ON THE ROLE OF THE BALDWIN EFFECT IN THE EVOLUTION OF A LANGUAGE FACULTY

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Abstract

The Baldwin effect is a highly controversial part of a new perspective the Extended Evolutionary Synthesis, featuring the influence of learning and development and the extent of its influence on biological evolution. For humans , a species highly influenced by culture and learning, the Baldwin effect offers a potentially plausible explanation for some human bio-cognitive properties, inexplicable by Modern Synthesis. It is particularly well positioned for explaining the human innate predispositions for learning and processing of language, i.e. a language faculty, as adaptation to a pre-existing language system, a product of cultural processes.

Keywords: evolution of language**,** language faculty, Modern Synthesis (MS), extended evolutionary synthesis(EES) Baldwin effect,

1. Introduction : Darwin's theory, an evolving framework for understanding bio-diversity

In the original Darwin's theory of evolution by natural selection diversification of life forms is understood as alteration in heritable characteristics of successive generations of individual biological bodies by a three-step process, encompassing three interconnected phenomena in the living world, i.e. variation, inheritance and differential survival. In this context speciation and species' diversification results from series of small successive modifications, gradually accumulated in each new generation of descendants, leading to divergence into new species. Subsequent advances in science, crucially the discovery of the gene, triggered reevaluation and extension of the original Darwinian theory resulting in the Modern Synthesis(MS) as a new and improved understanding of evolution. Mendelian heredity bares the name of Mendel who in the 19 century designed a mathematical model for describing heredity. The modern interpretation of Mendel's theory understands the organism in terms of an abstract model as a combination of discrete elements and describes heredity as “ inheritance by which stable, non-decomposable characters, controlled entirely or overwhelmingly by a single genetic locus, are transmitted over many generations “ (www. medical-dictionary.thefreedictionary.com/ mendelian+ inheritance). It is influenced by classical physics and studies evolution in terms of recombination of stable immutable entities which act independently of context. Mendelian use of mathematical concepts is coupled with the influence of Turing's theory of computation in modern biology. In this context evolution is defined as a computation process where a finite number of basic discrete units of DNA molecules combine and form the diversity of life forms. MS, the currently dominant evolutionary paradigm, features the gene as the ruler of the biological universe and gene mutations as the only explanation for evolution of life on earth.

A relatively recent extension of the mainstream Modern Synthesis, population genetics, defines evolution as change in genetic frequencies within a population of life forms, genetically programmed for cooperation. In this context genetic diversification occurs when in a small reproductively isolated population a rapid proliferation of a chance mutation in a single individual or a small number of individuals(Mayr 2001). The process is driven by population-internal factors and progresses insulated from environmental interference, thereby altering the trajectory of evolution in unpredictable direction. Population genetics, as I understand it, largely transplants the principles of the Modern Synthesis to a smaller, population context, under the understanding that evolution happens at a local level, while maintains the main tenets of the Modern Synthesis, featuring the gene as the primary driver of evolution.

That said, the status of the gene has been questioned and criticized by various authors given that in biology pleiotropy (a single gene influences multiple, often unrelated phenotypic traits) is the rule, not the exception given that a change in a single gene most often than not has no significant effect on a trait, suggesting that the genome is inherited as a whole .This explains the fact that, although mutations occur quite frequently, organisms of the same species end up remarkably similar given that a damage in a gene is repaired by " this amazing system for maintaining the integrity of the DNA " (Jablonka, Lamb, 2005, p. 86). And identical twins, i.e. individuals with identical genomes, differ phenotypically, and these differences obviously emerge extragenetically, suggesting that the genome cannot be the sole mechanism determining heredity(for a summary see Bonduriansky, R. 2012). In addition, all cells in an organism inherit the same genetic information and yet they develop into specialized tissues and organs, very different from one another, e.g. skin, liver, etc. They follow developmental schedules, specific for the type of cells. Significantly, humans share 99% of the genotype with chimpanzees, but display vastly more complex behaviour. So, even to the outside observer with no expert knowledge it is noticeable that the genome is not all that is inherited and not all that is in the genome is heritable information. It is now known that only a small part of the genome codes for proteins, i.e. participates in the building of the biological body and, thus, participates in evolution. The genome is made of different types of genetic material, a good part of which has no role in the formation of the biological body. Moreover, beyond the genome other components of the cell are inherited and participate in the building of the phenotype. In short, not only the genome is not sufficient for the building of the biological body, but much of it has no function in its survival, i.e. selection and thus, in evolution(Jablonka, Lamb, 2005;).

From evolutionary perspective this suggests that the genome evolves as a whole, not as a sum of individual evolutions of single genes. Most importantly, this reveals that the role of a single gene can only be understood through its integration and interaction in the context of the genome in its entirety. In addition, it was found that " rates of molecular and morphological evolution are largely decoupled", i.e. " Phenotypic mutation rates and genetic mutation rates are dramatically different" (Skinner, Nilsson 2021, p.1-, see also references). Significantly, it is well known that some genes have not changed for millions of years and the same genes are found in species vastly different from one another. Humans share some genes with mice and yet, they don't have the same effect in us as in mice.

Moreover, the genetic code is one among various other mechanisms information is contained and transmitted, and different types of inheritance affect development at different times and to different degrees as they interact. This makes the role of genes and other inheritance systems and phenotypic characters difficult to evaluate in isolation. Thus, the genocentric paradigm faces empirical challenges, suggesting that the blanket understanding of mutations as genetic accidents, blind to functionality appears to be too simplistic as " the nature of inheritance in different traits and taxa (is) spanning along a continuum from purely genetic to purely non-genetic "(Bonduriansy, 2012, p.334).

" ...there is really no chance of predicting what (the organism) will be like merely by looking at their DNA. " (Lamb, Jablonka, 2005,p. 67)

This prompted the argument for revision of the MS as a gold standard and conceptual enrichment of the evolutionary theory, by proposing EES, which introduced new concepts, e,g. extragenetic inheritance, epigenesis, niche construction, reciprocal causation, gene-culture coevolution. Epigenesis is a processes of formation of the phenotype through interaction of the genome with the environment at the molecular level. Epigenetic mechanisms " regulate genomic activity independent of DNA sequence"(Skinner, Nilsson 2021,p.3), therefore, genomic activity is conditioned on epigenetic processes. The environmental influence on genomic activity thorough epigenetic processes produces variation at the level of cells, organ tissues and morphology. Epigenesis is by definition non-genetic and thus, not Mendelian. The epigenetic routines are also referred to as "canalization" as they constrain and shape the developmental process to follow established pathways(Jablonka, Lamb, 2005 and elsewhere). The information about the post- fertilization process of building various organs and tissues of the new organism is contained in the so called regulatory genes which follow established pathways of turning on and off specific chemical processes at specific time-frames depending on the type of tissue, i.e. development unfolds determined by regulatory genes.

Epigenesis is poorly understood and controversial topic and its role of epigenesis in evolution is currently debated. Epigenesis is poorly understood and controversial topic and its role of epigenesis in evolution is actively debated as its adequate understanding is hampered by obstacles both theoretical and experimental. As Burggren (2016) explains, on the one hand epigenesis is regarded in digital terms as presence vs. absence of a trait, while in fact epigenetically derived traits become detectable not in the first but in successive generations of offsprings and thus are counted as absent, especially in species with long lifespan for which developmental data is not accessible. In addition, epigenetic routines are not uniformly preserved as in some species the effects of epigenesis dissipate with time. Thus, epigenesis displays complexity and irregularities not accounted by theoretical instruments. Epigenetic routines are subjects to evolutionary processes and a growing number of scholars recognize that most epigenetic changes are preserved over time, i.e. they are heritable and affect multiple successive generations and have the potential to affect evolution, which justifies arguments for the conceptual integration of epigenesis into the evolutionary theory. To note, although epigenesis can be effective adaptive response to environmental fluctuations, as per Burgeren (2016) this may not always to be the case as in rapidly changing environments today's beneficial epigenetic adaptations may suddenly become counter-adaptive in a new environment.

