Purplsoc and ISSS in 2016 and 2017. Finidori (2016); Finidori, Borghini & Henfrey (2016); Finidori & Tuddenham (2017).
[2] Bertalanffy (1968).
[3] Finidori (2018).
[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 (1996).
[7] At Plop 2017, Manns & Yoder (2017).
[8] At Plop 2017, 2018 and 2019. Wirfs-Brock (2017); Wirfs-Brock (2018); Wirfs-Brock & Kohls (2019).
[9] In particular Finidori & Tuddenham (2017) from p.12, and appendixes
[10] I will use the terms pattern and pattern language without any caps throughout the paper, due to the versatile nature of patterns, even in Christopher Alexander's work, as I underline in Finidori (2018).

The key issue I am exploring here, as an underpinning of the rest of my work, is the detailed role that patterns play in our cognitive capacity as humans to orient and adapt ourselves to -or in other words to model- our environment, and how this knowledge affects our capacity to design and or transform systems. This becomes particularly critical in a context of an ever-increasing specialization and fragmentation of the solution or action space, while the problem space is characterized by growing complexity and highly intricate and interdependent multidimensional factors to make sense of. The key difficulty is the coordination of action across knowledge, language and culture boundaries, whether conscious or unselfconscious, intended or not. 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 the use of language and symbolic reference, i.e. 'languaging' as 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, or on strict representational forms, 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'. Being aware of the distinction and specificities of each, and able to assess how each can be leveraged in understanding and communication, within and across domains, may bring us closer to grasp the 'order of things' and how they evolve, and overcome fragmentation.

To move discussions forward on innovation and the future of Pattern Language, I therefore explore in the present paper the origins of and the relationships between 'patterning' and 'languaging'. To do so I take the reader on a journey through the evolutionary dynamics, seen from a biosemiotics perspective, which shaped the co-evolution of cognition, niche/social behavior and sign systems at the species and then more precisely at the human level. Going this far back is important to understand the different functional aspects of language, and the biological basis of social construction processes and symbolic reference beyond the ontological and epistemological positions people may take on nature and culture. These functional aspects of sign processes and language are at the foundation of incommunicability and incommensurability in language and paradigm, and perspective / worldviews. I will attempt to show here that nature and culture are intimately related, and that this knowledge can help bridge a significant number of divides.

In the first section of this paper, I briefly describe the challenges we are faced with from a cognition and language perspective. I outline in particular the difficulties change agents run into when trying to find solutions across boundaries, and I discuss the extent to which language in general and pattern languages in particular are involved in seeking to overcome these. In the second section, considering evolution of living organisms from a sign process and communication perspective, I examine how patterns as signs and biosemiotic processes, aka 'patterning', are key to life processes and biological exchanges, and I outline how they contributed to the co-evolution of cognition, niche/social practice and communication systems, as an evolutionary continuum through which these systems became increasingly complex, providing species with new affordances. In the third section, I discuss the origins of language, and I examine the two steps in human evolutionary dynamics which lead to the emergence of human language in the light of the co-evolutionary processes described at section 2. In the fourth section, I explore the characteristics of human language. I focus on how patterning gave birth to languaging, and on the break-through this constituted, and I draw distinctions between these two functions of language. In the fifth section, I finally examine the challenges entailed by this dual nature of human language in relation to shared experience and action, 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[11] in order to address systemic issues from different perspectives.

As in any foundational work, it is always difficult to assess how much background information is needed for anyone to follow a researcher's line of reasoning and come to their own conclusion. I will do my best to summarize key points and provide some pointers for orientation throughout the paper.

[11] 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 *Configuring Patterns* paper that this has not quite been fulfilled.

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[12], not to mention the different purposes or interests that may be involved.

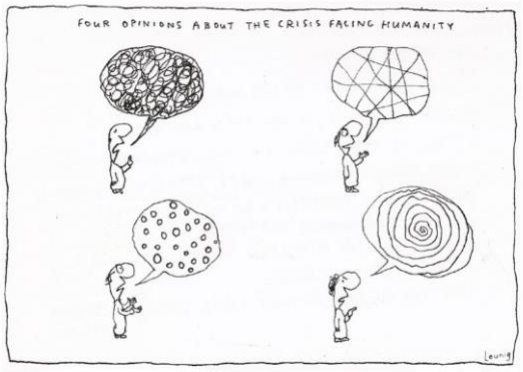
Pattern Languages have often been proposed as Lingua Franca[13] for such an endeavor. How they can be developed and used in contexts where these differences may seem irreconcilable is a key question. Even within cohesive domains of practice, Rebecca Wirfs-Brock[14] challenges the actual ability that 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.

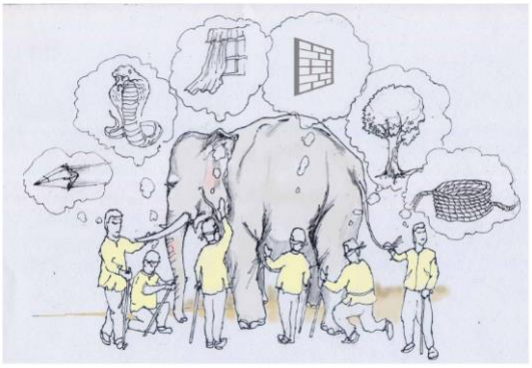
The construction of shared languages and understandings which transcend cultural and knowledge differences have not proven effective to date. Entangled issues that require transdisciplinary and systemic knowledge are often assumed to be solved through dialogue or discourse, which focuses mainly on language -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[15], 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 Fable of the Elephant is one of them. The Tower of Babel Myth is another, which presents language and its confusion as a curse rather than a blessing.

[12] Finidori (2016).
[13] Erickson (2000); Reiners (2013).
[14] Wirfs-Brock (2017).
[15] 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.



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.

On April 23, 2019, Bruno Latour tweeted[16]:

> "*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*."[17]

Politics is a case in point. This phenomenon of increased fragmentation and entrenchment can be found in numerous contexts, including Science[18]. It is not 'just' a question of language and translation, or finding the 'better truth', supporting evidence, 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[19]. 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[20]. It assumes that by focusing on language itself as a mode of consensual coordination -languaging as per Maturana[21]-, 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, and to necessarily reach a consensus. Forms of agency / action logics are not interchangeable[22]. In addition, confrontation and adversariality may be a beneficial driver for moving forward.

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[16] https://twitter.com/BrunoLatourAIME/status/1120939140923760641
[17] 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!
[18] The broadening divide even in the scientific assessment of the Covid19 pandemic is another illustration.
[19] Winograd & Flores (1987), Mingers (1991).
[20] 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.
[21] Maturana (1988).
[22] Finidori, Borghini & Henfrey (2016).

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, to try and explain why coherence is so difficult to achieve, and to understand how patterning and languaging 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[23]. The focus is essentially on the 'observational' and 'inquiry' aspects of patterns [24] and their role in the coordination of action, altogether from a cognition, communication and social perspective.

