NEGATION, AMBIGUITY, AND THE IDENTITY TEST

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Abstract

Negation has been closely tied to semantic presupposition since the concept was first discussed. In most accounts there is a definition or a theorem to the effect that A presupposes B if and only if A and the negation of A, in one sense of negation, both entail B. The multiple senses of negation assumed by such principles have been criticized and along with it the concept of presupposition. Indeed one of the most interesting arguments against semantic presupposition is the joint claim that many-valued semantics for presupposition require ambiguous negation and that negation as found in English is not ambiguous. In this essay I propose to discuss quite generally the idea of ambiguity and the role of negation in presupposition theory. Along the way I shall argue that it is quite difficult to explain precisely how the usual identity test for ambiguity employed by linguists should apply to a logical connective like negation, and that most versions of the test when clarified do not yield the result that negation in English is ambiguous. I argue for these conclusions by attempting to clarify what the theoretical properties of language would have to be if this critique of semantic presupposition were right. The kind of syntax and formal semantics needed to support the identity test when combined with the relevant data about natural language usage does not yield the result that negation is ambiguous. The argument is based on details that are of some interest in themselves. An effort is made to formulate precisely what the identity test is, and in particular what the conditions are that must be met before a meaningful conjunctive abbreviation is permissible. Two different sorts of conditions are distinguished which really amount to two quite different versions of the test. Only one of these is really relevant to the issue of negation. This variety is also of interest because failure in this sense amounts to what philosophers have called zeugma. Both sorts are distinguished from a third version of the test, probably the most common, in which it establishes syntactic but not semantic ambiguity.

In recent years the idea that presupposition should be explained in semantic terms has been attacked from various directions. It has been claimed that alleged cases do not require non-classical truth-values, that they are cancellable and hence pragmatic, that purely pragmatic explanations in terms of implicature and other such notions are possible, and that those cases that are not pragmatic are really varieties of classical implications requiring no special semantic account. But Jay David Atlas and to a lesser extent Ruth Kempson have developed their own critique questioning in a way others have not the assumption they find in semantic accounts that natural language negation is ambiguous.[1]

The postulation of ambiguity arises as follows. If we suppose that A semantically presupposes B, then we know by basic principles shared by such theories that whenever A or its negation not-A are true, so is B. Then it should not be possible to find a case of B failing while not-A is true. Yet there are uses of negation in natural language, often called 'metalinguistic' and translated 'it is not true that', that are true when the contained sentence is anything other than true. Such a not-A will be true so long as A has any property that keeps it from being true, whether this be falsity, incoherence, absurdity, undefinedness, or even ungrammaticalness. Thus if A's presuppositions fail, A will not be true, and thus not-A will be true, contradicting the previous claim that when not-A is true, so are A's presuppositions. Presuppositionalists, however, have always been aware of this use of negation and usually maintain that a different sense, sometimes called internal or choice negation, or negation in secondary occurrence, is operative when A presupposes B. Such severe critics of the semantic notion as Wilson, and Boër and Lycan have not called into question the postulation of this ambiguity on the part of negation.[2] But what they and traditional theorists overlook, it is alleged, is the fact that there is really just one natural language negation and the so-called metalinguistic uses are just additional proof that presuppositions are cancellable and hence not universal in the way required in the semantic account. Atlas' strategy is to show in detail that natural language negation fails the ambiguity tests recently adumbrated by Zwicky and Sadock, and Wilson's argument is similar.

Briefly, the argument runs like this. One criterion for ambiguity recognized by linguists is the identity test. According to this procedure transformations that abbreviate conjunctions of similar structure and overlapping content to shorter phrases that omit redundant material sometimes signal the presence of an ambiguity by rejecting some readings because they are equivocal. For example, (1) and (2) are each open to two readings, one verbal and the other nominal, but their abbreviation (3) admits readings in which both must be verbal or both nominal; so-called cross-readings are rejected.

(1) I saw her duck.
(2) I saw her swallow.
(3) I saw her duck and swallow.

The rejection of cross-readings is thus taken as a mark of ambiguity.

Atlas makes use of this criterion by observing that abbreviations making use of *not* are open to cross-readings in which *not* is simultaneously used to abbreviate expressions that logicians have taken to represent different 'senses' of negation. The use of *not* in (4), for example, is called external, and that in (5) internal, but both sentences yield an acceptable reduction (6).

(4) The king of France is not wise.
(5) The queen of England is not wise.
(6) The king of France is not wise and the same thing goes for the queen of England.

Thus, Atlas concludes that negation in English is not ambiguous.

The argument is difficult and interesting for several reasons. First of all, it raises the question of exactly what the tests are for ambiguity and how seriously they should be taken. The accepted view seems to be that they offer mere 'criteria' for ambiguity, and that criteria in this sense are just marks or symptoms of a phenomenon. Exactly what this cautious linking amounts to is difficult to say. I think part of what is meant is that the link is not very deeply understood. The mechanism explaining the tie is unknown, and it is even left open how inextricably they go together. Essentially what the tests record is a rather rough generalization from examples. Many, many cases of conjunctive abbreviation that reject cross-readings harbour intuitive ambiguities. So at the very least, rejection of cross-readings seems to be a kind of prima facie ground for suspecting an ambiguity. But it remains an open question what the theory would be like that explains why this is the case. One of the tasks I'm interested in pursuing here is to sketch what such a theory would be like. In particular I'm interested in the mathematical and formal features of syntax and semantics that would yield the result that failure of cross-readings marks ambiguity.

A second interesting feature of Atlas' argument is that it seems to presuppose a very tight tie between failure of cross-readings and ambiguity. Indeed, for the argument to work the failure must constitute not only sufficient but also necessary conditions for ambiguity. On the usual account finding a failure of cross-readings is taken to mark an ambiguity, to be sufficient at least prima facie for concluding that there is an ambiguity. But Atlas' argument works in reverse. He observes the acceptability of cross-readings in a few examples and generalizes that it is not the case that some cross-reading is ever rejected in conjunctive reductions involving *not*. He also assumes that failure of cross-readings is a necessary condition for ambiguity - that if there is ambiguity, then there is some failure of cross-readings. It follows then by modus tollens that uses of negation are not ambiguous. Thus Atlas goes somewhat further than is customary in tying criterion and phenomenon. In doing so he helps to sharpen the inquiry into what sort of metatheory could explain all these claims. It would have to be one that yields as a theorem an inevitable, one to one linking of criterion to what it marks.

