Indicative Conditionals

Anthony S. Gillies
Rutgers University

1 The Target

Sometimes philosophy gets started by pointing. Carving out the target for theories of *indicative conditionals* is a case in point. So some examples to point at:

(1) a. If the gardener didn't do it, (then) it was the butler.
b. If your blue marble is in the box, then your red one might be under the couch.

Our target is the class of ordinary *if ... then ...* constructions like these. They express conditional information: information about what is or might or must be, if such-and-such is or turns out to be the case.

Indicatives (the name is not great but is entrenched) stand apart from two other sorts of conditional constructions. First, from subjunctive or counterfactual conditionals:

(2) a. If Oswald didn't kill Kennedy, then someone else did.
b. If Oswald hadn't killed Kennedy, someone else would have.

As Adams (1975) originally pointed out, the conditional information these traffic is different: (2a) is an indicative and true; it's counterfactual cousin (2b) is false. Subjunctive conditionals — that is, those with a distinctive tense/aspect marking like (2b) — say something about would or might *have been* if such-and-such *had been*.[1]

1 A natural thought: the "subjunctive" marking goes exactly with counterfactuality. Alas, no, as an example from Anderson (1951) shows:

(i) If Jones had taken arsenic, he would have shown just exactly those symptoms which he does in fact show.

A doctor may well use a conditional like this to argue that what afflicts poor Jones is arsenic poisoning. If counterfactuality means anything like (the speaker is taking it that) the antecedent is false, then the distinctive marking isn't sufficient counterfactuality. Nor is

Second, indicatives stand apart from *biscuit conditionals*. The example from Austin (1956):

(3) There are biscuits on the sideboard if you want them.

It's a fine thing to say, but not normally a thing that (or at any rate, does't straightforwardly) expresses conditional information at all. While it is of course open to connect a story about indicatives and counterfactuals, and while it is of course open to connect a story about indicatives and biscuit conditionals, we will be largely setting such outreach aspirations aside.

Having pointed a few times, we can now get going. After a little more stage setting (Section 2), we will sketch the theories most familiar in philosophy (Sections 3–5), raise some issues with indicatives and how they interact with other operators (Sections 6–7), and then sketch a few more approaches (Section 8).

2 Landscape

Saying that indicatives carry conditional information isn't yet to say very much. What we are after is a better grip on:

i. Just what that conditional information is. This is a story about what indicatives in natural language mean (what semantic values they have) and how they are used in well-run conversation (what their pragmatic profile looks like).

ii. Just how sentences of natural language manage to express those meanings. This is a story about how *if* interacts with the rest of our language (that holds good both for compositionally deriving how

---

it necessary. In sportscasterese, seemingly run-of-the-mill indicative conditionals are used to convey counterfactual meanings. It's the top of the ninth, the visiting team is down a run but they are down to their last out with a runner — Speedy, as it happens — on second. Slugger hits a double to the gap — surely Speedy should score! — but as Speedy rounds third he trips, falls, and is thrown out. The visitors lose in a shocker. The announcer almost can't believe it. In the aftermath he says:

(ii) If Speedy stays on his feet, they probably win the game.

The announcer isn't confused about how the game ended: he's sure Speedy would have scored and Slugger would have been hit in, too. See von Fintel 1998 (and the references therein) for the status of the connection between "subjunctive" marking and counterfactuality.

*if*s express conditional information and for seeing how conditional sentences contribute their conditional meanings to embedding environments).

Let's suppose that semantic values (whatever they are) determine truth values at points of evaluation (worlds, situations, whatever). This holds, let's assume, for both iffy and non-iffy sentences. These aren't innocent assumptions — as we'll see, some theories say indicatives don't have or determine truth values at all — but it is a place to start.

To regiment things a little (and to highlight a way in which philosophy of language/semantics/logic all converge on indicatives), let's distinguish between (i) conditional sentences of natural language and (ii) conditional connectives of some formal language that serves to represent the logical forms of conditional sentences. The aim is then to associate an *if*-in-English (via well-behaved mapping that we won't bother with) with an *if*-in-the-formal-language that then is associated (via a well-behaved mapping we will bother with) with its semantic value.[2] For the most part, we can be content with a simple propositional language with the usual sentential connectives ($\neg, \wedge, \vee, \supset$) together with a binary sentential connective $(if\ \cdot)(\cdot)$ for the indicative.[3] This indirect route to assigning meanings to indicatives isn't required, is in-principle dispensable (assuming our mappings are, in fact, well-behaved), and makes for a more unobstructed view.

One way to make sense out of the idea of conditional information is to let (some version of) the Ramsey Test guide us. Rough version: the conditional information carried by an $(if\ P)(Q)$ is true or accurate or acceptable in a situation iff Q is true or accurate or acceptable in that situation-plus-the-information-that-P.[4] That connects up the epistemic feel indicatives have

2 There are, of course, ways to express conditional information in natural language without resorting to *if* (in some languages, it's the only way). The issues in this particular ballpark won't matter too much for our purposes so we can (pretty) safely focus on the *if ... then* of English.

3 Whether conditionals in natural language can be represented by a binary conditional connective in a regimented intermediate language is also, as we'll see, up for grabs.

4 Here's what Ramsey (1929/1990: 155) says: "If two people are arguing 'If p, will q?' and are both in doubt as to p, they are adding p hypothetically to their stock of knowledge and arguing on that basis about q ...." The adding this involves can't be feigned or hypothetical belief. (Thomason is credited with this observation in van Fraassen 1980.) If it were, the Ramsey Test would be doomed for conditionals like this:

(i) If my students are cheating in class, then I will not discover it (because they're so with how they express conditional information.

Theories of indicatives are constrained by the patterns of intuitive entailment they participate in. So what intuitively entails what is important and we want to explain those patterns as best we can. For example (and to anticipate things just a bit), we might ask whether indicatives generally go in for a *deduction theorem* (a.k.a. conditional proof):

(4) $\Gamma \cup \{P\} \vDash Q$ iff $\Gamma \vDash (\mathit{if}\ P)(Q)$

If so, then we have an especially tight connection between what $(\mathit{if}\ \cdot)(\cdot)$ means and what we can and can't say about entailment. The point is just that 'entailment' is as much part of the theoretical machinery as is anything. Take it as given that what we may say about *if*s can interact in non-trivial ways with what we may say about entailment. Then the best route to the best theory may be one in which what we say about entailment bends to the will of the *if*s as much as the other way around.

Now take a concrete example of an intuitive entailment: what Stalnaker (1975) calls the *direct argument*.

(5) a. Either the Butler did it or the Gardener did it.
$P \vee Q$
b. So: if the Butler didn't do it, then the Gardener did.
$(\mathit{if}\ \neg P)(Q)$

Seems like (5a) entails (5b). We want to do justice to that. The trouble is that treating such *or*-to-*if* arguments as entailments seems to get us very quickly to the conclusion that indicatives mean just what their corresponding material conditionals do. Suppose semantic values are something that determine truth values and that entailment is preservation of truth. And assume the direct argument is an entailment (that $P \vee Q \vDash (\mathit{if}\ \neg P)(Q)$). Then $P \supset Q$ entails the indicative $(\mathit{if}\ P)(Q)$.

Argument. Suppose $P \supset Q$ is true (at a world w). Then so is $\neg P \vee Q$. Thus by the direct argument so is $(\mathit{if}\ P)(Q)$ (at w). (That indicatives entail their

clever).

