Do Indicative Conditionals Express Propositions?

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1 Two Views of Meaning

One central question in contemporary linguistics semantics and philosophy of language is what theoretical device we should use to represent the meaning of sentences. There are, of course, many different aspects to this question. In recent years, the semantics/pragmatics debate has centered over the gap between sentence meaning and speaker meaning. Generally participants in that debate take for granted that, at the end of the day, what gets expressed by a sentence used to make an assertion is a proposition, something that at the minimum determines a set of truth-conditions. The semantics/pragmatics debate, then, focuses on *how* sentences come to express propositions.

However, it is not at all uncontroversial that sentences *do* even express propositions. There are some philosophical traditions, of course, which views talk of propositions as generally suspect. However, even outside of these traditions there are some who think that while propositions are perfectly kosher objects (or anyway acceptable theoretical tools for thinking about language), and while one *could* have a language in which sentences expressed propositions, as it happens, our language or, at least, parts of our language simply don't behave like that.

I find this position interesting because it rests not on some abstract claims about the nature of meaning but rather on the contingent facts about our language, or at least some parts of our language. Anti-propositionalism of this variety are putting forward a claim that is not just of

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interested to philosophers but also to working linguists, since they're claim is necessarily about actual features of our language.

Now, some have seen in anti-propositionalism a sort of anti-theoretical or anyway an anti-formal bent. However, recent work has dispelled the Wittgensteinian air from the position. One can be an anti-propositionalist and still endorse formal methods for studying language. (Of course, the relevant question is not formal methods themselves, but rather the precision of claims one is making about language: it just often happens that formal methods facilitate precision.) There is a natural framework for viewing meaning non-propositionally that can easily be made rigorous and systematic.[1] In this framework, roughly speaking, we view sentences as not expressing propositions but rather as directly expressing properties of attitudes. I'll call this the "attitude-view" of semantics, and as we shall see, it's naturally thought of, in more traditional terms, as a form of expressivism.

One way to see the difference between the attitude-view of semantics and the propositional view is in their differing expressive power. Asserting propositions may be seen as *one* way of expressing properties of attitudes. The property of attitudes expressed, when I assert say, "John went to the bank," is simply the property of believing the proposition that John went to the bank. So, naturally, every propositional assertion can in this way be described as a property of an attitude.

However, it is not in general true that every property of attitudes that can be expressed can be understood as a propositional assertion. Consider for example the property that one's belief state might have of not ruling out the proposition that p as a doxastic possibility. In general, there is no one proposition one can accept such that one doesn't rule out p if only and if one accepts that proposition (p itself is already too strong). So if our language provides the resources to simply express that we don't rule out p, then it seems we will not be able to understand that bit of language if we confine ourselves to a framework where sentences express propositions.

Indeed, it seems that our language does allow us to express that we don't rule out p, using epistemic modals:

(1) It might be dark outside.

[1] The work of Yalcin (2007) and Swanson (2006) are good examples of the basic view.

(1) on a natural understanding would seem to express the fact that we do not rule out the proposition that it is raining. It doesn't *appear* to express anything more than that.

However, one might find the above sketch of an argument the attitude view, far too quick. After all, we can use certain propositions to express any property of attitudes we want. All we need is to use propositions about our mental states. So, why shouldn't we understand (1) as being a statement about our own beliefs? In this way, then, (1) would express a constraint on attitudes by way of expressing a proposition about our own mental state.

Taking (1) to be merely a statement about our beliefs, is not a very promising strategy. For example if we negate (1) we get a new sentence which entails that it is not dark outside;

(2) It's not the case that it might be dark outside.

However, if we negate a statement about our beliefs we get no such entailment:

(3) It's not the case that it's compatible with my beliefs that it is dark outside.

All is not lost, however, for the propositional view. If we switch belief with knowledge and perhaps even consider the knowledge attribution to be one to someone besides oneself, then this difference goes away. We might then think that (1) expresses a proposition of the form:

(4) It's compatible with some source of knowledge X that it's dark outside.

If we negate this we do get something that entails that it's dark outside, by the factivity of knowledge.

Yalcin (2007) argues that the propositionalist views of this sort are wrong, but his argument is quite subtle and there is perhaps still room for propositionalism of a suitably sophisticated kind. Indeed propositionalism (via attitudes) about epistemic modals is the probably the most common strategy in the semantics and philosophical literature, despite its problems.

