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**Massachusetts Institute of Technology**

# 59. Conditionals

Kai von Fintel
Massachusetts Instititute of Technology
Department of Linguistics and Philosophy
Room 32-D808, 77 Massachusetts Avenue, Cambridge, MA 02139
fintel@mit.edu
+1.617.253.3228

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# 59. Conditionals

This article introduces the classic accounts of the meaning of conditionals (material implication, strict implication, variably strict conditional) and discusses the difference between indicative and subjunctive/counterfactual conditionals. Then, the restrictor analysis of Lewis/Kratzer/Heim is introduced as a theory of how conditional meanings come about compositionally: *if* has no meaning other than serving to mark the restriction to an operator elsewhere in the conditional construction. Some recent alternatives to the restrictor analysis are sketched. Lastly, the interactions of conditionals (i) with modality and (ii) with tense and aspect are discussed. Throughout the advanced research literature is referenced while the discussion stays largely non-technical.

## 1  Conditional meanings and ways of expressing them

Conditionals are sentences that talk about a possible scenario that may or may not be actual and describe what (else) is the case in that scenario; or, considered from "the other end", conditionals state in what kind of possible scenarios a given proposition is true. The canonical form of a conditional is a two-part sentence consisting of an "antecedent" (also: "premise", "protasis") marked with *if* and a "consequent" ("apodosis") sometimes marked with *then* (the syntax and semantics of *then* is an interesting subject, which we won't cover here, see e.g. Iatridou (1993)):

(1)     If Grijpstra played his drums, (then) de Gier played his flute.

Conditional meanings can be conveyed with other means as well, each of which merits its own study:

(2)     Had he admitted his guilt, he would have gotten off easier.

(3)     Take another step and I'll knock you down.

(4)     He was pushed or he wouldn't have fallen down the cliff.

(5)     Without you, I would be lost.

(6)     *I* would have beaten Kasparov.

Some languages are reported to have no conditional construction of the *if …then*-type and use paratactic means only (see for example Levinson 2000: p.125 on Guugu Yimithirr):

(7)     *Nyundu budhu dhadaa, nyundu minha maanaa bira.*
        You     maybe go      you    meat get      for sure
        'Maybe you will go, (then) you will certainly get meat.'
        = 'If you go, you'll get meat.'

The cross-linguistic study of conditionals and the various means by which conditional meanings can be expressed is only in its infancy. Here, we will focus on the canonical *if … (then)* construction of English as our object of investigation.

The semantics of conditionals is an exceptionally rich topic at the intersections of semantics, pragmatics, philosophy of language, and the cognitive science of reasoning. The concept of conditionality is in many ways central to human thought and action. One might note that conditionals are a primary exhibit for one of the "design features" of human language: displacement (Hockett & Altmann 1968).

Exactly what conditionals mean and how they come to mean what they mean is one of the oldest problems in natural language semantics. According to Sextus Empiricus, the Alexandrian poet Callimachus reported that the Greek philosophers' debate about the semantics of the little word *if* had gotten out of hand: "Even the crows on the roof-tops are cawing about which conditionals are true". It finally became too much for Cicero, who famously complained in his *Academica*:

> In this very thing, which the dialecticians teach among the
> elements of their art, how one ought to judge whether an

> argument be true or false which is connected in this manner, 'If it is day, it shines', how great a contest there is; — Diodorus has one opinion, Philo another, Chrysippus a third. *Need I say more?*

It is unclear whether we are any closer to solving Cicero's Problem.

## 2 Types of conditionals

There are four types of conditionals that have been distinguished in the literature. Starting with a type that often gets short shrift (as it will here; see though DeRose & Grandy 1999, Siegel 2006, and Predelli 2009, among others), there are conditionals variously called speech act conditionals, biscuit conditionals, relevance conditionals:

(8)     There are biscuits on the sideboard if you want them. (Austin 1956)

(9)     I paid you back yesterday, if you remember. (P.T. Geach p.c. to Austin 1956)

These conditionals do not state in any sense conditions under which the consequent is true, rather they seem to somehow operate on a higher speech act level.

Another not all that well-studied kind of conditional is what Iatridou called "factual" conditionals (called "premise conditionals" in Haegeman 2003), conditionals that often echo someone else's introduction of the antecedent:

(10)     If you're so clever, why don't you do this problem on your own?

(11)     If it is indeed that late, we should leave.

The two main kinds of conditionals that semantic research has been concerned with are usually called indicative and subjunctive/counterfactual conditionals:

(12)     a.  If Grijpstra played his drums, de Gier played his flute. (indicative)
         b.  If Grijpstra had played his drums, de Gier would have played his flute.                                    (subjunctive/counterfactual)

The terminology is of course linguistically inept (as we'll discuss in Section 6.2, the morphological marking is one of tense and aspect, not of indicative vs. subjunctive mood), but it is so deeply entrenched that it would be

foolish not to use it. Superficially, the striking difference between the two kinds of conditionals is that indicative conditionals somehow convey that the truth of the antecedent is an open issue, while subjunctive conditionals seem to convey that the antecedent is false. (Are there conditionals that convey that the antecedent is true? Perhaps, if one considers locutions like *since* or *given that* to be conditional connectives.) Upon closer investigation, it is not possible to maintain that subjunctive conditionals are invariably counterfactual in this sense, as shown dramatically by an example due to Anderson (1951):

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

A doctor who utters (13) might be prepared to use it as part of an argument that the antecedent is in fact true, so the subjunctive conditional could not be conveying counterfactuality as part of its meaning. There are some subjunctive conditionals that arguably are automatically counterfactual, for example the ones that Ippolito (2003) calls "mismatched past counterfactuals" and the verb-first counterfactuals studied by Iatridou & Embick (1993):

(14)    If Charlie had married Sally tomorrow, he would have had his bachelor party tonight. #So, let's see whether the party is tonight.