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 units for the coordination of action can be used for the study of living systems[25] and for providing insights on ways to understand the world and design sustainable[26] systems. Design patterns as they are understood and practiced by the pattern community could help designers and change agents become aware of the different kinds of patterns and patterning processes involved as our environment is transformed by our actions and designs. They could become a more deliberate tool to capture and transform systems patterns, in a way more adaptive and less dependent of the words and symbols we use, or the worldviews we adopt.

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, across knowledge, cultural or language divides. In particular this knowledge provides an understanding of the central role patterns have played in the co-evolution of cognition, communication systems and organism interactions at the species and human level. It brings light on the way living organisms in general and humans in particular make sense and orient themselves in their environments, and on how they can initiate and adapt to changes.

2. PATTERNING 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[27]

2.1 Why look at patterns from a biosemiotic perspective?

Signs are the basic units of life[28], and the basic units for the study of living systems[29].

Biology is not only about the organization of molecules and physical exchange or chemical transformation of energy and matter[30]. All living things whether cells, fungi, plants, animals, or humans, and more broadly, all self-

[23] Alexander (1964). p.33. Alexander refers to the unselfconscious ways of vernacular cultures where "there is little thought about architecture or design as such"
[24] As opposed to patterns as tools for intentional design
[25] 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. Alexander, C. (2002), Book2, p18.
[26] I define sustainable systems as systems that are viable and do not produce harmful externalities or unintended consequences.
[27] Hoffmeyer (1996). p.61
[28] Hoffmeyer (1995).
[29] Brier (2006).
[30] Hoffmeyer (2008)

organizing systems[31], 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"[32], 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 co-operative[33] processes are semiotic and communicative[34].

All organisms "create, understand, act upon, exchange and, ultimately, know the world and make their livings in it through the use of signs"[35]. Cognition is involved here in more or less complex forms. As a biological phenomenon, it manifests through "effective action or successful behavior"[36]. 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.[37]

Processes which involve signals as mediators ensuring 'optimal performance of organisms' via interaction with cues present in dynamic situations[38] are characterized as semiotic. Hoffmeyer suggests that organisms that are 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."[39]

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[40], 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[41], upstream in evolutionary terms of human language and

[31] As long as they involve undeterministic parts -such as human systems.
[32] Hoffmeyer ibid p.1. See also Pattee (1996).
[33] I use the term co-operative here and throughout this paper in the sense of operating in the same context or environment.
[34] Brier, Donacheva, Fuchs, Hofkirchner & Stockinger (2004).
[35] Favareau (2015). quote p.593, referring to Peirce.
[36] Maturana (1978). p30
[37] Surprisingly there is little connection between the work of biosemioticians and the work of Maturana and his colleagues and followers.
[38] Hoffmeyer (2008)
[39] Sebeok (2001). quoted by Kull (2009).
[40] Such as Eco, Foucault, Barthes, etc...
[41] As demonstrated in the work of Uexküll, Sebeok, Brier.

social communication. It studies sign processes in their embodied cognition dimension.

I explore in this paper pattern processes, aka patterning, as sign processes from a Peircean biosemiotic perspective. This allows to take an evolutionary perspective through which the evolution of human cognition and language are part of a continuum, and where humans are not 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.

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[42]. One can compare this to Alexander's concept of structure-preserving transformation[43]. 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[44]. 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'[45] 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[46]. 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, at section 4.1.

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[47].

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

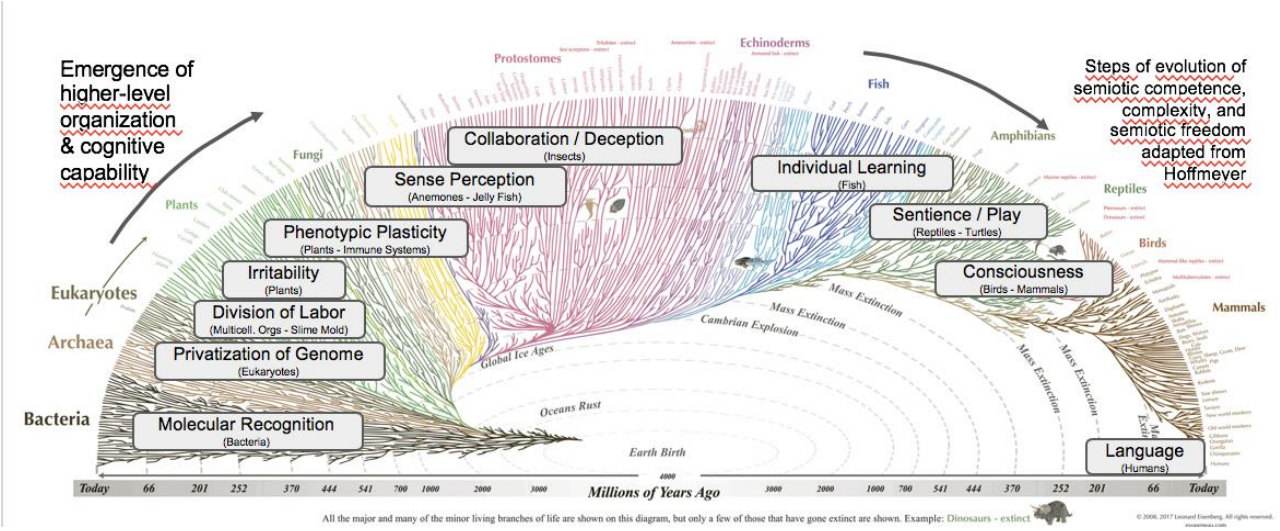
[42] Maturana (1978), Brier et al. (2004).
[43] Alexander (2002). Book 2, ch. 2 & 3.
[44] Maturana (1978). Would that be akin to Alexander's unfolding of wholeness? The whole determines the shape of the parts? Starting from the whole to build the parts?
[45] Hoffmeyer (2010).
[46] Hoffmeyer (2008).
[47] Brier (2006).

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[48].

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[49] systems) resulting in recurrences and co-adaptation (third order coupling). Coordination of independent behavior in such third order couplings[50] 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.

Hoffmeyer and Stjernfelt[51] 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[52]. 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

[48] Hoffmeyer (2008); Schwartz & Berry (2008).
[49] A socio-technological system can be understood as an extension of human cognitive and physical capability via technology.
[50] 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...
[51] Hoffmeyer & Stjernfelt (2015).
[52] https://www.evogeneao.com/en/learn/tree-of-life © 2008-2017 Leonard Eisenberg. All rights reserved

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[53].

Human language, shown at the tip of the tree on Figure 1, is the result of a continuum of evolutionary dynamics which generated increasing semiotic competence and broader cognitive capacity at its various steps, I will elaborate on human language origins and specificities in sections 3 and 4.

