Modular Evolution: A Hypothesis for Language Acquisition

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'*Science is a bit like the joke about drunk who is looking under lamppost for key that he has lost on the other side of street, because that's where the light is. It has no other choice*.'

Noam Chomsky

Abstract

Language has made it possible to communicate and learn in human society thanks to the formation of all modules, but especially those formed from neural, socio-cultural and linguistic information, which respectively realize neural interaction, the interaction of a referent (or object) with the word and, subsequently, the interaction of words, sentences and texts between them.

Also, from the interaction of the modules with the internal and external environment, modular or meaningful information arises, which value is measured by the probability of the function performing.
On the other hand, the probability of the function performing or the value of the semantic information is determined by the module structure, which is formed as an interaction of its parts.

In the functional perspective, a linguistic module is analogous to a neural module and to a genetic module, and all modules can be considered intelligent agents.

An intelligent agent (A) perceives a referent (R) (or object O), which can be considered as a 'lock' to be opened, stores information about it and according to this information an effector (E) is formed, i.e. a 'key' that performs the right function, ie opens the 'lock'.

In this way, linguistic modules, which most often act as socio-cultural modules, perform socio-cultural and linguistic functions in human society, the same as any other module in the living world.
Our data support the idea that modularity is a general organizing principle and that modular thinking is a new form of thinking in evolutionary biology as well as in linguistics.

Keywords: information, module, structure-function, neural modules, linguistic modules, agent intelligent

Introduction

Harari states that 'The emergence of a new way of thinking and communicating, between 70,000 and 30,000 years ago, constitutes the Cognitive Revolution' (Harari, 2011). The answer to Harari's question (Harari, 2011) about what caused this Cognitive Revolution, i.e. the acquisition of language, is the subject of study as for any other evolutionary phenomenon related to living organisms, including humans and human society. It is now accepted that the explanation of these phenomena begins and ends as the history of matter, energy and information.

The study in question supports the idea that evolution is the acquisition of information over time (Frank, 2012).
In a previous study (Bajrami, 2023 *in press*) it was shown that several forms of information appeared during evolution: chemical, cellular genetic, epigenetic, neural, socio-cultural and linguistic. From interactions based on information and force (Roederer, 2003) the modules or units of construction and function of living organisms, including man and human society, are formed.

Chomsky (Chomsky, 1965) notes that language ability is realized through a module (pattern), as the basis of competence, which is innate in humans. Hence, being innate, the ability to speak is enabled not only by the socio-cultural and linguistic modules, where the human being stands out, but also by the whole set of module types formed by the above-mentioned forms of information in living things. In general, the question of whether language is modular or not (Armstrong *et al*. 2012) has received positive answers. We think that the answer cannot be otherwise, because living organisms and especially the brain (Fodor, 1983) have modular or at least semi-modular construction and function.

This is the main reason why the foundation of our idea is the modular construction and function of the language. Specifically, it is hypothesized that language consists of modules of words, sentences and texts, whose similarity to biological modules will be argued based on the modules nature as a structure and as a function in relation to the intelligent agent concept.

- **Interactions, information forms and module types**

Tomasello (Tomasello, 2003) has given two aphorisms. In the first he writes that 'meaning is use'. According to it, words or sentences acquire meaning when they are used in a certain socio-cultural or linguistic context. This is as true as the other statement that words and sentences have meaning when they perform a function. It means that meaning before use is a function, because something is used when it performs a function. An approach similar to Tomasello's was previously expressed by Wittgenstein (Tractatus, 1993), who in fact with the expression *meaning is use* understands two sides of meaning: the systemic character, on the one hand, and its connection with the socio-cultural context, on the other hand (Rrokaj, 2012).

In the next aphorism, Tomasello says that 'structure arises from use'. In fact, the modular hypothesis of language acquisition, which will be presented below, is supported by the view that structure arises from information.

The idea that in language a structure arises from information is justified by the fact that even in "living organisms the modules, which ensure their survival and reproduction" (Maynad-Smith and Szathmary, 1995), are formed as structures from some forms of information, which have appeared at different times during chemical, biological and socio-cultural evolution.

We find the idea that information 'feeds' evolution interesting (Lehn, 2002). Almost eight decades ago, in his famous book 'C is life' Schrodinger (Schrodinger, 1944) wrote that 'life feeds on negative entropy'. Information, like mass, is a property of matter (Spirkin, 1990). Also, information is a factor of interaction and organization of matter (Stonier, 1990; 1996) and that interactions are a consequence of information (Gershenzon and Fernandez, 2012) etc.