(15)    Had Charlie married Sally yesterday, they would have left on their honeymoon by now. #So, let's see whether they're gone.

Even abstracting away from the issue of counterfactuality, there are strong reasons to conclude that the two kinds of conditionals are quite different in their meaning. This is best shown by minimal pairs, the most famous one of which is due to Adams (1970):

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

While most people would accept (16a) as true (since they know that Kennedy was assassinated), only the most conspiracy-minded would accept (16b).

The meaning of the indicative conditional seems to correspond fairly accurately to the "Ramsey Test" (Ramsey 1931):

> 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*.

Knowing that Kennedy was assassinated and having maybe only the slightest doubt that the assassin may not have been Oswald, our stock of knowledge incremented hypothetically with *Oswald didn't kill Kennedy* would support *somebody else killed Kennedy*, and thus we accept (16a) as true.

Informally, (16b) is evaluated quite differently. We are invited to go back to the time around Kennedy's assassination and project how things would have turned out if Oswald hadn't killed Kennedy. And many of us have only the haziest ideas of what would have happened, certainly no conviction that some assassination was inevitable. So, we reject (16b).

The questions for the semanticist are two-fold: (i) what is the formal analysis of the different meanings that conditionals convey, and (ii) how are these meanings compositionally derived? A quick look at the examples suggest that there are significant difference in meaning deriving from the tense/aspect/mood morphology on the verbs in the two clauses. So, in the end, we'd like a compositional analysis that explains the semantic effects of these morphological choices. First, though, we will focus on the prior question here: what do conditionals mean?

Before we turn to the main theories of conditional meaning, we should note that semantic analyses of conditionals are also responsible for explaining a host of facts concerning the combination of conditionals with other constructions. These include: the role of *then* in the consequent, complex conditionals like *only if*, *even if*, *unless*, modals in the consequent, disjunctions in the antecedent, negative polarity items in the antecedent (cf. article XX (Giannakidou) *Polarity items*), embedding of conditionals under quantifiers (cf. article XX (Keenan) *Quantifiers*), conditional questions (cf. article XX (Krifka) *Questions*), conditional imperatives (cf. article XX (Han) *Imperatives*). Only some of these will be touched on in this article. The field is wide open for a lot of exciting future research.

## 3   The classic accounts and beyond

The classic analyses of conditionals, some of whom were already discussed by the crows of Ancient Greece, are (i) *if ... (then) ...* as a truth-functional connective, material implication, (ii) the strict conditional analysis, (iii) the non-monotonic possible worlds analyses of Stalnaker and Lewis.

## 3.1 Material implication

If conditionals correspond to a two-valued truth-functional connective, it has to be the one dubbed "material implication", which yields falsity if and only if the antecedent is true but the consequent is false. Suber (1997) presents a good example motivating this distribution of truth-values. A professor who declares that *If I am healthy, I will come to class* can only be said to have broken her promise if she is healthy but doesn't come to class. Clearly, if she is healthy and comes to class, she'll have spoken the truth. And if she is sick, it is immaterial whether she comes to class (going beyond the call of duty and beyond what she promised) or doesn't — neither case constitutes a breaking of the promise.

One of the "paradoxes of material implication" (not paradoxes in the sense of a formal system that is internally incoherent, but shortcomings in the match between the formal analysis and the natural language data it might be thought to cover) is that disbelief in the antecedent $p$ should result in a proportionate willingness to believe *if $p$, $q$*, no matter what the consequent $q$ might be, because as soon as the antecedent is false, material implication makes the conditional true no matter what the consequent is. Clearly, this does not correspond to the actual behavior of language users. Just because I find it unlikely in the extreme that the sun will explode in a minute from now, I do not find it likely at all that if the sun explodes in a minute from now, a Vogon Constructor spaceship will come and rescue all of Earth's inhabitants.

There are several heroic efforts (cf. in particular Jackson 1979, 1987) to maintain that material implication is an adequate semantics for natural language conditionals — in particular, indicative conditionals. The general idea is to supplement a material implication *semantics* with a sophisticated pragmatics of *assertibility*, whether derivable via standard Gricean conversational implicature or stipulated as a construction-specific conventional implicature. Jackson argues that indicative conditionals trigger a conventional implicature that the assertion as a whole is robust with respect to the antecedent; that is, that a speaker who utters an indicative conditionals is not just claiming that the material conditional is true but is also signalling that should the antecedent turned out to be true they would still claim that the material conditional is true. In the exploding sun example, above, Jackson would say that while I do (almost) believe that the indicative conditional is true, strictly speaking, because I believe that the antecedent is very likely to be false, I do not believe in the robustness of the conditional relative to its antecedent. If it

turned out to be true that the sun will explode in a minute from now, I would then not believe the material conditional anymore. So, I'm not in a position to assert the conditional because I would be sending the wrong signal (that my belief in it was robust with respect to the antecedent). Edgington (2007: 135-138) raises an important objection to the implicature-based accounts: the non-equivalence between indicative conditionals and material implication doesn't just arise at the level of assertibility. The problem with the exploding sun example isn't just that I can't assert it properly, rather: I don't even believe the conditional to the extent I should. Bennett (2003: Chapters 2 and 3) gives other strong arguments against Grice/Jackson-style theories; at the same time, the perhaps quixotic goal of defending material implication with non-truth-conditional enhancements continues to be pursued, see for example Rieger (2006).

In linguistic work, the material implication account (pragmatically enriched or not) is usually dismissed because of the unsurmountable problems it faces when one looks at embedded conditionals. One such case is the embedding of indicative conditionals under nominal quantifiers:

(17)    a.   Every student will succeed if he works hard.
        b.   No student will succeed if he goofs off.

