philosophies

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Richard Montague's Turn Towards Natural Language

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Abstract

Richard Montague (1930–1971) is known as a founding figure of natural language semantics, i.e., the formal study of the semantics of natural languages by means of tools from mathematical logic. Less well known is that Montague maintained a strongly skeptical view on the possibility of a systematic logico-philosophical analysis of natural language for most of his short life, adhering to the then-common belief that natural languages are fundamentally different from the languages of logic. Completely unknown, until now, has been how Montague underwent a 180-degree turn in the last few years of his life, in the late 1960s, and pioneered a precise formal analysis of the syntax and semantics of fragments of English in three seminal papers that established the research framework, the methodology, and the formal tools for the new field of study. I provide a precise and documented answer to when, where, and how Montague's intellectual turn occurred and how it relates to Montague's previous research interests and work.

Keywords: Richard Montague; Montague Grammar; natural language semantics; natural language; intensional logic; Chomsky; Quine; Frits Staal

In memory of
Anita Burdman Feferman (1927—2015) and
Solomon Feferman (1928—2016)

1. Introduction

Richard Montague (1930–1971) is known as a founding figure of natural language semantics, i.e., the formal study of the semantics of natural languages by means of tools from mathematical logic. Less well known is that Montague maintained a strongly skeptical view on the possibility of a systematic logico-philosophical analysis of natural language for most of his short life, adhering to the then-common belief that natural languages are fundamentally different from the languages of logic. Completely unknown, until now, has been how Montague underwent a 180-degree turn in the last few years of his life, in the late 1960s, when he became convinced that "[t]here is [. . .] no important theoretical difference between natural languages and the artificial languages of logicians" ([1], p. 373) and pioneered a precise formal analysis of the syntax and semantics of fragments of English in three seminal papers that established the research framework, the methodology, and the formal tools for the new field of study.[1]

Academic Editor: Glyn Morrill

Received: 3 January 2026
Revised: 10 February 2026
Accepted: 12 February 2026
Published: 26 February 2026

My research findings for a forthcoming intellectual and personal biography of Montague [9][2] provide a precise and documented answer to when, where, and how Montague's intellectual turn occurred and how it relates to Montague's previous research interests and work. I summarize these findings in this paper for an audience already somewhat familiar with Montague's work and natural language semantics, while the biography is written for a broader audience and proceeds more gradually, without presupposing any formal background.

The paper is structured as follows. Section 2 first outlines Montague's intellectual background, interests, and work that preceded the turn, to then highlight the sudden, radical turn itself in Montague's own words. Section 3 describes Montague and the academic world around him immediately before the turn. Section 4 examines in detail how, where, and when the turn took place. Section 5 first traces how Montague developed his new research program about natural language semantics from the turn until his death, to then briefly sketch the immediate impact of his new research framework on philosophers and especially linguists who were interested in natural language semantics. Section 6 concludes.

2. A Sudden, Radical Turn

Montague studied philosophy and mathematical logic at the University of California at Berkeley from 1948 to 1954, under the supervision of Alfred Tarski (1901–1983), one of the towering figures of 20th century logic. He then joined the philosophy department at the University of California Los Angeles (UCLA) in January 1955, at age 24, and advanced through an unusually fast academic career. At the time of his violent death at age 40 on 7 March 1971, Montague was the highest-ranked and best-paid faculty in the department, on a par with Alonzo Church (1903–1995), another towering figure of the 20th century logic, who was 27-years his senior and had been Alan Turing's advisor at Princeton.

For most of his career, Montague worked on developing set theory and his "intensional logic", which he then applied to various areas of philosophy, as the appropriate tools to conduct any kind of philosophical investigation. He explicitly states this in *On the nature of certain philosophical entities* [10], a paper published in 1969 but conceived between the end of 1966 and the beginning of 1967:[3]

> It has for fifteen years been possible for at least one philosopher (myself) to maintain that philosophy, at this stage in history, has as its proper theoretical framework set theory with individuals and the possible addition of empirical predicates. [. . .]
>
> Philosophy is always capable of enlarging itself; that is, by metamathematical or model-theoretic means—means available within set theory—one can "justify" a language or a theory that transcends set theory, and then proceed to transact a new branch of philosophy within the new language. It is now time to take such a step and to lay the foundations of intensional logic. ([10], pp. 165–166)

In this paper, Montague applies his theoretical framework to investigate the nature of philosophical entities like events, tasks, pains, and obligations. Previously, he had made use of it to discover the epistemic puzzle now known as the "Paradox of the Knower" by providing its logical formulation ([11]; see [12] for a recent discussion), to highlight the differences between the notion of necessity in logic, physics, and ethics [13], to formulate a logical analysis of the notion of determinism in physics [14], and to logically prove the fallacy of Hempel and Oppenheim's notion of scientific explanation [15]. Back in the late 1950s, Montague had also written a short paper with his then-friend and department colleague Don Kalish on some paradoxes generated by clauses introduced by *that* [16].

https://doi.org/10.3390/philosophies11020025

Their attitude towards natural language (for which they use the label “ordinary language") was common among logicians and philosophers of that time:

> The difficulties [“which have concerned philosophers of language”] arise when systems of formal logic are applied to ordinary language, and consist in the apparent failure, in this context, of certain presumably valid rules of inference. ([16], p. 54)

The solution was to “regiment” natural language and make it closer to logic, with the usual problematic consequence that this attempt would fail to fully capture natural language, as stated in the very last sentence of the paper:

> It remains to extend our analysis in such a way as to combine the virtues of the present treatment with a closer conformity to ordinary usage. ([16], p. 61).

Six years later, in 1964, Montague—again together with Kalish—made an even stronger claim against studying natural language. It appeared at the beginning of their well-regarded textbook *Logic: Techniques of Formal Reasoning* [17], an introduction to logic based on their almost one-decade-long experience creating and teaching a logic-course sequence for UCLA undergraduate students:

> [The] systematic exploration of the English language, indeed of what might be called the ‘logic of ordinary English’, [. . .] would be either extremely laborious or impossible. In any case, the authors of the present book would not find it rewarding. ([17], p. 10)

It is therefore even more surprising that only three years later Montague radically changed his opinion on natural language. In August 1967, at a symposium in Amsterdam, Montague claims that there is no substantial distinction between natural language and formal language. At the same time, he reveals that he is working together with his student Johan Anthony Willem “Hans” Kamp (born in 1940), who was at the symposium as well, on an actual, formal, and precise analysis of a significant fragment of English:

> I deplore the distinction customarily drawn [. . .] between formal and informal languages. The syntax and semantics of certain not insignificant fragments of English can be treated just as formally and precisely as those of the first-order predicate calculus, and in very much the same manner. No adequate treatment of this sort has yet been published; one has, however, been recently developed by my student J. A. W. Kamp and myself. ([18], p. 274)[4]

One year later, in 1968, Montague presents the first results of his announced treatment of the syntax and semantics of English in a talk in Vancouver in July and another one in Milan in October. The latter was then turned into his famous first paper on natural language, *English as a formal language* (aka *EFL*) [19], whose very first sentence unambiguously states Montague’s new take:

> I reject the contention that an important theoretical difference exists between formal and natural languages. ([19], p. 189)

Montague repeats the same point the following year, in 1969, as the incipit of his second paper on natural language, *Universal grammar* (aka *UG*) [1]:

> There is in my opinion no important theoretical difference between natural languages and the artificial languages of logicians. ([1], p. 373)

Just a few months before his death, in the fall of 1970, Montague proudly states his accomplishments to then further develop them in his very last paper, *The proper treatment of quantification in Ordinary English* (aka *PTQ*) [20]:

> Suppes [. . .] claims [. . .] that "at the present time the semantics of natural languages are less satisfactorily formulated than the grammars . . . [and][5] a complete grammar for any significant fragment of natural language is yet to be written." This claim would of course be accurate if restricted in its application to the attempts emanating from the Massachusetts Institute of Technology, but fails to take into account the syntactic and semantic treatments proposed in Montague (1970a and 1971).[6] Thus the present paper cannot claim to present the *first* complete syntax (or grammar, in Suppes' terminology) and semantics for a significant fragment of natural language [.] ([20], p. 221; italics in the original)

What happened to Montague in the mid-1960s that brought him to radically change his attitude towards natural language and to decide to make natural language a central object—if not the central object—of his research interests? My investigation and findings have allowed me to conclude that Montague's turning point can be precisely identified in terms of space, time, and even modality.

Montague spent the first half of 1966 in Amsterdam on sabbatical leave. There he taught a graduate seminar on philosophy of language centered on the discussion of two recent books: W.V.O. Quine's *Word and Object* [21], which had appeared in 1960, and Noam Chomsky's *Aspects of the Theory of Syntax* [22], published just a few months earlier, in 1965. By the end of the seminar, Montague seems to have felt he could "do better"—a feeling that, according to friends and colleagues, had triggered several of his previous projects. Montague may have felt that Chomsky's skepticism towards a semantic for natural language was unjustified once a different formal framework had been adopted to study natural language, a formal framework in which syntax and semantics would be strictly intertwined, neither possible without the other—Montague's intensional logic. As for Quine, Montague may have felt that the logical analysis that his esteemed colleague was applying to natural language could be substantially improved by using Montague's intensional logic. Also, both Chomsky (born in 1928) and Quine (1908–2000) were already leading figures in their respective fields, Chomsky two-years Montague's senior, while Quine 22-years. This may have been a further incentive for Montague, who loved recognition, to follow his feelings that he could do better than such important figures.

The next sections unpack this turning point by providing further details, including what preceded it and what followed it.

