

Conditional Probability

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Edgington gives an intuitive account of what it is to believe or be more or less confident that *if A, B*: “A person’s degree of confidence in a conditional, *if A, B*, is the conditional probability he assigns to *B* given *A*.”¹ Her account is based on Adams’ technical thesis that the conditional probability of *B* given *A* is equal to the probability of *A* & *B* divided on the probability of *A*:

Adams’ thesis

$$Pr(B/A) = Pr(AB)/Pr(A)$$

Adams’ account of conditional probability has found more or less universal support from researchers on conditionals as an adequate expression of the conditions of assertability for indicative conditionals. However, there are various positions with respect to the relation between these conditions of assertability and any conditions of truth or absolute probability.

Lewis claims to demonstrate that Adams’ definition of conditional probability cannot serve as a definition of truth conditions or (absolute) probability of truth. Hence Lewis initially supported a modified version of the so-called Equivalence thesis. According to this thesis, the corresponding material conditional gives the truth conditions of the conditional. The assertability, however, is regulated in accordance with a modified version of Grice’s maxim of asserting the stronger statement, which again supposedly is given an exact expression in Adams’ thesis. Jackson showed that Lewis’ account lacked explanatory power, and proposed an explanation of Adams’ thesis built on a general intuitive notion of robustness, an account that Lewis subsequently preferred to his own earlier account.

Edgington, on the other hand, finds the arguments against truth functionality for conditionals convincing. She also maintains that any plausible account of conditionals must accept Lewis’ debunking of conditional probability as an expression of the truth

¹ Edgington (1991), p. 188.

conditions of conditionals. Thus she claims that conditionals do not have truth conditions. Instead, she defends Adams' thesis as a plausible account of the conditions of *belief* in conditionals. She sets out to do so by first giving an intuitive account of our degree of belief in a conditional. On Edgington's intuitive account, in order to assess how probable it is that *if A, B*, one assumes *A*, ignoring the possibility of *not-A*, and considers how probable it is that *B* under this assumption. This means that someone will judge it likely that *if A, B* to the extent that they judge *A&B* to be nearly as likely as *A* and more likely than *A and not-B*. But according to Edgington, this should not be understood as a reductive account of conditionals:

...the ratio must not be taken as a reductive definition of the conditional probability, as though one first had to ascertain how probable it is that *A* and that *A&B*, and then divide the second by the first. Typically, one does not have to decide how likely it is that *A* in order to judge that *B* is likely given *A*.²

On our view, however, this reductive account is in fact part of Adams' thesis for conditional probability, as will be argued in this paper. This means that if Edgington's intuitive account is not supposed to involve such a reduction, it cannot coincide with Adams' technical thesis. Thus we will finally argue that the discrepancy between Edgington's intuitive account and Adams' thesis should be understood as an indication that Adams' thesis does not hold: We will show that neither truth, assertion, belief nor probability conditions of conditionals are given by Adams' thesis.

The first and second paradox of material implication

The account of conditionals in terms of probability is thought as an alternative to the truth functional account, where the truth conditions of a conditional *if A, B* are defined according to the material conditional $A \supset B$. A conditional is then true when *A* is false or *B* is true, and false only in those cases where *A* is true and *B* is false. This truth functional account generates some paradoxical results:

First paradox of the material implication

$$\neg A \supset (A \supset B)$$

² Edgington (1991), p. 188.

Edgington presents this paradox by sketching a scenario of an opinion poll just before an election. The subject can answer ‘Yes’, ‘No’ or ‘No opinion’ in accordance with his beliefs about the propositions in the survey. A person can then be consistent in his beliefs and still give truth functionally inconsistent answers, as for instance is shown by the following responses:³

- | | |
|--|-----|
| 1. The Labour Party will win (L) | No |
| 2. The Labour Party won’t win ($\neg L$) | Yes |
| 3. Either the Labour Party won’t win or _ ($\neg L \vee _$) ⁴
(Fill in the blank as you will.) | Yes |
| 4. If the Labour Party wins, the National Health Service
will be dismantled by the next government (<i>If L, N</i>) | No |

This paradox is resolved by replacing the truth functional account with the account of conditional probability. This follows since to judge a material conditional $A \supset B$ probable is to judge $A \& \neg B$ improbable, while to judge it conditionally probable that *if A , B* is also to judge $A \& \neg B$ less probable than $A \& B$. So according to Adams’ thesis of conditional probability, “ X believes that (judges it likely that) *if A , B* , to the extent that he judges that $A \& B$ is nearly as likely as A , or roughly equivalently, to the extent that he judges $A \& B$ to be more likely than $A \& \neg B$.”⁵ In the opinion poll above, our subject, in considering whether *if L , N* , assumes L , ignoring the possibility of *not- L* , and asks how likely it is that N . The answer he gets is ‘very unlikely’. And as mentioned above, Edgington maintains that one does not have to know or consider how likely it is that L in order to judge how likely it is that N *given L* :

I may have given no thought to the matter of how likely it is that the Labour Party will win yet be confident that if they win public spending will increase; this latter confidence entails confidence that, however likely it is that they win, it is nearly as likely that (they win and public spending increases). The non-reducibility is particularly obvious when, as part of some practical reasoning, one considers conditionals of the form ‘If I do x , such-and-such will happen.’ It would be absurd to hold that I have to know how likely it is that I will do x before I can assess such a conditional.⁶

³ Edgington (1991), p. 182.

⁴ It seems odd to believe a disjunction to be true only based on the belief in one of the disjuncts. Would someone for instance believe that ‘Either the Labour Party won’t win or I throw myself off this bridge’, just because he believes that the Labour Party won’t win?

⁵ Edgington (1991), p. 188, and Edgington (1995), p. 263.

⁶ Edgington (1991), pp. 188-189.

Adams' thesis then seems to prohibit the occurrence of the first paradox of the material implication. At least as long as the absolute probability of $Pr(A \& B)$ is not playing any direct role in the calculation, that is, if the conditional probability is more or less directly accounted for on the basis of an estimation of the *relation* between $Pr(A \& B)$ and $Pr(A)$. However, another paradox still remains:

Second paradox of the material implication

$$B \supset (A \supset B)$$

By means of a second opinion poll, Edgington demonstrates that this paradox is equally problematic as the first paradox:

5. The Conservative Party will win (C) Yes
6. Either ____ or the Conservative Party will win ($_ \vee C$)⁷ Yes
(Fill in the blank as you like)
7. If a horrendous scandal emerges involving the Prime Minister and most of the Cabinet, the Conservative Party will win (*If S, C*)..... No

On Edgington's account, "Such answers are not inconsistent. I grant that someone who is 100 per cent certain that the Conservatives will win will accept any conditional with an antecedent which he takes as an epistemic possibility and C as a consequent. But that is not enough to prove the validity of the inference from C to '*if S, C*'."⁸ A problem with this statement is Edgington's claim that one must accept *any* conditional with a consequent one holds as 100 per cent certain. We certainly want to disagree on that.

A serious problem, apparently not completely evident to Edgington, is that replacing truth conditions with conditional probability does not solve this second paradox of the material implication. According to Lewis, Adams' thesis as such, or the estimate of the assertability given by the conditional probability of C *given* A , is not in general secured against this paradox.⁹ This will have to be explained if Edgington's intuitive account is supposed to be completely in accordance with Adams' thesis. However, Lewis argues that this problem is

⁷ Also here, it seems unlikely that someone would believe any disjunction made with the statement 'The Conservative Party will win' and any disjunct, as for instance: 'Either I get killed or the Conservative Party will win'.

⁸ Edgington (1991), p. 185.

