Probability in Philosophy of Language

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Philosophers of language investigate foundational questions about the nature of linguistic communication. Much language that uses probabilistic vocabulary—in particular, what I'll call *the language of subjective uncertainty*—bears on these questions in important and distinctive ways. Better understanding how the language of subjective uncertainty works will help us get a better picture of the general features of communication and of the vehicles of communication.

Early analytic philosophers of language like Frege, Russell, and the Wittgenstein of the *Tractatus* were principally interested in mathematical language, where there is little need for probabilistic expressions. But in the middle of the twentieth century many philosophers of language began to pay attention to a wider variety of language uses. J. L. Austin, for example, opines that "It was for too long the assumption of philosophers that the business of a 'statement' can only be to 'describe' some state of affairs, or to 'state some fact', which it must do either truly or falsely" (1962, 1). On many recent views, when we communicate from a position of significant subjective uncertainty, we sometimes use language in a way that doesn't describe how the world is. The language of subjective uncertainty is, on such views, like the later Wittgenstein's primitive 'slab language' at least in that both are used to communicate without being used to describe.

Here is an example. Suppose Alice is curious about whether Bob won a deterministic raffle. I know that the raffle was fair, and that Bob purchased four of the hundred tickets that were sold. I might say

(1)   There's a 4% chance that Bob won the raffle.

I would thereby be communicating from a position of significant subjective uncertainty, and I (arguably) would not be trying to describe how the world really is. After all, I know that either (2) or (3) is the correct relevant *description* of the world:

(2)   Bob won the raffle.

(3)   Bob didn't win the raffle.

But because I don't know whether (2) or (3) is true, I fall back on the probabilistic, hedged language of (1). I am not trying to communicate the objective chance of Bob winning the raffle, since the raffle was deterministic, making the objective chance that Bob won either 0 or 1. We might instead say that I communicate something like an *estimate* of the truth value of (2).[1] But I am (arguably) not trying to describe or represent the world because there is (arguably) no way the world could be that would make the estimate that I communicate with (1) true or false.

What's at stake here? Prima facie, when we make sincere assertions we aim to represent how things are. But perhaps this isn't quite right, if the language of subjective uncertainty isn't in the business of representing the world. Similarly, many have thought it plausible that an important vehicle of communication—the 'content' of a sincere assertion—simply distinguishes between ways the world might be, or between ways the world might be thought to be, or between ways the world might be represented as being. But perhaps this isn't quite right, if these thoughts don't generalize to the language of subjective uncertainty. Disregarding the language of subjective uncertainty may encourage a distorted picture of the vehicles of communication.

Anticipating this dialectic, many theorists have claimed that the language of subjective uncertainty merely indicates something about the speaker's attitudes, signaling perhaps the "reservations to which [some statement] is subject" (AUSTIN 1962, 3). This kind of view often treats the language of subjective uncertainty as a sort of side comment that is semantically and syntactically isolated from the language on which it comments. But recent work has shown that the language of subjective uncertainty enters into extensive semantic and syntactic relations with other language. So the language of subjective uncertainty must be analyzed by any complete compositional (or largely compositional) semantic theory, and such a theory must account for the ways in which it interacts with other language. Because traditional compositional semantic theories traffic in propositions (as opposed to, say, probability spaces), this makes it more challenging to explain how and in what sense such language could be used to communicate subjective uncertainty without thereby describing the world. On the one hand, we want compositionality; on the other hand, we want vehicles of communication that successfully model the states associated with the language of subjective uncertainty. But it has long been unclear whether these two desires can be jointly satisfied.

In this article I take conditionals as a case study, to illustrate how philosophical thought on the language of subjective uncertainty has evolved. As I use the term, the language of subjective uncertainty includes conditionals, 'unless' claims, epistemic modals, epistemic comparatives, and so on, since speakers often use such expressions when communicating from positions of relevant subjective uncertainty. (By contrast, the use of probabilistic vocabulary to convey information about objective

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[1]On estimates of truth value, see JEFFREY 1986 and JOYCE 1998 and 2005.

chance or as a shorthand representation of relative frequencies is not of special interest to philosophers of language, and I leave such uses aside here.) Conditionals are the most instructive case to study because of the extensive literature discussing them. That literature has long taken into account both arguments that the content or semantic value[2] of conditionals must be non-propositional, and arguments that conditionals interact with other linguistic items in systematic ways. At the end of the article I return to the language of subjective uncertainty more broadly construed.