The state I get into by feigning belief in the antecedent, won't be one in which I believe the consequent. The right way to understand augmenting for the Ramsey test is restricting a body of information (say, my belief state B) by the content of the antecedent. That's a tad different.

corresponding material conditionals is generally not in dispute.) □

We can follow where the argument leads or we can look for places to get off the boat.

Another example: a *boundedness* argument (Gibbard 1981; Veltman 1985). It seems like indicatives fall somewhere on the spectrum of logical strength between strict implication and material implication: when P entails Q the indicative $(if\ P)(Q)$ must be true and the falsity of $P \supset Q$ entails the falsity of the indicative $(if\ P)(Q)$. That last bit — that indicatives are bounded from below by material conditionals — is equivalent to saying that they go in for modus ponens. And it seems like we have other intuitive entailments, *import/export*:

(6) a. If the gardener is away and the driver is away, then the mansion is empty.
$(if\ (P \wedge Q))(R)$

b. If the gardener is away, then if the driver is away then the mansion is empty.
$(if\ P)((if\ Q)(R))$

Pairs like these seem to be mutual entailers. We can again argue from modest resources that indicative conditionals and material conditionals say the same thing. That is because we can argue that the truth-conditions for $P \supset Q$ — which are very weak — are sufficient for the truth of the indicative $(if\ P)(Q)$.

Argument. Suppose $\neg P$ is true. Since $(\neg P \wedge P)$ entails Q and indicatives are true when their antecedents entail their consequents, we have that

(7) $(if\ (\neg P \wedge P))(Q)$

is true. By import/export

(8) $(if\ \neg P)((if\ P)(Q))$

is true. And since $\neg P$ is true and material conditionals are the lower bound, the material conditional $(if\ P)(Q)$ is true, too. Now suppose Q is true. The argument goes just as before, except now we rely on the boring fact that $Q \wedge P$ entails Q. So if $\neg P \vee Q$ is true so is $(if\ P)(Q)$. □

As before, we either follow the argument to the material conditional or we can start looking for escape routes. That is a tidy way of organizing things.

One escape route — flat-footedly denying modus ponens — hasn't proved to be very popular. Though, as things go in philosophy, that's not because no one has pushed for it. McGee (1985) sees boundedness arguments as pitting modus ponens and import/export against each other. He thinks there are counterexamples to modus ponens and not to import/export, so that forces his choice.[5] Others deny some mixture of modus ponens and import/export, but not obviously for reasons connected to boundedness-style arguments.[6] This route is, to put it gently, not without cost.

3 Horseshoe

The *horseshoe theory* is both the simplest response to arguments like the boundedness argument and the simplest story about the meaning of everyday indicative conditionals: $(\mathit{if}\ \cdot)(\cdot)$ has just the truth conditions that $\supset$ does.

Horseshoe Theory Indicatives are material conditionals:

$$[\![(\mathit{if}\ P)(Q)]\!]^{c,w} = 1 \text{ iff either } P \text{ is false or } Q \text{ is true (at } w\text{, in } c\text{).}$$[7]

5 The counterexamples all share a basic structure of involving a right-nested indicative we think true (and whose antecedent we think true) even though we do not especially think the embedded conditional on its own is true. There is a not-small literature on the status of the counterexamples.

6 For instance, Lycan (2001) denies both import/export and (for good measure) modus ponens.

7 Of course this treats conditionals as truth-functional — the truth-values of P and Q at w completely determine the truth value of $(\mathit{if}\ P)(Q)$ and so of *if P, then Q* at w. Assuming truth-functionality, is there any way of assigning a semantic value to $(\mathit{if}\ \cdot)(\cdot)$ so that it doesn't stand and fall with $\supset$? No, the material conditional is the only choice. We want

(i) If Jimbo is taller than 6 feet, then Jimbo is taller than 5 feet.
$(\mathit{if}\ P)(Q)$

to be true at w no matter how tall Jimbo is at w. Look at these three possible heights for Jimbo:

- Jimbo is taller than 6 feet. So the antecedent is true. But then he is obviously over 5 feet. And so the consequent is true.
- Jimbo is between 5 feet and 6 feet tall. Then the antecedent is false but the consequent true.
- Jimbo is less than 5 feet tall. So both antecedent and consequent are false.

These are the conditions under which the material conditional $P \supset Q$ is true. So there is an indicative that is true when it's corresponding horseshoe is true. But, assuming that *if*s are truth-functional, this has to be true for *any* conditional. Moreover, indicatives must be false when the corresponding horseshoes are false: otherwise, all indicatives would always be

The horseshoe theory is, to put it mildly, not the most widely held view these days (not in philosophical circles and certainly not in linguistic circles). But it's not as though the horseshoe theory has nothing going for it. Ordinary indicatives certainly behave like material conditionals in mathematical contexts. And the horseshoe theory says that instances of the direct argument, import/export, and modus ponens — an impressive who's who in properties conditionals seem to have — strike us as entailments because they are.

It's easy for the horseshoe theory to claim entailments (entailments to conditionals at any rate). That is because the material conditional is so weak. The problem is — for just that reason — we have *more* entailments (to conditionals) than we want. (In)famously among them: the paradoxes of material implication.

(9) a. Carl came alone.
??So: if Carl came with Lenny, neither came.

b. Billy got here first.
??So: if Alex got here before Billy, Billy got here first.

These don't strike as entailments even though the truth of either $\neg P$ or Q at w secures the truth of $P \supset Q$ at w. The defender of the horseshoe story owes us some answers.

What we need is an extra-semantic explanation that says that these are entailments, all right, but ones we can live with because the pragmatic facts about conditionals — how they are reasonably and appropriately used — explains their weirdness. That is Grice's (1975) strategy. The conditionals like the one in (9a) are true, but ruled out for completely general pragmatic reasons. Once we know that Carl came alone, it is pointless (though true) to say that either he didn't come with Lenny or neither came. Since it is pointless, as Lewis (1976: p.142) says, "also it is worse than pointless: it is misleading." Ditto for (9b): if you are in a position to say Q then you shouldn't really be in the business of saying the weaker conditionalized thing. This kind of explaining away is principled. It doesn't rely on anything special about conditionals: once we take on board the general Gricean picture of conversational implicature, we have enough to say something about why the examples in (9) are so odd even though the underlying entailments are real.[8]

---

true. So, assuming truth-functionality, the horseshoe is the only choice.

8 Lewis (1976) initially goes for this defense of the horseshoe theory for indicatives, and uses (part of) it to try to explain why assertability of indicatives goes with their conditional probability and not with the probability of their truth.

That's one kind of explanation. Another is to say that indicatives are horseshoes but that they *conventionally* implicate something extra. Jackson (1991) develops this defense, saying that that they are "robust" with respect to their antecedents: when you issue an indicative $(if\ P)(Q)$ it conventionally implicates that your credence in $P \supset Q$ conditional on P is high enough — that is, the implicature is that the probability of Q conditional on P is high enough.[9] So *if* is supposed to be like *but*: truth-functional in meaning but with an extra, conventionally encoded signal.[10] The problem with, for instance, (9a) is that our reason for thinking the conditional is true is just that we think the antecedent false — and that's a paradigm case where robustness fails (we drop thinking the conditional is true upon learning that — to our surprise — Carl came with Lenny). Similarly for (9b).

