Introduction

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This book endorses and further develops a conception of human language that relies on two main ideas. The first idea is that core aspects of human language are determined by *grammar*, i.e., a set of features and principles that are specific to language, and that grammar determines fundamental components of language *meaning*, i.e., the informational content that language conveys. What is crucial is not just the two concepts of grammar and meaning and their close interaction, but also the direction of their interaction: *from* grammar *to* meaning. In other words, the phono-morpho-syntactic properties of a linguistic string systematically affect the content that the string conveys, and not the other way around.

The second main idea is that human language meaning can and must be studied by means of mathematical formal tools in order to unveil its *spontaneous logicality*, i.e., the deductive inferential system – the *logic* – that is tightly intertwined with human language and is responsible for a multiplicity of aspects of meaning.

These two main ideas about human language and meaning are fairly recent and far from being universally accepted. Only forty-three years ago, the logician Richard Montague still felt the need to make the claims and express the concerns below:

> There is in my opinion no important theoretical difference between natural language and the artificial languages of logicians; indeed, I consider it possible to comprehend the syntax and semantics of both kinds of languages within a single natural and mathematically precise theory. On this point I differ from a number of philosophers, but agree, I believe, with Chomsky and his associates. It is clear, however, that no adequate and comprehensive semantical theory has yet been constructed [footnote omitted, eds] and arguable that no comprehensive and semantically significant syntactical theory yet exists [footnote omitted, eds]. (Montague 1970: 373)

In the past four decades, the semantic and related syntactic landscape has changed substantially. Montague's research program on the semantics of natural language and the papers he wrote to implement it before his premature death in 1971 triggered the creation and rapid growth of the field of *formal semantics*, possibly in ways that Montague himself might not have expected or necessarily endorsed.

Formal semantics has borrowed and adapted formal tools from mathematical subfields like logic, set theory, model theory, type theory, and algebra (among others) and has created its own. It has also developed a very close connection with syntactic theory (both Chomskyan generative syntax and other varieties) with the so-called *syntax–semantics interface*, and, more recently, with some areas of pragmatics, with the so-called *semantics–pragmatics interface*. These developments have been crucial in describing the new data formal linguists have discovered, precisely formulating new generalizations, and providing fully explicit explanations and verifiable predictions.

Formal semanticists have paid increasing attention to the insights coming from semantic data from field work with understudied languages and cross-linguistic/typological data in order to substantiate broader generalizations (*cross-linguistic semantics*). Also, they have started to apply experimental techniques and developmental data (often in collaboration with psycholinguists, psychologists, and cognitive scientists) to further test the predictions their theories make (*experimental semantics*).

An overview of the main issues and a history of formal semantics fall largely beyond the purposes of this introduction. Among many useful resources, Chierchia and McConnell-Ginet's (1990) classic textbook provides a detailed introduction to most of the main formal tools and their application to a variety of linguistic constructions, together with an excellent overview of the empirical and theoretical foundations of semantic theory. Barbara H. Partee, one of the founders and protagonists of formal semantics, presents a fascinating and detailed historical reconstruction of the birth and development of the field in Partee (2011), while Partee (2005) contributes further with a more autobiographical approach and more personal details and insights.

The two ideas, that grammar affects meaning and that language is spontaneously logical, are at the core of formal semantics and are shared by all researchers in the field (with possible disagreement on specific details). A progressively larger number of linguists have endorsed them, also thanks to the developments and interaction we mentioned above. These ideas, though, are far from being widespread, commonly known, or accepted within the larger intellectual community that inquires about human language.

This book shows these ideas in action, and in doing so aims to broaden awareness of their force within the broader community of linguists and researchers working on language. Both its goal and its content owe a great deal to Gennaro Chierchia, who has been one of the protagonists of the development of these ideas and, more generally, formal semantics in all its aspects over the past three decades. This book has been deeply inspired by Chierchia's highly influential theoretical, cross-linguistic, and experimental work on semantics and its interfaces with syntax and pragmatics. The contributors to this book – from extremely promising young scholars to leading figures in

linguistics – are all among Chierchia's intellectual mentors, former students, or collaborators. Their chapters range from broad foundational issues concerning the kind of data or principles semantic theory is based on to sophisticated and detailed theoretical analyses of complex data patterns, cross-linguistic generalizations, and new evidence coming from experimental and developmental investigations, often within the same chapter. Chierchia's assumptions, ideas, proposals, and findings are applied to new data, further developed, improved, and/or criticized. The variety of contributors and contributions further highlight the breadth, depth, and influence of his scholarship.

