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Dependency from Biology to Linguistics

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Abstract

This paper explores how dependencies contribute to the explanation of the evolution of the faculty of language and language diversity. Recently language-related genes such as FOXP2, CNTNAP2, ROBO1, ROBO2 among others have been found to contribute to human language. Furthermore, it is suggested that language diversity is attributed to genes like ASPM and Microcephalin. We now understand that genes not only play important roles to acquire the faculty of language but also involve in language diversity. We also consider the operation called Merge is vital in core syntax, and argue that recursive application of Merge to hierarchical structures.

Keywords:

ASPM, Microcephalin, FOXP2, dependency, tonal languages, linguistic diversity

1. Introduction

Dependencies are outstanding concepts in generative tradition to explain linguistic phenomena in phonology, morphology, and syntax. Dependencies are also viable concepts in biology. This paper explores how dependencies contribute to the explanation of the evolution of the faculty of language and language diversity. Language is likely to attribute to the third factors especially in biology rather than the UG (Chomsky 2005). Recently language-related genes such as FOXP2, CNTNAP2, ROBO1, ROBO2 among others have been found to contribute to human language (Boeckx, C. and Benitez-Burraco, A. 2014a, b, Benitez-Burraco, A. and Boeckx, C. 2015, Dediu, D. 2011, 2017). Furthermore, it is suggested that language diversity is attributed to genes like ASPM and Microcephalin (Dediu, D. and Ladd, R. 2007). We now understand that genes not only play important roles to acquire the faculty of language but also involve in language diversity. We also show that humidity is a vital element for the origin of tonal languages. Thus, the climate is a factor of language differences in terms of sounds (Everett, C. et al. 2015).

There are two competing positions in terms of the origin of the human language faculty. One position as Chomsky and linguists along the line of Chomsky's evolutionary proposal says

that the human language faculty had to emerge suddenly as the result of a single mutation of possibly FOXP2 (Estruch, S. B. et al. 2015). Another position claims that the evolution of the language faculty had to be gradual based on natural selection. In recent literature on language evolution, the gradual position of the language faculty evolution is more dominant than the Great Leap Forward idea of a single mutation. We will consider these arguments on the evolution of language.

As Chomsky and researchers along the same line propose, Merge as a simple operation in UG emerged as a result of the sudden single genetic mutation. Thus, human language possesses this operation of Merge, being applicable recursively to generate sentences (Berwick and Chomsky 2016, Berwick, Friederici, Chomsky, and Bolhuis 2013, Boexckx 2013, Bolhuis, Tattersall, Chomsky, and Berwick 2014). However, Merge is not a unique operation in UG but is observable everywhere in cognitive capacities in humans as well as animals. We also observe that the concepts of numbers can be accounted for by Merge so to speak. The concepts of numbers and number words are said to be co-evolutionary (Wiese 2007). Notice that those number concepts are uniquely human.

In what follows, we will argue two points: 1) two important positions of the evolution of language and 2) the emergence of Merge. We will conclude that Merge is not special to UG but found everywhere and the emergence of the language faculty is not sudden as a result of a single mutation. Note however that this does not mean that UG is empty, hence disappears or UG does not exist as Tomasello mentions (Tomasello 2009). It follows that Merge emerged in UG (appropriately it must be in the faculty of language), which applies recursively, processing hierarchically structured sequences (Friederici 2019). Crucially the hierarchical language processing is unique to humans.

2. The Evolution of the Human Language Faculty and Language-Related Genes

An interdisciplinary approach to FL (the Faculty of Language) may reveal some unexpected outcomes as the discovery of spiral structures of DNA by biologist Watson and physicist Click in 1950 showed us an excellent example. The same thing is said for the Science of Language (Lenneberg 1968 for early enterprise in biolinguistics). There exist many questions and mysteries to be solved as to the origin and evolution of human language. Without cooperation with various fields of biology such as genetics, genomics, neurology, evolutionary biology among others, biolinguists cannot find answers to those questions and mysteries. The main questions are: 1) why do only human beings have an ability to use intricate language? 2) why are there so many different languages but not the only one in the world? That is to say, the problem of language diversity.