3. Before the Turn

The fall semester of 1965 was probably Montague's most difficult period since he had moved to Los Angeles more than ten years earlier. Tensions with his colleagues in the UCLA philosophy department had reached a new peak—becoming known even outside the department—and former close friends like his department chair Don Kalish had turned into potentially dangerous enemies. Months before, Montague had accepted an academic invitation to spend the spring semester of 1966 in Amsterdam. It was a much-needed break in a place he had already enjoyed four years earlier. "Best wishes for a pleasant spring in Amsterdam. It will be a good antidote for what you have been through!"—his former teacher and now friend and colleague Benson Mates (1919–2009) wrote from Berkeley right before his departure.[7] Neither Mates nor Montague himself could have imagined what was about to begin in Amsterdam: the discovery of a major research interest, the birth of a new field of studies, and the beginning of the intellectual contribution for which Montague would be principally remembered in the decades to come.

At the same time, the fall semester of 1965 was also when several positive developments occurred or began that would shape Montague's linguistic turn over the following years. Barbara Partee (born in 1940) arrived at UCLA right after receiving her Ph.D. in

linguistics at MIT under Noam Chomsky's supervision. She was a new hire of what would become the department of linguistics the following year. Montague's new student Hans Kamp arrived from Amsterdam. Montague and Kamp had met during Montague's previous sabbatical in 1962 and had impressed each other. Kamp had impressed Montague as a uniquely bright student, while Montague had impressed Kamp as a uniquely bright scholar. That initial impression will then turn into a close intellectual interaction and friendship until Montague's death. The logician Arthur Prior (1914–1969), the father of tense logic, was visiting UCLA as Flint Professor of Philosophy in the fall of 1965. Kamp attended Prior's upper division course on Tense Logic, whose lecture notes would be then developed into Prior's book *Past, Present and Future* [23] a couple of years later. This course and the interaction with Prior inspired Kamp for his dissertation on tense logic [24], which was supervised by Montague.[8] Montague couldn't attend Prior's undergraduate course since he was teaching his own undergraduate course at the very same time, but he attended the other course Prior taught—a graduate seminar on objects of thought, in which Prior presented chapters from the book he had started working on in 1964.[9] Prior also interacted with another of Montague's students, Nino Cocchiarella (born in 1933), who was about to file his dissertation on tense logic [27]. Prior would later refer to them as "California tense-logicians" when he discusses their findings in his book ([23], pp. 56–57). In the fall of 1965, despite being extremely busy, Montague managed to spend many hours each week in the UCLA Language Center to improve on his Dutch.[10] (Montague had studied Arabic and French extensively, German, Greek, Latin, Spanish, and to a lesser degree Hebrew and Polish in high school and/or college).

Montague went to Amsterdam at the invitation of the mathematician and logician Arend Heyting (1898–1980) and the philosopher and linguist Johan Frederik "Frits" Staal (1930–2012), who he had met in his previous sabbatical in Amsterdam in the fall of 1962. Heyting and Staal asked Montague to teach two courses and be the temporary Director of the Institute for Foundational Research at the University of Amsterdam. It was a great honor. Evert Beth (1908–1964), the leading logician in Amsterdam and the first to hold a chair in logic in The Netherlands, had founded the institute and had directed it until his premature death in 1964. The Polish logician Andrzej Grzegorczyk (1922–2014) had temporarily replaced him in the fall of 1965, while the U.S. logician Haskel Curry (1900–1982) would take over as the permanent Director starting in the fall of 1966. Curry had been contacted, together with other leading logicians, by Heyting and Staal in 1964 to ask for suggestions for Beth's replacement. Curry mentioned Montague first among the several candidates from the U.S. he suggested:

> I consider him one of the best logicians in the world from the standpoint of philosophy; that is, he is one of the strongest contributors to mathematical logic who is officially rated as a philosopher. I understand he has a very desirable appointment at Los Angeles and he may be difficult to move.[11]

4. A Seminar That Triggered a Major Change

Montague taught two courses in Amsterdam, primarily between February and March. They were both graduate courses that met once a week.[12] One was a seminar on *Gödel theory and its generalizations*, held on Monday from 2 to 5 p.m., beginning on January 31. It resembled the graduate course on metamathematics he had taught at UCLA the previous semester.[13] The references listed in the syllabus are the last chapter of Quine's *Mathematical Logic* on Gödel's incompleteness theorem and Tarski's indefinability theorem and the 1953 monograph *Undecidable Theories* by Tarski, Mostowski, and Robinson [28]. The latter concerned theories "for which no effective step-by-step procedure can be found to tell whether or not a statement is provable from its axioms." ([29], p. 192). The students who

attended it—no more than ten—felt that the seminar was above their heads and Montague's interests were more geared towards the details of the complicated formalism rather than towards students' understanding and grasping the broader picture. Still, Montague was friendly. He often proposed to the students to go for drinks at a nearby terrace after class and spent time talking to them.[14]

The other course, instead, was completely new and would trigger a major broadening of Montague's research interests. It had initially been planned as another graduate course on logic. Staal came up with the suggestion to replace it with a seminar on philosophy of language that Montague and he would co-teach until February 20, when Staal left for a two-month trip to India.[15] The seminar met on Wednesday from noon to 2 p.m. It began on Wednesday January 26, just one day after Montague had landed. Unlike the other course, it was geared more towards philosophers and linguists than logicians. It was announced as centered around Quine's best-known book *Word and Object* [21] and some unspecified "other topics". Montague admitted in a letter to Staal that he had not yet read *Word and Object*, "although it concerns things in which I am much interested and I cannot think of a better choice for such a seminar."[16] The "other topics" would turn out to be Chomsky's newest book *Aspects of the Theory of Syntax* [22].

4.1. Chomsky's Challenge

Unlike *Word and Object*, Montague was familiar with *Aspects*. He had started reading it in the fall of 1965 and immediately recommended it enthusiastically to his student Hans Kamp. A few weeks later, Montague had completely changed his opinion, as Kamp remembers vividly:

> I had just arrived as a graduate student in the Philosophy Department. When we ran into each other outside the Department Office, Montague told me that he had just started to read Chomsky's *Aspects* and thought it was really wonderful in its methodological clarity. I should absolutely read it. Then, another two or three weeks later—I hadn't managed to get started with the book yet—he mentioned *Aspects* to me again, saying that yes, he had recommended the book to me, but that was just on the basis of what he had seen at that point—just Ch. 1, or maybe Ch. 2 too (which, was never fully clear to me)—and that the book [became] terrible when one read on, that after the lofty methodological principles at the outset there was nothing of real substance to follow and instantiate them; and that reading the book was a complete waste of time. (So I didn't read the book, for a very long time.) That, as far as I can see, was when and where Montague's implacable contempt for Chomsky originated.[17]

In Amsterdam, Montague was likely to be lecturing on Chomsky's work for the first time. Staal, instead, had been interested in Chomsky and his theory of grammar early on, under the influence of Evert Beth, Staal's mentor and the leading Dutch logician, who had introduced and defended Chomsky's main ideas in Amsterdam and Holland since Chomsky's first groundbreaking book *Syntactic Structures* in 1957 [30]. Maybe it was Staal who suggested to Monague to read *Aspects* in the fall, even before they decided to discuss it in their seminar. Here is how Henk Verkuyl (born in 1938), one of the students who attended the seminar, remembers it:

> Staal together with Montague [...] sat next to each other, and the lecture was, at that time, *Aspects of the Theory of Syntax*, which was very popular, and it was all the people could see, and Staal was in favor of that [...]. They analyzed a sentence [like] *The man walked around the corner* [...] And so they discussed the Verb, they discussed the Subject Noun Phrase, and they discussed the Directional Phrase—*around the corner*—Prepositions, etcetera, and the Tense, it was in the past

> tense, etcetera. What then happened was that Staal explained how this would be treated and analyzed in terms of *Aspects*, and Montague, he explained himself, on the blackboard. He was not good at talking. [. . .] So, he wrote formulas, and it went on and on. I think that the role of Staal was to translate what happened on the blackboard to us.[18]

Aspects summarizes Chomsky's radically new view of linguistics and proposes detailed solutions to major syntactic problems. It contains several claims that probably captured Montague's attention since he would later directly or indirectly mention and often criticize them in his own work on natural language. Chomsky argues that earlier linguistics has not provided a fully detailed rule-based formal system describing Universal Grammar—those aspects of human language that all languages share because of shared innate human cognitive and biological endowment.[19] Traditional linguistics focused on describing peculiarities and exceptions that distinguish languages rather than commonalities that unify them. One crucial aspect that is common to all languages is their "creativity": each human language can produce a potentially infinite number of sentences and other complex expressions from a finite set of words and rules. Although the creative dimension of human languages had been noticed and discussed at least a couple of centuries earlier, Chomsky highlights that previous linguistic theories did not focus on creativity and did not have the formal tools to handle it:

> But the fundamental reason for this inadequacy of traditional grammars is a more technical one. Although it was well understood that linguistic processes are in some sense "creative," the technical devices for expressing a system of recursive processes were simply not available until much more recently. In fact, a real understanding of how a language can (in Humboldt's words) "make infinite use of finite means" has developed only within the last thirty years, in the course of studies in the foundations of mathematics. Now that these insights are readily available it is possible to return to the problems that were raised, but not solved, in traditional linguistic theory, and to attempt an explicit formulation of the "creative" processes of language. There is, in short, no longer a technical barrier to the full-scale study of generative grammars. ([22], Ch. 1, § 1.1)

A simple example of what Chomsky is referring to is provided by "clause embedding"—the property that human languages exhibit to allow for a clause to be part of a larger clause. The clause *Richard fainted* can be embedded inside the clause *Bob said Richard fainted*, which in turn can be embedded inside the clause *Don knows Bob said Richard fainted*, which can be embedded inside a clause like *Veronica claims Don knows Bob said Richard fainted* and so on. English grammar allows for this process to go on infinitely and create a potentially infinite number of clauses. This is similar to the set of natural numbers: each natural number is finite, but there is no largest one, and the set of all of the natural numbers is infinite. We need a "recursive" rule to capture this property of human language. A "phrase structure rule" is the kind of formal rule introduced in *Syntactic Structures* that can handle the recursive nature of natural language, as shown in (1):