In section 2.3 below, I bring the role of signs or patterns more precisely into the evolutionary picture. At section 2.4, I describe the actual recursion and evolutionary dynamics by which sign use, niche interaction and cognitive development interact to shape communication systems, social behavior and cognition throughout evolution, leading to collectively constructed behavior and sign systems. This prefigures the relationship between nature and culture in its very evolution, and sets the foundations for the explanation of what is commonly called 'social construction' which manifests for each lineage and co-evolving groups of organisms in the course of evolution.

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[54].

For Favareau[55], the semiotic process by which physical structures or events are transformed into signs plays a great role in moving to the next adjacent possible[56], 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[57] 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[58] and not just deterministic or stochastic way, through the negotiation of "simultaneous yet mutually exclusive action-taking possibilities"[59], 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.

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[53] Hoffmeyer (2008).
[54] Hoffmeyer (2008).
[55] Favareau (2015).
[56] 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."
[57] This includes recognition which is not necessarily 'quantitative'.
[58] 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.
[59] Favareau (2015), referring to Kull (2015). One can refer to Boyd's OODA loop here also.

The process enables the recursive reshaping of the immediately next adjacent possible that resembles improvisational comedy[60]: 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[61]. 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'[62]. 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[63]. 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'[64]. 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[65] which ensure an organism's activity is 'tuned' to its needs. Semiotic processes are thus directly linked to the teleological property[66] 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[67], 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[68]), "milieu" (Maturana & Varela[69]), or "lifeworlds" (Husserl[70]/ Habermas[71]): 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[72]. Organisms are however to an extent limited to the potential cues / signs that their sensing and interpretative capabilities, i.e. their system of 'interpretance'[73] allow -their perceived reality. In other words, organisms rely on the sign

[60] Favareau (2015), referring to Kauffman & Gare (2015). 4
[61] Hoffmeyer (2008), p150.
[62] Bateson (1972). pp 423 & 421
[63] Favareau (2015), Kull (2015).
[64] Favareau (2015).
[65] Hoffmeyer (2008) 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.
[66] Per Hoffmeyer (2008), a teleological property of a system is one that explains its end or purpose, independently from whether it is intentionally designed or not.
[67] See here: Finidori, Borghini & Henfrey (2016), where the authors point to the need for a pattern language that allows such adaptive modelling.
[68] The term first used by von Uexkuüll became a technical term in biosemiotics and beyond. See Kull (2010).
[69] Maturana & Varela (1980).
[70] Husserl (1954 (1970)).
[71] Habermas (1987).
[72] Without however asserting that 'reality' exists as a whole, to keep out of ontological debates
[73] Hoffmeyer (2008).

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[74] 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[75]. The example of fish in water comes to mind here.

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.

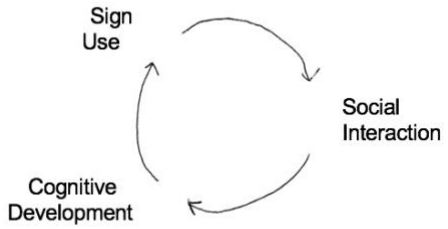


Figure 2: The semiotic recursion

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[76] generates through time what Maturana and Varela call a structural drift, the co-adaptation and co-evolution of coupled organisms, which lead to "structural congruence"[77]. This can be thought of as con-formation, i.e. mutual concomitant change, leading to shared features. The "fitting" or congruence 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[78].

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.

[74] Described by Sebeok (2001). Danesi (2015).
[75] This is one of the 13 theses or biosemiotic principles set forth in Emmeche, Kull & Stjernfelt (2002). See also Hoffmeyer (2008).
[76] Maturana prefers to refer to it as 'milieu'.
[77] Maturana & Varela (1987).
[78] Dessalles (2007), referring to Monod (1970). Gould, S. J. (1980).

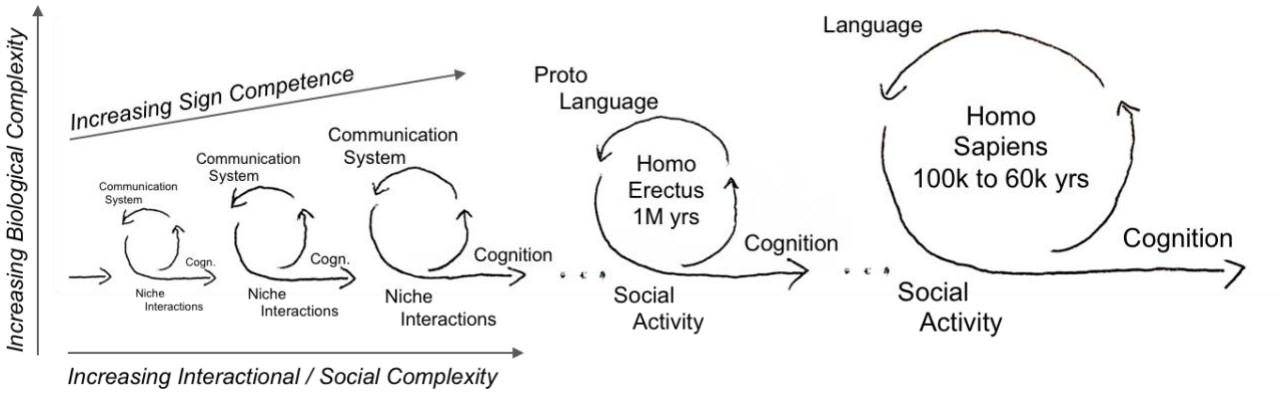


Figure 3: Semiotic niches and evolutionary dynamics

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

The take away here for what follows is that the formation of what Hoffmeyer calls semiotic niches or of what Maturana calls consensual cognitive domains is the result of organisms co-operating, i.e. operating together / interacting, in a shared context where cognition, communication systems, and niche behavior shape one another and co-evolve in a recursive co-evolutionary process (structural coupling and structural drift). This recursive process brings the characteristics of members of a species closer together (structural congruence), while setting species apart from one another, as they differentiate in different directions each in their own domains.

The evolution of human cognition, language and social behavior also followed this recursive pattern enabled by and generative of sign processes, i.e. 'patterning', and is part of this continuum.

In the next section, I delve into the discussions about the origins of human language, and I put some additional focus on the two recursion steps illustrated in figure 3 that led to language as we know it.

This will bring us to examine, in section 4, what distinguishes human language from other organisms' sign or communication systems, and in section 5, to focus on human capacity for 'languaging': the ability to use language to perfect the use of language as a tool, resulting from humans' ability for reflexivity; to discuss how this brought about the fragmentation of the action space described in section 1, and to explore ways forward.

From this point on, most of the instances of the word language used here refer to human language, even if it can be argued that other organisms' sign and communication systems constitute language.

3. HUMAN EVOLUTIONARY DYNAMICS AND THE ORIGINS OF LANGUAGE

Much attention has been placed on the study of language as factor of difference between humans and other species. The roots of this difference have been sought out through the study of the origins of language. A variety

of disciplines are involved in explaining how human language may have emerged, which have been working in silos: evolutionary biology, paleoanthropology, ethology, genetics, linguistics, cognitive linguistics, neuroscience. They are now cooperating at broader scales.

