MODEL THEORY AND SEMANTICS

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I Introduction

In this paper I discuss some questions that arise if one compares natural languages with the constructed languages of formal logic. The point of comparison that will concern me is meaning, and the question that provides my theme is this: Could a semantic theory for a natural language take the same form as the semantic accounts that are usual for the artificial languages of formal logic? ('Model theory' is a name for the study of the semantics of these artificial languages: thus to a logician my title would be merely repetitive— but it is intended only as a shorthand way of introducing the comparison.)

I shall try to say nothing that presupposes knowledge of formal logic or of model theory because it seems to me that questions of importance for my subject have to be settled, or begged, before formal semantics can be developed at all. I shall therefore be dealing with some basic concepts of model theory rather than with any detailed formal developments.

It may help to identify my topic more clearly if I explain why it seems to me to survive two criticisms that might be brought—two views about the role of formal logic in the semantics of natural languages that imply (from opposite directions) that no question about the applicability of formal semantics to natural languages arises.

One school of thought is very hospitable to formal logic: allowing a distinction between deep and surface structures in a grammar, it claims that in a correct grammar deep structures will be nothing other than sentences of formal logic, and that such deep structures are necessarily bearers of clear semantic information. The only serious semantic questions that arise for natural languages would then be questions about the derivation of surface structures from deep structures. This view, a caricature to be sure, seems to me too hospitable for formal logic. If formulas of logic are usable as deep structures in a generative grammar, and the principle that meaning does not change in proceeding from deep to surface structure is espoused, semantic questions are simply thrown back onto the deep structures. The semantics of first order predicate logic (to mention the most familiar logical system) is well established for the purposes of logic textbooks but not without its problems if it is taken as accounting for meaning in natural languages. A linguist who chooses logical formulas for his deep structures enters the same line of business as the philosophers who have puzzled over the philosophically correct account of the semantics of the logical formulas themselves. Even if it were legitimate to take the semantics of standard first-order logic for granted, that logic notoriously cannot deal in a straightforward way with many aspects of natural languages, such as tenses, modalities and intentional verbs, and indexicals. But the semantics of the more complex logical systems designed to deal with such notions is sufficiently controversial among logicians that no one can safely take it for granted.
Another school of thought, viewing my subject from the opposite direction, holds that we know that a semantic account appropriate to an artificial language could not be appropriate to a natural language just because the former is artificial. The formulas of an artificial language are stipulated at their creation to have the meaning that they have, whereas a natural language, although it is a human creation, must be investigated empirically by the linguist before he can hope to erect a semantic theory\(^2\). It seems to me that the bare charge of artificiality is a pointless one: there is no reason why a semantic account that fits a language we have invented should not also fit another language that we have not. (Just as there is no reason why a human artefact should not be exactly the same as an object found in nature, for example in respect of its shape.\(^3\))

The idea that the semantics of natural languages is subject to empirical constraints that do not operate for artificial languages is worthy of greater respect, however. Whereas I may, it seems, decree what my artificial symbols are to mean I must take the natural language as I find it — we can talk of 'getting the semantics right' for a natural language but not for an artificial one. As a matter of fact there is such a thing as getting the semantics wrong, even provably wrong, for an artificial language, because of the requirements of consistency and completeness that formal semantic accounts are intended to meet: but this remark, although it may make formal semantics sound more interesting than you thought, does not meet the difficulty about natural languages.

Let us imagine that we have a proposed semantic theory for English before us, and that it gives an account of the meaning of the words, phrases, and sentences of the language. As empirical linguists we must then inspect this theory to see if it squares with the facts. But what facts? The answer to this question depends to some extent on the nature of the theory; it may be a theory with obviously testable consequences. If, for example, it alleges that speakers of the language will assent to certain sentences, then provided you know how to recognize speakers of the language, and asssents, such consequences can be tested in the field. Alternatively, the theory may provide a translation of sentences of English into another language. If the other language is Chinese, and you speak Chinese, you can check the translations for accuracy. If the other language is a language no one speaks, such as semantic markerese, whose existence is asserted only by the theory, then no such check is possible\(^3\).

