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Towards the Multistage Ecosocial Theory of Glottogenesis: Modern Evolutionary Concepts, Principles, and Extension of the Nomological Approach

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Abstract

In recent decades, studies of the origin of language have seen shifts toward multistage concepts, explanations based on social and ecological patterns, and the integration of different levels of analysis (from behavioral practices to gene structures). The article develops these ideas. It aims to streamline and integrate evolutionary concepts and principles, suggest a special explanatory methodology. The models of gene-culture coevolution (Wilson et al.) and cultural drive (Laland et al.) are connected with the functionalist model of homeostatic dynamics and development (A. Stinchcombe). The conceptual core of the theory consists of the "zone of nearest evolutionary development," "concern (need)," "providing structure," "magic wand." The formulated fundamental principles — a kind of "universal laws" of glottogenesis — draw on a rich intellectual tradition in biology and macrosociology. A priori rules fix the conditions of each new complexity stage of glottogenesis emergence. The main difficulty lies in justifying and explaining these stages. Moreover, the data obtained in archaeology, paleoanthropology, paleoclimatology, and paleogenetics are indirect. The extended variant of nomological explanation (C. Hempel) allows "on the industrial basis" to construct theoretical hypotheses and check them with the help of modern observations, comparisons, and experiments. Justified by this way, regularities connected logically with various indirect paleoscientific data can explain the main stages of early language evolution.

Keywords: language origin, glottogenesis, gene-cultural coevolution, cultural drive, functional approach evolutionary principles, language complexity, nomological approach.

1. Gene-cultural Coevolution

What is the biological basis of sapientation processes? Significant anatomical and psychophysiological changes accompanied the emergence and development of speaking ability. During evolution, there appeared (Wildgen, 2012: 361):

1) the organs of articulation that produce speech (control of breathing through innervation of pectoral muscles, specific vocal cords, the shape of larynx, forms of mouth, lips, and teeth);

2) a precisely tuned auditory system (mainly the inner ear);

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3) specialized brain areas (in the cortex and the brain stem) with their specific abilities of perception, recognition, categorization, memory, and self-control; Broca and Wernicke's speech centers.

The *concept of gene-culture coevolution* that has become popular was born to combine Neo-Darwinism with the ideas of the Baldwin effect and Waddington epigenesis. So, the priority of gene mutations sounds in the very name. Researchers emphasize the evolutionary success of behavior acquired during ontogeny and conditioned by innate potential.

Researchers pointed out similarities of this model with Lamarck's doctrine seemingly long rejected. Some authors also mention the importance of a changing external environment (Richards, 1987: 399; Oppenheimer, 2012).

There is a clear departure in modern genetics from the former strict corpuscular (in fact, Mendelian) ideas about unidirectional causality "from the bottom up": from the genotype to the phenotype. Instead, flexible epigenetic processes are increasingly recognized. In other words, the ideas and positions of neo-Lamarckism are strengthened (Wilson & Lumsden, 1983; Koonin, 2011; Popov, 2018).

The gene-culture coevolution theory authors adhere to the idea of a dynamic relationship between genotype-determined assignments, brain, psyche formation during ontogenesis, and behavior. The latter becomes successful in adapting and sexual selection in a changing environment. Here "epigenetic rules" are the key concept, and "cultural alternatives" become a significant property of the changing environment (Wilson & Lumsden, 1983: 70-71). The authors describe the main links of the relevant cycle as follows (*Ibid*., 1983: 117-118):

- The genes prescribe the rules of development (the epigenetic rules) by which the individual mind is assembled.
- The mind grows by absorbing parts of the culture already in existence.
- The culture is created anew in each generation by the summed decisions and innovations of all the members of the society.
- Some individuals possess epigenetic rules enabling them to survive and reproduce better in the contemporary culture than other individuals.
- The more successful epigenetic rules spread through the population, along with the genes that encode them; in other words, the population evolves genetically.

An important direction in developing these ideas is to consider the inheritance and distribution due to the Baldwin effect of not so much individual potential to specific forms of behavior, as more general and *broader mental potential* to learning, experience borrowing, thinking, and constructive abilities.

When confronted with new challenges, some individuals give successful responses thanks to their innate predispositions. Thus, *individual learning* occurs — the choice of the best of alternatives. If no one imitates such a pioneer, the effect dies with him. Nevertheless, if the most successful tribe members are imitated ("biased transmission"),[1] the innovation is preserved. Then *social learning* can take place — acquiring abilities in interaction with elders and imitating them. Such knowledge is effective in a stable environment. However, when the environment changes and

[1] "Biased transmission" — individuals in groups usually imitate successful tribesmen, choosing among several known behavioral alternatives the best one (Richerson & Boyd, 1992: 65).

creates *challenges*[2] (especially with migrations and encounters with outsiders), more of those who learn individually must emerge for the group to succeed (Richerson & Boyd, 1992: 70-71).

Individuals who have gained advantages through innate epigenetic rules propagate their genes primarily in their group. Successful practices spread through imitation. This group becomes more successful in the following generations than other groups due to its "advanced" members. In intergroup encounters mixing, mutual contributions of genes happen (as an essential mechanism of population reproduction and integrity). As a result, benefits derived from combinations of genes, rules, and culturally translated practices spread throughout the population. The extinction of those groups left without this evolutionary advantage only accelerates extending the latter.

The success of individual learning has its regularities associated with the Skinnerian mechanisms of reinforcement (Richerson & Boyd, 1992: 64).

Acquired successful forms of behavior are closely related to innate predispositions. The scheme in Fig. 1. presents the complex mechanism of joint action of gene mutations, heredity, development of neural brain structures, sexual and intergroup selection, translation, updating cultural patterns, and social practices. The scheme includes two clearly expressed contours: the lower one presents processes on genes, heredity, and selection, and the upper one — the processes in behavior, imitation, interaction with the environment, and social transfer of experience, the transmission of various kinds of cultural patterns.