On the other hand, it is taken for granted that at every stage of chemical, biological and socio-cultural evolution, interactions based on force and information occur (Roederer, 2003). Such are considered even the statements that 'information and function are the two main features of life' (Emmeche, 2002) and that there is no function without information' (Jonk and Treur, 2006) etc.

In a previous study (Bajrami, 2022, *in press*) it is shown that a form of information forms its type or types of modules (Table 1).

In table 1 it is noted the difference of interaction that occurs due to the presence of one or several forms of information (B1) from where appears for the first time interactions of semantic, modular or functional information (B2). The birth of semantic information marks the birth of life, where meaning is a set of functions that make possible the survival and reproduction of living organisms. Each module contributes to the survival and reproduction of living organisms, during its interaction with the external or internal environment.
Below we will focus only on complex neural modules.

Table 1: Interactions, information forms and module types.

Nr.	Interactions	Information	Modules
A	Force-based interactions	They participate but do not form modules alone	-
B	Information-based interactions		
B1	Molecular and macromolecular interactions	Chemical information Genetic information	Chemical modules Genetic modules
		Epigenetic information	Epigenetic modules
B2	Somatic and sexual cellular interactions	Cellular information	Somatic cell modules Sexual cell modules
B3	Neural interactions	Neural cellular information	Simple neural modules Neuro-endocrine modules Complex neural modules
B4	Intramodular interactions among individuals, between individuals of the same species and of different species	Mixed information	Organism modules Specific modules Ecosystem modules Holobiontic modules
B5	Interactions of individuals by means of gestures	Mirror information	Mirror modules

Nr.	Interactions	Information	Modules
B6	Object-word links	Linguistic information	Linguistic modules
B7	Interactions between words	Socio-cultural and linguistic information	Socio-cultural and linguistic modules
C	Interactions of modules with the environment (behavior of modules as an intelligent agent)	Semantic information	

2. Semantic information

In one of his studies, Krzanovki (Krzanovki, 2020) presented the features of the information C, that he calls physical or concrete information, and A or abstract information. The semantic information has the properties of the information A. Information A is considered an intelligent agent and has meaning.

In our concept, every module that interacts with the environment is an intelligent agent because it perceives the environment around it, collects relevant information and according to this information performs a function that makes survival and reproduction possible. This cognitive or intelligent agent is analogous to intelligent agents in artificial intelligence (Russel and Norwig, 2021).

Let's analyze the paramecium leave from an acidic environment. The function that the module performs in this case has a meaning: the survival of paramecium.

Hence, paramecia are cognitive or intelligent agents because their action, reaction or function, as Mennat writes (Mennat, 2003), takes on a meaning and this meaning is the survival and reproduction of the paramecium, which is achieved only when they perform the function, ie leaving from the acidic environment.

In this way, the module is considered functionally successful when it dictates the acidity at the lowest limit of its presence in the environment and when it manages to leave this environment as quickly as possible.
From this point of view, the probability of performing the function in question will depend on the knowledge of the acidic reality and the reaction speed of the paramecium.

The modular or semantic information value of a module, when it interacts with the environment, can be found by calculating it as log2 of the probability of performing the function (pi).

When the probability of performing a function is below or equal to 0.5, formula (1) is used:
$Im = \log_2 pi$ (1)
When the probability of performing the function is greater than 0.5, formula (2) is used:
$Im = 1 + (1 - \log_2 p1)$ (2)
If we assume that 99% of paramecia leave an acidic environment then we have:
$Im = 1 + (1 - \log_2 pi) = 1 + (1 - 0.01) = 1.99$ bit.
With these formulas, the probability or percentage of individuals performing the appropriate function can be converted into a quantity or value of information, which ranges from 0 to 2 bits per module.

2. Module as structure and as function

There are different definitions for modules. The reason for this diversity is that researchers refer to different levels of organization of the living world, starting from the molecular level to the level of ecosystems (Bolker, 2005; Esteve-Altava, 2016).

This study supports the approach that modules should be viewed from the perspective of structure and function or process (Schlosser and Wagner, 2004).

From the structural point of view, a module is a community of molecules, macromolecules, cells and cellular structures, modules, individuals of the same type and individuals of different types where, from the interactions of their components, a function is performed or an effector that performs a function is formed.

According to this definition, the aphorism that structure arises from use falls away (Tomasello, 2003). The structure, ie the module as such, is formed as a result of information-based interactions (Roederer, 2003) during the process of organization itself (Wagener, 1996; Wagner and Lynch, 2010). Whereas the use itself is a contextual display of an inherent property based on the information organized in the module.