The implicature explanations differ (both in mechanism and commitment) but have a lot in common. Both say that it is some extra-semantic fact about asserting indicatives that explains away the oddness of the entailments in (9). Both say that when it comes to indicatives it's assertability preservation, not some notion of entailment tied to the semantic values of indicatives, that matters and that judgments about entailment may well be clouded by judgments about assertability preservation.

But both also have difficulty explaining facts about indicatives that occur unasserted in embedded environments. The mechanisms for the assert-the-stronger conversational implicature explanation don't apply. The same is true for the assert-only-the-robust conventional implicature explanation[11] That is too bad because conditionals *do* occur in larger environments and the horseshoe theory inherits some pretty bad commitments when they do. Everyone knows it was either the gardener, the driver, or the butler. So when the novice on the beat declares that if the gardener's alibi checks out then you can arrest the butler, you rightly object:

(10) a. It's not so that if the gardener didn't do it then the butler did.
b. Just because the gardener didn't do it that doesn't mean the butler did.

9 Lewis, in the "Postscript" to his 1976, drops the conversational story and instead goes for a slight variant of Jackson's conventional implicature story.

10 There is not a terrific amount of independent evidence in favor of this (see, e.g., Bennett 2003: §16 and Edgington 2009: §4.2).

11 In principle, we could be given an extra theory of the projection behavior the special conventional implicatures of indicatives, saying when and how and why they project. That's not a task that Jackson (1991) (nor anyone else) takes up.

In (10a) we have an ordinary indicative under a wide scope sentence negation. There's a little funniness in the "it's not the case that" construction — it's not the most common construction in the world and conditionals (like some modal operators) don't really want a plain negation on them.[12] English also has a perfectly good special-purpose construction for negating indicatives: it's the *just because ... doesn't mean* construction in (10b). Either way, what you say doesn't entail that the gardener didn't do it. (And it doesn't entail that the butler didn't do it.) There is little to recommend this line of reasoning:

(11) Since the driver is still a suspect, it's not so that if the gardener didn't do it then the butler did.
??So: it wasn't the gardener.

The point for the horseshoe theory is that you can be all signed-up for $\neg\,(\textit{if}\ P)(Q)$ without being signed-up for the truth of P. But if $\neg(P \supset Q)$ is true then so is P. This is the price material conditionals pay for being so weak: their negations must be strong. So we need to explain away this entailment. But the implicature gymnastics invoked thus far don't seem up to it. You didn't assert any conditional at all and so whatever we might be able to glean from what asserting a conditional implicates won't be of much help here. But maybe some *other* pragmatic mechanism is at work. For instance, perhaps the apparent widescope negation isn't a regular negation at all but is really a denial or metalinguistic negation operator (Horn 2001): when you say (11a) you are not asserting the negation of a conditional but you are denying that you will assert the embedded conditional. The negation is not ordinary negation; it marks some sort of denial speech act.[13] This seems

12 It may be choppy or inelegant English, but it's still English. Some examples from the wild:

(i) a. The global economy is not a zero-sum game. It's not true that if an economy gets worse then we're better off.
(Ben Bernanke, remarks at Jacksonville University, November 5, 2010)
b. There's no way that if someone sits around saying: "I'm rich and successful," that they'll become rich and successful.
http://www.getinthehotspot.com/the-real-secret-to-success-in-4-words-2/

13 This is, in fact, Grice's reply. Horn seems happy enough to follow him, and indeed argues that all negations taking binary connectives in their immediate scope are metalinguistic (Horn 2001: 476). We might worry that resisting embedding under a simple negation lumps things wrong, though: some modals don't like it (*may* and *must*) even though others don't mind at all (*can* and *have to*). But *may* and *can* (and *must*/*have to*) express the same thing and that thing (whatever it is) is a thing we can sign-up for negating.

a little dodgy: we're now wheeling in another explaining-away to save our original explaining-away. And the new explaining-away won't help once we embed the (apparent) negated conditional in a larger environment. Example:

(12) If there is no God, then it's not so that if I pray my prayers will be answered.

So the implicature defender has a lot to do, including now telling us how the speech act of denial compositionally mixes with the assignment of semantic values for the rest of the language.

4 Variably Strict Conditionals

Assume that indicatives do not have the truth conditions of material conditionals. So they say more. What can that more be? Stalnaker (1975) argues that indicatives share a core semantics with counterfactuals. Both kinds of conditionals, he says, are *variably strict* conditionals, but indicatives are governed by additional pragmatic mechanisms that counterfactuals aren't subject to. The variably strict semantics allows indicatives to say more than their horseshoes, and the pragmatic mechanisms allow Stalnaker to explain why certain patterns that *aren't* entailments — in particular, the direct argument — nevertheless seem so compelling.

The core semantics is based on (a family of) orderings over the set of possibilities. For each w, we assume there is a (connected, transitive) relation $\leq_w$ recording relative similarity or closeness between worlds. There is an interaction between contexts and the ordering. First, because we assume that what ordering is relevant is a contextually determined matter. Following tradition, we'll largely ignore this here. Second, as we'll see below, Stalnaker posits a substantive pragmatic constraint that links contextually relevant possibilities and the ordering. Let's simply model contextually relevant information determined by contexts as functions from worlds to sets of compatible worlds. (We won't constrain the functions just now.) The core semantics is this:

Variably Strict Semantics Indicatives are variably strict conditionals:

Assume for any worlds w, v and proposition X, that $\leq_w$ is such that:

i. (Centering Assumption) w is minimal in $\leq_w$: if $v \leq_w w$ then $w = v$

ii. (Limit Assumption) X has at least one $\leq_w$-minimal world

iii. (Uniqueness Assumption) X has no more than one $\leq_w$-minimal world

Then an indicative $[\![(\textit{if } P)(Q)]\!]^{c,w} = 1$ iff Q is true at the $\leq_w$-minimal P-world.[14]

Still assuming that entailment is preservation of truth(-at-a-world), this predicts that indicatives say more than their material conditional counterparts. The paradoxes of material implication won't be reproduced: neither of the inferences in (9) is an entailment for a variably strict conditional. And while the material conditional validates antecedent strengthening and contraposition, variably strict conditionals do not:

(13) a. If there is sugar in the coffee, it tastes sweet.
$(\textit{if } P)(Q)$

b. #So: If there is sugar and diesel oil in the coffee, it tastes sweet.
$(\textit{if } (P \wedge R))(Q)$

(14) a. If it rains, it won't pour.
$(\textit{if } P)(\neg Q)$

b. #So: If it pours, it won't rain.
$(\textit{if } Q)(\neg P)$

The nearest P-worlds need not include the nearest $(P \wedge R)$-worlds, so (13a) won't entail (13b). Similarly, the nearest worlds where it rains can all be drizzly worlds, in which case (14a) is true. Still, the nearest pouring-worlds will all be rainy worlds, and so (14b) will be false.