The problem of empirical adequacy is a central one for semantics. A semantic theory must provide an account of the meaning of the sentences of the language it purports to describe. If the language is our own language, we should be able to tell straight away whether the account is correct. It is a minimal requirement of a semantic theory that it offer a translation, reading or representation of each sentence of the language. Any translations it offers should be synonymous with the sentences of which they are translations. If the translations talk about abstract entities of a kind of whose existence we
were unaware, we shall need to be persuaded that we were really talking about them all the time, without knowing it. (It is an even more basic requirement that the translation of a declarative sentence should be a declarative sentence, rather than (for example) a verbless string.)

It is not obvious that these platitudes bring us any closer to an understanding of the empirical constraints on a semantic theory. Certainly, if we think of translation as a simple pairing of sentences, it does not. But if we think of translation as the explaining in one language of the sentences of another, we may find a way out. Compare:

(1) 'Pierre attend' means the same as 'Pierre is waiting';
(2) 'Pierre attend' means that Pierre is waiting.

(1) informs us of a relation between two sentences: (2) tells us what a particular French sentence means. A semantic theory should not simply pair sentences, it should tell us what they mean. (1) and (2) are both empirical truths, but the same cannot be said of both (3) and (4):

(3) 'John is tall' means the same as 'John is tall';
(4) 'John is tall' means that John is tall.

We know that (3) is true in virtue of our understanding of 'means the same as', and so it is true a priori. We also know that (4) is true, but (4) is an empirical truth about the sentence 'John is tall'. Moreover a semantic theory about English in English, worthy of the name, should have (4) as a consequence, as well as (5):

(5) 'Four is the square of two' means that four is the square of two.

and in general should have as consequences all sentences like (A)

(A) S means that p

where 'S' is replaced by a syntactic description of a sentence and 'p' is replaced by that sentence or a recognizable paraphrase of it. Such a theory does not simply pair sentences: it tells us what they mean.

A minimal requirement on a semantic theory for a natural language is that it have as consequences sentences of form (A). The fact that the A-sentences are empirical truths rather than stipulations or a priori truths proves to be no block to providing for a natural language a semantic account similar to some that can be given for formal languages: indeed the founding father of formal semantics, Alfred Tarski, made it one of his basic requirements for a formal semantic theory that it yield something very like the A-sentences.

It may seem that the requirement that a semantic theory yield the A-sentences is a weak one, and that the production of such a theory would be a trivial matter. It will be part of my purpose in what follows to show you that this is not the case.
II  Simple Semantics

Model theory is the investigation of the relationship between languages that can be formally described and the structures, interpretations or models for which their sentences are true. The sentences of such a formal language are typically true only in certain models, so that, given a collection of sentences, it is often possible to say what features any model in which all the sentences hold must have. (For example, some of the earliest results in model theory establish that any collection of sentences of the standard first-order logic that holds in any model at all must hold in some countable model, i.e. a model in which the totality of objects the sentences are taken as talking about do not outnumber the natural numbers 1,2,3,...) Starting from the other end, with a model, it is usual to find that only certain sentences hold in it. Thus, given some sentences, we can investigate their possible models: given a model, we can investigate which sentences it makes true.

The connection between a language and a model is set up by means of a recursive definition of truth: by a definition that explains under what conditions a sentence holds, or is true, in the model. The definition is recursive in the sense that it states first in its basic clauses how the simplest sentences hold or do not hold, and then in the recursive clauses how the truth-conditions of complex sentences are determined by their simpler parts. This makes possible in a finitely long definition the determination of the truth conditions of the sentences of an infinite language. (An example of a simple recursive definition is the following definition which tells us which objects are the natural numbers 1,2,3...:
(a) $1$ is a number;  (b) if $x$ is a number, $x + 1$ is a number;  (c) nothing else is a number.)

The classical account of the recursive definition of truth is Tarski's paper 'The concept of truth in formalized languages'. It seems to me to be essential, in order to explain the potential contribution of model theory to the semantics of natural languages, to present the main themes of that important paper.