In this paper, I do not address propositionalism about epistemic modals, but rather discuss propositionalism about conditionals. In particular, the relationship between conditionals and probability creates a particularly pressing problem for propositionalism, one which I think has never been adequately answered by propositionionalists. Here I sketch both the problem and a way propsoitionalists can respond to it. I remain skeptical of propositionalism, but I think the worry from conditionals and probability is not insurmountable.[2]

2 The Problem with Conditionals and Probability

Consider these two sentences:

(5) a. It's likely that the airbag will go off

b. It's likely that if the car crashes at greater than 35mph, the airbag will go off.

Intuitively, it seems that both sentences are of the form: *it's likely that* x, where, in the first case, x = *Georgia will join the E.U.* and, in the second case, x = *if Russia needs foreign aid, Georgia will join the E.U.*. Understanding how these sentences get their meaning as a function of the meaning of both the embedding construction, *it's likely that ...*, and the embedded sentence, x, would seem an easy task. The natural way would be to assume i) that in each case the particular sentence x expresses a proposition, and ii) that sentences of the form *it's likely that* x are true iff x expresses a proposition that has a probability greater than one-half. In other words, in general, *it's likely that* x is true iff $p(x) > .5$. This simple proposal leaves various questions unanswered. For instance, what does it mean for x to have a probability greater than one-half? Is it that the speaker has a credal state that assigns a subjective probability of more than one-half to x, or is that there is a more objective or intersubjective probability at stake? I will put this question aside, though, as a more basic problem confronts the proposal.

The problem goes as follows: Suppose we understand (5-b) to be true iff $p(x) > .5$ where x is *If the car crashes at greater than 35mph, the airbag will go off.*. It seems that as a matter of fact (5-b) is judged true iff the conditional probability that the airbag going off given that the car crashes at greater than 35mph is high. Recall that where $p(y) \neq 0$ the conditional probability of x given y, $p(x|y) = \frac{p(x \wedge y)}{p(y)}$. To see this think about two sorts of cases: in the first, you think it's very likely that car will crash at greater than 35mph, but you think it's very unlikely that

[2] My skepticism has two sources: i) the worry in Yalcin (2007) and ii) the sense that statements involving epistemic modals don't seem to involve any ascription of knowledge or belief to anyone.

it's both the case that the car will crash at greater than 35mph and the airbag will go off. Then your conditional probability of the airbag going off given that the car crashes at 35mph cannot be very high, and correspondingly you must judge (5-b) as false. By contrast, if you think it's likely the car will crash and only slightly less likely that the car will crash*and* the airbag will go off then you would seem to need to judge (5-b) as true. Generalizing, away from this example it's intuitive that *it's likely that if* a *then* c is true iff the conditional probability of c given a is greater than one half. Our prior assumptions about the meaning of sentences of the form *it's likely that* x along with this last observation should lead use to the conclusion that conditionals express propositions whose probability is just the conditional probability of the consequent given the antecedent. This hypothesis is what is often called *the equation* or *Adams's thesis*: the probability of "if a then c" is equal to $p(c|a)$ (see Edgington, 1995, and references therein). The problem with this conclusion, is that, in a certain sense, *there is no proposition that satisfies the equation*.

Here's the sense:[3] suppose we assume that there's a set of possible worlds W, and any given sentence, x, expresses a proposition by picking out a subset of W, i.e. the worlds where x is true. Let's then say that any given credal state is a probability function defined over the power-set (or some sigma algebra) of W, i.e. a function that tells you for any given set of possible worlds how much credence you have that the actual world is one of those. Now let $a \rightarrow c$ be *if Russia needs foreign aid, then Georgia will join the E.U.*, and a and c, be the antecedent and consequent respectively. Since $a \rightarrow c$, a, c are all sentences that we can have credences in, they each pick out a subset of W. Suppose that on someone's credal state, p, $p((a \rightarrow c) \wedge a) > 0$, and $p(c|a) \neq p(c) \neq p(a)$, and none of those values are 0 or 1. Further suppose, as suggested, that $p(a \rightarrow c) = p(c|a)$. Now, it is easy to show that there will exist another probability function p_1 such that $p_1(a \rightarrow c) \neq p_1(c|a)$.[4]

What's the problem with this? Well, what we've just shown is there isn't any subset of W to which every probability function assigns a probability equal to the conditional probability of c given a. This suggests that our semantic theory will not be able to assign a *general* meaning to

[3]This is a variation on Lewis's first "triviality theorem" (Lewis, 1976).