A third interesting feature of the argument is that it must be taken as claiming that the ambiguity in question is semantic rather than syntactic. As we shall see in the discussion, many of the ambiguities marked by the identity test can be straightforwardly explained as syntactic. Indeed this explanation is available for the examples (1) to (3). But the issue in metalogic that Atlas is addressing concerns a claim about the semantic ambiguity of negation in natural language. No logician has made any claim about the natural language syntax of *not*. What is at issue is rather its semantic analysis, whether its various natural language occurrences shift from context to context, meaning sometimes external and sometimes internal negation. Thus the theory that would be necessary to explain Atlas' link between negation, ambiguity, and cross-reading can be sharpened even more. It must be a theory which is capable of formulating the distinction known as semantic ambiguity, and it must yield the result that such ambiguity goes hand in hand with failure of cross-readings.

The purpose of the paper may now be set forth more clearly. It is a kind of rational reconstruction of the formal metatheory that would be necessary for language to be as Atlas says it is. The interest of such reconstruction is to see whether language so viewed is plausible. I shall argue that it is not. The reconstruction has several limitations to serve as guides. First of all there are the quasi-theoretical claims of Atlas himself. An expression must be semantically ambiguous if and only if some of its conjuntive reductions have failures of cross-reading. Secondly, there is the constraint of the standard sort of linguistic theory that seems to be presupposed by users of the identity test. These assumptions will require us to give definitions to a string of standard concepts like conjunctive reduction, reading, cross-reading, syntactic ambiguity, semantic ambiguity, and the distinction often made between general and ambiguous expression. For this standard material I will assume for the syntax a stripped-down version of transformational grammar. For the semantics I will sketch a minimal possible world semantics and explain its motivation as we go along. In both it will be my goal to assume the minimum, only as much structure as is necessary to get the desired results. Another constraint of the enterprise and measure of its success will be how well the predictions of the theory match the facts of usage. For the most part, however, I will not be arguing with Atlas' data. The question is rather how this data, accepted as genuine, is to be explained. When we get down to serious detail, will a metatheory of the sort he envisages hold together?

Let us begin with syntax. The basic building blocks of a syntax are assumed to be the following.

The elements of syntax consist of sets of basic or *lexical* expressions, a set of *formation operations* for 'deep structure', and a set of single-valued *transformations* yielding 'surface structure'. For brevity we shall refer to both sorts of functions as *grammatical operations*, and we impose various structural conditions on them to insure that every grammatical *expression*, defined as any argument or value of a syntactic operation, can be generated in a finite manner. I shall list here just enough of these conditions to develop a workable identity test. In order to ensure that surface structure is transformed from a prior deep structure, we require that formation operations are never defined for the values of both formation operations and transformations. Though transformations are all one-place, taking one expression at a time as arguments, formation operations are typically defined over a series of argument expressions, each operation always taking a set numer of input expressions as an argument series and pairing with it a unique expression as value. Formation functions, but not necessarily transformations, are required to be *syntactically unambiguous* in the sense that they are uniquely decomposable: no two formation operations and no single operation assign the same value to more than one argument series. Two different transformations or even the same transformation, are, however, allowed to pair the same value with different arguments. Finitary construction of expressions, without loops, is assured by requiring that every expression have at least one *grammatical tree*. These are finite trees with the expression in question occupying the position of maximal element, lexical expressions those of minimal elements, and such that the expression occurring at any node is obtained from those at its immediate predecessors by the application to these expressions of one of the grammatical operations. Such a tree is required to be annotated in the sense that along with it (in the form, say, of a function on its nodes) comes certain information about the construction. Specifically, it must be stipulated for each expression at a non-minimal node which function generated it and the order of its immediate predecessors used. This additional information serves to distinguish the various trees of an expression producible in more than one way. Trees also allow us to distinguish the various occurrences of a single expression within a longer expression, and within two different expressions. We merely identify an *occurrence* of an expression relative to a particular grammatical tree with one of the nodes it occupies. When there is no possibility of confusion, we shall speak of a node and the occurrence of the expression 'occupying' it as the same. Strictly speaking, a single expression could have two or more isomorphic trees with the same lexical expressions occupying minimal nodes, the same expressions assigned to corresponding non-minimal nodes and generated from its immediate predecessors by the same functions, applied to its arguments in the same order, and the same annotation assigned to corresponding nodes. But these need not be distinguished for most purposes.

It will also prove useful to define the notion of a syntactic type or part of speech. By a sub-domain of a function let us mean the set of entities such that for some i, these entities are all those occupying the i-th place in some argument series for which the function is defined. By a function's range we shall mean as usual the set of all its values. We may then identify a *syntactic type* with any sub-domain of any range of any formation function, and we require that if a formation is defined for some member of a syntactic type, it is defined for all.

The necessary semantic theory postulates a series of elements corresponding to the elements of the syntax which I shall call their correlates. Corresponding to each set of lexical expressions there is a set of appropriate semantic values, and to each syntactic operation there is a unique semantic operation. By a *language* let us mean a specification of the elements of syntax (lexical classes and syntactic operations) and corresponding elements of semantics (types corresponding to the syntactic operations). The motivation for the semantic structure paralleling syntax is that if the right structure is imposed on it, a projection of meaning to all expressions is determined from an assignment of meaning to just the lexical items. Let me now list a minimum set of such structural conditions sufficient for stating the identity test.