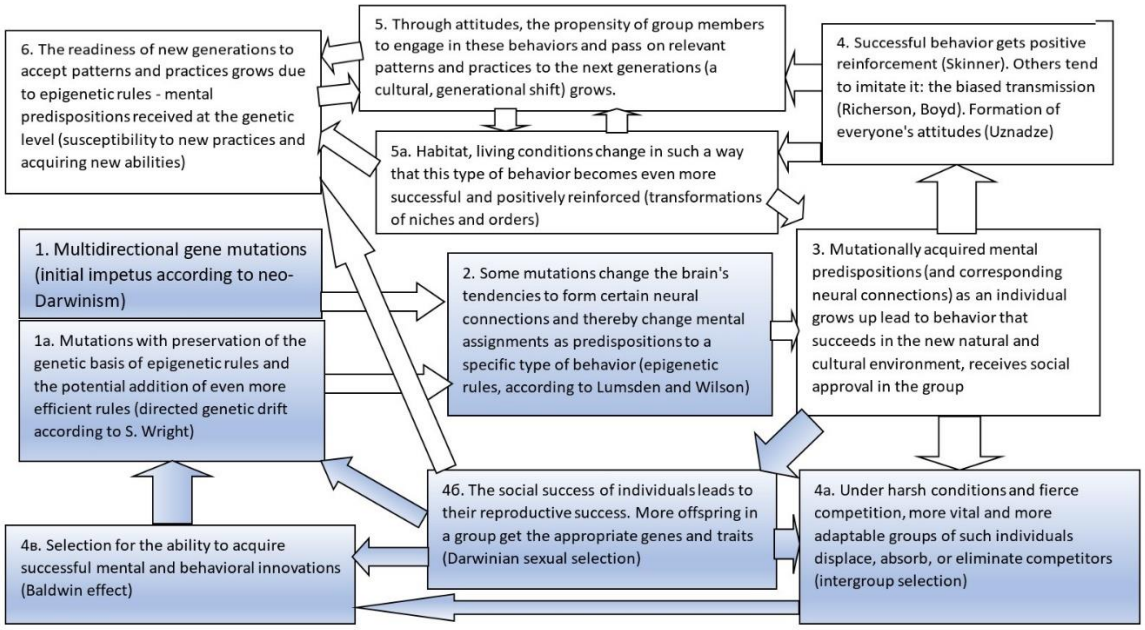


Fig. 1. Model of gene-culture coevolution, where blocks indicate conditional phases and arrows indicate transitions between stages. The shaded blocks and arrows denote processes mainly related to heredity and selection, while the white blocks denote behavior, psyche, and culture.

[2] The concept of "challenge" here correlates with the more accepted idea of "stress" in biology. Numerous experiments have shown that stress causes directed mutations — the so-called stress-induced mutagenesis as a quasi-Lamarckian mechanism of evolution. Moreover, as environmental pressures mount, the Darwinian model weakens and gives way to the Lamarckian mode. See more details in Koonin (2011: 263-273).

Read the scheme according to the ordinal numbers of blocks. The numbers with letters (1 1a, 4a-4b-4c, 5-5a) mean parallel or conjugate (separable only analytically) phenomena in the circuit of causal relationships. Divergent mutations (block 1) are eventually replaced by mutations "in a narrower spectrum" (1a) with preservation of the epigenetic rules supported by selection (4a, b, c).

Trial and error in block three can only partially be considered behavioral analogs of gene mutations. The successful answers (individual or group actions, practices, strategies) are not accidental.

First, not all group members come to them, but the carriers of the most pronounced innate epigenetic rules. Second, successful responses are not created "out of nothing." They are always a transfer of an idea, structure, or technique from another sphere. Third, they can be a new combination of such patterns with some modifications and adjustment of elements to each other.

In other words, successful behavioral responses are generally "indebted" to predispositions, the inherited genome, and cultural patterns transmitted through generations. They allow for various recombination.

The death of individuals and groups that have not received a practical behavioral innovation (block 4a) enhances the reproductive success of those who have received it (4b) and contributes to selection for the ability to acquire such innovations (4c).

Block 5a expresses the incorporation of the Baldwin effect into the model: hominid groups not only adapt to their environment but also adapt the material, social, and cultural environment to their needs. These changes lead to the even greater success of behavior according to acquired epigenetic rules in subsequent generations. Here we are talking about the arrangement of stays and hearths, trail-building, establishing contacts with other groups (cross-marriages, exchanges, joint warfare), and later already about storage technologies, construction of dwellings, domestication of animals and plants

2. The cultural drive

The models of gene-culture coevolution (Wilson & Lumsden, 1983) and cultural drive (Laland, 2017: 124) are closely related and sometimes difficult to distinguish. However, the treatment of the vector of changes causality in recent years reversed: not from genes to culture and back, but *from adaptive behavior and culture to genes*. Like this approach and alternative to (Neo)Darwinism, Russian evolutionists already in the 1920s developed the ideas of orthogenesis, nomogenesis, and the importance of the interaction of entire populations (not just individuals) with the environment.

In a similar vein, Daniel Dor and Eva Jablonka, staking on the factor of *specific hominid sociality*, propose to speak not about gene-culture coevolution but about culture-driven coevolution ("from gene-culture coevolution to culturally driven coevolution"). In doing so, they rely on the ideas of James Baldwin, Conrad Waddington, and Ivan Shmalghausen.

> "As the growing literature within the framework of Evolutionary-Developmental Biology (evo-devo) makes clear, genuinely new behavioral patterns emerge from exploratory processes made possible by brain plasticity. They are gradually shaped by experience to approximate their functions, become objects of learning, mould capacities in their shape, and eventually, if the selection pressure remains, drive a process of genetic accommodation. Adaptation thus begins at the level of phenotype: capacity emerges from behavior, not the other way around. Genes are followers in evolution" (Dor & Jablonka, 2014: 17).

These sensible ideas, however, quite rhyme with the well-known metaphor of the "whip," when a behavioral adaptation forced due to changes in climate, landscapes, available means of subsistence then "pushes" multiple morphological, psychophysiological shifts, fixed already in the genome (Givón, 2009). Turner and Maryanski (2008) conceptualize these "whips" as "Spencerian selection pressures."

Here we talk about the same mass behavior of hominids, whose enigmatic changes led to progressive sapientation: morphological and cognitive.

3. Zones of nearest evolutionary development and stages of glottogenesis

"Zone of the nearest development" (ZND) is an essential concept in Leo Vygotsky's psychology, which means a discrepancy between the level of a child's actual development and their possible development level. A child can achieve this level when solving tasks with an adult or peers (Vygotsky, [1930] 1997). Thus, a child successfully masters each zone of the nearest development through interiorization.

Cognitive evolution and glottogenesis occurred stepwise. Evolutionary developing species ascents to each new step only when it has mastered the previous one. Therefore, I suggest the concept of Zones of Nearest Evolutionary Development (ZNED) as an analogy to Vygotsky's notion. In the aspect of glottogenesis, each actual stage included already used linguistic distinctions and structures, individuals' speech tasks and abilities, features of social interactions, and communicative practices, which were potential ingredients for the emergence of new structures of these types. The field of possibilities for modifying and combining these potential ingredients constituted each ZNED in this sphere. In terms of the parametric space of potential attractors, the achievement of each ZNED makes a new set of attractors available.

However, a living system, i.e., a group or population of hominids with a particular cognitive and speech abilities level, needs to be "pushed" toward them. New challenges and concerns played a role as the "pushes" (drivers) that led to new tryouts. In anthropogenesis, a certain it was a "main way" between attractors: an ascending ladder of steps of glottogenesis and cognitive evolution to a full-fledged language with Hockett's universals (Hockett, 1963). Exceptionally flexible and potentially rich providing structures had set this path (below, I will discuss these *magic wands*).

Advancing in the mastery of ZND in ontogenesis, a child learns a native language in just a few years. Constant communication with native speakers is the backbone of this acquisition.