(1) $S \longrightarrow NP\ V\ S$

Montague must have felt intellectually at home while reading all this. His formal training in logic and mathematics had made him familiar with recursion and ways of capturing an infinite number of outputs out of finite sets of devices. Also, Chomsky's claim that intrinsic properties of human language could only be captured by adequate formal tools fully resonated with Montague's overall goal to develop logic as the tool to investigate and understand many—if not all—areas of knowledge, including areas that, like language, concerned human capacities. While in Amsterdam, Staal asked Montague to write a brief

letter to explain to Staal's department colleagues and the university administrators the need for more logic and more logicians in the philosophy department at the University of Amsterdam:

> On historical grounds, on the basis of contemporary applications, and in view of potential applications logic has to be regarded as a branch of philosophy and indeed an important one; and a philosophical education that does not include thorough training in logic must be considered unbalanced. In the light of the current status of philosophy I should suggest that at least one-fourth of the requirements at any stage in a philosophy program be devoted to logic. This is the situation in my home department of philosophy at the University of California at Los Angeles, and I believe at Harvard, the University of California at Berkeley, and several other major American universities. Yale is at present engaged in enlarging its logic program.
>
> I have my own ideas as to the nature of a good logic program, but it would be pointless to express them here. The exact nature of the courses and examinations required of the students should be worked out in consultation with Professor Curry, who will be primarily responsible for the program. (Let me only emphasize my agreement with Professor Grzegorczyk that some way should be found to make regular exercises obligatory.) The important thing at this stage is to reserve sufficient space in the total pattern of requirements.
>
> By logic I mean what is sometimes called symbolic logic (including, among other things, set theory and metamathematics), and I use the term in such a way as not to include the independently interesting discipline of philosophy or methodology of science. I also do not mean to include Aristotelian logic, Stoic logic, and the like, which represent important stages of the development of modern logic, but belong now to the history of philosophy.[20]

Something else in Chomsky's work may have also intrigued Montague. As we saw in § 2, in 1964 Montague was still endorsing logicians' common view about natural language: the study of the logic of English would be "extremely laborious or impossible". One of the main reasons behind this pessimistic conclusion was the lack of a formal and complete rule-based system for describing which sentences are possible in a natural language and which are not, unlike what logicians and mathematicians are used to doing for logic or other formal languages. Chomsky, instead, was arguing that such a system could be formulated for natural language too, by means of phrase structure rules and other formal devices, and its precise definition should become the main goal of linguistics.

Aspects also discusses the role of semantics in linguistic theory, recognizing the lack of a fully developed semantic theory and highlighting some open issues:

> It is quite apparent that current theories of syntax and semantics are highly fragmentary and tentative, and that they involve open questions of a fundamental nature. Furthermore, only very rudimentary grammatical descriptions are available, for any language, so that no satisfactory answers can be given for many factual questions. Consequently, the problem suggested by the title of this section [*Degrees of grammaticalness*] can, for the present, be at best a source for speculation. ([22], Ch. 4, § 1.1, first paragraph)
>
> In general, one should not expect to be able to delimit a large and complex domain before it has been thoroughly explored. A decision as to the boundary separating syntax and semantics (if there is one) is not a prerequisite for theoretical and descriptive study of syntactic and semantic rules. On the contrary, the problem of delimitation will clearly remain open until these fields are much better understood

> than they are today. Exactly the same can be said about the boundary separating semantic systems from systems of knowledge and belief. That these seem to interpenetrate in obscure ways has long been noted. One can hardly achieve significant understanding of this matter in advance of a deep analysis of systems of semantic rules, on the one hand, and systems of belief, on the other. Short of this, one can discuss only isolated examples within a theoretical vacuum. It is not surprising that nothing conclusive results from this. ([22], Ch. 4, § 1.2, last paragraph)

When Chomsky talks about semantics and semantic rules, he has in mind the issues related to sentences like his famous *Colorless green ideas sleep furiously* from *Syntactic Structures*. This string of words sounds like a fully "grammatical" sentence of English, although meaningless. In other words, it does not violate any rules of English syntax. Compare it with the string of the same words but in the reverse order: *Furiously sleep ideas green colorless*. The latter is both meaningless and ungrammatical. Clearly, the anomaly of *Colorless green ideas sleep furiously* is not a syntactic/grammatical one, but a semantic one. How could this be explained? Each word is stored in our lexicon—the areas of our mind/brain where information about lexical items is preserved—as a set of various "features" or pieces of information: from the way the word is pronounced to its morphological and syntactic properties all the way to its meaning. Chomsky proposes that each word comes with its own "semantic features"—specifications of basic semantic properties that word has. For instance, a word like *idea* will be stored in our mind/brain with features like [+abstract] and [−abstract], among many others, meaning that we speakers know that *idea* refers to some entity that is abstract and is not animate. A word like *green*, instead, will be [±abstract], a short way for saying that *green* is unspecified as far as animacy is concerned, since we speakers know that both animate and inanimate entities can be green, like frogs and emeralds. *Green* will also be [−abstract], since we speakers know that abstract entities don't have colors. Chomsky thinks that semantic features on a word have to match those of the other words it is combined with by the syntactic structure it is part of. If these semantic "matching rules" are violated, the sentence sounds awkward. *Green* and *idea* occur in the same NP *colorless green ideas* as in the sentence above: *ideas* acts as the core element of the NP—the noun, while *green* is its closest adjectival modifier. The "semantic rules" impose full feature-sharing, but those two elements don't share the same features. As we just saw, *green* is [−abstract], while *idea* is [+abstract]. Therefore, semantic matching rules are violated and the whole sentence sounds awkward. *Colorless green ideas sleep furiously* contains many such violations.

Chomsky's view of semantics in *Aspects* was essentially the same as the one he had conveyed in *Syntactic Structures*—syntax and semantics are two independent dimensions of language that are governed by different principles:

> A serious discussion of [. . .] the question of dependency of syntax on semantics, awaits a development of the theory of universal semantics, that is, an account of the nature of semantic representation. Although various positions about these questions have been stated with great confidence and authority, the only serious work that I know of on the relation of these domains is that of Katz, Fodor, and Postal [. . .]. For the moment, I see no reason to modify the view, expressed in [*Syntactic Structures*] and elsewhere, that although, obviously, semantic considerations are relevant to the construction of general linguistic theory (that is, obviously the theory of syntax should be designed so that the syntactic structures exhibited for particular languages will support semantic interpretation), there is, at present, no way to show that semantic considerations play a role in the choice of the syntactic or phonological component of a grammar or that semantic features (in

> any significant sense of this term) play a role in the functioning of the syntactic or phonological rules. Thus no serious proposal has been advanced to show how semantic considerations can contribute to an evaluation procedure for such systems or provide some of the primary linguistic data on the basis of which they are selected. ([22], Ch. 3, fn. 15)

Chomsky's MIT colleagues Jerrold Katz, Jerry Fodor, and Paul Postal had just begun developing the theory of semantics Chomsky was referring to. It was based on semantic features assigned to individual lexical items and on rules that combined these features in parallel with the way syntax combined the same lexical items into larger units or phrases. In this way, they could systematically derive the ambiguity of a sentence like *Richard went to the bank* from the lexical ambiguity of the word *bank*—a financial institution or the land alongside a river or a lake [31].

The only other form of ambiguity they considered was syntactic. *Bob saw a friend with binoculars* has two meanings because it has two different syntactic structures. When the Preposition Phrase (PP) *with binoculars* directly combines with the noun *friend* as part of the NP *a man with binoculars*, the sentence means that Bob saw a friend who was carrying binoculars. On the other hand, when the PP *with binoculars* combines with the VP *saw a friend*, the sentence means that Bob saw a friend by means of binoculars. They were also concerned with accounting for semantic intuitions like synonymy—the fact two sentences that are different in their wording and syntactic structures may nonetheless convey the same meaning. *Frits hosted Richard* and *Richard was hosted by Frits* is a typical example of a pair of synonymous sentences with the former in the so-called "active form" and the latter in the so-called "passive form".

4.2. What Semantics Is Really About

Montague must have nearly fallen off his chair reading Chomsky's passages above. Neither Chomsky nor his MIT colleagues seemed to pay attention to, or even be aware of, other well-known kinds of ambiguities such as "ambiguity of scope" and "opacity." Logicians deeply cared about them, instead. Chapter 4 of Quine's *Word and Object* dedicates several pages to those ambiguities. Interestingly, Chomsky was lecturing on *Word and Object* in those years, but was asking Barbara Partee and the other students in his new linguistics graduate program at MIT to read only the first two chapters, in order to criticize Quine's endorsement of behaviorism.[21] Let's briefly touch on ambiguity of scope and opacity. The sentence *Every doctor visited a patient* can be interpreted as true in a situation in which every doctor visited at least one possibly different patient or in a situation in which there's a single special patient who every doctor took care to visit. Notice that if we change one of the two NPs, the ambiguity may disappear. For instance, *Every doctor visited the patient* is not ambiguous. Second, the sentence *Each thing that glisters is not gold*[22] is true in a situation in which no things that glister are gold or in a situation in which not everything that glisters is gold. If negation is removed, the resulting sentence is not ambiguous: *Each thing that glisters is gold*. These are examples of scope ambiguities. Unlike the ambiguities the MIT scholars focused on, they do not contain words that are ambiguous nor have more than one syntactic structure each. Their ambiguity is triggered by the way the meaning of a certain kind of NP interacts with the meaning of a different kind of NP or the meaning of negation. Last, let's look at an example of opacity ambiguity. The sentence *Richard is looking for a friend* can be true in two very different situations: if Richard has a specific friend in mind and is looking for her or if Richard doesn't have a specific friend in mind and is just looking for any friend. The sentence is, therefore, ambiguous. Its ambiguity depends on its verb: *look for*. If the verb is changed to *write to*, the resulting sentence is no longer

ambiguous. *Richard is writing to a friend* can only be true if Richard has a specific friend in mind and is writing to her.