⁹ Lewis (1991), p. 88.

not as grave as the problem with the first paradox, by showing that Adams' thesis at least in some such cases is still confirmed by examples:

This supposed diminution is left out, and I think rightly so, if we measure the assertability of a conditional $A \supset C$ (in abstraction from context) by $P(C/A)$. If A and C are probabilistically independent and each has probability 0.9, the probability of the conditional (0.91) is predominantly due to the probability of the consequent (0.9), yet the conditional probability $P(C/A)$ is high (0.9) so we count the conditional as assertable. And it does seem so, at least in some cases: 'I'll probably flunk, and it doesn't matter whether I study; I'll flunk if I do and I'll flunk if I don't.'¹⁰

The example that Lewis here uses to explain away the second paradox of material implication is a certain type of conditionals, in general used to assert the consequent independently of the truth or probability of the antecedent. This type of conditionals is used to assert that something is an insufficient condition for the consequent, as in: 'If he wins the *lottery*, he cannot afford that car' and 'If you give me a *million*, I wouldn't do it'. One could also reformulate these conditionals as 'Even if A then (still) C ': 'Even if I study, I'll (still) flunk.' This means that rather than asserting an *ordinary* conditional relation between the antecedent and the consequent (in which case the antecedent is taken to be a sufficient condition for the consequent, and the consequent is taken to be a necessary condition for the antecedent), these conditionals are typically used to *deny* an ordinary conditional relation. *Modus ponens* and *modus tollens*, together with contraposition, are then characteristically applicable to ordinary conditionals, but not to this type of conditionals. When Lewis, then, uses such "even-if" conditionals as typical examples of conditionals that fit Adams' thesis, we should expect that it is not an adequate formula for calculating Edgington's intuitive conception of conditional probability for ordinary conditionals. As her choice of examples shows, Edgington's intuitive account is modeled on ordinary conditionals that have a sufficient/necessary dependence relation between the antecedent and the consequent.

Actually, Lewis has a problem with the reconciliation of his support for Adams' thesis and his initial adherence to Grice's version of the pragmatic explanation of the assertion conditions, according to the maxim to assert the stronger. If one applies this maxim without any restrictions, then (material) conditionals that are held true for the sole reason

¹⁰ Lewis (1991), p. 88.

of having highly probable consequents will be unassertable. This hiatus between Grice's pragmatic account of the assertion conditions for conditionals and Lewis' simultaneous support for Adams' thesis is eventually only bridged by a conventional exemption from the maxim in the case of conditionals with very probable consequents:

The best I can do to account for the absence of a marked diminution in the case of the probable consequent is to concede that considerations of conversational pointlessness are not decisive. They create only tendencies towards diminished assertability, tendencies that may or may not be conventionally reinforced. In the case of the probable consequent, apparently they are not.¹¹

However, as pointed out by Jackson, there are counter-examples to this general exemption to the maxim of asserting the stronger:

Both the following conditionals are highly *unassertable*, but have very probable consequents: 'If the history books are wrong, Caesar defeated Pompey in 48 BC', 'If the sun goes out of existence in ten minutes time, the earth will not be plunged into darkness in eighteen minutes' time.'¹²

A more plausible counter-example is perhaps the following: 'If sugar dissolves in water, then it (sugar) tastes sweet'. This conditional has a highly probable consequent as well as a highly probable antecedent, and they are in general considered to be probabilistically independent: There is no such causal connection between dissolvability and sweetness, as the conditional suggests. Thus, being unsophisticated in the complexities of modern theories of conditionals, most people would hold the conditional to be plainly false, while Lewis and Jackson may say that the conditional is highly unassertable but true, though the technical value of its conditional probability is high.

Anyway, these and lots of other examples show that conditionals cannot conventionally and in general be considered to be assertable if they have highly probable consequents. For these and other reasons, Jackson rejects Lewis' modified Gricean account of the assertability of conditionals, and proposes his own in terms of robustness with respect to the truth of the antecedent. Since this seems to be equivalent to Adams' thesis, the hiatus between the pragmatic explanation and the technical version expressed in the thesis is apparently closed; and Lewis subsequently endorses Jackson's account.

¹¹ Lewis (1991), p. 88.

¹² Jackson (1991), p. 114.

However, the counter-examples mentioned by Jackson seem to go against his own account as well as against Lewis' original account. Both accounts are in general vulnerable to the problems associated with the second paradox of the material implication. That neither Jackson nor Lewis acknowledges this could be explained by the rather specific examples they discuss. Jackson and Lewis both use examples of conditionals that assert the consequent independently of the truth or probability of the antecedent ("even-if" conditionals) to argue that assertability should not take heed of the second paradox of the material implication. Thus they may have thought that it is enough to add the condition that the antecedent and the consequent are probabilistically independent to the demand that the consequent is highly probable, in order to secure against the problems demonstrated by this paradox. In these cases, Adams' thesis gives that the conditional is highly assertable. But as shown particularly by the sugar example, this will not guarantee intuitive assertability in all cases. This will shortly be discussed more thoroughly in connection with a second paradox of *conditional probability*. More to the point of the present discussion is it that Adams' thesis is unable to protect sufficiently against the more general problems of the second paradox of the material implication.

The first paradox of conditional probability

It is actually a problem for Adams' thesis that it does not resolve the second paradox of the material implication. As Edgington convincingly demonstrates, the first and the second paradoxes are equally problematic, and Lewis has not succeeded in demonstrating otherwise. His alleged counter-example turns out to be irrelevant for the discussion on conditional probability, something that should make it clear that what kind of conditionals one uses in the debate on the logical properties of conditionals is decisive for the outcome.

In fact, Adams' thesis involves a paradox corresponding to the second paradox of the material implication, namely what we will call the first paradox of conditional probability. These paradoxes coincide when one has a 100 per cent confidence in the consequence, as in Edgington's example with the opinion poll when one is convinced that the Conservative Party will win the election. This example is an effective counterexample both against the material interpretation as well as against Jackson's account, neither of which secures sufficiently against the second paradox of the material implication. However, Adams' thesis gives a correct estimate of the conditional probability in this example only because, at least in this particular case, we base our estimation of $Pr(A \& B)/Pr(A)$ directly on our

understanding of the intentionally conceived conditional relation between A and B , and not on a freestanding evaluation of the (absolute) probabilities. Thus Edgington's counterexample against the second paradox of the material implication shows that the assertion or truth conditions are just plausible estimations of conditional connections between events taking place in the political arena, among them foremost that scandals usually weaken a political alternative in the polls:

Suppose our subject is 90 per cent certain that the Conservative Party will win. He allows that they may not win, and that if certain, in his view unlikely, things happen, they will not win. So it is consistent to have a high degree of confidence that C and a low degree of confidence that *if* S , C . On the truth-functional account, this is, again, logically on a par with being very confident that it's red and square but very unconfident that it's square.¹³

As long as we are dealing with facts and events, and particularly with future facts and events, we would not always claim a 100 per cent certainty. As a result, there is often a possibility, as long as we do not know more about the particular context of a subject's evaluation of his or her beliefs, that we would accept S as false and C as true, and still not accept *if* S , C ; and thus, also, strictly according to Adams' thesis and Edgington's account, would state that $Pr(C/S)$ is close to zero, or at least much smaller than 1.