[4]One can construct p_1 for instance by making it the result of conditionalizing p on $\neg(\neg a \wedge (a \rightarrow c))$. It will then follow that $p_1(a \rightarrow c) < p(c|a)$, since $p_1(a \rightarrow c) < p(a \rightarrow c)$ but $p_1(c|a) = p(c|a)$.

$a \to c$ which 1) applies across different credal states *and* 2) fits into the natural account of the semantics for sentences of the form *it's likely that* x. This is not a happy situation, since $a \to c$, intuitively, has some sort of uniform meaning.[5]

So this looks like a powerful argument that conditionals do not, in fact, express propositions. For it seems that no proposition they could express would have the right probability. If that's right then then the relationship between probability and conditionals yields a formidable consideration in favor of the attitude view of semantics, at least with regard to conditionals. Certainly this is the view taken by Adams (1975) and Edgington (1995).

However, before we consider the view that conditionals express propositions to be thoroughly discredited we should consider other possibilities:

Kratzer (1981, 1986) denies the syntactic parsing that is required to formulate this problem.[6] She claims that the function of the 'if'-clauses is to restrict higher-up modal quantifiers in the sentence. In the case of (5-b) the natural choice of the operator to be restricted by the 'if'-clause is the probability operator *it's likely that*. Thus, when we parse (5-b) we, in fact, do not treat the conditional as one unit, but, rather, treat the antecedent, 'if Russia needs foreign aid' as a restrictor on the probability operator which then operates directly on the consequent, 'Georgia will join the E.U.'. If we make normal assumptions about the semantics of probability operators, then this should give us a good compositional semantic treatment of (5-b).

While there is much to be said for her view, I think that, generally speaking, her strategy, as normally understood, will not explain all the recalcitrant facts about probability and conditionals that the proposal presented below aims to. For example, many judge (6-b) in the dialogue below[7] to have the same truth conditions as (5-b):

(6) a. If Russian needs foreign aid, Georgia will join the E.U.
    b. It's likely that that's true.

[5]Some have argued that the proposition expressed by a conditional sentence varies with the epistemic state of the speaker—this is, for instance, a direct consequence of Kratzer's theory of epistemic modals and indicative conditionals. In this case, the argument I gave in the previous paragraph would have no force. There are, in fact, further problems with maintaining "the equation" even if one allows conditionals to express different propositions relative to different credal states, but I won't discuss them here. See Edgington (1995) and Bennett (2003) for discussion and citations to the major results.

[6]Her work is an extension of the treatment of conditionals in Lewis (1975).

[7]Inspired by von Fintel (2007).

However, in this case it seems rather implausible that the antecedent of the conditional embedded in the anaphora in (6-b) pops out to restrict *it's likely*. Other cases can be found of this sort: such as cases where there is no linguistically present modal at all and speakers or audiences merely make *judgments* of the probability of various conditional sentences without expressing them in sentence. For instance suppose that you utter this sentence to me:

(7) If Russia needs foreign aid, Georgia will join the E.U.

Then I make the *judgement* that what you said was likely to be true. For Kratzer to explain this my judgment itself would need to have a linguistic form. Thus the story is committed to something like the use of a language in thought whenever conditionals are involved. While this isn't such an implausible thing to say, it is a rather strong commitment about the nature of thought to come out of a theory of *conditionals*.[8] Kratzer's approach than can explain the connection between conditionals and conditional probability only by means of positing extensive syntactic operations and assuming that *thought* about the probabilities of conditionals always takes a linguistic form. I think there are probably appealing ways of working out this view, but I take it its prima facie difficulties warrant a look at alternative explanations.

In Rothschild (2009), I outline a trivalent approach to conditionals that explains the conditional-conditional probability link without further ado.[9] This strategy represents perhaps the most minimal departure from a classical semantics that allows one to explain the conditional-conditional probability link above. In the literature there are more ambitious departures from classical semantics for conditionals that can also explain the conditional probability/conditional link within the framework of a systematic, semantic theory. Notably Yalcin (2007) gives a non-classical semantics for conditional and probability operators that derives the correct results.[10]

Here, I propose another way of explaining the relationship between conditionals and probabilities. This method takes a standard semantics for indicative conditionals, essentially that of Kratzer (1986) minus the special syntax of antecedents. On this semantics, indicative condition-

[8]See also von Fintel (2007) for further discussion of the limitation of Kratzer's approach to conditionals.

