Montague's "Linguistic" Work: Motivations, Trajectory, Attitudes

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Abstract. The history of formal semantics is a history of evolving ideas about logical form, linguistic form, and the nature of semantics (and pragmatics). This paper discusses Montague's work in its historical context, and traces the evolution of his interest in issues of natural language, including the emergence of his interest in quantified noun phrases from a concern with intensional transitive verbs like *seeks*. Drawing in part on research in the Montague Archives in the UCLA Library, I discuss Montague's motivation for his work on natural language semantics, his evaluation of its importance, and his evolving ideas about various linguistic topics, including some that he evidently thought about but did not include in his published work.

Keywords: formal semantics, formal pragmatics, history of semantics, Richard Montague, Montague grammar, logical form, linguistic form, intensional verbs, generalized quantifiers.

1. Introduction

The history of formal semantics is a history of evolving ideas about logical form, linguistic form, and the nature of semantics (and pragmatics). This paper[1] discusses Montague's work in its historical context, and traces the evolution of his interest in issues of natural language, including the emergence of his interest in quantified noun phrases from a concern with intensional transitive verbs like *seeks*. Drawing in part on research in the archived Montague papers in the UCLA Library, I discuss Montague's motivation for his work on natural language semantics, his evaluation of its importance, and his evolving ideas about various linguistic topics, including some that he evidently thought about but did not include in his published work. For a good overview of Montague's work and its changes over time from a logical and philosophical perspective, see (Cocchiarella, 1981).

For present-day formal semanticists, the historical context of Montague's work includes both the linguistic wars between Generative Semantics and Interpretive Semantics and the philosophy of language wars between Ordinary Language Philosophy and Formal Language Philosophy. In Montague's own work, it was the latter that was more important, and probably even more important were the developments in logic and philosophy that had taken place from Frege to Russell to Carnap and Church and especially Montague's teacher Tarski. For reasons of space,

[1] This paper differs substantially from the talk I presented at Sinn und Bedeutung in September 2012; here I have omitted virtually everything about the history of formal semantics before Montague and after Montague, which would have overlapped considerably with (Partee, 2011) and (Partee, In Press), and have added much more about Montague's work. I am grateful for comments and discussion to Hans Kamp, Rich Thomason, Nino Cocchiarella, Ivano Caponigro, and Theo Janssen, to the audiences at Sinn und Bedeutung in Paris in September 2012 and at my Baggett Lectures at the University of Maryland in November 2012, and to the many colleagues who have given me interviews in the last two years. For this paper I am particularly indebted to the UCLA Library's Department of Special Collections, where the Richard Montague papers have been curated and stored. All references to notes of Montague's found in Box n, Folder m, are to materials from that collection. All mistakes are my own.

I'm omitting discussion of that background here; see, for instance, (Cocchiarella, 1997, Feferman and Feferman, 2004, Huck and Goldsmith, 1995, Partee, 2011, Partee, In Press, Tomalin, 2006). I presuppose some familiarity with the basics of Montague's work in formal semantics; see (Dowty et al., 1981, Gamut, 1991, Link, 1979, Partee, 1975).

2. The beginnings of Montague's "linguistic" work

2.1. Montague's early work

Montague's early work was philosophical and logical rather than explicitly natural-language oriented, as was true of Frege, Carnap, Tarski, and others whose work is now seen as foundationally central to formal semantics. Montague would have contributed greatly to the development of formal semantics with his development of intensional logic and his combination of pragmatics with intensional logic (1970b, Montague, 1970c), even if he had never written his last three papers. The intensional logic he developed unified modal logic, tense logic, and the logic of the propositional attitudes. In a paper delivered orally in 1955 and published as (Montague, 1960)[2], Montague started from Carnap's notion of logical necessity as truth in all models and extended it with relations between models with which he was able to show the parallels among logical necessity, physical necessity, and obligation (deontic necessity), and the parallels between these notions and universal quantification.

In that first paper, Montague, like Kanger, did not distinguish between worlds and models, but did make use of different accessibility relations to model different sorts of modal logics. This is a modal logic paper, containing nothing about natural language *per se,* but it does have some insightful discussion of puzzles of subjunctive conditionals and the possibility of regarding them as elliptical for versions with explicit "On the evidence that X" phrases.

Another early paper, joint with Donald Kalish (Montague and Kalish, 1959), addresses difficulties with the application of Leibniz's principle in embedded *that*-clauses. The paper is concerned with the combination of *that*-clauses and quantification, and with reconciling apparent problems in the application of formal logic to ordinary language. "The difficulties of this type 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" (p. 84)[3]. Montague and Kalish resolve the difficulties by a particular means that is not related in any obvious way to Montague's later 'grammar' papers, but it shows some of his early concern with logical structure and ordinary language.

[2] Montague says in the first footnote to that paper that originally he did not plan to publish it, but was doing so now because "some closely analogous, though not identical, ideas have recently been announced by Kanger in (Kanger, 1957a, 1957b) and by Kripke in (Kripke, 1959)." This raises possible questions of priority, as some of my colleagues have noted; I don't know whether there is a copy of a 1955 handout in the Montague archives or not.
[3] Page numbers for Montague's articles all refer to their reprinted versions in (Montague, 1974).

In his later papers, as he got into 'formal pragmatics', he went further and treated both worlds and times as components of "indices", and intensions as functions from indices (not just possible worlds) to extensions. The strategy of "add more indices" was accepted from Dana Scott's "Advice on modal logic" (Scott, 1970), an underground classic long before it was published.

Montague also eventually generalized the intensional notions of property, proposition, individual concept, etc., into a fully typed intensional logic, extending the work of Carnap (1956), Church (1951), and Kaplan (1964), putting together the function-argument structure common to type theories since Russell with the treatment of intensions as functions to extensions.

2.2. Montague's work on pragmatics and intensional logic, with applications to philosophy

The immediate precursors to Montague's three centrally language-related papers were three papers developed in seminars and talks from 1964 to 1968: 'Pragmatics and Intensional Logic' ('P&IL'), (Montague, 1970c); 'Pragmatics' (Montague, 1968), and 'On the nature of certain philosophical entities' ('NCPE') (Montague, 1969). I'll refer to these as his three "middle papers".

In P&IL, Montague distinguished between 'possible worlds' and 'possible contexts'; contexts were introduced to treat the indexical character of such words as *now*, *I*, and *here* (this latter development represents joint ideas of Montague, Dana Scott, and Hans Kamp). In NCPE, he applied his logic to the analysis of a range of philosophically important notions (like *event*, *obligation*); this was all before he started working directly on the analysis of natural language.

That work, like most of what had preceded it, still followed the tradition of not formalizing the relation between natural language constructions and their logico-semantic analyses or 'reconstructions': the philosopher-analyst served as a bilingual speaker of both English and the formal language used for analysis, and the goal was not to analyze natural language, but to develop a better formal language. Montague's work on the formal treatment of natural languages came only with his last three papers, "English as Formal Language" (EFL) (Montague, 1970a), "Universal Grammar" (UG) (Montague, 1970b), and the last and most famous, "The Proper Treatment of Quantification in Ordinary English" (PTQ) (Montague, 1973).

P&IL was the first written, but the second or third published, of Montague's three middle papers. It was delivered as a talk in January, 1967, and originally submitted to an unnamed journal in November 1967, "but was withdrawn after two and one-half years because of the great delay in its publication; it was thus intended to appear before either [Pragmatics] or [NCPE], for both of which it supplies a certain amount of background" (Montague, 1970c, p. 119). His starting point is Bar-Hillel's idea that pragmatics should concern itself with indexical expressions, and his main idea is to develop a theory of pragmatics as a theory of "truth and satisfaction with respect not only to an interpretation but also to a context of use" (p.120). What he presents is a general treatment, due to joint work by Dr. Charles Howard and himself, that subsumes as special cases earlier treatments by himself and by Cocchiarella of "personal pronouns, demonstratives, modal

operators, tenses, probability operators, context ambiguity, and direct self-reference" (p.120). In a footnote he says that the treatment of those special cases was reported in a talk for the UCLA Philosophy Colloquium in December 1964; the treatment of those cases in the framework of the present paper is promised for a later publication. Although Thomason in an editor's note (p. 120) added that that later publication was apparently never completed, it seems clear now that the "later paper" that Montague refers to here is 'Pragmatics', which was written after this one although published earlier. Thomason agrees (p.c. February 3, 2013).