1   Some background on conditionals

While it is difficult to draw precise distinctions here, it is helpful to call conditionals like (4) *indicative*, and conditionals like (5) *subjective* or *counterfactual* (ADAMS 1970, 90).

(4)   If Oswald did not kill Kennedy, then someone else did.

(5)   If Oswald had not killed Kennedy, then someone else would have.

Clearly there are important semantic differences between (4) and (5). Most people familiar with the Kennedy assassination believe (4). By contrast, only those who believe there were backup assassins believe (5). So there is some important distinction between 'indicative' conditionals like (4) and 'subjunctive' conditionals like (5), even though many conditionals are difficult to classify as falling on one side or the other.

Conditionals are interesting for a host of reasons. They help us communicate not about how things actually are, but about how things are (or would be) *under some supposition*. And communicating about how things are (or would be) under a particular supposition is incredibly useful. It is difficult to do much deciding, planning, and coordinating without using conditionals; similarly it is difficult to do much work in philosophy without using conditionals or closely related constructions. Most importantly for present purposes, however, probability—and in particular conditional probability—seems intimately connected to indicative conditionals. Frank Ramsey articulated this thought in a way (now known as 'the Ramsey test') that connects it back to supposition:

> 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; .... We can say they are fixing their degrees of belief in q given p. (1931, 155)

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[2]The literature isn't as clear as it should be on the distinction between content and semantic value, although I don't have space to take up the issue here. See YALCIN 2014 for a helpful discussion of this distinction.

Ramsey's phrase "degrees of belief in q given p" is somewhat ambiguous. That said, Ernest Adams articulates one extremely influential reading:

> …*the probability of an indicative conditional of the form "if A is the case then B is" is a conditional probability.* [In other words]…the probability of "if A then B" should equal the *ratio* of the probability of "A and B" to the probability of A…(1975, 3)

While the idea of connecting indicative conditionals to conditional probabilities is prima facie very attractive, it has proven surprisingly difficult to spell out the details.

Sections 2 through 5 consider four families of analyses of indicative conditionals like (4). According to the first two families of analyses, these conditionals have truth conditions. But only on the first are they truth-functional—that is, only on the first are their truth values wholly determined by the truth values of their antecedents and consequents. Analyses in the second family try to connect indicative conditionals to conditional probability, giving them non-truth-functional truth conditions. The third and fourth families of analyses deny that indicative conditionals have truth conditions, but differ in the ways in which they account for apparent semantic compositionality. All the analyses I consider aim to capture the apparent connection between natural language conditionals and conditional probability. The different ways in which the analyses try to do this constitute different ways of thinking about the general features of communication and about the vehicles of communication.

2   Truth-functional theories

It is generally agreed that *if* the natural language indicative 'if' is a truth-functional connective, then it is the material conditional—true if the antecedent is false, the consequent is true, or both; false otherwise.[3] A naïve material conditional analysis predicts the truth of odd conditionals like

(6)   If the moon is made of cheese, then I had oatmeal for breakfast.

But since some true sentences aren't appropriately assertible, (6) might sound strange because it is misleading, or conversationally infelicitous in some other way.

The canonical starting point for approaches in this family is Paul Grice's argument that when a speaker uses the indicative conditional she conversationally implicates "that there are non-truth-functional grounds for accepting $p \supset q$" (1987, 58, originally delivered in 1967; see also THOMSON 1990). Those grounds might be something like

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[3]See, e.g., EDGINGTON 1995, 242–243. GIBBARD 1981, 234–235 argues that if indicative conditionals have truth conditions then those truth conditions must be those of the material conditional; see KRATZER 1986 and GILLIES 2009 for responses.

"*p* would, in the circumstances, be a good reason for *q*" or "*q* is inferable from *p*". (6) is odd because there aren't such grounds for it.

