

## Book Review

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Yoad Winter, *Elements of Formal Semantics. An Introduction to the Mathematical Theory of Meaning in Natural Language*. Edinburgh Advanced Textbooks in Linguistics. Edinburgh University Press, 2016, ISBN: 978 0 7486 4043 0.

### 1 Introduction

This is a textbook on formal semantics intended for undergraduate courses in linguistics, philosophy, artificial intelligence or computer science, as well as for “any reader interested in human language and its mathematical modeling”.

As such, it is not the first in its kind. One used to say about a book like this that it fills a gap, but as time goes by and more introductions to formal semantics see the light of day, that is hardly an apt way of putting it anymore. Still, perspectives and priorities will differ, different books will tend to target different audiences, and since the field is still rather unsure of what is canonical in it, choices must be made that make another book not just another book. It has been noted that this book is formally-driven rather than empirically- or philosophically-driven (Rett 2016), particularly helpful for students with formal backgrounds but little knowledge of linguistics, and I agree; it will be more accessible and interesting to the formally-minded. Which is all right—and indeed, there are topics that are treated more accurately and systematically here than anywhere else. But as I see it, there are also topics and ways to treat them that suffer, sometimes unnecessarily, and some chances that are missed.

In the following I will elaborate on what sets this book apart and on its pros and cons, drawing comparisons with three existing comparable books: Heim and Kratzer (1998),

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Zimmermann and Sternefeld (2013), and Jacobson (2014). On the whole, the closest kin is Jacobson, with the emphasis on direct compositionality; the farthest removed is Heim and Kratzer, with their reliance on the (post-)syntactic level of Logical Form.

## 2 Chapter 1: Introduction (11 pages)

Motivation is everything, so one important thing to be expected from a book like this at the outset is that it engages the reader in some plot or problem (s)he would invest something in seeing solved, something intriguing, installing in her or him an urge to understand—an urge that can only be satisfied with tools from the box of formal semantics. There are various ways to go about this. In this book, the focus is squarely on the phenomenon of *entailment*: how can it be and how can we show that different expressions share parts of their meaning, so that from one sentence, we unflinchingly conclude another? The following statement is characteristic (p. 3, my emphasis):

Mathematical semantic models help us see what meanings are, and, **more importantly**, why they can be shared by different expressions.

To illustrate, the author presents a piece of poetry by the 2016 Nobel laureate and demonstrates that it can be paraphrased with a piece of prose where the phrasing is rather different. Unfortunately, though, this sample of authentic language, in fact the only one in the book, is only used for superficial purposes, as the differences between the poetry and the prose are not among the things discussed later on. In chapter 2, more streamlined examples of entailment are presented, the paradigmatic one turning on conjunction; of four others, two turn on phenomena discussed in later chapters (intersective adjectives, *be* of identity). The examples that are treated (*Tina is tall and thin* etc.) are at the other extreme of being very simple and also somewhat artificial-looking; there is nothing in between. Generally, not much effort is expended on finding natural linguistic examples. It is inevitable to begin at the basic beginning and to idealize a bit, yet I cannot help feeling that opportunities are missed for stirring a curiosity which can eventually be satisfied.

That said, chapter 1 also offers an instructive contextualization of the field of formal semantics, historically and in relation to neighboring fields, as well as an overview of what is to come in later chapters, and a very useful survey of basic set theoretic notions, supplemented by exercises, concludes the chapter.

## 3 Chapter 2: Meaning and Form (32 pages)

This chapter introduces and defines entailment in terms of truth across models, denotations of simple expressions like names, adjectives, predicate conjunction and predicate negation in models, compositionality, and structural ambiguity, with the help of simple set-theoretic concepts.

The denotation of an expression in a model is defined as an abstract object that the model, a description of a hypothetical situation, associates with the expression. Denotations are thus abstract mathematical objects like entities, sets of entities, or truth values, and whether these bear any relation to anything real that we model with

them, whether in the mind or in the outside world, is a question which might interest students, maybe particularly students of philosophy or cognitive science, but which is not put on the table.

Another chance to address an issue that naturally arises in connection with the definition of denotations (and to smoothen the transition to intensionality in chapter 6) is missed when no general notion of the meaning of an expression is introduced—as, for example, a function from models to denotations. Only denotations are defined, and meaning remains a pretheoretic term, although the former are described as depending on and varying with models—in model one, a predicate denotes this set of entities, in model two, the same predicate denotes a different set—so it would be easy to establish a relationship between denotations and meanings, or extensions and intensions. The means are there for drawing the distinction, quite literally, with the definition of the double brackets indexed with a model for an arbitrary expression on page 18: it would only be a matter of saying what the double brackets are without the index. That this is not done is all the more puzzling as the term ‘meaning’ figures in the title of the book as well as in the key quote above from page 3.

