Formal Semantics and Pragmatics: Origins, Issues, Impact.

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Formal Semantics and Pragmatics: Discourse, Context, and Models

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Introduction

- "Semantics" can mean quite different things in different contexts; fields concerned with semantics are as diverse as psychology, law, computer science, lexicography, logic, philosophy, and linguistics.
- "Pragmatics" is an equally wide-ranging term, with applications in politics and ethics as well as in linguistics and philosophy.
- Formal semantics and pragmatics as they have developed over the last 40+ years have been shaped by fruitful interdisciplinary collaboration among linguists, philosophers, and logicians.
- In this talk I'll reflect on the growth of formal semantics and formal pragmatics in linguistics and philosophy starting in the 1960's.
- I'll touch in passing on innovations and "big ideas" that have shaped the development of formal semantics and its relation to syntax and to pragmatics, and draw connections with foundational issues in linguistic theory, philosophy, and cognitive science.

Introduction

- I'm not a historian of linguistics (yet) or of philosophy; what I know best comes from my experience as a graduate student of Chomsky's in syntax at M.I.T. (1961-65), then as a junior colleague of Montague's at UCLA starting in 1965, and then, after his untimely death in 1971, as one of several linguists and philosophers working to bring Montague's semantics and Chomskyan syntax together, an effort that Chomsky himself was deeply skeptical about.
- But I do want to slightly 'become' a historian and try to write a book on the history of formal semantics, going beyond what I know first-hand. So while much of what I will say today is familiar to many of you, let me take the occasion to ask you to compare my interpretations with your own, and please give me feedback and additional information and perspectives, in discussion and/or in writing.

"Semantics" can mean many different things

- Semantics is inherently interdisciplinary, and benefits from multiple perspectives. Different central concerns lead to different questions and methodologies:
  - language and thought
  - language and communication
  - language and culture
  - language and truth, inference, logic
  - human-machine interfaces
  - the "structure" of language

"Semantics" can mean many different things, cont'd

- "Semantics" has meant quite different things to linguists and philosophers, not surprisingly, since different fields have different central concerns.
  - Philosophers of language have long been concerned with truth and reference, with logic, with how compositionality works, with how sentence meanings are connected with objects of attitudes like belief, and with the semantic analysis of philosophically important terms.
  - Linguists at least since the Chomskian revolution have been concerned with human linguistic competence; what's "in the head" of the speaker of a language, and how it's acquired.
  - And here I'm really only speaking of 'analytic philosophy' and 'formal linguistics', two relatively compatible schools of thought within those fields.

"Semantics" can mean many different things, cont'd

- Different research methodologies in different fields also lead to different research:
  - Phonology influenced the use of "semantic features" in early linguistic work.
  - Field linguists and anthropologists use componential analysis and structural methods to study kinship systems and other systematic patterns.
  - Psychologists experimentally study concept discrimination, concept acquisition, emphasis on lexical level.
  - Syntax has strongly influenced linguists' notions of "logical form"; 'structure' of meaning suggests 'tree diagrams' of some sort.
  - Logicians build formal systems; axioms, model theoretic interpretation. 'Structure' suggests 'inferential patterns'.

The principal sources of formal semantics

Formal semantics has roots in several disciplines, most importantly logic, philosophy, and linguistics.

The most important figure in its history was undoubtedly Richard Montague (1930-1971), whose seminal works in this area date from the late 1960's and the beginning of the 1970's.

(There were of course many other important contributors, whom I'll mention later.)

The principal sources of formal semantics

- The development of formal semantics over the past 40+ years has been a story of fruitful interdisciplinary collaboration among linguists, philosophers, logicians, psychologists, and others, and by now formal semantics can be pursued entirely within linguistics as well as in various interdisciplinary settings (cognitive science, informatics,...)
- In the U.S. it's mostly within linguistics departments now, but in parts of Europe (e.g. Amsterdam) it's still strongly embedded in the context of logic and philosophy.
- But now let me back up and take a more historical perspective. Partly in linguistics, partly in philosophy, and especially about how they've worked together.

Semantics and generative grammar: from before *Syntactic Structures* to the linguistic 'wars'.

