Rethinking the Acceptability and Probability of Indicative Conditionals

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Abstract

The chapter is devoted to the probability and acceptability of indicative conditionals. Focusing on three influential theses, the Equation, Adams' thesis, and the qualitative version of Adams' thesis, Sikorski argues that none of them is well supported by the available empirical evidence. In the most controversial case of the Equation, the results of many studies which support it are, at least to some degree, undermined by some recent experimental findings. Sikorski discusses the Ramsey Test, and Lewis's triviality proof, with special attention dedicated to the popular ways of blocking it. Sikorski concludes that the role of the three theses in future studies of conditionals should be re-thought, and he presents alternative proposals.

1 Introduction

Indicative conditionals, like:

(1) If you press this button, the fire alarm goes off.

are an important part of our language. We use them, for example, to express our prediction or generalizations. Partly because of their importance, conditionals are interesting for philosophers and psychologists. They are interested, for example, in truth conditions[1] of conditionals or updating our

[1] See e.g., Baratgin, Politzer, Over, and Takahashi (2018) or Jackson (1987).

beliefs with them.[2] Two other issues which received a lot of attention are the probability and acceptability of indicative conditionals.

In the case of probability, the reasons for all this attention are clear. For instance, if we were able to define the probabilities of conditionals, we could incorporate reasoning with conditionals into the popular and successful framework of Bayesian epistemology.[3]

In the case of acceptability, the attention is a bit harder to explain. The acceptability conditions of other complex expressions are not so widely discussed. They are, to be sure, studied as a part of pragmatics or epistemology, but it seems that there is not, for example, a special problem of the acceptability conditions for conjunction. What is different in the case of conditionals? It seems to me that it is an influence of a very popular philosophical position called the non-truth value view (NTV). It claims that conditionals do not have truth values.[4] The proponents of NTV have to deal with at least two problems. Firstly, we systematically recognize that some conditionals are appropriate to utter in some situations while others are not. In the case of other sentences, it can be often explained by the difference between truth and falsity. So how can we explain that without postulating truth values for conditionals? Secondly, if we claim that conditionals are not truth-apt, it seems natural to assume that they are not probability-apt. The probability of a sentence is the probability of that sentence being true and if a sentence is not truth-apt (think for example about commands or questions), it makes little sense to ask about its probability. If it is so, we even in principle cannot incorporate the conditionals to the Bayesian framework. The answer to both challenges is provided by the notion of acceptability. We can use graded acceptability as a substitute for probability and categorical acceptability as a substitute for truth.

The discussion concerning the probability and the acceptability of conditional, $(A \to B)$, is mainly organized around two influential theses. The first of them is so fundamental for the currently dominant paradigm of thinking about conditionals (see e.g. Over and Cruz, 2018) that it usually just called the Equation:[5]

[2] See e.g., Eva, Hartmann, and Rad (2019).

[3] See e.g., Talbott (2016) or Sprenger and Hartmann (2019).

[4] For the details and motivation of the view see e.g., Bennett (2003) or Edgington (1995). For the critical discussion see: Douven (2015).

[5] See e.g., Edgington (1995).

Equation $P(A \to B) = P(B|A)$

The second thesis is called Adams' thesis:

AT $ac(A \to B) = P(B|A)$

where $P(B|A)$ indicates conditional probability and "$ac()$" indicates acceptability. AT in this form is not a good substitute for truth conditions. It does not provide us with a threshold of acceptability above which a conditional would be acceptable. Such a threshold is provided by another version of AT, the Qualitative Adams' Thesis:

(QAT) An indicative conditional "If A, B" is assertable for/acceptable to a person if and only if the person's conditional degree of belief, $P(B|A)$, is high.[6]

All three theses were evaluated from both empirical and theoretical perspectives. In this chapter, I will examine both of these perspectives and show that there are no convincing reasons to accept any of them, and therefore we should rethink their role in the future study of conditionals. In the second section, I will discuss the experiments dedicated to all three theses. Then I will discuss the theoretical considerations for and against them. In the last section, I will conclude and point to some alternative conceptualizations of the probability of conditionals.