In Montague's eyes, Chomsky and his MIT colleagues were guilty of an even worse sin: they did not mention—let alone deal with—the empirical pillars, the core facts that any respectable semantic theory had to be able to account for, according to Montague: truth and entailment. Declarative sentences (aka "statements") are associated with the intuition that they are true or false under given circumstances. For instance, if Bob utters *Richard fainted*, this sentence will be true if and only if the person named Richard is among those who fainted before Bob uttered the sentence. If these conditions are not satisfied, our intuitions are that the sentence is false in those circumstances. One or more declarative sentences that are asserted as true can also trigger the intuition (entailment) of the truth of one or more sentences that haven't been asserted at all. If we know that the sentence *Richard fainted* is true, then we know for sure that the sentence *Somebody fainted* is true as well, while we do not feel the same certainty about the truth of a sentence like *Everybody fainted*. In other words, in any situation in which we can think of *Richard fainted* as true, then we also have to think of *Somebody fainted* as true as well. Logicians say that *Richard fainted* entails *Somebody fainted* or, put another way, *Richard fainted* has *Somebody fainted* as one of its logical consequences.

Truth and entailment had been core notions for natural and artificial languages for Montague since the very beginning of his training as a logician in Berkeley. He had written an entire logic textbook with Kalish to show which arguments are valid, that is, under which "rules" the truth of some sentences ("premises") entails the truth of other sentences ("conclusions"). Chomsky and his acolytes were on the wrong track in handling meaning in natural language. He could definitely do better than them, Montague must have thought.

4.3. Beyond Quine, and Russell Too

Word and Object [21] felt more like home for Montague. Quine's book exhibited the usual investigative strategy of logicians working on natural language in those years. Let's briefly examine this to better appreciate the change Montague would introduce with his own work later. Logicians (including philosophers of language within the so-called analytical tradition) focused on specific constructions in natural language and translated them into expressions of some logical language whose interpretation was precisely defined. A classic example is the way they analyzed the meaning of a sentence like *Every logician is fallible* and the meaning of a sentence like *Quine is fallible*. The two sentences share the same simple syntactic structure, which can be described by the phrase structure rule in (2):

(2) $S \longrightarrow NP\ VP$

Despite their syntactic identity, logicians assigned very different interpretations to the two sentences. *Quine is fallible* asserts that the individual referred to by the name *Quine* (q) has the property of making mistakes (F), as in (3):

(3) *Quine is fallible* $\rightsquigarrow F(q)$

On the other hand, *Every logician is fallible* asserts something very different: it states that for every logician (L) one might consider, that logician has the property of being fallible (F), as rendered in the logic translation in (4):

(4) *Every* logician *is fallible* $\rightsquigarrow \forall x\ [L(x) \longrightarrow F(x)]$

In (3), the NP *Quine* refers to a specific person, while in (4) the NP *every logician* does not refer to anything. Instead, the quantifier *every* imposes a relation ("quantifies") over two sets—specifically, the subset relation. Logicians took this mismatch about syntax and semantics as another instance of what they took to be the "illogicality" of natural language with the consequent need to bring clarity by translating natural language into

logic. One thing to note is that logicians never provided a fully explicit formal procedure—an algorithm—to link the English expression to the left of the wave arrow with the logic expression to the right. They used their own intuitions as native speakers of English and their own knowledge as logicians to go from English to logic. The complex process takes place privately in their minds and we are only provided with the final output. Montague's theory of semantics will challenge both the assumption and the practice by providing a full match between syntax and semantics and a fully detailed translation procedure from English (or, in principle, any natural language) to logic.

Returning to Quine, *Word and Object* contains many instances of the attitude towards natural language we just saw. The interpretation via logical translation for restrictive relative clauses is an important example. His core insight will be adopted by Montague himself and has remained essentially the same until today. An example of a restrictive relative clause is the underlined string in *The students in my class that are Italian talk a lot*. What's the meaning of *that are Italian*? Quine argues that it is the same as the adjective *Italian* in *The Italian students in my class talk a lot*. They both refer to the same object: the set of human and non-human entities that are Italian in the given situation. When the adjective or the restrictive relative clause combines with the expression *student in my class* syntactically, it restricts the meaning of that expression from the set of all the students that are in my class to the subset of those that are in my class and are also Italian. This "restrictive" meaning can be assumed to be the basic meaning of the single word *Italian*, but needs to be derived compositionally for relative clauses like *that are Italian*. Quine is, of course, aware of the syntactic complexity of relative clauses and even describes an informal way to interpret a relative clause: it "is true of just those things which, if named in the place of the relative pronoun, would yield a true sentence" ([21], Ch. 4, § 23). So, in the case of *that are Italian*, Quine would say that it is an expression that is true of just those humans x such that x are Italian. Montague will develop Quine's intuition into a fully explicit treatment of restrictive relative clauses that makes use of a logical tool developed by Alonzo Church—the lambda-abstractor [19].

Quine's discussion of opacity and opaque verbs in *Word and Object* is another issue that intrigued Montague but also left him unsatisfied. Quine handles the opacity ambiguity of a sentence like *Richard is looking for a friend* by postulating that *look for* has two very different meanings. One of them assigns the sentence a meaning that Quine would paraphrase as 'Richard endeavored (-to-cause) himself to find a friend', whereas the other assigns it the meaning 'Richard endeavored (-to-cause) himself and a (certain) friend to be related as finder and found' ([21], Ch. 4, § 32). Montague objects that this solution would postulate massive ambiguity in natural languages since there are plenty of predicates that behave like *look for* (*seek*, *want*, *wish*, *hunt*, etc.) and each of them trigger ambiguity only when combined with certain kinds of objects: *look for a friend* triggers ambiguity, whereas *look for the friend* does not. In other words, *look for a friend* is just one lexical item with its fixed meaning for Quine, whereas *look for the friend* would be a completely unrelated lexical item. Montague is concerned that this strategy "would raise the psychological problem of explaining how a natural language containing infinitely many primitive predicate constants can be learned?" with "primitive predicate constants" being the logician's way to label words like verbs ([10], pp. 174–175).[23]

More broadly, Quine exemplified the typical attitude of logicians towards natural language: unlike logic, natural language is vague, ambiguous, messy, and in need to be brought to clarity and regimented by means of logic (*Regimentation* is indeed the title of Chapter 5 in *Word and Object*). Quine discusses various kinds of opacity and argues that they should all be "regimented" via the logic he is adopting, essentially first-order predicate calculus with quantification—a well-established and relatively simple form of

logic. Montague must have found this decision highly unsatisfactory, as shown in his subsequent work. He was already developing a more complex logic as a better framework to conduct rigorous philosophical analysis in all areas. His closer encounter with natural language in his seminar in Amsterdam must have triggered the idea that his new logic was the perfect tool for analyzing natural language as well and that he could definitely do better than Quine.

4.4. A More Personal Challenge?

Quine and Chomsky may have been responsible for Montague's interest in natural language for an additional, more personal reason. Professor Quine, then 57-years old, was a towering figure among the logicians and philosophers of his generation. From Harvard he dominated the East Coast logic landscape in the Unites States, much as Tarski did on the West Coast. Montague knew Quine personally. They had participated in events together and served on numerous logic-related committees. Professor Chomsky, 38-years old at the time, was an emerging MIT star and a revolutionary thinker in linguistics and beyond. It does not appear that Chomsky and Montague ever met in person,[24] though Montague may have seen Chomsky at lectures or public appearances Chomsky gave at Berkeley and at UCLA in the 1960s.

Montague was slightly younger than Chomsky. He was a star in his department and at UCLA, an excellent public university—though not of the stature of Harvard or MIT. Within the field of logically inclined philosophers of his generation, Montague ranked at the top. But he was ambitious and eager for additional recognition and to demonstrate that he could surpass his peers. Now he had the knowledge and the tools to do better than Quine and Chomsky, he must have thought. While Montague was always respectful towards Quine despite their sharply divergent views on logic, he never missed an opportunity to criticize Chomsky and his followers in his publications on natural language.

David Berlinski (born in 1942) recounts an anecdote that reinforces this picture. He had a brief encounter with Montague, probably a couple of years after Montague's sabbatical in Amsterdam. Dan Gallin, Berlinski's close friend and Montague's student and friend, had arranged for the three of them to meet for a drink at a hotel bar in New York City. They started talking about taxes, politics, and the city itself:

> Then the discussion turned to mathematics and Montague cheered up. He had just commenced his research program into formal grammars [...]. He liked to imagine that he and Chomsky were rivals. "There are," he said, "two great frauds in the history of twentieth-century science. One of them is Chomsky." I reached for the peanuts. "And the other?" "Albert Einstein," Montague said decisively, glad that I had asked. ([32], p. 77).