- Before *Syntactic Structures* –
  - Starting from linguistics within philology (Europe) /anthropology (US), adding a mathematics-influenced "science" perspective, linguistics emerged as a science. Part of the Chomskyan revolution was to view linguistics as a branch of psychology (cognitive science).
  - Negative attitudes to semantics in American linguistics in the 20th century, probably influenced by logical positivism (cf. behaviorism in psychology). Rather little semantics in early American linguistics. Fieldwork tradition: start with phonetics, then phonology, then morphology, then perhaps a little syntax …
  - Semantics in logic and philosophy of language: much progress, but relatively unknown to most linguists.

Semantics and generative grammar: before *Syntactic Structures,* cont'd.

- 1954: Bar-Hillel wrote an article in *Language* inviting cooperation between linguists and logicians, arguing that advances in both fields would seem to make the time ripe for an attempt to combine forces to work on syntax and semantics together.
- 1955: Chomsky wrote a reply in *Language* arguing that the artificial languages invented by logicians were too unlike natural languages for any methods the logicians had developed to have any chance of being useful for developing linguistic theory.

Syntactic Structures (Chomsky 1957)

- Paraphrasing: We don't understand anything about semantics, but deep structure reveals semantically relevant structure that is obscured in surface structure.
- Surface structure:

  (1) a. John is easy to please
- Deep structure:

  b. (for someone) to please John is easy

Syntactic Structures, cont'd.

- Chomsky 1957:
- Sometimes transformations change meaning: The following active-passive pair have different meanings, with the first quantifier having wider scope in each case:

(2) a. Everyone in this room speaks two languages.

b. Two languages are spoken by everyone in this room.

- In later years, those judgments about (2) came to be questioned; some argued that (2b) is ambiguous, some argued that both are. No good methodologies for settling such debates.

From *Syntactic Structures* to *Aspects*: Katz, Fodor, Postal

- Katz and Fodor, early 60's, started working on adding a semantic component to generative grammar.
- They were concerned with what we call compositionality, which they called the Projection Problem: how to get the meaning of a sentence from meanings of its parts.
- At that time, "Negation" and "Question Formation" were transformations of affirmative declaratives. They were prime examples of meaning-changing transformations.
- So meaning depended on the entire transformational history. "P-markers" (phrase structure) were extended to "T-markers", to which semantic Projection rules applied.

From *Syntactic Structures* to *Aspects*: Katz, Fodor, Postal, cont'd.

- Katz and Fodor's idea of computing the meaning on the basis of the whole T-marker can be seen as aiming in the same direction as Montague's derivation trees.
- (3a) [The airplanes [will [fly]]] (deep structure)
  $\Rightarrow_{\text{T-NEG}}$ (3b) [The airplanes [will not [fly]]]
- (4) T-marker for (3b) includes P-marker for its deep structure (a constituent structure tree for (3a)) plus a graph showing what transformations have been applied in its derivation.

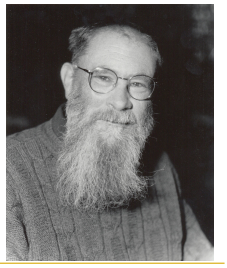
From *Syntactic Structures* to *Aspects*: Katz, Fodor, Postal, cont'd.

- But their semantics was very primitive. Katz and Fodor worked with "semantic features", and their semantic representations were "bundles of features" – suitable at best for decompositions of one-place predicates.
- Quine (1970):"Logic chases truth up the tree of grammar"; Katz and Fodor's position might be characterized: "Semantic projection rules chase semantic features up the tree of grammar."
- What they were trying to capture had nothing to do with truth-conditions, but rather properties like ambiguity, synonymy, anomaly, analyticity, characterized in terms of 'how many readings' a sentence has, whether two sentences 'share a reading', etc.

Philosophers' reactions to linguists' "semantic representations"

David Lewis (1970, p.1):

- "But we can know the Markerese translation of an English sentence without knowing the first thing about the meaning of the English sentence: namely, the conditions under which it would be true. Semantics with no treatment of truth conditions is not semantics."
- "Translation into Markerese is at best a substitute for real semantics, relying either on our tacit competence (at some future date) as speakers of Markerese or on our ability to do real semantics at least for the one language Markerese."



Philosophers' reactions to linguists' "semantic representations", cont'd.

- But linguists *did* presuppose tacit competence in Markerese; they took it to be universal and innate, and many still do take that or some kind of semantic representation language to be universal and innate (e.g. Jackendoff; also Jerry Fodor).
- To philosophers and logicians doing formal semantics, the language of Markerese looked empty, since it was uninterpreted.
- To linguists, concern with *truth* looked puzzling. Linguists were trying to figure out mental representations that would underlie linguistic competence. "Actual truth" was (correctly) considered irrelevant, and truth *conditions* were not really understood or appreciated.
- When the linguistic relevance of truth conditions finally penetrated (later), the very nature of linguistic semantics changed – not just in terms of the tools used, but also in the questions asked and the criteria of adequacy for semantic analyses.