The other definition is about the module as a function and specifically when the module is connected to the external world and performs a function. In the function view a module is an intelligent agent which, after gathering information about the organism's request or the task it has to perform (metaphorically called opening the 'lock'), forms an effector which is a key that opens the lock, so it performs the corresponding function.

In conclusion, the structure of a module indicates the information forms of which it is composed, while the connection of the module with the external and internal world indicates its function. In this way, a module makes it possible to simultaneously study the information-function connection. The way of thinking of a process or phenomenon as connection between information to function or structure to function is called modular way of thinking. The present study is an attempt to explain language acquisition through a modular process.

As an example to study the information-function or structure-function connection, the gene-meme analogy can be used. Dawkins (Dawkins, 1976), author of the term meme, defines it as follows: 'A meme should be see as a unit of information residing in the brain ... The Phenotypic effect of un meme are in the form of words, music, visual images, clothing styles, facial and body gestures, skills such as opening a milk bottle, or panning Japonese macaque.' From this definition it is clear that just as the gene is the unit of genetic information located in the nucleic acids, the meme is also the unit of neural information located in the brain.

The analogy of the meme with the gene was made and is made due to the fact that both types of modules perform a function, based on certain information.

In the function perspective, both genes or genetic modules and memes or complex neural modules, such as: concept, memory in the semantic triangle, have in common the presence of an intelligent agent (A) which, according to the information gathered about the referent (R) that we will call it the 'lock', forms the 'key', or the effector (E) that will open this lock, i.e. it will perform the proper function (Fig.1).

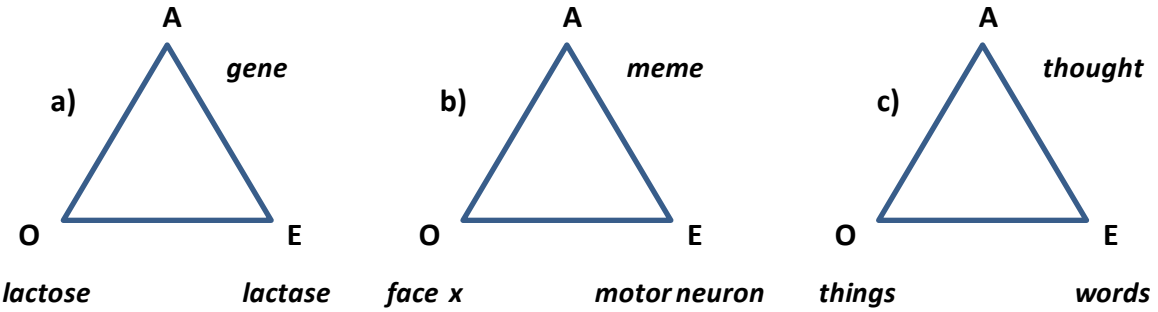

Fig.1. Representation as a function of genetic modules (a), complex neural modules (b) and word modules (semantic triangle): Agent (A), Effector (E), and Referent (R).

By agent in genetic modules (1a) we understand the structure that is formed by the interaction of molecules that begins with the transcription of RNA (m), RNA (t) and RNA (r) from DNA, continues with the connections of amino acids with RNA (t) and RNA (m) with ribosomes, with the genetic code, etc., until the synthesis of a protein such as the effector enzyme lactase to the object lactose.

The same structure also applies to complex neural modules, where one of their types is cognitive modules, such as recognizing or distinguishing faces.

In cognitive modules, the structure is formed by the interaction of memory neurons for faces with those of the current face image. In this interplay of neurons, complex categorization processes and inductive and deductive reasoning are also involved (Hayes *et al.*, 2014). As a result, as in the case of genetic modules, an effector, such as motor neurons, is formed from these interactions. The latter recognize the given face, the same as in genetic modules, where lactase breaks down lactose.

Even today, cognitive sciences are looking for such a complex process, such as the structure of neural modules or memes.

4. Interactions, forms of information and types of modules in linguistics

In table 1, the forms of information were presented according to which the different types of modules and interactions are formed as a consequence of the information.
Each module is a Maxwell daemon because each of them performs a meaningful function and has the semantic information of an intelligent agent.
Only complex neural modules are found in table 1, but it is understood that in humans all modules appear, however special are the socio-cultural and linguistic modules. Complex neural modules can be considered the main agents of the initiation of language acquisition.

