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THE BIOLINGUISTIC APPROACH TO THE STUDY OF LANGUAGE NATURE

Dominant linguistics paradigms in the past several decades were focused exclusively on the surface forms of language, the product of human behavior, rather than on internal processes that underlie and shape that behavior. According to this studies the nature of language can be understood studying the external language, the set of expressions produced by speakers, the external forms of language: sounds, morphological units, words, utterances, texts, that exist apart from any individual (Anderson and Lightfoot 2002).

The biolinguistic perspective, in the broad sense, began to delineate almost half century ago when, on the path of Chomsky, the linguistics was mainly considered as the study of the system of rules and representations present in the speaker's mind. Nevertheless, in the famous article written with Hauser e Fitch (Hauser et al 2002), Chomsky still promote a research program that will enable a productive interchange between biologists and linguistics:

> One aim of this essay is to promote a stronger connection between biology and linguistics by identifying points of contact and agreement between the fields. Although this interdisciplinarity marriage was inaugurated more than 50 years ago, it has not yet been fully consummated. We hope to further this goal by, first, helping to clarify the biolinguistic perspective on language and its evolution (Hauser et al 2002:1570).

In order to determine the distinctive features of human language and their evolution we need a comparative approach with a collaborative effort among linguists, biologists, psychologists, anthropologists and neuroscience. The faculty of language, according to Chomsky, must be studied in the same way that visual system, immune system, circulatory system, and any other organ.

> The approach is "mentalistic" […] it is concerned with "mental aspects of the world", which stand alongside its mechanical, chemical, optical and other aspects. It undertakes to study a real object in the natural world – the brain, its states, and his functions – and thus to move the study of the mind towards eventual integration with the biological sciences. (Chomsky 2000:5-6).

In contemporary research there is both a weak and a strong sense to the term "biolinguistics": the weak sense of the term refers to the extent of linguistics that are engaged in discovering the properties of grammar, carrying out the research program Chomsky initiated in *Syntactic Structures* (1957) e culminated, after various revisions and reviews in the *Minimalist Program* (1995); a strong sense that refers to a research program that requires the combination of linguistic insights and insights from evolutionary biology, genetics, neurology and psychology (Boeckx e Grohmann 2007).

The best example of biolinguistics in the strong sense is E. Lenneberg's book (1967) *Biological Foundations of Language*[1], in which many topics that will be discussed in the successive years are anticipated: evolution and acquisition of language, impairment in linguistic function. The biolinguistics develops thanks to this book and the debate which has grown upon its contents.

[1] Trad. it 1971, *Fondamenti biologici del linguaggio*, Torino: Bollati Boringhieri.

The term “biolinguisitcs” is coined just in 1974 by Piattelli-Palmarini in a interdisciplinary meeting that involves evolutionary biology, neuroscience and linguistics. Through an interdisciplinary approach it has been tried to give an explanation of the human capacity to acquire and use language. The biolinguistics perspective deals with the component of human biology that occurs in the use and acquisition of language. The development of our linguistic capacities can’t be explained only in terms of learning, rather the faculty of language develops and must be studied as any other organ of human body. The main goal of the biolinguisitcs is to delineate a precise framework of biological and neural mechanisms that underlie human behavior.

The focus of the bioliguistics inquiry can be broken down into five precise questions: how can we describe the knowledge of language? How is that knowledge acquired and put in use? How did this knowledge implement in the human brain? How did that knowledge emerge in our species? (Boeckx 2010).

The aim of Chomsky, in the biolinguisitcs perspective, is to search the three factors that play a role in the development of language: genetic endowment, universal for all the individual of the species, the topic of the Universal grammar; the experience, which selects one or another language; principles not specific to the language faculty, principles of structural architecture and efficient computation, principles which are independent from the different languages (Chomsky 2010).

According to Chomsky there is a innate knowledge, the universal grammar, which represents the initial state of the faculty of language and determines all the possible

languages. The universal grammar has some syntactic principles, one of this is the principle of structure-dependency, this principle asserts that knowledge of language relies on structural relationship in the sentence rather than on the words' sequence. This knowledge is not derived from experience, but is innate of the faculty of language, part of universal grammar, a set of abstract principles that regulate the acquisition of language.