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[79] 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[80], following the recursive form of 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 definitions of language itself, between language in the singular as cognitive and communication capability, shared humanity-wide, and languages in the plural, as specific systems of signs, instances of the former, of which multitudes can be found. The two are often conflated, resulting in an overconfidence in the use of language instances to solve cross-domain issues, which often leads to incommensurability and incommunicability, therefore perpetuating divides, as we will see in more details in section 5.

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 and life conditions), 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 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[81].

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. 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[82].

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[83]. None however was

[79] Described in Harris (1993). and Bickerton (2014). and 'in action' in Piattelli-Palmarini (Ed.) (1980).
[80] Which steps these are and their period of occurrence still remain subject to debates.
[81] See among others Calvin (1990).
[82] Aiello (1996).
[83] Most are cited in Dessalles (2007).

significant enough to trigger a breakthrough by itself:

- arranging objects with the development of the retina, and visual spatial organization[84];
- throwing stones and spears, with the mobilization of neurons in parallel[85];
- building and handling tools and resulting planning and execution skills, with changes in the organization of the brain[86];
- coordination of information on extractive foraging and protection against predators, with communication coordination capability[87];
- uttering alarm calls and pooling knowledge practice, with sound articulation[88];
- grooming used as 'group massage' and the communications and rituals around it, with the development of social 'conversation' and social bonding[89];
- mimetic capacity, with reciprocity and reflectivity[90];
- seeking trust as political advantage through argumentation and validation, with syntax and logical connections[91]...

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.

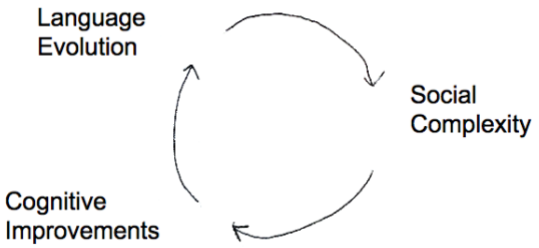
From what is examined in earlier sections, one can extrapolate that human cognition as coordination of action evolved from the ability, in the primates that came before us and our whole lineage, to generate, interpret and associate an increasing number and types of signs within the limits and constraints of what biology had endowed us with in terms of sensorimotor capacity[92]. This occurred by jumping from moment to moment into what

[84] Gregory (1970).
[85] Calvin (1991).
[86] Leroi-Gourhan (1993 (1964)).
[87] Bickerton (2009).
[88] Lieberman (2007).
[89] Dunbar (2010).
[90] Donald (1998).
[91] Dessalles own theses.
[92] I include cognition and speech capability here.

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[93]. 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.

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[94]. The same recursive process is at play here as the one which applies to the evolution of all living organisms. 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....



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[95]. 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[96]. 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[97].

In the following section, focus is on the characteristics of what these two steps afforded humanity, and how, by construction, they prepared humanity for the Babel Curse.

4. THE SPECIFICITIES OF HUMAN LANGUAGE AND THE BIRTH OF LANGUAGING

Let's look in more details at these two steps in language evolution and at what they afforded human kind.

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

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

[93] A need described in Dessalles (2007); Bickerton (2009).
[94] Bickerton, op. cit.; Dessalles, op. cit.
[95] Bickerton, op. cit.
[96] Dessalles, op. cit.
[97] Dessalles, op. cit.

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. As an evolution from primate language, 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[98]. 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 an 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[99]. The problem we currently have however with pattern language[100] is that we still lack a way to summon and mobilize pattern language in immediate adaptive ways, as we summon concepts. [101]

Seen from a biosemiotics perspective, one can refine the notion of referential system in relation to patterns. In particular, Peirce[102] 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[103].

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.

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[98] Dessalles (2007); Bickerton (2009).
[99] Simon (1962).
[100] Described in Finidori, Borghini & Henfrey (2016) and Finidori (2018) and also mentioned by Wirfs-Brock (2017).
[101] 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.
[102] CP 2.274 in Peirce (1994).
[103] Luhmann (1995 (1984)) and Brier (2008).

Barbieri[104] and Deacon[105] describe each of these referential forms in a manner that is quite relevant to a pattern perspective[106]:

- 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 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, words, projects, imaginary objects are the produce of social conventions, built upon a history of recurrent use and stored in collective memory.

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 to tap into. 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 indexical and iconic references; the 'primary modelling system' thanks to which any organism adapts to its environment and evolves[107].

A few authors endow all organisms with some form of symbolic system[108]. 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[109].

With symbolic reference, the sign-relations used to communicate, initially denotative and inferential (indexical, such as pointing to a buffalo track; and iconic, figurative, literal, such as mimicking the horns of a buffalo as in the example below or drawing the buffalo) that mirrored perception and enabled direct interpretation, were complemented with connotative and referential ones (evocative and symbolic, such as naming the buffalo). The increased capacity in cognitive processing provided by a symbolic sign system and the 'shortcuts' it afforded, highly increased possibilities for enhanced reflexivity and reflection, communication and social interaction, both in quantity and in kind.

Indexical reference

Iconic reference

Three types of sign reference
Peirce

Buffalo

Symbolic reference

[104] Barbieri (2010).
[105] Deacon (1997).
[106] 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.
[107] Sebeok & Danesi (2000). Brier (2008).
[108] See Barbieri (2009). A few examples of symbolic associations have been reported in animals. Pattee (1996) 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.
[109] 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'.

Freeing from the 'here and now', symbolic references allow multiple recursions and bring freedom to the thought process[110], but because they are disconnected from immediate sensorimotor activity[111], they do not bare in themselves the clues, easily inferable, intrinsic to iconic or indexical references[112] . They are 'detached' from the "perceptual groundedness of language as an orientational activity in a consensual domain of interlocked conduct"[113]

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 and convention -metastabilization of form-, and from learning collectively, forming a code[114] that all members of a 'society' or domain of action share. As we will see later on in section 5, however, this code may appear esoteric to those who are not part of this society or shared domain of operation. This means that the very process that made communication increasingly effective within domains of actions lead the way for the fragmentation of communication across domains of action, and for misunderstandings among people or groups regardless of whether a coherence or an understanding may exist at a more pragmatic, lower cognition level.

4.2 Syntax as spatiotemporal mapping

To complete the story of human language evolution, the second and final breakthrough came with syntax, which enables the translation of referential relationships into reliable and reproducible spatiotemporal, contextual, relations[115]. The mental operation of conceptualizing a spatial-temporal 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[116]. 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, in order to individually and collectively operate in an environment.

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[117]. 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.

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[110] Deacon (1997). Kravchenko (2016).
[111] Bickerton (2009), and Dessalles (2007)
[112] Deacon, op cit
[113] Kravchenko, op cit
[114] Symbolic communication is in this respect the sole focus of Saussurean semiotics, the domain of Eco,
[115] Dessalles op.cit; Lakoff & Johnson (1980). Jackendoff (1999).
[116] Bickerton op. cit.
[117] Dessalles, Jackendoff op. cit, citing Gruber (1965).