In cognitive evolution as a phylogeny of language and consciousness, there were no those "adults" who could transmit linguistic structures in the ready-made form and already standardized cultural patterns. Therefore, hominids moved to speech and language very slowly, with constant strenuous attempts to break through to mutual understanding in new spheres of discussion and at new levels of precision. The progression through ZNED as stages of linguistic complexity — *glotto-aromorphosis* — took many hundreds of thousands and even millions of years, albeit with increasing acceleration (Dediu & Levinson, 2018; Gabora & Smith, 2018).

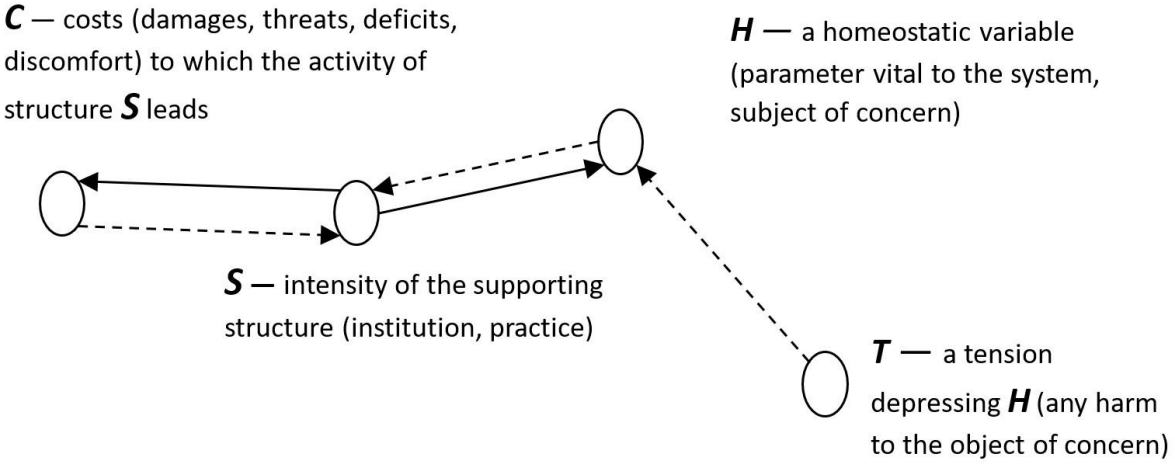
For each stage, we should reconstruct the new *techno-natural niches* that emerged, the new systems of relations (social orders) associated with them, and the corresponding *communicative concerns*[3]: a kind of analog of the child's learning tasks

[3] Communicative concerns can be understood (somewhat simplistically) as objectively given needs to transmit and perceive messages meaningful in the context of a particular social order and techno-natural niche. The theoretical notion of "concern" I will deploy below. "Communication" is here understood quite

The concept of "concerns" as one of the key concepts in theory developed here requires justification and clarification. The basic construct for this notion is the functional model, which has wide systemic application and is also a helpful tool in analyzing evolutionary processes.

4. Artur Stinchcombe's functional model and its application in explaining cognitive evolution

Figure 2 represents the scheme of Stinchcombe. The activity of *the providing structure* ***S*** (social institution, practice, technology, ritual, or tradition) maintains *the homeostatic variable* ***H*** (object of constant concern) at an acceptable level. The lower the homeostatic variable ***H***, the more intensive becomes the action of structure S (negative connection). The structure ***S*** itself restores and strengthens ***H*** (positive connection), thereby neutralizing the oppressive effect of the *tension* ***T***. It is the classical cybernetic principle of feedback providing stable equilibrium.



Note: From now on, solid arrows mean positive (strengthening, increasing) connection, and dashed arrows mean negative (weakening, decreasing) relationship.

Figure 2. A. Stinchcombe's model of functional causality

Stinchcombe enriches the classical canon. The action of structure ***S*** is "not free," its activity increases *costs* ***C*** (positive relation). The growth of costs naturally depresses the intensity of the structure *S* (the negative link). Costs ***C*** also can directly increase the tension ***T*** (Stinchcombe, 1987: 136).

As applied to cognitive evolution and glottogenesis, the values of variables and the dynamic relationships between them receive the following interpretation:

- *the homeostatic variable* is the state of the object of concern (e.g., peace, harmony, mutual understanding, coordination of collective action in a group) in terms of acceptability for a given live system; when homeostatic variables values are high, the group (as well as group alliance, population) is more likely to survive, expand and prevail in encounters with other groups (alliances, populations);

traditionally as the interaction between living beings to exchange some meaningful content (information in the broadest sense).

- the *providing structure activity* ***S*** in the aspect of social and cognitive evolution is the intensity of the effective impact on the object of concern ***H*** or the interaction of individuals and groups, especially with the use of communication;

- the magnitude of the *costs* ***C*** that directly depend on the activity ***S*** of the providing structure is the adverse effects of this activity; for example, the development of speech and verbal memory led to the growth of the brain and skull of the fetus, which increased the risk of birth traumas; the suppression of aggressive loners led to the decline in the effectiveness of coercion and control by direct violence as the former primary way of disciplining tribe members;

- *challenges* as effects of *tension* ***T*** can come from outside (f. e. lack of food, raw materials for necessary stone tools, threats from predators, rival groups, other forms of "whips" — the Spencerian selection pressures); increased costs ***C*** also can cause stresses damaging the objects of concern ***H*** (f. e. effective weapons against outsiders become dangerous for group members; becoming attractive to a desirable partner increases the risk to be a potential victim of rapists).

5. Concerns, their providing structures, and magic wands

Let us call a concern a stable complex of variables significant for the existence of a live system (an individual, group, or community) in its niches, which manifests itself in the increasing variability and renewed activity of the live system aimed at getting into a definite ("comfortable") zone of values of these variables.

Variability and activity represent attempts in the broadest sense: variants of the phenotypes, genomes, behavioral trials and probing speech actions, new social practices and rules, finally, innovative cultural patterns, including language ones.

The attempts, if successful, are fixed thanks to special fixation mechanisms that include multilevel selection, genetic heredity, and intergenerational cultural transfer.

As a result, a providing structure of any type (adaptation in the broad sense) emerges. This structure restores the homeostatic variable (object of concern), i.e., returns it to the required zone of values. A providing structure can be an organ, a property of an organ. In cultural and cognitive evolution, such structures also include types of behavior, social practices, rules, institutions, mental and speech abilities, various patterns, values, intellectual schemes, and linguistic constructions.

Environmental and social pressures form challenges and concerns for living beings (individuals), groups, and populations. Behavioral attempts are activities of these subjects, and fixation mechanisms conserve resulting successful structures (in that broadest sense). So, this conceptualization enwidens and explicates the Spencerian evolutionary ideas that Turner and Machalek (2018: 31) formulate:

> "Societies are fit if individuals and corporate units can respond to these pressures through their capacities for agency; and these responses do not come from some underlying genome and the shuffling of genes into new variants on which selection occurs but, instead, by goal-directed actions and/or luck of individual actors or collective/corporate actors seeking solutions to these selection pressures."