Chomsky doesn't study the ways in which we use language in daily interactions with others, the language seen from a social/cultural perspective, that he calls E-language, but studies the language as a natural object, a I-language, where I means internal, individual and intensional. The faculty of language is internal in that it deals with an inner state of mind, is individual in that it deals with one individual and with language communities only derivatively, it is intensional in the sense that is a function specified in intension, not extension (its extension is the set of linguistic expressions) (Chomsky 1995). To Chomsky, the term "language" means internal language, a state of the computational system of the mind/brain that generates structured expressions. These expressions, generated by computational system are connected to the interface systems: conceptual/intentional (semantic/pragmatic) system that uses linguistic expressions to reason, interpretate and organize action; sensorimotor system that externalizes expressions in production and constructs them from sensory data in perception (Chomsky 2009). According to Chomsky the only uniquely human component of the faculty of language is the recursive rule: the capacity to yield with a finite set of elements a potentially infinite array of discrete

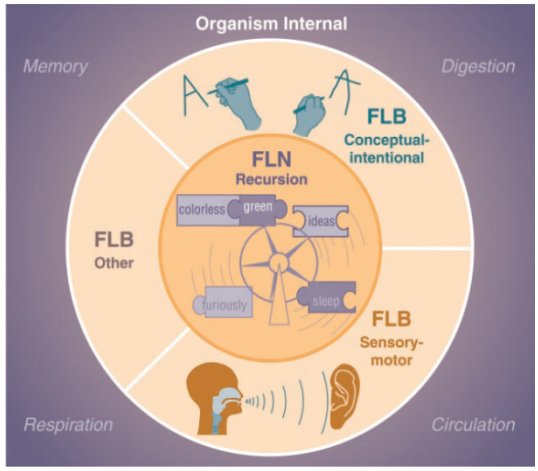
expressions. It's the creative aspect that differs the human language from any other animal communication system.

Having mastered a language, one is able to understand an indefinite number of expressions that are new to one's experience, that bear no simple physical resemblance and are in no simple way analogous to the expressions that constitute one's linguistic experience; and one is able, with greater or less facility, to produce such expressions on an appropriate occasion, despite their novelty and independently of detectable stimulus configurations, and to be understood by others who share this still mysterious ability. The normal use of language is, in this sense, a creative activity. This creative aspect of normal language use is one fundamental factor that distinguishes human language from any known system of animal communication (Chomsky 2006:88).

The identification of the hallmark of the human language leads Chomsky to delineate two conceptions of the faculty of language: one broader and more inclusive – FLB (*faculty of language - broad sense*) the other more restricted and narrow - FLN - (*faculty of language - narrow sense*). The faculty of language in broad sense includes an internal computational system combined with at least two other systems, the sensory-motor and conceptual-intentional systems. FLB includes the biological capacity of human that allows to readily master any language and excludes other organism-internal systems that are necessary but not sufficient for language: memory, respiration, digestion, circulation. The faculty of language in narrow sense includes

instead only the computational system, independent of the other systems it interacts and interfaces with.

FLN takes a finite set of elements and yields a potentially infinite array of discrete expressions. This capacity of FLN yields discrete infinity (a property that also characterized the natural numbers). Each of these discrete expressions is then passed to the sensory-motor and conceptual-intentional system, which process and elaborate this information in the use of language (Hauser *et al.* 2002:1571).



There are also many organism-internal factors, but external to FLB and FLN, that impose practical limits on the usage of the infinite combinatorial capacity of the human language. For example, lung capacity imposes limits on the length of actual spoken sentences.

Therefore the peripheral components of the faculty of language in broad sense are shared to some extent with other vertebrates, with differences in quantity rather than type, the faculty of language in narrow sense and the internal operation whereby this

interfaces with the other faculty of language in broad sense's systems are instead the only uniquely component of the human language.