It was recognized above that the basis of the gene-meme analogy, that is, of genetic modules with complex neural modules (Fig. 1) is the connection of three elements: the intelligent agent (A), the referent (R) and the effector (E).
These connections are identified when the modules are analyzed from the view function, which is one of the two sides of the module, seen as a coin.

Suppose that about fifty thousand years ago, a mother was picking mushrooms with her three-year-old child. Of course, much more sophisticated vocalizations are heard among them than those described by Seyfarth and Cheney (Seyfarth & Cheney, 1997) in monkeys. Today it is accepted that some vocalizations of primates are semiotic, because they signal the individuals of their herd about various objects and events that threaten them.

...The mother recognizes the poisonous mushroom as an object and also knows the name that she learned from her relatives. The mother points to the mushroom and pronounces its name, and with gestures she teaches him that the mushroom is not edible, it is even poisonous. The same module has already been formed in the child (Fig. 2).

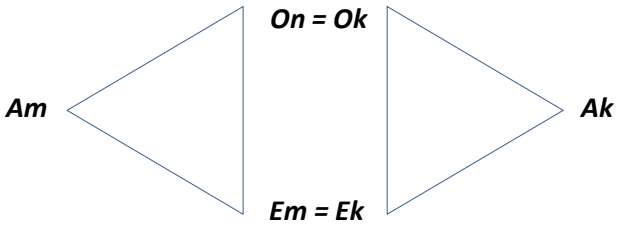

Fig. 2. Formation of the module for the word 'mushroom' in the child by his mother.

In figure 2, it is shown that the child forms the same module as his mother: Am = Ak, because for the same object (On = Ok) they use the same word (En = Ek). It is possible that mirror neurons may also participate in this process (Rizzolatti, 2009), from which mirror modules are formed. This figure shows how a certain combination of sounds, the same as in the monkeys mentioned above, produces a combination of sounds that names an object.

Also, figure 2 shows that each function in the child's cultural development appears twice: the first time at the social level and later at the individual level.

The mother and child modules bring to mind the semantic triangle (Ogden & Richards, 1923), where the connection of the referent with the marker, the symbol is mediated by a marker, concept and specifically in our example shown in figure 2 the connection of the effector (E) as a word with the Referent (R) it is mediated by the agent (A) (Rrokaj, 2012).

The effectors as a group of motor neurons in the cognitive modules (Fig. 1b) based on the ideo-motor theory seem to be the same as those of the neurons from which the speech effector is produced (Fig. 2).

5. The modular hypothesis of language acquisition

In support of the concept of modularity we mention the general modular similarity, the ideo-motor theory, the social environment, and the mirror neurons.

5. 1. The analogy of the word module with the sentence module

In figure 1, based on the concept of the intelligent agent, it was shown that in the function perspective, genetic modules are analogous to complex neural modules or memes. This analogy is shown in figure 3, between word modules and sentence modules.

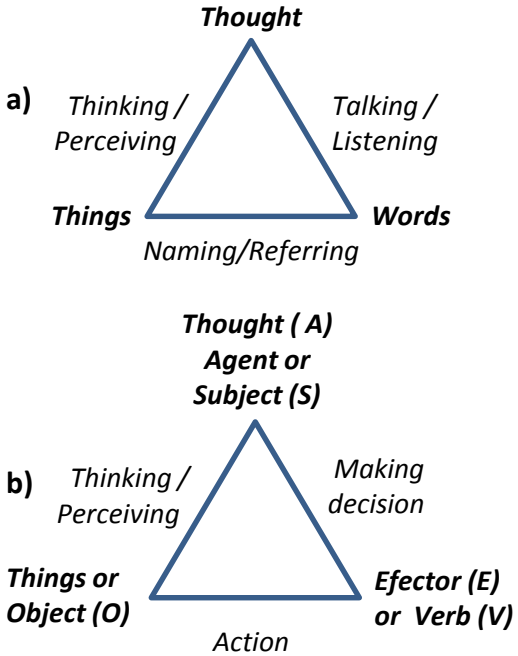

Fig. 3. Word module based on the concept of the semantic triangle (a) (Hampton, 2007) and the sentence (b).

From the comparison between them there are similarities and differences... We find the similarity in the agent (A) that, according to the information stored in the word modules, forms an effector (E) in the sense that the substitution that the word makes for a referent (R), manages to perform a function, while a self-organizing selection process takes place in sentence modules, such as the decision-making discussed above. In reality, these processes also occur in word modules, which the above-mentioned author concretizes with the terms 'talking/listening'

5. 2. Connection of the agent to the object and the effector: the ideomotor theory

Psychologists have formulated the theory of action for which there are two points of view. According to the sensorimotor point of view, an action is a response to a stimulus (S-R). In this context, perception and action have different mental representations.