An operation corresponding to an n-place formation function is to be an n-place function on semantic values. It is allowed that two of these functions, unlike the formation rules they correspond to, may assign the same value to different arguments. Operations corresponding to transformations are more complex. In order to determine the value of the transformed expression from that of its unsimplified prototype, two things need to be known: first, whether the syntactic and semantic history of the expression allows that the transformation be meaningful, and second, what the value of the untransformed expression is. If the transformation is meaningful for the expression, then the transformed version has exactly the same meaning as its untransformed original. Transformations preserve meaning, if they are defined at all. But it is allowed that if an expression violates certain grammatical and semantic constraints, the transformation may be grammatical but semantically meaningless because the corresponding semantic operation is undefined for it. Exactly this situation arises in the transformations that are used in the identity test. Exactly what these constraints are is a long story that we will take up later. For now we shall just set up the framework so that transformations will be sensitive to such information. Accordingly, we require that the semantic correlate of a transformation be a function from what we shall call the *semantic history* of an expression, by which we shall mean one of its grammatical trees together with an assignment of semantic values to all nodes but the top one. It should be remarked that in formal semantics, it is not all that unusual to find semantic rules that need more information than the reference of the immediate part in order to determine the reference of the whole. Semantic rules for the operators of modal logic or the connectives of supervaluations are good examples. But the ancillary information needed by these more familiar cases consists really of facts about the semantic interpretation of the immediate parts throughout other possible semantic interpretations. In the case of transformations like the ones we shall discuss, the supplementary information is of a different sort, concerning grammatical details of the deeper parts of the sentence itself and of their semantic values. Nevertheless semantic correlates determine a general interpretation in much the standard way. Information about the parts of a sentence will determine an interpretation for the whole. A second feature of the correlates to transformations that we must make explicit is that if they are defined, they assign to a transformed expression exactly the same value that is assigned to its immediate part as determined in its semantic history. That is, they 'preserve sense'. If they are defined at all for a semantic history, they assign to it exactly the same semantic value that its maximal expression has in that history. A last condition, already alluded to, is that the semantic correlates of transformations may be partial functions. It is not the case that they are defined for all semantic histories. Thus it is possible that some expression of surface structure has no value, and that it is meaningless in this sense. To make a projection of meaning well-defined, we also require that if the i-th sub-domain of a syntactic operation f is included in the range of another syntactic operation g, then the i-th sub-domain of the correlate of f is included in the range of the correlate of g.

What is perhaps the only novel formal feature of the notion of interpretation we shall use is that in conformity with practice in linguistics, it allows for different occurrences of the same expression to have different meanings in the same context of use. People do as a matter of fact equivocate in this way, and the possibility of such equivocation is assumed in the identity test. We capture it here by defining interpretations relative to grammatical trees in such a way that the various occurrences of an expression may have different meanings, but that the meaning of any occurrence is determined by applying the corresponding semantic rule to the meanings of its immediate predecessors. Any interpretation for an expression that is obtained this way is legitimate. More precisely, let us first define the notion of an *interpretation of a grammatical tree* as any partial function on the nodes of the tree such that (1) every minimal element is assigned something in the corresponding set of appropriate semantic values, (2) any node generated by a formation function is assigned that value determined by applying the correlate of the function to the previously defined interpretations of the node's immediate predecessors, in the annotated order, and (3) any node generated by a transformation is assigned that value, if there is one, determined by applying the correlate of the transformation to the node's semantic history. We may now define the simpler notion of an *interpretation for the language* as any partial function on expressions that assign a value to an expression only if some interpretation of one of its trees assigns that value to its maximal node, and it is undefined for an expression only if some interpretation for one of its trees is undefined for the maximal node.

The reason why logicians avoid equivocation on occurrences of the same expression is that it tends to undermine the purely formal nature of logical truth and validity. When we can mean different things at different occurrences of P, then 'if P then P' is no longer a logical truth. Thus, for the purposes of logical theory, special importance attaches to the subset of interpretations defined above in which all occurrences of each expression have the same value. But since we are less interested here in logic than in making sense of the identity test, it is reasonable to allow the relevant equivocation. An expression may then be said to be (semantically) *ambiguous* if there are interpretations of the language that assign it different values.[3]

It should be acknowledged that from the perspective of formal semantics the theory is a bit complicated and somewhat inelegant. Transformations are interpreted by rather baroque functions and interpretations are assigned not to individual expressions primarily but to grammatical trees. But some such complications seem required by the project of capturing standard linguistic assumptions.

The various versions of the identity test are formulated in terms of a family of transformations that, in Chomsky's words, "permit or require the deletion of repeated elements, in whole or in part, under well-defined conditions." He gives as examples that (7) may be transformed to (8), and (9) to (10).[4]

(7) I don't like John's cooking any more than Bill's cooking.
(8) I don't like John's cooking any more than Bill's.
(9) I know a taller man than Bill, and John knows a taller man than Bill.
(10) I know a taller man than Bill, and so does John.

Lakoff discusses other examples, as do Zwicky and Sadock in their summary of identity tests, and Atlas constructs similar cases employing negations in his application of the test to presupposition theory.[5]

Lakoff discusses *and so does* constructions. Zwicky and Sadock cite the straightforward deletion of repetition without proform as in the deletion from (11) yielding (12).

(11) I saw her duck and I saw her swallow.
(12) I saw her duck and swallow.

The way such examples figure in evidence for ambiguity can be informally sketched. Each of the various abbreviated forms is open to different readings, some of which are closed to its transformation. Thus *John's cooking* and *Bill's cooking* in (7) may refer either to single acts or to a product. Moreover, one may refer to an act and the other to a product. But such so-called cross-readings are excluded in (8). Therefore, what is intended by *cooking* must either be a single act for both John and Bill or a product, but not one of each. Likewise in (9) each occurrence of *know a man taller than Bill* may be read as *know a man taller than Bill is* or *know a man taller than Bill does*, but (10) can abbreviate only cases in which one or the other is used in both occurrences. In (11) *duck* may be a verb or a noun, and likewise for *swallow*, but (12) abbreviates only uses in which both are verbs or both nouns. When such cross-readings are eliminated, the sentence abbreviated is claimed to be ambiguous.

These cases are contrasted to others in which cross-readings of the reduced form are acceptable. Thus, Lakoff says that no reading appropriate to (13) is inappropriate for (14):

(13) Harry kicked Sam and Pete kicked Sam.
(14) Harry kicked Sam and so did Pete.