5. After Amsterdam

The issues and the ideas that emerged during the seminar in Amsterdam continued resonating with Montague. Once back in Los Angeles, he worked on three papers in a row, resuming his longstanding practice of having some sparring partner around while doing his own research. This time he chose his new student Hans Kamp, who remembers as follows:

> Since there happened to be no one else around at that time who he considered suitable for this purpose he asked me, and so I had the unique opportunity for a graduate student to look over his shoulder while he was making his progress through what have since come to be recognized as seminal papers. I do not all that much remember now from the individual sessions. But what I do remember is that I was present at some of the work on 'Pragmatics and Intensional Logic' and then

> through most of the gestation period of 'On the nature of certain philosophical entities' and through that of 'English as a formal language'; and in that order, I do not think there was a great deal of temporal overlap in the work on those particular papers.[25]

Montague worked on further developing his "Higher-Order Intensional Logic" in *Pragmatics and Intensional Logic* [33] in summer and fall of 1966. The paper benefited from extensive discussions and correspondence with a number of important logicians of the time, including Montague's friends Dana Scott (born in 1932) and David Kaplan (born in 1933). It presents what Montague considered the new and right framework for doing formal philosophy, replacing set theory with individuals, which he had considered as the right framework until then (see first quote in § 2 above). The first philosophical application of the new formal framework is found in the paper Montague wrote soon after—*On the nature of certain philosophical entities* [10]. Montague's former Berkeley teacher and dear friend Benson Mates gave a talk on *Sense Data* at the UCLA Philosophy Colloquium on 18 November 1966.[26] Mates's presentation "largely provoked [Montague's] considerations"([10], fn. 1), including Montague's bold statement on the need for a change in his way of pursuing philosophical research (see first quote in § 2 above). This paper can be seen as an investigation of ontological categories (entities) that are at the center of different branches of philosophy like pains, tasks, obligations, and events, and how philosophers have dealt with them and talked about them. Montague's conclusion is that "ordinary English is an inadequate vehicle for philosophy" but, at the same time, "there is philosophic interest in attempting to analyze ordinary English"([10], p. 193).

This is exactly what Montague did next, by developing a precise syntactic and semantic analysis of natural language that would lead to his three foundational papers: *English as a formal language* [19], completed by the fall of 1968, *Universal grammar* [1], completed by December 1969, and *The proper treatment of quantification in Ordinary English* [20], completed by the fall of 1970.[27]

Before those papers were completed, Montague had already begun presenting his new research program in talks (as discussed next in § 5.1), courses (as discussed in § 5.2), and grant applications (as discussed in § 5.3), which underscores the depth of his engagement with his new intellectual enterprise.

What emerges from this activity is that Montague's interest in natural language grew rapidly and soon became his main research and teaching interest during the last three years or so of his life. All three new papers he conceived in those years were about natural language. Most of his talks were about natural language and a significant portion of his advanced courses and grant applications were dedicated to natural language. More work was planned, had not Montague's sudden, violent death intervened. He was preparing a book collecting his published work on natural language, together with a few new chapters he was planning to write. It is announced as "in preparation" under the title "The analysis of language" in the references of *Universal grammar* [1] in 1970. Montague handwrote the same title on a piece of cardboard labeled "Titles (for book)?", together with two other options: "Logical analysis in ordinary language" and "Language and meaning".[28]

5.1. Talks About the New Research Program

Yehoshua Bar-Hillel (1915–1975), who was intellectually and personally close to Montague, must have known about Montague's new intellectual passion when he invited Montague to the international symposium that he was organizing in Amsterdam on 26 August 1967, on *The role of formal logic in the evaluation of argumentation in natural languages*—part of the *Third International Congress on Logic, Methodology, and Philosophy of Science*. As Partee reminds us:

> In 1954, Yehoshua Bar-Hillel wrote an article [36] 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. He was arguing against logicians who considered natural language too unruly to formalize, and appealing to linguists to make use of some of the logicians' methods. ([37], p. 27)

Staal, who also participated in Bar-Hillel symposium in Amsterdam, would then edit the transcribed version of the debate [18]. In his editor's note, he singles out Montague as representing one of "two important recent trends in the analysis of natural language [. . .] model theory" ([18], p. 256)—the other trend being Chomsky's transformational generative grammar, represented by Jerrold J. Katz (1932–2002) at the symposium. Montague's student Hans Kamp attended as well. Montague's contribution stands out for breadth, strength, and scope. In the months preceding the symposium, Bar-Hillel had circulated a document to guide the discussion that opens with a strong statement about the relationship between formal logic and natural language:

> Formal logic, very roughly put, states that if certain linguistic entities have certain properties, other linguistic entities standing in certain relations to the first ones, have certain properties. Since the appropriate properties, such as truth, are in general not directly assignable to linguistic entities of natural languages, such as sentences, formal logic is not directly applicable to argumentation in natural languages. The customary applications are often careless, rough and unprincipled, or rely on reformulations of the original linguistic entities under discussion into different ones belonging either to some constructed languages or to some standardized natural languages, through processes which are again mostly unprincipled and ill understood. ([18], p. 257)

Bar-Hillel's document then lists a series of problems arising from the situation just outlined, the first one of which is:

> Does there exist a language in whose sentences all statements made, commands given, questions asked, etc., by natural language utterances can be rendered without loss, so that the logical relations between those non-linguistic entities can be mirrored by formal relations between the corresponding linguistic entities? ([18], p. 257)

Montague spoke last. He addresses the issue at the center of the symposium directly, highlighting some of core aspects of the new research program he is developing:

> I deplore the distinction customarily drawn—though not, I believe, by Professor Bar Hillel—between formal and informal languages. The syntax and semantics of certain not insignificant fragments of English can be treated just as formally and precisely as those of the first-order predicate calculus, and in very much the same manner. No adequate treatment of this sort has yet been published; one has, however, been recently developed by my student J. A. W. Kamp and myself. ([18], p. 274)

As is usually the case in Montague's prose, all words are chosen carefully. "Recently developed" signals that it was a new research interest that Montague had just started developing.[29] Montague adds a parenthetical immediately after the paragraph above (probably during the editing process for the publication), in which he mentions other work on natural language, including Ajdukiewicz's categorial grammar, which he would later use in his papers on natural language to define syntactic categories:

> (I should, however, mention a valuable and suggestive treatment of another, *translational* sort that appears not to have received adequate attention; it appears in an IBM report by H.G. Bohnert and P.O. Backer, 'Automatic English-to-logic translation in a simplified model'; Ajdukiewicz' work is also certainly suggestive. On the other hand, I must confess that the attempts of Chomsky and his associates impress me as most unsuccessful.) ([18], p. 274; italics in the original)

Montague makes it fully clear that it is the notion of logical consequence (aka, entailment) between sentences that should be at the center of a satisfactory theory of natural language semantics, rather than the notion of truth of a sentence:[30]

> Context-dependent sentences present no special problem, and I feel we should get them out of the way. Professor Bar-Hillel is of course right in saying that truth is not applicable to such sentences, but in my opinion wrong in concluding that other logical notions—for instance, that of logical consequence, which would appear central to the present symposium—are therefore also inapplicable. ([18], p. 273)

Despite being—in Montague's view—a core semantic property of natural language, logical consequence had been completely ignored. As mentioned in § 4.2, Chomsky and the generative semanticists who were developing their semantic theory for natural language in those years did not even consider the truth of a sentence—let alone logical consequence between sentences—as semantic intuitions or facts. The philosopher Donald Davidson (1917–2003) was also working on a theory of meaning for natural language, building on Tarski's definition of truth for an artificial language. Davidson would present a preliminary version of his theory in the talk *Semantics for natural languages* immediately before Montague would present *English as a formal language*, at the same event in Milan on 15 October 1968. Montague began his talk with some diplomatic but critical remarks about Davidson's talk, showing that—as usual—he fully understood what a colleague was trying to develop and could already see its limitations:

> I found myself in the unprecedented state of almost complete agreement with the preceding speaker. Like Professor Davidson, I reject the contention that there is a basic theoretical difference between artificial and natural languages; like him, I also regard the construction of a theory of truth as the basic goal of serious linguistics. I should say, not exactly a theory of truth, but rather a theory of the more general notion of truth under an arbitrary interpretation. It is this more general notion that it is required to analyze the notion of logical consequence, and indeed the notion of logical consequence itself was, I think, required in Professor Davidson's discussion, particularly when he called attention to the various logical relationships among the sentences 1 and 2 and their variants. Like Professor Davidson, I am also unable to see any value in the attempts of Chomsky and his associates.[31]

When Montague participated in the symposium in Amsterdam in August 1967, he had already developed his intensional logic, which encompasses a unified formal treatment of indexical reference (tense, modality, deixis) and allows for a definition of truth relative to a model and a set of indices ("under an arbitrary interpretation"), as he states in his contribution:

> A comprehensive formal treatment can be found that will apply to every other sort of indexical reference known to me: briefly, one replaces moments by possible contexts, or rather *points of reference*, by which I understand the complexes of relevant features of possible contexts. [. . .] For precise analyses see my 'Pragmatics'. ([18], p. 273; italics in the original)

After delivering the final version of *English as a formal language* in Italy in October 1968, Montague presented a preliminary version of his new paper *Universal grammar* at the Southern California Logic Colloquium in April 1969 and again at the Association for Symbolic Logic one month later. The final paper was delivered at a joint symposium of the Association for Symbolic Logic and the American Philosophical Association in December 1969, at the UCLA Philosophy Colloquium in February 1970, and at the *Symposium in Linguistics and Philosophy* that Barbara Partee organized at UCLA in May 1970.

Partee's symposium had Montague engage with a significant number of linguists for the first time. Montague shared his 7–10 p.m. session on 6 May with linguist George Lakoff (born in 1941), who presented his *Linguistics and natural logic* immediately before Montague. Lakoff would also give a plenary talk on *Generative Semantics* at the end of the following day. Partee presented on *Does De Morgan's Law operate in English?*. It was at a coffee break during that event that Montague offered Partee his highest compliments: "Barbara, I think that you are the only linguist who it is not the case that I can't talk to."[32]

In the summer of 1970, Montague worked on his third and last paper on natural language semantics—*The proper treatment of quantification in Ordinary English* [19], which he presented and discussed at the two meetings of the *Workshop on Grammar and Semantics of Natural Languages*, organized at Stanford University by Jaakko Hintikka (1929–2015), Julius Moravcsik (1931–2009), and Patrick Suppes (1922–2014) in the fall of 1970. He finished editing the final version of the paper for the proceedings of the workshop just a few days before his death. The volume will appear in 1973 and will be dedicated to Montague's memory [41].