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 in systematic ways organization and movement in space and time, such as described above, rather than a set of underlying universal structural rules embedded in our minds such as Chomsky proposed with Universal Grammar[118]. 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, which probably predate the emergence of language. 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;
- agents and their goal directed actions;
- places, and their relations of distance and direction.

Our inferences are made from the combination of these percepts. We can think of it as a capability for cognizing predicates, before we are able to articulate them in language. 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. This is at the basis of 'patterning'.

Other mammals also have all or part of these knowledge / patterning 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, that helps render the 'order' and dynamics of things, may have been what Chomsky called 'universal grammar'[119], 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."[120]

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 language 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… Neither of these languages or disciplines are performed mainly through conscious reflection, and by 'looking up' their components as they are being used[121]. They are of an embodied nature, performed unselfconsciously. 'Mastery' comes from a history of accumulated practice, which inscribes patterns in lower cognition.

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[118] 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 (2014). and the talk by Stanislas Dehaene - D'où proviennent nos intuitions mathématiques? at the IHES in 2016.

[119] Bickerton (2014). provides a good account of the evolution of Chomsky & followers on Universal Grammar.

[120] Deacon (1997) p.41

[121] 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.

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

As far as the structure of language is concerned, the analogue composition of sensory motor components producing perceptual prototypes, or schema[122], 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[123] - materialized by a:

- Combinatorial of phonemes/syllables that produce lexical references - words[124] A way of generating categories and naming them.
- Combinatorial of morphemes/words that produce syntactic structures - sentences[125] Combining categories and concepts into more complex concepts.

Two new features / functionalities are integrated in language, 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.[126]
- A digital function based on combinatorial of discrete elements which evolved from simple linear associations to increasingly complex nested syntactic structures.[127]

Language is therefore not a unitary phenomenon[128]. It is both an analog and a digital mechanism, which combines symbolic meaning with combinatorial logic.

Such combinatorial mechanisms allow constant rearrangement of discrete elements into meaning. They make use of finite resources to produce infinite meaning[129] -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 … Each 'domain of mastery' hence has its sets of elements to combine to share this meaning with other members of the co-operative domain.

This combinatorial capability which is the essence, with symbolic reference, of human language fulfils the need for new modes of organization and 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 through shared symbolic understanding, which allows individuals to summon their own indexical and iconic representations in order to reground these symbolic references during the process of interpretation[130]. The regrounding can however only occur when there exists a prior history of tacit grounding that enables the rebuilding of a reference architecture. This tacit grounding that enables the detachment is operated during child development via successive construction of higher level indexical and iconic relations at multiple integration levels, which ultimately give place to the symbolic reference.

Interpretation is supported by an ongoing familiarity with symbolic semiotic relations, re-enforced through

[122] Lakoff (2014).
[123] Hockett (1990).
[124] Hockett, ibid. These probably emerged with symbolic reference, as part of the primary modeling system
[125] Chomsky (2002).
[126] See Section 4.1.
[127] See section 4.2.
[128] Bickerton (2016).
[129] Chomsky (2016) quotes von Humboldt's "infinite use of finite means.
[130] Deacon (1997). p451.

learning, recursively shaped by and shaping the frames through which interpretation is made, constructing the consensual cognitive domain. The consensual cognitive domain as defined by Maturana, applying to the living world not only to humans, is the domain where individuals co-operate, i.e. operate together, and make-sense together, intentionally or not, cohesively or not, through shared experience which shapes their communication systems and behavioral codes.

In each cognitive domain, language behavior enables a consensual -i.e sensed together- coordination of action. Individuals use language to co-operate, i.e. operate together in their environment. We see this everywhere in nature, from ants to birds to vervet monkeys and to humans, of course.

But there is more to human language. Human language behavior used as a mode of coordination of action led to the emergence of another level of language behavior. At the human level, individuals, thanks to their reflexive capacity, also use language behavior to focus on language behavior itself as object of coordination, as a recursion of language, to refine/wordsmith the clarity and precision of what needs to be conveyed in action: a metaprocess, that only humans have access to. This recursive process is called languaging by Maturana, to distinguish it from the use of language in action, which is part of the basic patterning and the semiotic process. The languaging process results in further refinements of symbolic reference and strengthening of symbolic construction within any given domain, creating more cohesion and efficiency in communication within this domain, while further setting it apart from other domains' symbolic systems. We recognize here the congruence of characteristics of organisms operating within semiotic niches, described in the conclusion of section 2.

In the following and final section, the discussion focuses further on what languaging brings to human co-operation, and the limits it may entail. Some directions on how to overcome these limits are explored, and the implications this may have for the future of pattern language are discussed.

5. BRIDGING THE DIVIDE

So why are these extraordinary capacities that enable us to create and express ourselves with quasi infinite possibility not of so much help when we try to understand each other across domain barriers? And what can be done about it?

Language, commonly seen as what sets us apart from the animal world represents a huge breakthrough for the human species. Sometimes, however, it is credited for what it is not or cannot bring about. As seen in section 1, it is commonly thought that language can help bridge divides and reach common understanding. Naming and formulating through discourse or by developing dedicated languages -i.e. languaging- is seen as the way through. But why is this not quite effective if we only have specific instances of language at our disposal? How can we succeed in 'languaging' when using multiple different sign systems, which all come with their own 'symbolic load'? Not to mention the prospect of linguistic imperialism when one language seeks to take over…

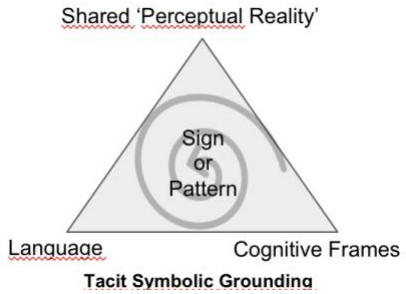
This is where I believe pattern literacy and pattern languages can help, as tools for inquiry and design, by reconnecting us with and enhancing the use of our "patterning" ability, our 'patterning instinct'[131], which underpins our languaging one.

5.1 Language: A Blessing Or A Curse?

We just saw earlier that language is the result of the human species' semiotic evolution, which developed through structural couplings from interactions among humans and with their milieu: an evolutionary process which shaped communication systems, niche/social behavior and cognitive capacities for all living organisms. Human language developed first using iconic and indexical, i.e. pragmatic, associations through which any organism can

[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 (2017).

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[132] 'offloaded' a 'large fraction of our communicative capacity' 'onto social transmission' or in other words, which externalized the 'grounding' of language in 'perceptual reality', tacitly understood and reproduced through a history of personal and social experience, out, into collective memory,



Semiotic Construction Via Languaging

The above figure shows the process by which experience of reality, language systems and cognitive frames recursively shape each other through shared experience, language behavior and practice of inference. We recognize here the same recursion as the one operating at the semiotic niche level. This process enabled the exponential development of collective habit taking that we know as culture, which is group or context dependent: specific to a group's consensual (i.e. sensed together) cognitive domain (domain of action or co-operation). Symbolic reference and syntax gave humans the capacity to discourse, detached of time and space immediacy, and to acquire increasingly reflexive capacity via both language behavior (the use of language to coordinate action) and languaging (the use of language to refine language behavior).