According to the theory of action, called ideomotor theory (Shin *et al.*, 2010; Stock and Stock, 2004) there is a co-activation of perception and action, which have the same mental representation.

This view matches the module definition in the function perspective. In fact, the joint mental representation of perception and action is the information that the intelligent agent (A) has gathered about the referent (R). This information is stored in the module structure. Based on this information, the corresponding effector (E) is formed, which performs the corresponding action.

Hence, the concept of the module as a unit of construction (or as structure and information) and as a unit of function supports the ideomotor theory of action.

On the other hand, the concept of the module as a deposit of certain information, i.e. as a memory, makes more convincing the opinion that the acquisition of the language by the speaker is a product of the interaction between him and the surrounding environment with the born ability (competency) to generate language.

We think that the existence of a common neural substrate of tool use and syntactic exercises (Thibault et al., 2021) shows the analogy that all modules of the living world have between them. For example, it has become known that the area of the brain that controls the processes of understanding words, i.e. the process of forming word modules are also under the control of fine motor skills. This fact explains that motor or tool training improves linguistic syntax and vice versa.

5. 3. Environment of the language acquisition

Several decades ago, Vigotsky (Vygotsky, 1978) argued the primary role of social interaction in the development of cognition. Like Chomsky (Chomsky 1965), Vygotsky also admits that children are born with some basic abilities related to some elementary mental functions such as attention, perception, memory, etc.
But one of Vygoski's main contributions is the idea that a cognitive and cultural developmental feature appears first in the community and then in the individual.

One can rightly compare the acquisition or language use to swim learning. Just as swimming can only be learned in an aquatic environment, language can only be acquired in a social environment. Various data show that language ability can only become a reality in a socio-cultural environment, where living in a group is a condition of human survival. Being in a group is a characteristic of the human being itself. In the meantime, the capacity for memory and group interaction serve man as an environment suitable for his nature, where the pre-structure of the relevant modules flourishes, as a certain form of information.

But neither language acquisition nor swimming learning occurs solely as a result of the existence of the social environment and memory experience unless the modular structure is formed, which is the history of information acquisition over time, as presented in the table 1.

5.4. Mirror neurons and language

The origin of the nervous system is considered one of the major transitions of evolution (Jablonka, 2006). Although this is not the place for a detailed explanation of this transition, we are nevertheless emphasizing that with the appearance of neural modules in general, and especially with the formation of complex neural modules, the immediate and adequate adaptation of living organisms to the environment was achieved. The most culminating achievement of this major transition was marked by the formation of the human motor neuron system, which shows itself clearly in higher animals and in humans through the formation of complex neural modules.
Perhaps it is not an exaggeration when it is said that with the appearance of mirror neurons, the second replication system was born, after that of nucleic acids, with which the origin of life itself is connected.

If in the DNA macromolecule from one strand another strand is formed, the same thing happens in mirror neurons. Just as the mirror neurons that are at work in the individual who performs an action, a behavior, a facial expression, a body movement, a gesture, etc., all those neurons are also at work in the other individual who observes the first individual. Thus, in any case, when one person does something, the other also observes it. In this way, the same complex neural modules are formed in both individuals: modules of action, behavior, facial expression or emotions,

body movement, various gestures, etc. These facts lead us to the conclusion that mirror neurons are the basis of socio-cultural and linguistic inheritance (Rizzolatti, Iacobini, 2009; Cross *et al.,* 2009; Dickerson *et al.,* 2017; etc.).

There is no doubt that mirror neurons participate in the formation of complex neural modules that enable not only communication and socio-cultural interaction, but also learning in general and language acquisition in particular.

5. 5. The formation of linguistic modules as a self-organizing selection process

It is already known that the main characteristic of the brain is the organization itself and that its modules, like all other modules, are formed as a result of self-organizing selection processes (Schlosser, 2004; Wagner, 2007). For this reason, the cognitive ability of the brain should not be sought in the combinatorial reports (paradigmatic and syntagmatic) of thoughts, images and actions, but primarily in the processing of neural information, that leads to the formation of cognitive modules, from which certain thoughts, images and actions arise.