Standardly, the expressions denoting entities in this chapter (as in fact in the book as a whole) are proper names. But, non-standardly, and in contrast to how they are treated by Zimmermann and Sternefeld (2013: 63, 173ff.) and Jacobson (2014: 52ff.), names are not assumed to have constant denotations—on the contrary, their denotations are assumed to vary from model to model (pp. 26). I can see a reason for this in that in chapter 6, an example of names in belief contexts is used to motivate intensionality, and their extensions are assumed to vary from world to world (p. 206). But for one thing, intensionality can be motivated without entering such contentious terrain, and secondly, leaving the impression that proper names are just as model-sensitive as definite descriptions seems a high price to pay.

These critical comments aside, one of the major pros of this book is its wealth of exercises, many of which are supplied with solutions, at the end of each chapter. Some are technical and others are more advanced, and many of these are singled out as introducing new notions not addressed in the text.

#### **4 Chapter 3: Types and Meaning Composition (55 pages) and Chapter 4: Quantified Noun Phrases (40 pages)**

These two chapters form the core of the book and its most successful portion. All the blocks and tools that are needed for building denotations of sentences with sortal nouns, adjectives, intransitive or transitive verbs, and determiners, in short, everything necessary for doing extensional compositional semantics in all its basic essentials, are introduced clearly and thoroughly. In particular,

- There are clear and illuminating sections on characteristic functions, types, function application, and currying,
- Lambda notation is introduced relatively early, in chapter 3 (on pp. 64ff.), in a clear and instructive way.

This latter feature compares favorably with Zimmermann and Sternefeld (2013), where lambda terms are introduced in the very last section.

Also in contrast to that book, Winter is very sparse and austere with his composition principles: there is just the one, function application.

Maybe a bit too austere though. When modeling modification, semanticists often employ intersection: when two expressions denoting sets of the same type combine, the combination denotes the intersection between the two sets. This extra principle, Predicate Modification in the book by Heim and Kratzer (1998: 65), is simple and natural, and without it, we are forced to ascribe to intersective adjectives two different types,  $(et)(et)$  when they are used attributively and  $(et)$  when they are used predicatively (pp. 80ff.). Zimmermann and Sternefeld (2013) ascribe the uniform type  $(et)$  and apply intersection; Jacobson (2014) presents both options.

On a related note, both the copula and the indefinite article in predicative constructions like *Tina is a pianist* are ascribed the type  $(et)(et)$ —they are described as denoting the identity function on sets of entities (p. 61, 81). Jacobson (2014) does the same with the copula; Zimmermann and Sternefeld (2013: 136f.) present the alternative option of disregarding both *is* and *a*.

When it comes to determiner phrases in chapter 4, one would half expect the indefinite article to receive another treatment, this time as contributing existential quantification, but in fact, both it and the definite article are set aside “due to the special properties of the articles”, and the reader does not meet them again. As far as *a* is concerned, this does not matter much, since existential quantification is taken care of by the determiner *some*, but leaving *the* out of a book like this is an unusual choice which could be considered a missed chance of an instructive lesson, be it in Russellian or Fregean terms.

Otherwise, the chapter on quantification contains what it should in explicit and transparent terms, including sections on monotonicity, conservativity, and proper names qua quantifiers. On the whole, this chapter guides the reader to a clear understanding of the state of the art of generalized quantifiers.

But the next chapter leads off the well-trodden paths into territory which, though not unmapped, is less likely to provide the student reader with a clear and representative view of what is going on in natural language semantics.

## 5 Chapter 5: Long-distance Meaning Relationships (51 pages)

This chapter deals with phenomena like quantified NPs in object position, including inverse scope readings, and relative clauses with object position gaps, including dependencies across clause boundaries.

The customary way of handling these phenomena in scholarship as well as in classes, many using Heim and Kratzer (1998), is by means of overt and covert movement leaving indexed traces in the syntax. That method is not used here, which is understandable: it is out of tune with contemporary minimalist syntax, and the interface level of Logical Form is at odds with the program of direct compositionality which this book is committed to. However, what is offered in its stead is an unconventional scheme of composition which one may fear will prove intangible to many students.