As first discussed by Higginbotham (1986), the material implication analysis may be adequate for (17a) but it is clearly wrong for (17b), which would be predicted to mean that every student goofs off and doesn't succeed.


## 3.2   Possible worlds semantics for conditionals

C.I. Lewis (1918) proposed his "strict implication" as a better approximation of ordinary conditionals. According to this analysis, *if p, q* is true iff the material implication is *necessarily* true. This would for example deal quite well with the fact that the exploding sun conditional is not one that one should believe just because the antecedent is very likely to be false. Whether or not it is even possible that a Vogon Constructor fleet would rescue Earth's inhabitants it is certainly possible that the sun explodes and we are not rescued, and thus the material implication is not necessarily true, and thus the strict implication account predicts that the conditional is false, which is a good reason not believe it.

If one assumes a possible worlds semantics for notions like necessity, the strict implication analysis amounts to the claim that *if p, q* is true iff *q*

is true in all worlds in which $p$ is true. By far the most influential semantics for conditionals, in particular counterfactual conditionals, developed independently by Stalnaker (1968) and Lewis (1973), departs from the strict implication analysis in that it doesn't quantify over *all p*-worlds but just about a distinguished subset thereof. This move is motivated in part by problems with conditional inferences, as we will soon see.

To a first approximation, the Stalnaker/Lewis analysis assumes an *ordering* of the set of worlds according to how similar they are to the world of evaluation (the one for which the truth of the conditional is being evaluated). Rather than saying that *if p, q* is true iff $q$ is true in *all* worlds in which $p$ is true, the Stalnaker/Lewis account selects from the worlds in which $p$ is true those that are most similar to the evaluation world and claims just about those most similar $p$-worlds that they are $q$-worlds. This has significant effects on what kind of inferences will be valid with conditionals.

Under the strict implication analysis, the pattern known as Strengthening the Antecedent, for example, is predicted to be valid:

(18)    Strengthening the Antecedent
        *if p, q*
        ∴ *if p & r, q*

If all (contextually relevant) $p$-worlds are $q$-worlds, then *a fortiori* all $p\&r$-worlds, a subset of the $p$-worlds, have to be $q$-worlds.

This pattern becomes invalid in the Stalnaker/Lewis analyses. If the $p$-worlds that are most similar to the evaluation world are all $q$-worlds, that does necessitate that the most similar $p\&r$-worlds are also all $q$-worlds. Lewis (1973) gives a humorous example:

(19)    a.   If kangaroos had no tails, they would topple over.
        b.   ⊬ If kangaroos had no tails but used crutches, they would topple over.

(19a) intuitively does not license the inference to (19b). The similarity-based analyses explain why: the worlds where kangaroos have no tails but that are otherwise as similar as possible to the evaluation world are not worlds where kangaroos use crutches, so the first conditional does not connect logically to the second conditional. The Stalnaker/Lewis analyses thus differ from the strict implication analysis in being *non-monotonic* or as Lewis put it "variably strict".

Other patterns that are expected to be valid under the strict implication analysis but arguably aren't are Hypothetical Syllogism and Contraposition:

(20)  *Failure of the Hypothetical Syllogism (Transitivity)*
      If Hoover had been a Communist, he would have been a traitor.
      If Hoover had been born in Russia, he would have been a Communist.
      ⊬ If Hoover had been born in Russia, he would have been a traitor
                                                    [Example due to Stalnaker 1968]

(21)  *Failure of Contraposition*
      (Even) if Goethe hadn't died in 1832, he would still be dead now.
      ⊬ If Goethe were alive now, he would have died in 1832.
                                                    [Example due to Kratzer 1979]

The non-monotonic analyses predict correctly that Hypothetical Syllogism (Transitivity) fails because even if all the closest (most similar to the evaluation world) $p$-worlds are $q$-worlds and all the closest $q$-worlds are $r$-worlds, we are not necessarily speaking about the same $q$-worlds (the $q$-worlds that $p$ takes us to may be rather remote ones). So in the Hoover-example, we get the following picture: The closest $p$-worlds in which Hoover was born in Russia (but where he retains his level of civic involvement), are all $q$- worlds in which he becomes a Communist. On the other hand, the closest $q$-worlds in which he is a Communist (but retaining his having been born in the United States and being a high level administrator) are all $r$-worlds in which he is a traitor. The closest $p$-worlds do not include the closest $q$-worlds, so the Transitive inference does not go through.

Again, the non-monotonic analyses correctly predict that Contraposition fails because the assumption that the closest $p$-worlds are $q$-worlds does not preclude a situation where the closest non-$q$-worlds are also $p$-worlds. The selected $p$-worlds in which Goethe didn't die in 1832 are all $q$-worlds where he dies nevertheless (well) before the present. But of course, the closest (in fact, all) non-$q$-worlds (where he is alive today) are also $p$-worlds where he didn't die in 1832.

Lewis and Stalnaker differ in their assumptions about the similarity ordering. Stalnaker assumes that for any (non-contradictory) antecedent and any evaluation world, there will be a unique most similar antecedent world. Lewis neither makes this Uniqueness Assumption nor the weaker Limit Assumption (that for any antecedent and evaluation world, there is a set of most similar antecedent worlds). For discussion of this difference, see Lewis (1973:

19–21) and Stalnaker (1984: Chapter 7, esp. pp. 140–142); Pollock (1976), Herzberger (1979), and Warmbrod (1982) argue for the Limit Assumption as well. Informally, here, we have been using the Limit Assumption but not the Uniqueness Assumption when we talk about the most similar or closest antecedent worlds. The issues discussed under this heading are relevant for the attempt we'll mention later to treat conditionals as definite (plural?) descriptions of possible worlds; see Section 5.1.