He explains that Harry may have kicked Sam with his left foot but Pete may have done so in a different way, for example with his right foot, and yet both sentences may be used to describe this situation. Cases that admit cross-readings are contrasted with genuinely ambiguous ones and are variously called vague (Lakoff), general (Zwicky and Sadock), and non-specific (Atlas).

But explaining in detail why such a test marks ambiguity, if it does, is no easy matter. My previous remarks proceeded by giving examples of the relevant transformations and then suggesting that in certain conditions they mark ambiguity. The mathematical task is to find a general characterization of the relevant class of transformations and a general statement of the conditions in which they mark ambiguity. Details must conform with the background theory already laid down.

Syntactically the family of abbreviating transformations act by simplifying conjunctions. Both conjuncts typically have the same overall structure, but within this structure they differ at one place. Where the first has one phrase or expression the second has another, though these are of the same part of speech. The simplification then consists in disregarding the long conjunction in favour of a shorter expression with the same structure as each of the conjuncts with the position of the variable phrase or expression taken by some combination of the disparate parts. This very vague procedure can be made precise by first laying down some technical terms. By a *conjunctive formation rule* we shall mean a formation operation that maps pairs of sentences onto their conjunction. Let N be an n-tuple of arguments in the domain of a syntactic operation f, and let N-M be the n-m-tuple of arguments obtained by deleting m arguments from N. Let M be the m-tuple of arguments deleted. Then a *syntactic operation relativized to f and M* is any function g that assigns to N-M what f assigns to N. For example, if f is a 2-place formation function defined for expression A, then g(X) = f(A,X) would define a syntactic operation relative to f and A. An operation on expressions is said to be *iterated* and to be relative to the set O of formation operations and the set E of expressions if it is a one-place function defined by applying to a given expression a finite series of relativized syntactic operations such that O is the set of all formation functions these operations are relativized to, and E is the set of expressions they are relativized to. For example, if f is a syntactic operation relative to formation function g and expression A, and h is another such operation but relative to formation function j and expression B, then k(X) = h(g(X)) would define an iterated syntactic operation relative to $<g,j>$ and $<A,B>$. We can now state the first condition characteristic of the kind of transformations used in the identity test. This condition is purely syntactic. For a transformation T to be used in the identity test we would require as a minimum:

(i) (a) T is a transformation defined over some subset of the range of a conjunctive formation operation (which we shall call f);

(b) there is some iterated relativized syntactic operation (which we shall call g) such that if T is defined for an expression, that expression is obtained by applying f to conjuncts obtained from g, i.e., it is f(g(A) , g(B)), for some expressions A and B.

Let us say the common content of g(A) and g(B) in the conjunction f(g(A), g(B)) consists of the occurrences of expressions occupying nodes in the trees of both g(A) and g(B), but not in the trees of just A and B. Thus, any expression C in the *common content* of a conjunction has two occurrences, which we shall call *parallel*, one of which is part of the tree headed by g(A) and the other of which is part of the tree headed by g(B), and these occurrrences are such that the sub-trees headed by them are isomorphic.

Then condition (i) may be summarized as requiring that the relevant transformations are defined only for conjunctions both parts of which have the same structure and a common content.[6]

It is not the syntactic but the semantic conditions on the transformations that are the most interesting. There are in fact two rather different semantic constraints. On the whole they have not been clearly distinguished in the literature, and their difference proves important in applications of the identity test to presupposition theory.

The first condition is fairly non-controversional and is George Lakoff's requirement that the common content of the conjunction must have the 'same meaning' if the transformation is itself to be meaningful. In addition to (i), we thus require:

(ii) the semantic correlate of T is defined for the grammatical history of a conjunction f(g(A), g(B)) if and only if the parallel occurrences of every expression in its common content have the same semantic value in that history.

The condition says in essence that we cannot equivocate over a deleted element. The requirement is natural enough and lies behind claims like Lakoff's that because (15) does not admit cross-readings, it is ambiguous.

(15) Selma likes visiting relatives and so does Sam.

Her *visiting relatives* may mean the act of going to visit relatives or the relatives who visit, but not both. Though the condition is plausible enough, a number of important points need to be made.

I have chosen to state the condition semantically, in terms of a restriction governing cases in which the semantic correlate of the transformation is defined. From many of the examples given in the linguistic literature it is not clear that the relevant condition need be interpreted this way. In a sense, cross-readings of (15) and of other examples like Lakoff's (16) and (17) are eliminated by the syntactic conditions (i) without mentioning semantic structure at all.

(16) Harry was disturbed by the shooting of the hunters and so was Al.
(17) The chickens are ready to eat and so are the children.

As (i) is formulated, the syntactic structures of g(A) and g(B) fed into the transformation T in the form of the conjunction f(g(A), g(B)) must be structurally isomorphic except that where a tree headed by A appears in the first a tree headed by B appears in the second. Both conjuncts must be of the same part of speech, and it is not implausible to think that the various senses displayed in Lakoff's examples (15)-(17) represent different parts of speech. Many ordinary uses of the test by linguists can be viewed as uncovering in this way what are really syntactic ambiguities. But the kind of ambiguity that interests Atlas and that we are trying to explain in metatheory is semantic, and we can construct other examples using more traditional sorts of lexical ambiguity that cannot plausibly be traced to switches in syntactic type.

(18) Tony Benn is a radical and so is the square root of 2.
(19) Ink goes in pens and so do pigs.

It is implausible to think that *radical* and *pens* here are syntactically ambiguous, falling into different parts of speech. Rather what is wrong is that there has been an equivocation. Literally the same syntactic entity has been used in two different senses.

It is, moreover, a semantic constraint as formulated in (ii) that is appealed to in applications of the ambiguity test to negation in presupposition theory. Atlas suggests that in some examples negation may be part of the common content of a reduction, yet because cross-readings of the reduced form are acceptable, the reduced sentences are not ambiguous. His example is (20), but I think (21) would do as well.

(20) The king of France is not wise and the same (thing) goes for the queen of England.

(21) The king of France and the queen of England are not wise.

One glosses the examples by explaining that the king of France is not wise because there is no such person, and the Queen of England is not wise because though existing she lacks the relevant properties. It does seem true that such a context can be convincingly described in which it is fair to say one could summarize the situation by either (20) or (21).