Of course, we are referring here primarily to objective concerns. They have a subjective representation as needs among animals. Humans can perceive concerns in the ordinary sense as desires, aspirations, passions, interests, motives.

Let us relate the concept of "concern" to those close to it. In evolutionary biology, *"function"* generally refers to the purpose of an organ or system of organs.

Concern, unlike function, is not attached to an organ or system of organs. The concern is not a characteristic of an organism but the whole complex, including an individual (or a group, a community) with a particular encompassing niche of existence.

Need is a renewable state of readiness of an organism or a subject (an individual, a group) to fill some deficiency in air, food, water, sex, social support, play, physical or mental abilities manifestation.

"Concern" as a word of everyday speech is subjective (somehow perceived) need. *"Concern"* (in the systemic, broad sense) manifests itself in activity and/or changes driving to achieve acceptable, preferable values of the variables of that caring, keeping them within certain limits.

In what follows, we will deal primarily with hominids' fundamental concerns and their communicative concerns. The *areas of fundamental concerns* include:

- security, control of violence, and the ability to use it;
- sustenance;
- comfortable, acceptable external conditions (protection from cold, heat, wind, precipitation);
- sexuality;
- position among their kind, level of group membership, status, dominance, prestige, leadership, influence, dignity;
- parenthood as protection, sustenance, upbringing, and education of children;
- possession, ownership, preferential or exclusive access to territory, the bodies of potential sexual partners, things, resources, raw materials, and everything regarded as good.

Fundamental concerns play a vital role in the entire evolution of the human species (prehistory and history) and thus in cognitive evolution, including glottogenesis. In the most general sense, they play the role of primary drivers in the renewal of techno-natural niches and social orders, and already in these niches and orders, new — derived — concerns emerge.

Providing structures (adaptations in the broad sense and related elements, constraints, connections, processes) can be vastly different: from anatomic organ to social practice. Moreover, the origin of a structure can also be quite different, including through compromise with other structures, through their integration, through following rules (i.e., previously established structures), through conscious responses to challenges, i.e., decisions and their implementation.

The structures that make up the "building material" for the new structure are called its ingredients. A particular case of the sufficiency of only one ingredient is pre-adaptation, i.e., a structure that previously provided other concerns. Exaptation means using a structure or function for a purpose other than that for which it initially evolved.

In addition, distinctive features of structures have different plasticity, some change beyond recognition or disappear altogether, while others remain almost unchanged.

Among the providing structures, there are special ones that I call metaphorically magic wands because they have a fantastic property of high plasticity and multifunctionality, a vast potential for development, for which sometimes there are no limits. In other words, a magic wand is a source of multiple future exaptations.

The brain and skillful hand have become such a structure in the human organism. In prehistory and history, such major magic wands have emerged as language, consciousness, technology, thinking, philosophical and scientific cognition, art.

In languages, the magic wands are diverse ways of phonological distinction, word formation, sentence composition, and semantic values.

6. Principles of evolution applied to sapientation and glottogenesis

The principles formulated below, which have within the framework of the outlined concept the status of initial postulates, outside have their empirical and theoretical grounds. These principles are partly directly borrowed, partly obtained by generalization, conceptual stylization from works on the general theory of evolution, anthropogenesis, developmental psychology, social psychology, and sociology (Spencer, [1901] 2021; Vygotsky, [1930] 1997; Alexander, 1987; Collins, 2004; Boehm, 2015; Turner & Machalek, 2018; et al.).

These postulates are often assumed and implicitly used in many works on the language origin and evolution (Jackendoff, 2002; Bybee, 2002; Dessalles, 2007; Tomasello, 2008; Turner, Maryanski, 2008; Bickerton, 2009; Wildgen, 2012; Dor et al., 2014; Sterelny, 2016; Laland, 2017; Gabora & Smith, 2018).

The principle of providing, or "whip": when a new acute concern (objective group need) emerges, if there are sufficient ingredients, abilities for trials, fixation mechanisms, there is bound to be a structure that provides this concern to some extent; in particular, social practices, individual attitudes, and speech abilities are such structures.

The advantage of the breadth of available ingredients: a live system chooses response to a challenge always in the accessible space of possibilities. Accordingly, evolutionary responses always use the available arsenal of ingredients, i.e., already functioning alternative structures. The wider this arsenal, the wider the possibilities of various combinations, the higher the probability of forming and winning a competition for more effective providing structures.

The advantage of colliding diversities: the more encountering populations and their cultural traditions are carriers of structures available for modification and use in new combinations, the wider the arsenal of ingredients, the more likely new effective forms will emerge to provide the emergent concerns (see above).

The principle of magic wand expansion (proliferation of successful structures): if some found or established (for example, linguistic) structures prove highly effective in providing current concerns, new attempts to use them for various other concerns will undoubtedly emerge; in such cases, the mechanism of positive reinforcement in ontogenesis, positive selection in phylogenesis, is activated; if these structures again lead to success, then the intensity of subsequent attempts to use and modify them grows.

The principle of adaptation to previously established structures: if a new structure comes into conflict with already existing structures that successfully function, supporting its stability, the new structure is likely to be adapted and modified. So, a new word, a construction, an inclusion from an alien language will change (say, phonetically, grammatically) to be easily pronounced and recognized.

The principle of collateral consequences, or costs: the activity of many structures developed to provide concerns (objective needs) leads to various tensions, leading to new concerns requiring new providing structures.

The principle of cultural drive: successful behavioral practices and abilities are fixed not only in social learning but also through the formation of hereditary prerequisites for such behavior due to the operation of diverse selection levels.

The principle of zones of nearest evolutionary development (ZNED): the structures developed to provide some concerns are potential ingredients of future structures that may be needed to provide new concerns; the area of possibilities for modification and combination of these potential ingredients constitutes the ZNED; only within it structures with parts or aspects built from these ingredients may emerge.

The principle of no complete evolutionary gaps: it is legitimate to extrapolate known similar features of the initial and final periods of some evolutionary epoch to an unknown middle period; if at the early stages or similar levels of evolution, members of a species had some distinct trait and a similar trait is present in much more evolutionarily advanced species as their presumed descendants, then it is reasonable to assume that this trait existed in the intermediate stages that we do not know.

The principle of the rhythm of formative (breakthrough) and cumulative stages: in formative stages, new cognitive structures with significant potential for functionality, modifications, and deployment (*magic wands*) appear; in subsequent cumulative steps, these new structures realize their deployment potential by modifying and articulating with other forms, which leads to accumulation of changes and possible maturation of a new breakthrough stage.

Skinner's principle of reinforcement: attitudes and abilities are formed and strengthened in the psyche thanks to positive reinforcement (or negative for rejected structures); in humans, from early childhood and in higher mammals (dogs, horses, and apes), the explicit (un)approval from significant others serves as sufficient reinforcement.