A definition of truth is given in a language for a language. There are thus typically two languages involved, the one for which truth is defined, which plays the role of 'object-language', and the one in which truth is defined, playing the role of 'metalanguage'. The metalanguage must be rich enough to talk about the object-language, in particular it must contain names of the symbols or words of the object language and the means to describe the phrases and sentences of the object language as they are built up from the words: it must also contain translations of the sentences of the object language. Tarski lays down, in his Convention T, requirements for an adequate definition in the metalanguage of a truth-predicate: that is, requirements that a definition must fulfil if the predicate so defined is to mean 'is true'. The convention demands that it should follow from the definition that only sentences are true; and that the definition should have as consequences all strings of the form

$$(b) \text{ S is true if and only if } p$$

where 'S' is replaced by a structure-revealing description of a sentence
of the object-language and 'p' is replaced by a translation of the sentence S in the metalanguage.

You will note the similarity to the requirement that an adequate semantic theory must have the A-sentences as consequences. If we require that the definition of truth be finite, then for an object-language with infinitely many sentences it is not possible to take as our definition of truth simply the conjunction of all the infinitely many B-sentences. It is in the attempt to compass all the B-strings in a finite definition of truth that the interest of the Tarski-type definition of truth lies. It is perhaps still not widely appreciated even among philosophers that the production of a definition of truth that fulfils Convention T for an interesting but infinite object-language is far from a trivial matter. Tarski himself showed that one superficially attractive trivialising move does not work. We might be tempted to use the axiom

\[(6) \ (x) \ ('x' \ is \ true \ if \ and \ only \ if \ x)\]

but this does not succeed in doing what was intended since the expression immediately to the left of the 'is true' is but a name of the letter 'x'.

In his paper, Tarski showed how Convention T's requirements could be met for one logical language. In order to illustrate his method I shall use a tiny fragment of first-order logic, with the following syntactic description:

\[(7) \ \text{Symbols:} \quad \text{nouns:} \ a \ b \\
\text{variables:} \ x \ y \ z \\
\text{predicates:} \ F \ G \\
\text{the existential quantifier:} \ E\]

\begin{itemize}
  \item [(i)] 'F' followed by a single noun is a sentence;
  \item [(ii)] If S is a sentence, '¬' followed by S is a sentence, called the negation of S
  \item [(iii)] If S is a sentence containing a variable, the result of writing 'E' followed by the variable followed by S is also a sentence, called (if the variable is \(v_i\)) the existential quantification of \(S\) with respect to \(v_i\).
\end{itemize}

Thus the following are sentences of the fragment:

\[(8) \ Fa \ Ga \ ¬Fb \ ExFx \ EyGby \ ¬ExFz \ Fx\]

You will see immediately that this language has infinitely many sentences.

In order to explain my recursive definition of truth for the fragment, I need to introduce the notion of \textit{satisfaction}. The fundamental semantic notion that we use is not \textit{truth} but \textit{truth of}, a relation between an individual and a predicate (or verb-phrase). 'Smokes' is true of John just in case John smokes: 'is red' is true of this poppy just in case this poppy is red. We have to complicate the notion in a natural way to fit a sentence like 'John loves Mary'. We can already say: 'Loves Mary' is true of John if and only if John loves Mary, and 'John loves' is true of Mary if and only if John loves Mary. But we cannot say that 'loves' is true of John and Mary, for that would also be to say that 'loves' is true of Mary and John, but 'John loves Mary' means something different from 'Mary loves John'. We have to say in what order John and Mary are taken: so we use the notion of an ordered pair, John then Mary, — of a sequence
with two members, John and Mary (in that order). Thus in general we say that a sequence satisfies a predicate, by which we mean that the objects in the sequence, ordered as they are, fit the predicate, ordered as it is. We must use some notational device to keep track of the places in the predicate and to correlate them with the places in the sequence. (Note however that the places in the sequence are occupied by objects, the places in the predicabe by names or other noun-phrases.)

