David Lewis and his place in the history of formal semantics

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1. Introduction

Among David Lewis's contributions to the formal investigation of meaning in natural languages are trail-blazing ideas that have lasted. There is a thriving field of game-theoretic pragmatics that took off from *Convention* (Franke 2013, Lepore & Stone 2015). "Adverbs of Quantification" (1975a) inspired a new view of conditionals, where *if* is not considered a sentential connective, but *if*-clauses restrict quantifiers (Kratzer 1978, 1981, 2012). "Adverbs of Quantification" also led to an explanation of the puzzling binding properties of indefinites. Lewis proposed that indefinites introduce variables that are unselectively bound by adverbs like *always*, *usually*, *never*. This idea was crucial for Irene Heim's and Hans Kamp's versions of Discourse Representation Theory (Kamp 1981, Heim 1982). "Scorekeeping in a Language Game" (1979b) was influential for the development of dynamic theories of presuppositions and presupposition accommodation (Heim 1982, Roberts 2015). " 'Whether' Report" (1982) anticipated Groenendijk and Stokhof's unified treatment of embedded questions (Groenendijk and Stokhof 1984).[1] "Attitudes De Dicto and De Se" (1979a) led to the discovery of dedicated *de se* pronouns in natural languages (Chierchia 1989, Anand 2006, Pearson 2012).

My chapter is not about David Lewis's contributions to particular areas of semantics like those I have just mentioned. It is about his role in helping shape the current field of formal semantics as it is taught in textbooks and practiced by linguists and philosophers today. In the United States, formal semantics is sometimes referred to as "Montague Semantics". That name has created the impression that Montague's work marks the beginning of formal semantics—even a revolution in our thinking about meaning. My chapter is meant to lead to a more informed and accurate history of formal semantics that recognizes the many and varied influences that have shaped the field gradually and cumulatively. David Lewis has a place in this history. His

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[1] " 'Whether' Report" was originally presented at the 1974 Workshop on Semantics and Syntax of Non-Extensional Constructions, University of Massachusetts Amherst.

work built bridges between two disciplines, both emerging in the 20th century. One was early 20th century formal semantics, as conceived by logicians who had become interested in natural language under the influence of Frege. The other was Chomskyan generative syntax, a field Lewis was familiar with from his student days.

Here is a preview of the chapter. Section 2 tracks ideas from logic that Lewis could rely on when he began his work on formal semantics in 1967. Section 3 presents a fragment of English as an illustration of what a logic-inspired semantic theory for natural languages might look like. The fragment features the tools David Lewis inherited, but also the choice points where he took a different path. Section 4 clarifies the relation between Lewis's and Montague's work in formal semantics, and, relying on Lewis's letters, discusses the influences that directly inspired chapter V of *Convention* and *General Semantics*. Section 5 concludes.

2. From conventions of language to intensional semantics

David Lewis became interested in formal semantics when he saw a way to connect his theory of conventions of language to a referential semantics over possible worlds. This happened at some time in 1967 when he was revising his dissertation for publication as *Convention*. Lewis realized that one of the things that were seriously wrong in his dissertation was that his theory of conventions of language had "no visible connection with referential semantics."[2] His new insight, which he conveyed to Quine, was that for any language $\mathcal{L}$, there is a regularity of persistent truth-in-$\mathcal{L}$-telling. A population's convention of language is such a regularity. However, for a regularity to be a convention in Lewis's sense, it has to be one of several possible alternatives. The alternatives to regularities of persistent truth-in-$\mathcal{L}$-telling are regularities of persistent truth-in-$\mathcal{L}'$-telling for all other possible languages $\mathcal{L}'$.[3]

While Lewis's theory of convention was meant to apply to possible languages with or without grammars, natural or not, he nevertheless chose for discussion an example that could be actual English. In *Convention* English is presented as a natural language with a grammar of the kind discussed by transformational grammarians at the time, and with an intensional semantics of

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[2] Letter 544. To W. V. Quine, 18 October 1967, in Beebee & Fisher 2020a: 220.

[3] Letter 545. To W. V. Quine, 27 November 1967, in Beebee & Fisher 2020a: 221.

the kind investigated by logicians and philosophers since at least the forties. Bringing together contemporary thinking in logic, philosophy, and generative linguistics in this way was innovative, bold, and farsighted. Chapter V of *Convention* stands out as a landmark and turning point in the history of formal semantics for natural language, soon to be followed by "General Semantics" (1970a), with a worked-out fragment of English that took on quantifier scope ambiguities, context-dependency, hyperintensionality, and speech acts. Both works are foundational for formal semantics as a linguistic discipline today.

Connecting conventions of natural languages to a referential semantics over possible worlds required logical techniques that could relate natural language expressions of different categories to their intensions. By 1967 logicians had taken an interest in natural languages. Several systems of intensional logic in the tradition of Frege were in place (Carnap 1947, 1956, 1963; Church 1946, 1951a, 1951b; Kaplan 1964).