Vygotsky's principle, or interiorization: if behavioral acts in social interaction (especially communication) lead to successful responses to challenges (especially repeated ones), then participants' attitudes (predispositions, abilities) are likened to these actions, because of which participants become inclined and capable of reproducing corresponding behavioral responses to subsequent similar challenges.

The shift from Darwinian to Lamarckian mechanisms in human evolution. The more the life of individuals depends on social practices, relationships, structures (rather than directly on the natural environment), the more they seek to enhance or maintain their position in the communities that provide them, the more their behavior depends on social control and the dynamics of competition in those communities. Various rewards (including reproductive success) go to those with good social reputations (Alexander, 1987). The systematic effect of this trend in generational change through the Baldwin effect (changes in genes, brain structures) and through the translation of cultural patterns (changes in mentality) sets the vector of directed evolution. This principle is a result of the joint action of the “whip,” cultural drive, Vygotsky, and Skinner principles.

Spencer’s principle, or a combination of differentiation and integration: if initially used structure is syncretic (for example, an inarticulate sound, protosyllable, protoword), and for successful responses to different calls, separate actions are necessary, then thanks to repeated attempts, different structures will emerge; if for successful responses to the subsequent calls and concerns these structures are required together, then as a result of corresponding attempts, encompassing constructions will necessarily form.

The principle of convolutions: if structures (for example, words, parts of words, word combinations) are repeatedly and successfully used both together and separately in providing different concerns (communicative tasks), then an integrative structure, or convolution (for

example, a new compound word, a new stable phrase, a new syntactic form for similar phrases) will invariably emerge.

The principle of gluing: if structures (e.g., words, parts of words, phrases) are repeatedly and successfully used only together to provide the same concerns (communicative tasks), they are combined into a merged, inseparable whole, or gluing (a new word or particle, whose complex origin is hidden from speakers and revealed only by special linguistic analysis). A particular case of such gluing is the well-known phenomenon of grammaticalization.

The principle of ceasing the search upon success: if in finding an answer to the threat challenge, the established structure protects against risks and damage, or if due to the response to the challenge-opportunity attractive goals are achieved through the new structure, and no new concerns appear, then the providing structure is maintained and further used without new attempts (trials, probes, searches) at modification.[4]

7. Glotto-aromorphoses as rises in the stages of linguistic complexity

At the heart of every significant growth of language complexity is a flexible and multifunctional structure, i.e., a linguistic *magic wand*. Let us formulate as a priori postulates the rules of progression of glottogenesis steps based on the evolutionary principles presented above, especially the *ZNED principle*.[5] The essence of the rules is that the emergence of a subsequent step of language complexity cannot occur in the absence of the previous one:

- constructions of *complex syntax* (with recursion, polysemy, rhetoric decorations) can appear only when structures of simple syntax and grammar already exist and are in use;
- encompassing structures of *simple syntax and grammar* that govern combinations (chains) of words can emerge only when such combinations with simple order and coherent values are already present in speech;
- word combinations with simple order and coherent values (i.e., *pidgin-sentences*), and full-fledged words themselves can appear only when protophrases are present;
- *full-fledged words* (which are used arbitrarily, clearly articulated, and identifiable, which have constant values independent of the situational context but semantically connected) could appear and multiply only when the protowords (not clearly articulated with syncretic, vague values recognizable only in context);
- *withdrawing (leading away) protophrases* describing situations in another place and time could only appear when reactive and situative protophrases were already in use;
- *reactive and situative protophrases* as chains of protowords arranged in no order, but with a general syncretic meaning conveying what is happening "here and now" can only appear when there is already a practice of uttering individual protowords;
- *individual protowords (holophrases),* being gluings of syllables or phonemes aimed at conveying integral situational meaning, can appear because of many

[4] "…once a cognitive demand is satisfied at a linguistic level, there is no need to have another strategy for the same purpose" (Coupé & Hombert, 2005: 40).

[5] See also (Donald, 1998; Gabora & Smith, 2018; Jackendoff, 2002; Bybee, 2002; Burling, 2005; Dessalles, 2007; Bickerton, 2009; Hurford, 2012).

repeated communicative interactions, possible only under certain social conditions of joint intentionality and shared motivation to mutual understanding.

Suppose we manage with the help of these principles and rules to construct and substantiate a plausible conception of the stepwise evolution of language and associated cognitive abilities supporting it through the expanded Hempelian approach and various indirect data (see below). In that case, it will be the best confirmation of the formulated postulates and rules adequacy.

A direct empirical, much less experimental, verification of this consistency is impossible for obvious reasons (which is quite distressing for pedantic adherents of Popper's falsifiability principle).

Indirect confirmations of the rules are structurally similar sequences of a child's acquisition of their native language (Vygotsky, [1930] 1997). Without systematic learning, the adult, who finds himself in a completely new language environment, also moves from mastering individual words to protophrases and pidgin-sentences. If he masters the syntax and grammar of a foreign language, it is only with great difficulty, purposefully developing his speech ability using frequent corrections by others.

8. Renewal of techno-natural niches and social orders

The development of a glottogenesis research program focused on accounting for changing social interactions and types of communication is already taking place in dozens of particular studies. However, the rise to a new stage usually requires a new encompassing conceptual construct. The multistage ecosocial conception draws on the models, principles, and rules, outlined above, and in addition, includes the following components:

- ideas of niche construction and social order renewal (Odling-Smee et al., 2003; Dor & Jablonka, 2014; Laland, 2017);
- an extension of the classical challenge-response scheme (Toynbee, [1961] 2013);
- evolutionist notions of multilevel selection, pre-adaptations, and exaptations, attempts or trials in a broad sense (from behavioral to mutational ones), fixation mechanisms (through imprinting, interiorization, social learning, sexual or group selection) (Gintis, 2004; Richerson & Boyd, 2005);
- synthesis of the concepts of interiorization, interactive rituals, operant conditioning, and attitudes as controlling parts of the psyche (Skinner, 1986; Collins, 2004; Vygotsky, [1930] 1997; Boehm, 2015).

The idea of niche updating as the most crucial driver of cognitive evolution is already widely accepted (Odling-Smee et al., 2003; Bickerton, 2009; Laland, 2017). In evolutionary biology, "niches" represent areas of interaction between species and their environment, primarily in foraging, breeding, and providing security, comfortable living conditions. Some species' niches are delimited from or overlap with the niches of others, which is usually associated with stiff competition, adaptations, and selection. The niches of hominids, especially beginning with Early Homo (c. 2.7 mya), had crucial features.

First, hominids updated and expanded their interactions with the natural environment faster, more successfully, and on a larger scale through the discovery of new sources of subsistence.

Secondly, the development of instrumental technologies transformed natural niches into techno-natural ones, as their capture, construction, renewal, also the transformation of new niches became increasingly dependent on the progress of Stone Age technologies.

Thirdly, there was an equally rapid and large-scale transformation of the systems of social relations: the structures of interactions initially adapted to the survival of communities in their natural niches. As time passed, social relations acquired their autonomous dynamics and evolution.