[9]See also Belnap (1970) and Huitink (2008) for discussion of the trivalent approach.

[10]His semantics is non-classical in the sense that it adds an extra 'epistemic' parameter that the truth of sentences is sensitive too. I use 'non-classical' merely to mean that the theory goes beyond the standard framework of bivalent compositional semantics.

als are context sensitive, but within a given context they express a normal proposition which we can evaluate the probability of in a normal way. I then show how certain assumptions about the truth-conditions of indicative conditionals can, in many cases, validate the judgement that the probability of a conditional is its conditional probability. I defend these assumptions and show where we must depart from the assumptions behind Lewis's triviality proofs in order to avoid contradiction. Needless to say this approach has its own problems, but even if it is not ultimately the correct semantics for conditionals it is important to see how certain propositions naturally have as their probability the conditional probability of two related propositions.

3 A Classical Explanation

3.1 Classical Semantics via Epistemic Modals

A number of semantics for indicative conditionals treat them as restricted epistemic necessity modals, i.e. as expressing the epistemic necessity of the consequent in all cases in which the antecedent is true (e.g. Kratzer, 1986).[11] To see one reason why this idea is attractive, consider these two sentences:

(8) a. John must be here.
    b. If Mary is here, then John is here.

A natural thought is that (8-a) expresses the epistemic necessity that John is here and (8-b) expresses the restricted epistemic necessity: in all epistemically possible worlds where Mary is here, John is here. According to Kratzer (1986) there is a hidden epistemic necessity modal in all unembedded indicative conditionals and the antecedent acts as the restrictor of the modal and the consequent as its matrix clause. The classical proposal we will take up here treats *both* embedded and unembedded conditionals as having these truth-conditions. What remains is to give a semantics for epistemic necessity modals.

[11] Note that even some non-classical approaches to indicative conditionals and epistemic modals draw this same connection. See particularly Yalcin (2007) and Gillies (2004).

For the reasons sketched in section 1 we will treat epistemic necessity modals as statements about knowledge states. We will call the particular the source of knowledge in question X and formulate our semantics for conditionals and epistemic modals as claims about X:

Classical Semantics for Epistemic Modals and Indicative Conditionals

- $\Box p$ is true iff p is true in every world w compatible with X's knowledge (more simply put: 'X knows that p')
- $p \to q$ is true iff $p \supset q$ is true in every world w compatible with X's knowledge (more simply put: 'X knows that $p \supset q$')

The status of X is controversial. Kratzer (1986) proposed that (for conditionals) X should be identified with the speaker, but there are numerous examples that this proposal cannot handle.[12] I will posit a much more abstract identity for X. X is a context-sensitive abstract knower the extent of whose knowledge depends on the conversational participants but often goes beyond it. Hence, there is some sense in which X represents an idealized, but still limited, source of knowledge. One way of thinking about this source, more is to take $a \to c$ to mean "it is known that all a worlds are c worlds" which perhaps better captures the "objective" flavor of the knowledge source than the use of X does.[13] Below I will propose some more concrete principles governing the choice of X that explain the link between conditionals and conditional probability.

3.2 The Nature of X and the Probability of Conditionals

As mentioned, I will not use Kratzer's syntax for conditionals embedded under probability operators. Rather, we will assume that conditionals have the truth conditions above and try to figure out what probability we should assign to them, just as we would assign probabilities to any other proposition. Even if you think Kratzer's syntactic approach is right in many cases,

[12] See, for instance, the discussion in von Fintel and Gillies (forthcoming), where practically every possible value is tried and rejected and the paper concludes by maintaining the classical approach to epistemic modals only at the cost of largely rewriting the rules of assertion for these constructions. See also Yalcin (2007) for a presentation of a particularly thorny problem for any semantics of epistemic modals along these lines.

[13] Thanks to Brett Sherman for suggesting this formulation.

this project might still be of interest, since you might wonder what probability we should assign to Kratzer's unembedded indicative conditionals.

Let me first note something obvious: if we allow X to be the speaker and we think of probabilities as being subjective probabilities for the speaker then the probability of conditionals will often be either zero or one. For example, consider the conditional (7). If X is just me, the speaker, then (7) is true just in case I know that in any case in which Russian needs foreign aid it will also be the case that Georgia will join the EU. Obviously my judgment about the probability that I know something will (in the normal case, putting aside cases in which one does not know about one's own beliefs) be either 0 or 1 (depending on whether I believe it or not). So we will be hard-pressed to find a case where we can say that (7) is likely but not certain. Obviously, in this case we cannot preserve the observed connection between conditionals and conditional probability.