It is now possible to give the recursive definition of satisfaction for the fragment:

(9) For any sequence q of persons:
   (i) q satisfies 'p' \[\equiv \neg v_i\] if and only if the i'th member of q smokes
   (ii) q satisfies 'q' \[\equiv v_i - v_j\] if and only if the i'th member of q loves the j'th member of q
   (iii) if S contains the name 'a', \(v_i\) is a variable that does not occur in S, and \(S'\) is the result of replacing 'a' in S by \(v_i\), then q satisfies S if and only if q' (the sequence like q but with John in its i'th place) satisfies S';
       if S contains the name 'b', \(v_i\) is a variable that does not occur in S, and \(S'\) is the result of replacing 'b' in S by \(v_i\), then q satisfies S if and only if q' (the sequence like q but with Mary in its i'th place) satisfies S'
   (iv) q satisfies the negation of S if and only if q does not satisfy S
   (v) q satisfies the existential quantification of S with respect to the i'th variable if and only if at least one sequence differing from q at at most the i'th place satisfies S.

and the definition of truth:

(10) A sentence is true if and only if it is satisfied by all sequences of persons.

If the implications of this definition are unravelled, we find out for example that

(11) 'ExGxa' is true if and only if someone loves John.

The definition of truth just stated tells us what the fragmentary language is to mean rather than what it does, as a matter of fact, mean: but this is only because the language that served as object-language was not one whose sentences already had a definite meaning. The procedure for defining truth could equally be followed for English sentences where both the metalanguage and the object-language were English. If it was followed, the role of the semantic definition of truth would be to articulate the structure of the language — to show how the meanings of sentences of arbitrary complexity depend on the meanings of their parts — rather than to give any very helpful information about the meanings of the parts. A definition of truth of the simple type that I have presented does all its serious work in the recursive clauses, and we look

\[\neg\] The dash '---', symbolises concatenation.
to it in vain for more than obvious information about the meanings of the simples (in this language, the elementary predicates and names). The attempt to extend a definition of truth according to Convention T to a more useful fragment of English is a much more difficult task than it at first appears, however. Although we can leave many questions aside in this project, it is still necessary to decide how sentences are built up and to determine the precise semantic role of the parts.

I may illustrate the difficulties by a suggestive example familiar to philosophers. Students of modal logic (so-called) interest themselves in the notion of necessity, and concern themselves in particular with 'necessarily' as an adverb modifying whole sentences. The consequences required by Convention T of the truth definition would include sentences such as (12)

(12) 'Necessarily John is tall' is true if and only if necessarily John is tall.

The obvious way to accommodate necessity in the recursive definition of satisfaction would be this:

(13) q satisfies the necessitation of S (i.e. the result of writing 'necessarily' then S) if and only if necessarily q satisfies S.

But the idea of a necessity linking a sequence and a sentence goes well beyond anything in the original. Intensional notions resist such straightforward treatment in the definition of truth.

About the idea of a simple definition of truth in English for English that satisfies Convention T I must offer two warnings. The first is that there are formal reasons why a definition of truth in a language for the same language is not possible: unless the language concerned is very weak, a version of the Epimenides paradox will emerge:

(14) 'Is not true of itself' is not true of itself.

If we are committed for independent reasons to the project of defining truth for English in English, I think this difficulty can be circumvented. The second is that such a definition would not fall within model theory as narrowly defined, since the definition defines truth absolutely, whereas in model theory we define truth relative to a model. Convention T requires the absolute definition of truth, but Tarski's own later work and model theory in general is concerned with the relative notion. In recent years some writers have urged that the absolute definition of truth is the paradigm of a semantic theory for a natural language, but others have pressed the claims of a relative definition. One of the supposed advantages of the approach from model theory proper is that difficulties like the one about necessity can be dealt with in a definition of truth of the appropriate form.

III Model Theory

An influential recent writer who supported the claims of model theory was Richard Montague, whose name is now firmly associated in Europe as well as in America with the project of applying methods of formal semantics to natural languages. Here are two typical statements of faith:
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. 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.