From *Syntactic Structures* to *Aspects*: Katz, Fodor, Postal, cont'd.

- In a theoretically important move, separable from the "Markerese" issue, and related to the problem of compositionality, Katz and Postal (1964) made the innovation of putting such morphemes as Neg and a Question morpheme Q into the Deep Structure, as in (5), arguing that there was independent syntactic motivation for doing so, and then the meaning could be determined on the basis of Deep Structure alone.
- (5) a. [NEG [Mary [has [visited Moscow]]]] $\Rightarrow_{\text{T-NEG}}$
  [Mary [has not [visited Moscow]]]

  b. [Q [Mary [has [visited Moscow]]]] $\Rightarrow_{\text{T-Q}}$
  [Has [Mary [visited Moscow]]]

From *Syntactic Structures* to *Aspects*: Katz, Fodor, Postal, cont'd.

- This led to a beautiful architecture.
- Deep Structure is the input to semantics.
- Syntax maps Deep Structure to Surface Structure.
- Surface Structure is the input to phonology.
- Semantics ← **Deep Structure**
  ↓ Syntax
  Surface Structure → Phonology

From *Syntactic Structures* to *Aspects*: Katz, Fodor, Postal, cont'd.

- This big change in architecture rested on the claim that transformations should be meaning-preserving.
- It was an interesting and provocative claim, and even without any 'real semantics' at the foundation, it led to interesting debates about apparent counterexamples.
- And the architecture of the theory (syntax in the middle, mediating between semantics on one end and phonology on the other) was elegant and attractive.

Garden of Eden period

- Chomsky's thinking about semantics evolved from *Syntactic Structures* (1957) to *Aspects* (1965). There he tentatively accepted Katz and Postal's hypothesis of a systematic connection between syntax and semantics at the level of Deep Structure.
- During the brief period when *Aspects* held sway, there was a rosy optimism that the form of syntactic theory was more or less understood and we could start trying to figure out the "substantive universals".
- In that period, roughly the mid-60's, before the linguistic wars broke out in full force, I think generative grammarians generally believed the Katz and Postal hypothesis.

Garden of Eden period, cont'd.

- The idea that meaning was determined at this "deep" level was undoubtedly part of the appeal of the notion of Deep Structure beyond linguistics (cf. Leonard Bernstein's Norton Lectures, *The Unanswered Question*) and probably contributed to the aura surrounding the notion of "language as a window on the mind."
- So around 1965, there was very widespread optimism about the Katz-Postal hypothesis that semantic interpretation is determined by deep structure, and the syntax-semantics interface was believed to be relatively straightforward (even without having any really good ideas about the nature of semantics.)

Expulsion from Garden of Eden and the roots of the linguistic wars

- What happened to upset that lovely view? Linguists discovered quantifiers! Transformations that preserved meaning (more or less) when applied to names clearly did not when applied to some quantifiers.
- "Equi-NP Deletion"
  - With names: John wants John to win ⇒ John wants to win.
- But with quantifiers, should we derive:
  - Everyone wants everyone to win ⇒ Everyone wants to win ??
  - (We'll return to this in discussing early MG & TG efforts.)
- Similar problems for derivation of
  - Every candidate voted for himself
  - Every number is even or odd

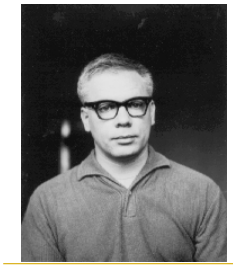
The linguistic wars

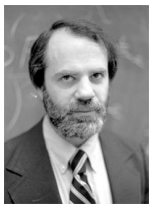
- Two responses by linguists to the problematic relation between classic transformational derivations and semantics:
- **Generative semantics** (Lakoff, Ross, McCawley, Postal, early Dowty, Larry Horn, sometimes Bach): In order for deep structure to capture semantics, it needs to be deeper, more abstract, more like "logical form" (first-order-logic). The syntax seemed implausible to some (but rules like "Quantifier Lowering" were later reproduced "upside down" by the "interpretivists"). But semantics was taken seriously, much more so than by Chomsky.
- **Interpretive semantics** (Jackendoff, Chomsky): Keep syntax beautiful and 'independently motivated'. Different semantic modules may work at different levels. The semantics often seemed architecturally *ad hoc,* though with many strong points as well.
- So with the battles of the late 60's and early 70's raging in linguistics, let's turn to philosophy and logic.

