

## Introduction

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*Ángel J. Gallego and Roger Martin*

Let us begin by recalling the old tale of the blind men and the elephant.<sup>1</sup> Six blind scientists set out to analyze an unfamiliar object that is both massive and complex – which turns out to be, in fact, an elephant. Each of the scientists examines it by touching a different part of the animal and draws a conclusion based on that experience alone. They compare their results only to discover that they are in complete disagreement, leading to an endless argument over whose interpretation is correct, whereas in reality their hypotheses are all completely off the mark. In some of the more optimistic versions of the tale, the scientists eventually realize their fallacy, at which point they begin to integrate their perspectives in a way that yields a more complete and unified description of an elephant-like creature. The moral of the story is simple: Insisting on a particular line of analysis or clinging to overly narrow scientific biases usually leads to a distorted picture of reality; more often than not, it is more productive to consider things from a variety of perspectives. Doing this is by no means easy. It requires the willingness to cooperate with others (within one's own field or not) in order to seek the understanding of the object of inquiry.

In the above fable, the blind scientists are merely exploring the external morphology of the elephant. Imagine if they had been trying to understand its internal morphology or, for that matter, how things work at the cellular or molecular levels, the structure of its protein folding, etc., all of which constitutes understanding what it means for something to be an elephant. The study of human language, which seems in many respects even more complex than an elephant, presents similar challenges. Research is commonly carried out from various disparate perspectives. For example, there are theoretical studies of the structure of language, biological studies of the genetic bases of language and language evolution, studies of brain function, not to mention computational studies, statistical studies, and the list could go on.

Of course, it is not necessarily the case that all imaginable perspectives should be viewed as equal, and in fact some may be irrelevant to the

<sup>1</sup> An analogy of the sort we pursue here was presented earlier in the introduction to an unpublished monograph by Martin and Uriagereka (2013).

understanding of some particular phenomenon. For example, studies of certain cultural, political, or social aspects of language use may turn out to have very little relevance to the study of the human language faculty as a natural object. Furthermore, there may turn out to be situations where one approach has a sort of “methodological priority” over others; in order to make progress in understanding a particular natural phenomenon, it may sometimes be necessary to examine it from one perspective before further questions can even be seriously raised from another. As just one illustration, we point to Noam Chomsky’s now famous remarks that although purely statistical approaches have led to little progress in our scientific understanding of human language, a number of rather successful studies exist that have integrated statistics or probabilities with notions from theoretical linguistics, such as the existence of particular grammatical constraints.<sup>2</sup> We think the same general point can be made about many other types of approaches as well – where language has been examined from the perspectives of biology, genetics, neurophysiology, computer science, or even physics or mathematics, the more such studies are based on a solid understanding of the results of theoretical linguistics, the more they tend to yield fruitful results, and as is typically the case, the integrated studies often lead to reworking their basic components, including of course (fundamental) ideas of theoretical linguistics.

It is in this light that we would like to present this book, the goal of which is to explore recent developments in linguistic theory as well as more integrated approaches to the study of language as a natural object. All of the studies in this volume essentially assume the theory of generative grammar (cf. Chomsky *et al.* 2017 for a summary, pointing out some challenges and open questions), in which language is taken to be a component of human cognition. On such a view, the study of language (or *I-language* in the sense of Chomsky 1986) would seem to fall squarely within the domain of biology. Indeed the so-called biolinguistics program (see, for example, Berwick and Chomsky 2011, Boeckx and Grohmann 2013, Boeckx *et al.* 2012, Di Sciullo and Boeckx 2011, Piattelli-Palmarini 1974, Piattelli-Palmarini *et al.* 2009, Uriagereka 1998, amongst many others) has gained much steam over the past couple of decades, fueled in part by the emergence of the minimalist program (Chomsky 1995 and ff.) with its emphasis on the reduction of language-specific, or first-factor, principles in favor of external factors, so-called third-factor principles, such as conditions imposed by performance systems and general principles of physics/mathematics determining the boundaries within which any biological system may develop.

<sup>2</sup> The remarks, made at the *Brains, Minds, and Machines* symposium held at the Massachusetts Institute of Technology in 2011, gained some notoriety since they set off a high-profile debate between Chomsky and Google’s Peter Norvig.

We do not expect, however, that we will be able to understand everything about human language by examining it through the lens of modern-day biological science alone. Research on the structure of language from the more abstract perspective of linguistic theory should, we believe, continue to shed a guiding light on biolinguistics endeavors, although the exponents of the former must also do more to embrace the results of the latter.<sup>3</sup> Moreover, additional perspectives from physics, mathematics, the theory of computation, and probability/statistical theory, at the very least, also seem to us to be crucial in order to reach a more complete picture of the beast (our “elephant”) that we call human language, and should be actively and enthusiastically integrated into the natural scientific study of language in our view.

This volume is organized into three parts. Part I deals with the core first-factor principles of the computational component of language. Part II focuses on the nature of the interfaces, in particular between the computational component and the external systems (conceptual-intentional and sensory-motor) that utilize it, and also between linguistic experience and attained grammatical knowledge. Part III is concerned with the substantive integration of linguistics and other scientific disciplines, such as biology and physics, as well as placing of the study of language and mind within the larger context of the natural sciences.