It is important to see that just as in (18) and (19) the acceptability of (20) and (21) is not a syntactic matter resolvable by appeal to (i) alone. No one has questioned that the formation rules of English seem to use exactly the same syntax for the various sorts of negation. Rather the issue facing Atlas and ourselves, as we try to state a metatheory compatible with Atlas' prescriptions, is semantic. Given a single formation rule for negation, should some uses be interpreted semantically by the semantic operation for exclusion negation and some by one for choice negation? Believers of the ambiguity thesis say yes, doubters no. Thus to make sense of the debate over the ambiguity of negation and the use of the identity test to settle it, we must assume the semantic condition (ii).

Now let us see exactly how (ii) bears on ambiguity in cases for which cross-readings are excluded. Ideally what we want to do is first define a conjunction reduction transformation as any transformation meeting conditions (i), (ii) and perhaps other conditions as well. We then need to define the notion of a reading, and prove some theorem like the following:

If T is a conjunctive reduction transformation, then f(g(A), g(B)) is ambiguous if and only if there are some readings for f(g(A), g(B)) that are not readings for T(f(g(A), g(B))).

As will emerge the readings open to the conjunction but closed to its reduction are what we have been calling informally the excluded 'cross-readings'.

The theorem as stated is quite strong. It requires that the failure of some cross-readings is both a necessary and sufficient condition for ambiguity. Strictly speaking the so-called identity test for ambiguity requires only that it be a sufficient condition. What we do is hunt around for an example of a reduction that does have some excluded cross-readings and then conclude that the transformed sentence harbours an ambiguity. But Atlas' application of the test to presupposition theory requires the converse also. He generalizes from cases like (20) to the thesis that all cross-readings of the conjuctions involving negation also apply to their reductions. Then by appeal to the converse he can conclude that the conjunction is not ambiguous. Part of our task then is to see whether the properties of the transformations will support both directions of the principle.

Before proceeding further into theory, it is relevant to point out that the converse viewed as a generalization about language is not very accurate. It has some counter-examples. Both (22) and (23) admit cross-readings. In the first contained expressions are ambiguous between a wider class and its male subset, and in the second they are ambiguous between disjoint sets. But even by the identity test itself, the terms in question are ambiguous: there are cases, (24) and (25), in which cross-readings fail. In (24) both terms are limited to the male reading, and in (25) both stand for animals.

(22) I saw a dog and a man.
(23) The search uncovered only a bug and a bat.
(24) A man's aggressive sexual behavior is correlated to testosteron levels and so is a dog's.
(25) The wings of the bat are covered by a thin membrane and so are those of the bug.

But a technical and, from our viewpoint, a more interesting preliminary to evaluating either direction of the identity test is finding the right analysis of 'reading'. This idea as it is used in linguistic discussions is a bit slippery. On the one hand, genuinely ambiguous expressions are said to be so because they have more than one reading. In this usage, which I shall call intensional, reading seems to mean something like meaning, sense, semantic representation, or synonymous paraphrase. It is what is represented in our foregoing theory by the idea of an expressions's semantic interpretation. Thus Zwicky and Sadock speak of (26) as having multiple 'understandings'.

(26) They saw her duck.

On the other hand, what makes some sentences vague, general, and non-specific is also that they have many readings. They differ from ambiguous expressions in that all of their readings also apply to their conjunctive reductions. Using essentially this idea of reading, Lakoff allows that *Harry kicked Sam* may be consistent with Harry's kicking Sam with the left foot or the right foot, and likewise Zwicky and Sadock explain that (27) may have as distinct understandings as both (28) and (29).[7]

(27) My sister is a prominent composer.
(28) My sister is the composer of "Concerto for Bassoon and Tympani".
(29) My sister published a concerto last week.

Now this sense of reading differs from the first in several important ways. First, this sort of reading is clearly not synonymous with the expression it interprets and is something quite different from the traditional notions of an expression's sense or intension. Harry's kicking Sam is not equivalent to his kicking with the left foot or to his kicking with the right. Likewise (27) is not synonymous with either (28) or (29), and none of these entail any of the others.

It might be possible to explain this sense of 'understanding', as Zwicky and Sadock suggest, as any state of affairs describable by the sentence. But in introducing states of affairs to semantic theory we would be adding a new theoretical concept that would itself need to be explained. Some recent formal work on facts or events might be used to this end. But there is a more obvious approach that does not introduce any more semantic entities than are regularly appealed to in intensional logic. We interpret state of affairs in the full-blooded sense of possible world. A possible world is, if you like, a total and complete state of affairs.

Now the advantages and disadvantages of using possible worlds in semantic theory are well-known. Their attraction here is both general and specific. They can be used first of all to give concrete examples of languages and semantic interpretations as these notions have been defined in our general background theory. Indeed, it would tell against these notions if they could not be seen as embracing the ordinary possible world semantics of logical theory. In these accounts semantic values or 'intensions' are set-theoretic constructions made up out of a postulated set of possible worlds. The sense of a sentence, for example, is a function that pairs a possible world with the truth-value of the sentence in that world. How to define semantic operations on such intensions so as to generate well-defined semantic interpretations for simple formal languages is now well-known, and extensions of these methods to richer languages closer to natural speech is now also commonplace. It would be a strength of any account of the identity test to explain how it fits with these standard ideas.

More specifically, the idea of possible world also provides a straightforward analysis of the second usage of reading. In this sense, which I shall call referential, a reading of a sentence is any possible world in which it is true. A sentence would then have more than one reading, and various other sentences would be partial specifications of it. Thus (16) and (17) help to specify a reading of (15) in that they could each be true in some world in which (15) is true. All three might even be true together. It must be admitted at once that this notion of reading is rather trivial. Every sentence but a contradiction would have various readings, and saying of a sentence that it is general, vague, or non-specific because is has various readings is then to say not very much of interest. Most sentences, ambiguous or otherwise, would be general in this sense. It is not a very interesting idea. To be fair to those who use the notion, we should say that it is not given much weight; it is used for little more than as a means of contrasting the genuinely ambiguous from the merely general. But what is very interesting about the referential account is its ability to provide a simple and useful sense of 'reading'. Given the rather weak notion of referential reading, we can explain how the identity test establishes ambiguity. But before we do that let us backtrack to the intensional sense of 'reading' and investigate to what extent it is reconcilable with the identity test.