This means that the second paradox of the material implication can be dissolved in its presentation as the first paradox of the conditional probability, but only on the condition that one avoids using values of 100 per cent certainty for the consequents.¹⁴ One is then forced to base the estimations of $Pr(B/A)$ (or $Pr(C/S)$) on one's intuitive understanding of a presumed plausible ordinary conditional relation between the antecedent and consequent, not the other way around. That 100 per cent certainty of the consequent will guarantee 100 per cent certainty of the conditional, according to Adams' thesis, is therefore a clear indication that this thesis does not contain everything there is to be known about the conditionals' logical properties, since we are then no better off than with the material interpretation. It is to be expected that some of the paradoxes that Lewis has discovered

¹³ Edgington goes on: "On the other hand, his high degree of confidence in (5) [The Conservative Party will win] does constrain him to at least that degree of confidence in (6) [Either ___ or the Conservative Party will win]." The subject's high degree of confidence in (5) and therefore in (6) shows that the disjunctive (or-construction) should be conceived of as an enumeration of non-exclusive and not (necessarily) conditionally related possibilities; and thus not as an ordinary disjunction based in a particular disjunction ground. Edgington (1991), p. 185.

¹⁴ In this case $P(A \& B) = P(A)$, and thus $P(B/A) = P(A \& B)/P(A) = P(A)/P(A) = 1$.

can be reduced and dissolved as consequences of the first paradox of conditional probability discussed here.

The cluster of conditionals

But why does Edgington adopt Adams' thesis if it cannot be used to solve the second paradox of the material implication (or what is here called the first paradox of conditional probability)? The reason for this seems to be that she believes that Adams' thesis actually resolves this paradox, and she is led to believe this because she uses a certain kind of conditionals, namely betting conditionals, as her paradigm examples.

Conditionals such as 'If I toss this coin, it will land heads' are particularly well suited for the demonstration of the two-way plausibility of Adams' thesis in certain specific cases. Such betting conditionals are also naturally independent of the estimation of the subjective probability of the antecedent. However, the subjective belief in the conditional is solidly founded in *objective* probability estimations, expressible in conditionals of other types. When we toss a coin we usually presume that it is fair, i.e. that there are no causal factors that will tilt the coin one way rather than another (by uneven distribution of weight, the manner in which the coin is tossed, magnetism or wind, and so on). Thus it is not *objectively* more probable that it for instance will land heads rather than tails. On the plausible assumption that there are no such causal factors involved in the situation, the mathematical theory of objective probability tells us that the (objective) probability that the coin will land heads is exactly 50 per cent, or $\frac{1}{2}$. The background knowledge, just referred, constitutes the truth conditions of any betting conditional any person may make about coin tossing. Thus the judging subject's distribution of subjective probability or confidence in the various outcomes is based in knowledge of these objective probabilities, expressible in causal and mathematical conditionals.

This is why it seems a bit odd when Edgington makes use of these betting conditionals to prove that no theory of truth conditions for conditionals can adequately account for these conditionals and the subjective distributions of belief and confidence they are plausibly associated with:

Non-truth-functional accounts of the truth-conditions of conditionals demand some sort of ‘strong connection’ between antecedent and consequent for the conditional to be true. Such a connection is clearly lacking in

If you toss this (fair) coin, it will land heads.

On such accounts, the conditional is then certainly false. It should have probability 0. But surely, if someone is told ‘the probability is 0 that if you toss it it will land heads’, he will think it a double-tailed or otherwise peculiar coin.¹⁵

This conditional is ambiguous or underdetermined with respect to how it relates to the truth conditions of betting conditionals. If it is understood to refer to certain causal factors giving biased outcomes of the tossing, well then one is talking about the material grounds for the estimates of objective probabilities. If one denies that there is a causal relation between the tossing of the coin and a particular outcome, one could spell this out and say: There are no causal factors such that if you toss this coin, it must land heads, or must land tails.

Quite frequently, contexts for coin tossing (on soccer fields, for instance) are situations of fair decision making between balanced alternatives. In such a situation, one could, in an awkward and rather cumbersome manner, announce one’s choice (that eventually opens for a decision, for instance of the side of the playing field that one’s team is going to defend in the first half of the game): ‘If you toss this (fair) coin, I bet that it will land heads.’ This is certainly some sort of conditional prediction, but it is made on the assurance that the coin is fair and on the background knowledge that there are no particular causal factors that will determine the outcome one way rather than the other, and on the simple understanding of the objective probabilities this implies. Thus one is close to 100 per cent certain that there are no such biasing causal relations in the situation, and 100 per cent certain that if there are no such causal factors, then the objective probability that it will land heads is exactly $\frac{1}{2}$. Anyhow one chooses to interpret the conditional there certainly are “some strong connections” that constitute its truth conditions.

Accordingly, one must distinguish between subjective and objective probability. In betting conditionals one obviously has to consider the objective probability of the conditional, describing the causal and mathematical relations, when estimating the probability of the

¹⁵ Edgington (1991), p. 189.

outcome in this particular situation. Hence one's subjective confidence in the conditional is grounded on its objective probability. In Adams' thesis, however, one is only concerned with a person's subjective confidence in *B given A*, not in some objective statistic or causal facts. So even though betting conditionals seem to be representative for conditionals that are subject to Adams' thesis, they are in fact grounded or asserted on more general and objective background conditions, and not in the purely subjective confidence one has of *A&B* divided on the purely subjective confidence one has in *A*. As argued above, betting conditionals are thus much more complex than they are characterized as in Adams' thesis. In fact, they are especially instructive examples of a quite common phenomenon: that conditionals are clustered, i.e. that conditionals of different types are built together or interrelated, in such ways that we cannot give an adequate account of one type without analyzing its internal relations to conditionals of other types.

The theory of conditional probability thus seems to reveal confusion with respect to the interconnections and large variety of conditionals that we actually use and understand. We saw how Lewis' defense of Adams' thesis with respect to the first paradox of conditional probability (and the second paradox of the material implication) depends upon the use of a special kind of conditionals, (Even if I study, I'll (still) flunk), characteristically used to deny an ordinary sufficient/necessary conditional relation between the antecedent and the consequent (If I study, I'll pass), and, at the same time, to assert the consequent (I'll flunk).

In Adams' thesis, but also in the material interpretation of conditionals, the conditional relation that one attempts to account for is a sufficient/necessary relation between antecedent and consequent, a relation that is found in ordinary conditionals only. And as already mentioned, these conditionals take contraposition, *modus ponens* and *modus tollens*. "Even-if" conditionals, on the other hand, being denials of ordinary conditionals, is logically between ordinary conditionals and rhetorical conditionals, in which the ordinary conditional relation is exploited for rhetorical purposes. Neither "even-if" conditionals nor rhetorical conditionals take contraposition, nor will they take both *modus ponens* and *modus tollens* at the same time. Examples of different rhetorical conditionals are: 'If he's telling the truth, then I'm a Dutchman'; 'If he made a mistake, it wasn't a big mistake' and; 'If you're hungry, there's some food in the kitchen'. Common for all the different types of conditionals is however that they are grounded in some more general background

conditions that guarantee the conditional relation of whatever kind characteristic of the different types of conditionals.

Furthermore, when Jackson attempts to describe our reasoning with conditionals in terms of his notion of robustness, he operates with several interrelated levels of conditional understanding. Jackson wants to be able to guarantee the existence of an ordinary conditional relation by claiming robustness with respect to the antecedent, thereby avoiding the first paradox of the material implication. A problem for this account, however, seems to be that Jackson then explains natural conditionality with the help of natural conditionals; hence he seems to be argumentatively circular. Jackson claims that there are two ways to respond to this objection: either by defining robustness in terms of the technical notion of conditional probability, or by reference to a relevant difference in the conditionals explained and those used to explain. He eventually decides to go for the latter alternative:

P is robust for person *S* relative to *I* just if *P*'s high probability for *S* would not be substantially reduced if *S* were to acquire the information that *I*. One reply would be to urge that we simply define robustness in terms of conditional probability,
$$Pr(P/I) = df Pr(PI)/Pr(I).$$

No conditionals there.