Everyone occupies a particular position in the relations system, i. e., an internal social niche for social animals within a group. At the same time, the group outside must interact with groups of the same species: as a rule, competing for territory, feuding, or entering friendly and mating relationships. Such internal and external social niches are significant for lion pride. Social interactions and relations occupy almost the main forces, energy, and attention in groups of baboons, chimpanzees, and bonobos (our closest relatives).

Due to hominids' initial cohesion and subsequent successful expansion, their intragroup and intergroup interactions have become even more critical. As a result, social niches with behavioral adaptations appear as *social orders:* systems of typical relations and practices with patterns of behavior of individuals and groups, set by positions occupied with corresponding possibilities of mutual influence, access to each other, and benefits and resources. In the long run, these relations and positions began to supplement by systems of rules, i.e., *social institutions*.

Natural niches and social orders, including typical vital circumstances, are addressed to individuals and groups as *concerns*. These concerns initially take the form of *challenges-threats* and *challenges-opportunities*. Then, prospective responses become behavioral strategies and practices. It is a process of *providing structures* formation.

9. Coevolution of niches, orders, and communications

Consider the causal influences between techno-natural niches, social orders, communicative concerns, and practical, verbal behavior. There is no direct causal determination here. The role of techno-natural niches is to supply challenges-threats ("whips" or "sticks") and challenges-opportunities ("carrots") primarily in the *areas of sustenance* (hunger or new delicious, nutritious food), *security/violence* (fearful predators, dangerous enemies, or opportunities to defend against them, defeat them) and *living conditions* (heat, cold, harsh weather, or pleasant comfort). Hominids in their main response strategies — creation, use of external means, and coordination of complex group behavior — used intragroup communication.

What is necessary to convey, convince, learn, or understand: all this depends no longer directly on natural challenges ("sticks and carrots"). It began to depend on the established social order in the group (later, in the alliance of groups, in complex configurations of relations). It is at this point that the sociological approach takes on particular significance. Moreover, the life of hominids, so distant and alien to us, was permeated by *social universals* that have not lost their relevance to this day: violence and control over violence, power, status (in perspective — prestige, and influence), material goods (in view — wealth, property). Thus, natural "sticks and carrots" are refracted in different social orders.

Each stage of anthropogenesis begins with the emergence of new features in technology, in the way of life and nutrition, in anatomical changes. These changes are always associated with shifts in social interaction, material and communicative practices, and cognitive abilities.

Let us now turn to the general approach of explaining each glotto-aromorphosis and the corresponding ascent to a new stage of cognitive evolution.

10. Extension of C. Hempel's nomological explanatory model

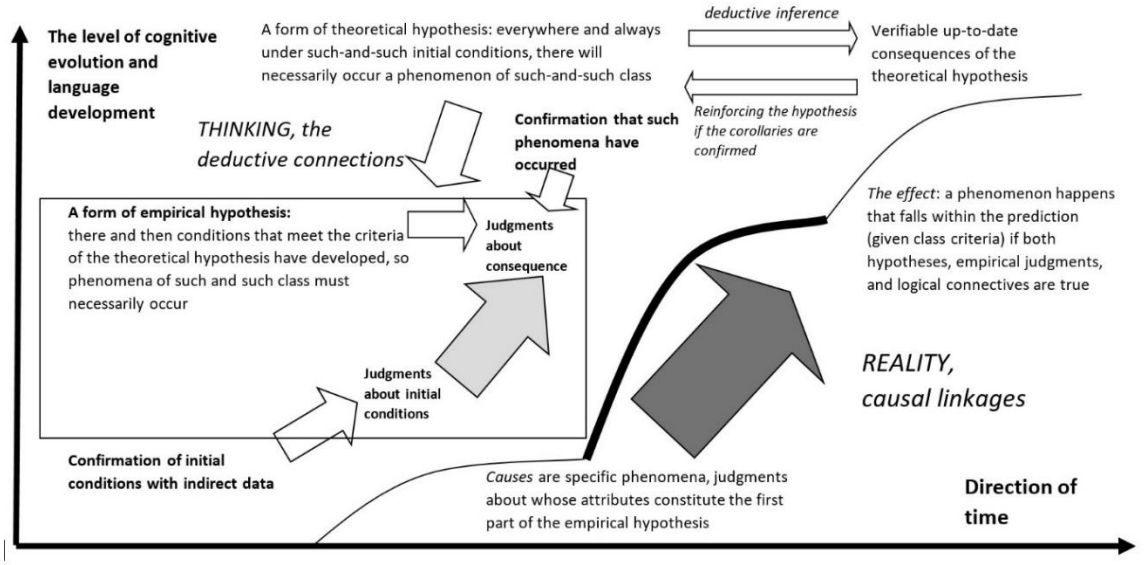
A methodological approach is needed that encompasses multiple methods of obtaining, interpreting indirect data on glottogenesis, and turning them into a kind of megamachine for hypothesis making and hypothesis testing.

First, it is necessary to present the regular connections between the phenomena as *a pair of theoretical and empirical hypotheses* for each glotto-aromorphosis — the breakthrough to a new stage of linguistic complexity through the formation and spread of language magic wands.

Second, paleoclimatic and archaeological data on the changes in the corresponding period's material practices and social interactions are *used to evaluate each empirical hypothesis*.

Third, each theoretical hypothesis's general concepts and logical connections should ensure its reliable verification and *not only (!) by indirect data*.

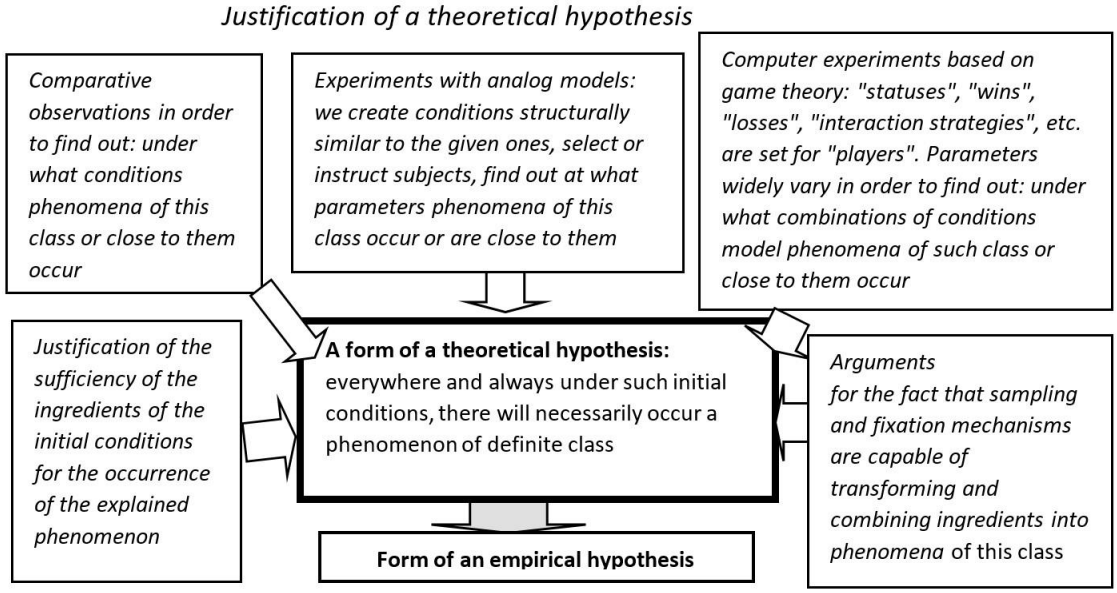
Carl Hempel's nomological scheme with a deductive derivation of judgments about phenomena-sequences from judgments about initial conditions-causes and from "universal hypotheses" (Hempel, 1942) seems to be a promising ideological core of such an approach. The empirical hypothesis of each transition to a new stage of language development has the following form: "*there and then under such circumstances, linguistic structures of such class must have formed."* Fig. 3 presents a diagram of this explanatory logic.