The second edition of Church's *Introduction to Mathematical Logic* appeared in 1956. It was a highly unusual textbook for students of mathematics, with 590 consecutively numbered footnotes and a 68-page introduction, which was essentially an introduction to Frege's philosophy of language. In his review of the textbook in the *Journal of Symbolic Logic*, Leon Henkin described Church's introduction as "a conceptual framework for a general theory of linguistic systems, important features of which, especially the concepts of sense and denotation (which are fundamental to Church's analysis of language), the author traces back to Frege." (Henkin 1957: 321) Henkin continues:

> … the emphasis throughout the book is on logic as applied, rather than pure, mathematics, and from this viewpoint the introductory material becomes relevant as explaining the relation between the mathematical theory of formal systems and the languages (of which these systems are idealized models) to which the theory applies. . . . The linguistic analysis which the introduction affords is the subject of continuing controversy in philosophical circles, but this in no way reflects on the mathematical portions of the book. (Henkin 1957: 321)

By the early sixties, formal semantics as a method of inquiry into natural language had advanced to a point where *Synthese* published a survey article of the field: "A Survey of Formal Semantics" (Rogers 1963). As Rogers explains, formal semantics is "a certain kind of systematic

inquiry into the problems of meaning and interpretation. More specifically, it is concerned with the problems of meaning in the sense of *cognitive*, or *declarative* meaning, as contrasted with such other types of meaning as emotive or exhortative meanings." (Rogers 1963: 17f.) Rogers' article makes clear why the new field of formal semantics was of interest to all scholars investigating ordinary, unformalized, languages, including philosophers and linguists.

> Before I give an account of the nature of formalized languages, let me state why it is that formal semantics has come to use such languages. Principally, it is because of the clarity and precision that are made possible once one relativizes the problems of semantics to such languages. There is about them, and results based upon the use of them, a kind of definiteness which it is impossible to obtain when one is working with an ordinary language. And because, though formalized, such languages have much in common with ordinary languages, and can be made successively to approximate such languages in power of expression, semantic analyses carried out with respect to formalized languages are of interest not only to students of such languages, but also to those who are especially interested in the semantics of ordinary, unformalized languages. (Rogers 1963: 18)

The UCLA Philosophy department Lewis joined in 1966 was a hotbed of Frege-inspired intensional semantics. Rudolf Carnap was emeritus. David Kaplan's 1964 dissertation on the *Foundations of Intensional Logic* was the last dissertation Carnap supervised. Kaplan stayed on as faculty member. Richard Montague came to UCLA in 1955 and remained there until his death in 1971. Alonzo Church was a visitor at UCLA in 1960–1961 and moved there in 1967 after retiring from Princeton.

Church had been thinking about intensional extensions of his 1940 typed λ-calculus at least since 1944: "I have in mind although only in vague outline, a system based on that of my *Formulation of the Simple Theory of Types* which I would propose as a treatment of extension and intension, or of denotation and sense, along the line of Frege's ideas."[4] By the time Church wrote "The Need for Abstract Entities in Semantic Analysis", he had designed formal languages that were similar enough to natural languages for him to conclude that "although all the foregoing account has been concerned with the case of a formalized language, I would go on to

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[4] A. Church to R. Carnap, 9 February 1944, in Church 2019: 1045.

say that in my opinion there is no difference in principle between this case and that of one of the natural languages." (Church 1951b: 106). These words were echoed almost twenty years later by Richard Montague: "I reject the contention that an important difference exists between formal and natural languages." (Montague 1970c: 189)

Carnap had taught seminars on intensional semantics at UCLA in 1955 and 1959. He sent revised versions of the notes for his seminars to his colleagues. They were published posthumously as "Notes on Semantics":

We shall deal here with the *designative* (or cognitive) meaning component only, leaving aside all others (e.g., the emotive and the motivative meaning components). The designative meaning component is the one that is relevant for questions of truth. Thus our theory is *pure, designative semantics*. Therefore we consider only declarative sentences (called simply "sentences") and their parts. (Carnap 1972: 8)

The intensional semantics taught in today's introductory semantics classes is largely Carnap's, except that we no longer represent possible worlds as state descriptions, but take them as basic (Kripke 1963). Like Carnap, we take propositions to be sets of possible worlds, and we may or may not think of properties as functions from individuals to propositions (Carnap 1947: 181f.), and of intensional relations as functions from pairs of individuals to propositions (Carnap 1947: 182).

Montague's papers on pragmatics supplemented Carnap's intensional semantics by taking into account possible contexts of use (Montague 1968, 1970; also Scott 1970). The extensions of linguistic expressions were now relativized to indices or points of reference. Depending on the indexical features of the language considered, an index may not just include a possible world, but also a moment of time, a speaker, a listener, a place of utterance, and so on.