On David Lewis's elaboration of Grice's theory, the assertibility of "If *p*, *q*" comes in degrees. That assertibility is equal to the subjective probability of *p* ⊃ *q* minus a discounting factor, which is the product of two other factors: the probability of the conditional's vacuity (due to the falsity of the antecedent) and the probability of the consequent's falsity conditional on the antecedent's truth (Lewis 1976, 142–143; cf. Lewis 1973, 72). In other words, Lewis holds that the assertibility of "If *p*, *q*" is equal to

$$P(p \supset q) - P(\neg p) \cdot \frac{P(\neg q \wedge p)}{P(p)}$$

which just is the conditional probability of *q* on *p*. This connection between assertibility and conditional probability is very attractive.[4]

Frank Jackson criticizes Grice's approach and Lewis's elaboration of it on several grounds. Most importantly for our purposes, he argues that it may be better to assert the *weaker* claim *W* even if *W* is equiprobable to the stronger (and no more prolix) claim *S*. In particular, if *W* is more likely than *S* to prove useful as new information comes in, then there might be greater expected value to asserting *W* rather than *S*. In his 1979 Jackson calls *P robust* with respect to *I* iff the probability of *P* and the conditional probability of *P* on *I* are "close and high" (6), and argues that while "High probability is an important ingredient in assertibility … so is robustness" (12). Jackson argues that the indicative conditional "signals robustness with respect to its antecedent" (12) because an indicative conditional that wasn't robust with respect to its antecedent wouldn't be useful for *modus ponens* (13). And if the robustness of a material conditional *p* ⊃ *q* with respect to *p* is high, then so is the conditional probability of *q* on *p* (15). So again, an indicative conditional is assertible only if the probability of its consequent conditional on its antecedent is high.[5]

One problem with the truth-functional approach is that it

> …yields counterintuitive results for sentences containing conditionals as constituents. For example, it tells us that the following is a tautology:
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>> (If A, B) or (if not-A, B).

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[4]Note, however, that Lewis isn't saying (with Adams) that "the probability of an indicative conditional of the form 'if *A* is the case then *B* is' is a conditional probability" (1975, 3). The next section discusses Lewis's reasons for abandoning the notion of the "probability of an indicative conditional" altogether, and instead talking of "assertibility." For illuminating criticism of Lewis's 1976 approach, see Appiah 1985, 177–181.

[5]Lewis refines Jackson's story somewhat, and endorses the refined story: see the postscript to his 1976.

> So anyone who rejects the first conditional must, on pain of contradiction, accept the second. So if I reject the conditional 'If the Conservatives lose, Thatcher will resign', I am committed to accepting 'If the Conservatives win, Thatcher will resign'! (EDGINGTON 1991, 187)

The essence of the problem here is that we want a theory that handles indicative conditionals well whether or not they are asserted. But theories that are based on conversational implicature do not straightforwardly generalize to non-assertive settings, like the individual disjuncts of a disjunction. While this is a serious problem, recent work in linguistics suggests that it may not be insuperable. That work argues that implicatures can occur in non-assertive settings, and develops explanations of the relevant data (see CHIERCHIA et al. 2012 for a helpful recent survey). No one has yet tried to extend such explanations to conditionals, and there isn't space for an exploration of the possibility here. Moreover, it's very unlikely that such explanations would help with other expressions in the language of subjective uncertainty.

The truth-functional theories sketched in this section aim to establish a link between assertibility and conditional probability. But because these analyses make a sharp distinction between the probability of the proposition expressed by a conditional and the probability of its consequent conditional on its antecedent, they need to explain assertibility in pragmatic terms. In other words, these analyses aim to unite conditional probability and meaning, but aim to effect that unification through an amalgam of pragmatically and semantically conveyed content. This hybrid approach makes it difficult (though perhaps not impossible) to secure compositionality.

3   Truth-conditional semantics and conditional probability

Robert Stalnaker's 'selection function' analysis is expressly intended to "make the transition from belief conditions to truth conditions; that is, to [provide] a set of truth conditions for statements having conditional form which explains why we use [the Ramsey test] … to evaluate them" (1968, 44–45; see also his 1970). In particular, Stalnaker attempts to link semantic meaning, in the form of truth conditions, and conditional probability. One aspect of his analysis that is crucial to this aim is the validity of

Conditional excluded middle: Either if a, c, or if a, $\neg c$.[6]

The validity of this principle is intended to reflect the fact that $P(c|a) = 1 - P(\neg c|a)$.

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[6]Other 'modal' analyses, like C. I. Lewis's strict conditional analysis (1918, 1932) and David Lewis's variably strict conditional analysis (1973), do not validate this principle, and so do not impute a logic to conditionals that reflects the logic of conditional probability.