The proponents of EES argue that epigenetic mechanisms are active participants in the overall evolutionary process on par with genes (Jablonka, Lamb, 2005). This is reflected by the developmental systems theory (DST)(Griffiths, Hochman, 2015,West-Eberhard 2003) where the unit of selection is the life cycle and its replication, thus, the biological organism at its developmental stage is the unit of selection as it determines the viability of the adult organism. The contributions of EES to the evolutionary theory include acknowledgement of learned behaviours as another dimension in the overall evolutionary process.

To remind, in the context of MS learning is understood as genetically pre -specified and evolution of behaviour as a result of learning is predetermined or at least highly constrained by genes, and given that fruits of learning are by nature ephemeral, limited in duration and scope, these are envisioned to have limited contribution in biological evolution.

That said, as per Lamb and Jablonka (2005) variations of new behaviours are selectively perpetuated by the next generation only on the basis of their superior survival benefits to alternatives. This means that inheritance of behaviours contributes to the survival advantages of individuals, e.g. the mother's food preferences influence the survival or at least the quality of life of the new generation and with it its superior reproductive potential. Crucially, evolution of adaptive behaviours often results in permanent change in the phenotype by evolution of new morphological properties supporting these behaviours (Brakefield, 2011)

In addition EES has enriched our understanding of evolution by acknowledging the role of the environment and its active participant in diversification of life forms, an idea pioneered by Lewontin (1983, 2002), who has argued that the interrelation of three factors, the genotype, the phenotype and the environment, acts as a complex eco-system whose components influence each other. Species are adapted to specific facets of the environment, i.e. environmental niches, and the relationship between species and their niches is by-directional, e.g. species evolve as they adapt but also alter the environment simply with their normal metabolic processes. Thus, the organism is an active participant in its own evolution as the environment and life forms form an integrated complex, the components of which evolve in tandem by a process of co-evolution, a process of reciprocal evolutionary change which occurs in entities (species, groups of species) as a result of their interaction and interdependence. In other words, "...Taken together the relations of genes, organisms and environments are reciprocal relations in which all three elements are both causes and effects. Genes and environment are both causes of organisms, which are , in turn, causes of environments"(Lewontin, 2002 p.100). In short, evolution is a process of interaction of multiple inheritance subsystems, i.e genome, epigenesis, learning, environment, or evolutionary dimensions in constant interaction where "Something like evolution can occur in each dimension. But...we are not made up of four neat and separate dimensions, we are a messy complex. And it is the complex that evolves " (Lamb, Jablonka, 2005, p. 231).

To conclude, evolution is a multidimensional process integrating multiple levels of inheritance in reciprocal relationship.

2. From learning to genes : Baldwin effect and its controversy

A well-known example of the role of epigenetic influence on the genome is the Baldwin effect.

" ...natural selection can convert what was originally a learned response to the environment into behaviour that is innate." (Jablonka, Lamb, 2005, p.285).

It is traditionally assumed that learning influences the life of the individual, but this influence dies with the biological body, which is why the argument by Lamarck for biological inheritance of learned behaviour is widely rejected.

That said, M. Baldwin postulates a type of evolution by which learned behaviour, proven to be beneficial to evolutionary success, can gradually become easier to master with every new generation to the point when very little or no learning is required and the behaviour essentially becomes instinctive, a process known as the Baldwin effect. To note, the transition from learning to genes as, envisioned by Baldwin, is a gradual and protracted evolution of development, and should not be confused with the theory of Lamarck who argued that the fruits of parents' learning become converted into instincts in the next generation of offsprings.

Scholars diverge in their interpretation of Baldwin' s original hypothesis and the conceptual framing of the Baldwin effect. For example, genetic assimilation, a key concept in the hypothesis, is defined by some as genetic change either by taking advantage of existing genetic variation, or as creation of new genes (Depew, 2003, Downes, 2003). The place of the Baldwin effect in the overall evolutionary process is also subject to debates as some identify it as independent mechanism, while others regard it as simply an extension of the regular evolutionary process(Weber, Depew, 2003; Godfrey-Smith, 2003).

To sum up, genetic and epigenetic inheritance interact as two interdependent processes which often cannot be separated. Given the scarcity of empirical evidence in support of the hypothesis, the status of the Baldwin effect in evolutionary theory is currently unclear.

2.1. The adaptive advantages and disadvantages of learning in evolution

Some recent studies have brought new attention to Baldwin's argument and highlighted its focus on development in evolution(Moore, 2003; Jablonka Lamb, 2005) by stating that normal evolutionary processes of variation and selection work on epigenetic mechanisms, i.e. epigenetic processes also evolve. Some are triggered by accidental copying errors in gene replication, in others, environmental factors can influence the epigenetic processes directly, e.g. environmental changes, especially high levels of stress may cause deviation from the normal direction of canalization, as in Waddington's experiments with Drosophila (1953) where external stressful conditions, applied repeatedly, result in deviation form the normal pattern of development. Significantly, the argument stipulates that once the organism adapts to the new environmental conditions by altering its developmental routines, even if these environmental pressures are no longer in place, the new developmental pattern will be preserved and inherited by the new generation of Drosophila, a process termed " genetic assimilation of acquired characteristics". Waddington's study of Drosophila challenges the argument for the unidirectional nature of information transfer from genotype to phenotype as it shows that extra-genetic developmental factors cause alterations of the genome through alteration in the functions of regulatory genes, causing "reverse translation", i.e. the phenotype does influence and trigger changes in the genome.

Significantly, contrary to the genocentric argument that genes remain unchanged, unaffected by development, Jablonka and Lamb show(2005 chap. 2.p.68) that change in the genes is a normal response as feedback from development in many organisms. The immune system is one example, where genes producing antibodies become altered in various ways in response to the environment. The point here is that it is not reasonable to expect that the information in the genome would necessarily become faithfully copied, as it is subjected to interpretation and often edited during development under environmental influences(Caroll, S.2005)

To clarify, Waddington shows that environmental conditions can alter the development of biological properties, while Baldwin argues for internalization of learned behaviours, and even learning directed by consciousness, i.e. Baldwin hypothesizes will and choice as a factor in evolution.(Downes 2003). It is also useful to clarify that the term “innate” and “ internalized” here stands for properties which develop regularly and uniformly with minimum input from the environment, be it by direct genetic encoding, bio-chemical triggers of embryonic growth as in epigenesis, or neuronal networks formed from input from experience, as in development.

It is argued that internalization of learned behaviours has both advantages and disadvantages, e.g. while genetic facilitation for learning is adaptive in stable environments, learning plasticity is adaptive in environmental variability, learning is a costly investment given the time and energy involved. On the other hand, fixing in the genome a previously learned behaviour is adaptive as it eliminates phenotypic variability, i.e. delivers phenotypic uniformity and decreases energy cost (Sznjder, et all. 2012). At the same time replacing learning and thus, flexibility with internalization, understood as limiting learning flexibility, is viewed by some as a detriment to adaptability (Weber, Depew, 2003). In this sense Baldwinian processes reveal nature's compromise: a spectrum of innateness and environmental adaptability.

“ In between these extremes lies a spectrum of outcomes where traits contain a genetic component, but they are also to various degrees modifiable in response to environmental influences” (Sznajder et all. 2012, p. 301).