The same goes for the linguistic ability of the brain. The modules of naming words, which were mentioned above, are products of not only self-organizing processes, but also of selection processes (Bajrami, 2023, *in press*). This opinion is supported by the fact that the word pronunciation is not learned without repeating it several times. This means that every time a word is repeated, where a module is formed each time, the elimination of the initial module and its replacement with the next module occurs simultaneously.

Let's stay at the analysis of the formation of cognitive decision-making modules.

In a study by Yukalov and Sornette (Yukalov & Sornette, 2014) it has been argued that the self-organization that occurs during the formation of each module is a process similar to human decision-making. According to the authors, the similarity in question is the result of using the same mathematical formulation that belongs to probabilistic methods:
Në një studim të Yukalov e Sornette (Yukalov & Sornette, 2014) është argumentuar se vetorganizimi që ndodh gjatë formimit të çdo moduli është një proces i ngjashëm me vendimmarrjet humane. Sipas autorëve të këtij studimi, ngjashmëria në fjalë është rezultat i përdorimit të të njëjtit formulim matematik që u përket metodave probabilitare:
-Self-organization is the process of evaluating the probabilities of system states in search of the most thermodynamically stable state.

- Decision-making is the process of evaluating the probabilities of decision-making alternatives (states) in search of the most preferred alternative.

From here it is concluded that cognitive modules are formed during a decision-making process, from where a part of them also forms the linguistic modules of words.
The first modules of words, which were formed at the beginning of language acquisition, must have been those with imitative exclamatory nature (exclamations), or onomatopoeic (sound-limiting) that marked common referents in the struggle for survival, natural phenomena related to life around or even those related to relationships of love or care for the offspring during breeding.

It is now a widely accepted opinion that the common feature of all modules is their property to make living organisms adaptable. As a result, language is rightly considered a complex adaptive system (The 'Five Graces', 2009), and as such it must be viewed within the history of human society.

5.6. The Trade-off between neural and linguistic modules: locality Theory

Six decades ago Greenberg (Greenberg, 1963) pointed out that sentences consisting of three parts: subject (S), verb (V) and object (O) dominate equally in the languages of the world: as those with word order SVO (50%), including those word order SOV (50%).

Whereas Tomlin (Tomlin, 1986) and Hammerstron (Hammerstron, 2016) observed approximately the same percentages: respectively 44.78% (SOV), 41.79% (SVO) and 44.3% (SOV), 40.3% (SVO).
In the variety of theories about word order, *locality theory* gives us an approach to dealing with the role of neural and linguistic modules according to structure and function.

According to *Locality Theory* (Futrell *et al.,* 2022) the words in the sentence and specifically their proximity in the linear state of the sentence is under the influence of *information and dependence locality*. If *Information locality* makes possible the proximity of words, because they look for each other thanks to their semantic proximity, *dependence locality* does the same, because words have pressure to occur as close as possible due to syntactic connections.

At first glance, the idea that information such as process and syntax can work together seems more acceptable, but this profitable connection has not always been achieved and in some sentences the information of the structure of the neural modules comes into conflict with the linguistic modules or with the socio-cultural modules and

linguistics. Hence, minimizing linguistic dependency increases the pressure against informational dependency, and conversely, increasing the predictability of one word to another word, exerts pressure against syntactic dependency.

Probably, we can get closer to the most objective explanation if we are based on the thermodynamic stability of the structure of the neural modules, which means first of all achieving the desired function with the least expenditure of energy. As mentioned above, neural modules, like all modules, are formed during self-organizing selection processes. This means that new modules are always being formed, but this production depends on the energy expended. Under these conditions, neural modules will either be mass produced or become strong competitors to linguistic modules or they will be mass produced and give way to linguistic modules. The same thing happens in the structure of linguistic modules. Everything speaks of a non-linear dynamic, where the determination of word order is often under the power of chance, which manifests itself in individual, dialectal and pan-linguistic diversity. The issue of word order is related both to the typology of languages (with/without accent) and to the socio-cultural level of communication, where the sentence appears as a hierarchical structure in terms of the function that the words perform depending on the emphasis placed according to the speaker's intention.

However, the dominant orders SOV and SVO or AOE and AEO in modular language show that speaking or listening, like writing and reading a sentence, always implies a module which can function if the agent (A) is connected to the object (O) as much as it is related to the effector (E).

It is a fact that in the order of the words subject (S), verb (V) and object (O), in the sentences those with the order of words SOV and SVO are dominant.