A truth-conditional semantics for conditionals that would explain the connections between conditionals, supposition, and conditional probability would unite a wide range of otherwise distant looking domains. Alan Hájek writes that if 'Stalnaker's Thesis' were true—that is, if it were true that the probability of a conditional equaled the corresponding conditional probability in any probability space that modeled a rational agent's credences[7]—then "logic, probability theory, and Bayesian epistemology would all be enriched" (2011, 6). One might add that philosophy of language, formal semantics, and pragmatics would also be enriched, since we can read Stalnaker as trying to integrate formal epistemology—in particular, the dynamics of credal states—into truth-conditional semantics. This is because, as he puts it, the essential innovation in his semantics for conditionals is meant in part to "represent …methodological policies" governing "how I would revise my beliefs in the face of a particular potential discovery" (STALNAKER 1970, 80; cf. STALNAKER 1984, 115–116; 119–120).

But David Lewis's renowned 'triviality results,' and the many subsequent variations on them, make it notoriously hard to say whether this goal is attainable. Lewis argues that "there is no way to interpret a conditional connective so that, with sufficient generality, the probabilities of conditionals will equal the appropriate conditional probabilities" (1976, 135). Of course, little is ever uncontroversial in philosophy: some resist Lewis's results, while others generalize and strengthen them.[8] Here is one perspicuous Lewis-style triviality proof, adapted from BLACKBURN 1986, 219:

$$P(a \Rightarrow c) = P\big(c \wedge (a \Rightarrow c)\big) + P\big(\neg c \wedge (a \Rightarrow c)\big) \tag{1}$$

$$= \big(P\big((a \Rightarrow c)|c\big) \times P(c)\big) + \big(P\big((a \Rightarrow c)|\neg c\big) \times P(\neg c)\big) \tag{2}$$

$$= \big(P\big(c|(a \wedge c)\big) \times P(c)\big) + \big(P\big(c|(a \wedge \neg c)\big) \times P(\neg c)\big) \tag{3}$$

$$= \big(1 \times P(c)\big) + \big(0 \times P(\neg c)\big) \tag{4}$$

$$= P(c) \tag{5}$$

For the move from (1) to (2) it suffices that $\frac{P(a \wedge c)}{P(a)} = P(c|a)$, so $P(a \wedge c) = p(c|a) \times P(a)$. For the move from (2) to (3) it suffices that $P\big((a \Rightarrow c)|b\big) = P(c|a \wedge b)$—intuitively, that there's no difference between the probability of 'If b, then if a then c' and 'If a and b, then c.' But if (5) is true—if the probability of 'If a, then c' just is the probability of c—then the probability of the conditional is completely trivialized. Results of this

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[7]As I discuss later, Stalnaker came to reject this thesis; the name for it has nevertheless stuck. It also sometimes goes by 'CCCP'—the "conditional construal of conditional probability" (HÁJEK & HALL 1994) and sometimes by 'Adams' Thesis.' (Some theorists, however, reserve 'Adams' Thesis' for the claim that the *assertibility* of a conditional equals the corresponding conditional probability.)

[8]See section 6 of EDGINGTON 1995 and HÁJEK 2011 for overviews of the literature.

ilk led Stalnaker to reject 'Stalnaker's Thesis,'[9] and led Lewis to endorse the theory of indicative conditionals sketched in the last section.

Here is another important problem for the project of integrating probability theory into truth-conditional semantics, due to Allan Gibbard. Suppose that

> 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." I know that these notes both come from my trusted henchmen, but do not know which of them sent which note. I conclude that Pete folded. (1981, 231)[10]

As Gibbard points out, analyses of conditionals like Stalnaker's "share a law of *Conditional Non-contradiction*: that $a \rightarrow \bar{b}$ is inconsistent with $a \rightarrow b$" (231). But if Zack and Jack have contradicted each other, then one of them must have said something false. Intuitively, though, neither has said anything false; indeed the formation of the beliefs they express on their notes looks impeccable. Gibbard concludes that to save analyses like Stalnaker's we must posit "radical dependence" of the semantic value of conditionals on the "utterer's epistemic state" (234)—something that "the audience does not know" (233). Stalnaker (1984, 109–111) and others—including the influential linguist Angelika Kratzer (1986, 655) and many influenced by her—embrace this kind of context sensitivity and try to explain how we can accept that "conditionals [are] too closely tied to the epistemic states of the agents who utter them for those conditionals to express propositions which could be separated from the contexts in which they are accepted" (STALNAKER 1984, 111).[11]

A full assessment of analyses like these is beyond the scope of this article. Suffice it to say that for conditionals, at least, the goal of tightly connecting probability and truth-conditional semantics is not obviously attainable. We should see what would happen if we were to leave truth conditions behind, thinking of the vehicles of communication in some other way.

