The Semantics Adventure
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1. The Chomsky Revolution - 1960’s.

For me the adventure began just 50 years ago, here at MIT in 1961. The Chomskian revolution had just begun, and Noam Chomsky and Morris Halle had just opened up a PhD program in Linguistics, and I came in the first class. I want to start by thanking Chomsky and Halle for building that program, and I thank MIT and the Research Laboratory of Electronics for supporting it. I’m indebted to Chomsky for revolutionizing the field of linguistics and making it into a field whose excitement has never waned. Chomsky redefined linguistics as the study of human linguistic competence, making linguistics one of the early pillars of cognitive science.


At the center of the Chomskian revolution was syntax, generative grammar: a finite specification of the infinite set of sentences of a language. That launched an extremely productive research program, but it didn’t include semantics; Chomsky considered meaning scientifically intractable, and he wasn’t alone. When linguists did soon try to add semantics to generative grammar, there were two big obstacles: a lack of good formal tools, and the absence of any non-subjective notion of meaning.

It was the UCLA logician Richard Montague who revolutionized the study of semantics in the late 60’s. He built on successes in formalizing the syntax and semantics of logical languages – the work of Frege, Tarski, and others. Montague himself developed a higher-order typed intensional logic with a model theory, and with its help he was able to formalize a significant part of the syntax and semantics of English within a clearly articulated theoretical framework. The result was what we now call formal semantics.

Emmon Bach has summed up Chomsky’s and Montague’s cumulative innovations thus: Chomsky showed that English can be described as a
formal system; Montague showed that English can be described as an *interpreted* formal system.

3. **Progress in Formal Semantics in the Last 50 Years.**

For me as a young syntactician at UCLA in the late 60’s, Montague’s work was eye-opening. Linguists had been building tree-like “semantic representations”, OK for capturing scope ambiguity, but otherwise with endless arguments about competing representations. We never dreamed of truth-conditions being relevant for linguistics; but Montague’s work, and David Lewis’s, showed that truth-conditions are crucial for giving semantics a non-subjective foundation. A linguistically exciting part was that with such a rich logic, we could get a close match between syntactic constituents and semantic constituents, and meanings of sentences could be built up recursively and compositionally from the meanings of their syntactic parts.

One brief illustration: Bertrand Russell argued that natural language syntax is logically misleading, since it puts “John” and “every man” into the same syntactic category, whereas in first-order logic, “John walks” and “Every man walks” must have radically different structures. Montague showed that natural language syntax is not logically misleading at all: *all* noun phrases can be treated uniformly in higher-order logic as so-called “generalized quantifiers”, and English subject-predicate sentences like “John walks” and “Every man walks” can then be interpreted straightforwardly. Generalized quantifier theory is now one rich topic in formal semantics, and can explain many things that we couldn’t explain with just syntax.

I started working on “Montague grammar” in 1970, to integrate it into linguistics by finding ways to put Chomsky’s and Montague’s work together. From the early 70’s, collaborative work among philosophers, logicians, and linguists in the US and Europe built in many directions.

One important result is that with a serious semantics to share the load, syntax doesn’t have to do all the work we once imagined. Syntactic and semantic advances now often develop in tandem, each informing the other.

By the late 1980’s, formal semantics was well established within linguistics departments in the US; in Europe, it may be in linguistics or in philosophy. Among middle generation leaders of formal semantics I will just mention two who are involved in this symposium, and who were my PhD students at UMass in the 1980’s: Irene Heim, Head of the Department of Linguistics
and Philosophy, became MIT’s first formal semantics faculty member in 1989. And Gennaro Chierchia is now Head of Linguistics at Harvard. Both have made seminal contributions that have helped to shape the field.

I have to mention one seeming paradox, which relates to open challenges as well as to past progress. I stressed how the Chomskian revolution made linguistics an early pillar of cognitive science. Yet Frege’s anti-psychologistic stance, shared by Montague, was crucial in the foundations of formal semantics. Frege argued that truth-conditions, and not mental “ideas”, have to be at the core of the meaning of a sentence. And the work of generations of linguists and philosophers has shown the fruitfulness of that approach: first formalize what the semantics of our language IS – what our sentences say about how the world is. Then figure out how our knowledge of it, such as it is, is acquired and exploited.

This stance might seem to exclude formal semantics from cognitive science, but I believe that on the contrary, it makes the contributions of semantics to cognitive science all the more interesting. Human language is a remarkable achievement; part of what is remarkable is how we implicitly recognize and navigate the social construction of meaning. When we converse, we simultaneously exchange information and negotiate meaning. David Lewis’s work on “Convention” was an early milestone in exploring the relation between individual competence and social intelligence, an important dimension that is still under-explored.


The best-understood parts of formal semantics concern the semantic composition of parts from wholes, the ‘semantics of syntax’. There has also been great progress on formalizing parts of pragmatics, involving the interaction of meaning, language use, and context, including the study of how context both affects and is affected by interpretation. Studies in language processing now include formal semantics and pragmatics, and game theoretic approaches are having a growing influence. Computational formal semantics is now a subfield of computational linguistics, contributing to both theoretical and applied goals.

And there is promising early work on universals and typology in semantics, with innovative fieldwork uncovering semantic and pragmatic subtleties of various indigenous languages. And just as in syntax, such languages prove to be as semantically rich and complex as familiar European languages.
6. Challenges.

There are many challenges facing formal semantics and its relatives – these are young fields. I’ll just mention two that I think are important both for the field and for the goals of this symposium.

1. The semantics of sentential structures is increasingly well understood; but lexical semantics is really hard, and formal methods are weakest here. It’s in lexical semantics that we most clearly can’t equate the language with our knowledge of it. (As Hilary Putnam observed years ago, the fact that he doesn’t know anything that would distinguish a beech tree from an elm tree doesn’t mean that “beech” and “elm” are synonyms in his language.) The lexicon has lots of linguistically important substructure; but it’s also the part of language that interfaces most strongly with non-linguistic knowledge – encyclopedic knowledge, common sense ontology, visual imagery, cultural associations, and on and on.

2. And connected with that, another challenge is how to build formal semantics into real-time processing models – whether psychological or computational - that involve the integration of linguistic and not-specifically linguistic knowledge. This concerns not only lexical semantics, but also all kinds of context-dependence, implicit content, meaning shifts, and non-literal uses of language. I know there is progress – I’m not an expert in those areas – but I think this is a domain where major interdisciplinary innovation may be crucial.

An illustration of the challenges: I’m pretty sure that the most successful search engines do NOT do any formal semantic analysis of questions or of texts they are searching. I’ve heard of some nice work in that direction, but large-scale all-purpose fast search engines or ‘intelligent machines’ that ‘really know and use semantics’ are probably still far in the future.

7. Conclusions

I would suppose that ‘really knowing semantics’ is a prerequisite for any use of language to be called intelligent. So if there’s to be a new basic research effort to understand intelligence and the brain, semantics is ready to contribute to it – and to gain from it.