The human language possess the ability to generate, starting from a finite set of elements, new combinations of grammatical elements, by applying certain syntactic rules, in a potentially infinite number of times. The combinatorial property of human language is attributable to complex syntactic rules. Every individual can understand and produce the infinity of linguistic expressions thanks to the syntax. Chomsky attributes to syntax a central role, omitting the importance of the other linguistic levels, including pragmatic level. The pragmatic level has a central role in processes of language interpretation. It is proved, in neuroscience, by Hagoort's studies (Hagoort 2009) of Broca's region, but it is already showed by Jackendoff, a linguist student of Chomsky that criticizes his teacher for the lack of recognition of the pragmatic level's importance.

Jackendoff

Jackendoff stands in sharp contrast with some of the chomskian generative grammar key points. Jackendoff gives up some of this key points: in his later study there is a rejection of syntactic movement and accordingly of the deep structure's existence[2]. It's very interesting the review of the syntactic component's status: he presents an hypothesis that is deeply in conflicts with the idea of syntax developed within the chomskian generative grammar. All linguistic theories assume the

[2] Per una discussione dettagliata si rimanda a Culicover e Jackendoff 2005.

existence of three representation's levels: phonological structure, syntactic structure and semantic structure. Differences between the various theories reside in the identification of additional layers, for example the morphological layer or pragmatic layer; in the way of conceiving the internal articulation of each level and the interaction between the different levels; in the role ascribed to individual levels. Despite the considerable changes that have characterized the generative grammar, during the different versions, some aspects remained constant: the idea of "hidden" syntactic levels, the idea that syntax is the only source of the compositionality, the idea that the lexicon (fixed elements) is separated by grammar (rules that allow the infinitive linguistic productivity). In the generative grammar, the syntax is the central object of study, the part of language faculty that includes the rules that govern the grammatical organization of words and phrases. The syntax is seen as the distinctive feature of the human language, the only component that allows the creative properties. The problem of language's acquisition is therefore discussed in terms of syntax.

Instead in Jackendoff's parallel architecture theory (Culicover e Jackendoff 2005) the combinatory complexity arises independently in fonology, syntax and semantic. It is no longer recognized the primacy of syntax on phonology and semantic: these components have their own independent combinatorial character. Each of linguistic structure's component is the result of an independent generative system. The syntax is just a language component like other, each of which helps to create creativity, complexity and astraction. The syntax is central only "geographically", as represents

the connection between semantic and phonology. The grammar consists of parallels generative components, each of which creates its own combinatorial complexity. Phonology, syntax and semantic are independent components, divided in levels or subcomponents. The grammar also includes a set of rules that determine the connection between the independent components. The language (*narrow sense*) includes syntactic and phonological structures, the interface that correlates syntax with phonology, the interface that correlates syntax and phonology with conceptual structure (conceptual-intentional interface), with perceptive input and motor output (sensory-motor interface). The conceptual structure is epistemologically prior to linguistic structure: it's a system of mental representation that codifies the way the world is filled, a mental structure in which present experience, episodic memory and planning for future actions are stored and correlated with each other, a structure which includes pragmatic considerations and "world knowledge", basic processes of reasoning and logical heuristic. The conceptual structure is the mind's central system: it's not considered part of language rather is the mental structure whereby language encodes communicable shape (Jackendoff 1999). Since the conceptual structure is considered an autonomous component, there is no need for any aspect to be reflected in syntax.

Another point of rupture with generative grammar is the refusal of the clear distinction between lexicon and grammar, which is replaced by the idea of a multidimensional continuum, ranging from particular, the idiosincracy of the words, to general, the grammatical rules. In generative grammar the lexicon is part of syntax

and is interpreted phonologically and semantically. Instead in Jackendoff's parallel architecture the lexicon is part of, or better is a essential part, interface components: a word is conceived as part of interface between syntax, semantic and phonology. The lexicon sets the connections between the parallel structures. The lexical items are placed simultaneously in the three structures and a connection is established between them.

In the parallel architecture, the linguistic structure is viewed as a collection of independent but linked levels of structure (phonology, syntax and semantic). Each level of structure is characterized by its own set of primitives and combinatorial principles. So it is rejected the classical distinction between phonology, syntax and semantic: according to the parallel architecture this division is based on generative components of phonology, syntax and semantic. Within this organization, the syntax is only one among several generative components. The parallel architecture is non-directional: in each component, starting from any part of the structure you can build a larger coherent structure. Starting from phonology, through interfaces, you can build the correspondent syntax and semantic or starting from semantic you can build the correspondent phonology and syntax.