Montague goes on in P&IL to improve on the joint Montague-Howard approach by the introduction of an intensional language, introducing intensions first and defining extensions in terms of them. Some parts of the development are credited to joint work with J.A.W. Kamp, including the part that leads to this: "We thus have a reduction of pragmatics to intensional logic which amounts, roughly speaking, to treating one-place modalities (that is, relations between points of reference and sets of points of reference) as properties of propositions" (p. 136.) He includes an account of belief-sentences and of sentences with *seems* as in ⌜*u* seems to be perfectly spherical to *v*⌝. And he refers to applications to metaphysics and epistemology discussed in NCPE, many of which also have linguistic repercussions.

'Pragmatics' (Montague, 1968), reporting talks given in 1964 through 1968, was intended to follow P&IL. Montague here gives a general definition of a pragmatic language and of its possible interpretations, of notions of extension and intension for such a language, of truth at a point of reference under an interpretation, and of logical consequence. He then goes on to discuss a number of "specializations" with corresponding relativized notions of consequence and validity, regarding these as "some of the special branches of pragmatics", including various tense logics, personal pronouns and demonstratives, generalized and special modal logics, various combinations of those, and the future subjunctive conditional, redoing all of these in the framework laid out in P&IL. Credit is given to work of Prior, Cocchiarella, Kamp, David Lewis, and Dana Scott. He also remarks that "a kind of second-order extension of pragmatics has been developed in [P&IL] and identified with intensional logic; what appears to be the first fully adequate treatment of belief contexts and the like is thereby provided. A number of philosophical applications of the enlarged system are given in [NCPE]." (p. 116.)

NCPE (Montague, 1969), the paper that's devoted to philosophical applications, contains a great deal that can be considered as much a matter of semantics as of philosophy, and foreshadows some of his work in his three final "language" papers. That paper corresponds to a talk he gave at UCLA in February 1967 under the title "On certain entities considered in metaphysics, epistemology, and ethics" and later in 1967 at the APA Western meeting under the title the published paper has. A version was also given in Vienna in September 1968 with the title "Hints at the philosophical relevance of intensional logic." There are two important credits in the first footnote: "I should like to express gratitude to my student, Dr. J.A.W. Kamp, who participated in discussions leading to that talk and to whom I am indebted for many valuable criticisms and suggestions, too pervasive to be mentioned specifically below; and to Professor Benson Mates, whose talk "Sense Data", given before the UCLA Philosophy Colloquium on November 18,

1966, largely provoked the present considerations." He also credits David Lewis and Charles Chastain for profitable conversations.

The main concern of the paper is the status of such entities as pains, events, tasks, and obligations. He notes that some philosophers prefer to ban them from the domain of entities and try to paraphrase them away. He believes that's possible sometimes, but that there are

> "other sentences that most of us on occasion accept and that entail the existence of such dubious epistemological, metaphysical, and ethical entities as pains, tasks, events, and obligations. I have in mind sentences like 'Jones just had a pain similar to the one he had yesterday', 'Not all psychological events have physiological correlates', 'God cannot perform every possible task', and 'Jones has not discharged all his obligations'. ... It therefore appears desirable to investigate the nature of the entities in question, construct an exact and convenient language in which to speak of them, and analyze the pertinent notion of logical consequence. The last task would seem a necessary preliminary to the rational treatment of certain philosophical paradoxes." (pp 148-49 in Montague 1974).

The sentences he cites as evidence for the need for such entities involve quantification and/or anaphora, recalling Quine's 'to be is to be the value of a variable'. And they are among the sorts of sentences that show up in the fragments of his last three papers. But here the main task involves constructing a logical language, not analyzing English. Yet as he proceeds, he spends a lot of effort (like most good philosophers of language) examining the semantic structure of English sentences. The very next paragraph after that one begins, "To see what an event is, consider the sentence 'the sun rose at eight'. This can be regarded as, in a sense, made up of two linguistic components – the individual constant (or definite singular term) 'eight' and a formula (or open sentence) containing one free variable – 'the sun rises at t'." (p 149) Then he goes on to consider the relation between the event of the sun's rising and that formula, examining various possibilities. (He settles on taking the event of the sun's rising as the property of being a moment at which the sun rises, i.e. analyzes (instantaneous generic) events as (a certain class of) properties of moments of time.)

The important passage in that paper with respect to Montague's program in general occurs on pp. 154-56, explaining his change from believing that philosophy should be done in the framework of set theory ("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" p. 154) to believing that it should be done in the framework of intensional logic, and announcing his claim that he has constructed an adequate intensional logic. ("One system of intensional logic now exists which fully meets the objections of Quine and others, which possesses a simple structure as well as a close conformity to ordinary language, and concerning the adequacy of which I believe no serious doubts can be entertained[4]." (p.156) For additional technical details, arguments

[4] At this point in the paper, he inserts footnote 4: "This system was constructed by me on the partial basis of ideas of Kripke and Cocchiarella, reflects in my judgment the intentions of Frege (1892), was presented, along with other

concerning adequacy, and applications to belief contexts, he refers the reader to P&IL. This big "framework" change in Montague's approach to logic and philosophy is described and discussed in (Cocchiarella, 1981).

The Mates problem about 'sense data' mentioned in the acknowledgement, which 'provoked' this paper, is described on pp 169-170.

> Now Benson Mates (in the talk to which the introductory footnote refers) raised the interesting problem of describing in an exact way such situations as that about which we might ordinarily say
>
> (19) 'Jones sees a unicorn having the same height as a table actually before him';
>
> It was this problem that gave rise to the present paper, as well as to the construction of the intensional logic which it contains. In the light of that logic, the treatment of (19) is fairly obvious. Since we have decided to use 'sees' only in the veridical sense, we must first reformulate (19) as
>
> 'Jones seems to Jones to see a unicorn having the same height as a table actually before him'.
>
> And this can be represented as follows:
>
> (20) $\exists x$ (Table [x] & Before [x, Jones] & Seems [Jones, Jones, $\hat{}\lambda u \exists y$ (Unicorn [y] & Sees [u,y] & y Has-the- same-height-as x)]).

So Montague realized that Mates had considered a nice solution but rejected it because it would require "quantifying into" indirect contexts (here with *a table*), which before P&IL it seemed could not be done intelligibly. Thus Montague was motivated to further develop his intensional logic and to demonstrate that it had useful applications in the domain of such problems.

He goes on to note that we *can* provide for sense data if we wish – he has already considered the nature of pains, which are one class of sense data – but quantifying into *seems* contexts is now possible and therefore examples like Mates's do not *force* the admission of sense data as entities.

2.3 Montague's turn to the analysis of natural language

No one seems to know for sure why exactly Montague decided to turn his attention to the task of explicitly constructing a formal framework for the syntactic and semantic description of language. All of his last three papers, EFL, UG, and PTQ, were devoted to the project of providing a comprehensive semantical theory applicable to formal and natural languages alike, and showing how it could be applied to fragments of English. His change of direction came as a

material, in a talk before the Southern California Logic Colloquium on January 6,1967, and appears in Montague (1970c). The system outlined below differs from the one in Montague (1970c) in one inessential respect only: in Montague (1970c) the set of possible individuals is required always to coincide with the set of individuals that exist in some possible world."

surprise to some of his colleagues; Solomon Feferman, for instance, had been working with Montague on a book on the method of arithmetization of metamathematics and some of its applications, incorporating the results of both of their dissertations (both under Tarski). And up until his last years, about half of Montague's seminars had been devoted to the mathematical side of logic. A great deal the joint book was written, but before it could be completed, their paths diverged, Montague's principally in the direction of his "linguistic" work. To Feferman, Montague's work on formal semantics of natural languages came "out of the blue" (Solomon Feferman, p.c. January 10, 2011).