I conclude that in 1967, when Lewis was looking for a way to connect conventions of natural languages to an intensional semantics, there was a field of formal semantics that—under that name—investigated formal languages with the stated goal of approximating properties of natural languages. That field had a strong tradition right where Lewis was at UCLA. What was still missing was a theory that would link actual realizations of expressions of natural languages

to their intensions in a systematic and empirically well-motivated way. Here, too, logicians had had ideas. Lewis was too much of a linguist to adopt them wholesale.

In natural languages, syntax does not only group morphemes for semantic interpretation. It also groups them for phonological interpretation.[5] A well-motivated theory of syntax thus has to be embedded in a theory of grammatical architecture that satisfies the needs of both semantics and phonology. Phonology is not what a philosopher or logician would normally bother about. Lewis did. In his sketch of a grammar of English in *Convention*, Lewis gives an illustration of a proposed grammatical analysis for an English sentence that includes a phonetic transcription delivered by what he calls a "representing" component. Lewis's representing component applies to syntactic representations built by a generative grammar. Those representations are also the input for semantic interpretation.

3. Connecting expressions of natural languages to intensions: The logicians' way

If the job of connecting expressions of natural languages to intensions had remained in the hands of logicians, the connection would have been made in the way familiar from logic textbooks. The system $\mathcal{E}$ below is an illustration of the general method for a fragment of English. I am using $\mathcal{E}$ to illustrate the formal semantic techniques Lewis inherited from those before him, but also to bring out the distinctive properties of his own approach to formal semantics.

Inventory of basic expressions of $\mathcal{E}$

NPs	*detective*, *mathematician*
Adjectives	*curious*, *alert*
Verbs	*ruminates, meditates*
Connectives	*and*, *or*
Quantifiers	*every*, *some*

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[5] This applies to both spoken and sign languages. The principles that lead from morphosyntactic representations to sequences of sounds in a spoken language or to sequences of signs in a sign language are structurally so similar that they are both referred to as "phonology".

Intensions of basic expressions of 𝓔

NPs $⟦ \textit{detective}⟧ = λxλw$ detective(x)(w)
                       $⟦\textit{scholar}⟧ = λxλw$ scholar(x)(w)

Adjectives $⟦\textit{curious}⟧ = λxλw$ curious(x)(w)

                       $⟦\textit{alert}⟧ = λxλw$ alert(x)(w)

Verbs $⟦\textit{ruminates}⟧ = λxλw$ ruminates(x)(w)

                       $⟦\textit{meditates}⟧ = λxλw$ meditates(x)(w)

Connectives $⟦\textit{and}⟧ = λpλqλw$ (p(w) & q(w))

                       $⟦\textit{or}⟧ = λpλqλw$ (p(w) v q(w))

Quantifiers $⟦\textit{every}⟧ = λPλQλw\ ∀x\ (P(x)(w) → Q(x)(w))$

                       $⟦\textit{some}⟧ = λPλQλw\ ∃x\ (P(x)(w)\ \&\ Q(x)(w))$

Syntactic and semantic rules for 𝓔, working in tandem

S1   If $α$ is an adjective, and $β$ is an NP, then ⌜ $α\ β$ ⌝ is an NP, and

        $⟦⌜ α\ β ⌝⟧ = λxλw\ (⟦α⟧(x)(w)\ \&\ ⟦β⟧(x)(w))$.

S2   If $α$ is a quantifier, and $β$ is an NP, then ⌜ $α\ β$ ⌝ is a term, and $⟦⌜ α\ β ⌝⟧ = ⟦α⟧(⟦β⟧)$.

S3   If $α$ is a term, and $β$ is a verb, then ⌜ $α\ β$ ⌝ is a sentence, and $⟦⌜ α\ β ⌝⟧ = ⟦α⟧](⟦β⟧)$.

S4   If $α$ is a sentence, $β$ is a sentence, and $γ$ is a connective, then ⌜ $α\ γ\ β$ ⌝ is a sentence,

        and $⟦⌜ α\ γ\ β ⌝⟧ = ⟦γ⟧(⟦α⟧)(⟦β⟧)$.

𝓔 lists basic vocabulary items, assigns them to syntactic categories, and pairs them with their

intensions. There are four syntactic rules defining the well-formed expressions of 𝓔. S1 is a

recursive rule that creates a noun phrase from an adjective and a noun phrase. S2 combines a quantifier and a noun phrase to yield a term—a quantifier phrase in this case. S3 combines a term and a verb to yield a sentence. S4 is another recursive rule that produces conjunctions and disjunctions of arbitrary length, possibly repeating the same disjunct or conjunct over and over. *Æ* generates sentences like *Some curious curious detective meditates and every curious alert scholar ruminates.* Every syntactic rule is matched with a semantic operation telling us how to compute the intension of a complex expression from the intensions of its immediate constituents. This technique for compositional semantic interpretation is known as "rule-by-rule" interpretation. It was pioneered in Katz (1966). Lewis used it in *Convention*. All sentences of *Æ* are compositionally assigned propositions— (characteristic functions of) sets of possible worlds.