2.2. Baldwin effect and culture-cognition co-evolution

Culture is broadly defined as the sum total of learned behaviours, and human culture also includes artifacts and ideas which makes it part of the environment as a selection factor in evolution. And although many species have demonstrated extensive learning abilities, e.g. birdsongs are partially learned, the term “culture” is better attributed to humans. In fact human species are unique in that our evolution has been highly influenced by gene-culture co-evolution, including language evolution (Pinker, Bloom,1990; Levinson, Dediu 2013; Stromswold, 2010). The finding that biology/nature and culture/nurture mutually influence one another makes the reference to these two in opposition irrelevant. The effects of culture on the human organism are easy to notice, e.g.changes in digestion as adult milk tolerance as an effect of farming, evolution of tooth morphology as a result of cooking are some of the most obvious examples, although pinpointing of specific genes altered by cultural practices remains challenging (Richerson, Boyd, Henrich, 2010)

At the same time it is challenging to identify the effects of culture on the evolution of cognition and the brain's processing mechanisms and especially the genetic inheritance resulting from cultural innovations, given the scarcity of clear evidence for direct causation as a learning mind is flexible and adaptable. And although some animal species have demonstrated some limited learning abilities, e.g. young vervet monkeys must learn to use their vocalizations in the appropriate , culturally formed context (Hilliard,White, 2009), culture and cultural learning is most clearly associated with human species. Learning flexibility is especially adaptive in rapidly changing climatic fluctuations known to have occurred during Middle and Late Pleistocene, correlated with the evolution of the Homo branch and the evolution of large brains and more technologically advanced culture(Richerson, Boyd, Henrich , 2010), suggesting a co-evolutionary processes between learning, culture and the environment given that culture becomes part of the environment to which the body and mind must adapt. In this sense, it is reasonable to deduce that cognition would not be immune to cultural changes (Lotem et all. 2017). Thus, as a default, one is justified to hypothesize that culture is both shaped and shapes cognitive processes and, presumably, even their genetic bases. Lotem et all. (2017) argue that adaptation of cognition to culture is better understood in terms of co-evolution of data processing mechanisms and memory. The need for extensive retention of data by the memory is constrained by the limitations of memory storage, which results in a bottleneck and restructuring of information by processing mechanisms via segmentation of the stream of data into simplified chunks, combinable into larger information units, which allows simplification of storage and reduces the memory load. In this sense the same information is represented in a more compact forms in terms of generalizations. And given that adaptation of cognition to environment is to be expected, it is argued that with time the data processing mechanisms of the brain have evolved from memorizing large sequences of data to retaining information in terms of structures of combinable primitives, i.e. memory storage is traded for computational abilities, and such evolutionary transformation is empirically demonstrated by the extended ability for computation in humans as compared to primates, especially in language learning and tool-making. Observation that young children have larger memorizing capacities compared to adults, who on the other hand display extended computational capacities suggest that large memory storage was probably an earlier stage of cognitive evolution and computation was a late evolutionary achievement, possibly in response to extended information load of the Paleolithic cultures, suggesting Baldwinian processes. In social species, e.g. primates and especially humans, learning is achieved usually by observation and interaction with fellow conspecifics. In this context cognitive adaptation to social learning is to be anticipated, despite scarcity of direct evidence, although the discovery of mirror neurons offers a reliable demonstration that this must be the case (Rizzolatti, Craighero, 2004)

3. The origin of language as adaptation to pre-existing linguistic and sociocultural environment

Baldwin effect has been evoked by some scholars in efforts to explain the evolution of the language faculty as adaptation to a pre-existing language system, originated as a learned behaviour, as a demonstration of adaptation of the human body and mind to cultural products. In this context Pinker and Bloom(1990) argue that the language faculty, i.e. Universal Grammar, has evolved by Baldwinian processes in adaptation to a culturally formed language system, based on the speculation that languages of pre-civilization communities were the same as those of modern societies marked by mass proliferation of writing, advanced culture, science and technology, as per the uniformity argument.

Nevertheless, we can assume with confidence that a language system formed as cultural product would reflect the communicative needs of the first speakers, which must have been very different from those of members of modern societies. Given our current knowledge of lifestyle and culture of the first human populations from anthropological, archeological, etc. findings, we can assume with confidence that they lived in small communities of genetically related individuals, i.e. extended families, organized in culturally and informationally homogeneous, egalitarian societies, implying that a significant portion of knowledge is shared by all members with a life style centred on informing others about perceived treats, solving ecological problems, organizing a hunt, or settling a dispute among rivals, in interpersonal and inter-tribal conflicts, i.e. in circumstances typical for the daily life of our ancestors as members of small groups of individuals, usually united by family ties (Givon 2002; Everett, 2005, Hallpike, 2018). This suggests, among other things, that the social structure of the community and the number of its members is a significant contributing factor for the communicative interactions among them and by association, for their communicative demands and ultimately, for the properties of the language system. Moreover, the close relations among communicators in a small isolated community suggest that a significant portion of knowledge is shared by all members, as it is either implied, or shared by non-linguistic means e.g. songs, rituals, gesticulations, i.e. the information encoded in linguistic forms is a small portion of the sum total of information available. And given information equality, there is not much new information to share, suggesting lack of demands for elaborate language system. In these circumstances smaller vocabulary and simple grammar, organized in short, loosely connected utterances in face-to-face dialogues, suffices. In addition, in direct dialogues the linguistic message is accompanied by non-linguistic multimodal signs, e.g. facial expressions, body posture, etc, the potential for misinterpretation, inherent to such language systems, is neutralized by the immediate direct contact of communicators. In this sense one would anticipate that language systems, as reflecting the communicative demands imposed by this lifestyle, must be very different from languages in use by today' multiethnic societies and their millions of speakers, organized into hierarchies based on social standing, profession, access to education, possession of material goods, etc. suggesting information inequality, leading to a much higher demand for information exchange and, consequently, much more elaborate and tightly organized language systems.

From a different angle, the informational advantages of a language system must outweigh the physiological and cognitive expense to justify its continuous perpetuation. Languages of small communities living with nature are likely to be composed of linguistic forms easy to process, learn and pronounce, that is, they must be energy-efficient to be adaptive in a body for which life in pre-civilization reality demands a great deal of energy, emotional, cognitive and physiological. Efficiency, precision and accuracy in communicating essential information, especially in situations of life and death, is essential especially if daily encounters with the uncertainty of brute nature are part of life. On the other hand evolutionary explanation for a Universal Grammar delivering linguistic complexity far beyond the speakers' survival necessities is unconvincing as the grammatical complexities and intricacies of modern languages have no adaptive value in our ancestors' original habitats. This is demonstrated in emergency situations today when use of language is severely reduced to the very essentials, e.g." Fire!", "Out !", where complex grammar is clearly absent . Moreover, complex grammar has high energy demands for both human cognition and physiology as long sentences with multiple recursive structures take longer to rapidly and correctly process and articulate with precision, which a human body living in pre-civilization conditions cannot afford. All this makes the argument for the evolution of Universal Grammar implausible.

Significantly, there still are human populations which have preserved to a large extent the lifestyle and social organization of the earliest stages of humanity, suggesting similarities in communicative demands, dictating the organization of language. And if one assumes that a language system is a reflection of communicator's needs for information, ultimately reflected in the individual's bio-cognitive properties with which it must have co-evolved, one must conclude that a human language faculty, evolved to reflect pre-civilization socio-cultural environments, must have many or most of the properties displayed in languages of today's small pre-literate communities. This suggests that one can make inferences, although with caution, about earlier stages in language evolution from these indirect sources of information. So, dialogues composed of short messages, which require little cognitive expense to process and little physiological effort to pronounce, were adequate to answer the needs for exchange of information most essential for survival. It is this type of communication which was adaptive in pre-civilization habitats and which is the best indication of the innate Language Faculty and its evolutionary raison d'etre. In comparison, languages with long literary traditions which carry the better part of the extended communicative demands of a large, diverse society, marked by information inequality, necessitates a large vocabulary of constructions with extensive use of highly abstract grammatical machinery, mastered by extensive learning and practicing like any other skill. Language systems of such sophistication impose high processing demands and extra efforts for articulatory precision. That said, human populations with prehistoric lifestyle as well as western college graduates are born with the same language-relevant innate predispositions, a language faculty, limited to the essentials of language , as it has evolved in pre-civilization environments.

4.1.The languages of today's pre-literate communities

The conceptualization of language by the prominent linguistic paradigms is based on languages of advanced societies.

