Language and Complexity Considerations: A Biolinguistic Perspective

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1. THE FACULTY OF LANGUAGE AND LEVELS OF COMPLEXITY

From the perspective of biolinguistics , the study of language amounts to studying the biological basis of the universal, human-specific language faculty, understood as the capacity that makes it possible for children to acquire at least one natural language. Given the uniform character of language acquisition, it has been often assumed that all languages, understood as final states of a developmental process, are equally complex. As Fromkin & Rodman put it in their celebrated (1974) textbook: «All languages are equally complex and equally capable of expressing any idea in the universe». But rather than focusing on complexity issues in languages, we turn our attention to complexity as it pertains to the language faculty.

Complexity matters famously figured in Chomsky's earliest work (Chomsky 1956, 1957), where natural language grammars were shown to display properties that went beyond the scope of finite state automata. More recently, the advent of the minimalist program (Chomsky 1995, Boeckx 2006) suggests that much of the complexity ascribed to Universal Grammar in previous theoretical models is an epiphenomenon. Revisiting the Chomsky hierarchy, Boeckx & Uriagereka (2011) observe that as far as syntax is concerned, the simplest position within each complexity layer of the Chomsky hierarchy is the one natural syntax occupies. In related work, Heinz & Idsardi (2013) stress that the language faculty is not uniform in this respect, as phonological properties never appear to transcend the finite-state boundaries, on a par with Berwick *et al.*'s (2011) conclusions regarding birdsong grammars.

But what is meant by complexity? Deacon (2006) usefully distinguishes between various notions or levels of emergence (and attendant complexity), and we think that they could be useful in the context of biolinguistics. Specifically, Deacon's notion of second- and third-order emergence have worth distinguishing. Deacon argues that many thermodynamic effects correspond to first-order emergent relationships. These arise when relational properties of systems amplify intrinsic material properties, eventually resulting to a reduction in complexity. Deacon's second-level involves the self-organization of systems; what he calls 'autopoietic' sets. Self-organization gives rise to what one might call spontaneous complexity. Deacon's third level encloses the additional factor of 'recursive causality' of self-organized systems, arising from interaction among agents. As he notes, this type of emergence inevitably entails an evolutionary, historical character. Call this cumulative complexity.

Traditionally, this latter type of complexity has not been given much attention in the Chomskyan literature: social phenomena are often relegated to 'E(xternal)-language', a notion distinct from what Chomskyan linguists focus on (I-language).

'I-language' and 'E-language' have been first defined in Chomsky (1986) along the following lines: E-language treats language «independently of the mind/brain» (p. 20), and I-language «is some element of the mind of the person who knows the language, acquired by the learner, and used by the speaker-hearer» (p. 22). Different definitions of these terms have been suggested in the literature, however most of these definitions reach a point of agreement on assuming that E-language entails a socio-cultural perspective, whereas I-language entails a cognitive/biological perspective. So far this state of affairs suggests that I-language and the environment factor can be kept far apart, probably to the extent of arguing that internalists give a negative answer as to whether (i) «some ontology of 'language' [exists] outside of individuals' mind/brain» and (ii) «we can ever construct a serious scientific theory of such 'language'» (Lohndal & Narita 2009: 325).

While we generally agree with this broad distinction, it seems to us that recognizing the influence of environmental factors on the range of properties grammatical systems manifest may be of interest in the context of complexity issues (specifically, Deacon's levels 2 vs. 3). Here we review recent work in biolinguistics that bear directly on this.

2.LANGUAGE EMERGENCE AND LESSONS FROM BIOLOGY

In biology, it is standardly recognized that there is a mutual relation between what counts the genetic makeup of an organism and the environmental influences it undergoes. Genes determine the capacities of organisms, yet the limits of these capacities are affected by the environment and eventually may never be explored, depending on how adequate the environmental factor proves to be; in other words, «human beings can speak because they have the right genes and the right environment» (Lewontin 2000: 28).