Æ uses expressions of Daniel Gallin's intensional logic Ty$_2$ in the meta-language to specify intensions (Gallin 1975).[6] Ty$_2$ is a straightforward extension of Church's Simple Theory of Types (Church 1940) that adds a basic type s for possible worlds to Church's two basic types for individuals and truth-values. The type s was introduced by Montague (1970b), but unlike Montague's intensional logic, Ty$_2$ also has variables and constants of type s. Zimmermann (1989) proves that Montague's intensional logic has no advantages over Ty$_2$. For all ends and purposes, the two are equivalent. Allowing full λ-reduction, Ty$_2$ is easier to work with, hence is more commonly used today.[7]

Æ brings out two properties of Church's λ-calculus and its descendants that have been instrumental for the development of a formal semantics for natural languages. First, those calculi can give us names for the fanciest denotations we may ever want to assign to an expression. In *Æ*, expressions of Ty$_2$ are used to specify the denotations of the binary connectives *and* and *or*,

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[6] Church's own Logic of Sense and Denotation was meant to be a logic of the concept relation, e.g., the relation between an individual and a concept of that individual, an individual concept and a concept of that individual concept, a concept of an individual concept and a concept of that concept of an individual concept, and so on. Gallin's extension of Church's Simple Theory of Types would not have satisfied Church's own goals for a Fregean intensional logic. Church's intensional logic faced difficulties and was revised multiple times (Church 1951a, 1973, 1974, 1993). See also Parsons 2001 and Klement 2010.

[7] Basic Types: e for individuals, t for truth-values, s for possible worlds. Type assignments to variables: *x* is type e, *w* is type s, *p* and *q* are type <s,t>, *P* and *Q* are type <e,<s,t>>.

the quantifiers *some* and *every*, and of quantifier phrases like *every detective* and *some scholar*. *And* and *or* denote Schönfinkeled functions mapping pairs of propositions to propositions. The quantifiers denote Schönfinkeled functions mapping pairs of properties of individuals to propositions, and quantifier phrases denote functions mapping properties of individuals to propositions.

The second property that make Church's λ-calculus and its descendants corner stones for formal semantics is that they provide the technology for a theory of semantic composition in the spirit of Frege. In Æ, semantic composition proceeds via functional application in S2, S3, and S4, and by combining functions via a cross-categorial conjunction operation in S1.

Æ uses expressions of Ty_2 in the meta-language to name the intensions of basic and complex expressions. The possibility of this method of indirect interpretation via expressions of a typed λ-calculus was not what Church was talking about when he concluded that "the difference of a formalized language from a natural language lies not in any matter of principle, but in the degree of completeness that has been attained in the laying down of explicit syntactical and semantical rules and the extent to which vaguenesses and uncertainties have been removed from them." (1951b: 106) What Church had in mind was that natural languages are literally very much like formalized languages—guided by the same kinds of syntactic and semantic rules. The formalized languages Church was thinking of were languages that, like that of his Simple Theory of Types, minimize syncategorematic symbols, that is, symbols that are not assigned a type and do not have a meaning themselves, but only acquire a meaning as part of a larger expression. Minimizing syncategorematic notation was one of the most important steps towards aligning logical languages with natural languages. It was a goal Church explicitly stated for the Fregean theory of meaning he was after (1951b: 101).[8] It was also a goal the Polish logicians Leśniewski and Ajdukiewicz had been working towards, but hadn't quite achieved (Simons 2015).

In standard setups of the propositional or predicate calculus, the logical connectives and the quantifiers are introduced syncategorematically. In contrast, in Church's Simple Theory of Types and its descendants, the λ-operator and the two parentheses are the only "improper",

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[8] Church also mentions the possibility of eliminating the λ-operator and variables, following Schönfinkel and Curry: "By the methods of the Schönfinkel-Curry combinatory logic it may even be possible further to eliminate the abstraction operator, and with it the use of variables altogether." (Church 1951b: 108)

syncategorematic, symbols. To be completely faithful to Church, then, the Ty$_2$ formulas in the fragment $\mathcal{E}$ above should be understood as convenient abbreviations of formulas where the only syncategorematic symbols are the parentheses and the λ-operator. Binary connectives are represented as constants of type <<s,t>,<<s,t>,<s,t>>>, negation as a constant of type <<s,t>,<s,t>>. Most importantly for natural language semantics, the syncategorematic interpretations of the quantifiers is eliminated with the help of λ-abstraction. In $\mathcal{E}$, we would have a constant Π of type <<e,<s,t>>,<s,t>>, and understand $\ulcorner \forall x\; \alpha \urcorner$ as an abbreviation of $\ulcorner \Pi\,(\lambda x\; \alpha) \urcorner$. These abbreviations can be found in Ajdukiewicz (1935), Church (1940), Kemeny (1948, 1956), and Henkin (1950). For natural language semantics, forming predicates from sentences via abstraction is one of the most important techniques afforded by Church's λ-calculus. Lewis exploited this technique for the representation of quantifier constructions and quantifier scope ambiguities in "General Semantics".