A variant of the ordering based semantics is given by "premise semantics", inspired by Goodman (1947) and Rescher (1964) and developed in rival forms by Kratzer (1977, 1979, 1981) and Veltman (1976). Lewis (1981) showed that technically the two approaches are intertranslateable. More recent work in the premise semantic tradition includes Kratzer (1989), Djordjevic (2005), Veltman (2005), Kanazawa et al. (2005), Kratzer (2005).

## 3.3 The indicative/subjunctive distinction

We have now surveyed the three classic theories of conditional meaning, and we will soon look at more recent variants and alternatives. At this point, though, let us discuss how one could approach the indicative/subjunctive distinction in terms of the classic approaches.

While the Oswald/Kennedy pair shows that indicatives and subjunctives have distinct truth-conditions, it is not obvious *how* distinct they should be seen as. Do they have distinctly different kinds of meanings? Or is the difference more subtle?

Among philosophers and logicians, it is very commonly held that quite different approaches are appropriate. David Lewis, for example, thought that his variably strict semantics was not applicable to indicatives (he favored material implication plus Jackson's pragmatic enrichment for those). Others adopt even more radically different analyses for indicatives, such as the conditional assertion view or the "No Truth-Value" (NTV) view, both of which we'll briefly discuss below.

Some indication that the semantics for the two kinds of conditionals shouldn't be all that different comes from the fact that they seem to show the same kind of inference patterns (or invalidity patterns). For example, Strengthening the Antecedent fails with indicatives just as it did with subjunctives:

(22)    a.    If John left before noon, he arrived in time for the meeting.

b.   ⇏ If John left before noon but got in a car accident, he arrived in time for the meeting.

For a linguistically realistic semantics, it would also be relevant that both kinds of conditionals employ the connective *if* (although we'll soon see that that might not actually mean that much) and that the only overt distinction between the two kinds lies in tense and aspect morphology, which might suggest that there shouldn't be a deep semantic division.

Stalnaker (1975) argues that his version of the non-monotonic semantics for conditionals is applicable to both indicatives and subjunctives and that the only difference is that indicatives come with the default assumption that the selected antecedent world is within the context set (the set of worlds that are compatible with the current assumptions of the conservation). In other words, the subjunctive conditional is chosen when for some reason, the speaker does not want the assumption in place that the selected antecedent world is compatible with what is taken for granted. As explored in von Fintel (1999b), this approach predicts not only that subjunctives are chosen when the antecedent is known to be counterfactual but also in Anderson-type cases, as repeated here:

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

Within the context set, all the worlds are trivially worlds where Jones shows the symptoms he shows. So, for the conditional to be non-trivial the world that the antecedent is taking us to needs to be outside the context set, even though the speaker in the end intends the hearer to infer that Jones did take arsenic. Since the conditional needs to reach outside the context set, we need to use subjunctive marking.

## 3.4   Dynamic strict analyses

Let us return to the argument from the apparent failure of Strengthening the Antecedent. When Lewis discussed this, he tried to forestall the idea that what is treated as semantic non-monotonicity in his account could actually be explained in a strict implication account by saying that the contextually relevant set of worlds that the conditional quantifies over is easily shifted in a sequence of sentences. He argued that this move would not be able to explain the well-formedness of what became known as Sobel Sequences:

(23)    If the USA threw its weapons into the sea tomorrow, there would be war; but if all the nuclear powers threw their weapons into the sea tomorrow, there would be peace.

Lewis deliberately put this example "in the form of a single run-on sentence, with the counterfactuals of different stages conjoined by semicolons and *but*", suggesting that it would be a "defeatist" move to say that in such a tight sequence the context could shift in response to the introduction of a new antecedent clause.

Defeatist or not, based on an observation by Heim (MIT class handout), von Fintel (2001b) develops such an account. Heim had noted that Lewis' Sobel Sequence cannot be reversed:

(24)  ??If all the nuclear powers threw their weapons into the sea tomorrow, there would be peace; but if the USA threw its weapons into the sea tomorrow, there would be war.

This is unexpected from the point of view of a semantically non-monotonic analysis. In von Fintel's paper, a dynamic strict analysis is developed in which the antecedent has the potential to expand the "modal horizon", the set of contextually relevant possible worlds which the conditional then ranges over. It is shown that if the expansion of the modal horizon is governed by the same similarity ordering used in the Stalnaker/Lewis systems, the analysis replicates the truth-conditions of those systems for isolated or discourse-initial conditionals. The context shifts become only relevant in sequences of conditionals and then create the appearance of semantic non-monotonicity. One crucial argument von Fintel gives for his account is that negative polarity items are licensed in the antecedent of conditionals and that therefore we would prefer a monotonic analysis. It turns out, however, that only a very special notion of monotonicity (dubbed Strawson Downward Entailingness) holds for von Fintel's conditionals: these conditionals are downward monotone in their antecedent only under the assumption that the initial context is such that the modal horizon is already large enough to be unaffected by any of the conditionals in the sequence. This idea is explored for other puzzles for NPI-licensing in von Fintel (1999a); cf. also article 64 (Giannakidou) *Polarity items*. The dynamic strict analysis is developed further by Gillies (2007) and critically compared to a pragmatically supplemented non-monotonic analysis by Moss (2007).

## 3.5 Conditional assertion

For at least some types of conditionals, it may make sense to think of the *if*-clause as operating at a speech act level. That is, perhaps, the *if*-clause does not actually change the truth-conditions of the consequent clause it is attached to, but it marks that the content of the consequent clause is only to be considered as asserted if the antecedent is true. This "conditional assertion" account might be most appropriate for "biscuit-conditionals" (mentioned earlier), see DeRose & Grandy (1999), for example. Lycan (2006) argues that conditional assertion accounts are not to be taken seriously as analyses of indicative conditionals in general.