So X will have to *not* be the speaker if we are to find non-trivial probabilities for indicative conditionals on this semantics. As I said, we will instead think of X as a sort of idealized (but not omniscient) knowledge source.[14] Obviously there will also be some context sensitivity about the extent and nature of X's knowledge since epistemic modals are context sensitive: so the knowledge source X must reflect, in some way, the speaker and hearer's knowledge even if it does not correspond exactly to either one (or the combination of the two). I have no particular theory about the nature of X, but I will make a few posits which will do all the necessary work:

Properties of the Knowledge Source for Indicative Conditionals Whenever one utters an indicative conditional $a \rightarrow c$ the following default assumptions about X are made (when probabilities are mentioned they are with respect to the speaker's subjective probabilities):

1. all the a worlds compatible with X's knowledge are either all c worlds or are all $\neg c$ worlds
2. the probability that all a worlds compatible with X's knowledge are c worlds is independent of the probability that a is true[15]

[14] This idea, I suppose, might be floating around somewhere in the literature.

[15] Note that by definition if the probability of a is independent of the probability of c then $p(a \wedge c) = p(a)p(c)$.

To better explain and justify these assumptions I will illustrate them with an example of a *real world* idealized knowledge source. Consider this conditional said of a certain car:

(9) If the car crashes at greater than 35mph, the airbag will go off.

Imagine that there is a defect for cars of this sort such that cars with the defect have airbags that wouldn't go off at 35mph crashes but cars without the defect have airbags that would go off in such crashes. Imagine that our idealized source of knowledge, our X, knows whether or not the car has this defect and knows the effect of the defect on crashes, but that he doesn't know whether or not the car will crash in the future. Suppose moreover, that the conversational participants don't know whether or not the car has this defect. This seems like a pretty typical case of an idealized source of knowledge: the knowledge source knows a bit more than us about the workings of the car but he is not omniscient. As before let $a \rightarrow c$ mean that according to this X all a worlds are c worlds. Given our example it is reasonable to make both assumption 1 and 2 above about X. Assumption 1 simply follows from the descriptions, and assumption 2 is reasonable since we have no reason to think that X's beliefs about the car having the defect depend in any way on whether or not the car will have an accident, so we should assume probabilistic independence of these two questions. (To assume they were *not* independent would amount to thinking that X would be more (or less) likely to know about defect if the car were going to crash, and this would be a strange thing to think without further information.)

Now I want to show, in the general case, that it follows from these assumptions 1. and 2. and the meaning of $a \rightarrow c$ that $p(a \rightarrow c) = p(a|c)$.[16] This may seem intuitively obvious, but it's worth going through the proof, since it is somewhat involved:

Proof. Assumption 1. can be expressed as follows:

$$(a \rightarrow c) \vee (a \rightarrow \neg c) \tag{a}$$

From this we can observe that

$$a \supset (c \leftrightarrow (a \rightarrow c)) \tag{b}$$

[16] This observation is closely related to that **?** who shows that the Stalnaker conditional satisfies Adams' thesis when the probability of the antecedent is independent of the probability of the conditional itself.

since if the actual world is a world then $a \rightarrow c$ is true iff c is true (note that this inference doesn't depend just on logical form, but on the fact that the conditional formulas are about states of knowledge). The assumption of probabilistic independence of the knowledge source from the antecedent (assumption 2.) can be expressed as follows:

$$p((a \rightarrow c) \wedge a) = p(a)p(a \rightarrow c) \tag{c}$$

If we divide each side of (c) by $p(a)$ we get:

$$\frac{p((a \rightarrow c) \wedge a)}{p(a)} = p(a \rightarrow c) \tag{d}$$

Because of (b) we can substitute $p((a \rightarrow c) \wedge a$ in d with $p(a \wedge c)$ giving us the needed equivalence:

$$\frac{p(a \wedge c)}{p(a)} = p(a \rightarrow c) \tag{e}$$

Given the standard definition of conditional probability we get the equation (Adams' thesis).

$$p(a \rightarrow c) = p(c|a) \tag{f}$$

□

What this demonstrates is that for certain choices of knowledges source X it's necessary to assign the same probability to the proposition that the knowledge source X thinks all a worlds are c worlds as one assigns to the conditional probability that a given c. Note that this proof only makes use of the assumptions 1. and 2. and the definition of the conditional operator.