On the other hand, the languages of small isolated communities with pre-historical lifestyle demonstrate significant differences in all aspects of the language system, demonstrating that language cannot be understood by preconceived notions furnished by modern western thought. Cysouw and Comrie (2013) outline some structural typological similarities among a number of languages spoken by small hunter-gatherer communities in Australia, summarized as follows : lack of dominant order of sentence constituents, word order is notoriously flexible and where there is such, it is non-SVO, lack of adpositions, a few postpositions, no dominant order of noun-genitive, preference for genitive-noun, interrogatives in initial position, a few subject clitics, small phonological inventory. The outlined structural features are only statistical preferences, i.e. there is no stable structure. The system flexibility suggests a potential for ambiguity, compensated by significant reliance on contextual clues for the disambiguation of the message for assuring successful communication. Piraha is another example of a language untouched by modern civilization. D. Everett (2005) describes it as follows: Piraha grammar is designed to capture immediate experiences , that is, no detachment from here-now, no past tense marking , folk tails are descriptions of experiences of direct observers of events , no embedding of phrases and sentences, the simplest pronoun inventory, no semantic quantifiers, women use simplest phonological inventory known. In addition, Pirahas use extensively prosody as well as non-verbal vocalizations, e.g. humming, whistling, singing. In the lexicon no colour terms, no numerals, the simplest kinship system . Straits Salish, a language spoken by small communities in the North West coast of Canada and the USA does not distinguish verb and noun as grammatical categories. The lexicon contains a single open class of predicates which denote events, entities and qualities which function as arguments, modifiers or predicates depending on their position in a syntactic slot. In a predicate role they appear in initial position in a sentence, followed by a subject and object (Evans, Levinson 2009, p.434). The anthropologist Christopher Hallpike (2018)describes the language of Korso, a small tribe in Ethiopia as follows: no comparatives and superlatives, no linguistic markers for indirect speech, very little use of adjectives and adverbs, preference for use of short phrases which nevertheless successfully convey the intended meaning, conceptual recursion, e.g. in story telling events are verbalized in the absence of grammatical recursion. Hallpike (2018) also describes Tauade, language spoken by about 7,000 in Papua New Guinea as follows: occasional use of recursion, usually avoided with preference to concatenation of short sentences, as in Korso. The standard word order is SOV, little use of adjectives and adverbs, no comparatives and superlatives. Stories are told by sequences of individual phrases and short sentences. He also describes Neo Melanesian, or Tok Pisin, a pidgin with vocabulary borrowed from German, syntax form English and Melanesian, spoken by non-literate natives of New Guinea, as follows: short sentences are preferred, juxtaposition of independent sentences with or without connectives for expression of conceptual recursion, only two prepositions with multiple meanings specified by context, e.g *in, on , at , to, from, with, at, about, because, for.* Nouns have only singular forms, i.e. no grammatical markers for plural. Verbs lack tense and aspect forms, time reference other than present is expressed by adverbial modifiers, no forms for passive voice or conditionals.

In contrast to the above-discussed languages of small isolated communities, Riau Indonesian is spoken by a large population of various millions in Sumatra. Gil(2007) describes Riau Indonesian as Isolating-Monocategorial-Associoational (IMA). Morphologically isolating means that words have no internal structure, that is, no morphology, so each word is a stem. Syntactically monocategorial means that there are no syntactic categories, that is, there is no distinction of parts of speech and any word can be noun or verb, or something else and belongs to one category, the sentence . Semantically associational means that compositional semantics is based on the so called "association operator" (A) which signals that in a sentence containing two words the meaning is interpreted as some form of association between the two word meanings. In sum, Riau " represents the limiting points of maximal simplicity within each of the three distinct domains , morphology, syntax and semantics." (Gil, .ibid. p. 2). Gil 's IMA is an abstract model as Riau has a few words with grammatical functions, e.g. it has a few affixes, uses compounding and reduplication. Hunter-gatherers of Central African Congo Basin use a mimetic language where a spoken message is mixed with singing, whistles, imitation of animal vocalizations, forest sounds, reenactments of events, dancing, etc. thus, iconic representation is widely used as a substitute, and/or in parallel to symbolic language (Lewis, 2014).

Importantly, as per Evans, Levinson (2009) 82% of languages attested today are spoken by communities of under 100,00 members and 39% by communities of under 10,000(ibid. p.432), suggesting that a large number of languages today are pre-literate.

The here referenced language systems differ significantly from the languages of today's highly industrialized literate societies known for rich vocabularies, e.g. a dictionary of English language contains some half a million items, highly abstract grammatical categories and extensive use of phrase and sentence embedding, designed to function with minimal participation of context, communicative and extralinguistic.

4.2. Conceptual systems of communities with pre-civilization lifestyle

All societies are organized around a common conceptualization of reality. The communities with pre-civilization life style live in constant interaction with nature and their conceptual systems reflect that. Taxonomic classification is limited in scope and guided by with practical utility, unconcerned with systematization and pattern extraction.There is no precision of counting, instead concepts like “some”, “ many”, “ most” are used. Pirahas lack the concepts of “left” and “right”. The number concepts are used for very practical purposes of counting material objects , e.g. fingers, toes, stones, shells, etc. Primitive systems of measurement are not standardized, use body parts for approximate estimation and depended on the material measured. Spatial concepts are also based on practicality and reflect everyday life experiences in the physical environment, sky, earth, village, house, human body. These form oppositions, e.g. inner/outer, high/low, closed/open, centre/periphery, etc. Conceptualization of time is based on perception of events in relation to one another, e.g. seasonal changes of dry and wet weather, cycles of sun and moon, etc. Similarly, the conceptualization of causality is rooted in the perception of natural processes and their relation to one another.

“ The world is perceived globally, such that each phenomenon is considered in its context: rain/water, well-water, stream-water, or sunlight, fire-light ...are all treated as separate entities, knowable only in their physical associations in particular circumstances..” (Hallpike, 2016, p.118)

Expectations about the future are based on past experiences about events, processes and locations, i.e. the future is based on repetition of the past. Importantly, the world is evaluated from anthropomorphic perspective.

Thus, the concept of universality of conceptualization of reality is an artificial construct and is contradicted by facts on the ground as human communities form and organize their mental life differently in reflection of their daily experiences with the environment and each other. In this sense conceptual systems vary widely, which challenges the argument for universal innate ideas by Descartes and the argument for human Language of Thought(Fodor 1975).The main difference between advanced and primitive life style is that the later is organized as part of nature where nature is a partner, while the former regards the human civilization as controller of nature by subjugating it to meet human demands, e.g. by harnessing power sources, domestication of plants and animals, extracting natural resources for use in industries, etc.
In sum, pre-historic lifestyle and concepts are rooted in experiences with raw nature, quite unlike conceptual systems of industrialized societies rooted in our “invented reality”(Searle , 1997),based on laws, institutions, education, monetary systems, and languages reflect these different systems of thought.

5. Language as a multifaceted behaviour and its representation in the human body and mind

Language-relevant functions in the brain are understood by linguists from two mutually exclusive theoretical alternatives. In biolinguistic context the standard view of the representation of linguistic knowledge and processing advocates for spatial and functional segregation of language concentrated in Broca' s area of the brain, identified as the location of syntactic computations (Chomsky1968 and elsewhere ; Pinker 1994; Bickerton 2014). The segregationist argument was based on the argument for modularity of human cognition (Fodor 1983). Alternatively the brain is understood as a flexible multipurpose processor, where linguistic functions are highly distributed and coordinated by experience (MacWinney1998; Deacon 1997; Liebermann Ph.2000 among various others)

That said, recent empirical studies reveal that the localization of language in the brain is difficult to pinpoint given that a large portion of the brain is involved in language-relevant functions, including subcortical regions such as striatum, cerebellum, thalamus, among various others (Fisher, Marcus, 2006). Moreover, the young developing brain is flexible and able to compensate for damaged abilities, linguistic and other wise, as demonstrated by recoveries from injuries, which makes attempts to isolate language areas even more challenging.The finding that there is no one-to-one correspondence between syntactic phenomena and brain functions adds to the difficulty, e.g. the brain does not differentiate between pronouns and reflexives (Kaan, 2009).Significantly, the language faculty is said to be " the most invasive", (Gulyas, 2009, p. 59) i.e.the most widely distributed cognitive faculty in the human brain (Ph. Liebermann, 2000; Bickerton, Szathmari, 2009). Moreover, it is suggested that the widely extended and diversified interconnectivity of the human brain, compared to that of chimpanzees and macaques, makes possible the integration of various types of information, i.e. phonological, semantic, lexical, grammatical, stylistic, in the verbalization of thought (Sherwood et all. 2008).