Our ancestors of Homo Sapiens emerged in Africa some 2 million years ago, then according to Chomsky (2013), probably some 60,000 years ago language was there though a complex symbolic system was there before 60,000—100,000 years ago. In the course of human evolution, as Chomsky puts it, the Faculty of Language was acquired in the sense of the Great Leap Forward as a result of a single mutation, but not by the gradual acquisition by Darwinian natural selection. At the time of FL acquisition, that language was uniquely one is obvious. Then, a question arises. Why didn't language remain unique rather than it has proliferated in diversity? In the process of evolution and development (evo-devo), variations occurred across languages such as word order, morphology and speech sounds and so on. Notice however that these variations would be found at Sensori-motor systems, just the outside of the human brain/mind, i.e. the Faculty of Language in Narrow Sense (FLN). The investigation of FLN would shed light on the nature of human language, i.e. I-Language (Hauser, Chomsky, and Fitch 2002, Martins and Boeckx 2019, Yang, C. et al. 2017).

In the Biolinguistic Minimalist Program (BMP), the goals of the linguistic theory would be eventually the goals of the scientific inquiry, which constitute the investigation of optimal solutions to the organic systems. It is attested that the operations may produce maximal outcomes with minimal effort conforming to the economic principle. The system exists of any form consisting of various contents independently. These contents self-organize at the point when the system itself activates. The self-organization of the subsystems may form a higher and larger system (Chomsky 2000, 2005, 2007, 2008, 2012a, b, 2013, 2017 for Biolinguistic Minimalism).

Taking the biological foundation of language faculty in human beings for granted, the faculty of language (FL) constitutes part of the organic system in the brain neural cells. Assuming FL is biologically endowed, linguistic operations involved in syntactic, semantic, phonological processes among others would be similar to or parallel to other biological processes in the human body (Colonna et al. 2010, Fishbein, A.R. et al. 2019, Fitch 2019, Friederici, Chomsky, Berwick, Moro, and Bolhuis 2017).

Brown (1999) reports that Chinque and his research group investigated the biological characteristics of language faculty in such instances as word order, the position of adverbs among others, which are invariant across languages in the result of word orders in languages.

The importance of considering natural scientific approaches to linguistics is crucial for the sake of the advancement of linguistic science. As Chomsky states, (generative) linguistics is part of biology, essentially human biology. (Fukui 2012, Kuroda 2012 for linguistics as a natural science in detail).

Uriagereka (1998) mentions that the mobile model of Kayne's (1994) antisymmetry. This

implies the linguistic structure (syntactic, semantic and phonological ones) is three-dimensional. Baker (2001) also suggests that tree diagrams be three-dimensional. Klosek (2011) explicitly argues that by representing syntactic structure three-dimensionally. Thus, it will be possible to eliminate much of the complexity inherent in two-dimensional syntactic structures, proposing the potential for the universal syntactic representation of synonymous propositions expressed in any language. The observation that the syntactic structure is three-dimensional seems to be quite on the right track as Imai (2000, 2013, 2014) argue following Klosek's proposals, because we live in the three-dimensional world, and our brain is part of the same world. Unifying the preceding work by those linguists, we will propose that the linguistic structure could be explained if we set the basic unit as a three-dimensional structure in which the head X is always in the z-axis in the sense of the conventional mathematical axes of x, y, and z. It is posited that fixing the viewing angle is parametrized at the Sensori-Motor System. By fixing the viewpoint angle at externalization, the particular word order for a language is trivially derived, rendering a three-dimensional structure into two-dimensional structure as a result of linearization since we cannot speak words in a sentence simultaneously.

We have important consequences in that the uniqueness of the default structure on the earth could be attributed to the chiral asymmetry of the amino acid left-handedness of the solar system. (Engel and Macko 1997, Glavin and Dworkin 2009, Glavin et al. 2019) The left-handedness could be a clue to explain why most of the movement operations are leftward and very few are rightward in classical generative grammar. This coincides that linguistic processing takes place from left to right, and is closely linked with mental computation. The findings in physics and biology in a broad sense may well be useful for an explanation in linguistics. Note also that chemical structures, again three-dimensional ones, could be a good model for associating linguistic structures. It follows that if the language processing in the brain is a case of molecular reaction at the cellular network in the brain, it is not so unnatural to assume that the linguistic structures could be somewhat similar to chemical structures. This could be important as to merging categories and possibly the linguistic diversity (Widerg et al. 2019).

In the history of Homo Sapiens at the time of the departure from Africa, a gene mutation of FOXP2 suddenly occurred so that this gene became a language-related gene especially concerned with speech. Chomsky posits that this sudden acquisition of the faculty of language took place. Note that technically humans acquired the faculty of language, but not language. Consequently, language does not evolve, but the faculty of language does evolve.

At present, many language-related genes may or may not be directly liked to language or not. FOXP2 is the most well-known and is capable to link to other genes (CNTNAP2, ROBO1, ROBO2, etc.) related to language directly or indirectly (Boeckx and Benitez-Burraco 2014 a, b, Benitez-Burraco and Boeckx 2015, St Pourcain, et al. 2014).