And since indicatives are stronger than their corresponding horseshoes, we know that the direct argument will also not be classified as an entailment:

Counterexample. Suppose $c(w)$ contains just w and v, where w is a $(\neg P \wedge Q)$-world and v is a $(P \wedge \neg Q)$-world. Then $P \supset Q$ is true at w in c. Since P is compatible with c, the $\leq_w$-minimal P-world must also be compatible with c: so it's v. But since v is a $\neg Q$-world, then $(\textit{if } P)(Q)$ isn't true at w. □

14 This is Stalnaker's (1968) set-up. Lewis's (1973) version of the variable strict semantics differs by making neither the Limit Assumption nor the Uniqueness Assumption. The pragmatic mechanisms for indicatives that Stalnaker develops are independent of whether the variably strict semantics is Stalnakerian or Lewisian. So I will make the Limit Assumption and be willfully sloppy about whether what's required is the closest antecedent world or the set of closest antecedent worlds.

Why are instances of it — like (5) — so compelling? Stalnaker's (1975) answer is that it is a *reasonable inference*. For our purposes, a reasonable inference has this property:

Reasonable Inference Suppose P is successfully asserted (at w in c) and c' is the resulting posterior context. P, *so* : Q is a reasonable inference iff Q is accepted in c'.

This is not a semantic property. It all rides on what speakers are up to in (properly) asserting various things. In order to be successfully asserted, a premise has to first be felicitously asserted. And in order for a conclusion to be accepted in a context, it also has to get a clean bill of pragmatic health. Since the *or*-to-*if* inference begins with a disjunctive premise and ends with a conditional conclusion, we need two additional pieces of information. Begin with the disjunctive premise: in order for a disjunction to be felicitously asserted in a context either disjunct might be true without the other. That seems plausible and perhaps even open to a Gricean rationalization.

The constraint on indicatives is more substantive. The constraint is that in order to use an indicative conditional (owing perhaps to their epistemic connection) there is an additional requirement that the selected antecedent world(s) must be worlds compatible with the context, assuming the antecedent is:

Pragmatic Constraint If P is compatible with the context c, then the $\leq_w$-minimal P-world(s) is compatible with c.

This is motivated this way. First: indicatives really are happiest being asserted when their antecedents might, in view of the context, be. If you want to say something conditional on P in a context in which it is settled that $\neg P$, then the counterfactual is what you need to reach for. Second: in asserting run-of-the-mill indicatives, you are trying to say something about the possibilities compatible with the context. So the worlds relevant to whether an indicative is true had better be compatible with the context. This plus the plausible requirement for disjunctions is enough to see that the direct argument is a reasonable inference:

Argument. Suppose an assertion of (5a) is successful at w in a context c: it is felicitous in c and accepted. So $c(w)$ contains some Butler-but-not-Gardener possibilities (some $(P \wedge \neg Q)$-worlds) and some not-Butler-but-Gardener possibilities (some $(\neg P \wedge Q)$-worlds). Since the disjunction is then accepted, we eliminate worlds from $c(w)$ where it isn't true. In the posterior $c'(w)$, there are only $(P \vee Q)$-worlds left. We know that some are $(P \wedge \neg Q)$-worlds and some are $(\neg P \wedge Q)$-worlds. Now we consider the indicative (5b): $(\mathit{if}\ \neg P)(Q)$. Its antecedent is compatible with c' since there are not-Butler worlds in $c'(w)$. Thus the pragmatic constraint ensures that the ($\leq_w$-)closest $\neg P$-world(s) are also in $c'(w)$. But there aren't any $(\neg P \wedge \neg Q)$-worlds left in $c'(w)$. So no matter what the closest world(s) is in which the Butler didn't do it, it must be a world in which the Gardener did it. So the indicative is accepted in c'. □

That is why, according to Stalnaker, *or*-to-*if* instances (invalid as they are) are so compelling.

A variably strict semantics also fails to classify pairs of conditionals like (6) as mutual entailments: whatever the merits of import/export, given the variably strict semantics, it ain't a validity. That's simply because the nearest Q-world to the nearest P-world to w need not be the same as the nearest $(P \wedge Q)$-world to w, even when both P and Q are compatible with the context. In the case of the direct argument, there is an independently plausible felicity-requirement on the disjunctive premise — that in the prior context either disjunct may be true without the other — that does real work in making sure the posterior context will be one in which the indicative is accepted. For import/export it's not obvious what such an extra, independently plausible felicity-requirement on the conditional premises (in either direction) would look like. And so it's not obvious how to use the concept of reasonable inference to explain why import/export instances (invalid as they are) are so compelling.

5 NTV and Conditional Assertion

The boundedness argument can be seen as an argument that there is no good way of assigning truth conditions to ordinary indicative conditionals: the only options either come up short by giving up something important or saddle us with the horseshoe theory. Gibbard (1981) sees it that way and sees it as reason conclude, with Adams (1975), that indicative conditionals don't have truth conditions at all, that they are a means of expressing conditional belief and do not report conditional information. Edgington (1995, 2009) and Bennett (2003) (among others) follow them to this "N(o)T(ruth)V(alue)" conclusion.[15]

Another argument against truth conditions, this one due to Edgington (2009: §2): truth conditions come in two flavors, truth-functional and non-truth-functional, and neither seems right for indicatives. Truth-functional truth conditions are out because the horseshoe is out. That leaves non-truth-functional truth conditions. To say that the truth conditions for $(\textit{if } P)(Q)$ are non-truth-functional is to say that the truth values of P and Q at w don't fix the truth value of $(\textit{if } P)(Q)$ at w. So if P is false at w and Q is true at w then sometimes $(\textit{if } P)(Q)$ is true at w and sometimes it isn't. That's *variability*. But we have the *or*-to-*if* inference: if all the information you have is that $\neg P \vee Q$ then that is *always* sufficient for $(\textit{if } P)(Q)$. This is *uniformity*. Edgington says variability and uniformity are on a collision course and "Arrow" (her name for the champion of a non-truth-functional theory) can't get this right.[16] If all that is right, we are out of options truth conditions-wise.

A third argument is based on hedging. Lewis (1976, 1986) showed that on pain of triviality there are no conditional propositions such that their probability of truth always equals the conditional probabilities of their consequents given their antecedents.[17] The slogan that probabilities of conditionals equal their conditional probabilities is catchy, but it's also backed by some good motivation. A plain vanilla example:

(15) a. Probably, if my team doesn't sign some big players they won't win.

15 This view sounds like it denies that indicatives have truth values. In that it does not disappoint. But the spirit of the view is to deny something more. We have assumed that whatever semantic values conditionals have is the same sort of semantic value that other bits of declarative language have. While we have so far assumed semantic values that determine truth conditions in familiar ways, some theories deny this. For instance, dynamic semantic theories assign things richer than truth conditions or propositions of the normal sort as semantic values, but they do that uniformly across (a fragment of) the language (Heim 1983; Groenendijk & Stokhof 1991; Veltman 1996). But — this is the point for us — what the NTV view denies extends to those theories as well. NTVers mean to deny that indicative conditionals have or traffic in the same kind of semantic unit of exchange that other declarative parts of the language do: it's not truth and it's not some richer-than-than-truth thing either.

16 I myself think this isn't decisive, since for all that's been said it is possible that the variability be variability in truth value at a given world between contexts and the uniformity be uniformity across worlds compatible with a given context (Gillies 2009: §4).

17 The basic triviality result has been fortified and extended: see, e.g., Hájek (1994). Bennett (2003: §25–31) surveys in a digestable way some of the main territory.

b. If my team doesn't sign some big players they won't win.