## 3.6 NTV

An even more radical approach says that conditionals have no truth-conditions at all. This "NTV" (for "no truth-value", a name given by Lycan (2001)) account argues that conditionals do not make truth-evaluable claims but "express" that the speaker has a high subjective probability for the consequent, given the antecedent. The account is prominently championed by Adams (1965), Gibbard (1981), and Edgington (1986), among others. Lycan (2001) gives quite a few reason to think the account cannot be maintained; see also Bennett (2003) for discussion. As far as I know, the NTV account has had no impact at all in linguistic work on natural language semantics (but see Kaufmann (2005a) and Cohen (2009)).

## 4 The restrictor analysis

The dominant approach to the semantics of conditionals in linguistics is not so much an alternative to the accounts we have discussed so far, and in particular not to the Stalnaker/Lewis analysis, but a radical rethinking of the compositional structure of conditional sentences. It began with Lewis's (1975) paper on adverbial quantification, which dealt with sentences like

(25)    If it is sunny, we always/usually/mostly/rarely/sometimes/never play soccer.

Lewis argued that there was no plausible semantics for the conditional connective that would interact compositionally with the adverbs of quantification to give correct truth-conditions for these sentences. Instead, he argued that

the *if*-clause added no conditional meaning of its own to the construction. The idea is that the only "conditional" operator in the structure is the adverb and that *if* merely serves to introduce a restriction to that operator. In other words, where naïvely one would have thought that (25) involved the combination of an adverbial quantificational operator with the conditional expressed by *if*, Lewis argued that there was just one operator and that *if* didn't express any kind of conditional operator of its own.

Lewis himself did not generalize this idea; nowhere else in his writings does he give any indication that *if*'s found elsewhere are to be treated on a par with the *if* in adverbially quantified sentences. (It should be noted that in the adverbial quantification paper, Lewis does suggest that the *if* found in construction with probability operators is also not a conditional operator of its own, although he doesn't say whether it is to be seen as a restrictor in those cases. It is a shame that Lewis's insights in the adverbial quantification paper were not connected by him — or anyone else in the logico-philosophical literature — to the problems surrounding conditional probability, as discussed for example in Lewis (1976); cf. also Hájek (1993). Kratzer (1986) does make the connection but I do not think that her discussion of probability conditionals has been taken up by logicians and philosophers.)

Kratzer took the logical step and argued that Lewis' idea should be applied to all conditional constructions. She put the point very concisely in Kratzer 1986: "The history of the conditional is the story 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. Whenever there is no explicit operator, we have to posit one."

It should be noted that this proposal is not really a proposal meant to overturn any prior conceptions about the meaning of various conditional constructions. Rather, it is a proposal for how the meaning of those constructions comes about compositionally. The central idea is that *if* itself does not carry any distinctive conditional meaning, rather it is, so to speak, a helper expression that modifies various quantificational/modal operators (cf. article 58 (Hacquard) *Modality*). As indicated in the quote from Kratzer, this doesn't just apply to when an overt operator combines with an *if*-clause but also when an *if*-clause occurs on its own with no overt operator in sight. In that case, Kratzer suggest, there must a covert, or at least not obviously visible, operator. What one might call bare indicative conditionals either contain a covert epistemic necessity modal or a covert generic frequency operator ($\approx$ *usually/always*):

(26)  a.  If he left at noon, he's home by now.     [epistemic necessity]
      b.  If he leaves work on time, he has dinner with his family. [generic frequency]

In bare counterfactual conditionals, one should consider the possibility that the modal form *would* is the operator restricted by the *if*-clause, an idea bolstered by the fact that there are *if*-less *would*-sentences such as (6), repeated here:

(6)  I would have beaten Kasparov.

Following Partee (1991), the restrictor theory of *if*-clauses is sometimes called the "Lewis/Kratzer/Heim" analysis (henceforth restrictor), because after the initial idea of Lewis and the generalization by Kratzer, the application of the story to the analysis of donkey anaphora by Heim (1982) played a large role in the triumph of the theory in linguistic circles.

It should be pointed out that while we earlier stressed the desire to have a uniform(ish) analysis of indicative and subjunctive conditionals, partially because both are *if ... then* constructions, the restrictor analysis opens up a potentially large gap between them. The uniform presence of *if* would be almost entirely beside the point: how big the difference between the two kinds is depend on what, if any, difference there is between the modal operators present in them.

## 5   Recent alternatives to the restrictor analysis

### 5.1   Conditionals as definites

Some work has recently explored an alternative to the restrictor analysis that does give *if* a more substantial role to play. The idea explored by Schein (2003), Schlenker (2004), and Bhatt & Pancheva (2006) is that *if*-clauses are definite plural descriptions of possible worlds. These works point out a series of syntactic and semantic ways in which *if*-clauses behave much alike to definite descriptions (in particular, free relatives). An interesting subplot in that exploration is whether the semantics (for both *if*-clauses and for definite descriptions) should be non-monotonic, as argued by Lewis, or monotonic (supplemented with discourse dynamics). Schlenker (2004) leaves this as an open question.

## 5.2 Three-valued conditionals

Lewis (1975: fn.4) mentioned an alternative to the restrictor analysis of *if*:

> "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."

The idea would be to give *if p, q* a three-valued semantics where it is true if $p$ and $q$ are true, false if $p$ is true but $q$ is not, and has the third truth-value if $p$ is false. Then, operators can be defined so as to quantify only over cases where the truth-value of the embedded conditional is not the third truth-value, which is equivalent to them quantifying over $p$-cases only. This idea goes back to Belnap (1970, 1973) and despite Lewis' denunciation of it as carrying an exorbitant price tag, it has been revived recently by Geurts (2004b), von Fintel (2007), and Huitink (2008, 2009a,b,c). (Note that McDermott (1996) had argued that such a three-valued semantics was in fact adequate for at least certain simple conditionals.)