This reply is open to challenge. For the defence of so defining robustness must involve a defence of conditionalization, the thesis that the impact of new information is given by the relevant conditional probability, and it might be urged that talk of the impact of new information can best be understood as talk of what one's probabilities would or should be if one were to acquire the new information. But another reply is possible. The conditionals involved here are essentially subjunctive and counterfactual in character, and as such are importantly distinct from indicative conditionals. It is not, therefore, uselessly circular to appeal to the former in one's story about the latter.¹⁶

No, indeed, it is not uselessly circular to probe into the internal relations between indicatives and subjunctives. As shown by Johnston, most of the conditionals that are usually classified as indicatives actually have identical truth conditions with their corresponding subjunctive ones, that is, if they are ordinary conditionals that take *modus ponens*, *modus tollens* and contraposition. These ordinary conditionals may be considered as the basic sort of conditionals or the paradigm cases. This is because what is in focus is the (subjunctive) conditional relation itself, not the degree of hypotheticality, which means

¹⁶ Jackson (1991), pp. 128-9.

that it is irrelevant whether Jackson's conditional is expressed as: 'If one acquires the new information...', 'If one were to acquire the new information...' or as 'If one had acquired the new information...'

However, in the case at hand, we are actually considering a conditional about the conditional understanding a person *S* has when holding a conditional. When *S* is unwilling to accept the conditional based solely on the knowledge that the antecedent is false, we really probe with the help of a (subjunctive) conditional into that particular aspect of the conditional relations that the subject claims with the expression of the natural conditional. Thus, the conditional expression in the formula of robustness points directly to the particular intentional relations of conditionality in the focused basic natural conditional held by the subject *S*; whether or not this is subjunctive or indicative, ordinary or rhetorical.

Jackson therefore, though he himself is apparently unaware of the fact, points us into the cluster of conditionals that constitutes the background for estimations of robustness, and thus, contrary to what he claims, shows that robustness cannot explain conditionals, since the conception of robustness is heavily built on conditionals and conditional understanding: Robustness is constituted by (subjunctive) conditionals, which are about the conditional relations expressed in all kinds of conditionals. So even though reference to robustness is not uselessly circular, it is still circular considered as an explanation or reduction of conditionality, be it indicative, subjunctive, ordinary or rhetorical. Even Jackson's fallback position of defining robustness by the technical notion of conditional probability is in no way free from the allegation of use of conditionals to explain conditionals. First, the notion of (subjective) probability is based on conditionals. Secondly, all (subjective) estimations of the $Pr(PI)$ of plausible conditionals (if *I* then *P*), are based in the subject's primary valuation of the conditional, not the other way around.¹⁷

So far we have looked into three different ways in which conditionals of different types are internally related to each other: (1) The interrelations of causal, mathematical and betting conditionals; (2) the interrelations between ordinary conditionals, "even-if" conditionals

¹⁷ Since Jackson's intuitive notion of robustness of a conditional with respect to the truth of the antecedent is closely related to Edgington's intuitive notion of the subjective probability of *B* given *A*, and they are both used to support Adams' thesis, similar objections of circularity and insufficiency can be launched against her account – understood as an *explanation* of natural conditionals.

and rhetorical conditionals and; (3) the interrelations between natural conditionals (of different types) usually about some objective states of affairs, and the conditionals expressing the conditional-stating subject's conditional estimations of her or his confidence in the conditional. In all three cases we interrelate objective and subjective levels or dimensions.

Edgington's confusion of the intuitive and the technical account

In her intuitive account against the assumption of truth functional truth conditions for conditionals, Edgington correctly points to the inadequacy of the material interpretation. This intuition seems to be suspended, however, when she presents her argument against non-truth functional truth conditions for conditionals: In a discussion of cases where one has 100 per cent certainty in the truth or falsity of the antecedent or the consequent, her intuitive account is adjusted to coincide with Adams' technical thesis and, strangely enough, also with the material conditional. Her confusion, caused by her confidence in Adams' thesis, reveals a second paradox of conditional probability. Before going further into this paradox, we will present Edgington's informal argument against non-truth functional truth conditions for conditionals, which leads her to the conclusion that conditionals do not have truth conditions at all.

According to Edgington, if conditionals have truth conditions that are not truth functional, then these truth conditions ought to be in accordance with Adams' thesis, since this thesis gives at least some of the criteria for our belief in natural conditionals. She then assumes that a conditional *if A, B* has truth conditions which are not truth functional when *A* and *B* are both true. She finds this to be wrong, however, since it would follow from this assumption that "...someone may be sure that *A* is true and sure that *B* is true, without having enough information to decide whether '*if A then B*' is true; one may consistently be agnostic about the conditional while being sure that its components are true".¹⁸ Edgington holds that this consequence (*C*₁) is false, since according to Adams' thesis (and allegedly her intuitive account), if one knows that *A* and one knows that *B*, then one also knows that *if A then B*.

Being certain that *A* and that *B*, a person must think *A&B* is just as likely as *A*. He is certain that *B* on the assumption that *A* is true. *C*₁ also conflicts with common

¹⁸ Edgington (1991), p. 192.

sense. Admittedly, the conditional ‘*If A, B*’ is not of much interest to someone who is sure that both *A* and *B* are true. But he can hardly doubt or deny that *if A, B*, in this epistemic state. Establishing that the antecedent and consequent are true is surely one incontrovertible way of verifying a conditional. If you deny that *if A, B*, and I know that *A* and *B* are both true, I am surely in a position to correct you... Truth-functionality cannot fail when *A* and *B* are both true.¹⁹

First of all, if one starts out with any *A* and any *B* that one knows to be true, this alone is hardly enough information for us to infer that *if A, B* or even *if B, A*. For instance, if one knows that someone likes carrots and one knows that this person has got cancer, this is not in any way sufficient for knowing that *if* this person likes carrots, he has got cancer.

Secondly, in saying that “the conditional ‘*If A, B*’ is not of much interest to someone who is sure that both *A* and *B* are true”, Edgington must also be saying that, to someone who knows that his daughter was given some new medication at the hospital last year (*A*) and who knows that she died two days later (*B*), it is not of any interest whether or not she died *because* of the new medication. It also follows from what Edgington says here that it follows from *A* and *B* both that ‘If she got this new medication, she died shortly after’ and ‘If she died, she got this new medication just before that’. Accordingly, any cause-effect relation can be reversed.

With the rejection of this first assumption, Edgington is also saying that Adams’ thesis, or at least her own positive account, must treat any true pair of statements *A* and *B* as also implying a conditional relation *if A, B* and *if B, A*. This strongly indicates that the conditional probability account is a reductive account of conditionals.

Edgington further assumes that a conditional *if A, B* has truth conditions that are not truth functional when *A* is false and *B* is true. But she finds that also this assumption (Assumption 3) must be false. This is because if *B* is certain, *A&B* is as probable as *A*, something that follows from Adams’ thesis, and, according to Edgington, agrees with common sense:

I complain to John that he has not replied to my letter. He says he did – he posted the reply some weeks ago. I am not sure whether to believe him. Let *A* be ‘He posted the reply’ and *B* be ‘I didn’t receive it.’ Our positive account has it that *B* is certain on the assumption that *A*, and so does common sense. But by Assumption 3, I should reason like this: ‘I didn’t receive the letter. Suppose he posted it: then the

¹⁹ Edgington (1991), p. 194.

conditional is true. But suppose he didn't post it: this, together with the fact that I didn't receive it, is not sufficient for the conditional. It depends (say) on whether the closest possible world in which he *did* post it, I still didn't receive it. And I can't be sure of that'.