This means that within a given consensual cognitive domain, focus on language behavior -the semiotic process in Peircean terms- as object of coordination, i.e languaging, is remarkably effective. When symbolic reference and codes have a common grounding, language can focus on itself as already grounded in a socially constructed shared reality that becomes 'transparent' to the observer / agent, because unselfconscious. One can think of fish in water, or of so-called "cultural bubbles", which we only become aware of when we take a step out. In such closed contexts languaging shapes and 'perfects' language behavior and shared systems of signs. Languaging actually makes language behavior more effective for coordination of action: nuances within consensual cognitive domains or across closely adjacent ones can more or less easily be worked out...

Symbolic reference and syntax however offer no 'cues' for understanding, no clues to get to the patterns we may perceive and share across domains, if the symbols have not been learned and practiced via accumulation of shared experience. Outside of shared experience contexts there is no shared perceptual reality, no tacit 'grounding' of language, no support from historically shared experience, no ground for translation, no recursive habit that helps reflect, integrate and change. Languaging is thus not effective as enabler of coherence transcending domains. And if languaging can occasionally be effective for a group of diverse people put together in a room, while they are in the room, coherence usually does not 'stick', as the 'natural' inclination towards historically acquired reference systems comes back in spades.

As groups scattered and individuated independently from one another, they evolved different lexical and syntactic systems, each as described by Dave Gray[133] 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

[132] Schilhab, Stjernfelt & Deacon (Eds.). (2012).
[133] Gray (2016).

combine them. This is how the Eskimos end up with 250 words to say snow or for different shades of white[134], 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)[135]. Some variations are more subtle, with similar words or symbols meaning radically different things to different people -take freedom and equality for example, or American Values.... 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-[136], a large part of our capacity to understand each other across the boundaries of these domains. Through the course of human evolution, even if we retained some capacity for pragmatic grounding, our natural, biological, 'embodied cognition' capabilities, and our patterning capacities have somewhat been obscured by our propensity and skills to manipulate concepts that may be detached from perceptual reality

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, symbolic and logical form in which this capacity is expressed or performed -which Chomsky called External language, E-language[137]. *Langage* as capacity is unique/universal to all humans, it comes in the singular. *Langues* as sign systems, and systems of rules, are the multiple instances of *langage* as a capacity, which come in the plural. Language behavior, the use of *langage*, embedded in the semiotic process of modeling and operating in one's environment, i.e patterning, enabled humans to develop a capacity for the meta process of languaging, which complemented the recurrent use of language behavior to refine *langues* as sign systems.

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 language behavior abilities reflected in our capacity to use and associate not only the categories of percepts that constitute the key knowledges humans are born with mentioned in section 4, pattern-like (forms, quantities, motion, directions, positions), but also the iconic and indexical associations which form the related symbolic references, in infinite forms of combinatorial. This patterning capacity enables us to model and express the way we see the world and interact with it in logical and effective ways, whichever language instance 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. Through the joint effect of language behavior and languaging, 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[138]...

In particular it is a curse in a time when humanity needs to bring the pieces together, both in terms of knowledge and agency, to solve increasingly complex sustainability and societal issues.

How can we get out of this predicament? Being aware that our divergences come partly from culturally

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[134] This may well be widely exaggerated if not an anthropological hoax, but it still illustrates the variety... See https://en.wikipedia.org/wiki/Eskimo_words_for_snow
[135] Boroditsky (2011).
[136] The process of co-individuation follows a similar pattern: we become what we are in relation to one-another in our shared context.
[137] Chomsky (1997).
[138] Or so says the 'common' interpretation.

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. There is a need -an evolutionary pressure?- for reciprocal grounding across symbolic systems using human's advanced semiotic competences, processes and relations (patterning) in order to coalesce different forms of agencies and knowledges. 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. In other words, this means reconnecting with and putting to work our 'patterning' ability that underpins our 'languaging' one.

5.2 Ways Forward in Pattern Literacy

Reconnecting with this patterning ability supposes making a distinction between patterning and languaging. It involves recognizing their respective benefits and how they work together, in order to draw on their respective effectiveness and on the potential synergies towards both connectivity (in crossing domain boundaries), and focus (in context-based formulations). It also involves methods for comparing and confronting ways of patterning and languaging.

There is a whole potential to discover, by exploring and distinguishing further the processes of patterning and languaging, and by relating 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.

A path forward is summarized in my *Patterns as Connectors of Multiple Reality*[139] ISSS 2018 presentation, which challenges dualist epistemological and ontological positions. For one side, reality is objective and the same for everyone, discrepancies come from knowledge, and therefore common language is attainable. For the other side, reality is constructed, and all positions are relative to the constructed domain of reference in focus and can only be dealt with from within, using the codes of this domain, often assumed to be incommensurable with other codes. A more encompassing position is proposed, somewhat related to critical realism, based on an acknowledgement of the simultaneous existence of three levels of 'reality':

(1) socially constructed 'realities'[140], the consensual cognitive domains described earlier, resulting from a history of experience and cultural transmission, which constitute a plurality of complementary epistemic worlds and forms of agency, operating at the symbolic level,

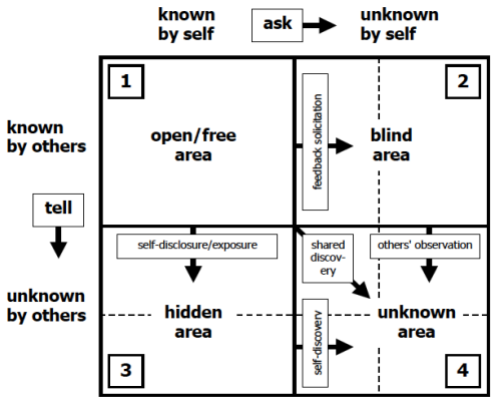
(2) experiential reality in the phenomenological experience, which can occur 'in between' domains, at the inference level,

(3) an unknown, unexperienced reality which includes systemic underlying patterns, and the possibility for yet to be discovered universal patterns, hidden from view, at the imaginary level.

The Johari Window model of interpersonal awareness[141], illustrated below[142] provides a good framework to explore these three levels.

Depending on the topic of focus and the domains involved, the use of languaging and patterning may be more or less effective. The resort to either may vary, and the tools used to explore these levels of reality or different areas of the model may be different.

[139] See my ISSS 2018 presentation Patterns as mediators of multiple realities:
https://www.academia.edu/37628809/Patterns_as_Connectors_of_Multiple_Realities
[140] I refer here to the portion of 'reality' or part of the semiosphere it has access to, its semiotic niche. I mentioned in section 2.
[141] Luft & Ingham (1955)
[142] Illustration © alan chapman 2003, www.businessballs.com



The Johari Window.