One argument in favor of paying the price and adopting this analysis comes from the behavior of conditionals in discourse. As pointed out by von Fintel (2007), examples like the following present a severe challenge to the restrictor analysis (the problem was first identified in von Fintel 2003):

(27)    A:   If he didn't tell Harry, he told Tom.
        B:   Probably so.
        B':  That's very unlikely.

In such dialogues, a propositional anaphor (*so*, *that*) appears to refer back to the conditional in A's utterance. In the restrictor analysis, the only conditional proposition made available by A's utterance is an epistemically modalized conditional. But the utterance by B and B' are not interpreted as involving that epistemic conditional embedded under *probably* or *unlikely*. Rather, *probably so* is interpreted as a simple probability conditional. So, it appears that the best account would be one where A's and B's utterances share a "bland" conditional meaning that then a local operator could be applied to (covert epistemic modal in A's utterance and probability operator in B's utterance). Adopting the Belnap meaning for conditionals, we can analyze the dialogue in (27) as follows:

(28)   A:   If he didn't tell Harry, he told Tom.
           must (if he didn't tell Harry, he told Tom)
           in all worlds compatible with the evidence where the embedded
           conditional has a truth-value (i.e. where he didn't tell Harry), he
           told Tom
       B:   Probably so.
           probably (if he didn't tell Harry, he told Tom)
           in most worlds compatible with the evidence where the embedded
           conditional has a truth-value (i.e. where he didn't tell Harry), he
           told Tom

There are obvious questions and worries about the Belnap-style approach. One is whether the Belnap conditional can stand on its own (as argued by McDermott (1996)) or whether it always requires an operator to embed it (if so, the account would mimic the restrictor analysis very closely). Another topic that would need to be sorted out is that using three-valued semantics for the mechanics of this account precludes using three-valued semantics for modelling presupposition (as is often done) at the same time, since clearly the antecedents of conditionals are not presupposed to be true.

## 5.3   Another non-restrictor analysis of *if*

Gillies (2009a,b) has been developing an account that also tries to restore a conditional meaning for *if*-clauses and achieve the restricting effect in a more indirect way than done in the restrictor approach. In his analysis, *if* expresses a contextually restricted strict implication operator, which means that there is no need for the covert operators needed in the restrictor account. To model the interactions with other overt operators correctly, the semantics for *if* has a second component which has it restrict the domain for any operators that might be in its scope. An interesting difference between the revived three-valued analysis and Gillies' analyis is that in the former operators that end up being restricted by an *if*-clause take the conditional in their scope, while in the latter they appear in the consequent of the conditional in the scope of the *if*-clause. One expects that this will be of crucial importance in deciding between the accounts.

   Note that Gillies' account will face the same problems with the behavior of conditionals across speakers as the restrictor analysis and thus appears at a disadvantage to the Belnap-style approach.

## 6 Interactions

A crucial topic in conditional semantics is how conditionals interact with other expressions. This has already been a thread in the preceding sections. Here, we will look a bit more at the interaction of conditionals with modality and with tense/aspect. Space precludes a discussion of complex conditionals like *even if*, *only if*, and *unless* conditionals; for some work on complex conditionals see Bennett 1982, von Fintel 1994 (Chapters 4 and 5), and Lycan 2001.

### 6.1 Conditionals and modals

The restrictor analysis predicts that *if*-clauses should be able to restrict any kind of modal operator, epistemic operators and deontic operators:

(29)  *if*-clause restricting epistemic modals:

    a.  If Grijpstra played his drums, (then) de Gier must have played his flute.

    b.  If Grijpstra played his drums, (then) de Gier might have played his flute.

    c.  If Grijpstra played his drums, (then) de Gier  played his flute. [ = covert epistemic necessity]

(30)  *if*-clause restricting deontic modals:

    a.  If you broke the vase, you ought to apologize.

    b.  If you're over 21, you are allowed to buy beer in this store.

### 6.1.1 Kratzer's version of the Samaritan Paradox

Kratzer (1991) argues that the restrictor approach to deontic conditionals is the crucial ingredient in the solution of a conditional version of the Samaritan Paradox. The first step in that story, though, is to consider the original non-conditional version of the paradox as introduced by Prior (1958). Imagine that someone has been robbed and John is walking by. It is easy to conceive of a code of ethics that would make the following sentence true:

(31)  John must help the person who was robbed.

If modal semantics only involved quantification over a set of accessible worlds, one would have said that (31) says that in all of the deontically

accessible worlds (those compatible with the code of ethics) John helps the person who was robbed. Prior's point was that under such a semantics, something rather unfortunate holds. Notice that in all of the worlds where John helps the person who was robbed, someone was robbed in the first place. Therefore, it will be true that in all of the deontically accessible worlds, someone was robbed. Thus, (31) will entail:

(32)    It must be that someone was robbed.

It clearly would be good not make such a prediction, since we might very well want (31) to be true and (32) to be false.

A doubly-relative analysis of modality, as proposed by Kratzer (1991) and surveyed in article 58 (Hacquard) *Modality*, can successfully avoid this unfortunate prediction. Such an analysis assumes that an ordering is imposed on the set of accessible worlds, with different "ordering sources" being associated with different flavors of modality (this can be seen as a generalization of the similarity-based ordering in the Stalnaker/Lewis analysis of conditionals). We can then conceive of (31) as being uttered with respect to a circumstantial modal base that includes the fact that someone was robbed. Among those already somewhat ethically deficient worlds, the relatively best ones are all worlds where John helps the victim.