With clues from several sources, a picture seems to be emerging. It seems clear that what Montague most valued intellectually were logical and philosophical results. He clearly considered the empirical description of natural language a matter of secondary importance; but he was not satisfied with what linguists were doing, felt he could do better, thought it was probably worth the small amount of effort he believed it would require, and I think increasingly took pride in his results and perhaps even began to consider some of the puzzles of natural language semantics to be non-trivial.

For many years, as I reported in (Partee, 2011), I had thought that Montague's interest in formalizing the syntax and semantics of natural language had come from his work with Kalish on their joint textbook (Kalish and Montague, 1964), which was unusual among logic textbooks for the degree of explicitness with which they treated the matter of translating from logic to English and vice versa[5]. Somewhere long ago, I don't remember from whom, I picked up the belief that it was from that process that Montague got the idea that it must be possible to give a precise formal treatment of the syntax and semantics of English in the same manner as was customary in logic.

In 2009 and 2010 I asked Hans Kamp and Nino Cocchiarella, both of whom did their PhD's with Montague and are cited in a number of his papers, what they thought. Condensing what I reported of their replies in (Partee, 2011):

> From Kamp (e-mail, October 2009): Developing a model-theoretic semantics for NL (natural language) is a somewhat different enterprise. Here the focus is clearly, naturally and inevitably on conditions of truth and reference; and in and of itself developing a model-

[5] Here is an excerpt from an anonymous referee's report on a revision of the manuscript, sent to Kalish and Montague by their editor at Harcourt, Brace & World, Inc. in May, 1962: "In my previous report (second paragraph, page 4) I commented on the possibility that this manuscript could become the best presentation in the current field on the translation of English sentences into symbolic form. In the earlier report I mentioned explicitly only Chapters I and III. This potential has been realized in the present manuscript. It is a measure of the work the authors have done that instead of signalizing just two chapters in the relevant respect, one may now elevate to this significant status Chapters I, II, III, IV, VI, and VII. The development has been realized partly by sectioning and, in this process, adding new sections with additional material, but mostly by improvement in the exposition. In other words, all of the chapters devoted to the usual elementary topics of symbolic logic now have first-rate material on translation from English into symbols and, as an additional emphasis, on translation from symbols back into English."

> theoretic semantics is not the same thing as defining a translation function from NL to Predicate Logic (not even when the models used in the model-theoretic semantics are models for Predicate Logic). However, a model-theoretic account of NL meaning can be used as a criterion (either as the only one or as one among others) for adequate translation. And of course, as became plain in Richard's later papers on NL semantics (not EFL, but UG and PTQ), a translation function could also be useful as a way of articulating a model-theoretic treatment.
>
> From Cocchiarella (December 2010): [Montague's] early work on pragmatics and intensional logic had not yet [in the mid 60's] affected [his] basic philosophical view: namely, that all philosophical analyses can be carried out within a definitional extension of set theory, which explains why in "English as a Formal Language" Montague uses set theory to construct the syntax and semantics of a fragment of English in a way that resembles the construction of the syntax and semantics of a first-order modal predicate calculus.
>
> But Montague did not remain satisfied with set theory as a *lingua philosophica*, nor with unprincipled 'paraphrasing' between natural language and logical language, and in the end he proposed instead the construction of an intensional logic as a new theoretical framework within which to carry out philosophical analyses[6] … .
> Once Montague moved on to an intensional logic we have a distinctive new tone about English and natural language in his papers ... .

Then while working in the Montague archives at the UCLA library in January 2011, I found a new clue about Montague's motivations, not inconsistent with either Kamp's or Cocchiarella's opinions, but adding two quite different factors.

Attached to a handout of an early talk version of "English as a Formal Language", July 31, 1968, UBC, Vancouver, is a page in Montague's handwriting of remarks he apparently made in introducing his talk, but didn't include in the handout itself. There Montague wrote,

> This talk is the result of 2 annoyances:
> - The distinction some philosophers, esp. in England, draw between "formal" and "informal" languages;
> - The great sound and fury that nowadays issues from MIT under the name of "mathematical linguistics" or "the new grammar" – a clamor not, to the best of my knowledge, accompanied by any accomplishments.
>
> I therefore sat down one day and proceeded to do something that I previously regarded, and continue to regard, as both rather easy and not very important – that is, to analyze ordinary

[6] Cocchiarella's description fits Montague's statement in NCPE quoted above; the only apparent discrepancy is that NCPE preceded EFL; but the talks they were based on were not so clearly ordered. NCPE is based on talks given in early 1967; EFL is based on material in seminars in 1966 and talks in 1968.

> language. I shall, of course, present only a small fragment of English, but I think a rather revealing one[7].

To this formal semanticist, discovering what Montague had said about regarding the task as being both rather easy and not very important came as something of a rude shock. In the next section I further explore his attitudes concerning the importance of such work, together with some evidence to support my own feeling, and Hans Kamp's, that he did nevertheless find the task of some interest and not without occasional challenges worthy of his efforts. As for the three principal papers EFL, UG, and PTQ, many pages have been devoted to them[8]; here I will allude to them only in remarks about the progressions of Montague's interests and concerns.

3. Montague's attitudes toward developing analyses of ordinary language

As to what Montague considered important, we have first of all the fact that he was Tarski's student. "Montague had been socialized in the mathematical logic community that Tarski had managed to establish in Berkeley, and thus in a community in which publications without 'deep' theorems (which I take to mean: 'theorems whose proofs are substantially harder than what it takes to formulate them and to understand what they say') don't count for much." (Hans Kamp, p.c. December 13, 2012)

"It's interesting to wonder whether he would have lost interest after PTQ, or that people like you might have been able to convince him that developing the formalization was anything but drudgery, and anything but uninteresting. Even so, I think he might well not have pursued this project, because I believe Richard's self-esteem was bound up with proving significant, difficult theorems." (Rich Thomason, p.c. March 2011.)

"I agree that Richard's self-esteem was bound up with proving important theorems. … I suspect that up until the early sixties Richard did not think that there were any important theorems in linguistics, perhaps because he thought of it as an empirical science and that there were no important theorems to prove." (Nino Cocchiarella, p.c. December 19, 2012.)

Montague is quite explicit about attaching more importance to the development of a good formal language than of a formal treatment of natural language. In his remarks in the 1967 symposium on "The Role of Formal Logic in the Evaluation of Argumentation in Natural Languages" organized by Bar-Hillel as part of the 3rd International Congress for Logic, Methodology and Philosophy of Science in Amsterdam, of which a transcript edited by Frits Staal (and by the

[7] Montague had added a note to insert: "Other creditable work: Traditional grammar, Ajdukiewicz, Bohnert and Backer, JAW Kamp." The Bohnert and Backer reference is to (Bohnert and Backer, 1967), which he cites in EFL, noting that although their work antedates his, he had not seen it until he had developed his own treatment. He remarks that his treatment of quantification bears some resemblance to theirs, and that like him, they developed an idea tentatively suggested in (Quine, 1960) that a predicate like *is a horse* can be treated with the usual *is* of identity and the indefinite singular term *a horse* treated, as usual, existentially. This is a reasonable analysis in isolation, but I argued against it in (Partee, 1986).