That said the established view that linguistic functions in most normal individuals are asymmetrically concentrated in the left hemisphere is still valid (Fedor, et all, 2009).
In addition, it has been argued that, as a general tendency, domain specific mechanisms arise during ontogeny under the influence of experience, forming domain-specific configurations of neuronal connectivity(Sherwood et all.2008). Moreover, scholars do not question the prominence of the Broca's and Wernicke's regions in linguistic functions.

At the same time, as per Fedor et all.(2009) although " the enormous plasticity of the developing brain ...demonstrates that the crucial involvement of Broca's area in syntactical processing in most people cannot be genetically hardwired, rigid condition...It seems more correct to say that some areas of the normally developing human brain are more prone (in quantitative sense) to host and process different components of language than others " (Fedor et all. 2009. p. 300). In a similar vein Friedericci (2017) made abundantly clear that the human brain is a unified whole of functionally integrated anatomically diverse neuronal assemblages, where perception, emotion, reasoning, socialization, imagination etc. are all interconnected. In this sense the representation of language in the brain is well beyond the physical location and cognitive specialization of a LF and integrates multiple processing functions in both hemispheres. Thus, processing of language engages the brain as an integrated whole to which the author refers as " language network". Its properties in the adult brain begin their formation early in childhood by initially engaging primarily the right hemisphere, most actively involved in perception of prosody and learning basic vocabulary, to gradually integrate the right hemisphere and Broca's region in processing of complex grammar, only after a decade of experience with language as it reaches adult proficiency. Importantly, it reminds that the brain evolves as an integrated whole over millennia as the bio-cognitive signature of human speciation. Similarly, Liebermann, in support of the " unified whole" argument, demonstrates that the human natural potential for language is a web of interrelated and spatially distributed groups of neurons. He envisions the human mind as a Hodge-podge where the same biological entities participate in various neural circuits and support multiple related behaviours.

“ ...a particular neural structure may play a part in different neural circuits that regulate different aspects of behaviour...(and at the same time) distinct neural populations may occur that project to neurons in different brain structures contributing to circuits that each regulate a different aspect of behaviour. “ For example, the basal ganglia was found to “ switch from one sequence of motor pattern generators to another” (Lieberman Ph.2008, p.218- 219)

Liebermann also argues that the basal ganglia participates in regulating coordinated movements in speech, dancing, walking and other behaviours unique to humans, an indication that these have evolved for a purpose broader than language alone. In addition, Liebermann argues that the basal ganglia , which affords a capacity of the brain to regulate the vocal tract's ability to form complex vocal gestures, is possibly the same ability which regulates also aspects of human cognition and syntax, which involves the recombination of primitives and formation of structures. Thus the basal ganglia is “ the sequencing machine “ of the brain, which participates in different neural circuits , regulating different behaviours. In short, the natural potential for language, i.e. the language faculty, is a web of neuronal connections with shared functions which have co-evolved in tandem.

Donald (1993 and elsewhere)points at a number of cognitive capacities, argued to be coordinated in a mimetic capacity which includes control over the flexibility of motor movements, i.e. motor movements are free from genetic predetermination, capacity for kinematic imagination, thus, spatial and temporal displacement of representations of action patterns, capacity for symbolic representation, enhanced socialization, extensive capacity to learn, or extended memory, human -specific capacity for mind reading or theory of mind , capacity for self-monitoring or meta-cognition, voluntary recall of memories as evolutionary prerequisites for the invention of the first primitive language systems.

Significantly, given that the learning and use of linguistic constructions, from lexical words to grammatical morphemes, involves the interconnection of a number of physiological and cognitive properties e.g. speech perception and production, concept formation and recognition, symbolization and symbol retention and recall, category formation and expectation of relevance, it is reasonable to assume that the evolutionary formation of an interconnected brain can be attributed to learning and use of language. In other words, the use of language has triggered evolutionary alterations in the functioning of the pre-human brain, resulting in a distinctly human brain, which, despite demonstrable similarity to pre-human brains in most functions, at the same time has unique properties as a language-processing brain.

5.1. Speculations on the language faculty

“ Language requires unique cognitive capacities: we evolved for language”(Dor, Jablonka, in The Social origins of language, Dor, Knight, Jerome, eds. 2014, chap. 2.p. 27)

Pinker and Bloom (1990) argued that the language faculty, a cognitive processor of Universal Grammar, has evolved as adaptation to pre-existing linguistic environment by Darwinian principles of gradual accumulation of minor improvements on pre-existing properties. The implementation of evolutionary principles in the evolution of language is interpreted differently by different schools of thought. In biolinguistic context it is speculated (Bickerton 1984 and elsewhere) that the onset of language is initiated by bio-cognitive attributes for processing a pidgin-like communication system, i.e. lexical protolanguage, a result of Darwinian processes. The transition to syntactic language as per Bickerton and like-minded biolinguists, is marked by a revolutionary event by which the bio-algorithm processing UG became superimposed and integrated with the much older protolanguage -processing abilities. The minimalist perspective, although reducing the hypothetical computational complexity of the grammar algorithm to the bare minimum, to the point of almost eliminating it, while attributing the majority of language processing functions to general learning and memory(Hauser, Chomsky,Fitch, 2002), in the language-processing algorithm, or UG is still a fairly complex computational mechanism (Hornstein 2018).

In rejection of the biolinguistic vision, the usage-based paradigm defines language as a cognitive technology supported by in the human organism as a conglomerate of multiple cognitive and physiological traits coordinated into a language faculty, emergent during language learning and activated by language use. In this context language has no innately pre-specified representation in the organism as it uses a number of pre-existing cognitive resources, evolved for pre-linguistic functions, interconnected and repurposed for use in language-relevant tasks. Similarly, Deacon (1997) states that abstract ideas , e.g., grammatical rules, cannot become internalized as they are by definition unrelated to sensory experience and as such cannot be adaptive .

“ Whatever learning predispositions are responsible for the unprecedented human faculty of language, they specifically cannot be dependent on innate symbolic information. No innate rules, ... no innate symbolic categories can be built in by evolution” (Deacon, 1997, p. 339). And, “ For these reasons, there is little possibility for mental adaptations to specific syntactic structures(Deacon 1997, p. 329).

Thus, a language faculty as UG is not a viable option, given that, as acknowledged by both the minimalist paradigm and by the usage-based perspective, languages are mostly learned, restricting the role of the so projected innate grammar algorithm to the bare minimum.

At the same time language learning and processing needs some specific capacities, not reducible to general cognition. For example lexical semantics is different from encyclopedic knowledge, phonetic pronunciation is different from vocalizing, word learning is different from fact learning, etc.(see Pinker, Jackendoff, 2005).

To remind, a fundamental principle of Darwinian evolution is adaptation to some part of the environment ,e.g. an evolved language faculty must be adaptation to pre-existing environment, i.e. some form of language must predate the evolution of the LF(Pinker, Bloom 1990). And if one assumes that a language system, much simpler than the languages of today's literate societies, but effective in pre-civilization contexts, was the environment in which a LF has evolved, a number of language-relevant properties, demonstrated universality across populations, which appear to develop early and with little effort, demonstrating instinct-like uniformity and universality, can be seen as its likely component parts. These include:

* *a human form of Theory of Mind*, i.e. capacity for anticipation of communicative intention and communicative relevance as as ability to participate in dialogue ,which allows ostensive communication , i.e. participation in dialogues by Grician principles of conversation to include expectation of relevance in linguistic communication (Sperber, Wilson 2004 and elsewhere ;