This is where students with a background in logic or computer science are particularly at an advantage. The key to composing denotations of strings like *praised*

*every teacher* or *that Mary praised* is in hypothetical reasoning, more specifically, in applying functions to hypothetical arguments and introducing them again at the right stages with the novel composition principle of function abstraction, set in the Lambek-van Benthem calculus and more broadly in the “recently emerging framework known as” Abstract Categorical Grammar, the relevant variant of which blends de Saussure’s theory of signs into an architecture that derives denotations simultaneously with forms.

The result is a chapter which is a challenge to read and understand, and the reason is in part in the nature of the subject matter. It may be possible to introduce the relevant aspects of hypothetical reasoning in an accessible way, but as it is, the chapter sets out to present a comprehensive theory still under development, doing justice to the underlying logic and to the superstructure of Abstract Categorical Grammar, and this is arguably a load too heavy for a chapter in an introductory textbook of formal semantics. Moreover, students may on the one hand get the idea that Saussurean sign theory is mainstream linguistics of today, which it is not, or on the other hand the idea that this is a theory superior to any alternative, which is also highly questionable.

## 6 Chapter 6: Intensionality and Possible Worlds (42 pages)

Intensions are introduced in the final chapter 6. As usual, they are motivated by the need to predict the failure of substitution of co-extensional expressions in belief contexts, and, as usual, the solution is to let the arguments of belief predicates be intensions instead of extensions, characteristic functions of sets of points of evaluation (or worlds), i.e., propositions, instead of truth values.

More specifically, the failure of substitution of co-extensional expressions is prominently exemplified with two proper names. This is less usual, because examples of this sort are problematic in regard to a Kripkean theory of names, where their extensions are constant across worlds; but in fact, as noted in Sect. 3, this book treats proper names as just as variable in their extensions as words of any other class, or as definite descriptions (which are not treated).

Anyway, in chapter 2, models were described as differentiating between denotations—denotations vary from model to model—and so a natural move would be to exploit this to say that there is one world per model, and to identify denotations with extensions. But instead, denotations are identified with intensions, sentences are said to denote propositions—functions from worlds to truth values—and models are said to contain sets of worlds. Thus rather than asking students to add something to the picture familiar to them from earlier chapters, this chapter asks them to replace it with another picture. In particular, denotations of one-place predicates are now functions from entities or individual concepts to propositions, and there is in fact no general notion of the intension of an expression as a function from indices to extensions.

By contrast, [Jacobson \(2014\)](#) introduces possible worlds in chapter 2 while intensionality as such is not introduced until chapter 19, and [Zimmermann and Sternefeld \(2013\)](#) introduce a situation index  $s$  in their chapter 5 “Composing extensions” (“The extension of an expression depends on the situation  $s$  talked about”), which is then supplanted by the world index  $w$  in their chapter 7.

As a consequence of the way intensions are set up, what is composed is intensions, not extensions. Winter claims that this treatment is conservative: “having a systematic intensionalization procedure has helped us to work in a conservative, modular way” (p. 217). One alternative is to compose extensions by default and appeal to so-called Intensional Functional Application (Heim and Kratzer 1998: 308) in exceptional cases (as Jacobson (2014) puts it: “if a function asks for an extension, it gets an extension; if it asks for an intension it gets an intension”)—and which strategy is more conservative is debatable.

The chapter—and the book, apart from a short chapter 7 “Conclusion and further topics”—ends with a section on so-called *de re/de dicto* ambiguities. Since, as noted in Sect. 4, definite or indefinite descriptions are not treated, such ambiguities are illustrated with the determiner *some*, where the *de re* reading is relatively hard to get. The account presented is in terms of scope: “A common solution to this puzzle is based on the idea that these interpretations are an instance of scope ambiguity”, reusing the machinery used in chapter 5 for quantifier scope ambiguities (“The Quine-Montague Hypothesis”, p. 226). The alternative account of transparent evaluation by index-binding, referred to by von Fintel and Heim (2011: 102) as the standard solution, is not mentioned, so again, it may be noted that this book follows a course which does not always stay close to the middle of the road of formal semantics.

## 7 Conclusions

All textbooks in formal semantics have their strengths and weaknesses. This book is strong in areas where others are weaker—and the other way around. But much depends on the point of view. In large measure, the present book takes the perspective of the student of logic and computation, somewhat at the cost of the student of language, who will be confused at times, partly over the sheer complexity of the formalisms, partly because the interfaces with grammar and with linguistic scholarship are less smooth than they might be.

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