For the time being let us call a *conjunctive reduction* any transformation meeting conditions (i) and (ii). Something like the identity test follows directly from the definitions.

Theorem -In any language in which T is a conjunctive reduction and in which there are some intensional readings of f(g(A), g(B)) that are not also readings of T(f(g(A), g(B))), the former expression contains an ambiguity.

Proof -Let T be as specified and let there be some reading for the conjunction that is not one for its transformation under T. The only reason a reading for the conjunction would not be the same as that of its T-transformation is that the semantic correlate of T is undefined for the semantic history of f(g(A), g(B)). But by (ii) it is undefined only if some expressions shared by g(A) and g(B) are ambiguous.[8]

This result also holds for the referential use of reading. Let a language be said to have a *possible world semantics* if it assigns as a semantic value to each sentence a function from possible worlds to truth-values. We make no assumptions about the number of truth-values beyond the classical two values T and F, but require merely that the semantic operation corresponding to conjunction be normal in the many-valued sense: if both parts of a conjunction are assigned classical truth-values T or F, then the semantic operation assigns that value dictated by the classical truth-table for conjunction. We can now prove that lack of cross-readings in the referential sense marks ambiguity. Since this is essentially the use of 'reading' employed by linguists, the result is really a statement of the identity test.

Theorem **(The Identity Test)** - In any language with a possible world semantics, and in which T is a conjunctive reduction, and in which there is some referential reading of f(g(A), g(B)) that is not also a reading of T(f(g(A), g(B))), the former expression contains an ambiguity.

Proof -Assume the conditions. There is some world in which the conjunction is true but its T-reduction isn't. Since the semantic correlate of T, if defined, is an identity mapping, the correlate of T must be undefined, and therefore, as in the last proof, g(A) and g(B) share ambiguous expressions.

It is important to see, however, that the relevant converses of both theorems fail.

Theorem -There are languages in which T is a conjunctive reduction and the conjunction contains some ambiguous expressions, yet every intensional reading of the conjunction is also a reading of the reduction.

Theorem -There are languages with possiblė world semantics in which T is a conjunctive reduction and the conjunction contains some ambiguous expressions, yet every referential reading of the conjunctions is also a reading of the reduction.

Proof -To see why the firts result holds it suffices to note that the semantic correlate of T is always defined if and only if the intensional readings of the conjunction are always readings of the reduction. Moreover, according to (ii) it is always defined if and only if all the common content of g(A) and g(B) is univocal. Languages are easily constructed that give the same interpretation to the common content but different interpretations to parts of A and B, by, for example, giving lexical items in the common content the same value, but items in A and B different values. In such languages the semantic correlate is always defined and hence all cross-readings are acceptable. Yet the expession contains ambiguities. Indeed with the right choice of f and g the conjunction itself can be made ambiguous.

For the referential case observe first that every referential reading may hold of both the conjunction and the reduction, yet the semantic correlate of T might still be undefined for some values of the conjunction. We can nevertheless construct a language in which all cross-readings apply to both and the correlate of T is always defined. We may then proceed as in the intensional case.

To the extent that these results fail to justify in our metatheory the converse of the identity test, they tend to undermine Atlas' argument. But they are in a sense too strong.

What is established is just that acceptable cross-readings are consistent with ambiguity when the ambiguity referred to is in those parts of the conjuncts which differ. All Atlas needs for his argument, however, is that acceptable cross-readings are inconsistent with ambiguity occurring in those parts of the conjuncts which are the same. It is negation he wishes to argue is not ambiguous, and in all his examples negation is in the common content of the reduction. Within the contraints of our reconstructed metatheory, aren't acceptable cross-readings formally inconsistent with ambiguity in the common content? The answer depends on the sense of reading. It is true that under the intensional notion all cross-readings apply if and only if the semantic correlate of the transformation is always defined. Hence by (ii) ambiguity in the common content entails that the correlate is undefined for some arguments and, therefore, that not all cross-readings apply. But under the referential sense of reading this inference does not follow. It is compatible with that notion to have a language in which every world in which the conjunction is true is also a world in which the reduction is true, i.e., for all cross-readings to apply in this sense, yet the transformation's correlate might also be undefined for some values. A trivial example can be constructed by defining a correlate that assigns to any proposition (function from worlds to truth-values) itself except in those cases in which the proposition is contradictory (assigns F to every world), and for these cases we let the correlate be undefined. Then any world that satisfies the conjunction will also satisfy its reduction. Other more complex examples are also possible. We have in effect established two simple results.

Theorem -In any language in which T is a conjunctive reduction and in which some expression in the common content of g(A) and g(B) is ambiguous, there is some intensional reading of f(g(A), g(B)) that is not a reading of T(f(g(A), g(B))).

Theorem -There is some language with possible world semantics in which T is a conjunctive reduction and in which some expression in the common content of g(A) and g(B) is ambiguous, yet every referential reading of f(g(A), g(B)) is also a reading of T(f(g(A), g(B))).

Discussion could stop at this point if it were not for the fact that we may have under-represented conjunction reduction in an important way. It is common in the literature to impose additional conditions in the form of category constraints on the disparate parts, and it might seem possible to obtain Atlas' converse if these additional assumptions are incorporated into the semantic theory. As I shall argue, I think such an approach fails, but it is interesting, especially in its need to clarify what sort of metatheory these category constraints presuppose.

The condition in question requires that the disparate parts of the conjunction can be yoked in a reduced form only if they are originally of the same type. "Roughly", say Zwicky and Sadock, "to be eligible for reduction two conjoined clauses must be of the forms X--A--Y and X--B--Y, where A and B are constituents of the same type." Likewise, Chomsky posits "some general condition of the applicability of deletion operations such as the one that gives (31) from (30), a rather abstract condition that takes into account not only the structure to which the operation applies but also the history of derivation of this structure."[9]

(30) I don't like John's cooking any more than Bill's cooking.
(31) I don't like John's cooking any more than Bill's.

