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Biolinguistic investigations on the Language Faculty

Introduction

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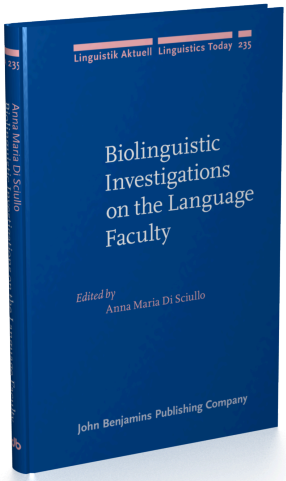

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Introduction

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The papers assembled in this volume aim to contribute to our understanding of the human capacity for language, understood as a generative procedure that relates sounds and meanings via syntax. While theoretical hypotheses about this relation are part of the generative enterprise since its beginnings, recent developments address the issue in terms of the properties of the 'language organ'. Different hypotheses about the properties of the generative procedure, giving rise to the discrete infinity of language, are under discussion, and their connection with biology is open to important cross-disciplinary work. Advances have been made in human-animal studies to differentiate human language from animal communication. Contributions from neurosciences also point to the exclusive properties of the human brain for language. Studies in genetically based language impairments also contribute to the understanding of the properties of the language organ. This volume brings together contributions on theoretical and experimental investigations on the Language Faculty, language variation and language impairments. The following paragraphs present the gist of their content.

Section 1. Language Faculty

In this first section, the main questions and hypotheses of the Biolinguist program are restated as well as new Biolinguistic research is discussed. While the paper on the Biolinguistic program provides a broad coverage of the field, focusing on the properties of the Language Faculty, the other papers focus on phonology, language externalization and the organization of speech in auditory cortex in a biolinguistic perspective.

The first paper by Anna Maria Di Sciullo and Calixto Aguero, "The Biolinguistic Program: Questions and hypotheses", presents a comprehensive overview of the Biolinguistic research program. This program aims to provide explanatory accounts of the fundamental facts about human langue, that it is an unbounded

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recursive system, that language acquisition is rapid and universal irrespectively of geographical or cultural differences across the species. The authors identify the questions and the hypotheses that are at the core of the biolinguistic program in current developments of linguistic theory and biology. The Biolinguistic Minimalism (Chomsky 1993, 2007a, b, 2008, 2013) relies on the one hand on the hypothesis that human language is a part of human biology, as evidenced by the fact that language develops in the child through the same typical steps, independently of socio cultural parameters. Facts from natural development and language impairments provide evidence of the biological basis of human language. Furthermore the authors bring evidence that language diversity and historical change find resonance in the diversity and change of bipartite biological organisms (Palmer 2004, 2009). The generality of the biolinguistic questions makes it difficult for any single scholar to be able to pursue such topics exhaustively from within the methodological boundaries of a single discipline. For this reason, research in biolinguistics abstracting away from the aspects of the problems that are irrelevant to the domains in which the research takes place while recognizing that findings achieved in the other related disciplines, including biology, mathematics and physics, may have an impact in confirming or disconfirming the hypothesis that are postulated at the local levels.

Camila Matamoros and Charles Reiss' paper on "Symbol taxonomy in biophonology" is complementary both to work like that of Hornstein and Pietroski (2009), who explicitly exclude phonology in their discussion of a possible set of 'basic operations' for language; and to work like that of Mesgarani et al. (2014) who report finding evidence for phonetic/phonological feature encoding in the brain. The authors are interested in the combinatoric and syntactic properties of phonological computation. The paper is influenced by scholars like Poeppel (2012) who maintain that neuroscientists need theoreticians to tell them what primitives to look for in the brain: "The commitment to an algorithm or computation […] commits one to representations of one form or another with increasing specificity and also provides clear constraints for what the neural circuitry must accomplish. The kinds of operations that might provide the basis for investigation include concatenation, segmentation, combination, labelling, and other elementary (and generic) operations that could be implemented quite straightforwardly in neural circuits". Their discussion of basic notions like variables and functions and the combinatorics of phonological data structures built from atomic symbols is inspired by Gallistel and King (2009).