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[9]See ROTHSCHILD forthcoming for an interesting recent attempt to save a restricted form of Stalnaker's Thesis.

[10]EDGINGTON 1997, 107 gives a nice way to set up Gibbard cases in which the people playing the roles of Zack and Jack are epistemically on a par.

[11]See especially STALNAKER 2011, 242–244; see also his 2005.

4 Non-compositional non-truth-conditional theories

On Dorothy Edgington's 'conditional assertion' analysis, the indicative conditional " 'If A, B' is an assertion of B when A is true, and an assertion of nothing when A is false" (1995, 290).[12] Whether a conditional has a truth value, according to Edgington, depends at least in part on whether its antecedent is true: "my conditional assertion is true if A and B are both true, and false if A is true and B is not, and has no truth value when A is false." She holds that belief in a conditional is a "conditional belief" and hence "not belief that something is true" and also "not belief that [something] is not false." Rather, "Belief that if A, B is a conditional belief that it is true given that it has a truth value" (290). But the degree of belief in the closely related belief "that 'If A, B' is true, given that it has a truth value, is just $b(A\&B)/b(A)$," vindicating a version of the thesis that one's degree of belief in B if A equals one's conditional probability of B on A (290, 262–263).

Another influential non-truth-conditional theory of indicative conditionals goes back to Ernest Adams' 1965, 1966, and 1975 (see also JEFFREY 1964 and ELLIS 1973). While Adams makes some allusions to conditional assertion (see especially (1965, 196)), conditional probability is foremost in his theory, and Adams doesn't flesh out any connections between the two notions. Adams sidesteps Lewis's triviality results by holding that conditionals are sometimes neither true nor false (7): "it is hopeless to hunt for the 'right' truth conditions for conditionals … if it is also required that truth-conditional soundness should closely approximate probabilistic soundness" (5). But Adams doesn't aspire to give a general compositional semantics for indicative conditionals. He focuses instead on patterns of reasoning, motivation, and action. Indeed, he sees his approach as "largely independent" of concerns about "Speech Acts, … language and communication" (1975, 71).

Aspects of Adams' theory were taken up by many theorists more directly concerned with natural language, however. Gibbard, for example, writes that any account of communication based on mutual intention recognition, in the spirit of GRICE 1957, "will extend naturally to communication of conditional belief" without requiring that "conditional beliefs must be communicated by means of conditional propositions."

> In felicitous cases, I utter an indicative conditional, and thereby insure that the audience comes to accept that I have a certain conditional belief, belief in b given a. The audience does so because it trusts my sincerity and command of language. The audience then infers from my believing b given a that I have some good grounds for so believing, and takes that as a reason for itself believing b given a. (1981, 230)

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[12]For a fascinating history of conditional assertion views, see MILNE 1997, 197–212. See also EDGINGTON 2008, which develops a conditional assertion account of counterfactuals.

Note that on Gibbard's account, the audience takes the speaker's utterance as evidence that the speaker has good grounds for believing *b* given *a*. To the extent that the audience believes the speaker is epistemically well-placed, the audience then has grounds for believing *b* given *a*. Such views are sometimes called 'expressivist,' on the grounds that the force of the speaker's utterance is an *expression* of her own conditional belief. If the utterance secures 'uptake' in the audience, that is in part thanks to the audience making inferences about the speaker's grounds for believing what she expresses. Note also that the "command of language" essential to Gibbard's explanation is simply that the speaker and audience associate the conditional belief in *b* given *a* with "If *a*, *b*."

What happens when a conditional occurs in an embedded linguistic context?

> Either we need new semantic rules for many familiar connectives and operators when applied to indicative conditionals—perhaps rules of truth, perhaps special rules of assertability like the rule for conditionals themselves— or else we need to explain away all seeming examples of compound sentences with conditional constituents. (Lewis 1976, 142)

Gibbard takes the second horn of this dilemma, arguing that many embeddings of conditionals don't make sense, and that every embedding that *does* make sense is "explainable in an *ad hoc* way" (1981, 238). For example, Gibbard argues that sometimes indicative conditionals have an "*obvious basis*: a proposition *c* such that it is presupposed, for both utterer and audience, that [the utterer] will believe the consequent iff he believes *c*" (237). In such cases, Gibbard suggests, we interpret the embedded conditional as if it simply expressed its 'obvious basis.' For example, we might interpret

(7)   If the cup broke if dropped, then it was fragile.

as

(8)   If the cup was disposed to break on being dropped, then it was fragile.