I have reviewed some of the most successful ideas behind 20th-century logicians' attempts to align formalized and natural languages with each other. Those ideas are almost perfectly instantiated by Church's λ-calculus and its descendants. They consist in minimizing syncategorematic interpretations, providing names for intensions of all kinds, and tools for a theory of semantic composition in the spirit of Frege. By the time David Lewis and Richard Montague became interested in natural language semantics at UCLA, those tools were ready for the taking.

What turned out to be too simple-minded about the logicians' attempts to connect logic and natural languages was the format of the syntactic rules they were assuming. This format, which is illustrated by the rules of $\mathcal{E}$, is the syntax format you find in logic textbooks. It's also the format of Church's rudimentary sketch of syntactic rules for English in Church (1951b). And it's the format that Montague followed in painful detail in Montague (1970b, 1970c, 1973), with some detours for quantifier and relative clause constructions. Lewis departed from that script in *Convention* and "General Semantics". His background in linguistics made it possible for him to develop a vision for formal semantics within a model of grammar that was in line with the linguistic theories of his time. Lewis's vision was general and non-committal enough to be of

philosophical interest and survive the Linguistic Wars[9], but, in "General Semantics", it was also technical and worked-out enough to serve as a guide for how to do semantics within linguistics to the present day.

4. The makings of a semantic theory for natural language

David Lewis and Richard Montague began actively working on natural language semantics at roughly the same time. When Lewis arrived at UCLA in 1966, Montague had just returned from Amsterdam, where he had taught a seminar with Frits Staal on the philosophy of language. On the reading list were Quine's *Word and Object* (1960) and Chomsky's *Aspects of a Theory of Syntax*, which had appeared in 1965.[10] Those readings left a mark on Montague, as shown by the references to *Word and Object* in Montague (1970c, 1973) and the blistering attacks on Chomsky's work and transformational grammar in each of Montague's three papers on semantics (Montague 1970b, 1970c, 1973).

In 1968 Montague taught a seminar on natural language semantics at UCLA. Lewis and Barbara Partee sat in.

> And it was sometime in 1968 that David first put me onto Montague's work. I had seen Montague in some Philosophy Department colloquia, and knew of his sharp tongue but knew nothing of his work. David told me that Montague was starting to apply some of his work in logic and recursive function theory to the semantics of natural language. . . . In post-seminar discussions, David helped us greatly in deciphering the logic and appreciating the ideas. (Partee 2015: 329)

It would be wrong to think that natural language semantics was the only, even the main, interest Lewis and Montague had in common. Lewis had already attended Montague's 1967

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[9] On the Linguistics Wars, see Harris 1993. Harris's *The Linguistics Wars* "tells the story of the acrimonious schism, during the sixties and seventies, that divided the ranks of linguistics after the publication of Noam Chomsky's influential Aspects of the Theory of Syntax." (From the publisher's website https://global.oup.com/academic/product/the-linguistics-wars-9780195098341)

[10] Ivano Caponigro dates Montague's turn towards natural language semantics to his stay in Amsterdam (Caponigro 2021).

seminar, but there, their point of contact was Montague's work on modal logic and pragmatics. Lewis presented his work on counterfactuals in that seminar, and Montague acknowledged that work as "the first adequate treatment of the present subjunctive conditional" within the framework of pragmatics (Montague 1968: 117).

Lewis dedicated his book *Counterfactuals* (1973) to the memory of Richard Montague. Other non-language related work from Lewis's time at UCLA that makes a connection with Montague's papers on indexicality or modal logic includes "Anselm and Actuality" (1970b) and "Counterpart Theory and Quantified Modal Logic" (1968). After Montague's death, Lewis wrote to Frank Vlach that "Richard had gradually become a good friend. He was kind to us, and we enjoyed his company, to say nothing of the fact that he taught me a lot about philosophy."[11]

Lewis and Montague differed sharply in their views on natural language semantics. Lewis did not share Montague's hostility towards Chomsky and transformational grammar, and he did not think highly of Montague's own way of connecting syntax and semantics. In a letter to Terry Parsons from 1 September 1968, Lewis mentions Montague's "attempts" to work out a semantically interpreted grammar for English.

> You ought to find out about Richard Montague's attempts to do semantically interpreted grammars for English. He has done a fragmentary example; his semantics, like yours, is a referential semantics over all possible worlds. However, he despises the transformationalists for some reasons; so his syntax is like nothing you ever saw before.[12]

Lewis is franker and more outspoken in a letter to Barbara Partee of 12 November 1969.