Philosophy and logic: Montague's work and its antecedents

- Within philosophical logic, the foundational work of Frege, Carnap and Tarski led to a flowering in the middle third of 20th century of work on modal logic, tense logic, conditionals, referential opacity, and other philosophically interesting natural language phenomena.
- The competition among different modal logics characterized by different axiom systems had led some philosophers like Quine to reject modal notions as incurably unclear; but the field was transformed when Kanger (1957a,b) and Kripke (1959) argued for the importance of distinguishing between **possible models** of a language (the basis for the semantical definition of entailment) and **possible worlds** (possible states of affairs), elements that should be included within a given model to be used in giving a model-theoretic semantics for modal notions.

Kanger, Kripke: Fathers of Possible Worlds Semantics





Philosophy and logic: Montague's work and its antecedents cont'd.

- Montague was himself an important contributor to these developments in philosophical logic. Montague had been a student of Tarski's, and at UCLA was an active part of a strong logic group spanning the departments of Philosophy and Mathematics.
- He considered his principal contribution to philosophy to be his development of higher-order typed intensional logic (Hans Kamp, p.c.), which he considered would be a better foundation for formal philosophy than set theory.
- His HOIL unified tense logic and modal logic (extending Prior's work) and more generally unified "formal pragmatics" with intensional logic. How did he do that?

Philosophy and logic: Montague's work and its antecedents cont'd.

- Montague treated both worlds and times as components of "indices", and intensions as functions from indices (not just possible worlds) to extensions.
- He also generalized the intensional notions of property, proposition, individual concept, etc., into a fully **typed intensional logic**, extending the work of Carnap (1956), Church (1951), and Kaplan (1964), putting together the function-argument structure common to type theories since Russell with the treatment of intensions as functions to extensions.

Philosophy and logic: Montague's work and its antecedents cont'd.

- The resulting extension of model-theoretic techniques into the realm of modal logic led to a great expansion of work in logic and philosophy of language in quantified modal logic, tense logic, the logic of indexicals and demonstratives, adjectives and adverbs, propositional attitude verbs, conditional sentences, and intensionality.
- With few exceptions, most of this work followed the tradition of not formalizing the relation between given natural language constructions and their logico-semantic analyses or 'reconstructions': the philosopher-analyst served as a bilingual speaker of both English and the formal language used for analysis.

A note on the Kalish and Montague textbook.

- The first edition of Kalish and Montague's logic textbook (1964) contains the following passage (p.10):
- "In the realm of free translations, we countenance looseness...To remove this source of looseness would require systematic exploration of the English language, indeed of what might be called the 'logic of ordinary English', and would be either extremely laborious or impossible. In any case, the authors of the present book would not find it rewarding." (p.10)
- On page 10 of the 2nd ed., 1980, the passage is altered:
- "In the realm of free translations, we countenance looseness...To remove this source of looseness would require systematic exploration of the English language, indeed of what might be called the 'logic of ordinary English', and would be extremely laborious or perhaps impossible. In any case, we do not consider such an exploration appropriate material for the present book (however, see Montague [4 [*Formal Philosophy*]] and Partee [1 [*ed., Montague Grammar*]])."
- Thanks to Nick Drozd (p.c.) for alerting me to this quotation and its revision.

The Kalish and Montague textbook, cont'd.

- It was reportedly the experience of co-authoring that logic text with Kalish that gave Montague the idea that English should after all be amenable to the same kind of formal treatment as the formal languages of logic.
- Kalish and Montague took pains to give students explicit guidance in the process of translation from English to first-order logic: rather than the usual informal explanations and examples, they produced an algorithm for step-by-step conversion of sentences of (a subset of) English to and from formulas of first-order logic.
- The algorithm was quite exact for a very regimented sublanguage of English; there were some guides but not an algorithm for converting between this 'strict' translation into English and the more idiomatic 'free' translation referred to in the p.10 passages.
- I thought I had been told that Montague then reasoned that if such translation could be formalized, it must also be possible to formalize the syntax and semantics of English directly. But here's Hans Kamp:

The Kalish and Montague textbook, cont'd.
Notes from Hans Kamp.