There is in my opinion no important theoretical difference between natural languages and the artificial languages of logicians; indeed, I consider it possible to comprehend the syntax and semantics of both kinds of languages within a single natural and mathematically precise theory. On this point I differ from a number of philosophers but agree, I believe with Chomsky and his associates. It is clear, however, that no adequate and comprehensive semantical theory has yet been constructed, and arguable that no comprehensive and semantically significant syntactical theory yet exists.

The aim of the present work is to fill this gap, that is, to develop a universal syntax and semantics.

Both papers from which I have quoted give syntax and semantics for fragments of English. These accounts are technically complex and even a summary is out of the question. What I shall try to do is to characterise in general terms the model-theoretical approach and to indicate the special contributions made by Montague.

If you open a logic textbook and find there a semantic account of first order logic it is likely to be a definition of truth-under-an-interpretation. ('Interpretation' and 'model' are interchangeable terms.) Whereas in the definition of truth as a property (the 'absolute' definition of truth) the only unfamiliar device that was used was the sequence, in definitions of truth-under-an-interpretation ('relative' definitions of truth) a much richer supply of sequences, sets and functions is required.

For first order predicate logic the models are families of sets, one, the domain, containing all the objects that can be talked about; predicates are assigned subsets of the domain or relations on the domain, and names are assigned members of the domain. An interpretation can thus be construed as a domain together with a function that assigns to each predicate or name an appropriate object associated with the domain.

A sentence is then said to be true for the interpretation if it is satisfied by every sequence of objects from the domain, given the interpretation.

In this approach, meaning is determined on two stages: the meanings of the logical constants — the connectives ('and', 'if — then —' etc.) and the quantifiers ('all', 'some') — that also provide the recursive elements in the definition of satisfaction, are fixed in advance for all
interpretations. An interpretation then fixes the meanings of the non-
logical constants (the predicates and proper names of the language).
One apparent advantage is that the method permits of the definition of
a notion of logical truth as truth in all interpretations. Moreover,
truth-in-an-interpretation can be defined in advance of knowing a
particular interpretation. In the simple semantics that I sketched
earlier, this was not so: to give a definition of truth, we need to
have all the basic clauses for the recursive definition to hand, and
we had no general way of characterising the interpretation of for example
a one-place predicate. This could be seen as an advantage: you may have
felt that the basic clauses in the simple semantics, such as (9)(i),
were disappointingly trivial. The corresponding clause in a relative
definition might look like this:

\[(15) \quad q \text{ satisfies } 'F' \iff \nu_i \text{ in } I \text{ if and only if the } i^{th} \text{ member of } q
\text{ is a member of the set assigned by } I \text{ to } 'F'\]

This appears to open up the possibility of discussing alternative inter-
pretations of the basic elements in the language, a possibility that was
not evident for the absolute definition. An interpretation can be
thought of as a dictionary for a language whose syntax is known and
about which we have semantic information up to a point: we know the
meaning of the logical constants (we are not allowed to vary it from
one dictionary to another) and we know the kind of interpretation that
is allowed for any lexical item whatsoever, since the kind is determined
by the syntactic category. What a particular dictionary, or interpret-
ation, does is to specify which meaning of the appropriate kind each
lexical item possesses.

If we could approach a natural language in a similar way, we could
hope to describe its syntax precisely and to determine what the appropriate
meaning or interpretation for each lexical item would be. We could expect
to discover some logical constants, in particular among the devices for
constructing compound or complex sentences out of simpler parts. It is
plain, however, that shifting our attention from the absolute to the
relative definition of truth has not at all changed the problems that
must be met. The standard mode of interpreting predicate logic together
with the rough-and-ready methods we have for translating between English
and the logical symbolism fail to deal with a host of constructions and
aspects of English, such as intentional contexts in general, in particular
tense, modality, intentional verbs such as 'believe', 'seek'; and indexical
or token-reflexive elements such as personal pronouns. Moreover the
lack of a serious syntactic theory linking the logical notation and
English is an embarrassment. A defect that is likely to strike the
linguist as particularly important is the lack of syntactic ambiguity in
the logical notation.