In the remainder of this introduction, we briefly touch on Chierchia's work, introduce the structure of the book and its chapters, and highlight connections among the chapters and with Chierchia's work.

Gennaro Chierchia received his Ph.D. in 1984 with Barbara H. Partee at the University of Massachusetts at Amherst. His dissertation committee also included Emmon Bach, F. Roger Higgins, and Edmund Gettier III. Nino Cocchiarella, Hans Kamp, and Edwin Williams played an important role as well. Chierchia was among the generation of scholars who played a pivotal role in the development of the field. He has held positions at Brown University, Cornell University, University of Milan, and University of Milan-Bicocca. He is currently Haas Foundations Professor of Linguistics at Harvard University.

Chierchia is one of the foremost philosophical linguistic semanticists of the past thirty years and his research has spanned all the main aspects of formal semantics and formal pragmatics (see his list of publications in Appendix A). He has worked on foundational issues concerning the formal nature of semantic theory through his work on Property Theory. He has developed existing theoretical proposals and improved their empirical coverage with his work on Dynamic Semantics, Type-Shifting, and Alternative Semantics. He has investigated major syntax–semantics interface issues like control, anaphora, binding, quantification in questions, and bare plurals. He has proposed highly influential new solutions for classical (and puzzling) distinctions like mass vs. count nouns and kind-denoting vs. individual-denoting expressions that he has grounded on cross-linguistic data and generalizations. He has elaborated the new notion of *semantic parameter* in addition to the already familiar Chomskyan notion of syntactic parameter in order to handle cross-linguistic variability. He has changed the conception of the semantics–pragmatics interface by providing a radically new analysis of what used to be considered a core pragmatic phenomenon: scalar implicatures. He has argued, instead, that scalar implicatures depend on a logically based, grammatically driven mechanism, which manifests what he has called the *spontaneous logicality of language*. He has shown that the very same mechanism that is responsible for scalar implicatures can also handle what looks like a completely different phenomenon on the surface:

polarity items, for which he has also provided a detailed cross-linguistic investigation of their distribution and semantic behavior. Chierchia's seminal work on the semantics-pragmatics interface has been fundamental for the recent birth and fast growth of the new field of formal pragmatics. Chierchia has also been among the first semanticists to closely collaborate in psycholinguistic, neurolinguistic, and language acquisition research. When he joined the University of Milan-Bicocca, he was a faculty member in the Psychology Department where he created a Linguistics Lab. Chierchia's work and his ideas continue to inspire new and exciting research in theoretical as well as experimental domains.

The FIRST PART of the book contains chapters by Barbara H. Partee and Noam Chomsky, who address historical and foundational issues concerning formal semantics and philosophy of language, and help trace the development of Chierchia's work and his thinking about the relationship between grammar and meaning and the spontaneous logicality of language.

In **Chapter 1**, Barbara H. Partee portrays her former advisee's early years from the late 1970s to the late 1980s: first as a brilliant graduate student at the University of Massachusetts at Amherst, and then as one of the leading young scholars at Brown University and later at Cornell University. In addition to the (auto)biographical details (see also the play in Appendix B), Partee reconstructs the vibrant intellectual climate of the early years of formal semantics and Chierchia's central role in it: the discussion about the best formal apparatus for the theory, the division of labor and the interaction between syntax and semantics, the exchange and collaboration among linguists, logicians, computer scientists, mathematicians, philosophers, and psychologists.

In **Chapter 2**, Noam Chomsky, the founding figure of modern linguistics and a point of intellectual reference for Chierchia (and many others), questions the notion of denotation, which is at the core of formal semantics together with the two ideas that grammar affects meaning and that language is spontaneously logical. The importance of the concept of denotation in the theory of meaning has been argued for in the philosophical tradition stemming from Frege. Denotation is at the root of the so-called *aboutness* of human language, i.e., the idea that human language is *about* something else and meaning is the bridge between language and this something else. Although Chomsky does not deny that we can use language to convey information about the external world, he strongly objects to the view that the notion of denotation is solid enough to play a critical role in the scientific investigation of language. In his opinion, formal semantics, including model-theoretic semantics, should be viewed as a form of symbol manipulation, much like syntax.

The SECOND PART of the book is devoted to studies that exemplify how formal semanticists proceed from grammar to meaning and, in doing so, how they develop semantic theory, discover novel data and generalizations, and raise

new issues and challenges. All the studies contribute to topics that Chierchia has brought to the center of the debate as quintessential instantiations of the spontaneous logicality of language: bare nominals, polarity sensitivity, scalar implicatures, and presupposition projection.