In this respect, four directions of work have been outlined, which mutually reinforce each other[143].

First, is making a prior clear distinction between the patterning aspects of language, at the phylogenetic, species level, and the languaging aspects, at the ontogenetic, developmental level. It is also developing frameworks such as the Johari Window above, that deal with intersubjective boundaries, and addressing which type of processes best apply: languaging within 'subjective' consensual cognitive domains, and patterning for exploring intersubjective worlds across or 'in between' consensual cognitive domains and for co-discovering the unknown. This would involve an assessment of the degree of 'self-sealing' or closure of the consensual cognitive domains involved and the evaluation of their potential for intersubjectivity, to determine how effective patterning and languaging may be.

Second, based on the distinctions above, is the use of patterns as research objects as proposed by Cunningham & Mehaffy[144], and the development of methods to confront and relate ways of knowing, perceiving, evoking and interpreting different or shared perceptual realities. The pattern thus becomes a boundary object, center of focus of a plurality of domains, which can record different ways or representing and interpreting, their coherence and discrepancies and the controversies thereof.

Third, which provides modelling tools to achieve the previous, is finding ways to work deeper, directly at the semiotic and systemic process level, and to develop a pattern literacy based on patterning processes. This involves studying sign processes and relationships, patterns and their formation. Further studies of semiotic referential systems may provide directions, which were not considered in my previous work, for re-constructing sign relations at the foundation of symbolic representations, in order to re-ground them. I will elaborate on this a little more in the following paragraphs.

Fourth, is the development of mapping and navigation systems, enabled by the above, to identify, map and navigate semiotic networks, and relative positions in the action and knowledge spaces.

Let's go back to sign relations and to the 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. The three systems of reference or types of sign-relations[145] seen at section 4.1 are not however completely detached or

[143] All are elaborated on to different degrees in Finidori (2016); Finidori & Tuddenham (2017); Finidori (2018)
[144] Cunningham & Mehaffy (2013).
[145] Kull (2019), distinguishes two forms of iconic reference, a basic form 'anterior' to indexical reference, and the more complex, preceding symbolic reference, bringing the total to four.

mutually exclusive. A same sign can be an icon, an index or a symbol depending on the interpretative process at play and the level of interpretation. Deacon describes 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 of iconic references 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.

The complexification or refinement of the symbolic construction is accomplished through learning, and can be seen in infant development, where children first make iconic associations (they recognize individual attributes of Papa, Mama etc), then they relate them (they connect sets of iconic attributes as indexically 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 the same story as yesterday).

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), with indexical and iconic signs playing the role of clues, to reconstitute more complex forms and concepts. This is an implicit, unselfconscious process, similar to the timeless way evoked by Christopher Alexander[146], 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[147].

This is done 'naturally' and implicitly when the symbolic code is shared.

I believe that doing it explicitly, i.e. by cracking open our semiotic and interpreting processes in participatory ways[148], and by looking for and analyzing patterns and patterning processes, both at the level of percepts, and at the level of the construction of symbols, would help improve communication among humans, in particular across different kinds of knowledges and forms of expression and understanding. Patterns and pattern languages, if they are configured to do so, would be an ideal medium for hunting for clues, the indexical and iconic signs that could both help construct larger systemic patterns and operate the co-grounding of various symbolic systems in experiential reality.

5.3 Ways Forward in Pattern Language

So how could pattern languages fulfil this role?

Pattern Language, because it seeks to integrate the *timeless way* of patterning and to capture patterning schemes and processes in dedicated languages, seems to be an ideal candidate for connecting patterning and languaging, and breaking through not only systems organization and processes, but also, as proclaimed lingua franca, the languages used for this purpose. But is it really so? How good are pattern languages at making the distinction between 'patterning' and languaging? How much 'patterning' and 'languaging' are involved in pattern language?

[146] Alexander (1979).
[147] Something Robert Rosen touched upon in his "Modelling Relation". Rosen (1990).
[148] Indigenous knowledge and forms of pattern-based expression can help. See Yunkaporta (2020).

I contend that patterns and pattern languages probably involve more languaging than patterning; or at least more languaging than would be required to reclaim and relearn our patterning ability in order to actually acquire pattern literacy and 'do' patterning unselfconsciously.

Naming and making explicit for reuse what is implicit in action and seeking to 'refine it' to elegance if not perfection is by essence a form of languaging. Christopher Alexander grasped the difference between the two 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[149]. Often however, as patterns are contextualized to an environment, pattern language design becomes absorbed by wordsmithing and abstraction for precision and recognition. These processes are akin to languaging, where language focuses on itself. Here, form (of pattern) focuses on itself, with the consequence that in many cases only insiders can relate[150]. In the process the cues that would enable the discovery of signs, their combination into larger systemic patterns, and the grounding to context that could further enable cross domain exploration and extrapolation are neglected. As a result, patterns and pattern languages themselves may become trapped in their own self-sealing logic…

In my *Configuring Patterns* paper[151], I focused on the systemic aspects of patterns and pattern languages, and on the effectiveness of pattern languages as they are currently practiced to address complex systemic issues. I challenged the common definition of patterns as solutions to a problem in a context. In particular I challenged the fact that neither problems, forces or desired outcomes were expressed as patterns, i.e. as recurring manifestations or signs of systems organization and behavior, which could be recognized and discussed, and themselves evolve. I suggested that formulating patterns (design patterns, the P patterns) in a modular way, using patterns (systemic patterns, the p patterns) as signs of what to look or to aim for, would be a way to make patterns and pattern languages more systemic, and therefore 'more fit' to deal with complex problems. Although I did not focus then explicitly on semiotic referential systems and the grounding processes that would enable an effective rendering and contextualization of these systemic elements, my intuition however led me to hypothesize that using patterns as signs could operate this grounding. The realization of the distinction between patterning and languaging and of the role of symbolic reference bring some clarity and supporting elements to this earlier questioning and intuition.

Patterns are not only formal representations of a design heuristic. They are also manifestations or signs of systems at work, 'sign' as referred to by Rebecca Wirfs-Brock[152], that can be tracked and "stringed together" to form 'trails' in the discovery of larger processes. Such constitution or reconstitution of trails, operated for the purpose of inquiry as well as of design, whether within or across domains, could be configured to enable the connection of different representation instances of similar patterns and the interconnection in semiotic maps and navigation systems of a plurality of symbolic reference systems or languages, revealing the patterning behind the languaging,

Wirfs-Brock elaborates on trails, referring to Moor quoting Richard Irving Dodge and his experience as a tracker, defining a trail as "*a string of "sign" that can be reliably followed [Moor]*". She goes on; "*"Sign" refers to the various marks left behind by an animal in its passing—scat, broken branches, spoor, etc. A track is evidence; a mark or a series of marks or "sign" that something has passed through. A track only becomes a trail when a series of "sign" can be followed. "Sign", according to Moor, can be physical, chemical, electronic, or theoretical. An animal might leave "sign" but unless it can be tracked reliably, a series of "sign" doesn't automatically make it a trail. Trails are trails because they can be trailed. Moor claims that, "something miraculous happens when a trail is trailed. The inert line is transformed into a legible sign system, which allows animals to lead one another, as if telepathically, across long distances.*" We are in semiotic territory here. This 'telepathy' is driven by the semiotic process whereby signs are perceived, combined, interpreted as clues and acted upon as cues in an ongoing manner[153], aka patterning. There is no esoterism here.