The list of obstacles could be prolonged, and I do not need to per-
suade you that they are serious ones. Montague and others have sought to
overcome them all by providing a single theory of language, embracing
syntax and semantics, which provides a framework within which a complete
formal grammar for any particular language, natural or artificial,
could be located.9
The framework offered by Montague is complex but the semantic theory that he puts forward — or rather, the schema for any semantic theory — depends on the use many times over of two simple ideas. Universal semantics lays down the ground-rules for any semantic theory, and a semantic theory determines under what conditions a declarative sentence is true. This can be stated in a more abstract way by saying that a semantic theory defines a function from declarative sentences to truth-values so that every sentence has a truth-value. The abstract way of talking, in terms of functions, appears quite gratuitous at this point, but it is indispensable for the steps that follow.

Consider a simple declarative sentence:

(16) John is running.

We want a semantic theory to assign a truth-value to it: in particular, we want it to entail

(17) val('John is running') = T if and only if John is running.

According to the standard account of the model theory of predicate logic, the name 'John' would be assigned to a member of the domain of an interpretation, and the predicate 'is running' would be assigned a subset of the domain. The resources of this mode of interpretation do not allow us to say that the subset assigned to 'is running' varies: but this leads to a difficulty, for of course the extension of 'is running' — the set of people who are running — varies from moment to moment but the meaning does not. How can we assign a single meaning to 'is running' within a formal semantic theory which allows for this complexity? The answer is, we assign to the predicate a function from times to subsets of the domain; a function, it could be argued, that we already know to exist — for we know that at any time some people are running and some not.

The resulting account of the truth-conditions of 'John is running' would look like this:

(18) val('John is running',t) = T if and only if val(val('x is running'), val('John'),t) = T.

The standard interpretation of predicates by subsets of the domain can be progressively complicated to deal with any features of the occasion of utterance that are relevant to truth-value. A particular valuation, or model, will then ascribe to each predicate an appropriate function.

The other simple idea involved is really the extension to the semantic realm of Ajdukiewicz' syntactic ideas which derive in turn from Frege. Ajdukiewicz showed how, given two fundamental syntactic categories, it was possible to assign syntactic categories to other parts of sentences. The categories other than the basic sentence and name are all functions of more and less complexity, so that the criterion of sentenceness is that the syntactical categories of the component expressions should when applied to one another yield 's'. I shall illustrate the idea and its semantic analogue by the case of a simple verb-phrase. If we know that
(19) Arthur walks.

is a sentence, and 'Arthur' a name, we know that the syntactic category of 'walks' is s/n, i.e. the function that takes a name into a sentence. A semantic analogue (much simpler however than anything in Montague) would be this: if we know that the interpretation of the whole sentence is to be a truth-value, and the interpretation of the name 'Arthur' is to be a person, we can infer that the interpretation of 'walks' is to be a function from people to truth-values.

As a matter of fact Montague gives a far more complex account of the interpretation even of simple predicates, as he wishes, for example, to allow for the occasion of utterance. But the principle by which the appropriate meaning for items of a certain syntactic category is discovered is the same. The case of adverbs that modify verb-phrases is in point. Syntactically speaking, such adverbs turn verb-phrases into verb-phrases (e.g. 'quickly', 'at 10 p.m.'): so semantically speaking, they must turn verb-phrase meanings into verb-phrase meanings. We therefore know the type of function that adverbs require as interpretations — they are functions from verb-phrase interpretations to verb-phrase interpretations.

Adjectives that attach themselves to common nouns are treated in the same way. The syntax of the fragment of English described in Montague's 'Universal Grammar' is sufficiently sophisticated to allow that

(20) Every man such that he loves a woman is a man.

is a logical truth, whereas:

(21) Every alleged murderer is a murderer.

is not. The assignment to syntactic categories is not a trivial matter given the semantic principle I have just presented, and it seems to me, although I claim no expertise in this matter, that the syntactic descriptions given of fragments of English in 'Universal Grammar' and 'English as a formal language' are ingenious and interesting. Both fragments contain syntactic ambiguities, and in the latter paper Montague shows how to deal with ambiguity by relativising his semantics to analyses that resolve ambiguities.