Gibbard and other advocates of non-truth-conditional analyses are clear that they do not have a general theory of embedding to offer (Adams 1965, Edgington 1995, 284). But Gibbard suggests that if ad hoc explanations suffice where embedding *is* possible, then this is not a significant cost.

Such ad hoc explanations—and the need to appeal to them in the first place— leave most linguists and an increasing number of philosophers of language dissatisfied. For example, the influential semanticist Kai von Fintel writes that accounts like Adams', Gibbard's, and Edgington's have had "no impact at all in linguistic work on natural language semantics" (2009, 14). The lack of impact is due to the fact that such accounts abandon compositionality, and so need *lots* of ad hoc explanations. Such

explanations are often very difficult to assess. For example, Edgington discusses (9), which has a quantifier scoped over a conditional, at length:

  (9)   There is a boy in my class who, if I criticize him, will get angry. (KÖLBEL 2000, 105)

After considering and rejecting several ways in which one might paraphrase (9), she writes that "we are free to construe it … as saying something along the following lines":

  (10)   There is a boy in the class such that, on the supposition that I criticize him, he will get angry. (2000, 114)

Suppose for sake of argument that this is a successful paraphrase of (9). What has been gained by offering it? Semanticists would say that the paraphrase does nothing to help us analyze (9) unless we have a detailed analysis of (10) itself. And while Edgington does describe credal states that she thinks typically accompany sincere assertions of (9), this is not to offer a semantic value for (9), let alone for the expressions in it. For her part, Edgington would respond that the meaning of 'if' is not explained via semantic value, but rather by the respects in which conditional assertion differs from assertion simpliciter. It would be helpful, though, to know more about how speech acts and semantic values are supposed to interact in (9). Do speakers use (9) to make a conditional assertion? One might think not; (9) and its putative paraphrase seem to be used to assert something about a boy in the class. But then it seems that there isn't anything distinctive about the conditional assertion account of sentences like (9), leaving us no better off than we were with truth-conditional analyses.

Stepping back a bit: according to conditional assertion accounts, what sort of vehicle of communication is associated with a conditional varies depending on whether the antecedent of the conditional is true. That's what it is for an assertion to be conditional: the assertion of the consequent is made if and only if the antecedent is true; otherwise we have "an assertion of nothing" (EDGINGTON 1995, 290). The act of uttering a conditional can be helpful to communication whether or not the antecedent is true, however.

> I say to you "If you press that switch, there will be an explosion". As a consequence, you don't press it. Had I said nothing at all, let us suppose you would have pressed it. A disaster is avoided, as a result of this piece of linguistic communication. It is not as if nothing had been said. This is no objection to the idea that I did not (categorically) assert anything. For let us suppose that I am understood as having made a conditional assertion of the consequent. My hearer understands that if she presses it, my assertion of the consequent has categorical force; and, given that she takes me to be trustworthy and reliable, if it does acquire categorical

> force, it is much more likely to be true than false. So she too acquires
> reason to think that there will be an explosion if she presses it, and hence
> a reason not to press it. (EDGINGTON 1995, 289)

Like truth-functional theories, then, Edgington's theory treats the vehicles of communication as an amalgam of semantically conveyed and pragmatically conveyed content. As with truth-functional analyses, compositionality is a challenge for this sort of approach but not clearly an insuperable challenge. I think it is fair to say, however, that the prospects for making conditional assertion analyses compositional are more dim than they are for truth-functional analyses. This is because the case for grammaticalized speech acts is much weaker than the case for grammaticalized implicatures.

5   Compositional non-truth-conditional theories

The last option to consider is the development of compositional semantic theories delivering vehicles of communication that, unlike truth conditions, directly represent probabilities and relationships between probabilities. But while conditionals help motivate this approach—and are, again, perhaps the most historically important motivation for it—they are just one motivation of many. After all, we also want to analyze sentences like our earlier

(1)   There's a 4% chance that Bob won the raffle.

So in developing a positive account, it's important to step back and think about the language of subjective uncertainty in a more general way. This perspective will help us explore ways of theorizing about conditionals that generalize to other expressions of subjective uncertainty.

It's also important to see that a dialectic similar to the one discussed for conditionals applies to the explicitly quantitative parts of the language of subjective uncertainty, even though its development in the literature is less extensive and more recent. Suppose, for example, that we tried to give a truth-conditional analysis of a sentence like (1). We might treat it as elliptical for (11):

(11)   I believe that there's a 4% chance that Bob won the raffle.