We can now see how certain judgments about the probability of conditionals really are judgments of the probability of the proposition a conditional expresses. Of course, Lewis's proof (and the latter variants of it) show that we can't make this in any way a *semantic rule* (at pain of absurdity) but there's no reason (that I know of) to think that we shouldn't take it as *applying as a default* because of certain assumptions we naturally make about knowledge sources. In section 4, I'll discuss exactly where in one version of Lewis's proof of his triviality theorem the default assumptions above are not unwarranted and hence we can drop them and avoid contradiction.

I have not yet fully justified the assumptions about the knowledge source X. However, we have seen that these assumptions are strong enough to give us the conditional-conditional probability link. So, if we want to give a Kratzerian semantics for conditionals (without using her syntax), and to uphold the conditional/conditional probability connection, then we might want to make these assumptions.

3.3 Supporting the Assumptions

3.3.1 Probabilistic Independence

I think more can be said for these assumptions beyond the work they do. The probabilistic independence assumption is the most innocuous. It simply states that $p($every a world compatible with X's knowledge state is also a c world and that a is true$)$ is equal to $p(a$ is true$)$ times $p($every a world compatible with X's knowledge state is also a c world$)$. This is reasonable when we don't think X's knowledge state is causally linked to the question of whether the antecedent is true, which it is reasonable to assume in our example. The point is if there is no such causal link then our learning the antecedent is true or false has no effect on our confidence in the propositions about X's knowledge.[17]

3.3.2 Conditional Excluded Middle

The conditional excluded middle assumption is far more dubious. In this case, it means that X either knows that all a worlds are c worlds or that all a worlds are $\neg c$ worlds. Obviously, in some cases, such as those involving genuine indeterminacy, such knowledge will not be possible. One cannot know whether, if a quantum coin is tossed that it will definitely land heads or not. At least, so say some theories of physics, ones that people happen to think are correct! On the other hand, I am on respectable ground in maintaining the conditional excluded middle as something that people act as if were true about the conditional. For different purposes, both Stalnaker (1968) and von Fintel (1997); von Fintel and Iatridou (2002) have defended the conditional excluded middle as a fact about conditionals. The most basic observation is that

[17] I'm not saying causal links are the only reasons to not have probabilistic independence, but that they would be the obvious ones in these kind of situations. Probabilistic independence is not reducible to something else, but it is a bit like a default assumption when two things are causally independent.

negated conditionals seem to behave like conditionals with the same antecedent as but the negated conclusions. Consider this sentence for example

(10) I doubt if John takes the exam he'll pass.

This seems to suggest that I think that if John takes the exam he'll fail. One explanation of why this seems to be so is that the conditional excluded middle holds: so if "If John takes the exam then he'll pass" is false then "If John takes the exam, then he won't pass" is true. This seems like good evidence that the conditional excluded middle is taken for granted by speakers. If we combine this with out semantics for conditionals we need to conclude that when thinking about conditionals, people simply make unrealistic assumptions about the capacity of X to know about different states of the world.

I should note that the conditional excluded middle, is, in fact, stronger than the assumption we might need. I used it because it is an assumption that there seems to be good direct empirical evidence for. However, we can also have a significantly weaker assumption such as this one:[18]

$$(a \wedge c) \leftrightarrow (a \wedge (a \rightarrow c)) \tag{g}$$

This is essentially a limitation of the CEM to cases where the antecedent is true, which might seem less controversial. If we want to abandon the CEM altogether the bare minimum we need (together with independence) is this:[19]

$$p(a \wedge c) = p(a \wedge (a \rightarrow c)) \tag{h}$$

This could be true even if (g) is false, so, e.g. in cases where you allow the a and c to be true but $a \rightarrow c$ to be false. In sum, there are many routes to a vindication of the equation that don't go through CEM, but I take it the independent empirical motivation for CEM makes it a particularly attractive one.

[18] I owe this particular suggestion to Dorothy Edgington and Lee Walters.

[19] This is what **?** uses for his proof.

3.4 Idealized Knowledge Sources

So both assumptions have something supporting them, though they involve positing what might be physically impossible 'knowledge sources'. Nonetheless we you might wonder why we should think that indicative conditionals (and possibly epistemic modals) make reference to context sensitive idealized knowledge sources at all.