Bare plurals are plural nominal expressions without a determiner, like *dogs* or *young men*. They constitute an intriguing puzzle for formal semanticists (and anybody who is interested in natural language) because they are widespread across languages and their interpretation within the same language varies in a similarly systematic way, despite the lack of any overt change in their morpho-syntactic shape. For instance, *dogs* can be close in meaning to the nominal expression *some dogs* with the overt existential quantifier *some* as in episodic sentences *Dogs are barking* and *Some dogs are barking*. On the other hand, the very same bare plural form *dogs* can be better paraphrased with a nominal with an overt universal quantifier *every* like in the generic sentences *Dogs bark* and *Every (standard) dog barks*. Since no specific lexical item in the nominal *dogs* can be responsible for its change in meaning and since the change in meaning is systematic across languages with bare plurals, it follows that bare plural interpretation must depend on general principles that regulate language meaning. In other words, bare plurals are a special window on the spontaneous logicality of language.

Chierchia's (1998) paper on bare plurals has been extremely influential and pivotal in the development of cross-linguistic semantics. Building on Carlson's (1977) seminal work, Chierchia highlights regularities and generalizations in the behavior of bare plurals across languages and advances a proposal that appeals to a relatively small conceptual apparatus. Adopting a view that bare plurals are always kind terms, Chierchia accounts for the complex cross-linguistic data pattern by means of three fundamental type-shifting operations that have been independently argued for, a ranking according to which those operations apply, a principle that favors semantic operations triggered by overt determiners over type-shifting, and a rule that existentially quantifies over instantiations of a kind when a kind-denoting term combines with a predicate that doesn't select for kinds.

In **Chapter 3** of this book, Veneeta Dayal first introduces Chierchia's system and discusses its main features and problems, then proposes a major simplification of this system by pushing it to its logical limits. She only assumes Chierchia's two type-shifting operations that are meaning preserving (i.e., they don't introduce any kind of quantification) without the need to rank them and with a slight but crucial modification for one of them having to do with variation in size (of the set of instantiations of a kind over situations). She also reformulates the combinatorial rules to eliminate quantification over instantiations and appeals to domain widening to get the relevant effects. Dayal supports her proposal with previously unnoticed data from English and Hindi and new

tests to detect them. Overall, the picture that emerges unveils an even simpler and more elegant spontaneous logicality behind language.

In the last decade, Chierchia has worked on a major investigation of the large family of polarity items (negative polarity items, free choice items, epistemic indefinites, etc.) and scalar implicatures, two broad phenomena that were considered completely unrelated (a.o. Chierchia 2004, 2006, to appear a). Chierchia, instead, has argued that their interpretation is regulated by a single mechanism, the same mechanism that has been suggested for handling the interpretation of focused material. Roughly put, Chierchia's main idea is that all these phenomena involve an enrichment of the basic propositional meaning of the sentence they occur in by means of extra inferences that are due to a systematic activation of a set of alternatives, i.e., a set of propositions that are closely related to the basic propositional content of the sentence. Once alternatives are activated, the grammar together with its logic provides a precise procedure for dealing with them, combining the result with the basic propositional content of the sentence. Polarity items, scalar implicatures, and focus differ along three parameters only: optionality vs. obligatoriness of the activation of alternatives, the kind of alternatives they activate, and the operator that is responsible for eliminating alternatives within a very limited set of grammatically determined options.

Free choice polarity items are the focus of Chapters 4 and 5, while Chapters 6 and 7 are about scalar implicatures in numerals. Finally, Chapter 8 deals with the related semantics–pragmatics topic of how presupposition triggers interact with quantifiers.

In **Chapter 4**, Anamaria Fălăuş investigates epistemic indefinites, a kind of polarity item, across several languages by studying how they behave when they are focused. Epistemic indefinites are nominal expressions introduced by a restricted class of determiners that license so-called "free-choice" inferences conveying some form of ignorance (or indifference) with respect to the entire set of individuals their noun refers to (e.g., German *irgendein* NP, Italian *un qualche* NP and *un* NP *qualunque*, Romanian *vreun* NP and *un* NP *oarecare*, and Spanish *algún* NP). For some of them, the ignorance/indifference extends to the entire set (total variation), while for others just to a subset (partial variation). Also, some epistemic indefinites can behave as negative polarity items as well. By looking at this cross-linguistic pattern, Fălăuş provides preliminary evidence in favor of a new generalization about the strength of the free choice inferences epistemic indefinites license and their ability to bear focal stress: total variation epistemic indefinites can be focused (and give rise to a 'not just any' reading in downward-entailing contexts), while partial variation epistemic indefinites disallow focus. After reviewing Chierchia's alternative-based framework for polarity, she applies it to account for the cross-linguistic pattern of epistemic indefinites.