We try to understand better how the parallel architecture is divided, so we can understand what are the unification processes that, as demonstrated by Hagoort (2009), requires the contribution of Broca's area. We take the Jackendoff's example (2002):

The little star's beside a big star

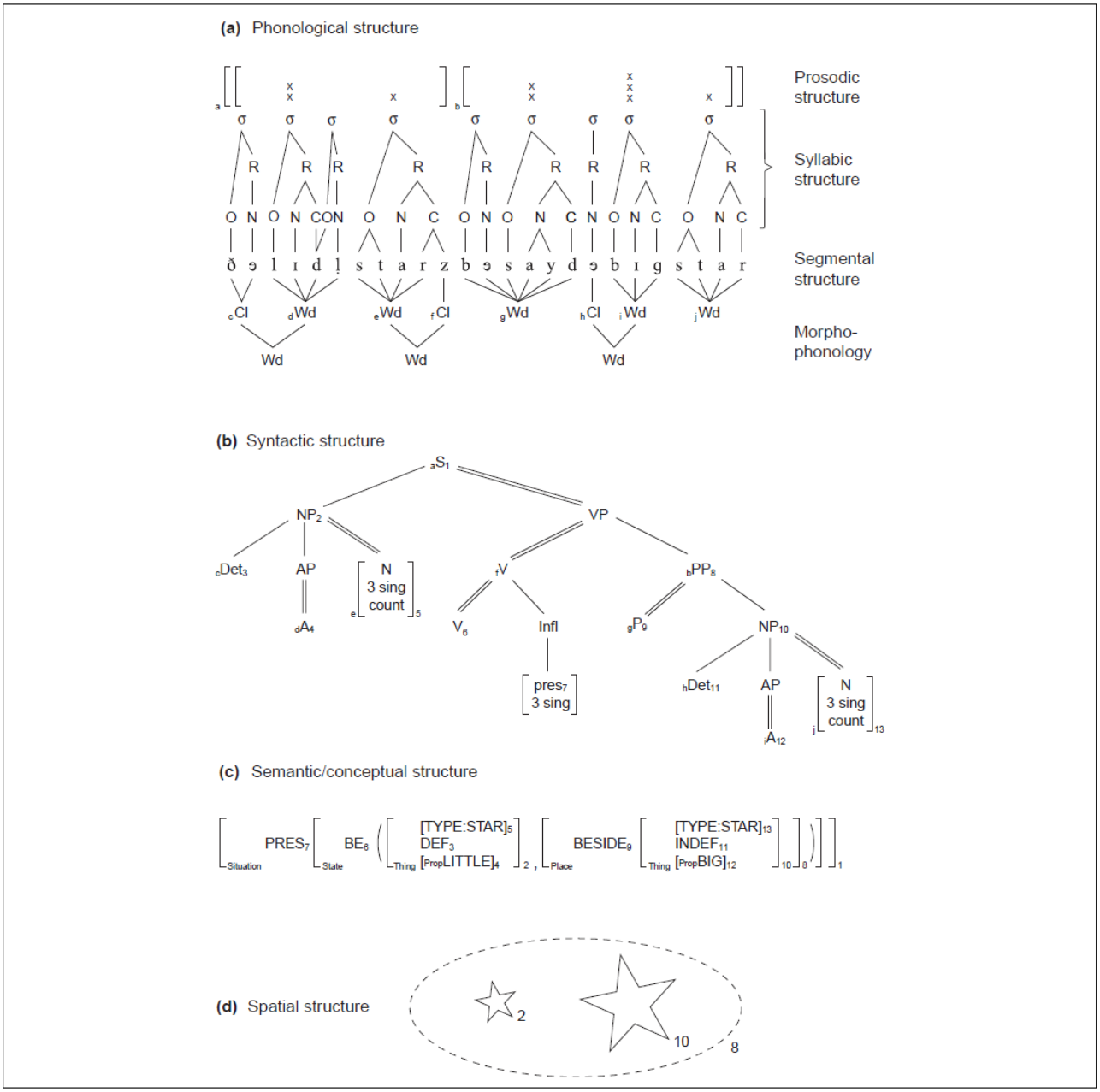


Figura 1. Struttura di The little star's beside a big star

The structure of the sentence *The little star's beside a big star* is organized into four levels, each one has a characteristic formal structure. The phonological structure consists of four subcomponents or tiers, one of this is the segmental structure, the string of phonemes. A phoneme is a phonic segment that can't be decomposed, characterized by distinctive traits that define the phoneme in opposition to all the others. The phonological structure is not simply a sequence of phonemes, there is

another subcomponent which brings together the sounds of spoken syllables. Above the syllabic structure is the tier of prosodic structure: the brackets indicate the organization of the syllables into intonational phrases. Below the phonological string there is the morphophonological structure, that combines the speech stream into words (indicated by Wd).

In syntactic structure the tree diagram represents the hierarchical structure of the sentence, that is the sintagms that make it and the different levels at which the compositions operates. The sentence (S) divides into a noun phrase (NP) and a verb phrase (VP). The noun phrase divides into a determiner, a modifying adjective phrase and a head noun. The verb phrase divides into a head verb and a prepositional phrase (PP). the prepositional phrase divides into a preposition and its NP object , and the NP divides as the subject NP. Attached to the V is an inflection with includes present tense plus the feature 3rd person singular, which agrees with the subject.

If phonology and syntax are fairly well settled, there is less agreement about the proper formulation of semantic/conceptual structure. The conceptual structure represents the descriptive, informative tier: it says that there is a situation in the present, consisting of a state. This state is an object located in a place. The function BE maps the object and the place into this state. The brackets surround the conceptual constituents. There are two kinds of relation among conceptual constituents. The first is the function-argument structure: F is a function that maps a constituent of type Y and a constituent of type Z into a constituent of type X.

$[_x F ([_y \ldots], [_z \ldots])]$

The second kind of relation is modification: there is a constituent of type X, in which the inner constituent, of type Y, specifies a further characteristic of the outer constituent.