First, we need to clarify what we mean by the connections between the words of the sentences expressed as percentages. The high percentage of connections between A and O, on the one hand, and A and E, on the other, shows that almost all people in the world, when they pronounce a sentence or hear a sentence, their brains are at work in relation to the object and in relation to the trigger of the action, forming the corresponding module or modules.

In the case of the formation of cognitive modules as a structure, it is not only about the direct perception of the referent, but also about extracting data from memory, categorization and reasoning about it. In the concept of the module as a process or function, this time of its formation as a structure is considered recognition of the 'lock', according to the information of which a 'key' is born, that is, an effector.
In reality, the formation of the 'key' begins with the decision-making module that decides on the most preferred 'key', i.e., the most thermodynamically stable, then it ends with the action of the key' and the performance of the corresponding function.

In this direction, in support of our approach is the opposite connection of the effector (E) with the agent (A). Perhaps this connection, used by 9.5% of languages, third in size after AO and AE connections, is the one that can indicate interactions with other cognitive and linguistic modules or with those that produce the sound from which the word is formed as a second effector (E2).

Explaining the word order in a sentence, our thought is helped from: "We must perceive in order to move, but we must also move in order to perceive" (Gibson, 1979). In modular language the above thought means that the agent (A), i.e. "We" must collect information about the object (O) and from there we must act on it (E). Likewise, the intelligent agent (A) again "We" must do an action (E) to learn about the object (O). This is why SOV (AOE) and SVO (AEO) word orders are dominant over other word orders.

Finally, in contrast to all double connections, it is noted that people of different languages in the world do not start sentences with OA order (Tomlin, 1986), or the percentage of this conjunction is negligible as a percentage (0.2%) (Hammerstron, 2016).

This fact supports our hypothesis about the order of words in the sentence, which is based on the agent (A), as the cause of the event. We must emphasize that the idea of 'teme first', or 'agent first' is a concept that researchers do not question regarding the primary role of the subject or agent.

However, in the modular concept, language acquisition finds a simple explanation if we rely on the opinion that the most appropriate sentence for communication and learning from the language is the one that has the greatest value of semantic information (Is), that is, that has the most probability high enough to perform the proper function.

Zipf's law (Zipf, principle of least effort, 1949) determines the minimum expenditure of energy, i.e. effort (biological, physical, physiological) during the realization of the sentence by the speaker, on the one hand, and the increase of semantic information with maximum probability, on the other hand other.

Sentences with word order SOV and SVO, also according to the concept of intelligent agent AO and AE, from the data of Greenberg (1963), are used in equal percentage in the languages of the world, 50% to 50%.
In these cases, formula (1) is used: Im = log2 pi, and pi = 0.5. By calculation the value Im = 1 is the same as for double bonds AO and AE.

5.7. Module structure and favored or dominant words

In a recent study (Pagel *et al*., 2019) it was concluded that people say a word with the same meaning as others not only because of the fact that they have heard it, but because they have a tendency to prefer one word than another. The authors of this study call these words dominant or preferred words and for this they quote the German philologist Muller (Muller, 1870) who, as early as 1870, wrote that there is a struggle for existence between words and that words have their own inherent property (own inherent virtue). Also, the authors of this study mention that Darwin (Darwin, 1871) was referring to Muller when he wrote that 'the survival or preservation of some favored words in the struggle for existence is natural selection'.

These data support the idea that language is built and functions as a module. The preference of words and their frequency goes in a fair ratio in all cases where information, structure and function occupy a special place in guaranteeing the survival of man within the socio-cultural environment where he lives.

In favor of the appearance of the language as a module, its structure serves. We emphasize once again that the structure of the module was born not from use, as Tomasello says (Tomasello, 2003), but from information. The information has made possible the continuous formation of socio-cultural and linguistic modules. The interaction between modules and individuals as well as the interaction of a module with its environment arise from semantic or modular information.
For this reason, the structure of a socio-cultural and linguistic module means an internal individual tendency that is formed during self-organizing selection processes.

As noted above (see § 5.5), word module structures are formed in this process, and from this it is clear when a modular structure is more stable than another structure and, consequently, a word is more favored or dominant. .

Discussions and conclusions

1. Modularity is a general organizing principle and our brain, as in all other living organisms, is built and functions in a modular fashion (Armstrung *et al.,* 2012). The advantages of modular structure and function are the reduction of complexity, the addition of new variations without damaging the old variations, solving several tasks in parallel and independently or semi-dependently, reducing the cost of connections, etc.