IV Discussion

We can expect increasing research along the lines of Montague's work in several countries. It seems to me that Montague and others working along the same lines have had ideas that will prove very fertile for formal linguistics.

The apparatus of sets and functions that model theory draws on is so rich that there is no doubt that a Montague-type universal grammar can be applied to a natural language in such a way as to interpret it successfully — in a sense. Model theory provides only the form of a semantic theory, however, and there is the same need as ever for detailed work on
the semantics and syntax of a language. In so far as detailed work within this framework has scarcely begun, it is too soon to pronounce on the likely success or failure of the enterprise.

It is however in order to offer reasons for scepticism that do not depend on the detailed proposals that may be made.

The role of empirical considerations in evaluating a semantic theory provides a point of departure. I suggested earlier that convention T provides one empirical constraint on a semantic theory. This constraint operates in a clear way for an absolute definition of truth, not so clearly for a relative definition. Moreover in model theoretic truth-definitions the statements of truth-conditions that we meet are heavy with references to sets and functions. In some such accounts all 'meaning' is denotation, so that every part of speech is construed as a referring phrase. This is not a universal defect, however: although functions enter into the determination of truth-values, no part of a sentence may be construed as denoting its associated function in the pragmatic intensional logics of Montague and Lewis. (It is still true, however, that statements of truth-conditions mention functions.)

Convention T provides a clear criterion for evaluating a proposed definition of truth. If a semantic theory is framed as a truth-definition, then we know how to test it.

Whereas I believe that the absolute truth-definition is promising as a semantic theory for English, I do not find the whole package of the Montague-type model-theoretic system persuasive. However there are in the system a number of interlocking parts that might also form parts of more acceptable systems. I have mentioned his syntactic apparatus as one of them. In the general theory of 'Universal Grammar' the most striking feature is the architectonic view of language according to which a semantic account of a language mirrors the syntax — in Montague's technical language, an interpretation is an algebra similar to the syntax together with a function assigning meanings to the basic expressions. This entails that any syntactic rule has an accompanying semantic rule — where the syntactic rule is a function converting an expression of category A into an expression of category B, the corresponding semantic rule leads from the meaning of the first expression to the meaning of the second.

Although it can be argued that such semantic rules must exist, I should wish myself to resist the conclusion that the wholesale proliferation of functions in a semantic theory is going in itself to solve semantic problems. I fear that the method of interpretation involved is too powerful to be informative; it becomes clear that any language with a well-defined syntax could be interpreted in this way. Once the principles of the method become clear, the interest of a particular contribution resides in the detailed application to a particular language.

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NOTES

1 This paper is a revised version of a paper read to the meeting of the Semantics Section of the Linguistics Association of Great Britain at the University of York on 5 April 1972.

2 In many presentations of first order logic, only the logical constants (the connectives and quantifiers and perhaps the identity sign) are regarded as having a fixed meaning. Then no formula (except one consisting entirely of logical constants) has a meaning until an interpretation is assigned to the non-logical constants.


4 This point can easily be misunderstood because any (true) statement about meanings might be thought to be true 'in virtue of meaning' and so true a priori. But we do not need to know what 'John is tall' means to recognise (3) as true: all we need to know is that the same expression occurs before and after 'means the same as'.

5 See Alfred Tarski, 'The concept of Truth in Formalised Languages' in Logic, Semantics, Metamathematics, Oxford: Clarendon Press,1956 (translated by J.H.Woodger),152-278, in particular section 3 (186sqq.). I owe the idea that Tarski's approach may yet be appropriate for natural languages to Donald Davidson: see in particular his 'Truth and Meaning', Synthese 17(1967) 304-323, and 'Semantics for natural languages' in Linguaggi nella società e nella tecnica, Milan: Edizioni di Comunità,1970,177-188.

6 See note 5. A more extended but still simple introduction to Tarski's paper is given by W.V.O.Quine in Philosophy of Logic (Englewood Cliffs: Prentice-Hall,1970) chapter 3: 'Truth'.


9 See Montague's papers cited in notes 8 and 9, and David Lewis' 'General Semantics' cited in note 3.