> Montague's been reading *Aspects* and Jacobs & Rosenbaum, and claims he still hasn't the foggiest idea what a transformation is; I'd like to try to shut him up, though it's probably not a worthwhile thing for me to try to do. . . . Speaking of which: he's on the program for the APA-ASL meeting in New York, to do yet another, allegedly mostly new version of the

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[11] Lewis, Letter 15. To F. Vlach, 21 March 1971, in Beebee & Fisher 2020b: 26f.

[12] Lewis, Letter 549. To Terence Parsons, 1 September 1968, in Beebee & Fisher 2020b: 227. The work by Montague that Lewis is referring to is "English as a Formal Language" (1970c).

"English as a Formal Language" stuff. Having read a little transformational grammar, he says

he plans to lambaste it more than ever. I'd like to sic Postal or someone like that on him.[13]

As he was working towards a theory of natural language semantics, there was little Lewis could learn from Montague that went beyond Montague's unquestioned expertise in modal logic and pragmatics. As a student of Quine's, Lewis had a stronger background in the philosophy of language, and he was also well acquainted with generative linguistics.

Partee (2015) reports that, together with Gil Harman and herself, Lewis had taken a linguistics class in the summer of 1960 while all three of them were undergraduates at Swarthmore. The class was a seminar on Structural Linguistics, taught by the Polish logician and linguist Henry Hiż at the University of Pennsylvania. As far as Partee knows, that was Lewis's first introduction to Linguistics. After Swarthmore, Lewis went on to Harvard and did a PhD in philosophy with Quine. Partee went to MIT and did a PhD on syntax with Chomsky. As a graduate student working with Quine, David Lewis's major interest was the philosophy of language. According to Stephanie Lewis, metaphysics was not his main interest then (S.R. Lewis 2015). Partee (2015) writes that she got to know Lewis better during their time as graduate students in Cambridge. She took a class at Harvard with Quine, and Lewis came to Chomsky's lectures at MIT (Partee 2015, also S.R. Lewis 2015). By the time Lewis graduated from Harvard, he had written a dissertation in the philosophy of language and had learned first-hand about generative syntax.

When Lewis was revising his dissertation and had to find a way to connect utterances of natural languages to their intensions, he did not turn to Richard Montague. Montague is not mentioned in the acknowledgments of *Convention* and his name does not appear in the references of "Languages and Language" (1975b).[14] In the September 1, 1968 letter to Parsons, Lewis writes that he was delighted to receive Parsons's draft of his semantics for English, and that he had "been thinking along similar lines for about a year." He told Parsons that it was papers by Stenius, Davidson, and Vermazen, which all appeared in *Synthese* in 1967, that had

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[13] Lewis, Letter 554. To Barbara Partee, 12 November 1969, in Beebee & Fisher 2020b: 236.

[14] Montague's work cited in *Convention* is "Logical Necessity, Physical Necessity, Ethics, and Quantifiers" (1960), "That" (1959, with Donald Kalish), "On the Nature of Certain Philosophical Entities" (1969), and "Pragmatics" (1968).

convinced him that "transformational grammars should be interpreted by referential semantics over all possible worlds."[15] Lewis didn't need to be convinced about the role of intensional semantics in theories of meaning. He needed to be convinced about how to fit a theory of semantics and pragmatics into a model of grammar. The influence of all three papers Lewis mentioned to Parsons is manifest in *Convention* and "General Semantics".

The Stenius paper was "Mood and Language-Game" (1967). Lewis adopted Stenius's proposal to separate sentences into sentence radicals and indications of mood. Sentence radicals could then be associated with truth-conditions and moods could be linked to conventions of truthfulness. I will not be able to go into details about this important aspect of Lewis's work on language. I'd like to add though, that the demonstration in *Convention* that truth-conditional semantics could be linked to a theory of linguistic behavior and speech acts was considered a sensation within the circle of linguists I was part of as a student in Konstanz. Irene Heim, who had been an undergraduate at Konstanz, left Konstanz for the University of Munich to write a master's thesis in philosophy on the relation between truth-conditional semantics and speech act theory that directly took off from *Convention* (Heim 1977). She then wanted to do a PhD in philosophy with Lewis in Princeton, but Lewis informed her that he was no longer doing philosophy of language.

The Davidson paper Lewis mentioned was "Truth and Meaning" (1967). It's not that that paper inspired Lewis to embark on the Davidsonian program of semantics. Lewis clearly did not agree with Davidson's conclusion that it "behooves us then to rephrase our demand on a satisfactory theory of meaning so as not to suggest that individual words must have meanings at all, in any sense that transcends the fact that they have a systematic effect on the meanings of the sentences in which they occur." (Davidson 1967: 305) What intrigued Lewis about Davidson's paper must have been that it connects the work of Frege and Tarski to Chomsky, calling for a meeting of minds between philosophers, logicians, and linguists. Davidson thought, and Lewis seems to have concurred, that Chomsky and other linguists are "doing much to bring the complexities of natural languages within the scope of serious semantic theory." (Davidson 1967: 315)

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[15] Lewis, Letter 549. To Terence Parsons, 1 September 1968, in Beebee & Fisher 2020b: 226.