Note we still have the problematic fact that among the worlds in the modal base, all are worlds where someone was robbed, and we would thus appear to still make the unfortunate prediction that (32) should be true. But this can now be fixed. For example, we could say that *must p* is semantically defective if $p$ is true throughout the worlds in the modal base. This could be a presupposition or some other ingredient of meaning. So, with respect to a modal base which pre-determines that someone was robbed, one couldn't felicitously say (32).

Consequently, saying (32) would only be felicitous if a different modal base is intended, one that contains both $p$ and non-$p$ worlds. And given a choice between worlds where someone was robbed and worlds where nobody was robbed, most deontic ordering sources would presumably choose the no-robbery worlds, which would make (32) false, as desired.

The paradox as presented by Kratzer (1991) has a conditional form:

(33)    If a murder occurs, the jurors must convene.

Kratzer points out that if one tried to analyze (33) as a material implication embedded under deontic necessity, then one quickly runs into a problem. Surely, one wants the following to be a true statement about the law:

(34)    There must be no murder.

But this means that in the deontically accessible worlds, all of them have no murders occuring. Now, this means that in all of the deontically accessible worlds, any material implication of the form "if a murder occurs, $q$" will be true no matter what the consequent is since the antecedent will be false. Since that is an absurd prediction, (33) cannot be analyzed as material implication under deontic necessity. The combination of the restrictor approach to *if*-clauses and the doubly-relative theory of modals can rescue us from this problem. (34) is analyzed as the deontic necessity modal being restricted by the *if*-clause. The set of accessible worlds is narrowed down by the *if*-clause to only include worlds in which a murder occurs. The deontic ordering then identifies the best among those worlds and those are plausibly all worlds where the jurors convene.

### 6.1.2   An expected ambiguity

As pointed out at various times (as far as I know, independently in unpublished work by Craige Roberts and by Geurts (2004a)), the existence of covert operators in Kratzer's analysis may predict that sentence with an overt operator and an *if*-clause are in fact ambiguous: one reading where the *if*-clause restricts the overt operator and another reading where the *if*-clause restricts a covert operator that somehow combines with the overt operator. An example from Sarah Moss (term paper for a 2005 MIT class) shows the reality of that prediction:

(35)    If Caspar vacuums on Saturday, then Chris has to cook dinner on Sunday.

There is a straightforward "one operator" reading of (35) where it expresses a rule of the group sharing the apartment: every acceptable scenario in which Caspar vacuums on Saturday is one where Chris cooks dinner on Sunday; this reading is obtained by having the *if*-clause restrict the deontic modal *have to*. But there is also a "two operator" reading where one says that if it were a given observation that Caspar vacuums on Saturday then one would

be able to conclude from that that Chris has the obligation to cook dinner on Sunday. This two operator reading can be obtained if one assumes that the *if*-clause restricts a covert epistemic necessity modal, which then in turn embeds the deontic necessity modal *have to*. In this reading, (35) would be essentially equivalent to a sentence with two nested overt modals:

(36)    If Caspar vacuums on Saturday, then Chris must have to cook dinner on Sunday.

(There are discussions of "iffy oughts"—that is, sentences combining *if*-clauses with deontic modals—, which might profit from considering the possibility of such an ambiguity. See for example, in the linguistic literatur: Frank (1996) and Zvolenszky (2002). In philosophy as well, deontic conditionals are of increasing interest, see for example Kolodny & MacFarlane (2009).)


### 6.1.3   More on epistemic conditionals

At various points, we have assumed that a resonable analysis of conditionals like (37) treats them as implicitly modalized with an epistemic necessity operator:

(37)    If Grijpstra played his drums, (then) de Gier played his flute.

Kratzer (1986, 2009) argues that this assumption can help solve a famous puzzle due to Gibbard (1981: 231). Consider this scenario:

> Sly Pete and Mr. Stone are playing poker on a Mississippi riverboat. It is now up to Pete to call or fold. My henchman Zack sees Stone's hand, which is quite good, and signals its content to Pete. My henchman Jack sees both hands, and sees that Pete's hand is rather low, so that Stone's is the winning hand. At this point, the room is cleared. A few minutes later, Zack slips me a note which says "If Pete called, he won", and Jack slips me a note which says "If Pete called, he lost".

The problem Gibbard saw with this example is that (i) both observers are entirely justified in saying what they're saying, neither is mistaken about anything, but (ii) the two sentences they utter are intuitively contradictory: it can't be that it is true that if Pete called, he won at the same time as it is

true that if Pete called, he lost. An obvious move to capture (i) is to say that the conditionals are epistemic conditionals and that each of them is about the respective speaker's epistemic state. But then it is hard to understand intuition (ii). Gibbard despaired of giving any account where conditionals express propositions and so took his puzzle as an argument for an NTV approach.

In recent work, much progress has been made on understanding the context-dependency of epistemic modals in the debate between relativist and contextualist accounts; see for example Egan et al. (2005), MacFarlane (2006), Stephenson (2007b), and von Fintel & Gillies (2007, 2008). One would then expect that integrating these insights into the analysis of epistemic conditionals might help understand the Sly Pete puzzle. This indeed what Stephenson (2007a) and Weatherson (2009) do within a relativist analysis of epistemic modality and what Kratzer (2009) does within a contextualist analysis based on von Fintel & Gillies (2007). This is not the place to adjudicate between these two approaches, but one can expect fireworks to continue in this domain.

## 6.2  Conditionals and tense & aspect

We will not be able to discuss the syntax of conditionals in this article (cf. Bhatt & Pancheva 2006) but we should take a look at the morphological fine structure of conditionals. It is quite apparent that in English at least, the indicative/subjunctive classification of conditionals is marked by tense & aspect morphology:

(38)   a.   If Grijpstra played his drums, de Gier played his flute.
       b.   If Grijpstra had played his drums, de Gier would have played his flute.