In saying (15a) I seem to say that the probability that my team will continue their losing ways, conditional on them continuing their frugal ways, is high enough.[18] I don't think that they definitely won't win if they don't make some big moves, but I think that's likely (enough). So the degree to which I am signed up for the bare (15b) seems to track what (15a) says. Suppose B is a probability function representing degrees of belief or assertability or whatever. That would seem to be reason to sign-up for this:

The Equation $B((\textit{if } P)(Q)) = B\text{-plus-}P(Q)$

We haven't yet said anything about how we arrive at this posterior probability B-plus-$P(Q)$. Maybe it's through conditionalization, maybe not. Well, in fact it can't be. The Equation implies:

Linearity If B is a mixture of B_1 and B_2 then B-plus-P is a mixture of B_1-plus-P and B_2-plus-P.

The proof is simpler than you might expect:

Proof. Assume B is a mixture of B_1 and B_2. Consider any P and Q. So $B((\textit{if } P)(Q))$ is a mixture of $B_1((\textit{if } P)(Q))$ and $B_2((\textit{if } P)(Q))$. But since we're assuming The Equation that means B-plus-$P(Q)$ is a mixture of B_1-plus-$P(Q)$ and B_2-plus-$P(Q)$. □

Gärdenfors (1982) showed that Linearity is at odds with conditionalization. So The Equation implies that the *plus* in B-plus-P can't be conditionalization:

Observation. The Equation is not compatible with conditionalization.[19]

18 Actually, the issue isn't frugality; my team is happy to pay top dollar for mediocre talent.

19 One way of seeing things: Gärdenfors showed that Linearity exactly characterizes changing the B's by *imaging* (and imagining and conditionalization can agree only at the boundaries). Another way: conditionalization implies *conservativism*: whenever $B(Q) = 1$ and $B(P) > 0$, then $B_P(Q) = 1$. Linearity rules that out (modulo triviality). Lewis's (1976) main triviality results then follow as corollaries. All of this is replicated if we think of the B's as sets of full beliefs. The qualitative counterpart of The Equation is known as the Ramsey Test:

(RT) $(\textit{if } P)(Q) \in B$ iff $Q \in B * P$

Again, no restrictions on how we arrive at the posterior $B * P$. (RT) implies the qualitative counterpart to Linearity:

There are nearby problems, too. I'm dead certain that the Cubs didn't win it all this year, but think it's possible that they won at least 70 games (at a certain point, you have to just quit keeping track).

(16) a. ??Probably, if the Cubs won at least 70 games, then they won it all this year.
b. If the Cubs won at least 70 games, then they won it all this year.

Given what I know, there's no hedge low enough for (16a) to be OK and no degree of belief small enough for me to sign up for the bare (16b) even to that minimal degree. Bradley (2000) argues that treating indicatives as things expressing propositions — subject to the same probability hedges that non-conditional stuff is — means having to say that it is sometimes OK to give positive weight to a conditional and its antecedent even though you give no weight at all to its consequent.

So if indicatives express propositions of the normal sort, and if they scope under probability operators, then we have trouble. NTVers say so much the worse for the idea that indicatives express propositions of the normal sort, have truth conditions, and determine truth-values at all. The Equation is all right, but we glossed it wrong. Here's what Edgington (2009: 22) has to say about it:

> A conditional judgement involves two propositions, which play different roles. One is the content of a supposition. The other is the content of a judgement made under that supposition. They do not combine to yield a single proposition which is judged to be likely to be true just when the second is judged likely to be true on the supposition of the first.

So NTVers don't have to worry about triviality under hedges, but this is an open route only if they can explain why the inferences involving indicatives seem so compelling — it can't be because they are entailments, the preservation of the main semantic value from premises to conclusion or something like that. Here they have a plausible thing to say: our intuitive judgments

---

(Mon) $B_1 \subseteq B_2$ implies $B_1 * P \subseteq B_2 * P$.

(Suppose $Q \in B_1 * P$. Then $(\mathit{if}\ P)(Q) \in B_1$ and so $(\mathit{if}\ P)(Q) \in B_2$. But then $Q \in B_2 * P$.) Just as Linearity is at odds with conservativity, (Mon) is at odds with it's counterpart "preservation" (Gärdenfors 1988; Segerberg 1989).

are tracking Adams's (1975) notion of *probabilistic validity*.[20] Modus ponens and modus tollens are probabilistically valid; the paradoxes of material implication (9) aren't. But neither is conditional proof. And without saying something extra and special-purpose about embedded conditionals, neither is import/export.

Embedding is another worry for NTVers. That is because they have to worry about what we're doing when we issue ordinary indicatives. Conditionals aren't, they say, for asserting. They are vehicles of conditional assertion. So in uttering an indicative $(\textit{if}\ P)(Q)$ (at w, in c), we are conditionally asserting Q-on-P in c at w. That affects $c(w)$ in the same way that flat-out asserting Q affects $c(w)$-plus-P. But for this to fly, Q has to be the sort of thing that can be flat-out asserted in the first place. That means NTVers have revisionary work to do to explain away apparently negated conditionals like (10) and revisionary work to do to explain away the apparently right-nested indicatives featured by import/export. They also face hard choices when it comes to epistemic modals. Consider:

(17) a. If Red isn't in the box, Blue must be.
b. If Red isn't in the box, Blue might be.

It's natural to think there is a (very) tight connection between epistemic modals and indicative conditionals. The NTVer can either extend the NTV thesis to the modals or not. If so, then embeddings are prima facie ruled out. If not, we cut ties between the modals and conditionals.[21]

6 Epistemic Operators

Set aside NTV views. Interaction between indicative conditionals and epistemic operators (hedges and modals alike) is still tricky. Examples:

(18) a. If Gardener isn't guilty, the Butler must be.

20 An argument is probabilistically valid iff the uncertainty of its conclusion is more than the sum of the uncertainties of its premises. A textbook introduction: Adams (1998).

21 Sometimes NTVers say that embedding facts go the other way: since indicatives don't always freely embed (they are tough to negate and it's tough to left-nest them) this suggests that they don't express propositions — we'd expect those to combine straightforwardly with other operators. But this is too fast. Some lexical items have syntactic restrictions on embedding that have nothing to do with whether they have semantic values of the normal sort. We've seen this before: *might* and *must* resist embedding under negation (and resist embedding under deontic modal operators) even though *can* and *have to* aren't so fickle.

b. If he didn't tell Harry, he probably told Tom.
c. If Carl is here, then presumably Lenny is here.
d. If the Cubs get good pitching and timely hitting, they might win.

These epistemic operators seem to occur embedded in the consequents, giving us (apparently) instances of this:

(19) $(\textit{if } P)(\textsc{operator}\ Q)$

This takes *if*-of-English to contribute a conditional relation as its meaning, and further says that that conditional relation holds between P-worlds and worlds where $\textsc{operator}\,Q$ is true. The trouble is there seems to be no such conditional relation. Grant some minimal assumptions about what conditional relation between (relevant) antecedent-worlds and consequent worlds an $(\textit{if } \cdot)(\cdot)$ picks out (at w in c).[22] Then:

Observation. The only conditional relation that $(\textit{if } P)(Q)$ can express between the relevant antecedent worlds and consequent worlds is $\subseteq$.

For proofs (of slightly different versions of this), see van Benthem 1986; Veltman 1985; Gillies 2010.