Frege's massive contribution was to show how "all", "some", "every", "each", "none", and associated pronouns, in some of their uses, could be tamed; for the first time, it was possible to dream of a formal semantics for a significant part of a natural language. This dream came true in a sharp way with the work of Tarski. It would be a shame to miss the fact that as a result of these two magnificent achievements, Frege's and Tarski's, we have gained a deep insight into the structure of our mother tongues. Philosophers of a logical bent have tended to start where the theory was and work out towards the complications of natural language. Contemporary linguists, with an aim that cannot easily be seen to be different, start with the ordinary and work toward a general theory. If either party is successful, there must be a meeting. Recent work by Chomsky and others is doing much to bring the complexities of natural languages within the scope of serious semantic theory. (Davidson 1967: 315)

Why would Davidson and Lewis think that the syntactician Chomsky, out of all people, might help with a serious semantic theory for natural languages? The attraction of Chomsky's view on grammar for semanticists and philosophers at the time was that it allowed more abstract syntactic structures as the input to semantic interpretation. There was an expectation that generative grammarians might come up with an abstract notion of logical form that was nevertheless empirically motivated and connected to surface representations in a systematic way. Chomsky's work made waves in philosophy at the time. He gave the John Locke lectures in Oxford in 1969, one year before Davidson.

The Vermazen paper Lewis mentioned (Vermazen 1967) is a review of two books: Katz and Postal's *An Integrated Theory of Linguistic Description* and Katz's *Philosophy of Language*. Katz and Postal's book subscribes to Chomsky's vision that the structures generated by syntax mediate between the phonetic and the semantic interpretation of a linguistic expression. While Chomsky himself dealt mainly with the integration of syntax and phonology, the emphasis of Katz and Postal's and Katz's books was on the integration of syntax and semantics. *Convention* and "General Semantics" leave no doubt that Lewis strongly disagreed with Katz's ideas about what meanings are. Katz took meanings to be expressions built from "semantic markers" representing conceptual elements. What Lewis found attractive about Katz's and Katz and Postal's work was their ideas about how meanings are projected from lexical items. These are the

projection rules he adopted in *Convention*. In a "rule-by-rule' interpretation system of this kind, meanings are composed in tandem with syntactic rules, as illustrated in *Æ* above.

In "General Semantics", Lewis took an important step beyond rule-by-rule interpretation systems. He eliminated rule-specific semantic composition rules altogether and pioneered a method for the compositional computation of meanings that is now known as "type-driven" interpretation. Like the grammar of *Convention*, the grammar in "General Semantics" separates a generative component from a representing component. But the generative component of "General Semantics" now has the shape of an Ajdukiewicz-style categorial grammar. There is an exact match between syntactic categories and the associated types of intensions so that all semantic composition amounts to functional application.

There is another theoretically important and distinctive property of Lewis's categorial grammar in "General Semantics". Its denumerable supply of individual variables comes with binders—λ-operators—one for each variable. Crucially, Lewis's λ-operators are not syncategorematic symbols. They have a syntactic category and are assigned intensions. Technically, this elimination of syncategorematic symbols is possible because Lewis's evaluation indices include an assignment coordinate for the interpretation of variables.[16] "General Semantics" thus quietly realized what logicians like Ajdukiewicz, Leśniewski, and Church had been striving for, but couldn't achieve (Simons 2015). It presented an interpreted formalized language that, except for the presence of variables and binders, looked very much like a natural language. It had eliminated all syncategorematic expressions. Lewis hoped that his categorial grammar could serve as the base component of a transformational grammar. Making the connection between the more abstract representations generated by his categorial grammar and surface representations for English was a task that Lewis left to experts knowing more about syntax, morphology, phonology, and phonetics than he did.

Given his linguistics background, Lewis's low opinion of Montague's attempts at natural language semantics is not unexpected. Montague's ideas about syntax and the connection

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[16] As Lewis explains in a letter to Peter Woodruff, the idea of treating assignments in the same way as worlds, times, speakers, and so on, goes back to Montague (1960). He also mentions that Montague's *Universal Grammar* treats variable assignments in parallel with worlds as coordinates of indices (Letter 20, 2 June 1971, in Beebee & Fisher 2020a: 35).

between syntax and semantics were amateurish. Despite controversy on many fronts, one of Chomsky's enduring and undisputed insights has been that the representations generated by syntax do not serve the exclusive needs of semantics.