[8] See, for instance, (Cocchiarella, 1981, Janssen, 2011, Partee, 1997, Stokhof, 2006).

contributing authors) was published in 1969 (Staal, 1969), Montague says:

> As far as the main points are concerned, let me say first that 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. I might add that our treatment [relies on] certain recent developments in intensional logic … Thus the methods developed in connection with artificial languages can be employed to yield completely precise, and not at all 'rough' or 'unprincipled', notions of truth and logical consequence for significant fragments of natural language. Yet, although I have myself devoted some time to this goal, I somewhat question its importance. … Is it really so important … to be able to establish conclusively that a given argument in a natural language is invalid? I believe that as the scope of exact artificial languages is enlarged, people will begin to use them for argumentation; witness the gradual abandonment of ordinary language by mathematicians between 1875 and the present. … In this context it would appear more important to extend the scope of constructed systems than to discover the exact rules of natural languages. (pp. 273-75)

In a number of his writings we can find some ambivalence about the importance of the task of formalizing natural language. In the first of his three "linguistic" papers, EFL, he includes with his treatment of quantifier scope ambiguities some remarks that indicate both the seriousness with which he takes the analysis of natural language and a continuing belief that natural language is not as well-suited to exact philosophical analysis as a well-designed formal language can be:

> Two special points should be noted. Within our treatment ⌜the⌝ introduces ambiguities of scope (or of order of construction) of exactly the same sort as those associated with ⌜every⌝ and ⌜a⌝. Further, English sentences contain no variables, and hence no such locutions as ⌜the v_0 such that v_0 walks⌝; ⌜the⌝ is always accompanied by a common noun phrase. In these two features virtually all artificial theories of descriptions differ from English, as well they might: it is sometimes desirable to avoid ambiguity, and the introduction of bound variables in place of property names permits a first-order treatment of a good deal of what would otherwise require nonelementary second-order methods.
>
> The moral for artificial languages ought I think to be this. If such a language is to avoid ambiguity completely, or is to fit within a first-order framework, then it should not attempt in its theory of descriptions to mirror English too closely; it should rather be influenced by other considerations, for instance, simplicity. (pp. 216-17)

We see continuing ambivalence, together with a bit of arrogance in his certainty that when he cares to think a bit about it, he can analyze natural language better than linguists or other philosophers had been doing, as early as (Montague, 1969) (NCPE):

> Neither of the forms of expression we consider in this paper, that is, a language applying to a single instant and a tenseless language referring explicitly to many instants, is a close approximation of ordinary English. A much closer approximation would be a formal language that combines tenses with modalities and perhaps in addition allows, but does not require, explicit reference to instants; event names in such a language could be made to look more like their English counterparts. It is perfectly clear how to construct and interpret a language of this sort, on the basis of Montague (1968) and the discussion in Prior (1967, pages 103-105) (later elaborated in unpublished work of Kamp) of how to fit the phrase 'at *t*' into the framework of tense logic; one feature would be the replacement of possible worlds by ordered pairs consisting of an instant and a possible world. I do not introduce this more elaborate development, because the points I wish to make can also be brought out, albeit at the expense of some awkwardness, in connection with the simpler tenseless language. (from footnote 16, p. 174)

And in the discussion of the absence of a category for representing *a unicorn, every unicorn, the unicorn* as constituents in his intensional logic: he knows how to do it, and the linguists don't, but he can't be bothered to "supply the details here" (he did later, in PTQ):

> For instance, 'x seeks a unicorn' and 'x seeks all unicorns' either would be treated in the earlier way, in terms of 'tries to find', or else would be represented by means of predicate constants or locution symbols bearing no special relation to the one used for 'x seeks y'. This is a situation which I believe could be relieved, but only after one has provided a general and adequate treatment of indefinite terms in English. Such a treatment can indeed be devised without much difficulty,[fn 20] and would suggest a further extension of our formal language; but it would lead us too far afield to supply the details here.
>
> Fn 20: I am aware that some mathematical linguists have attempted treatments of indefinite terms; but I do not refer to their attempts, which can only be regarded as inadequate for precise scientific purposes. (p. 183)

A particularly nice example of his ambivalence comes in EFL, where he talks about how one could add reflexive pronouns to make the language more accurately reflect normal English. His meta-attitude is rather dismissive of figuring out linguistic details, but he's quite clever about how one might do it and I think rather proud of it.

In the text, noting that he just uses anaphoric 'that N' where English distinguishes between plain and reflexive pronouns, he says (p 198),

> As another example of S9, notice that ⌜every man loves that man⌝ can be obtained from ⌜v_0 loves v_0⌝; here it would be much more natural to say ⌜every man loves *himself*⌝. It would be quite possible to give rules providing for such locutions, but I decline to do so because of the rather uninteresting complications that would be involved.)

But then he gives a page-long footnote explaining how he would do it, with very interesting ideas about reflexivization depending on (and hence giving evidence for) co-argumenthood.

These ideas were developed in (Bach and Partee, 1980) and (Partee and Bach, 1981), and later much further developed and refined in (Reinhart and Reuland, 1993). He starts that fertile footnote with the ambivalent "There may, however, be some interest in the following tentative observation, which would be relevant to the formulation of such rules."

By the late 1960's, when he was putting a great deal of his energy into the formalization of natural language, he seems to have been treating that work with more respect, and seems to have found it quite interesting. Cocchiarella reports, "Hans and I both worked on tense logic under Richard, and I believe Richard was clearly influenced by what was going on with the analysis of language. Indeed, I believe that in the end he was driven to add his own contributions to all that was going on because he began to see that that kind of project was interesting and worth doing after all." (Nino Cocchiarella, p.c. December 26, 2010.) And Hans Kamp writes, "From what I can remember from the many hours that Richard allowed me to be part of and a witness to his own research, his interest in natural language was genuine. And even if he started out in the vein of 'it is all much simpler than you linguists all think, if you only start out from the right premises and use the right methods', he was far too intelligent not to see the problems that come into focus once you sit down in an attempt to get the details of the syntax-semantics interface really right." (p.c., December 13, 2012)

It's also interesting to compare how he introduces his three "linguistic" papers. Both EFL and UG start with variations on his contention that there is no important theoretical difference between formal and natural languages, and both emphasize the importance of the intensional logic he has developed. PTQ, on the other hand, starts right in about natural language: "The aim of this paper is to present in a rigorous way the syntax and semantics of a certain fragment of a certain dialect of English. For expository purposes the fragment has been made as simple and restricted as it can be while accommodating all the more puzzling cases of quantification and reference with which I am acquainted." (p. 247). In all of his philosophical writings, we see his desire to solve significant puzzles; in PTQ, we first see the honorific description "puzzle" applied to linguistic phenomena. On the next page, we see even more clearly his sense of achievement in taking on some worthy puzzles (in a passage that of course makes me smile): "The present treatment is capable of accounting for such examples, as well as a number of other heretofore unattempted puzzles, for instance, Professor Partee's **the temperature is ninety but it is rising** and the problem of intensional prepositions." (p. 248).

He gives a good summary of his attitudes and priorities, along with his pride of accomplishment, at the end of this opening statement at the Bar-Hillel symposium in 1967:

> Let me summarize the situation as I see it. Professor Bar-Hillel maintains that no one has yet given precise and reasonable definitions of such notions as logical consequence that are applicable to arbitrary sentences of, say, English. We have, however, perfectly satisfactory versions of these notions for certain fragments of English -- first, for that very narrow fragment that consists of the 'literal translations' of formulas of ordinary extensional logic, and now for more comprehensive fragments. How can the scope of the formal treatment be further enlarged? The most practical course is, I believe, to attempt *first* to extend the scope

> of constructed languages and to investigate their model theory, and only then to treat an extended portion of English. The latter treatment could proceed either by developing exact procedures of symbolization, or directly, employing the methods and insights achieved in connection with the simpler and more transparent constructed languages. (If this is the objective, the sort of symbolic language to be constructed would of course be influenced by the recognition of problematic features of English.) I see no theoretical obstacle to a completely successful analysis of logical consequence for ordinary language. (Staal, 1969, pp. 275-76)

And the ending of NCPE is also a good summary of his evaluation of the enterprise at that time:

> What I have said about events is certainly incomplete and not completely certain; but I have reason to hope that the ambiguities I have pointed out will confirm two points sometimes mistakenly supposed incompatible: there is philosophic interest in attempting to analyze ordinary English; and ordinary English is an inadequate vehicle for philosophy. (Montague, 1969, p.186)

4. From intensional verbs to generalized quantifiers.

Montague's primary motivation was always logic and the use of logic in philosophical arguments. He explained why that merited some attention to natural language semantics; but Montague's interest in language and languages seems to have gone beyond what was "required", even if he didn't value that interest highly. In high school, he studied Latin and Ancient Greek. As an undergraduate at Berkeley, he studied mathematics, philosophy, and Semitic languages. He continued graduate work in all three areas, especially with Walter Joseph Fischel in classical Arabic, with Paul Marhenke and Benson Mates in philosophy, and with Tarski in mathematics and philosophy, receiving an M.A. in mathematics in 1953 and a Ph.D. in philosophy in 1957.