Now grant some minimal assumptions about the *if*-relevant worlds at w: (i) w is always relevant to an indicative $(\textit{if } P)(Q)$ at w; (ii) the *if*-relevant worlds (in c at w) are compatible with c. And grant that modals are quantifiers over worlds compatible with the context: in particular, that a *might* at w in c is an existential quantifier over $c(w)$ and *must* is the dual universal quantifier.

To highlight the trouble: I have lost my marbles and know that one and only one — either Red or Yellow — is in the box.

(20) a. Red might be in the box and Yellow might be in the box.
$\textit{might}\, P \wedge \textit{might}\, Q$
b. If Yellow isn't in the box, then Red must be.
$(\textit{if } \neg Q)(\textit{must}\, P)$
c. If Red isn't in the box, then Yellow must be.
$(\textit{if } \neg P)(\textit{must}\, Q)$

22 For instance, the relation has to be idempotent and right upward monotonic and it has to care about consequents.

These, I think, are all true. But it seems they can't all be true together if $(if\ \cdot)(\cdot)$ means *all*. No matter what semantics for indicatives we pick, the sentence in (20) form an inconsistent triad. While it's a lamentable fact that my marbles are lost, it's still a fact not an impossibility.

Proof Sketch. Suppose we have just two worlds compatible with the context, w and v. Look at i: it's either a $\neg Q$-world or a $\neg P$-world. Suppose it's a $\neg Q$-world. By assumption $(if\ \neg Q)(must\, P)$ is true at w in c so all the *if*-relevant $\neg Q$-worlds are worlds where *must* P is true. But w must be one of the relevant *if*-relevant worlds and it's a $\neg Q$-world, too. So it's a world where *must* P is true. So $c(w)$ has only P-worlds compatible with it. But *might* Q is true! Mutatis mutandis if w is a $\neg P$-world.[23] □

Ah, the problem is that we got the scope relations wrong! Epistemic operators, you say, scope over the indicatives in environments like (18). Replace (19) with

(21) OPERATOR $(if\ P)(Q)$

This is no better, really. For one thing if OPERATOR is a probability hedge, triviality looms.[24] We appear to be out of choices, scope-wise.

7 Restrictor View

This trouble is a lot like some trouble Lewis (1975) saw for *if*s in certain quantificational environments. Lewis argued that *if*s occurring under adverbs of quantification seem best understood as not expressing something properly iffy at all. For instance:

(22) $\left\{\begin{array}{r}\text{Always}\\ \text{Sometimes}\\ \text{Seldom}\end{array}\right\}$ if a farmer owns a donkey, he beats it.

23 This is equally an apparent argument against modus ponens for indicatives, assuming that entailment is simple preservation of truth(-at-a-point).

24 There are other reasons, but they involve questions about whether we decide to be *egalitarian* (all worlds compatible with the context are created equal when it comes to saying which are *if*-relevant) or *chauvinistic* (not egalitarian). Those questions are left open given what we've said, but when paired with the widescoping strategy in (21), each leads to different trouble (Gillies 2010: §6).

What single connective could *if* contribute in each of these? Maybe something iffy would work if the adverb is the universal *always*, but conjunction would be better if its an existential like *sometimes* and neither looks good for *seldom*. Lewis's (1975) conclusion: sentences like those in (22) are not instances of a conditional operator plus an adverb of quantification. It's a mistake to treat them as involving two operators, a conditional and a adverb of quantification.[25] Instead, he said, the *if*s here are a *non-connective* whose only job is to mark an argument slot for the adverb of quantification. A quote:

> The *if* of our restrictive *if*-clauses should not be regarded as a sentential connective. It has no meaning apart from the adverb it restricts. The *if* in *always if* ..., ..., *sometimes if* ..., ..., and the rest is on a par with the non-connective *and* in *between* ... *and* ..., with the non-connective *or* in *whether* ... *or* ..., or with the non-connective *if* in *the probability that* ... *if* .... It serves merely to mark an argument-place in a polyadic construction. (Lewis 1975)

The trouble was that the things in (22) all express some restricted quantificational claim about donkey-owning-farmer situations: that they are always/sometimes/never farmer-beating-donkey situations. But there seems to be no way for the *if* to both contribute a conditional meaning and do this restricting. Since these *if*s restrict, they aren't iffy.

Kratzer's idea is that this holds not just for *if*s under adverbs of quantification but for *if*s across the board.[26] Here's the most forceful way of putting it:

> The history of the conditional is the history of a syntactic mistake. There is no two-place "if... then" connective in the logical forms for natural languages. "If"-clauses are devices for restricting the domains of various operators. (Kratzer 1986: p.11)

The thing all *if*s do is restrict operators. So they aren't iffy. The choice between (19) and (21) is not what we are after. Instead what we have is something like this:

25 As with *if*/modal interaction, neither widescoping the quantifier ($\neq \mathcal{Q}\ (if\ P)(Q)$) nor narrowscoping it ($\neq (if\ P)(\mathcal{Q}(Q))$) seems right.

26 Developed (with some variations) in, e.g., Kratzer 1981, 1986, 1991, 2010.

Restrictor Analysis Indicative conditionals are restricted operators with logical forms like this:
Quantifier/Operator + *if-clause* + consequent clause
$\textsc{operator}(P)(Q)$

The binary connective $(\mathit{if}\ \cdot)(\cdot)$ makes no appearance here: the *if*-clause provides the restrictor for the operator and (what we thought was) the consequent provides the nuclear scope. When the operator is a modal like *must* or *probably* or *might*, the job of the *if*-clause is to restrict the domain over which the modal quantifies. This makes it easy to see how the conditionals (which is to say "conditionals") and the unrestricted *might*s in (20) can be true all at once. The conditionals make restricted modal claims, that within the not-Yellow worlds, Red must be in the box and that within the not-Red worlds, Yellow must be in the box. Those are both compatible with the pair of unrestricted modal claims that Red might be in the box and Yellow might be in the box.

So whenever we see an *if* we should start looking around for an operator for it to restrict. What if there is no operator? Since there must be one, then we posit a covert necessity operator. Often enough, the relevant operator is *must*.[27] With this the restrictor analysis can explain why import/export seems like a validity. Here was our example from earlier, but with the logical forms the *if*-as-restrictor analysis assigns:

(6) a. If the gardener is away and the driver is away, then the mansion is empty.
$\mathit{must}\,(P \wedge Q)(R)$
b. If the gardener is away, then if the driver is away then the mansion is empty.
$\mathit{must}\,(P)(\mathit{must}\,(Q)(R))$

The first makes a restricted modal claim that once we zoom in on the $(P \wedge Q)$–worlds, it must be that R. The second makes the doubly restricted claim that zooming in on the P-worlds will land us in a set in which it must be

27 A wrinkle to note so we can ignore it: some (quite a few) argue that epistemic *must* is not a strong necessity modal, that *must* P doesn't entail P (e.g., Karttunen 1972; Groenendijk & Stokhof 1975; Lyons 1977; Kratzer 1991). Others disagree (von Fintel & Gillies 2010). What is important for the restrictor view is that the posited operator be a strong necessity, so Kratzer generally takes it to be an inaudible strong epistemic necessity operator $\Box$ distinct from *must*. Since the weak vs. strong *must* issue isn't on our plate, though, I'm happy to treat *must* as strong and take it to be the posited operator.

that once we zoom in further to the Q-worlds, it must be that R. Given what we've been assuming about *must* (it's a universal quantifier over possibilities compatible with the context), these come to the same thing.