Assumption 3, then, is incompatible with our positive account, and once more, intuition vindicates our account.²⁰

Here, Edgington's appeal to common sense is based in the use of a certain type of "even-if" conditionals, which are used to cast doubt on some implicit assumption in the asserted consequent by adding it as an if-clause. In this example, Edgington asserts that she did not receive the letter. This seems in some way to imply that she believes that the letter is sent. But in fact, she is not sure whether John posted the letter at all. So if he posted it, she did not receive it. This means that the example should not be treated as a case of an ordinary conditional, where John posting the letter is understood as a sufficient condition for Edgington not receiving it.

Edgington goes on to assume that truth functionality fails when *A* and *B* are both false. But also this assumption (Assumption 4) is rejected, this time with an example where someone knows that *A* and *B* have the same truth-value:

For example he knows that John and Mary spent yesterday evening together, but doesn't know whether they went to the party. According to our positive account and according to common sense, he knows enough to be sure that if John went to the party (*J*), Mary did (*M*). (*J*&*M* is as likely as *J*: *M* is certain on the assumption that *J*). ... *J* and *M* may both be false, and if they are, some further condition has to be satisfied for '*If J, M*' to be true. Perhaps the further question, if John and Mary didn't go, is whether Mary would have gone if John had, and he can't be sure of that. Our positive account and Assumption 4 diverge, and intuition, once more, favours our account.²¹

Edgington here makes use of a conditional that is based in a disjunction that again is based in a simple fact: Now, we know that Mary and John are going to be together. This is the basic truth condition of our disjunction 'Either John and Mary went to the party, or John and Mary went somewhere else', and thus also of our conditional 'If John went to the party, then Mary went to the party'. We certainly do not base our trust in this conditional on the fact that *J* and *M* are both false. Neither do we base it on our uncertainty about their truth. In fact, the conditional seems to be less informative than the background knowledge

²⁰ Edgington (1991), p. 196.

²¹ Edgington (1991), p. 196.

given for it: We know more if we are told that Mary and John are going to spend the evening together than we know from various conditionals that can be inferred from this: ‘If John is at the library, Mary is at the library’, ‘If Mary is in England, John is in England’, ‘If Mary is in the bar, then John is in the bar’, and so on.

However, we may also show that Adams’ thesis does not support Edgington’s denial of this last assumption: If A and B are both highly improbable, Adams’ thesis still says that the conditional probability of the conditional *if* A , B is given by $Pr(B/A) = Pr(A \& B)/Pr(A)$. If A and B are probabilistically independent, such that $Pr(A \& B) = Pr(A) * Pr(B)$, it follows that $Pr(B/A) = Pr(B)$, that is, highly improbable. If on the other hand, as the example shows, A and B are highly probabilistically dependent, $Pr(A \& B)$ is close to $Pr(A)$, and $Pr(B/A)$ is close to 1. Thus the outcome does not depend solely on whether A and B are both highly improbable, such as Edgington suggests, but on whether or not there is a conditional relation between A and B , with the strength or probability of this relation indicated by the technical notions of probabilistic dependence and independence. Accordingly, there seems to be a discrepancy between Edgington’s intuitive account and the presumed outcome of the technical interpretation of it given by Adams’ thesis.

This makes it clear that it is the estimation of the occurrence of such conditional relations, stated in ordinary conditionals, that supports the estimation of conditional probability, not the other way around. And our discussion likewise shows that in no plausible manner can Adams’ thesis and common sense be said to support the material conditional interpretation in the case of the last assumption. Rather, both Adams’ thesis and common sense support the view that conditionals have non-truth functional truth conditions. What this last example actually reveals, is that a second paradox follows from Adams’ thesis, namely one that occurs when what is taken as antecedent and consequent are probabilistically independent.

The second paradox of conditional probability

While the first paradox of conditional probability showed that Adams’ thesis was not secured sufficiently from the second paradox of the material implication, the second paradox of conditional probability is characteristic of the account built on Adams’ thesis as *different* from the account of the material conditional. Thus the first paradox was caused by the collapse of the account of Adams’ thesis into the material account in cases where one

has 100 per cent certainty in the consequent. The second paradox of conditional probability follows from the treatment of Adams' thesis of cases where the antecedent and consequent are probabilistically independent. In those cases $Pr(A \& B)/Pr(A) = Pr(A) * Pr(B)/Pr(A) = Pr(B)$. Thus it follows that given that A and B are probabilistically independent, the conditional *if* A , B will be believed with subjective (conditional) probability equal to the subjective probability of B .

This second paradox is essentially related to the calculation of conditional probability in cases of absolute probabilities for A and B intermediate between zero and 1. It shows definitely that Adams' thesis does not include all that is essential to a conditional. That a conditional like 'If I am working hard now, there will be a sunny day tomorrow' has to be considered as equally believable as the prediction that there will be a sunny day tomorrow just because the antecedent and the consequent are probabilistically independent, goes against all common sense.

Symptomatically, the fact that Adams' thesis reduces the conditional probability to the absolute probability of the consequent when the antecedent and the consequent are probabilistically independent, surfaces as the central culprit for Lewis' triviality results. Lewis has demonstrated that if we assume that the conditional (as it is characterized in Adams' thesis) can function as a dual connective that is universally applicable to all sentences A and B in the language, it follows that all sentences in our language are probabilistically independent. The main consequence of Lewis' deduction is his formula (12) $P(C/A) = P(C)$.²² This just demands that all sentences of the language actually are probabilistically independent.

Lewis's proofs, then, can be seen to discover the same fundamental flaw with conditional probability (if this is understood as an expression of the meaning of conditionality) as we here identify as the second paradox of conditional probability. This result also readily explains why the conditionals in which 'if' is used to assert the consequent, namely "even-if" conditionals, seem to fit Adams' thesis better than ordinary conditionals that are used to express a sufficient/necessary relation between the antecedent and the consequent.

²² Lewis (1991), p. 80.

The main bombshell seen to follow from Lewis' triviality result was that conditional probability is unable to represent the truth conditions for conditionals. Adams and Edgington conclude from this that conditionals are not propositions, which means that they do not have truth conditions at all. They then see conditional probability, not as a way to assign truth conditions to conditionals, but as a way to demonstrate what it means to believe a conditional or hold it probable. Lewis and Jackson, on the other hand, maintain that the material account gives the truth conditions of conditionals, while conditional probability expresses a conditional's assertion conditions. However, one would not expect that the problems concerning conditional probability should just disappear if one only gives up on truth or probability of truth. Since assertability of non-conditionals in general goes by probability of truth, and the proofs of the triviality results do not in any way depend on the concept of truth, one certainly could also apply them to assertability (Lewis and Jackson) or believability (Edgington and Adams).

By all accounts, the proofs of the triviality results seem valid and sound. However, all our examples show that at least some conditionals certainly do have truth conditions, and even truth conditions that are confirmed by the expressions of Adams' thesis, contrary to what is claimed by Edgington, Adams and Lewis. What the triviality results mean, then, must be that conditional probability is not exhaustive with respect to what is essential to a conditional, and that the conditional cannot be considered as a universally applicable dual connective obeying only Adams' thesis. As clearly indicated by the variation in the examples of the particular conditionals considered above, conditionals cannot be reduced to one simple kind with exactly the same set of logical properties. Neither can one expect to construct a viable candidate conditional by putting any arbitrary pair of statements *A* and *B* into the grammatical form *if A, B*, whose believability or assertability is then determined simply by Adams' thesis.