There is a tantalizing and cryptic paragraph in Montague's 1967 comments in (Staal, 1969)[9]:

> Perhaps the most important applications of a formal treatment will occur in the realm of prehistory. Indeed, certain pairs of natural languages, hitherto, on the basis of relatively superficial criteria, considered unrelated, appear now to exhibit identical idiosyncrasies in very basic formal features; it would be difficult to account for these similarities except on the hypothesis of a common origin or very early, as yet unsuspected, historical interaction. (p. 275).

In this section I sketch what I currently see a partial picture of the trajectory of Montague's interest in "linguistic" topics, the topics that came to the center in his last three papers and laid the basis for Montague grammar. The picture is partial for many reasons: his papers and the notes he left behind often return to the same topics over considerable intervals with greater or

[9] I have not so far found any other notes or references to the work he alludes to here.

lesser changes, so a linear development is not to be expected; and I have still only scratched the surface of the materials he left behind, have not completed the interviews I am doing for my book-length project, and have not transcribed all of the interviews I do have. What I offer here is a way to connect the dots between Montague's early work on intensional contexts to his later work on generalized quantifiers in UG and PTQ. Then in Section 6, I describe just a small bit of the wealth of unfinished work that can be found in his folders of notes in the Montague archives.

Montague's earliest concentrated work on language-related topics seems to have taken place in the spring of 1966, much of which he spent in Amsterdam, where he gave a seminar on the philosophy of language. Notes from that period show an occupation with pragmatics and indexicality, and with problems of intensional contexts. He gave a talk on "Pragmatics" as early as December 1964, which is explained by what Cocchiarella told me (p.c. Dec 26, 2010): "Prior spent the 1964-65 academic year at UCLA, incidentally, and, according to Montague (in a personal communication to me), it was then that Prior, as a result of Montague's influence, began to have a greater interest in a more rigorously formal approach to the analysis of language. Prior, of course, also influenced Montague, especially about pragmatics and intensional logic." Montague was also corresponding with Bar-Hillel in those early years, when Bar-Hillel was advocating that pragmatics should provide a formal theory of indexical terms.

The other main topic that seems to have concerned Montague from very early on is modal and intensional contexts, including the puzzles about intensionality raised by Quine (1960) (and by Buridan, as Montague notes in NCPE). That family of problems was under active discussion among a number of philosophers Montague was influenced by, including Mates, Carnap, and Church, and is reflected in Montague's first two papers in the 1974 collection, from 1959 and 1960. Montague was clearly interested for some time in the problem of intensional verbs like *seeks* and *conceives*; Michael Bennett (1974) notes that we find a suggestion from Montague to Geach about how to treat intensional verbs reported in (Geach, 1965, p.432).

The particular problem of quantifying in to modal and other opaque contexts seems to have occupied Montague's attention as he was developing his intensional logic; see the discussion above of the Mates talk that provided the impetus for his NCPE, whose associated 'talk' was in 1967. NCPE is full of discussion of intensional verbs, and in particular the transitive intensional verbs *seeks, owes, worships, conceives*.

In NCPE much of the attention seems to be on the ontology: do various arguments drive one to admit such 'dubious entities' as sense data, events[10], obligations, pains? But much of the discussion focuses on how to analyze key examples containing intensional transitive verbs, including (for the sense data discussion) sentences with non-veridical *sees*, like Mates's earlier-mentioned example (19), repeated below.

[10] His concern with events can be separated from his concern with intensionality; it is more connected with his interest in time and tense logic and with his occasional exchanges of ideas and papers with Donald Davidson. Ideas about events recur in his work in the late 1960's, but I won't address them here.

(19) Jones sees a unicorn having the same height as a table actually before him.

Since Montague in NCPE countenanced only veridical *see*, he paraphrased the reading Mates was considering by (ii) (before analyzing it with the formula (20) given earlier):

(ii) Jones seems to see a unicorn having the same height as a table actually before him.

Montague notes that this path to analyzing the sentence, considered but rejected by Mates, had become possible only because of Montague's then-new intensional logic.

But he notes that there are still some kinds of examples he cannot handle straightforwardly because he does not have any semantic category corresponding to quantified noun phrases. It is at this point that I think we see the beginning of the path from intensional puzzles to the generalized quantifier treatment of noun phrases.

In NCPE he analyzes sentences with *seeks* via paraphrase. He wants to show why, as Quine (1960) had noted, the argument in (9) is not valid, although the analogous argument with *finds* is valid.

(9) 'Jones seeks a unicorn; therefore there is a unicorn'

He first describes a solution that rests on analyzing *seek* as *try to find*, symbolizing (9) as (10), which puts the existential quantifier for *a unicorn* in the premise under the scope of an intensional operator[11].

(10) Tries [Jones, ^λ*u* ∃*x* (Unicorn [*x*] & Finds [*u*, *x*])]; therefore ∃*x* Unicorn [*x*].

He then goes through a similar argument for *owe,* analyzing 'a owes b to c' as 'a is obliged to give b to c', to solve an analogous puzzle posed by Buridan. Then he raises the question of whether resorting to these paraphrases is necessary.

> The solution proposed in these two cases is substantially to reject 'seeks' and 'owes' as predicate constants, and to insist on circumlocution when we might be tempted to use those verbs. **We may wonder whether it is possible to approximate English more closely within our intensional language.** What we can do in the case of 'seeks'—and that of 'owes'

[11] The idea that intensional contexts are all contexts that embed a proposition was widespread at the time. Montague made a small step away from that idea by countenancing embedded properties as infinitival complements of verbs like *tries*. At this stage his intensional logic (the one presented in P&IL) was second-order; his fully typed intensional logic didn't come until UG. On the continuing controversy about whether all intensional contexts should be propositional contexts, and the proper treatment of *seek,* see (Larson et al., 1997, Partee, 1974, Zimmermann, 1993)

would be completely analogous—is to introduce *several* predicate constants[12]; and it would be possible to define them by means of the following equivalences: [emphasis added, BHP]

(14) $\Box\forall x\forall y(x$ Seeks $y \leftrightarrow$ Tries $[x, \hat{}\lambda u$ Finds $[u, y]])$,
(15) $\Box\forall x\forall P(x$ Seeks-a $P \leftrightarrow$ Tries $[x, \hat{}\lambda u\ \exists y\ (P[y]$ & Finds $[u, y])])$.
(16) $\Box\forall x\forall P(x$ Seeks-the $P \leftrightarrow$ Tries $[x, \hat{}\lambda u\ \exists y\ (\forall z\ (P[z] \leftrightarrow z = y)$ & Finds $[u, y])])$.
(17) $\Box\forall x\forall P(x$ Seeks-two-objects-having $P \leftrightarrow$ Tries $[x, \hat{}\lambda u\ \exists y\exists z(P[y]$ & P$[z]$ & $y \neq z$ & & Finds $[u, y]$ & & Finds $[u, z])])$.
(p. 167)

He goes on to note (p.168) that this list can be expanded indefinitely on the pattern of (17), but then we find ourselves with infinitely many predicate constants, a feature he had criticized in Quine's "radical course of regarding 'seeks a unicorn' and all its analogues as unanalyzable predicate constants – a course that would raise the psychological problem of explaining how a natural language containing infinitely many primitive predicate constants can be learned." (p.165) And then we find the following remark, suggesting that he had already worked out the UG treatment of terms as generalized quantifiers: "If, however, we were to pass to a *third-order*, rather than a *second-order*, language, the situation would change: we should then be able to introduce a single predicate constant in terms of which all notions analogous to those introduced by (14)-(17) could be expressed; I shall give a more detailed account of the situation in a later paper." (p.168)

That passage in NCPE suggests that he had gotten the idea of making the direct object of *seek* be the intension of a generalized quantifier at some time before the publication of NCPE in April 1969, although he first published it in UG and more fully (GQs plus 'quantifying in') in PTQ. I have been unable to track down who had the idea of analyzing English noun phrases as generalized quantifiers first, Montague or David Lewis. Montague's UG and Lewis (1970) were both published in 1970; Lewis read that paper at a conference in La Jolla March 1-3, 1969. Now I have found some new circumstantial evidence that Montague may have made the discovery first, or at least independently.