Note: The shaded arrow means the influence of causal phenomena on consequences in reality under study (lower right area). The white arrows are the logical justifications of judgments in theoretical thinking (upper left area). To K. Hempel's canonical scheme, justifications are added: separately for the theoretical hypothesis (through indirect data: up-to-date testing by observations and experiments) and the empirical hypothesis (through indirect data of paleo-sciences).

Figure 3. The extended scheme of the nomological explanation of cognitive evolution and glottogenesis phenomena

A more general theoretical hypothesis ("universal" in Hempel's terms) with the logical structure "if..., then..." is constructed for the empirical hypothesis. The extension of Hempel's scheme is necessary because the theoretical hypothesis itself must be justified. Moreover, one should formulate the hypothesis *so abstractly that it allows testing its consequences by up-to-date observations, analog (in-situ), or computer experiments*. Figure 4 presents the general logic of theoretical hypothesis justification.



Note: Here the blocks denote judgments and arguments. The arrows indicate logical reinforcement: increasing the validity, plausibility of judgments, confidence in them.

Figure 4. Scheme of theoretical hypothesis justification in K. Hempel's extended nomological approach

Examples among already conducted experiments include varying the nature of oral instruction in the practical making of Olduvai and Acheulian stone implements (Morgan et al., 2015; Laland, 2017: 189-207), teaching grapheme or gestural languages to chimpanzees (Lloyd, 2004; Rumbaugh, 2013), experiments and observations of language-learning children (Tomasello, 2008), computer simulations (Tamariz & Kirby, 2016; Kirby, 2017; Markov & Markov, 2020), experiments with communicating robots (Nolfi & Mirolli, 2010).

If this indirect method supports the theoretical hypothesis, the judgments of the empirical hypothesis become more plausible (the opposing arrows in Figure 3). On the other hand, if the theoretical hypothesis is not supported, then another meaningful explanation must be sought reformulated, and the hypothesis should be tested again. In addition, there are rich opportunities to vary experimental conditions.

Assumptive judgments about conditions and results of conditions' formation in each place and epoch (as a part *"if"* in an empirical hypothesis) have separate testing logic. Here the indirect data of paleo-sciences and the archaeology of sites and implements used in studies of anthropogenesis get their role, allowing us to judge the way of life and social interactions of hominids.

The theoretical hypotheses get their sources in the cognitive evolution principles formulated above, first, *the principle of providing*, *the principle of ZNED, the principle of magic wands expansion, the principle of adaptation to previously established structures*, and in *the rules of glottogenesis stages progression*. Therefore, the theoretical hypothesis form explaining a glotto-aromorphosis takes the following form.

With such a new type of social orders and communicative concerns, with such already used signification means (including linguistic structures), with the addition of such new practices of attempts and such fixation mechanisms, definite type of linguistic structures will emerge, use these means as ingredients, and provide the concerns mentioned above.

The substantiation of the empirical hypothesis, in this case, looks as follows (Figure 5).

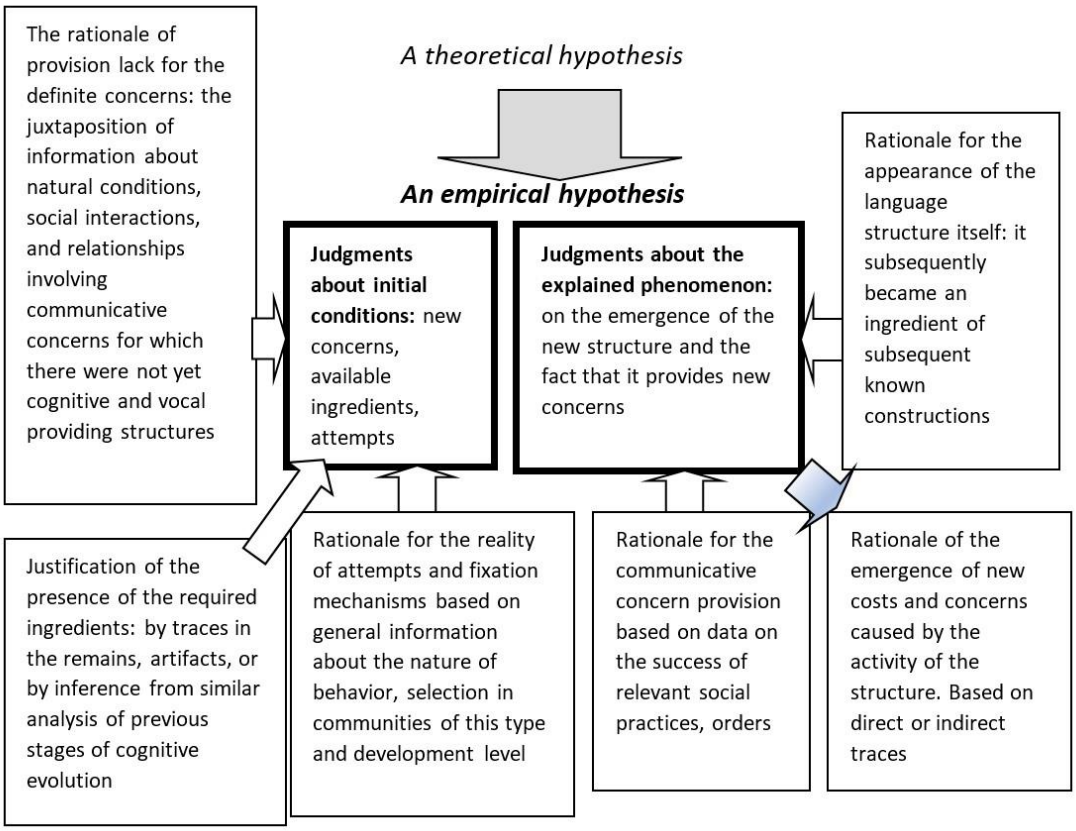


Figure 5. Indirect justification of the empirical hypothesis in the extended Hempelian explanation scheme

11. Conclusion

Studies of glottogenesis have made impressive advances in empirical, theoretical, and methodological aspects over the past 2 to 3 decades. Most promising are the ideas of multistage evolution driven by feedback circles between changes in natural niches, social orders, behavior, cognitive and communicative abilities, anatomy, psychophysiology, and innate gene potential.