Scott-Philipps, 2017)
* *bio-cognitive capacity for formation and processing of hierarchically structured of behaviour*, a phenotypic expression of various genes (Dediu, Levinson, 2018) most prominently FOXP2 involved in the formation of the human basal ganglia, responsible for rule-governed complex structured behaviours in cognition and praxis, e.g. ability to dance, produce and manipulate tools, use language, demonstrating the innate link between language use and extralinguistic activities. (Liebermann Ph. 2016 and elsewhere) One would hypothesize that this innate feature would be used as a potential for grounding linguistic symbols in extralinguistic activities as potential referents. These could be the same cognitive mechanisms hypothesized by Lotem et all.(2017) evolved for data processing into structured packages in co-adaptation of brain and culture, thus, not specific to language, but appropriated by language for encoding and communicating information efficiently.
* *developmental instinct to babble* as training of the articulatory apparatus for speech by mimicking the speech production of adults (J. Hurford, 2012)
* *a critical period for language learning*, where proficiency in a first language is achieved in early age within less than a decade by imitation and participation in communicative events (Hurford 1991; Hurford and Kirby 1999)
* *integrated neurobiological mechanisms for processing the language system and language use* (Pulvermuhler, 2005, 2018)as learned words are stored in memory as rich descriptions of individual examples of use during specific events of communicative interactions, where linguistic properties are combined with extralinguistic details in terms of detailed description of individual perceptual experiences(R. Port, 2007).
* *the human semantic memory contains some universal categories,* representing dichotomies of animate vs. inanimate, human vs. non-human, singular vs. multiple, close vs. distant , presence vs. absence, instantaneous events vs. processes of long duration, measurable vs. unmeasurable substances, etc.,(Dor Jablonka, 2000, p.39-)which can be interpreted as the tendency of the human mind to represent knowledge of reality in a compressed and structured form. And these universal patterns of categorization are identified as a common semantic core consistently reflected in the grammatical systems of all languages. Significantly, these universal frames of categorization come naturally to young language learners, suggesting innate aspects for the fundamental of human thought. These cognitive propensities for compressed organization and representation of knowledge seems to be belong to general processing mechanisms appropriated by language as meaning representation.
* *some guiding principles for word formation and learnin*g (Bloom 2000), e.g. a child demonstrates intuitions that a word is a label for a whole object, as opposed to a part of an object, and demonstrates affinity towards words which name whole objects, the child also appears to know without explicit instruction that there is one-to-one correspondence of words and objects, i.e demonstrating a mutual exclusivity bias. Moreover, as per Bloom (2000) children intuitively know that words are vocal signs with meanings and phonological properties which form part of a larger system, i.e. words are Saussurean signs.
Thus, a hypothetical LF is likely to integrate various aspects of the human organism at different stages of lifespan and reflect the integrated nature of language.

5.2. Innate propensities for unique human behaviours

Language is a unique human trait, although one among various others such as dance, tool use, music, abstract thought, art , etc. Given that, it is logical to speculate that they all may rely on some form of instinct-like innate intuitions, spontaneously demonstrated very early in life and triggered by very limited exposure to environment. To take an example, all humans are capable of some ability to participate in cultural activities , e.g. singing, dancing, etc. and demonstrate some innate potential for these abilities very early in life. Infants display sensitivity to rhythm, which indicates some rudimentary predisposition for music and dance. Similarly to language, with this minimum innate support any child can presumably learn any song or dance reflective of any cultural tradition. A comprehensive discussion on the topic of innate capacities for music can be found in Steven Mithen' s book The singing Neanderthals(2007). Infants also display basic ability to manipulate tools suggesting some biological foundations of tool manipulation in everyday manual tasks. On these essential biological foundations after persistence, dedication, and specialized training, some individuals achieve professional skills of a master craftsman . In addition, infants demonstrate sensitivity to visual symmetry which indicates innate potential for appreciation of beauty and visual arts and any person can learn to draw at some elementary level. These are innate ingredients which after extensive training produce a Michelangelo. Moreover, pre-linguistic infants are known to form abstract categories, e.g. animate /inanimate , singular/plural, and make inferences, which is the beginning of abstract thought, later developed as argumentation in everyday decision-making and further mastered as a professional tool in scientific argumentation, mathematics, law, philosophy, etc. The average human achieves a minimum proficiency in these activities with little instruction very early in life and with little effort, indicating some innate, instinct-like potential.

To note, I am not aware of any detailed studies of the biological foundations of singing or dance, or other uniquely human behaviours with the exception of Ph.Liebermann (2016) who has argued for innate potential for language and culture as a network of neuronal pathways and brain areas including the basal ganglia and the cerebellum, which in concert make possible dance, language and other structured behaviours .

Thus, humans have demonstrated some rudimentary, instinct-like propensities for unique behaviours, language being one of them, suggesting some role of nature. Upon these rudimentary biological foundations the average human builds to reach an average level of proficiency with minimum training. Further a small number of individuals achieve the highest levels of mastery only after extensive, conscious and rigorous training and education, which the innate flexibility of the human mind and body makes possible. And although my views are clearly speculative as I cannot rely on studies of cognitive foundations of uniquely human behaviours other than language, I am confident that my speculations are plausible and are likely to be confirmed by future studies in human cognition and development.

Returning to the topic of innateness of linguistic abilities, there is no reason why the same logic of anticipating innate predispositions limited at a very rudimentary level should not be applied to the language abilities as well, although language is treated differently by the major linguistic paradigms as it is assigned a status of the most defining characteristic of the human species.

In sum, a plausible argument can be made that **1**. all uniquely human behaviours follow the same pattern of relying on some rudimentary form of innate bio-cognitive foundations from which an adult level is reached by spontaneous learning . Further a professional level of mastery is reached by a few individuals after years of dedicated and supervised training. **2.** the natural potential for language should be measured in the same way the rest of the unique properties of the human species are to be measured, by the language proficiency of the average, normal individual.

6. Theories of evolution and the search for a LF

6. 1. The genome and the LF

To remind, a merging of MS and the biolinguistic perspective inspired much speculation about the genetic foundations of linguistic abilities and the search for a language gene. Initially the FOXP2 gene was pinpointed be the genetic foundation of human linguistic abilities, i.e. the "language gene" (Gopnik M. et all. 1996).
A population genetics perspective attributes the existence of a LF to a one-time event of genetic transformation producing a radical alteration in the brain architecture and functions in a single individual within a small population of pre-linguistic hominids with enormous consequences of transforming pre-human hominid species into human speakers of modern language, known as the "leap hypothesis" (Chomsky 2005; Berwick, Chomsky 2016 and elsewhere). The hypothesized transformative event is explicable with a genetic mutation, a genetic big bang, altering significantly the phenotype of a single individual by creating a new biological property, a grammar organ with the full package of highly abstract grammatical concepts and complex rules, producing a biological anomaly, i.e. a "hopeful monster" with superb cognitive and linguistic skills. The hypothesis has been rejected most consequentially by geneticists and evolutionary biologists, who argue that the likelihood of a felicitous mutation with such drastically different outcome, which defies all the general principles of evolution is extremely low. The attempt to minimize the transformative effect of the mutation by significantly reducing the complexity of the hypothetical linguistic algorithm by the Minimalist approach has not convinced scholars that this could be a satisfactory evolutionary explanation(most recently Martins, Boeckx, 2019; de Boer et all. 2020 to name a few).

The theoretical expectations for a language gene were contradicted by the subsequent finding that "all genes expressed in language-related cortex are expressed in more than one cytoarchitectonically defined areas" and " multiple genes participate in the formation of any cognitively specialized brain area" (Fedor, et all, 2009, p. 307). Importantly, FOXP2 gene is a transcription factor implicated in controlling the functions of various other genes with multiple and broad -ranging phenotypic effects , including the formation of the heart, lungs, the brain. The gene participates in brain development by affecting the formation of Broca's, along with various other parts of the brain, unrelated to language skills (Fisher, Marcus, 2006) It also participates in the formation of brain circuits of the basal ganglia, responsible for coordination of movements, including speech, the Broca's region, which processes syntax. A deleterious mutation of the gene results in a number of deficits causing difficulties with speech, grammar, general intelligence, known as Specific Language Impairment (SLI) (Vargha-Khadem F. and colleagues 2005). To add to the confusion, as per Fedor, Ittzes , Szathmary(2009 p.24) some children with SLI have the normal version of FOXP2 gene. In short, as per Dediu, Christiansen (