But *if*s can also combine with fancier modals:

(23) a. If he's a Quaker, he's presumably a pacifist.
b. If the bet is on odd, it's probably a loser.
c. If the coin is fair, then the probability of heads is $\frac{1}{2}$.

Each of these expresses some restricted hedge: that he's presumably a pacifist (given he's a quaker), that the bet won't be won (given it's on odd), and that the probability of heads is $\frac{1}{2}$ (given the coin is fair). The hedges — *presumably*, *probably*, and x-*probably* — are modal operators. Treating *if*s as restrictors means that when we look at environments like these we shift our attention to the operators involved. Getting straight about them is how we get straight about the conditionals in which they occur. Though our current topic is indicatives and not hedges like these, I'll just briefly mention two routes to modeling their contribution that fit hand/glove-wise with the restrictor view of *if*s.

Route one: introduce a qualitative ordering between possibilities and eek truth-conditions for a hedge at w in c out of this. This is the route that Kratzer takes. (There are a lot of choices for the qualitative structure used and choices for how to connect it to the hedges. Yalcin (2010) surveys some of the choices.) Route two: introduce a more fine-grained body of information at hand determined by a context c. In particular: allow contexts to provide probability measures over the possibilities compatible with them. Here, too, there are lots of choices. But even without making (or surveying) all these choices, it's easy enough to see why the routes can lead to where the restrictor analysis needs to go. That is because each route ties hedges to a certain body of information and that body of information can be restricted in pretty straightforward ways: all the choices allow for a well-understood way of "updating" information that bears a systematic and well-understood connection to conditionalization.[28]

28 For more on the choices for representing the needed uncertainty hedges trade on and how those ways of modeling it go in for updating, see Halpern 2003.

8 Re-Inventing Conditional Connectives

There are still reasons to explore properly iffy operators that carry conditional meanings. Here's one reason: the charge is that the restricting job that *if*s unquestionably do is a job that can't be done by any conditional operator. Does the charge stick? It fact: no. And that's worth knowing.[29] The re-inventions sketched here also have an answer on offer for what they extra bit is that indicatives say over and above their corresponding horseshoes (naturally enough the bit the different re-inventions offer do differ).

One way that *if* can express a uniform conditional meaning while still tending to its restricting job is for the conditional meaning to be a gappy one — we get gaps when things aren't as the *if*-clause says — and for our story of embedding operators to be sensitive to those gaps. The idea is Belnap's (1970) and it has been revived and pushed by Huitink (2009).[30]

Here is the bare bones Belnap view: a conditional $(\textit{if}\ P)(Q)$ (in c at w) says pretty much the same as Q does (in c at w) provided P is true. Otherwise, it says nothing. Two ways to try to make this go: "boring" and "interesting". The boring way says sameness is sameness of *truth-value*, interesting that it is sameness of *semantic value*. Interestingly, it is the boring way that seems more promising. This is what Huitink does.

Belnap Conditional Indicatives express gappy propositions:

---

29 There are other reasons. Among them is that the way hedged *if*s (and their partnering iffed hedges) behave in conversation seems to require a conditional connective to figure in the story. (The history of the problem is a little involved, but see von Fintel & Gillies (2011).) That would be surprising on a lot of levels. Two come to mind: the the restrictor view is so both general and successful and Lewis-style triviality seems to go exactly the other way. But the jury is currently still out on this particular bundle of puzzles.

30 Lewis knew this was a way out, but dismissed it:

> What is the price of forcing the restriction-marking if to be a sentential connective after all? Exorbitant: it can be done if (1) we use a third truth value, (2) we adopt a far-fetched interpretation of the connective *if*, and (3) we impose an additional permanent restriction on the admissible cases. Let $\textit{If}\ \psi, \phi$ have the same truth value as ϕ if ψ is true, and let it be third-valued if ψ is false or third-valued. Let a case be admissible only if it makes the modified sentence either true or false, rather than third-valued. [. . .] A treatment along similar lines of *if*-clauses used to restrict ordinary, selective quantifiers may be found in Belnap (1970).

$$[\![(\textit{if } P)(Q)]\!]^{c,w} = \begin{cases} [\![Q]\!]^{c,w} & \text{if } [\![P]\!]^{c,w} = 1 \\ \text{undefined} & \text{otherwise} \end{cases}$$

This treats $(\textit{if } P)(Q)$ like the horseshoe when P is true but diverges from it in just the cases that the horseshoe theory goes wild. But it doesn't by itself meet the challenge of getting the restricting behavior right. If the operator that needs restricting is out-scoped by the *if* we will get the wrong and unrestricted truth-conditions and if the operator does the out-scoping we will *still* get the wrong and truth-conditions. The fix is easy. First: widescope the operators. And second: reign in their quantificational domains to survey only worlds/cases/situations/whatever at which the embedded sentence gets a truth-value. That's it.

There is another way to re-invent conditional connectives based on Ramsey's (1929/1990) suggestion. The Ramsey test is a recipe for when to *accept* a conditional: you accept $(\textit{if } P)(Q)$ in a state B iff Q is accepted in the subordinate state got by taking B and adding the information that P to it. But we want a story about what *if*s mean not so much about when they are/ought to be accepted. Again the fix is easy. Assume again a standard set-up (sentences get truth values at indices with respect to contexts). An indicative $(\textit{if } P)(Q)$ in a context c says that all (relevant) P-possibilities are possibilities at which Q is true. What is the context relevant for checking at those P-possibilities whether Q is true? The subordinate context got by taking c and adding the information that P to it. Making the straightforward choice for how the adding goes (just zoom in to the possibilities where P is true):

Shifty Conditional Indicatives express shifty propositions:

$$[\![(\textit{if } P)(Q)]\!]^{c,w} = 1 \text{ iff } c(w) \cap [\![P]\!]^{c} \subseteq [\![Q]\!]^{c+P}$$

where $c + P = \lambda v.c(v) \cap [\![P]\!]^{c}$

If we narrowscope the relevant operators, leaving their plain vanilla semantics (necessity modals like *must* are universal quantifiers, *may*/*might*/*could* the existential dual), this is enough to get the restricting behavior of *if*-clauses to mesh with them expressing a genuine conditional connective.

This re-invention is equivalent to dynamic semantic accounts that types all sentences in the language as programs or instructions for changing the context.[31] Intuition: a program means what it does, and what it does depends on what things are like — the state you are in — when you execute it. So,

31 The classic references: Groenendijk & Stokhof (1991); Veltman (1996).

a program's content is a relation between prior states and corresponding posterior states.

Dynamic semantics treats all sentences that way: their contents are the characteristic changes that a successful assertion of them induces. A simple example:

Dynamic Semantics for Propositional Logic Take a state (or context) s to be a set of worlds.

i. $s[P] = \{w \in s\colon\ P \text{ is true in } w\}$ for atomic P's

ii. $s[\neg P] = s \setminus s[P]$

iii. $s[P \wedge Q] = s[P][Q]$

Here the relation is in fact a function $[\cdot]$ from states to states (read it post-fix). So (a successfully asserted) atomic sentence tells us to throw away worlds where it isn't true, negation tells us to throw out what would survive an update with the thing negated, and conjunction tells us to process things in order. The point of each these instructions is to have a non-null upshot.