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[149] Would the 15 properties be of a nature that allows a semiotic reconstruction and grounding? But how do these principles apply on other domains than architecture or 'place'?
[150] Wirfs-Brock (2018).
[151] Finidori (2017)
[152] Wirfs-Brock op cit
[153] The reader may relate this to the engineer's OODA loop: Observe, Orient, Decide, Act.

Wirfs-Brock suggests that patterns have the potential to be trails if one is able to move from one "sign" or pattern to the next. Pattern language in its form as well as in its practice has the potential to enable this process.

Stringing signs and trailing are a form of ongoing adaptive unself-conscious modelling, which could be undertaken self-consciously using micropatterns to construct or deconstruct structure or processes, as well as meaning, to describe and explain what is observed and/or to design something new, using referential systems that are more indexical and iconic than symbolic. One can think of a 'hacking' exercise or a Lego Serious Play game[154], where combinations are made of discrete objects, and each relation in a model can be explored and probed, and adapted in participatory ways. Such adaptive technique would allow different forms of modelling processes and different modelling languages to be compared and confronted.

Experiments in this direction were undertaken by the author at Purplsoc 2015 and Plop 2016 with a set of systemic interpretation cards[155]. Participants were to model situations and patterns they observed or experienced using these cards, and then explain and discuss these patterns with the group. The situations described in both instances were very diverse[156], and cards were used in many different ways, to 'tell systemic stories' using patterns, as some participants described in the debrief. The key take-away here is the participatory nature of the process, where the patterns expressed and the trails they compose are the focus as boundary objects, allowing some grounding, away from the conceptual and symbolic. A way of walking together looking at traces and building trails co-operatively as we go, and at the same time, walking each other through each other's trails, to compare and confront them. This does not necessarily involve alignment, agreement or consensus in the everyday sense[157] of the term consensus. It may be adversarial or confrontational when interpretations and purposes diverge, in which case using grounding processes can help minimize symbolic 'loads' and related misunderstandings.

It is interesting to note that Wirfs-Brock elaborates on tracks and trails in the context of design heuristics using examples from Domain Driven Design. Two concepts mentioned in the referenced paper[158] are highly relevant, as far as application into tools and methods is concerned, to a better understanding, monitoring and orientation of socio-technological systems faced with complexity, in a context of fragmented knowledge and agency. These are *Bounded Context* and *Event Sourced Architecture*. Both deal with signs from a semiotic and systemic/dynamic perspective. I will only briefly point here to how useful it would be to explore this further in the context of the present research.

A *Bounded Context* is defined as "*a unit of encapsulation where the interpretation and meaning of a group of domain concepts are congruent... Different Bounded Contexts can have same-named domain concepts but have completely different information and domain models associated with them. Consequently, in such designs, there are heuristics for identifying Bounded Contexts and determining the relationships between them.*" These bounded contexts are examples of cohesive consensual cognitive domains I was referring to earlier. It would be worth exploring how the heuristics mentioned could apply to identifying consensual cognitive domains, and how they could help determine relationships between them and the potential for intersubjective inquiry.

In the area of *Event Sourced Architecture*, events are records, traces of things that happened, which are interpreted to understand how a system is impacted, and which set possibilities for generating new events. An event is considered as a sign, a trail, that 'means' something for the next steps. This fits Favareau's description of the sign process from a systems perspective, summarized in section 2: *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)*. Sets of heuristics are applied, such as understanding how events flow around a system, tracking different kinds of events generated by the same process, looking for patterns of events to drive systems behavior. Such type of heuristics could also

[154] See Finidori (2016) and Finidori & Tuddenham (2017) for examples.
[155] More details are presented in Finidori (2017) and Finidori & Tuddenham (2017).
[156] Examples include modeling a known pattern, relationships in the workspace, organizational issues, power relations, new business models, business processes, scaling of good practices, continuous improvement, new technologies, the processes of good journalism, or urbanization
[157] The co-operation and con-sensus I am referring to generally in this paper are to be taken literally, in Maturana's sense: operating together and sensing/making sense together, in the same cognitive domain, not necessarily consciously and intentionally seeking to align.
[158] Wirfs-Brock (2018)

apply to track the patterns that transform and orient socio-technological and socio-environmental systems, towards systemic health.

More generally, and because heuristics and patterning are closely related, the techniques outlined by Wirfs-Brock for actively cultivating design heuristics could be applied to actively cultivating patterning capabilities in participatory ways. These proposed steps to which I added my own input[159] could constitute a basis to build upon for a patterning cultivation methodology[160]:

- Recording "sign": to keep tracks, capture meaning, as close as possible to percept and inference, using iconic and indexical references as clues for reconstructing meaning and cues to trigger action.
- Distilling what you hear: to bring things back to memory, to integrate them in your own patterning system by comparing to your own iconic, indexical, symbolic references, deconstructing the symbolic reference.
- Sharing heuristics to start conversation: to collectively distill and compare experiences, interpretations, representations through "sign".
- Holding an imaginary debate: to distill the heuristics embedded in each point of view, and confront what is perceived, interpreted represented.
- Reconciling new heuristics with your own 'state of the art': to map and connect different signs and ways of combining them.

I am using Wirfs-Brock's work here quite briefly as an example of where this can go. The work deserves more exploration, to evaluate how all the tools and methods described in this section may be integrated.

There are many avenues yet to explore, in order to expand and put the present theoretical work into practice. This will be the object of future research and papers.

6. CONCLUSION

This paper does not provide solutions or answers, rather, it sets a foundation to show how by construction, language systems enclose humans in self-sealing logics which hinder their ability to integrate different forms of knowledges and agency.

A way out of the Babel Curse, rather than waiting for the Pentecost[161] -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 inferential language) and languaging (which shapes 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 the sign processes we share at the most basic level of embodied cognition, rather than at the higher levels of values and culture.

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, would take us in this direction and bring new possibilities for the study and orientation of socio-ecological and socio-technological systems. This opens up opportunities to further explore how patterns and 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'. An endeavor not so remote from Alexander's intent, if one considers the adaptive and flowing nature of his approach to design and the 'nature of order', versus more rigid architectural programming.

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[159] Which may be twisting a bit Wirfs-Brock's initial intent

[160] Some directions and examples of tools and participatory methods, tapping in the potential of patterns, have been described Finidori (2016); Finidori, Borghini, Henfrey (2016); Finidori & Tuddenham (2017). Finidori (2018).

[161] 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/

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 may help us get there.

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