Various kinds of attempts are expanding, not only analogies and comparisons (with the learning of communication by great apes, with children mastering speech, with patients with aphasia, with communication in primitive tribes) and experimentation. The sketch of the concept presented above aims to combine and order various ideas, methods, and results, including them in an encompassing ontological construct with the possibility of strict justification of judgments.

Perhaps this conceptual construction and the version of extending Hempel's explanatory scheme have significant flaws, so they will not be recognized. Nevertheless, there is still an imperative to build an encompassing theoretical framework and a methodology that allows for logical justification of judgments about causes and drivers of glottogenesis based on indirect data. The strategy of this kind offers the best opportunity for further discoveries, for understanding the origins of human language and reason.

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References

Alexander, R. D. (1987). *The biology of moral systems*. New York: Aldine de Gruyter.

Bickerton, D. (2009). *Adam's tongue: How humans made language, how language made humans*. New York: Hill and Wang.

Boehm, Chr. (2015). The evolution of social control. In J. H. Turner, R. Machalek & A. Maryanski (Eds.), *Handbook on evolution and society. Toward an evolutionary social science* (pp. 424-440). Boulder, London: Paradigm Publishers.

Burling, R. (2005). *The talking ape. How language evolved*. Oxford University Press.

Bybee, J. (2002). Sequentiallity as the basis of constituent structure. In T. Givón & B. F. Malle (Eds.). *The evolution of language out of pre-language* (pp. 109-134). Amsterdam; Philadelphia: John Benjamins.

Collins, R. (2004). *Interaction ritual chains*. Princeton, NJ: Princeton University Press.

Coupé, C., & Hombert, J.-M. (2005). Polygenesis of linguistic strategies: A scenario for the emergence of languages. In J. W. Minett & W.S.-Y. Wang (Eds.), *Language acquisition, change and emergence: Essays in evolutionary linguistics* (pp. 1-49). Hong Kong.

Dessalles, J.-L. (2007). *Why we talk. The evolutionary origins of language*. Oxford University Press.

Donald, M. (1998). Hominid enculturation and cognitive evolution. In C. Scarre (Ed.), *Cognition and material culture: The archaeology of symbolic storage* (pp. 7-17). Cambridge: McDonald Institute.

Dor, D., Knight, Chr., & Lewis, J. (Eds.) (2014). *The social origins of language*. Oxford University Press.

Gabora L., & Smith C. M. (2018). Two cognitive transitions underlying the capacity for cultural evolution. *Journal of Anthropological Sciences*, *96*, 1-26.

Gintis, H. (2004). The genetic side of gene-culture coevolution: Internalization of norms and prosocial emotions. *Journal of Economic Behavior and Organization*, 53, 57-67.

Givón, T. (2009). *The genesis of syntactic complexity: Diachrony, ontogeny, neuro-cognition, evolution*. Amsterdam; Philadelphia: John Benjamins Publ. Company.

Hempel, C. (1942). The function of general laws in history. *The Journal of Philosophy*, *39*, 35-48.

Hockett, Ch. (1963). The problem of universals in language. In J. H. Greenberg (Ed.), *Universals of Language*. The MIT Press, pp. 1-22.

Hurford, J. R. (2012). *Language in the light of evolution: Vol. II, The origins of grammar*. Oxford: Oxford University Press.

Jackendoff, R. (2002). *Foundations of language: Brain, meaning, grammar, evolution*. Oxford University Press.

Kirby, S. (2017). Culture and biology in the origins of linguistic structure. *Psychonomic Bulletin & Review* 24: 118-137.

Koonin, E. V. (2011). *The logic of chance. On the nature and origin of biological evolution*. FT Press.

Laland, K. N. (2017). *Darwin's unfinished symphony. How culture made the human mind*. Princeton & Oxford: Princeton University Press.

Markov, A. V., & Markov M. A. (2020). Runaway brain-culture coevolution as a reason for larger brains: Exploring the "cultural drive" hypothesis by computer modeling. *Ecology and Evolution*, *10*(12), 1-19.

Morgan, T. J. H., Uomini, N. T., Rendell, L. E., Chouinard-Thuly, L., Street, S. E., Lewis, H. M., Cross, C. P., Evans, C., Kearney, R., de la Torre, I., Whiten, A., & Laland K. N. (2015). Experimental evidence for the coevolution of hominin tool-making, teaching and language. *Nature Communications 6*(6029), 1-8.

Nolfi, S., & Mirolli, M. (Eds.) (2010). *Evolution of communication and language in embodied agents*. Springer.

Odling-Smee, F. J., Laland K. N., & Feldman, M. W. (2003). *Niche construction: The neglected process in evolution*. Princeton University Press.

Oppenheimer, S. (2012). *Out of Eden: The peopling of the world*. Robinson.

Popov, I. (2018). *Orthogenesis versus Darwinism*. Springer Nature.

Richards, R. J. (1987). *Darwin and the emergence of evolutionary theories of mind and behavior*. University of Chicago Press.

Richerson, P. J., & Boyd, R. (1992). Cultural inheritance and evolutionary ecology. In E. A. Smith & B. Winterhalder (Eds.), *Evolutionary ecology and human behavior* (pp. 61-92). New York: Aldine de Gruyter.

Rumbaugh, M. D. (2013). *With apes in mind: Emergents, communication & competence*. CreateSpace.

Skinner, B. F. (1938). *The behavior of organisms: An experimental analysis*. Appleton-Century.

Spencer, H. [1901] (2021). *Essays: Scientific, political, and speculative*. London: Routledge.

Sterelny, K. (2016). Cumulative cultural evolution and the origins of language. *Biological Theory*, *11*(3), 173-186.

Stinchcombe, A. (1987). *Constructing social theories*. University of Chicago Press.

Tamariz, M., & Kirby, S. (2016). The cultural evolution of language. *Current Opinion in Psychology*, *8*, 37-43.

Tomasello, M. (2008). *The origins of human communication*. Massachusetts, MA: MIT Press.

Toynbee, A. [1961] (2013). *Studies of history*. Oxford University Press.

Turner, J. H., & Maryanski, A. (2008). *On the origin of societies by natural selection*. Boulder, CO: Paradigm Publishers.

Vygotsky, L. S. [1930] (1997). *The collected works of L. S. Vygotsky, vol. The history of the development of higher mental functions* (R. W. Rieber, Ed.). Springer Science+Business Media, LLC.

Wildgen, W. (2012). Language evolution as a cascade of behavioral bifurcations. *Estudios de. Linguistica Universidad de Alicante*, *26*, 359-382.

Wilson, E., & Lumsden, Ch. J. (1983). *Promethean fire. Reflections on the origin of the mind*. Harvard University Press.