Edgington's intuitive account seems to testify that she initially understood this, claiming that conditional probability should not be taken as a reductive account in which one has to consider how likely *A* is in order to find out how likely it is that *B given A*. As certainly is the case with betting conditionals, one does not need, and cannot expect, to know the subjective probability of *A* and of *A&B* independently of and as a base for one's estimation of the probability of *B given A*. One's subjective degree of belief in the conditional is therefore not grounded in conditional probability as technically defined in Adams' thesis.

On the contrary, one's degree of belief in events described by non-conditional statements *A* and *B* is often founded in one's belief in relevant conditionals; as when we observe only the effect or the cause of a well-known causal relation.

The Equation

Our presentation and discussion so far indicates that a conditional cannot be a universally applicable dual connective that is in essence governed by Adams' thesis. Edgington, on the other hand, claims to have proved that conditionals must have *belief* conditions in accordance with Adams' thesis. She further seems to believe that Lewis' proofs of the triviality results establish that the assumption that conditionals have *truth* conditions governed by Adams' thesis is self-contradictory. What Lewis actually demonstrates is that all sentences must be probabilistically independent, and that our language then is trivial in the sense that there cannot be more than two pairwise incompatible sentences:

Our supposition that $\rightarrow$ is a universal probability conditional has led to absurdity; but not quite to contradiction. If the given language were sufficiently weak in expressive power, then our conclusion might be unobjectionable. There might not exist any three possible but pairwise incompatible sentences to provide a counterexample to it. For all I have said such a weak language might be equipped with a universal probability conditional.²³

However, Lewis proves this triviality result *only* under the assumptions (among others more technical ones) that: i) conditional probability expresses *all* the truth conditions of conditionals; ii) *all* pairs of sentences *A*, *B*, etc. (in a language) can form conditionals *if A*, *B*, *if B*, *A*, and so on, that have truth conditions according to i) and; iii) *all* distributions of absolute probability to the sentences *A*, *B*, etc. are consistent with the conditional probabilities given according to i) and ii). As shown above, we disagree with all these three assumptions.

We still maintain that conditionals have truth conditions and that the truth conditions in many cases agree with the results of Adams' thesis applied to the subjective probabilities of the antecedent and consequent, although we do not disagree with Lewis in that his conclusions follow from his assumptions. More relevant for the question at hand is it that Lewis only claims to have proved a triviality result, no contradiction, and that the triviality

²³ Lewis (1991), p. 80.

result is only proved with respect to the *class of all* sentences $A \rightarrow B$ and to the *class of all* probability functions P . These functions and sentences obey particular closeness conditions that are related to an interpreted formal language, equipped with the usual truth functional connectives and the further connective $\rightarrow$, used to compound any sentences in the language.²⁴ Lewis does thus not claim to have shown that it is self-contradictory to assume that *any* conditional, taken by itself, i.e. disregarding all the assumptions of Lewis, can have truth conditions in accordance with Adams' thesis.

Edgington however claims to be able to prove that a conditional cannot have truth conditions; that assuming a conditional to have truth conditions in accordance with Adams' thesis is self-contradictory. She presents her proof as a *reductio ad absurdum* (RAA) of the equation between a proposition X (that has truth conditions) and *if A, B*:

Can we find a proposition X such that, in any consistent belief distribution over the relevant propositions in which $b(A) \neq 0$,
 $b(X) = b(B \text{ given } A)$ [Henceforth, the Equation]
 so that we may say, consistently with the Thesis, "*If A, B*" is true if and only if X ?²⁵

The Equation presupposes that for any (indicative) conditional *if A, B* there is a proposition X , such that: i) X has or expresses truth conditions (X can be true or false); ii) The probability of X coincides with the conditional probability of B given A , and; iii) Adams' thesis states what is essential for conditionals. We will maintain that the problem here is not to assign truth conditions to X , as Edgington argues, but rather the assumption she makes about Adams' thesis expressing the essential properties of conditionals.

The main idea of her proof is the following: Given the Equation, i.e. that X actually expresses the truth conditions of the conditional, we must have that: $p(A \& X) = p(A \& B)$: X must coincide with B in the A -worlds (i.e. possible worlds in which A is true). However, we do not in general know anything about the relation between $p(\neg A \& X)$ and $p(\neg A \& B)$, since X may or may not coincide with B in the $\neg A$ -worlds (i.e. possible worlds in which A is false). Therefore we may, according to Edgington, find probability distributions for X and B over A and $\neg A$, that agree in $p(A \& X)$ and $p(A \& B)$, but disagree in $p(\neg A \& X)$ and $p(\neg A \& B)$. Consequently, there are probability distributions in which $p(X) \neq p(B \text{ given } A)$,

²⁴ Lewis (1991), p. 78.

²⁵ Edgington (1995), p. 271.

as $p(X) = p(A \& X) + p(\neg A \& X)$. Edgington concludes that the Equation is false.

Conditionals do not have truth conditions that are identical with their belief conditions according to Adams' thesis:

The bombshell is that no proposition at all satisfies the Equation. If we stick by the Thesis, we must not think of conditionals as propositions, as truth bearers. If belief that if A , B fits the Thesis, it is nonsense even to say things of the form “‘if A , B ’ is true if and only if, if A , B ”. Your degree of belief that B is true, on the supposition that A is true, cannot be consistently and systematically equated to your degree of belief that something is true, *simpliciter*.²⁶

*The main steps in her proof are as follows:*²⁷

i) “According to the Thesis, the probability of ‘ B/A ’ depends only on our probability distribution for the A -worlds. Given $p(A)$ and $p(A \& B)$, we also know $p(B/A)$.”²⁸

The consequences of applying Adams' thesis to natural conditionals reveal a fundamental weakness with this approach. Take for instance the conditional ‘If one drinks such and such amount of sea water, one will die’. Our subjective belief in this conditional will depend upon the hypothesis that the salt in the water has a damaging effect on the body processes. In some possible worlds the water is pretty sweet, but some of those who drink it still dies for other reasons. In such a case our belief in the conditional in these A -worlds will be less than our belief in B/A , understood as the technical equivalence in Adams' thesis. It is therefore necessary that we regulate our distribution of belief in the A -worlds in accordance with the underlying understanding of the conditional, and not *vice versa*. This also means that it is not the case that every time we have a positive estimation of $p(B/A)$, technically understood, there must be a conditional X that we have a belief in of equal subjective probability.

ii) “Any proposition ‘ X ’ which satisfies the Equation must be true in some but not all $\neg A$ -worlds, and true in some A -worlds, as was shown. So $p(X)$ depends not only on how

²⁶ Edgington (1995), p. 271. Does this mean that, according to Edgington, there are no examples of conditionals with alleged truth conditions X so that $p(X) = p(B/A)$ for any probability distribution consistent with what we have assumed about X , A and B ? To refute this it should then be sufficient to give one such example. We will shortly demonstrate two.

²⁷ Her proof appears in Edgington (1995), pp. 273-274.