The earliest works taking the role of tense & aspect in the semantics of conditionals seriously came from Dudman (1983, 1984, 1988, 1989). Work on the interaction of tense and conditionals in philosophical logic includes Nute (1982, 1991), Slote (1978), Thomason & Gupta (1980), Thomason (1985). A more recent seminal contribution is Iatridou (2000). Since then there has been a proliferation of work on this topic; see Arregui (2005, 2007, 2009), Copley (2006), Ippolito (2007), Kaufmann (2005b), Schulz (2008), von Stechow (2007). Here, we can only introduce some basic facts and generalizations.

The central observation is that what is commonly called subjunctive in "subjunctive conditionals" is an additional layer (or two) of past tense morphology, no matter whether the referred to state of affairs is temporally located in the past, present, or future:

(39)  a.  If Roman comes to the party tomorrow, it will be a grand success.
      b.  If Roman came to the party tomorrow, it would be a grand success.
      c.  If Roman had come to the party tomorrow, it would have been a grand success.

(40)  a.  If Roman is at the post office now, he is missing the meeting.
      b.  If Roman were at the post office now, he would be missing the meeting.
      c.  If Roman had been at the post office now, he would have been missing the meeting.

(41)  a.  If Roman left before noon, he arrived in time.
      b.  If Roman had left before noon, he would have arrived in time.

Iatridou (2000) discusses this basic pattern (although she doesn't discuss the two layer pasts in future or present conditionals) and proposes that the additional past does not serve a temporal function. Instead, she argues that the past tense has a schematic semantics that can be applied both temporally and modally: past is an "exclusion feature", it marks that the topic set excludes the speaker set (the analysis is related to earlier ideas that the modal use of past relies on it being a marker of "remoteness", see for example Steele 1975, James 1982, and Fleischman 1989). When past is used temporally it marks the times talked about as distinct from the now of the speaker (an additional wrinkle is needed to explain why past means past rather than non-present = past or future). When past is used modally it marks the worlds talked about as distinct from the actual world of the speaker (this does not mean that modally used past is a counterfactuality marker; rather, the intent is to derive something very much like the Stalnaker-analysis of the import of subjunctive marking, see the discussion in Section 3.3 above).

The alternative to Iatridou's account is to try to maintain that the additional pasts in subjunctive conditionals do after all retain their usual temporal meaning. This idea goes back to Dudman (1983, 1984, 1988, 1989) and has been pursued by Ippolito (2003, 2007) and Arregui (2005, 2009), among others. We do not have the space to survey the details of these accounts. Let's rather look at a simplified sketch. Suppose that the extra layer of past

tense marks what the conditional quantifies over is a set of worlds that *were* accessible from the evaluation world at a past tense but may not be anymore. This is typically embedded in a branching futures version of possible worlds semantics. As the time index progresses, more and more open futures are precluded. Imagine that at some point in time, it was an open possibility that Roman would leave before noon, but by the present time it is settled that he did not. Then, assuming that the conditional employs a "historical necessity"-type of accessibility relation, the time index needs to be moved to the past to make sure that the domain of accessible worlds includes at least some worlds where he did leave before noon. Hence, the need for past tense marking on the modal (*would* = *will* + PAST) in *If Roman had left before noon, he would have arrived on time*; the past tense in the antecedent may be a mere agreement phenomenon.

What then about the indicative conditional in (41a)? Clearly, if we assume a historical necessity modal, at the time of utterance it is already settled whether Roman did or did not leave before noon. So, if there need to be at least some antecedent worlds in the domain of the modal, the covert modal in (41a) cannot be a historical necessity modal. Thus, it is not mysterious why (41a) is naturally analyzed as involving a (covert) epistemic necessity modal.

In this story, then, the difference between indicative and subjunctive is two-fold: (i) type of accessibility relation/type of modal (epistemic vs. historical), (ii) time index on the modal (present vs. past). An obvious question is whether these differences cross-cut: are there past epistemic conditionals? are there present historic necessity conditionals? The answer to the second question is possibly yes: *If Roman comes to the party tomorrow, it will be a grand success* might arguably be a non-epistemic conditional. The answer to the first question might be expected to be no, since it is well-known that epistemic modals resist embedding under past tense (cf. article 58 (Hacquard) *Modality*).

One possibly problematic fact for the view just sketched comes from hindsight counterfactuals (Barker 1998, Edgington 2003):

(42)    [A randomly tossed coin comes up heads.]
      a.   If you had bet on heads, you would have won.
      b.   If you bet on heads, you will win.

While (42a) seems acceptable and true after the coin has come up heads, there is no time in the past at which (42b) would have been rational to assert. While that doesn't mean that there wasn't a time at which the indicative conditional was true, it does throw some doubt on the simple idea that the only difference between (42a) and (42b) is the temporal perspective.

## 7 Further reading

Many references were given throughout this article. Here are some high-lighted readings. Indispensable classics are Stalnaker 1968 and Lewis 1973. Good overviews: Edgington 2007 and Bennett 2003. On disjunctive antecedents and related problems: van Rooij (2006) and Alonso-Ovalle (2009). On the syntax of conditionals: Iatridou 1991 and Bhatt & Pancheva 2006. On the contribution of *then*: Iatridou (1993). On the phenomenon of conditional strengthening: van der Auwera (1997a,b), Horn (2000), and von Fintel (2001a). On the psychology of conditionals: Oaksford & Chater (2003), Over & Evans (2003), and Evans & Over (2004).

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*Kai von Fintel, MIT, Cambridge (USA)*