Notes from Hans Kamp on Kalish and Montague in relation to the development of Montague's work

- Hans Kamp (e-mail, Oct 1 2009) offered me his memory of those beginnings:
- My reaction to the issue raised by Drozd: In a way I am not quite the right person to address this because I arrived in UCLA a little too late. (Fall of '65, ….) ... My impression is that Richard was already taking the idea of a model-theoretic semantics for natural language seriously at that time. I still can remember a seminar Montague offered in which one of the students, Bob Mattison, … had unearthed Ajdukiewicz's paper on categorial grammar, which Richard didn't know at the time and which became the inspiration for his way of dealing with NL syntax. By that time Montague was firmly set on the path of trying to develop a model-theoretic account of meaning in NL; … that seminar took place in the fall of '65 or in the fall of '66.
- In any case Richard's interests in giving a systematic account of meaning for natural languages must go back a good deal farther.

Notes from Hans Kamp, cont'd

- The passage in the Kalish-Montague logic introduction is I believe very relevant in this connection. … the text was available at UCLA for years … before it appeared as a book, and both Kalish and Montague used it on a regular basis in their courses. …
- The quoted passage from p. 10 is, I believe, highly significant. Richard emphasised to me repeatedly in relation to the book that there was something odd about the way it presents the subject:
- Everything about the formal languages of propositional and predicate logic is presented with (exemplary) precision, but when it comes to applying the formal languages in the way the student is asked to in the exercises - of the type: Translate this argument (given in English) into the formalism and derive the translation of the conclusion from the translations of the premises - an appeal is being made not only to the student's grasp of the formal definitions but also to his intuitive understanding of English.
- Montague was acutely aware of the oddity of this 'gap': What IS it that enables us to carry out those translations or to check whether somebody else got them right?

Notes from Hans Kamp, cont'd

- While I guess that [Richard had] an awareness of this gap … for quite some time before the appearance of the book, it may well be that an idea about what could be done to fill it ripened only during the second half of the sixties. Perhaps a contributing factor to this 'delay' was a difference in opinion between him and Kalish. Montague apparently wanted to include the model theory for first order logic in the book (and also in the courses based on it), but Kalish appears to have disagreed, thinking that that would make things too hard for the beginning logic student.
- So Montague gave in and model theory was left out. If it hadn't been, then perhaps his ideas about the model-theoretic semantics of English might have come to fruition a little earlier.
- [The relation of] … Richard's work on the semantics of NL … to the passage of p. 10 is I think pretty clear: Defining good translation functions between NL and symbolic logic is very hard, and it is also a task that is difficult to define, because it isn't clear exactly what the criteria should be ….

Notes from Hans Kamp, cont'd

- Developing a model-theoretic semantics for NL is a somewhat different enterprise. Here the focus is clearly, naturally and inevitably on conditions of truth and reference; and in and of itself developing a model-theoretic semantics is not the same thing as defining a translation function from NL to Predicate Logic (not even when the models used in the model-theoretic semantics are models for Predicate Logic).
- However, a model-theoretic account of NL meaning can be used as a criterion (either as the only one or as one among others) for adequate translation. And of course, as became plain in Richard's later papers on NL semantics (PTQ and Universal Grammar), a translation function could also be useful as a way of articulating a model-theoretic treatment.
- … [T]he last time I saw Richard (Christmas/New year '69/'70), he mentioned a new edition of the Logic Introduction. … [H]e thought the book would gain from having model theory included in it. I cannot remember whether he said some agreement with Kalish had been reached. In any case, the second edition that finally appeared must have been Kalish´s responsibility.

(end of relevant parts of e-mail from Hans Kamp, Oct. 1, 2009.)

Beginnings of Montague's work, cont'd.

- In any case, the first result of Montague's work on natural language was the provocatively titled paper "English as a Formal Language" (Montague 1970b), which begins with the famous sentence, "I reject the contention that an important theoretical difference exists between formal and natural languages."
- As noted by Bach (1989), the term "theoretical" here must be understood from a logician's perspective and not from a linguist's.
- What Montague was denying was the logicians' and philosophers' common belief that natural languages were too messy to be formalizable; what he was proposing, here and in his "Universal Grammar", was a framework for describing syntax and semantics and the relation between them that he considered compatible with existing practice for formal languages and an improvement on existing practice for the description of natural language.

Montague's work, cont'd.