These conditions would allow the reduction only if *cooking* in both conjuncts was of the same type, both a general practice or an isolated act.

The idea behind the condition is itself somewhat ambiguous; the notion of type involved may be construed as either syntactic or semantic. I think many of the examples used to illustrate this condition in the literature do make sense when the type restriction is interpreted strictly syntactically. Zwicky and Sadock's example in which reduction is allowed if both *duck* and *swallow* are verbs or both are nouns is a good case. Likewise Chomsky seems to think that the differences in type of *cooking* will be exhibited in its various syntactic histories and that *John's cooking* really does fall into two parts of speech. But if the condition is merely syntactic, it is essentially captured already in requirement (i). Formation functions are defined relative to parts of speech and in particular the operation g used in f(g(A), g(B)) is defined over a single part of speech. Therefore if g(A) and g(B) are defined, A and B are of the same syntactic type.

But the syntactic interpretation is not the most interesting, and the intentions of linguists in stating the condition are not always clear. Chomsky, like many others, posits a parallel between syntactic and semantic structures. Zwicky and Sadock are also typical in shifting from syntactic to semantic vocabulary in a manner justified by postulating a vague correspondence. Moreover, it is clear that the syntactic interpretation will not help Atlas' argument. For the syntactic restriction is already captured in the notion of a conjunctive reduction, and that idea does not yield the implication from ambiguity to failure of cross-readings which Atlas needs.

The semantic version is also interesting in itself. It would allow the possibility that two expressions of the same syntactic type might belong to distinct semantic categories, and then require that reductions are meaningful only if the two disparate parts were of the same semantic category. Technically we would have to augment the specification of a language with what we may call (following Thomason and others) a *sortal specification*, some partitioning of possible semantic values for each part of speech, stipulated prior to the definition of an interpretation. Then in lieu of condition (ii) we would require:

(iii) the semantic correlate of T is defined for the grammatical history of a conjunction f(g(A), g(B)) if and only if
  (a) the parallel occurrences of every expression in its common content have the same semantic value in that history, and
  (b) the interpretations of A and B in that history are of the same semantic category as defined in the sortal specification of the language.

This categorical restriction has been discussed in the philosophical literature under the topic of zeugma.[10] Indeed, a zeugma may be defined as a conjunctive reduction that violates (b). It is granted by most that some such violation occurs, often with literary effect, but it is a matter of contention whether they are seriously deviant and if so how this deviance should be marked within semantic theory. First some examples. The first two are standardly given and the latter two are cited by Fowler:

(32) She came in a flood of tears and a sedan chair.
(33) The room was not light but his fingers were.
(34) Half-clad stokers toasting in an atmosphere consisting of one part air to ten parts mixed perspiration, coal dust, and profanity.
(35) Such frying, such barbecuing, and everyone dripping in a flood of sin and gravy.

Most concede, I think, that such examples are grammatical. They differ on whether they are semantically deviant, and if so, how this deviance is to be marked. Theories include classical accounts which admit that zeugmas contain category mistakes but argue that these should be represented as false in a classical two-valued semantics. On this view, zeugmas are literally false. There are also various many-valued approaches that conform better to the intention of (iii) and render zeugmas neither true nor false.

The first point to make about the treatment of zeugma required in (iii) is that it is at odds with most formal approaches. It is not really true that zeugmas are meaningless in formal accounts even though their deviance is marked. Whether this marking consists in assigning the classical truth-value false or in assigning some more elaborate truth-value gap or non-classical value, the expression literally has an intension in the model theoretic sense. It is always interpreted by some function from possible world to truth-values, and the semantic operations generating interpretations of zeugmas would be defined for any argument. Another way to put this point is that the term 'meaningless' is itself ambiguous. It may mean that the semantic operations of the theory are really partial functions and that, though the interpretations of the parts are assigned, the whole has no semantic value because the appropriate semantic rule is undefined for those inputs. It is in this sense that (iii) ensures that zeugmas are meaningless. But the intensions assigning sentences non-classical values constitutes meaninglessness in a different sense. Such assignments usually assign set-theoretic meanings. Indeed there is an important technical reason why undefined values for semantic operations are avoided. The usual theory of logical consequence is defined in terms of truth-values and presupposes that expressions always have intensions in the model theoretic sense. We may speculate that a theory of logical consequence for the surface forms represented in conjunctive reductions would be inappropriate or that it might somehow be managed even in the presence of partially defined semantic operations. But in doing so we should realize that we're taking a big step into uncharted regions. As theories in formal semantics now stand, (iii) is actually implausible.

A second point to make about (iii) is that even if it is accepted as it is, it needs buttressing to provide any links to ambiguity. Let us call a *strengthened conjunctive reduction* any transformation meeting conditions (i) and (iii). We may now ask whether the additional structure imposed in (iii) ensures Atlas' converse. Let us suppose that f(g(A), g(B)) contains an ambiguous expression. Given that the expression is in deep structure and therefore is not syntactically ambiguous, this ambiguity must be traceable to either some of the lexical expressions in the common content of g(A) and g(B) or to A and B themselves. To show that ambiguity entails failure of some cross-reading, what we must then be able to prove is that ambiguity in any of these, together with (iii), entails that the semantic correlate of T is undefined. But (iii) as it stands only entails ambiguity if the source of the ambiguity is in the common content. Suppose the ambiguity is in A and B. To use (iii-b) we must be able to show that ambiguity in A and B entails a violation of sortal specification. We need some principle like the following:

> If A and B are ambiguous then their various meanings may be paired up in such a way that they fall together in different semantic categories.

But this idea is altogether too strong. Why couldn't all the meanings of two terms fall into the same sort?

Let us turn to the converse. Does failure of cross-readings continue to entail ambiguity as before? Assume that some cross-readings for the conjunction are closed to the reduction and that therefore the semantic correlate of T is undefined for some argument. Then by (iii) there is either an ambiguity in the common content or a sortal violation. To derive the conclusion that there must then be an ambiguity in either of these cases, we need again a supplementary principle, this time saying something like the following:

> Whenever the interpretations of A and B fall into different semantic categories, at least one expression in A or B is ambiguous.