5.2. Courses About the New Research Program

From September 1967 to March 1968, Montague taught a two-quarter Mathematical Philosophy graduate seminar with *Word and Object* as the main reading, together with Montague's most recent work. Kamp, Kaplan, and David Lewis (1941–2001) attended the seminar. The first topic was indexical expressions and pragmatics—the focus of the papers *Pragmatics* [42], which Montague had worked on while in Amsterdam, and *Pragmatics and Intensional Logic* [33], which he had just completed.[33] Another main topic was the application of intensional logic to metaphysics, epistemology, and ethics, which he had addressed in his recently completed journal paper *On the nature of certain philosophical entities*. Listed last, as "Other possible topics" (in the hierarchical order in which Montague gives them), pragmatics and intuitionist logic, modal logic, and finally grammar and semantics of natural languages. For this latter topic, Montague required the reading of most of Quine's book, while he left an unspecified "Chomsky" as optional.[34] Montague also discussed conditionals (with Lewis presenting his objections in class and Montague replying), tense logic (with a presentation by Kamp), Ajdukiewicz's categorial grammar, and Chomsky's notion of transformation via Kessler's presentation. At the end of the winter of 1968, Montague presented what the notetaker[35] labelled as "Prof. Montague's grammar", a detailed precursor of what will appear in *English as a formal language*. Montague even made the claim that "A free algebra serves the same function as Chomsky's trees (his 'deep structure')".

In the fall of 1968, Montague taught a Philosophy of Language graduate seminar. It was a last-minute change. He was originally scheduled to teach a graduate seminar on recursion theory, which had already been advertised to the department. The seminar focused on the first of Montague's three seminal papers on natural language—*English as a formal language* [19]. Lewis and Partee were among those who attended.

In the summer of 1969, Montague taught a Philosophy of Language graduate seminar at Berkeley in which he presented material that would be part of his next paper on natural

language—*Universal grammar* [1]. He continued working on the paper in the fall of 1969, while not teaching, and then made it the focus of the two graduate seminars in Philosophy of Language he taught at UCLA in the Winter (January–March) and Spring (Aprile–June) quarters of 1970. The young philosopher and logician Max Cresswell (1939–2024) was among those who attended the Winter seminar. He had received his Ph.D. with Prior at University of Manchester in 1964 and had returned as a lecturer to native New Zealand, where, in 1968, he had written the first modern textbook on modal logic together with G.E. Hughes [43].

5.3. Grants for the New Research Program

Montague's new research interest in natural language is evident not only from his teaching and public talks, but also from his grant applications. Montague's research had been supported by NSF grants from the early 1960s on. In the early winter of 1968, Montague worked with Kaplan on a renewal of their NSF grant titled *Research in Metamathematics*. The year before they had asked for a three-year extension of the grant, which expired in the summer of 1967, but they were awarded only one year, through the summer of 1968. In the research proposal for the renewal, they largely quoted from the previous application one year earlier, but added natural language already in the introduction:

> It should be pointed out [. . .] that in addition to the four areas specified in the last proposal (model theory and recursion theory, foundations of set theory, pragmatics and intensional logic, and the theory of arithmetical theories), a new area has been added—syntax and semantics of natural languages.[36]

Later in the document, they elaborated:

> Montague has recently begun developing some ideas, originally obtained in the Spring of 1966, for the general treatment of grammar. Montague's treatment appears to have several advantages over the well-known approach of Noam Chomsky: it comprehends not only natural languages but also formal mathematical languages, it is more elegant and "mathematical" than Chomsky's, and it leads to a simple and natural theory of meaning for certain natural languages. A theory of meaning appears not yet to have been seriously attempted by Chomsky and only in the most inadequate way by such Chomsky disciples as Katz. Montague's treatment of English does not depart radically from the normal model theory of higher-order languages, but requires the development of intensional logic in (22) and relies on ideas of Kamp for the semantical treatment of adjectives and adverbs. Montague's work in this area is at the present only incipient and tentative, but is expected to be fairly intense in the near future. It appears that there may well be definite application to the problem of mechanical translation (or at least the theory of mechanical translation).[37]

This section on natural languages is the last one of five in the grant application—and also the shortest. The application was ultimately unsuccessful, after almost a year of waiting. Eight out of the nine "mathematically oriented logicians" that reviewed it rated it "less than Very Good". They found the proposal "vague", and some believed "that recent developments in mathematical logic have diminished the importance of the proposed work".[38]

Montague did not give up. He decided to try again—this time without Kaplan. Montague applied to both the Mathematics Division and the Social Sciences Division, following a suggestion in the NSF rejection letter. The title of the new research proposal for 1969–72 was *Research in Metamathematics, Linguistics, and Scientific Philosophy*. It focused on only two areas: Generalized Recursion Theory and linguistics, with an appendix on

possible philosophical application of both intensional logic and the "contemplated linguistic research."[39] The first area took three pages; the second took only one, beginning with the same incipit the one in *English as a formal language* (see § 2). The grant is awarded this time. I was able to find the evaluation by a major reviewer—Alonzo Church. Church's comments on Montague's old and new research interests is revealing of not only the high value he placed on Montague and his work, but also a "classical" mathematical logician's prospective on Montague's application of logic to natural language. Church' review—dated 2 May 1969—is worth quoting at length:

> I have been a close personal friend of Montague's since 1952 and have often worked with him and had many discussions on logic over the years. He is a difficult but very original person with the highest standards of mathematical rigor. He tends to overrate certain things, however. For example his bibliography contains (roughly) only 26 published papers (+4 in press) among all the reviews and abstracts. But there are many important ones.
>
> At the present time, his work on intensional (modal) logic seems to be his strongest point. It can stand alone and does not need to be advertised as a semantics of natural language. It has already philosophical interest in itself as a brand of logic. Bar-Hillel, or Donald Davidson, or Paul Postal comment on the natural language aspect.
>
> The recursion theory seems weak to me. I do not think it is such a good idea to write a monograph. You should get G. Kreisel (Univ of Paris) to comment or G. Sacks (MIT). [. . .]
>
> Thus, I think the work deserves support—but maybe not for the reasons Montague thinks are the strongest.[40]

5.4. Immediate Influence and Legacy

Montague's work had an immediate effect on a variety of scholars who were interested in natural language semantics and looking for an actual formal framework for developing it compositionally and systematically. I will briefly highlight some central examples without aiming at exhaustivity or depth.[41]

At the time of his death on 7 March 1971, Montague was supervising at least three graduate students working on his new research program. Dan Gallin (1941–1982)[42] was investigating several issues concerning Montague's intensional logic and its application to natural language semantics, including the formulation of the Two-Sorted Type Theory (TY2) with abstraction and quantification over possible worlds—the logical language that is commonly used in natural language semantics these days. After Montague's death, Gallin will transfer to Berkeley and complete his work with Dana Scott in 1972 [44]. Michael Bennett (1943–1979) had begun developing Montague's work to account for a larger fragment of English. He will continue under the guidance of Kaplan and Partee [45]. Francis Jeffry (Jeff) Pelletier (born in 1944) had begun investigating the semantics of mass nouns under Lewis' supervision. Lewis' own interest in natural language had been significantly influenced by Montague's work, as discussed below. When Lewis left for Princeton University in 1970, Pelletier began working with Montague. He will finish his dissertation under the supervision of Montgomery Furth (1933–1991), the philosophy department chair, adopting the framework in the paper Montague had just finished writing—*The proper treatment of quantification in Ordinary English* [46]. Finally, Enrique Delacruz (born in 1943) had hoped to work on presupposition with Montague adopting his framework, but his dissertation was instead supervised by Kaplan and Partee [47].

Montague's influence on Partee and her students was fundamental for their work on natural language semantics—something that Partee herself has written about extensively and beautifully. Partee became aware of Montague's working on natural language in the Fall quarter of 1968, attending Montague's seminar. At the time of Montague's death in early 1971, Partee was planning to submit a grant proposal on the issues concerning natural language semantics that she hoped to engage Montague with. In 1975, Partee will publish *Montague Grammar and Transformational Grammar* [48], whose main goal is already stated in its title. The same year, her student Robin Cooper (born in 1947) will complete his Ph.D. at the University of Massachusetts at Amherst (where Partee had moved in 1972) with a dissertation on *Montague's Semantic Theory and Transformational Syntax* [49]. Soon after, Partee will edit *Montague Grammar* [50], a collection of papers that extend Montague's approach to natural language to cover further constructions (questions, adjectives, degrees, factive predicates, lexical semantics, etc.) or frame Montague's theory in relation to other theories of language.

Lewis—who will become one of the most important philosophers of the 20th century—had joined the UCLA philosophy department as young and brilliant assistant professor in 1966. His dissertation *Conventions of Language* [51] and his book *Convention* [52] are almost identical up to Chapter 4 included.[43] Crucially, the book has an extra chapter, Chapter 5, entitled *Conventions of Language*, which constitutes one-fifth of the whole book and is entirely dedicated to language. In this chapter, Lewis defines the notion of "grammars" by drawing on Chomsky [22] and defines the semantics of a "possible language" by means of possible worlds and modal logic—with reference to Montague's work (1969, [10]; 1968, [42]), together with work by Rudolf Carnap (1891−1970), Jaakko Hintikka, David Kaplan, and Dana Scott. Between the writing of his dissertation and the writing of his book, Lewis had moved to UCLA, had attended Montague's seminars on intensional logic and natural language (as mentioned in § 5.2), and had become deeply familiar with the work Montague had developed up to 1968. In 1970, Lewis will publish *General Semantics* [53], in which he bridges Chomsky's [22] generative syntactic theory with the model-theoretic semantics developed by Montague and others. Lewis [53] repeatedly cites all of Montague's work on intensional logic and natural language up to Montague [1] included. He also thanks Montague in the acknowledgement for his feedback, together with Kaplan, Lakoff, Partee, and a few others.