- The Fregean principle of compositionality was central to Montague's theory and remains central in formal semantics.
- **The Principle of Compositionality**: The meaning of a complex expression is a function of the meanings of its parts and of the way they are syntactically combined.
- Montague's syntax-semantic interface: Syntax is an algebra of 'forms', semantics is an algebra of 'meanings', and there must be a homomorphism mapping the syntactic algebra into the semantic algebra. Compositionality is the homomorphism requirement.
- The nature of the elements of both the syntactic and the semantic algebras is left open; what is constrained by compositionality is the relation of the semantics to the syntax.

Montague's work, cont'd.

- Details of Montague's own analyses of the semantics of English have in many cases been superseded, but in overall impact, PTQ was as profound for semantics as Chomsky's *Syntactic Structures* was for syntax.
- Emmon Bach (1989) summed up their cumulative innovations thus: Chomsky's Thesis was that English can be described as a formal system; Montague's Thesis was that English can be described as an *interpreted* formal system.

Montague's work, cont'd.

- **Truth-conditions** and **entailment relations** are basic.
- These are minimal data that have to be accounted for to reach "observational adequacy". That principle, inherited from the traditions of logic and model theory, is at the heart of Montague's semantics and is one of the defining principles of formal semantics.
- Cresswell (1978) put this in the form of his "Most Certain Principle": we may not know what meanings are, but we know that if two sentences are such that we can imagine a situation in which one of them is true and the other false, then they do not have the same meaning.

Montague's work, cont'd.

- As Cresswell showed, many decisions about semantic analysis, both in general architecture and in particular instances, can be seen to follow from that principle.
- The adoption of truth conditions and entailment relations as basic semantic data is not innocuous from a foundational perspective. Nevertheless it has proved so helpful in making semantic proposals more explicit that it has become widely (although not universally) adopted, especially but not only among formal semanticists.
- It may be hard to remember or realize how surprising and controversial an idea it was to linguists in the early 1970's to think about truth conditions rather than just ambiguity, semantic anomaly, and synonymy.

Montague's work, cont'd.

- Montague did not work single-handedly or in a vacuum; his papers include acknowledgements to suggestions from David Lewis, David Kaplan, Dana Scott, Rudolph Carnap, Alonzo Church, Terence Parsons, Hans Kamp, Dan Gallin, the author, and others.
- And there were of course other important early contributors to the development of formal semantics as well. Let me pause and mention that I'm not striving for completeness here; see my various published papers relating to the history of the field. (And I aim to increase coverage in my planned book project.)

Joint work by linguists and philosophers: Montague Grammar and the development of formal semantics

- Montague was doing his work on natural language at the height of the "linguistic wars" between generative and interpretive semantics, though Montague and the semanticists in linguistics had no awareness of one another.
- PTQ (Montague 1973) gave recursive definitions of well-formed expressions and of their interpretations, illustrating what Bach christened the "rule-by-rule" approach to syntax-semantics correspondence. That was quite different from both generative and interpretive semantics, which looked for some "level" or "levels" of syntactic description to interpret. (That approach can also be seen in the role played by "LF" in later Chomskyan theories. Perhaps somewhat less so in Minimalism, I'm told.)

Joint work by linguists and philosophers, cont'd.

- The earliest introduction of Montague's work to linguists came via Partee (papers starting in 1973) and Thomason (who published Montague's collected works with a long introductory chapter in 1974).
- Partee and Thomason argued that Montague's work might allow the syntactic structures generated to be relatively conservative ("syntactically motivated") and with relatively minimal departure from direct generation of surface structure, while offering a principled way to address many of the semantic concerns that motivated some of the best work in generative semantics.

Joint work by linguists and philosophers, cont'd.

- Let me describe an obstacle I faced when I started trying to put MG and TG together, whose solution is related to a leading idea that came into linguistics from philosophy and logic in this period, namely the (Fregean) idea that recursion must be done on *open* sentences.
- Obstacle: what to do about deletion rules? In classical TG, (13a) was derived from something like (13b) by "Equi-NP Deletion".

(13) a. Mary was eager to win.
b. [$_S$ Mary was eager for [$_S$ Mary to win]]

- But given the principle of compositionality, and given the way MG works by building up the meanings of constituents from the meanings of their subconstituents, there is nothing that could correspond to "deleting" a piece of a meaning of an already composed subpart.

Joint work by linguists and philosophers, cont'd.

- Recall the consequences of the analysis in (13b) for a sentence like (14a). The presumed deep structure (14b) would clearly give the wrong meaning.