In ''Language externalization is not secondary: On the integration of speech and thought', Joana Rosselló points out that the importance of speech/sign for thought has been overly underestimated. The paper focuses on externalisation and provides different arguments in favour of the thesis that language externalization

is not secondary, contrary to the classical Chomskian position (Chomsky 2007a, b, 2014) according to which the faculty of language matches optimally with thought, the Conceptual-Intentional system, rather than with externalization. Against this framework, the author provides different arguments in favor of her thesis, which reinforces the un-Cartesian view of language (Hinzen 2014). From a conceptual point of view, two arguments are developed. The first argument posits that language is the most complete faculty ever evolved in the sense that it embraces and interrelates a sensory system, which qualifies as an input/perceptual system (Fodor 1983), a cognitive system and a motor system, which crucially are all interdependent. That it is precisely the motor-cognitive – perceptual connection that is crucial is suggested by the openness of the externalization: the system can be oral-auditory or gestural-visual. The second argument shows that externalization can be vindicated without assuming that language evolution is crucially informed by animal communication (Bolhuis et al. 2014; Hauser et al. 2014). Once communication/externalization is restated, words and grammar are considered in its light. It is then argued that the communicative (sound/sign) and cognitive (meaning) dimensions of language go arm in arm irremissibly and are responsible of our species' mental and social profiles.

In "Neurobiological correlates of the temporal and spatial organization of speech in auditory cortex: A critical review," Mirko Grimaldi and Anna Dora Manca highlight that human speech processing shows a unique property: a high-resolution system for acoustic decoding and phonological encoding tied with ability for abstraction and a very efficient memory mechanism, both residing in high developed cortical (and sub-cortical) pathways. The authors point to the fact that in search for the neurobiological foundation of speech processing, studies have used Magnetoencephalography (MEG), a technique with good spatial and excellent temporal resolution, to investigate timing (tonochrony) and topography (phonemotopy) of the N1m – the magnetic counterpart of the N1 auditory evoked potential (AEP). Researchers want to know if the phonemotopic map is independent of the tonotopic map or, alternatively, whether phonemes are more simply represented according to their frequency content along tonotopic gradients in auditory cortex. To this end, investigators have mainly measured the cortical responses to vowel stimuli, a class of speech sounds differing acoustically each another on the basis of the distribution of F1-F2 formant frequencies. While these studies provide evidence that tonochrony and phonemotopy of the N100m may reflect differences in the quality of vowels, these findings require a number of caveats. First, the source locations described in these studies represent a single point in three-dimensional space in the cortex of the N100m response. As it is known that the N100 response has at least six separate cortical generators, the N100m sources can describe a simple cortical map representing a partial abstraction of the

underlying anatomy and thus, they should not be viewed as an exact representation of the auditory maps well-described in animal. Finally, none of these studies have tested whether the cortical responses to the F1-F2 dimensions for nonnative vowel sounds show a similar sensitivity to native phonemes. Despite these limitations, these studies provide consistent evidence that a perceptually critical aspect of the formant structure of vowels, such as the ratio between F1-F2, is represented in a temporal and spatial map within the auditory cortex.

Section 2. Language variation

The papers included in this section relate language variation to variation in biology. They present a view of the Language Faculty as parallel to any other biological system, as well as they show that a biolinguistic understanding of human language and variation also has implications for comparative linguistics. While the first paper relates macro and micro parameters to deep properties of I-language, the second and third papers present explanatory approaches to language variation in terms of third factor principles reducing complexity.

In "Feature-values and the expression of variation" Pritha Chandra argues that feature-values (e.g. singular/plural; 1st/2nd/3rd person) are as varied for dialects and closely related languages as for typologically unrelated languages. In other words, the I-language systems of related and geographically close languages are sometimes quite disparate in their feature-value pools, contra suggestions of micro-variationists (Kayne 2005). In this sense, the language system mirrors the variation patterns observed in population genetics, where genetic variation within a population/race is as varied or even more varied than that observed between different populations/races. These claims are substantiated in the present work with a wide array of split-ergative patterns. At the descriptive level, cross-linguistic split-ergative patterns show person and number values independently effecting interesting similarities and differences both between closely related and unrelated languages. Pama-Nyungan language Dyirbal exhibits ergativity in third person pronominals, but not with first and second persons (Bitter & Hale 1996; Legate 2012), a pattern also evident in Indo-Aryan Punjabi and Marathi. However, its dialect Giramay has no such restriction and closely resembles Walpiri, a typologically related language. Similarities also exist between Giramay/Walpiri and typologically unrelated languages like Basque and Indo-Aryan Nepali while Nepali exhibits notable differences from typologically related Hindi-Urdu. Number values like singular and plural on the other hand, play significant roles in the ergative patterns in the Mayan language Tzotzil as well as the typologically

unrelated Indo-Aryan Gujarati (Bhatt 2007). This paper goes on to demonstrate how feature-value pools have large-scale structural repercussions, just like what are expected of macro-parameters (Baker 2008). This leads the author to analyze them as reflections of deeper structural differences in I-languages than as mere values on functional heads.