$$\left(\cdots \right)_{x}[_{y} \cdots]$$

The object, first argument of BE, has three pieces of structure. The first designates the object as belonging to the category STAR, the second piece is a marker DEF, which indicates that the identity of the object can be fixed by either the previous discourse or the context, the third piece is a modifying constituent of the type Property, which designates the object as having the characteristic LITTLE. LITTLE has further internal structure: it says that the overall size of the object in question is smaller than a pragmatically determined norm. This norm in turn may be chosen from the average size of members of the category in question, the average size of stars in the contextual environment, the average size of all comparable objects in the contextual environment. The same is true for the other object, A BIG STAR, argument of the function BESIDE, that maps the object into a Place.

Finally, the spatial structure can be seen as an image of the scene that the sentence describes, a schema that must be compared to the world in order to verify the truth conditions of the sentence. In this case there are required two star-shaped objects, in the configuration must appear in some way the features of BESIDE, to represents the "beside-ness".

When we produce or perceive a sentence, this mental structure must be connected with each other: this operations are the problem of *binding*. A sentence have four independent structures, each one has multiple levels that must be connected, and also the four structure must be connected together. Correspondences between the levels are not obtained between primitive elements of any of the levels but between composite units. The primitive units of phonological structure such as distinctive features and syllables are completely invisible to syntax and semantic. Only the assembly of a number of speech sounds into a word has a connection to syntax and/or meaning. Similarly, the primitive units of syntax, the word's syntactic categories such a Noun, are invisible to phonology. Also, not every aspect of syntax corresponds to something in meaning. The units that are connected between phonology and syntax are not always the same units that are connected between syntax and conceptual structure. The mapping between phonology and syntax preserves linear order, while the mapping between syntax and meaning tends to preserve the relative embedding of arguments and modifiers. In turn, some parts of semantic/conceptual structure, but not all them, correspond to spatial structure, some parts of conceptual structure are harder to be represented directly in any spatial format: for example, LITTLE and BIG raise the problem of how to notate relative size in spatial structure.

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