After attending the Philosophy of Language graduate seminar that Montague taught in the Winter quarter of 1970 (see § 5.2), Cresswell returned to New Zealand and wrote the book *Logics and Languages* [54]—his own development of Montague's research program. He writes in the preface:

> The inspiration for this book arose as a result of spending three months of my sabbatical leave at UCLA in 1970 and attending lectures by Richard Montague on the philosophy of language. ([54], p. ix).

A few pages later, he adds:

> Ideas closest in spirit to those of this book will be found in the work of, among others, David Lewis and Richard Montague[44]. At that time of his death Montague as planning a monograph on the analysis of language and the present book owes much to his work. Although I shall be giving what is primarily an exposition of my own views on the formal analysis of natural languages I would hope that what I have written may also serve as an introduction to the kind of work that is currently being pursued by those who share similar convictions about the study of language. ([54], p. 4)

Young linguists including David Dowty (born in 1945), Lauri Karttunen (1941–2021), Stanley Peters, and Robert Wall at the University at Austin were working on understanding and applying Montague's framework as well. Karttunen had attended the UCLA workshop organized by Partee in the spring of 1970 where Montague presented *Universal grammar*. Peters had participated at the workshop at Stanford in the fall of the same year, where Montague presented *The proper treatment of quantification in Ordinary English*. In 1977, Karttunen will publish *The syntax and semantics of questions* [55], in which he extends Montague's framework to embedded interrogative clauses. Karttunen builds on the analysis for matrix interrogative clauses that the philosopher and logician Charles Hamblin (1922–1985) had developed in his 1973 paper. Hamblin's debts to Montague is already explicit in the title—*Questions in Montague English* [56]. In 1979, Dowty will publish the book *Word Meaning and Montague Grammar. The Semantics of Verbs and Times in Generative Semantics and in Montague's PTQ* [57], in which he integrates the lexical analysis of verb meaning from his 1972 Ph.D. dissertation [58] with Montague's model-theoretic approach. The previous year Dowty had published *A Guide to Montague's PTQ. Bloomington* [59], likely the first textbook on formal semantics in English. Three years later, he will further develop it with the help of Wall and Peters into *Introduction to Montague Semantics* [60], which hopes "to acquaint the reader with the fundamentals of truth conditional model-theoretic semantics, and in particular with a version of this developed by Richard Montague in a series of papers published during the 1960s and early 1970s".

Montague's research program reached Europe soon after his death. Arnim von Stechow (born in 1941) was a young German linguist who had received his Ph.D. in 1969 in Münster to then move to Konstanz as an assistant professor. He had studied mathematical logic on his own and developed a strong interest in creating a precise formal semantics for natural language. When Bar-Hillel visited Konstanz in 1971, he strongly recommended Montague's work to von Stechow. This is how von Stechow himself tells the consequences of Bar-Hillel's suggestion to Partee, who is interviewing him:

> So then I started reading Montague, and the first thing I read was English as a Formal Language. That I always liked, because I also always had the idea that you have to have sentence meaning as truth conditions somehow. And then the second idea was also that you had to interpret syntax directly, and EFL did that, without [some translation] in between, and that I liked. [...] And later on, the second thing I read then was Universal Grammar. ... It's hard, yeah, but that's the one I liked best in some sense. ([35], § 4, p. 34)

> We're all in some sense Montagovian grammarians, yeah, so we take the syntax, a reasonable syntax, it must be, and we interpret it and assign truth conditions or something more complicated—maybe to characters—..., so, fully Montagovian, and this is the framework still full of life, yeah, so that's standard. ([35], § 8, p. 41)

Von Stechow also mentions works that influenced him greatly by other scholars who, as we saw, were directly influenced by Montague:

> And later about Cresswell's *Logics and Languages*, "and that I liked a lot". ([35], § 8, p. 40)

> And David Lewis, for me, when it comes to the philosophy of language, was always in a way the greatest. [...] 'General Semantics' is one of the things that influenced me a lot. ...I'm still completely an adherent of David Lewis. ([35], § 8, p. 40)

> Karttunen's semantics of questions is a very great achievement; and also one of the personal heroes for me is Dowty—so that's the reasonable first account about

> the progressive, still the best we have, so that's the right way to go, and of course also this idea of lexical decomposition. ([35], § 8, p. 41)

A number of European formal semanticists point at von Stechow as the source of their earliest acquaintance with Montague's work. Irene Heim (born in 1954) and Ede Zimmermann (born in 1954) are among those. They both participated in the seminar in the fall of 1973 in which von Stechow guided his students through *Universal grammar* in Helmut Schnelle's German translation and commentary.[45]

Another young German scholar, Sebastian Löbner (born in 1949), who had recently majored in mathematics and minored in linguistics with a strong passion for semantics, will encounter Montague's work around the same time and become so interested in it to publish the book *Einführung in die Montague-Grammatik* ('Introduction to Montague Grammar'). Löbner himself describes his book as a "gradual introduction to Montague's *Universal Grammar* and *The proper treatment of quantification in Ordinary English*."[46] It will "become a standard textbook for several generations of students of formal semantics in Germany" ([61], p. 11). It was 1976.

Around the same years, two young students in philosophy and linguistics at the University of Amsterdam—Jeroen Groenendijk (1949–2023) and Martin Stokhof (born in 1950)—will be fascinated by what they learned about Montague's work at a conference linguist Ed Keenan (born in 1937) had organized in Cambridge in 1973 and convinced their new teachers—the philosopher of language Renate Bartsch (born in 1939), who arrived in 1974, and the logician Johan van Benthem (born in 1949), who had arrived in 1972—to teach seminars on Montague's natural language semantics and related work. Renate Bartsch had planned to visit and work with Montague in the fall of 1971. Because of Montague's death, she joined the group of UCLA faculty and students from linguistics and philosophy who were adopting and developing Montague's framework under Partee's guidance. Groenendijk and Stokhof will then develop their own research within Montague's framework and write the first introduction to Montague Grammar in Dutch in 1982, together with van Benthem, Dick de Jongh (born in 1939) and Henk Verkuyl [62]. In 1976, they will start a biannual conference *The Amsterdam Symposium on Montague Grammar and related topics* (later renamed *Amsterdam Colloquium*). The conference has become a major international venue for formal semantics. At the time of this writing, it is celebrating its 50th anniversary. It started exactly ten years after Montague's sabbatical in Amsterdam when—as I hope to have shown—everything started.

6. Conclusions

Up to the mid-1960s, Montague shared the skepticism of many fellow logicians regarding natural language as an object of systematic investigation. In the first half of 1966, while teaching with Staal in Amsterdam and continuing to develop his Higher-Order Intensional Logic, Montague began to consider natural language as fundamentally the same as the artificial languages of logic and, therefore, amenable to the same kind of rigorous, formal investigation of its syntax and semantics. Quine's *Word and Object* and Chomsky's *Aspects of the Theory of Syntax* played crucial roles in Montague's sudden and radical turn—although in different ways. Quine raised intriguing issues without providing fully developed formal answers. Chomsky focused on syntax, under the assumption that it was the core component of natural language and could be handled separately from semantics—an assumption Montague strongly disagreed with. Chomsky also endorsed the preliminary natural language semantic analysis emerging from generative semanticists, which didn't consider truth—let alone logical consequence—as facts semantics must account for. This assumption too was unacceptable to Montague. He likely believed that he could handle natural language better than either of his two famous colleagues. He was at least partially correct.

Montague developed a framework for the rigorous, formal, and compositional analysis of the syntax and semantics of natural languages in the last four years of his life and presented it in several talks and seminars, and in his last three seminal papers. His framework will immediately capture the attention of philosophers and even more of linguists who were interested in natural language semantics but lacked a framework within which to develop such an investigation. Many aspects of Montague's framework have been changed or abandoned. Montague's categorial syntax has been replaced with richer categorial systems or with some form of generative syntax.[47] Many new components have been added to his semantics to handle a much broader empirical landscape both within and across languages. On the other hand, logical consequence (aka entailment) is still considered a core semantic fact to account for, versions of Montague's proposal to treat all NPs as generalized quantifiers are still largely adopted, our standard treatment of restrictive headed relative clauses as set-denoting via lambda-abstraction is still Montague's, and core (functional) types are those that Montague introduced, including his notation.[48]

As the late Terence Parsons (1939–2022) shared when I interviewed him for my book:

> [Montague's] work—and especially *PTQ*—was extremely influential. It laid out a paradigm where you do everything from scratch. This meant linguists who knew about it would think of this as probably their enterprise. But more important I think was the rigorous semantics, the use of the possible worlds fragment, the use of the possible worlds as a tool, which ended up being used by linguists far more than by philosophers and logicians. He nailed down a certain tradition. [. . .] He made it possible. So, I think it was extremely influential. I think eventually people would have been doing formal semantics for natural language. He was a real leader in that field in that he showed a way to do it with standards of rigor. [. . .] if you're going to work on that stuff, you couldn't be sloppy. It just wasn't part of the tradition. Nowadays, a lot of what people call semantics in linguistics is a part of what a few years ago they were calling Montague Grammar.[49]

Funding: This research is part of a larger project of a biography of Richard Montague that has been supported by Fellowships from the Center for Advanced Study in the Behavioral Sciences at Stanford University (2014−2015) and from the American Council of Learned Societies (2014), by a Research Grant from the American Philosophical Society (2013), by a Summer Stipend Award from the National Endowment for the Humanities (FT-291408-23) (2024), and by several Academic Senate Research Grants from the University of California San Diego (2013–2025).

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: Data is contained within the article.