The second paper brings to the fore parallels between language variation and variation in biology by considering the effect of natural laws, or third factor principles (cf. Chomsky (2005), on language diachrony. In "Object pronouns in the evolution of Romanian: A biolinguistic perspective", Anna Maria Di Sciullo and Stanca Somesfalean assume that the Language Faculty does not change through time, and that syntactic variation is the consequence of minimal changes in the feature structure of functional categories, which are brought about by language acquisition and languages in contact. They also assume that evolutionary developmental principles emerge in the historical development of languages as a consequence of natural laws reducing complexity. One consequence of such principles is the Directional Asymmetry Principle (DAP) according to which points of symmetry tend to be eliminated (Di Sciullo 2011). The authors provide further arguments for such symmetry breaking universals by considering the development of object pronouns in the diachrony of Romanian. Relying on the two notions of complexity proposed in Di Sciullo (2012), Internal and External complexity, the authors address the facts that clitics and strong pronouns differ in their level of complexity (Kayne 1991, 1994; Uriagereka 1995; Cardinaletti & Starke 1999; Sportiche 1999; Di Sciullo 1990, a.o). Internal complexity is derived by the operations of the Language Faculty and is measured in terms of length of derivations. Thus, a derivation of a linguistic expression that involves fewer operations will be preferred over a more 'costly' derivation on grounds of computational efficiency. External complexity is legible at the sensori-motor (SM) interface and is calculated in terms of density of representations, which is not limited to string linear measure, but includes supra-segmental material such as stress as discussed in Di Sciullo (2005). Thus, a representation that contains less SM material will be less 'costly' on grounds of representational efficiency. The authors propose that the change in the pattern of pronominal objects from Old Romanian to Modern Romanian is the result of a bi-fold complexity reduction mechanism, namely the reduction of both I-complexity, which is basically derivational, and the reduction of E-complexity, which is basically representational. Given these assumptions, the derivation of proclitic constructions involves fewer operations than the derivation of post-verbal pronoun constructions. Thus, in a fluctuation period such as the one observed in Old Romanian, the analysis predicts that given DAP and the fact that the derivation of post-verbal clitic objects is more derivationally costly, proclisis will be preferred.

The third paper of this section "The interplay of silent nouns and reduced relatives in Malay adjectival modification", Manuel Espagnol Echevarria discusses facts from Malay and focuses on the variation in the area of adnominal adjectival modification. The author develops the idea that silent categories may also play a role in parametric variation due to their featural properties. Cinque (2010) has shown that, in spite of the great deal of variation found in adjectival modification, it is possible to identify two main classes with clear-cut syntactic and semantic properties: direct and indirect modification. Working on a restricted subset of adjectival classes, namely intersective, subsective and evaluative adjectives, the author puts forward a general proposal aiming to characterize in a precise way the syntactic distinction between these two main types of adjectival modification. The proposal crucially involves the presence of silent/overt nouns, cf. Kayne (2005), and a possessive relation in the case of direct modification, and (reduced) relatives for indirect modification. Under the set of proposals put forward in this paper, variation will mostly follow from (a) externalization, cf. Berwick and Chomsky (2011), Chomsky (2010), Richards (2008), Di Sciullo (2015), and (b) the set of silent nouns available, a "lexical parameter" of a quasi-inflectional nature, cf. Chomsky (2001).

Section 3. Language Impairments

This section assembles three papers on language impairments. The first paper considers a particular case of Specific Language Impairment, the second is on autism and the last on schizophrenia. In each case theoretical and empirical arguments as well as experimental data support the biological nature of the human Language Faculty.

The founder effect, whereby genetic drift occurs when a new population is established by a very small number of individuals, is an important source of information on genetics and phenotypic variation both in human and non-human populations. In "A study in Spanish SLI and the founder effect", Anna Gavaro and Myriam Cantú-Sánchez report an instance of the founder effect in a Pacific Spanish-speaking population associated in the genetic literature to a high incidence of Specific Language Impairment (SLI). According to Villanueva et al. (2008), the incidence of SLI in the child population of Robinson Crusoe Island, in Chile, is around 35%; that is, 5 to 7 times higher than its incidence in the continental population. This is explained as a consequence of the founder effect: 75% of the impaired subjects were descendents of two founder brothers and have been identified with a genetic abnormality with its main locus on chromosome 7q

(Villanueva et al. 2011). While the genetic profile of the population is well investigated, no detail is provided in any of the publications as to its linguistic performance. The goal of the authors is to start filling this gap and consider the linguistic performance of the current child and adolescent population. They designed and administered nine language tests to 45 children in the island, 31 descending from the original founder families, the other 14 of continental origin and with no consanguinity ties with the islanders. The overall results do not show any contrast as a function of the origin (continental vs. islander) of the subjects; they do show some age effect. At most three islander children tested may meet the criteria for a diagnosis of SLI, since they perform below their age peers in use of determiners, grammaticality judgment and/or sentence repetition. This result does not challenge the findings regarding the chromosomal abnormality affecting a sizeable proportion of the population of the island; rather it questions the relation between that affectation and a specific language impairment. This preliminary conclusion is in line with observations by Grodzinsky (2002) in connection to the KE family and the role of FoxP2.