But this approach seems to attribute the wrong subject matter to (1)—(1) simply isn't about the speaker's psychological state (BENNETT 2003, 90; see also YALCIN 2011). It also seems to mischaracterize the intended effect of (1), leading to the prediction that I can believe you when you assert (1), while being sure that Bob didn't win the raffle. It's more promising, I think, to appeal to a less subjective notion of evidential

probability—perhaps that developed in Williamson 2000—and then to analyze (1) as elliptical for

(12)   The evidential probability that Bob won the raffle is 4%.

Such accounts are plausible only if typical speakers have the appropriate kind of epistemic access to evidential probabilities in any situation in which they can appropriately use the language of subjective uncertainty. I'm skeptical of the thought that they do, but I don't have space to discuss the issue in depth here.

Another kind of account takes the operator 'There's a 4% chance that' in (1) to indicate that the way in which the speaker puts forward the proposition that Bob won the raffle is attenuated.[13] Such 'force modifier' approaches have had many advocates in philosophy and in linguistics over the years, but like the non-truth-conditional theories considered earlier, they have trouble with embedding. It is particularly difficult to see how to generalize force modifier accounts to Quine's "third grade of modal involvement" (1953): sentences in which a quantifier takes scope over a modal operator. In this case, it is difficult to see how force modifier accounts can handle a quantifier scoped over an expression of subjective uncertainty (for discussion, see Swanson 2006, 61 and Swanson 2010).

In sum, truth-conditional analyses of the quantitative language of subjective uncertainty look problematic, and so do non-compositional analyses. The remaining corner of logical space—compositional analyses that aren't truth-conditional—includes many different kinds of analyses. Some, like dynamic semantics, have much to say about conditionals, but at this point there is little work tying such approaches to probability.[14] For this reason, and because space is limited, I move directly to a compositional approach that is designed from the outset to interface well with probability.

The interpretation functions of constraint semantics takes declarative sentences not to propositions but to *constraints* (Swanson 2006 and forthcoming; Yalcin 2007 and 2010; Moss forthcoming). Intuitively, a constraint is a characterization of states an addressee could be in that are compatible with a sentence. For example, if we did not want to be realists about tastiness, we might say that the constraint associated with 'Artichoke hearts are tastier than broccoli' is the set of gustatory preferences according to which which artichoke hearts are ranked higher than broccoli. On this application of the constraint semantic framework, when a speaker says that artichoke hearts are tastier than broccoli, she advises her addressees to have gustatory preferences that conform to the constraint that artichoke hearts are ranked higher than broccoli. To effect the move to constraints compositionally, other semantic types are changed as well. For example, in an intensional semantic theory, the meaning of a predicate like

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[13]See, e.g., Toulmin 1950, Lyons 1981, Forrest 1981, Price 1983a and 1983b, and Yalcin 2005; see Swanson 2010 for more citations.

[14]Yalcin 2012 starts to develop such connections.

'is tall' is often modeled as a function that takes an individual concept and yields a proposition. In an intensional constraint semantics, the meaning of 'is tall' would be modeled as a function that takes an individual concept and yields a constraint (SWANSON 2006, 50–51).

When we apply constraint semantics to the language of subjective uncertainty, we need constraints on credal states. For example, the constraint associated with

(1)   There's a 4% chance that Bob won the raffle.

is the set of credal states that assign credence 0.04 to the proposition that Bob won the raffle. To say that Alice believes that there is a 4% chance that Bob won the raffle is to say that Alice's credal state is an element of the constraint associated with (12). This kind of approach sets itself apart from 'force modifier' accounts by securing compositionality below the clausal level. But to do this, constraint semantics must appeal to a function that takes a set of constraints and yields "the constraint associated with the disjunction of sentences that express those constraints" (SWANSON forthcoming, 14). The precise characterization of this function is not a project for semantics or philosophy of language—just as, say, the precise characterization of the semantic value of 'justice' is not a project for semantics or philosophy of language. Rather, just as ethicists and social and political philosophers work to improve our understanding of justice, formal epistemologists work toward improving our understanding of the functions that constraint semantics should deploy. What's important to see, on the side of philosophy of language, is that a compositional semantic theory can *accommodate* a wide range of characterizations of this function and of other functions that are important to the language of subjective uncertainty.