Acknowledgments: The whole project of an intellectual and personal biography of Richard Montague would not have been possible without the support and collaboration of many individuals—far too many to list here. I must, however, acknowledge at least the late Sol Feferman, Hans Kamp, Barbara Partee, and Dana Scott, without whom this project would never have come into being. I am also grateful to all those who agreed to be interviewed for the biography, as referenced throughout the paper. Thanks to three anonymous Reviewers and the Guest Editor of this special issue Glyn Morrill for their supportive and constructive feedback. Special thanks to Hans Kamp for sharing precious comments, thoughts, and memories; to Ede Zimmermann for precise, important suggestions; and to Gennaro Chierchia for illuminating discussions about Montague's work. All remaining errors are my own.

Conflicts of Interest: The author declares no conflicts of interest.

Notes

1 For an overview and evaluation of Montague's work on natural language, see Cresswell [2], Cocchiarella [3], Partee and Hendricks [4], Partee [5,6], Zimmermann [7], and Janssen and Zimmermann [8].

2 Further information on the biography and Montague is available at: https://www.richardmontague.com/ (accessed on 12 January 2026).

3 I have used italics not only for titles of books (as standard), but also for titles of papers, courses, and conferences (rather than single or double quotation marks) to minimize confusion, since quotation marks are already abundantly used for the many in-text quotations. I have capitalized book titles only.

4 The transcripts of the symposium were published after Montague was given the chance to edit the written transcriptions of the audio recordings of all contributions. It is unclear if the paragraph quoted above was changed as well (see *Richard Montague Papers*, LSC.0264, UCLA Library Special Collections, Box 1 File 10; in short, Montague B. 1 f. 10; this shortening convention will be applied henceforth to all materials within this archival collection).

5 Bracketing in Montague [20].

6 "Montague (1970a and 1971)" correspond to [19] and [1] respectively in the references in the present paper.

7 Letter from Benson Mates to Montague, 3 January 1966 (Montague B. 21 f. 1).

8 See Kamp [25] for a detailed reconstruction of the role Prior played in his dissertation and a touching homage to Montague for the role he played in his overall intellectual development.

9 The book will appear posthumous in 1971, edited by P. T. Geach and A. J. P. Kenny [26].

10 Written message from Hans Kamp, 4 February 2026.

11 Letter from Haskel Curry to Frits Staal, 9 July 1964 (*A. Heyting*, Noord-Hollands Archief, Haarlem, The Netherlands; in short, Heyting D1-57-3; this shortening convention will be applied henceforth to all materials within this archival collection).

12 Heyting D1-49.

13 Montague B4 f. 3–4.

14 E-mail message from Kees Doets, 10 October 2015; e-mail message from Erik Krabbe, 16 October 2015.

15 Letters from Frits Staal to Montague, 27 January 1965 (Heyting D1-20) and 3 January 1966 (Heyting D1-48-1).

16 Letter from Montague to Frits Staal, 25 October 1965 (Heyting D1-39-1).

17 Written message from Hans Kamp, 4 February 2026; also interview with Hans Kamp, Austin, Texas, 3 March 2013.

18 Interview with Henk Verkuyl, Amsterdam, 15 September 2013.

19 Montague's notion of "universal grammar" ("grammar" is lower case in the title of [1]) is fundamentally different from Chomsky's "Universal Grammar". For Montague, "universal grammar" is "a single natural and mathematically precise theory" that can account for "the syntax and the semantics" of both "natural languages and the artificial languages of logicians." ([1], p. 373).

20 Date is missing, but sometime in the winter or spring of 1966 (Heyting D2); underline in the original.

21 E-mail message from Barbara Partee, 14 July 2017.

22 Quine ([21], Ch. 4, § 29). Adapted from Shakespeare: "All that glisters is not gold." *The Merchant of Venice*, Act II, Scene vii.

23 Montague's objection to Quine's [21] approach also shows sensitivity to the learnability issues discussed in Chomsky [22]: a theory of natural language has to be such that it can be learned by a child who is exposed to a limited amount of data. Barbara Partee remembers that Montague attributed his interest in the learnability problem to Donald Davidson, rather than Chomsky (e-mail message from Barbara Partee, 17 September 2020).

24 Interview with Noam Chomsky, Cambridge, Massachusetts, 6 September 2013.

25 Written message from Hans Kamp, 4 February 2026.

26 It appeared as a journal article the following year [34].

27 See Cresswell [2] for an enlightening, brief review of the papers mentioned here—from *Pragmatics and Intensional Logic* to the papers on natural language—and how they are connected.

28 Montague B. 3 f. 2. The book project will then be taken over and reshaped by Richmond Thomason, who will edit a collection of Montague's main work, including all his work on natural language, under the title of *Formal Philosophy* in 1974 [35].

29 Hans Kamp describes his role as a careful, knowledgeable listener to Montague's thinking loud. Kamp was not working on natural language semantics before, during, or after Montague's sabbatical leave in Amsterdam. As Kamp recognizes, it was Montague's own idea and interest. (ter Meulen and Heusinger [38], pp. 634–635; Kamp [25], p. 5; interviews with Hans Kamp, Austin, Texas, 2–4 March 2013, and Stuttgart, Germany, 26–27 October 2023; written message from Hans Kamp, 4 February 2026).

30 Many thanks to Gennaro Chierchia, who many years ago shared his conviction that Montague believed that logical consequence—more than truth—is the empirical pillar of semantics. His suggestion stayed in my mind. Over years of research, I have found strong supporting evidence, including what is reported here.

31 Transcripts of *Convegno Internazionale Olivetti "Linguaggi nella Società e nella Tecnica*, Biblioteca/Sala G/Atti di Convegni, faldone 1, fascicolo 7. Associazione Archivio Storico Olivetti, Ivrea, Italy. Most of Montague's initial remarks will be omitted in the

published version, which otherwise closely resemble the version he presented in Milan (Davidson's paper in the proceedings, instead, is significantly different and shorter than the talk he delivered [39]). For convenience, here is the initial paragraph of the published version of *English as a formal language*: "I reject the contention that an important theoretical difference exists between formal and natural languages. On the other hand, I do not regard as successful the formal treatments of natural languages attempted by certain contemporary linguists. Like Donald Davidson [. . .] I regard the construction of a theory of truth—or rather, of the more general notion of truth under an arbitrary interpretation—as the basic goal of serious syntax and semantics; and the developments emanating from the Massachusetts Institute of Technology offer little promise towards that end." (Montague [19], p. 189)

[32] Partee ([40], p. xxiv) and interview with Barbara Partee, Stanford University, California, 23 February 2015.

[33] Both papers were already completed by the time Montague became fully engaged with developing a syntax and semantics for natural language. They are about language in general—Morris' semiotic system. Their main goal is to argue that pragmatics can be treated with the same mathematical rigor as syntax and semantics by means of a unified and precise formal treatment of "the notion of truth (in a model, or under an interpretation) [. . .] with respect also to a context of use" for those sentences containing "indexical expressions" (pronouns, tense, modals) ([33], p. 68; [42], p. 183). Montague [33] was conceived as the full-fledged formal execution of such a plan to appear on a journal, whereas Montague [42] was a contribution to a volume collecting overviews on issues and areas within contemporary philosophy.

[34] Montague B. 11 f. 5.

[35] Montague would require enrolled students in each of his seminars to take notes on a rotating basis. He would then check each set of notes, make the corrections he deemed necessary, and shared them with the whole class.

[36] D. Kaplan and R. Montague, *Research in Metamathematics*, NSF grant application, 1968 (Montague B. 27 f. 2).

[37] Same as note 36.

[38] Letter from Gaffney (NSF) to Montague, 11 February 1969 (Montague B. 27 f. 2).

[39] R. Montague, *Research in Metamathematics, Linguistics, and Scientific Philosophy*, NSF grant application, 1969 (Montague B. 27 f. 2).

[40] A. Church's review of R. Montague, *Research in Metamathematics, Linguistics, and Scientific Philosophy*, NSF grant application, 1969. Dated 2 May 1969. (Owned by the author).

[41] Barbara Partee has extensively and thoroughly discussed Montague's influence and legacy in Partee [5,6], among other papers of hers dedicated to the history of formal semantics.

[42] Interview with Janet Gallin, San Francisco, 5 July 2013, and e-mail message from Janet Gallin, 5 July 2013.

[43] Lewis ([51], Ch. 4) ends with a brief discussion on how the notion of convention is what is needed to make sense of the analytic vs. synthetic distinction—a section that feels like a due to his advisor Quine. In Lewis ([52], Ch. 4), this section is completely omitted and the analytic vs. synthetic distinction is only briefly mentioned in the final conclusions (Lewis [51] doesn't have any final conclusions).

[44] A footnote refers to Lewis [53] and Montague [1].

[45] Partee ([37], § 4, p. 31) and Ede Zimmermann's homepage: https://thomas-ede-zimmermann.de/ (accessed on 4 February 2026).

[46] "Stufenweise Einführung in Montagues *Universal Grammar* und *The proper treatment of quantification in Ordinary English*", from Sebastian Löbner's professional website: https://www.ling.hhu.de/semantik-pragmatik/team/sebastian-loebner (accessed on 15 January 2026).

[47] Ede Zimmermann noted that the categorial notation that Montague "used in PTQ was not part of his general theory; in fact, the non-categorial syntax of the UG-fragment was more sophisticated but for some reason largely ignored by the semantic community (a notable exception being Arnim von Stechow)" (e-mail message, 15 January 2026).

[48] Thanks to Ede Zimmermann for reminding me that the ubiquity of functional types in natural language semantics is due to Montague (e-mail message, 15 January 2026).

[49] Interview with Terence Parsons, Irvine, California, 26 August 2013. Terence Parsons had been working on the semantics of English even before encountering Montague's work. He had the manuscript *A Semantics for English* circulating in 1968 [63]. The influence of Montague's work on Parsons' work is apparent in later versions of the manuscript (e.g., [64]). Parson never published any version of his manuscript.

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