Not all instructions have that aim. You say to me: *Check whether the game is on.* You're not instructing me to change anything game-wise or TV-wise but instructing me to see whether the state we are in has a certain property. It's a *test* program. The dynamic idea is that indicatives are Ramsey-inspired test instructions:

Dynamic Conditional Indicatives express test programs:
$s[(\mathit{if}\ P)(Q)] = \{w \in s\colon\ s[P][Q] = s[P]\}$

Let's say that a sentence P is true in state s iff the information that P is already present in s. That is: P is true in s iff $s[P] = s$. Then we can put things this way: an indicative $(\mathit{if}\ P)(Q)$ is true in a state s iff Q is true in the subordinate state $s[P]$ got by taking s and adding the information P to it. That is very Ramseylike.

Acknowledgments

I've learned a lot about conditionals from a lot of people. Some of my personal intellectual debts are reflected in the references, some not (or not enough). So my biggest debtholders: Nicholas Asher, Josh Dever, Frank Veltman, and, of course, my frequent collaborator Kai von Fintel. Finally, I owe a tremendous

debt to John L. Pollock. I'd like to dedicate this to his memory. He will be missed (unconditionally).

References

Adams, Ernest W. 1975. *The Logic of Conditionals*. D. Reidel.

Adams, Ernest W. 1998. *A Primer of Probability Logic*. Center for the Study of Language and Information.

Anderson, Alan Ross. 1951. A note on subjunctive and counterfactual conditionals. *Analysis* 12(2). 35.

Austin, John L. 1956. *If*s and *can*s. In *Proceedings of the British Academy*, 109–132.

Belnap, Nuel D. 1970. Conditional assertion and restricted quantification. *Noûs* 4(1). 1–12.

Bennett, Jonathon. 2003. *A Philosophical Guide to Conditionals*. Oxford University Press.

van Benthem, Johan. 1986. *Essays in Logical Semantics*. D. Reidel.

Bradley, Richard. 2000. A preservation condition for conditionals. *Analysis* 60(3). 219–222.

Edgington, Dorothy. 1995. On conditionals. *Mind* 104(414). 235–329.

Edgington, Dorothy. 2009. Conditionals. In Ed Zalta (ed.), *Stanford Encyclopedia of Philosophy*, vol. Spring 2009 Edition. URL http://plato.stanford.edu/archives/win2003/entries/conditionals/.

von Fintel, Kai. 1998. The presupposition of subjunctive conditionals. In U. Sauerland & O. Percus (eds.), *MIT Working Papers in Linguistics: The Interpretive Tract*, vol. 25, 29–44.

von Fintel, Kai & Anthony S. Gillies. 2010. *Must*...Stay...Strong! *Natural Language Semantics* 1–33. doi:10.1007/s11050-010-9058-2.

von Fintel, Kai & Anthony S. Gillies. 2011. Hedging your *If*s and vice versa. Manuscript, MIT/Rutgers.

van Fraassen, Bas C. 1980. Review of brian ellis, *Rational Belief Systems*. *Canadian Journal of Philosophy* 10. 497–511.

Gärdenfors, Peter. 1982. Imaging and conditionalization. *The Journal of Philosophy* 79. 747–760.

Gärdenfors, Peter. 1988. *Knowledge in Flux*. MIT Press.

Gibbard, Allan. 1981. Two recent theories of conditionals. In W. L. Harper, R. Stalnaker & G. Pearce (eds.), *Ifs*, 211–248. D. Reidel.

Gillies, Anthony S. 2009. On truth-conditions for *If* (but not quite only *If*). *The Philosophical Review* 118(3). 325–348. doi:10.1215/00318108-2009-002.

Gillies, Anthony S. 2010. Iffiness. *Semantics and Pragmatics* 3(4). 1–42. doi:10.3765/sp.3.4.

Grice, H. Paul. 1975. Logic and conversation. In P. Cole & J. L. Morgan (eds.), *Syntax and Semantics*. Academic Press.

Groenendijk, Jeroen & Martin Stokhof. 1991. Dynamic predicate logic. *Linguistics and Philosophy* 14. 39–100.

Groenendijk, Jeroen A.G. & Martin J.B. Stokhof. 1975. Modality and conversational information. *Theoretical Linguistics* 2(1/2). 61–112.

Hájek, Alan. 1994. Triviality on the cheap? In Ellery Eells & Brian Skyrms (eds.), *Probability and Conditionals: Belief Revision and Rational Decision*, 113–140. Cambridge University Press.

Halpern, Joseph Y. 2003. *Reasoning about Uncertainty*. MIT Press.

Heim, Irene. 1983. On the projection problem for presuppositions 2. 114–125.

Horn, Laurence R. 2001. *A Natural History of Negation*. CSLI Publications, reissue edition edn.

Huitink, Janneke. 2009. Domain restriction by conditional connectives.

Jackson, Frank. 1991. *Conditionals*. Oxford University Press, USA.

Karttunen, Lauri. 1972. *Possible* and *Must*. In J. Kimball (ed.), *Syntax and semantics*, vol. 1. Academic Press.

Kratzer, Angelika. 1981. The notional category of modality. In H. J. Eikmeyer & H. Rieser (eds.), *Words, worlds, and contexts. new approaches in word semantics*, 38–74. Berlin: de Gruyter.

Kratzer, Angelika. 1986. Conditionals. *Chicago Linguistics Society* 22(2). 1–15.

Kratzer, Angelika. 1991. Modality. In Arnim von Stechow & Dieter Wunderlich (eds.), *Semantics: An international handbook of contemporary research*, 639–650. Berlin: de Gruyter.

Kratzer, Angelika. 2010. *Papers on Modals and Conditionals*. Oxford University Press.

Lewis, David. 1973. *Counterfactuals*. Blackwell.

Lewis, David. 1975. Adverbs of quantification. In E. Keenan (ed.), *Formal semantics of natural language*. Cambridge University Press.

Lewis, David. 1976. Probabilities of conditionals and conditional probabilities. *The Philosophical Review* 85. 297–315.

Lewis, David. 1986. Probabilities of conditionals and conditional probabilities II. *The Philosophical Review* 95. 581–589.

Lycan, W. G. 2001. *Real Conditionals*. Oxford University Press.

Lyons, John. 1977. *Semantics*. Cambridge: Cambridge University Press.

McGee, Vann. 1985. A counterexample to modus ponens. *Journal of Philosophy* 82(9). 462–471.

Ramsey, Frank P. 1929/1990. General propositions and causality. In H. A.

Mellor (ed.), *F. Ramsey, Philosophical Papers*. Cambridge University Press.

Segerberg, Krister. 1989. A note on an impossibility theorem of Gärdenfors. *Noûs* 23. 351–354.

Stalnaker, Robert. 1968. A theory of conditionals. In Nicholas Rescher (ed.), *Studies in logical theory*, 98–112. Basil Blackwell.

Stalnaker, Robert. 1975. Indicative conditionals. *Philosophia* 5. 269–286.

Veltman, Frank. 1985. *Logics for Conditionals*. Ph.D. thesis, University of Amsterdam.

Veltman, Frank. 1996. Defaults in update semantics. *Journal of Philosophical Logic* 25. 221–261. doi:10.1007/BF00248150.

Yalcin, Seth. 2010. Probability operators. URL http://semanticsarchive.net/Archive/Tg3OTQyZ/yalcin.po.2010.draft.pdf.