In **Chapter 5**, Maria Aloni and Michael Franke examine the distribution and interpretation of three elements in three languages and compare how the inferences they trigger vary depending on whether those elements are under the scope of an epistemic or deontic modal: the German indefinite determiner *irgendein* gives rise to different inferences under the two kinds of modals, the Romanian determiner *vreun* is licensed under epistemic modals, but not under deontic modals (Fălăuş 2009), and concessive scalar particles like Slovenian *magari* are licensed under deontic modals but not under epistemic ones (e.g. Crnič 2011b). Though exhibiting different restrictions, all these items license similar "free-choice" inferences, which Chierchia considers to be all slightly different instantiations of free-choice polarity (to appear a). Aloni and Franke notice that the explanations that have been proposed so far for these items share a common feature, which they call the *Modal Variability Hypothesis*: all proposals assume that deontic and epistemic modals differ in the way they license free-choice inferences. In particular, deontic modals trigger free-choice inferences that seem to enter into the recursive computation of compositional semantic values, whereas epistemic modals do not. Aloni and Franke acknowledge the possibility, explored in great depth by Chierchia (2006, to appear a) and others, of (quasi-)pragmatic inferences taking effect "locally" during the composition of semantic meaning; but they still argue for a purely pragmatic perspective on the distribution of such local pragmatic effects and propose a pragmatic explanation for the Modal Variability Hypothesis based on the notion of *pragmatic fossilization*.

Chapters 6 and 7 focus on scalar implicatures in numerals. Numerals have been central in the debate about contextual information and grammatical meaning since the interpretations of sentences containing numerals crucially seem to involve pragmatic enrichment of a more basic meaning.

In **Chapter 6**, Clemens Mayr investigates the pragmatic behavior of nominals containing a less studied kind of numeral, i.e., modified numerals like *at least three boys* and *more than three boys*. Previously, it has been noticed that modified numerals don't trigger scalar implicatures in the same way as unmodified numerals like *three boys*, though the two kinds of modified numerals had not yet been studied in parallel. Mayr brings strong evidence showing that both kinds of numeral modification behave in the same way as far as scalar implicature triggering is concerned and proposes a new generalization to capture this pattern. He then carefully reviews existing proposals that deal with just a subset of the data like the "density" approach by Fox and Hackl (2006) and shows that they cannot be easily extended to cover the entire empirical range of the new generalization. Finally, Mayr considers two alternative approaches to scalar implicatures, the neo-Gricean approach and Chierchia's grammatical view of scalar implicatures, and shows that neither can provide a straightforward account for the new generalization, including a

development of Chierchia's approach that relies on non-monotonic alternatives for modified numerals. Overall, this chapter reshapes the empirical landscape of scalar implicatures with modified numerals and prepares the ground for those who want to take on the challenge of accounting for Mayr's new generalization.

In **Chapter 7**, Christopher Kennedy deals with scalar inferences in numerals as well, but he focuses on unmodified numerals. It is well-known that unmodified numerals like *three boys* allow for an "exact quantity" interpretation ('exactly three boys') in many environments, but also for a lower-bounded interpretation ('at least three boys') in others. The standard pragmatic account, which Kennedy calls the *Classic Analysis*, assumes the lower-bounded interpretation of unmodified numerals as basic, combines it with the scalar implicatures triggered by the numeric scale, and in this way derives the exact quantity interpretation (Horn 1972). Kennedy challenges this account and its possible developments within the neo-Gricean framework (Horn 1992, a.o.) and Chierchia's grammatical theory of scalar implicatures (Chierchia 2004, 2006; Chierchia et al. 2012; Mayr this volume, a.o.). He shows that all these approaches fail to account for the interaction of numerals with negation, quantifiers, and modals. In particular, they incorrectly predict, among other things, that sentences with numerals should exhibit the same inferential pattern as sentences with other scalar items such as quantifiers like *some*, *many*, *most* as well as modals, aspectual verbs, and so forth. Finally, Kennedy argues for a new purely semantic analysis of numerals as generalized quantifiers over degrees, true of a property of degrees D just in case the maximal degree that satisfies D is equal to a specific numeric value. Language acquisition findings are discussed to further support the proposal.