Today some 6,000 or 7000 different languages are spoken in the world. The question arises. Why do so many languages exist? It is not so unnatural to say that linguistic diversity is part of biological diversity. Recently even genes (ASPM and Microcephalin) that are responsible for tones in linguistic diversity were found. At the same time, research was reported on the climate triggering language diversity in phonology especially tones. Thus, the diversity of tonal languages can be explained based on the factors of genes as well as climate differences (Everett et al. 2015, Lupyan and Dale 2016, Nettle 2007).

3. Merge: Biolinguistic Considerations

In this section, we will observe the unique operation in FL, Merge and its application for how categories created by Merge get a label. Note that labels are relevant only at the interface, assuming bare phrase structures in FLN (Chomsky 1995, Boeckx 2008).

FL would operate with the economy and optimal principles, then, operation Merge enters into the computational system, CHL (Yang, C. et al. 2017). Imai argues that as is assumed by Chomsky, the most fundamental operation for language processing in broad language systems is the operation, Merge, which selects two syntactic objects {α} + {β} and form {α {α, β}} (Imai 2000, 2013). Imai proposes that the relationship between the two selected objects can be specified as in (1):

(1) a. Suppose A is a merger and B is a dependent, then, A merges with B resulting in C in such a way that B is included in A. In this case, B is part of A retaining some characteristics of B. Hence, C is merger-oriented. {C {A, B}}, C=A.

b. Suppose A is a merger and B is a dependent then, A merges with B resulting in C in such a way that A is included in B. in this case, A is a part of B retaining some characteristics of A. Hence, C is dependent-oriented. {C {A, B}}, C=B

c. Suppose A is a merger and B is a dependent, then A merges with B resulting in C in such a way that A and B are indistinctly amalgamated. In this case, C is an entirely new entity consisting of A and B. {C {A, B}}, C = (A, B).

d. Suppose A is a merger and B is a dependent, then, A merges with B resulting in C in such a way that A is not included in B and B is not included in A, either. In this case, C is neutral. {C {A, B}}, C = Not (A, B).

The four types of Merge can be defined in terms of Acquisition.

(2) i . A acquires B and becomes C. (We call it the Progressive Merge.)
ii. B acquires A and becomes C. (We call it he Regressive Merge.)
iii. A and B acquire each other. The autonomy of each disappears. (We call it the Amalgamated Merge.)
iv. A does not acquire B and conversely, B does not acquire A.

The autonomy of each is independent. No labeling is available, hence this option is irrelevant. Chomsky (2013) for the labeling of Phrase-Phrase Merge. Imai (2000) for further discussions. It follows that the Operation, Merge is a universal operation with options mentioned above depending on a language to which the choice of items might be attributed. The consequence with (2) 1-2 is that we no longer need the head parameter anymore. Rizzi (2013) referring to Chomsky (2013), argues labeling the category created by Merge.

Chomsky (2013) argues how categories created by Merge get a label by postulating the labeling algorithm as follows:

(3) The Labeling Algorithm:

The category created by Merge inherits the label of the closest head.

(4) Nodes must have a label to be properly interpreted: the interpretive systems must know what kind of object they are interpreting.

(4) is different from the previous model in which labeling was thought to be a prerequisite for further applications of Merge. The new view makes Merge apply to unlabeled structures. Labeling is necessary only at the interface.

We have three cases to be considered as to Merge:

(5) a. Head - Head Merge {H, H}

b. Head - Phrase Merge {H, XP}

c. Phrase - Phrase Merge {XP, YP}

Rizzi defines the closeness of a head in terms of c-command as follows:

(6) H_1 is the closest head to α iff
i. α contains H_1, and
ii. there is no H_2 such that

i. α c-commands H_2 and
ii. H_2 c-commands H_1.

We apply (2iii) for (5a) to account for the root and functional categories. (2i-ii) account for (5b), which is subject to a natural language. We apply (2iv) for (5c) to form an unlabeled structure. As (2iii) is an instance of natural numbers, Fibonacci numbers among others in mathematics Wang, J. (2019).

4. Conclusion

What we have thus far observed is that identifying language-related genes are an important research program, and how they work for which part of language faculty. The unique origin of the faculty of language may attribute to a sudden mutation of a gene (genes) in human evolutionary history as Chomsky argues, but we should substantiate whether the faculty of language was formed suddenly or gradually in the course of natural selection. It is revealed that climate factors and genes have been responsible for linguistic diversity in the world.

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