In the Montague archives in Box 1, Folder 7, "Intensional verbs and Berkeley's argument", one of three folders[13] devoted to that topic[14], I've found three pages of notes from September 1, 1968,

[12] This solution analyzes the 'object' argument of *seeks-a, seeks-the*, etc., as a property, thus bearing some resemblance to Zimmermann's treatment of intensional verbs (Zimmermann, 1993), although it is by no means the same.
[13] Box 1, Folder 8 is labeled 'Intensional logic and some of its connections with ordinary language: talks". It includes two manuscripts for talks, one 'Indefinite terms, intensional verbs, and unconceived trees' for the L.A. Logic Colloquium, April 1969, and the other 'Intensional logic and some of its connections with ordinary language', delivered at the Association for Symbolic Logic in Cleveland, May 1, 1969. And Box 2, Folder 8 is labeled 'Intensional logic and some of its connections with ordinary language: notes". There are early ideas there about *seeks* (February 68), and *a unicorn* already makes an appearance then.
[14] Given how much there is about Berkeley's argument among the materials in the Montague archive, and how much of his work it seems to have motivated to some extent, it is surprising that Montague never discussed it in print. The

which seem to record his first idea about solving the problem of intensional transitive verbs by giving them "third order" arguments, properties of properties of entities, i.e. intensional versions of generalized quantifiers. I now suppose that that is the source of the comment in NCPE that such a thing could be done, an idea that came after the "talk" version of NCPE (early 1967) but before the final manuscript was submitted (presumably sometime in the fall of 1968). I quote from these pages to show both that the proposal is explicitly there and that it appears to be new to him at that time.

Page 1 begins with "We can improve on 25 Apr 68", followed by a section marked as to be deleted in which he analyzes sentences with *seeks* via formulas with *tries* and *finds*, as he did in (14)-(17) in the published paper. The second half of the page says "Try:" followed by three equations that are crossed out – they analyze *all R* and *an R* with formulas that mix lambdas and set-theoretic notation but are otherwise like the two formulas that follow. (Note that he did leave a mix of lambdas and set-theoretic notation in his formula for *the*-R below.) What follows on that page are proposed translations for term phrases, which he had never had before. These are essentially the translations we find in UG and PTQ, although there he didn't include the plural *two-R's*, and his universally quantified term phrase became the singular *every R* instead of plural *all-R*('*s*).

> *all-R* = $\hat{}\lambda Q\forall x[\ R[x] \rightarrow Q[x]\ ]$
> *an-R* = $\hat{}\lambda Q\exists x[\ R[x]\ \&\ Q[x]\ ]$
> *two-R's* = $\hat{}\lambda Q\exists x\exists y[\ x \neq y\ \&\ R[x]\ \&\ R[y]\ \&\ Q[x]\ \&\ Q[y]\ ]$
> *the-R* = $\hat{}\lambda Q\exists x[\ \{x\} = \{y\colon R[y]\}\ \&\ Q[x]\ ]$
> *Jones* = $\hat{}\lambda Q[\ Q$[Jones]] (with the "usual" denotation for the inner occurrence of 'Jones')
>
> Thus in general a term ζ of the sort above denotes the property of (being a property) applying to ζ.

Following that first page from September 1, we find the pages from April 25 that they are to replace; there he analyzes *u seeks the P* as *u tries to find the P*, and he writes out a formula for *u finds two P's* much like what we see in (17). He then had a note: "Perhaps the basic locution for *seeks* should be: *u seeks-all-objects-partaking-of-some-property-partaking-of P*", followed by several paraphrases and formulas. Clearly he was continuing to worry about *seeks two unicorns*, and was not yet satisfied with the formalization.

Then on page 2 of the pages dated 1 Sep 68, he works out '*u seeks an-R*' in this new third-order way and in his old *tries-to-find* way, and assuming as he did that *seek* is equivalent to *try to find,* he shows in three lines that they come out equivalent. And then he writes below that: "So this works." And then he checks the equivalences with *two-R*'s and with *all-R*'s.

---

argument in the form in which Montague summarized it is this (Box 1, Folder 7, in a set of handwritten pages dated 25 March 68): "It is impossible to conceive an unconceived tree. Nothing can exist which it is impossible to conceive. Therefore an unconceived tree cannot exist."

The "Try:" on page 1 and "So this works." on page 2 make it pretty clear that this was when intensional generalized quantifiers first occurred to him: they provided a solution to the problem of *seeks*. For *seeks*, he had been hoping to find a more natural formalization within his intensional logic, not paraphrasing the transitive verb away; and he believed that some intensional transitive verbs, including *worships, conceives,* and *thinks of*, and the intensional preposition *about*, can't be paraphrased with an embedded clause or infinitival phrase at all. (The claims about those three verbs and *about* were disputed in various ways by Michael Bennett in his dissertation (Bennett, 1974), but Bennett did not dispute the usefulness of the general idea, which he noted applies equally to nouns like *conception of*.)

There is no mention of David Lewis in any of Montague's three folders concerning intensional verbs. So although we still don't know anything about possible conversations between the two of them, these notes mean that the earliest known records now give the temporal priority for the generalized quantifier treatment of English NPs to Montague: September 1 1968 vs. March 1, 1969. That's very close, and I consider the question still open.

One historical detail that is clear from all the published and unpublished evidence is that Montague was greatly occupied with the analysis of intensional transitive verbs, and that his ideas about generalized quantifiers arose from that concern. The version of his intensional logic in which those intensional generalized quantifiers can be expressed is the version first published in UG and repeated in PTQ.

The English fragment of PTQ is the first in which generalized quantifiers occur together with bound-variable pronouns for which they are the antecedents: in that paper he introduces the rules for "Quantifying In" a term phrase into a sentence, a common noun phrase, or a verb phrase, giving an account of quantification, scope and anaphora that evidently satisfied him, judging by the title he chose for that paper. There too his motivation was to account for puzzles of intensionality, including examples of Karttunen's that I had told him about, like *John wishes to catch a fish and eat it*, which could not be generated in the UG fragment. There the content of such sentences could be expressed only with the help of predicate *such-that* locutions, as in *John wishes to be such that he catches a fish and eats it*. In PTQ the binding could be managed directly within the verb phrase.

What linguists found so interesting about Montague's treatment of English term phrases as uniformly denoting generalized quantifiers was how it offered a much better fit between syntax and semantics than had been possible using first-order logic: for the first time, the syntactic category NP (nowadays DP) could be assigned a semantic type. That was a crucial factor in defusing the "linguistic wars" between generative and interpretive semantics. And with the work of Barwise and Cooper (1981) and of Keenan and his colleagues (Keenan and Moss, 1985, Keenan and Faltz, 1985, Keenan and Stavi, 1986), the study of generalized quantifiers became one of the most active areas of research among linguists in formal semantics, focusing in part on long-standing puzzles about determiners and quantifiers and how semantics could help to solve them, and on the investigation of possible universals of determiner meanings. It is interesting to see in retrospect how different Montague's own concerns were. It's true that he kept searching for a way to analyze quantified term phrases as syntactic and semantic constituents; and it's well-

known that he insisted on having a function (not a 1-1 function, as is sometimes thought) from syntactic categories to semantic types[15], so that for instance all Term phrases must be given meanings of the same semantic type. But we see in the analyses in NCPE a willingness to countenance as "constituents" *seeks-a, seeks-all, seeks-the, seeks-two*; and even in PTQ he treats *believes-that* and *tries-to* as verbs. He was never a slave to surface syntactic constituency, since the semantically relevant "syntactic parts" could combine in ways other than concatenation, though he certainly considered it better, other things being equal, to try to respect both natural language syntactic structure and compositionality. What he was struggling with was how to characterize *seeks*, and especially the intensional verbs that he believed could not be paraphrased away with the aid of infinitival phrases or *that*-clauses, as a relation between an individual and a suitable intensional entity. To accommodate the full range of possible object noun phrases, he needed denotations that were higher-order but still intensional, and he then discovered that intensional generalized quantifiers were precisely what was required. (Linguists studying generalized quantifiers, ironically enough, normally disregard intensionality and work with extensional generalized quantifiers, sets of sets of entities.)