One piece of evidence is that epistemic modals seem to involve knowledge (or inferences, at least!) that go beyond any particular conversational member's knowledge (or the combination of all of their knowledge). Suppose for instance, we had mistakenly calculated, based on some ships logs, that the wreck could have happened at some spot. We might then utter:

(11) The wreck might have happened here.

But there is an obvious sense in which what we say is simply false, since it is based on a miscalculation, thus there seems to be an appeal to knowledge sources that go beyond our own.[20]

Let me briefly also explain how positing idealized sources of knowledge can yield prima facie plausible conditions for the felicitous assertion of epistemic necessity modals and conditionals. Obviously, the conditions for *asserting* an epistemic modal or indicative conditional include *knowledge/belief* that it is true. In the case of epistemic necessity modals, this will require knowing the truth of the prejacent, and in the case of conditionals requires knowing that at least the material conditional is true. If we assume that the idealized knowledge sources always have more knowledge than the speaker, then these will be not only necessary but also sufficient conditions for assertion for these two constructions. The theory that posits an idealized knowledge source, thus, makes plausible enough predictions for the conditions of assertions of epistemic necessity modals and conditionals.[21]

So we have seen that using idealized knowledge sources in our semantics for epistemic modals and conditionals both explains some of the 'objective' feel of modals and yields plausible enough conditions for assertion.

The main rival to this sort of semantics are theories that merely posit 'instructional' mean-

[20]See von Fintel and Gillies (forthcoming) for more on this.

[21]Modulo the issues about when one cannot assert a conditional because the antecedent is known to be false, but this is a common problem for many semantics of conditionals.

ings for conditionals and epistemic modals, understanding them as expressing states of mind or urging some sort of change to the common ground, such as the accounts of Veltman (1996), Swanson (2006) and Yalcin (2007). These non-classical theories, while very appealing in many respects, have their own troubles. In particular, they must struggle to explain why and how epistemic expressions can be embedded in contexts that take items of propositional values. The theories I mentioned all give compositional semantics for complex expressions involving conditionals or models, so the problem is not purely one of compositionality. Rather it is to explain what it means to uses these expressions embedded in various contexts, such as in questions, as in the following.

(12) a. Will John come if Susan does?

b. Must John be on the boat?

These questions are perfectly sensible if we understand them as asking about what sources of knowledge better than us know. Of course, instructional-style accounts, which I am sympathetic to, may be augmented to explain such uses of epistemic modals, but what I am pointing out here that it is not as natural for them to do so as it is for the straightforward classical account that I have outlined.

4 Disrupting The Triviality Proofs

We may now ask if these assumptions lead one into the sort of contradictions suggested by Lewis's triviality theorems. To simplify I'll reconstruct a version of Lewis's simplest demonstration of an absurdity that follows from Adams' thesis. We'll see that the proof uses a slight generalization of Adams' thesis, and this generalization is what we need to challenge. Here is the proof.[22]

$$p(a \to c) = p(a \to c|c)p(c) + p(a \to c|\neg c)p(\neg c) \tag{i}$$

[22]Thanks to Paul Égré for this version of the proof.

$$p(a \to c) = p(c|a \wedge c)p(c) + p(c|a \wedge \neg c)p(\neg c) \tag{j}$$

$$p(a \to c) = 1 * p(c) + 0 * p(\neg c) \tag{k}$$

$$p(a \to c) = p(c) \tag{l}$$

$$p(c|a) = p(c) \tag{m}$$

The conclusion is obviously an absurdity since we have proved with no further assumption that the conditional probability of c given a is the probability of c! On our classical account of the conditional connective no steps may be plausibly challenged except (j) which depends on the principle that $p(a \to c|b) = p(a|b \wedge c)$. Of course, this principle just seems like a generalization of Adams' thesis, and a plausible one at that. In fact, Lewis (1976) justifies this principle by simply applying Adams' Thesis to the new probability function found by conditionalizing on Z.[23] If we are to object to this thesis, then we need to explain why such a move is not in general acceptable. One reason, of course, is that it leads to absurd consequences, as Lewis showed, but that will probably not satisfy most people.