In "Syntax and its interfaces at the low and high ends of the autism spectrum", Arhonto Terzi, Theodoros Marinis and Konstantinos Francis discuss the language abilities of individuals with Autism Spectrum Disorders (ASD/autism). Research in this field has focused until recently on pragmatics and prosody, presumably because these are the areas afflicted the most cross-linguistically in autism. Recent research, in English primarily, has also targeted morphosyntax (Roberts et al. 2004; Perovic et al. 2012, 2013). The study by Terzi et al. (2014) looked at 5–8 year old high-functioning Greek-speaking children with ASD, discovering that they fall behind their language and age matched controls with typical language development (TD) on both production and interpretation (i.e., binding) of pronominal clitics. Given the profile of ASD, and the fact that clitics: (a) are an interface phenomenon, hence, their accurate comprehension and production involves discourse/pragmatics, syntax, and prosody (Anagnostopoulou 1997; Mavrogiorgos 2010, a.o.) and (b) constitute an area of grammar known to be problematic in impaired language (e.g. Jakubovic et al. 1998; Stavrakaki & Tsimpli 1999; Chondrogianni et al. 2014 on SLI), the above finding raises several questions. What is the source of the weakness on clitics that this particular population exhibits? Can the attested behavior possibly tell us something more about clitics in grammar? The study reported here investigates the difficulties that high-functioning ASD children have with (pronominal) clitics, by testing the contribution of discourse, syntax, and intonation on producing clitics and understanding their reference. Taken together, the findings indicate that children with ASD do not differ from TD children in the comprehension and production of clitics when demands are increased within the domain of

syntax, or when other criteria (such as given information) are offered by the experiment. However, ASD children are less successful than TD childrenin deciding on when to use a clitic, conceivably failing something like the *Prominence Condition* (Heim 1982). An additional difficulty they seem to have involves the prosody-syntax interface, in particular, to the processing of the prosodic cues of focused DPs, with repercussions for syntax.

In "Communication in schizophrenia, between pragmatics, cognition and social cognition", Marta Bosia, Giorgio Arcara, Mariachiara Buonocore, Margherita Bechi, Andrea Moro, Roberto Cavallaro, and Valentina Bambini point out that recent research describes language disruption in schizophrenia in terms of impairments at the pragmatic level, i.e., in the ability to match language and context. Importantly, pragmatics is acknowledged as resulting from the interplay of a number of cognitive abilities, spanning from Theory of Mind to executive functions, known to be compromised in schizophrenia. The present study aims at specifically assessing pragmatic skills with a newly developed protocol (Assessment of Pragmatic Abilities and Cognitive Substrates, APACS) on a sample of 39 patients with schizophrenia and 32 healthy controls, and to analyze relationships between communication-related skills and neuropsychological measures, especially focusing on aspects of social cognition. Patients performed significant worse than controls in all subtests, especially those assessing the comprehension of figurative language. Several cognitive and social cognition domains correlated significantly with the pragmatic tasks. Their data confirm that linguistic deficits in schizophrenia include specific pragmatic abilities that may be at the base of communicative dysfunction. Their findings also suggest that communicative behavior in patients is largely depending on cognitive and social cognition components. A deeper understanding of the interplay of the different components may thus lead to the development of new and effective therapeutic strategies.

Most of the papers assembled in this volume were selected from the conference on The Biolinguistic Investigations on the Language Faculty organized by the International Network in Biolinguistics and the NeTS Center at IUSS Pavia, and held 26–28 January 2015 in Pavia, Italy. We thank the audience of this conference for their questions and comments. We also thank the reviewers of the papers assembled in this volume, including Wolfram Hinzen, Dana Isac, James Idsardi, Dimitris Michelioudakis, Bert Vaux and Ken Wexler. We thank Brill for permission to reprint Di Sciullo and Somesfalean's paper, that appeared in a collection of papers on *Formal approaches to DPs in Old Romanian* in 2015. Finally, we thank the Biolinguistic Network and the Fonds de recherche du Quebec for providing the financial support to the Dynamic Interface Project ⟨www.interfaceasymmetry.uqam.ca⟩, ⟨www.biolinguistics.uqam.ca⟩.

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