5. Some of Montague's unfinished work.

It has often been noted that although Montague in PTQ analyzed *every man, a man, the man* as term phrases, interpreted as generalized quantifiers, he did not put *every, the, a* into any category, but treated them syncategorematically. As subsequent work made clear, there is no obstacle to putting them into a category of Determiners, categorially representable as T/CNP in the notation of PTQ. Montague evidently thought about that, but didn't bother as long as he had only three determiners and was treating each of them as having a logical meaning, not as constants to be assigned interpretations in a model. But we see notes in which he was considering expanding the set of determiners, and then giving them a category. He has discussion in various places about treating *any* as a wide-scope universal quantifier and *a certain* as a wide-scope existential, and the complications that would be required in the syntax to enforce that. The student-written notes from Philosophy 260 in Winter 1968 include two pages of "An example of Prof. M's grammar: English" – just the syntax, in very formal form, but it includes *a, all, every, some, no, two, three, any, a certain, the*.

Later in Philosophy 262A in Fall 1968 (the first seminar of his that I sat in on, together with David Lewis and Frank Heny), he was evidently working on polishing EFL for publication, but also discussed ideas which didn't go into EFL. In one set of notes (Box 11, Folder 7, pp 22-27) from late in the quarter, there is a discussion of two "possible extensions" (of the EFL fragment, I believe), each of which requires some supplementary defined syntactic notions. One is "modern negation" (EFL had just used sentence-final *not* for syntactic simplicity), for which we "need to be able to single out *main occurrence* of *main verb* of a formula." And then there come some more notes about quantifiers. "To do 'all', need to single out *main noun occurrence* in order to pluralize correctly." (Montague had in mind to derive plural common noun phrases from singular ones.) And then the notes report him as going on to say, "Cardinals should be easy once we can

[15] The many-one correspondence requirement between syntactic categories and semantic types is part of the homomorphism requirement of Section 3 of UG.

do plurals. Since there are infinitely many, we would probably want to introduce Quantifiers as a syntactic category." In another folder among notes that seem to be related to EFL, we find a handwritten page with an early idea about including a category Q of quantifiers, including lexical "basic quantifiers": "BQ = {*every, no, the, a, only the, ~~all, 1, 2, …~~* }". As well as striking out the last ones, he added a marginal note "Probably no category". (Box 3, Folder 2. "Logical analysis in ordinary language")[16]

In fall 1969 and spring 1970, he was still worrying about plurals. I think he had definitely hoped to include various plural expressions in PTQ, but in the end he did not; he even had to spoil the symmetry of his treatment of *and* and *or* as connectives that can conjoin sentences, verb phrases, or term phrases by omitting *and* as a term-phrase connective, clearly in order to avoid plurality.

Box 1, Folder 5, "misc phil of lg research notes 1969 --." from fall 1969 and into summer 1970, is full of interesting examples he was thinking about, and includes more musings about plurals. We find notes dated 22 oct 69 where he is worrying about 'committee' and about whether plurals designate sets and plural verbs sets of sets; in an update Mar 70 he notes that he still thinks so, and thinks 'committee' also designates a set of sets, … and that 'numerous' is a higher-order predicate (since it can apply to 'committee'). (This strategy, which he did not implement anywhere, was later followed by Michael Bennett in his work on plurals (Bennett, 1974).

The following notes from the same folder, from September 1970, may surprise Montague grammarians who used Montague's analysis of quantifiers and relative clauses to argue against Generative Semantics, since these proposed "indirect derivations" look rather generative semantics-like:

> 'two men love a woman who loves them' 'perhaps get this from: two men love a woman and she loves them. (How get THAT??)
>
> *A woman who loves them kills two men / Women who love them kill two men*
>
> perhaps get the first from: *a woman kills two men and she loves them*. (Box 1, Folder 5)

But he didn't put anything like that in any of his fragments; he evidently knew that he hadn't figured out everything about plurals and plural anaphora, and he evidently didn't like to put anything really speculative into published fragments.

It may also be of interest that in his handwritten notes from 1970, there are quite a few cases where he explores making a distinction between "deep structure" and "surface structure" (his words) for some problematic cases, e.g. involving the distribution of *any*. And in PTQ he says that now, unlike in UG, he is not directly deriving "J.M.E. Moravcsik's **a unicorn appears to be approaching**, in which an indefinite term *in subject position* would have a nonreferential

[16] That's one of several titles he considered for his planned book. A cardboard rectangle in that folder, presumably clipped from Montague's original folder, says in pencil, "Title? The logical analysis [of?] ordinary language / Language and meaning / The analysis of language", and in another folder (Box 20, Folder 12) we find, "I've written the first draft of about half of the monograph *The Analysis of Language*. It's to appear in the Springer Library of Exact Philosophy, but I can't say exactly how soon." That was in a letter to Bar-Hillel written in November 1970, about four months before Montague's death.

reading, but must treat it indirectly as a paraphrase of **it appears that a unicorn is approaching** or **that a unicorn is approaching appears to be true.**" (p. 248)

I want to mention one more topic that comes up quite a few times and never got into any published fragment: the treatment of passives. For a semanticist, the main problems about passives concern the semantic relation between a passive sentence and the corresponding active sentence. If an active sentence has an intensional object position (e.g. with the verb *seeks*), does the corresponding passive sentence with *is sought by* have an intensional subject position? Do quantifier scopes sometimes change when going from active to passive, as Chomsky claimed (Chomsky, 1957, 1975) with his famous pair of examples, 'Everyone in this room speaks two languages' and 'Two languages are spoken by everyone in this room.' Is the semantics of passives best accounted for by deriving them from active sentences, or by generating them separately?

At the time of Montague's death, I had been hoping to ask him how he would want to treat sentences like 'There was believed to be a unicorn in the garden', sentences with interaction of passive, existential *there*, and 'raising', all topics which Michael Bennett subsequently treated in his dissertation and in (Bennett, 1976).) Montague never discussed any of these issues in his writings, so it is interesting that we find in the archives that he did worry about passives, particularly in connection with intensionality, with quantifier scope issues, and with the same sorts of issues concerning direct compositionality vs. a transformation-like treatment that we just saw him debating for *appears* between UG and PTQ.

In Box 3, Folder 2, there is an undated page containing a passive rule made up from a TVP and two T's, putting one of them as subject and the other as accusative object of *by*, i.e. a direct derivation. But then he inserted a marginal note, "Probably omit."

In Box 1, Folder 8 (**"**Intensional logic and some of its connections with ordinary language: talks"), among a big set of handwritten notes from the summer of 1969, where he is working on a fragment, we find three pages about the passive (pages numbered 35-37, out of a set of more than 50 pages). The first of these pages begins with the word "Berkeley": so I think he was thinking about "unconceived trees". As he worked on Berkeley's argument, he constantly shifted from Berkeley's 'conceive' to 'seek': it looks to me as though he was concerned that there were too many different possible meanings for 'conceive (of)', which muddied intuitions and invited equivocation[17]. He seems to have concluded that *seeks* is possibly the clearest case of an

[17] Box 1, Folder 7 ("Intensional verbs and Berkeley's argument") Includes a thermocopy of letter from Mates to "Don" (I think that must be Donald Kalish), dated Nov 16, 1957. The letter is all about Berkeley's argument about 'conceives' and about differences between *conceive NP* and *conceive that S*. Mates thinks one main problem is that Berkeley has a very psychologically robust notion of *conceive NP* but then uses it as a criterion for (metaphysical) possibility. And Montague considers a number of nonequivalent paraphrases for *conceive NP* in notes in various places.

intensional transitive verb, and focused on its analysis. At any rate, just a few lines down the page he considers the structure (i)[18].