But this notion is even less plausible than the last. Why couldn't A and B just be univocal lexical expressions of different sorts?

This excursion into semantic category restrictions on conjunctive reduction has amounted in effect to a kind of elaborate *reductio*. True, there are some sorts of category constraints that make sense for conjunctive reduction, but these are syntactic and have already been captured in (i).

The overall dialectic of the paper so far has not been simple. What we have been doing, in effect, is considering various elaborations of the theory behind the identity test. We would like to make it work, to make Atlas' converse work, and to maintain the referential notion of reading. Given the background assumptions I have adopted, we can conclude that the identity test itself with its referential usage of reading is justified, and that even with the intensional use of reading, failure of cross-readings marks ambiguity. We may also conclude that ambiguity entails failure of some cross-readings in the intensional, *but not the referential sense. I suspect that it is the former entailment* that Atlas may have in mind. If so, he is right insofar as I have justified it here. But it is wrong to assume the entailment for the referential notion of reading, as he does in the critique of presupposition. Both the identity test and Atlas' particular examples about negation are formulated in terms of the referential sense. These conclusions depend in part on the technical details of the background theory, and these no doubt are arbitrary in places and open to negotiation. But as far as I can see, no small change will alter the major critical point.

It might seem that we could just do away with the referential sense and revert to readings as intensions. But to do so would be to ignore an important heuristic motivation. There is more to the referential idea than its use in the rather trivial definition of a general expression. Its attraction is methodological and epistemic. Intuitions about which situations make a sentence true are clearer, more positivistically palpable than intuitions about proper analysis or definition. This is especially true of disputes about ambiguity. It is not at all clear, to use a Quine's example, whether *hard* has two definitions or just covers a range of quite disparate things. It is precisely because intui*tions about intensions are unclear that the identity test is supposed* to be useful. It removes inquiry from the realm of meanings to judgements about truth and falsity. On this methodological preference, linguistic practice seems right. Intuitions about truth are clearer than intuitions about how many senses an expression has, and Atlas' examples about negation are quite convincing. But it is essential to this method that 'reading' be understood in the referential sense, and in this sense ambiguity is perfectly compatible with acceptable cross-readings.

We may speculate that on some other analysis of reading, perhaps *one somewhat in between the intensional and referential, the notion* would support both directions of the identity test and serve to define generality. Atlas has actually raised this interesting possibility with me in conversation. One approach might be to take the identification of reading with state of affairs more seriously, and to unpack reading in terms of various set-theoretic constructs of facts or events developed for other purposes in the logical literature. The reading of a sentence would then be any fact that if it obtained would make the sentence true. Whether facts could be defined sufficient to Atlas' purposes is, however, an open question.[11]

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Notes

I would like to thank Jay Atlas and Merrie Bergmann for helpful discussion of an earlier draft.

1 See especially Atlas (1977) and Kempson (1975: 99, 100). For an account of the history of the argument, see Atlas (1978: 402, note 3).
2 Wilson (1975) and Boër & Lycan (1976). See also Martin (1979).
3 There is another sense in which an expression is ambiguous if there is some tree containing more than one occurrence of that expression and an interpretation for that tree that assigns different values to those occurrences. But given ambiguity in the first sense there are two trees each with the same maximal element assigned different semantic values. From these trees we can make up a larger one by feeding the two maximal elements as distinct occurrences into some formation function that takes this pair as arguments. Then the expression would be ambiguous in the second sense. Conversely, given ambiguity in the second sense it is straightforward to break up the tree into two subtrees with the same sentence as maximal element but different interpretations. We may then define different interpretations over expressions, one that conforms to the interpretation relative to the first tree, and one to that relative to the second, and the expression is then ambiguous in the first sense. Note that if the expression is not in deep structure or cannot be repeated as part of the argument series of some formation operation, the implication from sense one to sense two fails. But the two notions are for practical purposes much the same, and I opt here for the former because it more closely conforms to usage in formal semantics and philosophy of language generally.
4 Chomsky (1972: 32-35).
5 Lakoff (1970); Zwicky & Sadock (1975); Atlas (1977).
6 The observant reader may have noticed that the syntactic condition (i) doesn't actually say anything about the shape or form of the simplification itself. In particular it doesn't require that the common content be displayed in its previous form and that the disparate elements be yoked in some fashion with an 'and'. A complete account of conjunctive reduction would indeed need these additional conditions however they should really be spelled out. But for our purposes the actual shape of the resulting abbreviation is irrelevant, so I haven't ventured to mention it. Syntactically, conjunctive reduction is one of a large family of transformations that eliminate redundancies. Other sorts, for example, reduce 'Tom wants Tom to come' to 'Toms wants to come', 'Tom is as large as Bill is' to 'Tom is as large as Bill', and 'Tom looks like Bill looks' to 'Tom looks like Bill'. Varieties of specific conjunction

reductions including *and-so-does* constructions have been studied since the early days of transformational grammar. See Chomsky (1957: 26-27, 65-67). One important variety of conjunctive abbreviation is known as gapping, the deletion of centrally embedded (verbal) material, as in 'Mary catches fish and Tom butterflies'. See Ross (1967). The syntactic literature on the varieties of conjunctive reductions is quite large. Cf. Ross (1970), Lakoff & Ross (1970), Jackendoff (1971), Grinder & Postal (1971), Hankamer (1973), Channon (1975), Stillings (1975), Neijt (1978). It is interesting that all such reductions, conjunctive and otherwise, eliminate cross-readings and are probably governed by the sorts of semantic constraints discussed in this paper. Another interesting paper ciritical of Atlas, one which I came upon too late to discuss here, is Blackburn (unpublished).

7 Zwicky & Sadock (1975), esp. p.3, note 9.

8 Note that even if g(A) and g(B) share some ambiguous expressions, any other whole they are parts of, like f(g(A), g(B)) and T(f(g(A), g(B))), might well be unambiguous because semantic operations as defined are allowed to give different combinations of arguments the same value.

9 Zwicky & Sadock (1975: 18); Chomsky (1972: 33).

10 See Thomason (1972); Martin (1975a); Bergmann (1977).

11 See for example Van Fraassen (1969); Martin (1975b); Martin (in press).

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