(14) a. Everyone was eager to win.
b. [$_S$ everyone was eager for [$_S$ everyone Tns win]]

- MG-TG resolution suggested in (Partee 1973, 1975): what we want as "underlying" subject in the embedded sentence is a bindable variable; I followed Montague's line and bound it by lambda abstraction to make a VP type. (Others kept an S type for the infinitive, with the variable bound by the higher quantifier.)

(15) a. [[to win]] = ^λx [win (x)]
b. alternatively: everyone'(λx[x was eager for [x to win]])

- That solution is one illustration of the importance of the Fregean principle that wherever quantifiers may be involved, recursion must be allowed to work on *open* sentences.

Joint work by linguists and philosophers, cont'd.

- Thanks to Paul Postal (p.c.) for reminding me that Jim McCawley was one of the first linguists to appreciate the importance of doing recursion on open sentences, at least as early as (McCawley 1968).
- The syntax and semantics of logical languages had been done that way since Frege – that's crucial to the semantics of quantified sentences and all of variable-binding.
- Trying to do recursion on closed sentences was what made transformational rules cast in terms of "identical NPs" break down when quantifiers were discovered. Expulsion from the Garden …
- In Chomskyan syntax, a corresponding change was eventually made, replacing the "identical NP" by the special null element PRO, interpreted as a bound variable. Other syntactic theories, like GPSG, HPSG, and LFG, and modern versions of Categorial Grammar, were developed after the quantifier issues had become well known, so they were designed from the start not to run into those problems.

Joint work by linguists and philosophers, cont'd.

- Doing recursion on open sentences together with another Fregean leading idea, using function-argument application as a principal means of semantic composition, together led to a far better semantic analysis of relative clauses than had been achieved any linguists before or during the semantic wars. (Quine actually presented this solution in *Word and Object*; Montague didn't invent it.)
- I won't go through the now-standard analysis of restrictive relative clauses as <e,t>-type lambda abstracts that conjoin with a common noun before the Determiner is added, but just want to recall how impossible it had been to do justice to relative clauses in quantified noun phrases in earlier linguistic work.

(16) a. The person who won the race was a Kenyan.
b. Every child who carved a pumpkin got a prize.
c. Some child who carved a pumpkin got a prize.

"Identical NP" gives bad results; Gen Semanticists tried analyses resembling first-order logic, using *if*-clauses, conjunction, … .

Joint work by linguists and philosophers, cont'd.

- More on **Function-argument structure** as semantic glue: (Of course that's not the only way things might be done, and by now there are other live proposals as well.)
- Before Montague, linguists knew nothing about lambdas or semantic types, and had no clear idea about how to combine meanings above the lexical level. That's why the usual attempts involved "semantic representations" in a hypothesized "language of thought", which looked very much like natural language. No one had entertained the idea that the things *denoted* by expressions could have a natural way of combining.
- "Argument structure" came into syntax from semantics.

Joint work by linguists and philosophers, cont'd.

- The appreciation of the importance of function-argument structure also helped linguists understand much more of the original motivation of categorial grammar, a formalism invented and developed by Polish logicians (Lesniewski 1929, Ajdukiewicz 1935) but dismissed by linguists as soon as it was proven to be equivalent in generative power to context-free phrase-structure grammar.
- Linguists had seen CG only as an alternative syntactic formalism, either not knowing or not caring that one of its central features is the way its category names encode an intimate correspondence between syntactic category and semantic type.
- Categorial grammars are therefore very attractive from the point of view of compositionality; this was pointed out by Lyons (1968) and Lewis (1970); Montague (1973) used a modified categorial grammar, and research on categorial grammars has blossomed since then.

The influence of formal semantics

- One of the methodological principles implicit in transformational grammar, and explicit in some (not all) versions that included the Katz-Postal hypothesis, and carried to extremes in Generative Semantics, was the principle that **sameness of meaning should be reflected in sameness of deep structure.**
- But with a real semantics, we don't need sameness at any syntactic level, including "LF", to capture sameness of meaning (cf. Thomason 1976).
- Oversimplifying hugely, but certainly true for some of us, and at least part of the story for many: this ended the linguistic wars. Eventually formal semantics became mainstream semantics in linguistics.
- A later divergence with respect to syntax-semantics architecture:
- (i) Non-transformational grammars, generally aiming for something close to direct (surface) compositionality.
- (ii) LF as a level of syntax in later Chomskyan approaches; the mapping to LF resembles upside-down Generative Semantics.