(i) $\mathcal{P}$ *is sought by* $\mathcal{Q}$:

For every term β without free variables, ⌜λ$\mathcal{Q}$ β is sought by $\mathcal{Q}$⌝ is extensional w.r.t. [model] $\mathcal{A}$. ⌜seeks⌝ is extensional w.r.t. its subject (but not its object) (in the intended model $\mathcal{A}$).
⌜is-sought-by⌝ is extensional w.r.t. its object (in the intended model $\mathcal{A}$).
…
Compare:

Every man loves a woman.
A woman is-loved-by every man

Perhaps these are not synonymous.

Hence also perhaps not

Jones seeks a unicorn
A unicorn is sought by Jones

No, I now think not. It's only that although ⌜loves⌝ is an extensional transitive verb and is extensional w.r.t. its subject, it's not extensional w.r.t. its object. For ⌜is-loved-by⌝ we have two courses: (i) to regard ⌜$\mathcal{P}$ is loved by $\mathcal{Q}$⌝ as synonymous with ⌜$\mathcal{Q}$ loves $\mathcal{P}$⌝ for all terms $\mathcal{P}$ and $\mathcal{Q}$; then ⌜is-loved-by⌝ would not be an extensional transitive verb. Or (2) to define

⌜is-loved-by⌝ ≡ λ$\mathcal{Q}$ λ$\mathcal{P}$ …

($\mathcal{P}$ is-loved-by $\mathcal{Q}$ ≡ $\mathcal{P}$ is$_u$ such that $\mathcal{Q}$ is$_v$ such that it$_v$ loves it$_u$.)

I think that course (2) is preferable. But let's try applying it also to ⌜is-sought-by⌝:

$\mathcal{P}$ is-sought-by $\mathcal{Q}$ ≡ $\mathcal{P}$ is$_u$ such that $\mathcal{Q}$ is$_v$ such that it$_v$ seeks it$_u$.

Then ⌜is-sought-by⌝ becomes an extensional transitive verb. And so will all passives.

[End of those three pages of notes.]

Later in the same set of notes (his page numbers 45-51), he considers issues connected with scope ambiguities involving the present perfect, the adverb *necessarily*, other adverbs, and the

[18] In the passages below, $\mathcal{P}$ and $\mathcal{Q}$ are variables over properties of properties of entities: intensionalized generalized quantifiers. *R* is a variable over the type of intensions of transitive verbs. The notation in the cited notes seems to be essentially the same as in UG and PTQ; see, for instance, p. 243 in UG, pp. 263-265 in PTQ.

passive. He starts by writing down what he believes about the passive (p.49), and then continues for two more (short) pages:

> Now the passive voice corresponds to a transitive verb modifier that has no counterpart among propositional or intransitive verb modifiers.
>
> Passive ≡ $\lambda R \lambda \mathcal{Q} \lambda \mathcal{P}$ [$\mathcal{P}$ is$_u$ such that $\mathcal{Q}$ is$_v$ such that [it$_v$ { $^{\vee}R$ it$_u$ }]]
>
> Then: $\mathcal{P}$ {passive stabs} $\mathcal{Q}$ ≡ $\mathcal{P}$ is$_u$ such that $\mathcal{Q}$ is$_v$ such that [it$_v$ stabs it$_u$]
>
> Thus every passive is an extensional transitive verb phrase. Despite the fact that ⌜stabs⌝ is extensional, it is not generally the case[19] that
>
> $\mathcal{P}$ {passive stabs} $\mathcal{Q}$ ≡ $\mathcal{Q}$ stabs $\mathcal{P}$
>
> E.g. *every man is stabbed by a woman* ≢ *a woman stabs every man*
>
> However, *Jones {passive stabs} Smith* ≡ *Smith stabs Jones.*
>
> $\mathcal{P}$ *joyfully kills* $\mathcal{Q}$
>
> $\mathcal{Q}$ *is joyfully killed by* $\mathcal{P}$
>
> Thus ⌜joyfully⌝ does not seem to be derivable from any adformula and perhaps ought to be taken as a primitive ad-1-verb.
>
> Suppose *joyfully* were derivable from an adformula. Then … [here he goes through several lines to show that the two sentence forms above would be incorrectly predicted to be equivalent.]
>
> But we can obtain an ad-2-verb from ⌜joyfully⌝ as follows:
>
> *joyful* (as applied to transitive verb phrases) ≡ $\lambda R \lambda \mathcal{Q} \lambda \mathcal{P}$ [$\mathcal{P}$ is$_u$ such that $\mathcal{Q}$ is$_v$ such that [it$_v$ {joyful ^{ $^{\vee}R$ it$_u$ }}]]
>
> E.g. $\mathcal{P}$ {{joyful ^ stabs} $\mathcal{Q}$} ≡ $\mathcal{P}$ is$_u$ such that $\mathcal{Q}$ is$_v$ such that [it$_v$ {joyful ^{ stabs it$_u$ }}]

There are other places in his notes where we can see him debating with himself about whether passive sentences unambiguously have wide scope for the surface subject (as he evidently believed when he wrote the notes just above) and about whether they are unambiguously extensional with respect to the surface subject position. Some of the same uncertainties appeared (independently – I never heard him say anything about passives in my presence) in my first work on Montague grammar (Partee, 1973). He seems to be accumulating evidence that passive should

[19] This claim matches Chomsky's claim (Chomsky, 1957, 1975) that the non-synonymy of "Two languages are spoken by everyone in this room" and its corresponding active sentence shows that transformations do not always preserve meaning.

be an operation on transitive verbs, as later advocated by Dowty (1979), or on transitive verb phrases, as advocated by Bach (1980), not as operations on sentences as in classical transformational grammar, not even on sentences with free variables in argument position, as suggested by Partee (1973).

In Montague's notes about how to treat the passive, and in the different decisions made about how to treat *appears* in UG and PTQ, we can see that he is interested not only in the intensional logic but in designing it in such a way that he can get good analyses of natural language. We already noted how he did not rest with paraphrase analyses of *seek* but asked if there weren't a way "to approximate English more closely within our intensional language." (NCPE, p. 167). And at the end of the introductory section of PTQ, Montague writes, with respect to the fragments of English in three papers EFL, UG, and PTQ:

> On their common domain of applicability the three treatments essentially agree in the truth and entailment conditions imposed on sentences. … Nevertheless, the details of the present development possess certain aesthetic merits, of coherence and conceptual simplicity, not to be found in the treatment of English in Montague [UG]. (It is in order to preserve these merits that I here forgo a direct account of such sentences as Moravcsik's.) (pp. 248-49)

6. Conclusions and Post-Montague postscript

I've focused in this paper on the development of Montague's ideas. It seems that for Montague, natural language was not an important issue in itself. What was important to him was the development of an adequate intensional logic, one that would replace set theory as the framework within which to do philosophy and evaluate arguments. What he found interesting to work on were puzzles that were challenges to the design of an such a logic, puzzles such as those that Quine and Buridan had posed, the problem of indexicals, Berkeley's argument, the status of such 'dubious entities' as events and pains, the "temperature" puzzle, etc. The logical problems were foremost; but from his earliest work he also paid attention to the structure of English and to how arguments were expressed in ordinary language, and he clearly considered it a merit of an intensional logic that it should possess "a close conformity to ordinary language" (NCPE, p. 156). His aims were not the aims of linguistic semantics; but his work nevertheless laid the foundation for the field that became formal semantics.

There is no time or space left to talk about the development of Montague grammar and formal semantics more generally through cooperative work by linguists and philosophers. For more about developments in formal semantics from 1970 until the present, see (Lappin, 1996, Maienborn et al., 2011, Partee, 2011, Partee, 1997, van Benthem and ter Meulen, 2010, Werning et al., 2012).

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