With this overall picture in mind, let's return to our discussion of conditionals. While I do not mean to take a stand on whether this is the *right* analysis of simple conditionals like (4), constraint semantics can easily accommodate the thought that the meaning of such conditionals is tightly tied to conditional probability.

(4)   If Oswald did not kill Kennedy, then someone else did.

It is straightforward, for example, to write a constraint semantic entry for 'if' on which the semantic value of (4) is the set of probability measures in which the probability of someone else having killed Kennedy, conditional on Oswald's not having killed Kennedy, is 1 (SWANSON 2006, 38, 67–69).[15] A theorist who thinks conditional probability comes apart from belief in conditionals—a theorist convinced, for example,

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[15]One such entry would 'reverse engineer' the propositions targeted by the constraints associated with the conditional's antecedent and consequent, respectively. Then it would yield the constraint according to which the probability of the proposition associated with the antecedent is equal to the probability of the conjunction of that proposition and the proposition associated with the consequent, thus making the probability of the consequent conditional on the antecedent 1. It's also possible to give a less demanding analysis, on which the relevant conditional probability must meet or exceed some threshold less than 1.

by the relevant arguments in MᴄGᴇᴇ 2000 or Kᴀᴜғᴍᴀɴɴ 2004—would give 'if' a different constraint semantic entry. Arguably there is even a sense in which we would want *both* semantic entries: one for highly idealized language users, who are in particular unusually adept conditionalizers, and another designed to match the judgments of most actual language users. But once the favored characterization of the circumstances in which one believes a conditional is complete, we can write a constraint semantic entry to match that characterization. Similarly, it isn't obvious what constraint should be associated with embeddings of conditionals. Many have despaired, for example, in the face of Gibbard's

(13)   If Kripke was there if Strawson was, then Anscombe was there.

Gibbard asks us to imagine being told this "of a conference you don't know much about," and asks, rhetorically, "Do you know what you have been told?" (235).[16] But because constraint semantics can accommodate many different characterizations of the semantic contribution of 'if', we are free to explore a wide range of possible characterizations and see which work best.

In a slogan: the need for a compositional semantic theory is neither a bar nor a guide to the task of characterizing complex credal and doxastic states. This slogan does exaggerate a bit. A simpler or more elegant semantic entry might be preferable to another entry for some purposes—for example, for modeling *how* humans understand language, as opposed to representing linguistic competence at a more abstract level. Moreover, finding the right roles for semantics and pragmatics (and the right balance between them) will eventually be important as well. But much work in formal epistemology is necessary first. The payoff of incorporating such work into the constraint semantic framework would be a compositional semantics for a natural language that would connect the semantic value of declarative sentences to credal states in a very direct way.

6   Conclusion

The approaches surveyed here differ greatly in how they see the relationship between philosophy of language and linguistics, on the one hand, and formal epistemology on the other. Non-truth-conditional theories aim to make the vehicles of communication resemble the models of credal states developed by formal epistemologists. Truth-conditional theories don't have this aim. And cross-cutting the distinction be-

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[16]This conditional is doubtless hard to interpret in many contexts. To see that it is interpretable, imagine that Kripke goes to a conference that Strawson goes to only if Kripke thinks it's an important conference. Then (13) might be used to say that Anscombe goes to every conference that Kripke thinks is important. For an interesting recent discussion of embedded conditionals, see Sᴇɴɴᴇᴛ & Wᴇɪsʙᴇʀɢ 2012.

tween truth-conditional and non-truth-conditional approaches, different theorists put differing emphases on the importance of compositionality.

The door is not shut on any of these approaches. But there has been a recent push toward compositional non-truth-conditional theories of the language of subjective uncertainty. Many factors have contributed to this push, including the recent surge of interest in epistemic modals (see the papers in EGAN & WEATHERSON 2011 for an overview). But two factors are especially likely to make this trend last. First, philosophers of language are increasingly aware of and concerned by the phenomena that make compositionality so important to semanticists and other linguists. Second, the data philosophers of language aspire to explain increasingly seem to demand collaborative work with formal epistemologists. This kind of work is facilitated by frameworks that, like constraint semantics, allow the representations of credal and doxastic states developed by formal epistemologists to be incorporated into compositional semantics.

Successes in this framework would enrich our perspective on the questions about the general features of language with which we began. If we think of linguistic communication as fundamentally a matter of describing the world, then it is natural to think that the vehicles of communication must be truth-apt. But the difficulties involved with analyzing the language of subjective uncertainty give us some reason instead to think of linguistic communication as a way of advising others about features of our perspective on the world.

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