2016) “ FOXP2 is really a hub in a complex regulatory network whose activity and effects are highly context-dependent, one facet of which affects speech and possibly language(ibid. p.363). Subsequently other genes were determined to participate in the formation of human linguistic abilities, e.g. ROBO1, ROBO2 and CNTNAP2 which increased in frequency after the speciation of anatomically modern humans, were determined to be implicated in language-relevant functions, among various others (Dediu, Levinson, 2018). Geneticists anticipate to find individual genes to have insignificant effect in the formation of the biological foundations of language (Fedor, Itzess, Szathmary, 2009, p. 22). Moreover, it is argued that human linguistic behaviour can be explained not in genetic but in epigenetic and developmental emergent aspects of the human brain's anatomy and connectivity under the influence of experience (Sherwood et all. 2008)

6. 2. Evo-devo/evolution of development in biolinguistics

The generative tradition and its biolinguistic approach define the evolution of language in terms of biological growth of the LF as part of the general growth and maturation of the human body, attributed to strong genetic support as gene-based developmental instinct, a position articulated in detail in well-known works of Chomsky, Bickerton, Pinker and others. Under this approach the content of the LF and the process of its biological growth were viewed as genetically controlled, an approach rooted firmly within the MS and focussed on FOXP2 gene as The grammar gene(Gopnik et all. 1996). In subsequent transformations of the biolinguistic paradigm e.g. the Principles and Parameters approach, focuses on the phenotype as it identifies two types of language -dedicated cognitive resources, FLN and FLB(Hauser,Chomsky, Fitch 2002 and elsewhere). By postulating a set of genetically determined principles and binary sets of parameters, where the universal properties of languages are attributed to the principles and the observable diversity of languages is explicable with variation in combinations of parameter settings during ontogenetic development, the attention is focussed on the developmental aspects of the language faculty (FLN). In this context the gene-centred perspective of the MS is maintained as *Evo-Devo gen,* despite allowing for some environmental influence by turning on a developmental program upon exposure to a local language. In the latest version of generativism, the Minimalist agenda(Chomsky, 1995; Hauser et all. 2002 and elsewhere) the role of genes is significantly reduced and a major role is attributed to symbol learning which by its nature is subjected to cultural evolution. A useful discussion of the evo-devo approaches and their understanding of biology, genetics, development and evolution in the formation of the language faculty can be found in Benitez-Burraco, Longa 2010.

A relatively recent challenge to the fundamental assumptions of the generative/biolinguistic perspective in the conceptualization of language, the language faculty and the critical period is articulated by Balari, Lorenzo(2015). To begin with, the traditional conceptualization of LF as genetically predetermined, i.e. universal and fixed entity, available a priori to language acquisition, and teleologically destined to grow into a predetermined adult state by equally preset stages of development, is replaced with the concept of “gradient of language”, where the LF is viewed as emergent during development where initial conditions, i.e. innate predispositions for language may be radically altered by developmental mechanisms, resulting in highly diverse range of adult states of I-languages . Significantly, in stark diversion from the traditional understanding of innate UG as a starting point of language development, here the musical skills of newborns are featured as the starting point, which allow the child to transform the incoming stream of speech into meaningful segments, i.e. words, and store these in declarative memory, thus compiling “ a catalogue of arbitrary pairings of sensory-motor and conceptual percepts”(Balari, Lorenzo, 2015, p.25), as potentially combinable units. In this sense perceptual abilities are used creatively without a priori anticipation for a predestined lexicon. Thus, language here is conceived as emergent in development from perceptual experience and the cognitive ability to identify and store discrete units of meaning and form. The notion of a stable and predetermined LF is replaced with a flexible combination of a number of bio-cognitive traits, recruited in varying degrees in dynamic negotiation during language development. This informs the elimination of the critical period as a succession of predetermined developmental milestones, and replaces it with a new understanding of development as a fluid succession of developmental states, “ following a more or less rigid schedule”(Balari, Lorenzo, 2015, p.27). Thus, a gradient view of language development articulated here conceives of development as a process, where “ different components participate to different degrees and intensity at different stages, in which a gradual hybridization is effected”(ibid. 2015, p.33). Perhaps more importantly, contrary to the currently held dichotomy of innate and learned, nature and culture, here the role of innate and cultural factors in language development is conceived as interpenetration, rendering these “ virtually indistinguishable” (Balari, Lorenzo, p. 28), in this way making the theoretically charted rigid boundaries between the two, irrelevant from developmental perspective. Balari and Lorenzo's vision is an interesting diversion from the traditional biolinguistic perspective, positioned firmly within the MS.

7.The evolution of the LF and Baldwinian processes

To remind, Baldwinian processes maintain the basic principles of evolution, i.e. variation and selective inheritance. And although a Baldwinian explanation for the presence of a language faculty is just a hypothesis, a number of observations make it a plausible one. For example, apes ' abilities to learn a protolanguage-like communication demonstrated that language can be learned without a language faculty. From this it is reasonable to suppose that at the onset all aspects of languages were entirely learned behaviours. A Baldwinian process would imply that with time, some key bio-cognitive properties with demonstrable specification for language, listed in previous segments, have become incorporated as innate propensities of the organism to assure their reliable, timely and uniform development. In this way the potential uncertainty of individual learning and the cognitive effort associated with that is effectively eliminated as nature has found a way to guarantee for all humans the potential for learning language.

Language is learned primarily by imitation (Tomasello, 2003)which indicates that neuronal networks representing linguistic forms are copied and proliferated in the brains in a community uniformly. This would allow for Baldwinian processes to convert the universal properties of language, initially learned, to become internalized (become instinctive) by altering permanently the development of language by canalization of learning. Importantly, evolutionary processes are slow and presuppose a stable environment. Biological evolution unfolds at a slow pace and Baldwinian evolution as a biological process must be of comparable pace. An evolutionary adaptation can only work in a persistently stable environment. Rapidly changing environment is counterproductive for evolution. Biological evolution unfolds at a slow pace and that of Baldwinian evolution as a biological process must be of comparable pace. In addition, in standard evolutionary processes changes are incremental, they are improvements upon prior adaptations, i.e. evolution prefers continuity. Baldwinian processes as a type of evolution, must follow the same fundamental principle by taking advantage of predispositions.

On the other hand cultural changes are much faster as most cultural conventions change rapidly which precludes a possibility for becoming an evolutionary targets. For example, linguistic properties produced by grammaticalization and language contact and display linguistic diversity, are not likely candidates for internalization.(Chater, Reali, Christiansen, 2008) In addition, abstract properties of grammar, outlined by the biolinguistic paradigm cannot be internalized as they have no adaptive value, especially in pre-civilization environments. So, linguistic properties which change the least or in steps comparable to biological evolution have a better chance of being internalized. In this sense only very limited aspects of behaviour can become targets of Baldwinian evolution. And given that Baldwinian processes work in a cultural niche, it is expected that cultural variation would produce variation in genetic assimilation, i.e. communities with different cultural practices would have different language faculties. This is obviously not the case given that humans from communities which have been isolated for thousands of years, usually islanders, can learn any language. Thus, only time- stable aspects of language reflecting universal cultural values and behaviours could have evolved by Darwinian principles and Baldwin effect is a type of biological evolution.

Culture-gene coevolution, and more specifically language-gene coevolution, could be easier to envision in the case of one-to-one correspondence of gene-language correspondence. Initially the FOXP2 gene was designated as the language gene, later found to have pleiotropic functions contributing to a number of physiological and anatomic properties, unrelated to language. Importantly, one-to-one correspondence of genes and characters is the exception rather than the rule and pleiotropy is pervasive .This is especially relevant to language as a complex behaviour, encompassing a number of properties making possible the memorization and creative use of a long list of constructions with phonological, semantic and combinatorial properties and rules of grammar and their semantic interpretation, must be necessarily polygenic (Friederici, 2017). In this sense a pleiotropic scenario, i.e many-to-many correspondences of genetic and language-relevant phenotypic properties would suggests that a possible language-gene co-evolution would also affect a long list of other properties and a large part of the genome.