Reactions to formal semantics among syntacticians.

- **Chomsky's skepticism**
- It turned out that Chomsky was deeply skeptical of formal semantics and of the idea of compositionality in any form.
- I have never been able to satisfactorily explain his skepticism; it has seemed to me that it was partly a reaction to a perceived attack on the autonomy of syntax, even though syntax is descriptively autonomous in Montague grammar.
- But syntax is not "explanatorily autonomous" in Montague grammar, or in any formal semantics, and I do not see any rational basis for believing that it should be.
- Maybe also because of puzzles about the nature of our knowledge of semantics (raised in my 1979 "Semantics: mathematics or psychology?").
- In any case, formal semantics spread and became "mainstream semantics" in the US and Europe in spite of Chomsky's skepticism, and MIT hired its first formal semanticist, Irene Heim, in 1989, and its second, Kai von Fintel, in 1994, and quickly became one of the leading programs in formal semantics as well as syntax.

Formal semantics as an autonomous subdiscipline of linguistics, and other later developments.

- I think the height of initial interaction on semantics between linguists and philosophers had passed by 1980, followed first by the rise of cognitive science, in which semantics was one of the highly interdisciplinary concerns, and then by a greater specialization of semantics inside of linguistics proper, though always with many individual scholars maintaining links of various kinds within and across the disciplines.
- Many (not all, of course) important developments in the 80's were by linguists – too many to list here – also beginnings of semantic typology, formal pragmatics, computational semantics …
- By the middle of the 1980's the increasing recognition of formal semantics as part of the core curriculum in linguistics was seen in the publication of textbooks and the growing number of departments with more than one semanticist, and a few, like ours, with more than two by the end of the decade; even more by now.

Formal semantics as an autonomous subdiscipline of linguistics, and other later developments, cont'd.

- By the beginning of the 1990's, formal semantics (no longer "Montague grammar", though that's about the time that the term "Montague grammar" made it into the OED) was a fully established field within linguistics, and students were not conscious that the core fields hadn't always been 'phonology, syntax, semantics'.
- In the 1980's and 1990's, there was noticeably less interaction between linguists and philosophers in semantics in the U.S., in part because within philosophy interest in the philosophy of language had declined as interest in philosophy of mind increased.

Formal semantics as an autonomous subdiscipline of linguistics, and other later developments, cont'd.

- Divergence between Europe and the US in the 1990's:
- The ILLC was founded in Amsterdam in the late 1980's, leading to the creation of the new journal *JOLLI* and the ESSLLI summer schools, with equal weight on language, logic, and computation.
- In the US, the journal *Natural Language Semantics* was launched in 1992 by Heim and Kratzer, specifically aiming to integrate formal semantics more closely into linguistic theory, especially to connect semantics with syntactic theory, unlike the older interdisciplinary journal *Linguistics and Philosophy*. And Heim and Kratzer 1998 is a fully post-Montague textbook in formal semantics.
- But I think there's been more back-and-forth in the last decade, and I don't feel that separation now as much as I did ten or fifteen years ago.

Examples of renewed linguistics-philosophy interaction.

- When I wrote my semi-autobiographical essay in 2003, there seemed to be little real linguistics-philosophy interaction. But now I've happily come to realize that it's on the increase, and more sophisticated than ever. [Nice irony: MIT has been a leader.]
- One reason: the rise of formal pragmatics in linguistics together with the rise of "contextualism" in several areas of philosophy.
- Other areas mutual interest and recent activity: semantics-pragmatics issues, dynamic semantics, modality, conditionals, "or", presupposition, quantification, ellipsis, interrogatives, anaphora, tense and aspect. And more.
- Much of this relates to meaning and context, a growth area now.
- It's a very long time since I could keep track of everything that was going on, so I know there's a lot that's significant that I don't even know about. But I have a good feeling about how things are now.

Selected references

Fuller references can be found in several papers, versions of which are downloadable from my site, http://people.umass.edu/partee/ .

- Partee, Barbara H. 1996. The development of formal semantics in linguistic theory. In *The Handbook of Contemporary Semantic Theory*, ed. Shalom Lappin, 11-38. Oxford: Blackwell.
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- Partee, Barbara H. 2005. Reflections of a formal semanticist as of Feb 2005. http://people.umass.edu/partee/docs/BHP_Essay_Feb05.pdf
- See also related presentations: 2009 Oslo video here; 2009 slides from RichFest (RT's 70th birthday festival).