²⁸ Edgington (1995), p. 274.

probabilities are distributed in the A -worlds, but also on our probability distributions in the $\neg A$ -worlds.”²⁹

The point is that Edgington actually *shows* that we cannot in general have that X is (1) implied by $\neg A$, (2) incompatible with $\neg A$ and (3) incompatible with A , since we in an abstract sense are able to construct specific probability distributions as counter-examples. However, she thinks these separate proofs taken together result in a proof that we *in general* have that X is *not* (1) implied by $\neg A$, (2) incompatible with $\neg A$ and (3) incompatible with A .³⁰ In a sense, it is a simple mistake of the placement of negation; but it is important nevertheless, as it shows the misconceptions of the relation between conditionals and distributions of probabilities over possible worlds. The formal character and appearance of Adams’ thesis and the Equation makes one think of the demands on X as something that can be given by general rules applicable to every particular conditional, especially if Adams’ thesis is understood to contain all the essentials of the conditionals.

iii) “There are distinct probability distributions which agree in all assignments in the A -worlds, but not in the $\neg A$ -worlds. They will agree on $p(A \& B)$ and $p(A)$, and thus on $p(B/A)$. And they will agree on $p(A \& X)$. But they will disagree on $p(\neg A \& X)$. As $p(X) = p(A \& X) + p(\neg A \& X)$, they will disagree on $p(X)$. So there are distributions in which $p(B/A) \neq p(X)$. End of proof.”³¹

There are of course purely mathematically possible probability distributions of X , A , and B that agree on the A -worlds so that $p(A \& X) = p(A \& B)$, but that differ over the $\neg A$ -worlds. For some of these distributions it must therefore be the case that $p(X) = p(A \& X) + p(\neg A \& X) \neq p(B/A)$. If X must agree with *all* such probability distributions p , so that $p(X) = p(B/A)$, then there are of course no such X . But the intuitively natural condition to demand

²⁹ Edgington (1995), p. 274.

³⁰ “Suppose there is such an X . We first show something of the logical relationships between X and A : X is (a) compatible with A , and (b) compatible with $\neg A$, but (c) not entailed by $\neg A$, i.e., X may or may not be true if $\neg A$ is true. Proofs, in reverse order: (c) There are probability distributions in which $p(\neg A)$ is high and $p(B/A)$ low. (e.g., let $p(\neg A) = 0.9$; $p(A \& B) = 0.01$; $p(A \& \neg B) = 0.09$. $p(B/A) = 0.1$.) So there are probability distributions in which $p(\neg A)$ is high and $p(X) [= p(B/A)]$ low. So $\neg A$ cannot entail X : if it did, X would be true throughout the $\neg A$ -worlds, and could not be less probable than $p(\neg A)$. So, in some $\neg A$ -worlds, X is not true. Similarly: (b) there are probability distributions in which $p(B/A)$ is high and $p(A)$ is low; hence in which $p(X)$ is high and $p(A)$ is low. So X cannot entail A : X must be true in some $\neg A$ -worlds. And a parallel argument will show that (a) X cannot entail $\neg A$: X must be true in some A -worlds. There is nothing surprising in these facts.” Edgington (1995), pp. 273-274.

³¹ Edgington (1995), p. 274.

is that all relevant probability distributions should be *consistent* with the $p(X) = p(A \& B)/p(A)$, or, that they are consistent with the circumstances that X gives expression to.

Edgington's technical confusion

As we have seen, Edgington draws the conclusion that there is no proposition X such that $p(X) = p(B/A)$ in *all* probability distributions in which these are defined. Certainly, there would not be such an X . The confusion is to even make the claim that X ought to satisfy the Equation for *every* probability distribution. Just because it is mathematically possible to have a probability distribution so that $p(X) \neq p(B/A)$, this does not mean that X does not exist. So why does she arrive at this conclusion? The reason for this is first of all her confidence in Adams' thesis as an exhaustive account of the logical properties of a conditional. This thesis is Edgington's main premise, and it is never questioned. And this assumption naturally poses problems for the supposition that X exists. Since it is possible to manipulate the probability distribution so that we can get whatever result we want for $p(X)$, the only thing we have to prove is that what we assumed about X does not *contradict* what we know about B/A . This leads us to her second confusion: Assuming Adams' thesis to hold, Edgington is bound to end up with this conclusion (that there is no such X that satisfy the Equation), if she assumes that X has to agree with *every* probability distribution consistent with Adams' thesis, since there certainly are such probability distributions that would not agree with X on the $\neg A$ -worlds.

Edgington's confusion is here with respect to the difference between '*any*' and '*every*' when applied to the class of probability distributions consistent with Adams' thesis. We only have to show that there are at least some probability distributions consistent with Adams' thesis, that also agree with X on the $\neg A$ -worlds. So the question is: Is there any probability distribution over the A - and $\neg A$ -worlds consistent with Adams' thesis that also agrees with X over the $\neg A$ -worlds? The answer is yes; and thus it is shown that it *is* possible for the conditional to have truth conditions that agree with Adams' thesis. Edgington shows that X cannot agree with *every*, but thinks she has shown that X cannot agree with *any*, of the probability distributions consistent with Adams' thesis.

Actually, already in her formulation of the Equation, Edgington seems to assume the conclusion of her argument. She claims that in *any* consistent belief distribution the

Equation must be upheld by the proposition X . Since $p(B/A)$ technically understood only depends on how B performs in A -worlds, while $p(X)$ also depends on how X behaves in the $\neg A$ -worlds, there are always belief distributions that agree with X on A -worlds but disagree with X on $\neg A$ -worlds, and that thus can be considered consistent with Adams' thesis.

Actually, this is the main valid point of her argument. Most of these distributions are however not consistent with the intuitive conception of the restrictions put on the distributions by the intuitive understanding of the conditional. This indicates that Adams' thesis cannot be an adequate expression of what a conditional is.

Furthermore, that we may have distributions of probability or belief for B and X over $\neg A$ -worlds that give $p(\neg A \& X) \neq p(\neg A \& B)$ has as such no dire consequences for the assumption that conditionals have truth conditions. We have that $p(A \& X) = p(A \& B)$; $p(X) = p(A \& B)/p(A)$; $p(X) = p(A \& X) + p(\neg A \& X)$. These formulas follow from the assumption that X expresses the truth conditions of the conditional *if A, B*, and the assumption that $p(B/A)$ gives a good estimation of $p(B \text{ given } A)$, intuitively understood. From these formulas it follows that $p(\neg A \& X) = p(A \& B)/p(A) - p(A \& B)$, i.e. $p(\neg A \& X)$ must have this particular value, which is completely determined by B 's probability distribution over the A -worlds and the absolute probability of A . Thus $p(\neg A \& X)$ is completely independent of $p(\neg A \& B)$. But since all probability distributions of B consistent with Adams' thesis are initially only restricted over the A -worlds, there certainly must be such distributions that disagree over the $\neg A$ -worlds. Thus for one of these we may have $p(\neg A \& X) \neq p(\neg A \& B)$. But this fact cannot influence the ability of X to give us $p(X) = p(B/A)$. What we must determine is the probability distribution of X over the $\neg A$ -worlds in accordance with the presumption that the truth conditions that X expresses shall always give a total probability equal to the conditional probability $p(B/A)$. Mathematically we are always allowed to adjust $p(\neg A \& X)$ so that this result can be sustained. We thus do not need to correlate X with B over the $\neg A$ -worlds.

Obviously, when the only information available is what degree of belief we have in A , B , $A \& B$, $\neg A$, and $\neg B$, this is not sufficient to infer a conditional relation between A and B . This much is a problem for Adams' thesis. Furthermore, if it is possible to find an X so that at least *one* probability distribution gives $p(X) = p(B/A)$, we have proved that there may exist such an X . If we had not found a probability distribution so that $p(X) = p(B/A)$, then

we could not have assumed that X existed, and thus we *would* have serious reasons to doubt that natural conditionals have truth conditions. Obviously, Edgington does not, by means of Adams' thesis, succeed in proving that there are no such truth conditions. This is then a problem for Edgington's general case against the natural assumption that there are truth conditions for conditionals.