And given the assumption that a form of language emerged as learned behaviour and predated the evolution of the language faculty (Pinker, Bloom, 1990) it is reasonable to speculate that the above listed universal properties could have started as linguistic innovations, initially passed on by learning, and with time gradually become easier to learn with each successive generation. Thus, although innate UG is not a plausible argument, it is reasonable to suggest that some key aspects of language, indispensable for its functioning as a communication system, i.e. a language faculty for the simplest forms of language, have undergone Baldwinian evolution. In this way a collaboration of nurture and nature has assured a reliable foundation for the uniform, fast and early development of the basics properties of language. On these humble bio-cognitive foundations the diversity of grammatical categories and their structural associations observed in languages is produced by cultural processes. To remind, only the simplest and the most stable aspects of language become internalized. This partial internalization frees cognitive room for more extensive and more complex learning , resulting in increased behavioural sophistication. And innate predispositions for the fundamentals of language do not impede but stimulate the learnability of linguistic properties produced by language diversity and change, by freeing space in the memory for more extensive learning, for example of a larger vocabulary, grammatical forms produced by grammaticalization, etc.

7.1. Baldwin effect and the evolution of the human speech capacities

Although genetic influence on cognitive abilities is difficult to demonstrate, anatomy and physiology offers clearly demonstrable examples in the human speech capacities. The supralaringeal vocal tract in humans has a unique configuration, e.g. it is composed of two tubes positioned at 90 degrees, each of almost equal length, the human tongue has a unique shape and position in the mouth, the speech organs have unique physiology, e.g. they are extremely flexible, allowing rapid production of maximally distinct vocal signals, used in speech . In addition humans have evolved species' specific breathing control, tied to speech production and the descent of the larynx and the descent of the tongue root are argued to be tied to speech production(Liebermann 2000, 2007, 2008; Fitch 2010). An evolutionary explanation for the anatomy and physiology of the human vocal tract is only plausible as adaptation to articulate speech as it is counter-adaptive for basic biological functions creating the potential for choking.

Speech capacities demonstrate innate predispositions as the human vocal tract development is inevitable as is the development of all biological organs, suggesting some genetic participation. The shape of the adult human vocal tract shows similarities in Neanderthals, suggesting the use of some form of speech, although the articulation of quantal vowels shows unique human adaptation for advanced articulation of speech(Liebermann, 2008 and elsewhere) P. Liebermann (2007) has argued that human speech capacities are the result of Darwinian processes combining genetic mutations and exaptation of preexisting structures, i.e. anatomical and neurological alterations. Thus, in human's anatomy and physiology the biological function is shared with the communicative one , suggesting that they are in accord with the evolutionary principles which prefer slight gradual changes in old structures to biological novelties. But most importantly for the purposes of the current article, speech capacities have evolved by adaptation to the communicative environment shaped by preexisting language, i.e speech capacities evolved in adaptation to phonology by language-gene coevolution as gradual incorporation of previously learned behaviour into human anatomy, physiology and cognition. Such changes involve the basal ganglia, which affords a capacity of the brain to regulate the vocal tract's ability to form complex vocal gestures, is possibly the same ability which regulates also aspects of human cognition and syntax, as it involves the recombination of primitives and formation of structures. Moreover, the basal ganglia, the “ the sequencing machine “ of the brain, participates in various neural circuits in regulating coordinated movements in speech, dancing and other behaviours unique to humans, suggesting an expanded coevolutionary scenario between the genome and cultural practices beyond language (Liebermann 2000 and elsewhere).

The speech capacity begins to develop very early with infant babbling, a developmental instinct as an adaptive response to a culturally formed communication by speech.

" The disposition to babble is thus adaptive in a social group that already benefits from communication in speech. It seems likely that a capacity for finer tuning of the articulators and more precise coordination of their interaction evolved biologically as the benefits of well articulated speech emerged. This would have been a case of gene-culture, more specifically gene-language, co-evolution." (Hurford, 2012 p. 488).

In a similar vein the human innate ability for speech sound perception suggests evolution of human development as adaptation to language learning. For example, infants discriminate speech form non-speech sounds (music), and also differentiate between voiced and unvoiced consonants. Suggesting that the fetus' auditory experience begins in the uterus and this experience helps shape auditory biases demonstrated after birth(Muller R.A.1996)

Animal perception shows some capacities for speech perception in some birds, monkeys and apes, suggesting evolutionary continuity. Moreover, raspberry sounds, squeals, i.e. voluntarily produced vocalizations, produced by infants in the first months of life and termed as *protophones* (Oller et all. 2016; Oller et all. 2019) are interpreted as signs of nascent speech capacities. Protophones are holistic vocalizations preceding babbling, which already displays syllable structure. Importantly for the study of the evolution of speech, bonobo infants produce vocalizations similar to protophones, demonstrating continuity and deep evolutionary roots of human speech capacities. That said, a comparison between human and bonobo infants demonstrates a 12 times higher vocal activity and much more extensive use of protophones by human infants suggesting a clear divergence from primate ancestors in the direction towards greater vocal flexibility and illuminates the very first steps in the evolutionary process towards articulate speech. Divergence is also in marked by the fact that human infants spontaneously engage in stimulus-free vocalizations. In addition, the propensities of adults to stimulate these vocalizations in facilitating speech development suggests the influence of culture which attributes high social value to language skills .Thus, the human capacity for speech demonstrates innate propensities in the human organism plausibly attributed to adaptations to cultural behaviours, i.e Baldwinian evolution.

7.2.The evolution of the language faculty as component of niche construction

To remind, an environmental niche is a sliver of the natural environment where a species exist which inevitably leads to interaction between the two. Niche construction is a concept which encompasses specie's behaviour and its influence on the environment which creates coordinated changes in both organisms and the environment. Organismal changes triggered by this interaction can be genetic, developmental, behavioural. One of the most widely cited example of niche construction is the " evolution of beaver aquatic adaptations in response to beaver-generated aquatic niche"(Deacon, 2009, p.3). A unique human niche includes the man-made environment, e.g products of culture and civilization, where the human individual has evolved by co-adaptation e.g. lactose tolerance is causally related with dairy farming(O'Btien, Laland, 2012 and elsewhere). The domestication of plants and animals as a human unique niche construction creates an artificial environment to which the human body and mind must adapt (Deacon 2009). For the occupants of the human niche the influence of natural selection is softened as competition and struggles for survival is minimized by the natural human propensity for socialization and cooperation. This unleashes physical and mental powers resulting in the formation of complex language and other cultural innovations, e.g. science, technology, art, etc. The human cognitive niche includes culture and language as depository of communal knowledge and a tool for its dissemination.

The evolution of language in the context of a bio-cultural niche is viewed as analogue to the beaver's adaptation to dams(Deacon(1997, 2009 and elsewhere). Language is defined here a from semiotic perspective as a system of symbolic signs. A hypothetical human capacity for symbol formation and symbolic reference (Deacon, 1997) is a complex combination of various types of referential relationships, e.g. among symbols as members of a symbolic system, between a symbol and its referent, and among objects in reality as perceived by the human mind. It is a product of evolution of development, in adaptation to cultural evolution of symbolic from motivated signs as a part of niche construction. Similarly, a unique human cognitive niche encompassing the coordinated evolution of human intelligence, sociality and the language faculty , i.e. Universal Grammar, as a signature trait of the human brain and mind, is proposed by Pinker (2010)

To sum up, as the beaver and the dam have co-adapted , so the human mind and body has evolved for language in adaptation to a cultural niche, i.e. the human organism has evolved for language and language has evolved for the human organism (Chater, Reali, Christiansen, 2008)

Summary and conclusions

Although still a hypothesis, the Baldwin effect may provide the best explanation for some unique human properties, currently inexplicable by the standard MS theory. It is particularly relevant in the study of language evolution and the evolution of a language faculty as adaptation to a pre-existing language system, formed as a communicative technology by cultural processes. A better understanding of Baldwinian evolution and the role of culture and learning in biological evolution would be a major contribution to the study of the evolution of language. In this sense, an evolutionary explanation , implicating Baldwinian processes for a language faculty with the attributes identified above, although still speculative, is plausible enough to justify further interest and intellectual curiosity. The humble contribution of this article is to attract attention an encourage further research on this topic currently under-explored by students of the evolution of language.

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