It would be nicer to have a more principled understanding of why we cannot in fact go through this line of reasoning on a theory such as the one I am proposing here. To see this it's worth going back to our toy example, and trying to make sense of Lewis's proof in this case. Recall the notation: a = car crashes c = airbag goes off, and $a \to c$ = X knows that all a worlds are c worlds. Obviously factorization is acceptable so we can state this formula with confidence.

$$p(a \to c) = p(a \to c|c)p(c) + p(a \to c|\neg c)p(\neg c) \tag{n}$$

What is the probability that X knows that $a \supset c$ given $\neg c$? According to Lewis, using his exportation, principle it is 0. However, this is clearly not the case: even if the airbag does not go

[23] Note that this is exactly what we did to derive the contradiction in footnote 4.

off, we may still think that X knew it would have gone off if the car had crashed (since X may have known the car had the defect). So it is clear in this case that $p(a \to c|\neg c) \neq p(c|\neg a \wedge a)$. What this amounts to, then, is a denial of Adams' thesis applying for this choice of X in the probability function reached by conditionalizing on $\neg g$. Why does Adams' thesis not hold for this new probability function? Suppose we learn the airbag will not go off (i.e. $\neg c$). Can we still maintain the assumption that the question of whether X knows $a \supset c$ is probabilistically independent of a? Obviously not: if a is true than X must *not* know $a \supset c$ on pain of contradiction.

So our previous derivation of Adams' thesis does not work any more since it depended on the crucial independence assumption which is disrupted by or learning that $\neg c$. For the new probability function P' (arrived at by conditionalizing on $\neg c$) it is not true that $P'(a \to c) = P'(c|a)$, for the latter is simply 0 while the former is positive. Thus, we cannot use the background assumptions that supported the simple (unconditionalized) case of Adams' thesis to also recreate Lewis's triviality proof. I take it this is a welcome result for the classical approach, though it highlights the extent to which, on the classical approach, we cannot make Adams' thesis a semantic rule.[24]

As we shall see in the next section, the failure of probabilistic independence in certain cases not only allows us to escape Lewis's triviality results, but also provides direct empirical evidence for this account.

5 When Independence Fails...

I will now argue that our account not only captures Adams' thesis in many cases, but also correctly predicts the cases in which Adams' thesis fails. This makes the empirical coverage of our account in fact stronger than accounts, such as that of Edgington (1995) or Yalcin (2007) that essentially hard-wire in Adams' thesis.[25]

The assumption that the antecedent of the conditional is probabilistically independent from

[24]I must reserve discussion of other triviality results, such as those of discussed in Hajek and Hall (1994) for another place. My review indicates that none of these results undermines the proposal here, but this is just a hunch.

[25]The first person to identify these sorts of cases I think is **?**. That such potential counterexamples to Adams' thesis exist was pointed out to me in conversation by John Hawthorne, who independently developed his own examples (which I think share some commonalities with McGee's, but I'm not entirely sure).

the conditional itself (i.e. the knowledge claim made by the conditional) is absolutely crucial to this account. But what about cases where such an independence would seem to fail.

Take our original car defect example. Suppose that the defect not only makes it so that the airbag does not go off, but that it also makes it the case that the car is more likely to crash. In this case, the fact that the car crashes then, increase's one's credence in the proposition that the car has the defect (and hence that X knows that all crash-worlds are airbag-not-working-worlds).

In this case, then, then $p(c|a) < p(a \to c)$ on our semantics, so Adams' thesis fails. But oddly enough, this judgment seems like it is partly supported by intuition, contra Adams' Thesis! It seems like the probability that if *this* car crashes it's airbag will go off just is the probability that it lacks the defect (at least on one salient reading of the conditional). The problem is that were you to learn that the car has crashed you would increase your credence in the proposition that the car has the defect. But in our initial position it seems that we assign a higher probability to the proposition that if the car crashes it's airbag will go off, than we would actually assign to the proposition that car's airbag will go off in the case in which we learn that the car has been in an accident. So in this case Adams' thesis fails, which is actually what our theory predicts. Obviously this corner of the world of conditionals and probability requires more systematic exploration, but the examples considered suggests that, as the classical account here predicts, Adams' thesis may fail when independence fails.

6 Conclusion

The problem with conditionals and probability looks less serious than perhaps it did at first. We saw that a very standard semantics for conditionals, with a few well-supported assumptions seemed to be able to explain Adams' thesis in a way that might not cause any worries about triviality. Moreover it turned out that, in certain cases, the theory predicts that Adams's thesis fails and this prediction actually seems like it just might be right.

I'm by no means convinved by this classical semantics: the postulation of idealized knowers is very unituitive. But it's surprising how well it fares.

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