2. All forms of information (chemical, genetic, epigenetic, neural, linguistic and socio-cultural information) operate in the human brain, from which the corresponding modules are formed, which are the cause of all types of interactions based on information (interactions molecular, neural, modular, individual, as well as for referent-word and word-word interactions). Unlike other living things, the interaction that occurs only in humans is the referent-word interaction and between words, which is a consequence of the origine of socio-cultural and linguistic information.

3. Linguistic modules (modules of words and sentences), as an object of study, are important because, the question correctly posed by Michael (Michael, 2021) has not been fully answered until today, about what we mean when speaking about structure-function connection.

In the modular concept, structure means the conditional connection between the constituent elements of a module based on one or several forms of information. Since structure arises from information, it (structure) can be identified as information. On the other hand, when the module interacts with the environment, it fulfills a function with a certain probability. The probability of performing the function by a module is converted into a new form of information, called semantic information (Is).

Thus, a module can be compared to a coin, one side of which is information and the other side is function. The probability of performing the function or the value of the semantic information indicates the adaptive nature of the language and that the linguistic module is the object of selection.

For example, if the word order SOV and SVO is used equally (50% to 50%) in all languages of the world (Greenberg, 1963), then the value of semantic information (Im) is calculated by the formula: Im = H (2). In our case pi = 0.5 and therefore H = 1 and Im = 1.

This value of Im, both for SOV (AO) and SVO (AE) orders is much higher than for other word orders.
But what are the reasons that most people in the world use the word order SOV and SVO?
3.1. Semantic or meaningful information arising from the interaction of a module with its external or internal environment arises only in an intelligent agent.
Only an intelligent agent perceives the referent (R), stores the information received from it (A) and, according to this information, forms the effector (E), which performs the corresponding function. So the module acts as an intelligent agent.
3.2. Genetic, complex neural modules, the semantic triangle or word module, and the sentence module are built and function as intelligent agents.
3.3. The analogy between the aforementioned modules is explained in the function view.

4. Rule 7.38.55. According to this rule, verbal communication (with words), vocal communication (with the tone of voice) and body movements are respectively 7%, 38% and 55% (Mehrabian, 1971). These data lead us to think that ordinary communication between people can be realized even without language. Mirror neurons have contributed to this gestural communication and not only (non-linguistic sign systems) but, with the increase in the complexity of human society, this type of communication has not been and is not as efficient as in its beginnings in relation to the learning process, because in human society its complexity has increased. In other words, the importance of language is more related to its universal learning potential, to the ability of linguistic signs for maximum semantic communication, on the one hand, and to linguistic economy (principle of least effort), on the other. But, non-verbal communication has preserved the efficiency in communication because, in many behaviors of socio-cultural life, it realizes a maximum semantic yield with instinctive speed and with little expenditure of energy.

It follows from these considerations that the acquisition of language in which a large number of linguistic modules are formed requires considerable energy and information to maintain modular thermodynamic stability.

What should be emphasized in our effort is the concept of the linguistic module as a system born from the interactions of its constituent parts based on neural information and socio-cultural and linguistic information. In other words, linguistic modules are the manifestation of modular evolution, which began with chemical information and then continued in three major transitions: the emergence of genetic information, neural information, and socio-cultural and linguistic information.

Of course, linguistic modules differ from other modules, because cognitive processes and categorizations are replaced by symbols (signs), which interact with each other and form modular structures, based on socio-cultural and linguistic information.

Also, it should be recognized that neural information has the same importance for socio-cultural and linguistic information as genetic information has for epigenetic information.

Specifically, the foundations of the structure of the linguistic module are formed by neural information. However, symbols are created from socio-cultural and linguistic information and, therefore, this information further enriches the neural information. Likewise, this information, facilitating the language acquisition process, has dominant advantages over neural information. If in the structure perspective the adaptive role of the module is determined by neural information and appears in the reduction of the energetic cost of connections (Clune *et al.,* 2013), in the process or function perspective the adaptive role of the socio-cultural and linguistic modules is shown by the probability of performing the function proper. Linguistic modules play an adaptive role at the group level and, therefore, socio-cultural and linguistic selection acts in the socio-cultural and linguistic evolution of human societies. From here we come to the conclusion that the object of action of the socio-cultural and linguistic selection are the socio-cultural and linguistic modules.

As mentioned above, a selective process is inseparable from the self-organizing processes that occur in the human brain.

From these data and arguments, light can be shed on the acquisition of language, relying also on the studies of evolutionary biology, cognitive sciences and evolutionary linguistics, and that language evolution should be conceived as modular evolution, that is, as evolution of socio-cultural modules and linguistics.

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