> The generative grammar of a language should, ideally, contain a central syntactic component and two interpretive components, a phonological component and a semantic component. The syntactic component generates strings of minimally functioning elements . . . and specifies the categories, functions, and structural interrelations of the formatives and systems of formatives. The phonological component converts a string of formatives of specified syntactic structure into a phonetic representation. The semantic component, correspondingly, assigns a semantic interpretation to an abstract structure generated by the syntactic component. Thus each of the two interpretative components maps a syntactically generated structure onto a "concrete" interpretation, in one case phonetic, and in the other, semantic. (Chomsky 1964: 51f.)

If syntactic representations do not only guide meaning composition, but are also responsible for intricate phonological, morphological, and syntactic patternings, figuring out the architecture of the human language faculty becomes a complicated empirical puzzle that needs the expertise of specialists trained in the relevant fields.

Lewis had a favorable opinion of generative syntax, not the least because of his association with Barbara Partee from the time he was an undergraduate and throughout his years as a graduate student. In a letter to Gil Harman from 24 November 1970, Lewis says that Partee was the one transformational grammarian that he "would trust to give a fair, sympathetic, and thoughtful account of her opponents' views and of what is good about them." He also mentioned that he "often went to her for explanations of current disputes in linguistic theory," and that he considered that he was "well taught" by her. Later in the same letter Lewis emphasizes the importance of transformational grammar:

> … it seems that transformational grammar is contributing a great deal to human knowledge and understanding. I refer here not to the famous psychological and philosophical conjectures of some transformational grammarians (though these, too, have some interest) but rather to recent discoveries and hypotheses about language itself. We cannot understand the human

mind without understanding the phenomenon of language; and I cannot see how there is any possibility of understanding the phenomenon of language without taking some account of the work of the transformational grammarians.[17]

Lewis's *General Semantics* is a paper that would still feel current if read in an introductory semantics class today. There is nothing outdated or old-fashioned about it. The paper has a light touch, expressing deep thoughts in simple, undogmatic, language. When Lewis makes a concrete proposal, he also discusses and weighs alternatives. Some of the protagonists in examples and illustrations are pigs. There is cheering for Porky, and we meet the unforgettable family of generic pigs. Comparing the style of "General Semantics" to the over-technical papers of Montague brings to mind Stephanie Lewis's report that Lewis used to cite Carl G. Hempel with approval: "it adds neither to the rigor of the argument nor the clarity of the exposition to say that a man M crossed the street S." (S.R. Lewis 2015: 11)

5. Final thoughts

I have traced the major influences on David Lewis's work in formal semantics and have placed it in its historical and contemporary context. The rich history of logic-inspired formal semantics for natural language earlier in the 20th century, the importance of Chomskyan syntax for semantics and the philosophy of language in the sixties, and Lewis's original contributions have not been properly recognized to the present day. The death of Richard Montague on March 7, 1971 robbed us of Montague's future work. It also robbed us of an accurate history of semantics. Shock about Montague's murder and concern about his legacy led to the creation of a founding father myth where formal semantics didn't evolve like other disciplines, but was fathered by a single man and sprang from a single mind.

Like David Lewis's other work in semantics, his foundational work on the relation between syntax and semantics lives on. It lives on, I believe, because Lewis went for ideas that could solve a theoretical puzzle in a principled way, regardless of where they came from and how they were packaged. His recently published correspondence lets us be witnesses to the formation of his views on semantics. Lewis was inspired by philosophers as different as Erik

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[17] Lewis to Gilbert Harman, 24 November 1970 (David Lewis Papers, C1520, 'Partee, Barbara', Box B-000672, Folder 8, Princeton University Library). Thanks to Anthony Fisher for discussion.

Stenius, Donald Davidson, and Jerrold Katz. He did not share their broader philosophical inclinations. With Stenius, it's the idea of separating sentence radicals from moods that caught his attention. In Stenius's paper, the idea comes bundled with Wittgenstein's language games. Lewis repackaged it with his theory of convention. Davidson's "Truth and Meaning" (1967) made a pitch for the viability of a truth-conditional theory of meaning for natural language, and included the surprising suggestion that Chomsky's transformational grammar may actually help with such a theory. Lewis did not sign on to the Davidsonian program of semantics. He went for a referential semantics over possible worlds. He stood with Davidson, though, when he took the bold step of considering the possibility that the input for semantic interpretation in a grammar are syntactic structures that may not be identical to the structures that are pronounced. The most unexpected influence on Lewis came from Katz. Lewis fiercely resisted Katz's ideas of what meanings are. Yet he was convinced by Katz's and Katz and Postal's ideas of how meanings—whatever they are—are compositionally computed from syntactic structures that mediate between semantics and phonology.

Lewis's ideas on formal semantics live on, not under a particular brand name, but as part of how we do semantics every day. Lewis taught us that it pays to hunt for ideas that solve a theoretical puzzle in a principled way.[18]

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