We suggest that the theoretical argument that the environment factor makes an impact on the development of certain I-properties can receive empirical support from cases of recently emerged or still emerging languages, where a sufficient period of development time has not yet elapsed and the emergence of (complex) I-properties is still in its earliest stages. The underlying assumption is that if language emergence is in its early stages, time is not enough for it to have already undergone significant environmentally driven adaptations (cumulative complexity, or third-order emergence in Deacon's terms). One such case is that of Al-Sayyid Bedouin Sign Language (ABSL), but we should stress that the facts reported below are generally in line with the predictions made by approaches such as Kirby (2001), Kirby & Hurford (2002), Kirby *et al.* (2008).

2.1. Complexity in language

ABSL is a language now in its third generation of speakers that emerged in the last 70-75 years within a small Bedouin community in southern Israel. The presence of a gene for nonsyndromic, genetically recessive, profound pre-lingual neurosensory deafness (Scott *et al.*, 1995) coupled with consanguineous marriage patterns within the tight-knit Bedouin community have resulted in the birth of a proportionately large population of deaf individuals in a relatively short period of time (Sandler *et al.*, 2011). ABSL is unique in that it can be treated as a case of truly spontaneous language emergence (similar was the case of Providence Island Sign Language, once known by the majority of the people on Providencia Island off Nicaraguan coast (Washabaugh 1986), but now nearly extinct (Lewis 2009).)

The gradual development of complex grammatical markers in this language is a well-documented fact: According to Meir *et al.* (2010), ABSL first-generation signers have the tendency to break an event that requires two arguments into two clauses which come along with two verb signs, each of them a predicate of a different argument; for example, a description of girl feeding a woman could be realized with two SV clauses rather than a single SOV, which would be the prevalent word order among ABSL signers. The conclusion these authors draw based on such data is that language takes time to develop grammatical markers such as the ones that facilitate distinguishing between the subject and the object phrases in a clause. By observing complexity in emergent language or in primary, spontaneously developed child or adult gestural systems of communication (i.e. home-signs), one can distinguish between those properties of I-language that are strictly speaking innate and those that have come to be internalized, but encompass an interplay between innate, biological predisposition and the influences of the environment.

Both types of properties would be properties of I-language; therefore, first the role of the environment is already smuggled into a discussion that has 'I-language' or 'the ontology of language' as its object of study and second the sharp distinction between I- and E-language in reflection of internalist and externalist inquiries respectively, is destabilized from the moment the boundaries between the two become blurred in certain cases. Complexity does instantiate this interplay in the sense that in home-signs, complexity is reasonably expected to be less advanced compared to its manifestations in extensively grammaticalized languages, however not totally absent. In other words, its existence does not depend solely on the environment: Biology provides a seed from which a capacity evolves, yet aided by the environment.

2.2. Complexity in birdsongs

Discussing the ontology of human language through approaching certain properties such as development of complex (grammatical) markers as environmentally-driven adaptations of an innate capacity is nothing more than extending to human language what biologists do for the systems of communication of other animals.

Complexity does not exhaust its existence in human language: Song quality in Bengalese finches «*partially* reflects early ontogenetic conditions», whereas «considering that song syntactic complexity is subject to female preference in the Bengalese finch, it is likely that maternal resource allocation strategies play a role in song evolution» (Soma *et al.*, 2009: 363, emphasis added); such strategies obviously being a component of the environment factor. Moreover, it has been argued that long-domesticated Bengalese finches display a phonologically and syntactically more complex courtship song compared to their cousins that leave in the wild (Okanoya 2012). Evidently, the path to deriving complexity goes through the environment and this happens not only in the case of human language. It seems that the existence of properties like varying complexity in what gets externalized is not restricted to humans and also the factors that affect these properties are quite alike across species in that they are environmentally-driven adaptations.

Leaving communication systems aside, the genotype-environment interaction is present in a plethora of studies that deal with the development of biological traits in organisms. The 'genotype-by-environment interaction' refers to the contributions to the phenotypic variation of differing effects of different genotypes across environments (West-Eberhard 2003: 15). The degree to which environmental choices affect the way genetic blueprint is expressed depends on the specific genotype-environment interaction in each case. This view is consistent with what Lupyan & Dale (2010) propose for language structure being determined in part by social structure. Having conducted a statistical analysis of over 2,000 languages, their results suggest that language structures adapt to the environment just as biological organisms are shaped by ecological niches.