In Part I, the nature of Merge is addressed in Tonia Bleam and Norbert Hornstein’s chapter, which explores multiple-object constructions, providing an account where the direct object (DO) and indirect object (IO) form a small clause that adjoins to the verb phrase (VP). Francisco Ordóñez’s contribution is devoted to the study of verbal complexes in Spanish, involving a series of verbal dependencies and a postverbal subject, which pose a series of puzzles to the analysis of control and subjects (and thus the status of Merge and Agree), as well as parametric concerns. Howard Lasnik focuses on asymmetries affecting A-bar displacement in defective clauses from the perspective of phase theory. Ricardo Etxepare and Myriam Uribe-Etxebarria discuss aspects of constituent-negation related to context-sensitive (transformational) processes of the focus type. Negation and its long-distance effects are also relevant to Esther Torrego’s chapter, which considers Romance *because*-clauses under clausal negation, where mood marking reveals that the negative head can c-command into the embedded domain, thus revealing that it cannot be treated as an adjunct. Ian Roberts ties together many of the above issues, considering the nature of Agree as well as the structure of DPs, ultimately arguing for the

<sup>3</sup> Here, we of course mean biolinguistics in the sense of trying to understand and explain linguistic phenomena using the ideas and tools of the biological sciences, in a real and serious sense, not just the labeling of theoretical linguistics (generative grammar or minimalism in particular) as a kind of abstract biology (see Martins and Boeckx 2016).

existence of  $\phi$ -features based on a “no-choice parameter,” which is a newly proposed type of parameter said to emerge from the interaction of Chomsky’s (2005) three factors.

Jairo Nunes kicks off Part II by addressing the long-standing problem of the interpretation of chains at the interfaces, arguing that linearization plays a key role, not only for sensory-motor functions but also at the conceptual-intentional interface. Wolfram Hinzen tackles the question of why Case exists in grammar – problematic from a minimalist perspective in that it appears to be a purely grammar-internal device – and attempts to rationalize it in terms of the mapping of grammatical hierarchies to semantic hierarchies in which increased grammatical complexity corresponds to increased complexity in the ontology of meaning. Following a similar line, Pablo Bustos and Juan Romero argue that concepts are categorized according to hierarchies in structural complexity and, furthermore, that categorization is module independent, which leads them to propose a “porous modular” approach to cognition. Paul Pietroski also deals with the mapping to the semantic interface but offers an opinion that is rather different from the previous chapters, arguing for a highly limited semantic typology and an interface where semantic representations of human language do not have the kinds of rich recursive hierarchies that have been postulated for the syntactic component. In the following chapter, William Idsardi makes a proposal for the sensory-motor interface that is very similar in spirit to Pietroski’s, arguing that phonology lacks recursion and is thus computationally simpler than syntax. Although not an interface in the technical sense that the word is typically used, the contribution by David Lightfoot takes up the mapping from external linguistic experiences (E-language) to attained internal grammars (I-language) in children as the only possible force driving language change as well as the acquisition of grammatical features specific to individual languages, hence not part of the initial state of Universal Grammar (UG). Carlos Otero’s chapter, which also looks at the interface between grammar and experience, is concerned with the nature and acquisition of the lexicon and how one’s lexical knowledge affects the externalization of language.

Part III closes off this volume. The first two chapters deal with approaches to language that are firmly grounded in biology. Sergio Balari, Antonio Benítez-Burraco, Marta Camps, Víctor Longa, and Guillermo Lorenzo deal with the evolution of language, arguing on theoretical and empirical grounds for an evolutionary connection between knotting ability and linguistic ability in humans. Cedric Boeckx and Constantina Theofanopoulou take on the so-called linking problem and argue that certain aspects of linguistic/cognitive structure can be explained as arising from basic neurophysiological processes such as brain oscillations. From a somewhat different perspective, Douglas Saddy tries to elucidate the basic operations of syntax by weaving together a number of threads from mathematics, physics, and cybernetics into a highly

dynamical model of language that crucially involves oscillations – between high-dimensional/non-metric and low-dimensional/metric spaces – adding a level of neurophysiological plausibility, as well as an interesting point of connection to the chapter by Boeckx and Theofanopoulou. Taking their inspirations mostly from physics and mathematics, David Medeiros and Massimo Piattelli-Palmarini propose a model of phrase structure in terms of matrices and, by rigorously analyzing characteristics such as eigenvalues, demonstrate that the X-bar schema uniquely exhibits special mathematical properties and thus may plausibly be emergent from third-factor principles. Noam Chomsky concludes Part III, and the volume, by providing a detailed and far-ranging reflection on the nature of the study of language and cognition from the perspective of the history and philosophy of science, both encouraging us to pursue inquiry into the mind with a broad scientific viewpoint and, at the same time, reminding us that some of the questions we raise may fall beyond the limits of human understanding.

A volume of this nature faces obvious issues in terms of scope, and in some respect we feel that we have only partially achieved our goals; and probably a similar feeling was that of the blind scientists analyzing different pieces of the elephant. Needless to say, there are many more valuable perspectives on the scientific study of language that are worthy of attention, including studies located outside of the theory of generative grammar, not to mention approaches based on statistical/probability theory, computational science, other modes of cognition, and so on. Still, we believe that the chapters that compose this volume provide the reader with a reasonably thorough overview of the current state-of-the-art when it comes to natural scientific approaches to the study of language and that the volume will encourage researchers from a variety of differing fields and perspectives to join together in the pursuit of understanding, so that someday we may come to better recognize the animal that stands in front of us.

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6      Ángel J. Gallego & Roger Martin

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