Intuitive versus technical account

Let us now use Edgington's own examples to show that conditionals *do* have truth conditions that, with the right precautions taken, can be shown to agree with the Equation: 'If John goes to the party, then Mary will go to the party'.³² A J -world is a world where John went to the party; an M -world one where Mary went to the party; and an X -world is a world where John and Mary are together. To make sure that the Equation will apply, we assume that John and Mary will not both show up at the party for any other reason than to be together. Thus, if John went to a $\neg X$ -world version of the party, Mary was sure not to go there; i.e. a $\neg X$ -world that is a J -world is then a $\neg M$ -world. The conditional in question is *if J, M* and the Equation says that: $p(X) = p(M/J) = p(M \& J)/p(J)$.

Let us assume that $p(X) = 0.7$, and that $p(J) = 0.3$. If we further assume that John goes to parties with the same probability whether he is together with Mary or not, we have also that $p(M \& J) = 0.7 \cdot p(J)$. Thus $p(M/J) = 0.7 = p(X)$. In *this* case then, the fact that Mary and John are together with 70 per cent probability is the relevant truth condition of the conditional. And this seems intuitively correct and is confirmed by Edgington's account of the example. Since J and X are probabilistically independent on these assumptions; $p(J \& X) = p(J) \cdot p(X) = 0.3 \cdot 0.7 = 0.21$. And since Mary only goes to the same parties as John, if she is together with John; $p(J \& M) = p(J) \cdot p(X) = 0.21$. Thus, $p(J \& X) = p(J \& M)$, as it should be, if X states the truth conditions of the conditional. On the same assumptions, $p(\neg J \& X) = p(\neg J) \cdot p(X) = 0.7 \cdot 0.7 = 0.49$. Then we have: $p(X) = p(J \& X) + p(\neg J \& X) = 0.49 + 0.21 = 0.7$, as is to be expected if X states the truth conditions of the conditional, and obeys the Equation.

³² Edgington introduces the Equation by referring to an equivalent example: "Can we find truth conditions for conditionals which fit the Thesis? Take any two logically independent propositions, e.g. 'Ann is in Paris' and 'Bill is in Paris'; call them A and B ; suppose you have a conditional degree of belief in B given A . Which truth conditions (if any) are such that your degree of belief in their obtaining must match your conditional degree of belief in B given A ?" Edgington (1995), p. 271. Strangely enough she does not try to exemplify her general points in the proof on this example. We would have expected her then to realize that something was wrong with the proof.

If we assume that Mary will not go to the party if not together with John, we have that $p(\neg J \& M) = 0$. But we are of course free to suppose many different scenarios that would be consistent with our basic assumptions, as long as the relevant factors are worked into the truth conditions. However, one very important fact is that under the assumptions we have made, and that secure that the Equation can be applied to J , M and X consistently with our intuitive understanding of the situation and the truth conditions of the conditional, we have that $p(\neg J \& X) = 0.49$. Consistently with our intuitive understanding, we are therefore not allowed to take any probability distribution of X (and M) consistent with the distribution of X over the J -worlds, and which thus may have any values over the $\neg J$ -worlds. We have to demand that the probability distributions agree with the truth conditions of the conditional in such a way that the percentage of the $\neg J$ -worlds where X is true is just as high as for the J -worlds, since, on our basic assumptions, the probability of John going to the party is independent of the probability of John and Mary being together. If we assumed otherwise, we would have to take that into account when analyzing the truth conditions of the conditional. The term ‘consistent’ in the phrase ‘consistent probability distributions’ in the statement of the Equation should accordingly be understood or reinterpreted as meaning ‘consistent with the restrictions put on the distributions by the relevant truth conditions characteristic of the precisely described situation’.

As a second example against Edgington’s reading of the Equation, we take a betting conditional, namely coin-tossing. A is ‘I toss this coin’; B is ‘This coin lands head’. X is stating the basic truth conditions of the conditionals, namely i) that the coin is fair and that the situation of the (possible) tossing is fair, and ii) that the theory of probability holds. In all worlds relevant for the calculations (both A - and $\neg A$ -worlds) the truth conditions are assumed true. Thus $p(X) = 1$. These are the only relevant truth conditions of the conditional ‘If A , then 0.5 objective probability of B ’. Let B' be: ‘0.5 probability that this coin lands head (when tossed)’. Then we have: $p(X) = p(A \& B')/p(A) = p(B'/A) = 1$: We are 100 per cent certain of the conditional (our subjective probability of belief is 1.0), given the objective truth conditions indicated above.

The truth conditions for the conditional *if A, then B* are however, in addition to X , also Y : ‘The theoretically postulated circumstances that would make B land heads instead of tails’. Let X' be $X \& Y$. Then, $p(X') = p(X \& Y) = 0.5 = p(B/A)$; $p(A \& X') = 0.5 \cdot p(A)$; $p(\neg A \& X') =$

$0.5 \cdot p(\neg A)$, since A and X' are naturally assumed to be probabilistically independent. We also have $p(\neg A \& B) = 0$, since the coin can land neither heads nor tails if it is not tossed. We thus find that we cannot allow, contrary to Edgington's analysis, arbitrary distributions of probability (or beliefs) in $\neg A$ -worlds, for instance one giving $p(X' \& \neg A) \neq 0.5p(\neg A)$.

Both examples show i) that we must muster a lot of the conditional knowledge we already possess in order to get the Equation right in particular cases and, ii) that Adams' thesis makes sense only on the assumed conditional knowledge, and then only in a rather cumbersome manner is able to express the conditional insight originally expressed in the actual conditional.

Concluding remarks

The revised version of the Equation, where we understand 'consistent' in the phrase 'consistent distributions of probability' as 'consistent with the assumptions of the conditional as intuitively understood', is thus not rejected. This means that Edgington's case against truth conditions for conditionals then depends solely on the effectiveness of Adams' thesis, considered on its own, or additionally, on Lewis' bombshell. We have certainly indicated that many, or even most, conditionals are not "ordinary" fact-stating propositions, since they seem naturally to have the same probability of truth across possible worlds, and, in fact, they are naturally used to express the structure of possibility of possible worlds. However, they do not, as a result, need to be without truth conditions. Adams, Edgington, Jackson and Lewis all claim that conditional probability reveals what is essential to and characteristic of conditionals. We have found good reasons to doubt this to be the full story.

Actually, if Edgington's disproof of the Equation had held water, she would have proved that Adams' thesis does not express the conditions for claiming a conditional relation, neither with respect to truth, assertability, belief or probability. Accordingly, she should have rejected Adams' thesis *as such*. The alleged disproof of the Equation does not in any essential way refer to conditions of *truth* rather than for instance to assertability. So if the proof had been sound and valid, it would have proved that no set of conditions, whether of truth, probability, belief or assertability, is able to fulfill Adams' thesis in a consistent manner.

Similarly, Lewis' triviality results follow solely from the assumption that Adams' thesis can be used to identify all conditional relations in a language. Thus the triviality results strike Adams' thesis in general, not only with respect to truth conditions. Implicitly, Edgington rejects Adams' thesis already in her intuitive account, when she says that she is not presenting a reductive account of conditionals. While Edgington's intuitive account of conditional probability was not intended as a reductive account of conditionals, Adams' thesis *is* presupposed as reductive in her disproof of the Equation. Lewis' triviality results should then likewise have struck her as an even graver bombshell than she is willing to admit.

The truth conditions expressed by conditionals are in general more basic than the truth conditions expressed directly by non-conditional (categorical) statements, and are usually presupposed in the latter. Edgington is then right in her intuitive assumption that there is a fundamental difference between conditionals and non-conditional statements. The problem is that neither she nor Lewis takes this difference into account in a meaningful way in the production of the bombshells.

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