According to their Linguistic Niche Hypothesis, there exists a relationship between social structure and linguistic structure such that «the level of morphological specification is a product of languages adapting to the learning constraints and the unique communicative needs of the speaker population» and «the surface complexity of languages arose as an adaptation to the esoteric niche» (p. 7). Apart from reflecting statistical correlations, these predictions map nicely onto the findings elicited by comprehension task which aimed to examine interpretations of spatially modulated verbs in Nicaraguan Sign Language. More specifically, Senghas (2003) notes a mismatch in form that is observed from one age cohort to the cohort that follows and suggests «that each age cohort [...] transforms the language environment for the next, enabling each new cohort of learners to develop further than its predecessors» (p. 511).

In a similar vein, Wray & Grace (2007) argue that the nature of the communicative context affects the (surface) structure of language. According to these authors, esotericity allows for grammatical and semantic complexity, whereas exoteric, inter-group communication leads language towards rule-based regularity and semantic transparency. In Bolender (2007), the link between exoteric communication and enhanced linguistic complexity is related to syntax. He suggests that the increase of inter-group communication, due to population expansion, is what triggered the realization of an up to then dormant linguistic operation: syntactic movement, or, as it is now called, internal merge. We think that such considerations ought to be paid attention to, as archeological evidence traditionally taken to point to the emergence of language goes back to periods of important demographical changes (see Mellars 2006).

Incidentally the possibility of environmental influences on the emergence of complex aspects of language was acknowledged in Chomsky (1980: 176), when he wrote that the development of some complex structures is subject to the degree of stimulation they receive from their external environment. In his own words:

> «it is entirely conceivable that some complex structures just aren't developed by a large number of people, perhaps because the degree of stimulation in their external environment isn't sufficient for them to develop. That wouldn't be too surprising. If we really look into the details of the development of this particular system we might find successive thresholds of this kind, but I would expect to find exactly the same thing in the study of any physical organ» (Chomsky 1980: 176).

Finally, Deacon (2010) observes that numerous organisms delegate to their environments properties that they once encoded in their genes. Such situations arise in the context of relaxed selection. The structural aspects of language, as they grow more complex and inter-linked, relax the process of selection, with its natural tendency to hone particular functional adaptations. In turn, this opens up new evolutionary spaces for the evolution of complexity. In the case of language, this relaxed selection opens up language to greater epigenetic influence and social and experiential learning. In Deacon's words, «the relaxation of selection at the organism level may have been a source of many complex synergistic features of the human language capacity, and may help explain why so much language information is "inherited" socially». We think that this could be the main source of what linguists call parametric variation (points of underspecification in Universal Grammar).

4. CONCLUSIONS

In the course of its history, biolinguistics has shifted its focus from a rich, complex, innate genetic substrate to something much simpler, and – it has been argued – more biologically plausible. We think that taking the possibility of social influences seriously helps narrow down the true nature of the biological endowment for language, and far from contradicting the overall program, it would strengthen it.

In our view, approaches like Blevins (2004) for phonology, which explains synchronic sound patterns through diachronic sound changes, are moving in the right direction. Instead of having a bulky, fixed set of constraints built in the synchronic phonology of speakers, such approaches attribute the complexity of attested phonologies to the intricate patterns that natural sound change follows. These patterns depend largely on the properties of the human articulatory and perceptual systems and the way they are used in a community of speakers. A pattern in a language will be as rare as the sequence of events that might lead to it, be it because of intrinsic human anatomic properties, social pressures or merely chance. This explains why some patterns are extremely recurrent and some are limited to a handful of attested languages, without the need of pre-existing internal constraints. All variation is thus relegated to the status of epiphenomena, eventually established in the language, but nonetheless extra-phonological and therefore having no place in a description of phonological competence. The latter, in turn, can therefore receive a more minimalist treatment (see Hale & Reiss 2000, Blaho 2008, Samuels 2011), in line with what we defend is the right way to go about investigating strictly internal components of the language faculty.

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