In **Chapter 8**, Danny Fox studies the way quantifier phrases project the presuppositions of their arguments. While in a simple sentence like *John drives both of his cars to school* one can say that the word *both* introduces the presupposition that a particular person (John) has exactly two cars, a similar treatment is not possible if the sentence contains a quantificational subject, as in *No boy drives both of his cars to school*. Furthermore, as Fox shows, the way presuppositions are projected in these quantificational contexts depends on a variety of factors like the type of the quantificational determiner, the type of presupposition triggers, and individual speakers' preferences. Despite this variability, Fox argues that at least one fact seems to be constant, namely the acceptability of the relevant sentences in specific contexts that Fox describes and exemplifies. Fox develops his account within a trivalent approach to presupposition projection, coupled with two independently needed mechanisms: one which strengthens presuppositions, and another which incorporates presuppositions into truth conditions at various scope positions.

The THIRD PART of the book deals with experimental studies and how they inform and are informed by semantic theory. Chierchia has participated in

studies on language acquisition, language processing, and neurolinguistics in collaboration with psycholinguists and psychologists. His theoretical work has also been influential, directly and indirectly, in inspiring other scholars to engage in experimental research into formal semantics and pragmatics. The three chapters in the third and last part of the book are examples of this influence.

In **Chapter 9**, Stephen Crain and Rosalind Thornton address the issue of a nativist approach versus a usage-based approach to language development by examining cross-linguistic acquisition work in semantics and pragmatics. They present and discuss a series of experimental studies that are inspired in large part by Chierchia's ideas about human language (see especially Chierchia 2004). The studies investigate children's and adults' knowledge of polarity items, scalar implicatures, and logical operators like disjunction in upward-entailing and downward-entailing contexts in languages like English, Japanese, Mandarin Chinese, and others. Crain and Thornton point out that their findings are highly problematic for a usage-based approach because the phenomena that exhibit the same patterns are very different on the surface and the language input children are exposed to is often insufficient or points in the opposite direction. On the other hand, they argue that their findings strongly support a unified view of polarity items, scalar implicatures, and logical operators, along the line of Chierchia's unified proposal and his idea of the logicality of language.

In **Chapter 10**, Francesca Panzeri, Francesca Foppolo, and Maria Teresa Guasti report novel experimental data on the acquisition of gradable adjectives, like *tall*, and suggest that children initially interpret these adjectives categorically, i.e., as referring to sets of objects, and only at a later stage switch to the adult comparative-like interpretation. They claim that their findings are more easily explained within a framework that assumes that gradable adjectives denote a partial function from individuals to truth-values, rather than in the alternative framework in which gradable adjectives correspond to a function that attributes to an individual the possession of the relevant property to a certain degree. They further suggest a parallelism with the phenomenon of scalar implicature computation in children. Children stick to the categorical interpretation of the adjective when they do not have enough resources to retrieve the standard of comparison, much as they stick to the logical (but uninformative) reading of *some* in sentences like "Some Ss are P" in situations in which the sentence "All Ss are P" would be more appropriate.

In **Chapter 11**, Adriana Belletti and Luigi Rizzi deal with the classical issue of intervention effects, which also play a role in the explanation of semantic phenomena like scalar implicatures and licensing of negative polarity items, as recently shown by Chierchia and others. Belletti and Rizzi's starting point is a parallelism concerning A-bar dependencies between psycholinguistic evidence and acquisition data. In experimental tasks adults show difficulties with

configurations in which a category which is similar to the target intervenes between the two links of an A-bar dependency. This difficulty takes a more extreme form in children who, for a long phase, do not comprehend sentences displaying the relevant configuration. Belletti and Rizzi propose a particular implementation of the Relativized Minimality principle according to which intervention effects are triggered only if the morphosyntactic features of the intervener fully match the morphosyntactic features of the target. Young children, they claim, show more severe intervention effects because they cannot compute a relation of proper inclusion in the relevant configurations.

All these chapters crucially rely on the two main ideas about human language we started with: that grammar affects meaning and that language is built on an intrinsic logic. Although in different ways, all chapters contribute to the development of a precise theory of human language and meaning according to these ideas. In doing so, they also highlight the crucial role that Chierchia, his work, and his scholarship have played in developing those ideas as an intellectual guide and source of inspiration not just for this book, but for an entire field and research community that investigates human language meaning.

We decided to work on this book for two reasons. The official reason is to honor Gennaro Chierchia, the scholar, the mentor, the friend, and to surprise him on his 60th birthday. The more secret reason is the same that has led us the editors, Gennaro, and all other linguists to choose this field for a living: to be rich and famous.