2 Empirical support

In this section, I will discuss empirical experiments concerning the three theses. Before that, I will make a distinction useful in this context.

Conditionals can be divided into positively relevant, irrelevant, and negatively relevant. The positively relevant conditionals are conditionals whose antecedents are positively probabilistically relevant for their consequents. If a sentence is positively probabilistically relevant for another one, then the truth of the first sentence makes the second one more probable. The negatively relevant conditionals are conditionals whose antecedents are negatively probabilistically relevant for their consequents, which means that the truth of

[6] This formulation is inspired by one from Douven and Verbrugge (2012) p. 483.

the antecedent decreases the probability of the consequent. Irrelevant conditionals are the conditionals whose antecedents are probabilistically irrelevant for their consequents. The concept of relevance can be mathematically represented in at least two ways. Firstly, we can use $\Delta P = P(B|A) - P(B|\neg A)$ as a measure of relevance, as proposed in Spohn (2012).[7] If the value of ΔP is 0 the corresponding conditional is irrelevant; when it is higher, then it is positively relevant, and when it is lower, the conditional is negatively relevant. Secondly, relevance can be conceptualized as the difference measure, $P(B|A) - P(B)$. As in the case of ΔP, when the value of difference measure is 0, the conditional is irrelevant; if it is lower, it is negatively relevant; and if it is higher, it is positively relevant. Both conceptualizations classify conditionals in the same way, but the exact level of relevance will differ in some cases.[8] Both notions have been used in experiments on conditionals, and the difference will not matter for our conclusions.

An example of an intuitively irrelevant conditional is:

(2) If I eat an apple today, I will not inherit 1000000$ today.

And a negatively relevant one is:

(3) If he smokes, he will not develop lung cancer.

Going back to our three theses, all of them have been traditionally regarded as descriptively true. Philosophers generally found all of them confirmed by their introspective case by case studies. Many such case were presented, for example, in Bennett (2003), Edgington (1995) or Jackson (1987).

More systematic experimental studies were, firstly, directed toward the Equation. The results of most of these experiments support it. For example, Evans, Handley, and Over (2003), Over, Hadjichristidis, Evans, Handley, and Sloman (2007) or Oberauer and Wilhelm (2003) found significant correlation between participants' responses concerning the probability of conditionals and conditional probability while using different types of conditionals. Over et al. (2007) used "causal" conditionals, i.e., conditionals justified by causal relations, while Oberauer and Wilhelm (2003) uses conditionals that describe

[7] The ΔP was earlier used in causal power theory see e.g., Cheng (1997).

[8] For a detailed discussion of the difference between the two notions and an experiment indicating that ΔP predicts intuitive relevance better than the difference measure, see Skovgaard-Olsen, Singmann, and Klauer (2016a).

relations between frequency distributions. Results of those, and many similar studies (e.g., Fugard, Pfeifer, Mayerhofer, and Kleiter, 2011, Barrouillet and Gauffroy, 2015, Evans, Handley, Neilens, and Over, 2007 or Cruz, Over, Oaksford, and Baratgin, 2016), support the Equation. They convinced many philosophers and psychologists that the Equation is a correct description of how people reason with conditionals and made it, and probabilistic theories based on it, a dominant paradigm for thinking about conditionals.[9]

Both AT and QAT did not receive so much attention. AT was first tested in Douven and Verbrugge (2010). In the experiment, the authors used inferential conditionals divided into inductive, abductive, and deductive conditionals. Inferential conditionals are conditionals that express inferences. Inductive conditionals express inductive inferences, deductive conditionals express deductive inferences, and abductive conditionals express abductive inferences. In the first experiment, the authors tested Adams' Thesis and four weaker versions of it:

(WAT1) $Ac(A \to B) \approx Pr(B|A)$

(WAT2) $Ac(A \to B)$ is high/middling/low iff $Pr(B|A)$ is high/middling/low.

(WAT3) $Ac(A \to B)$ highly correlates with $Pr(B|A)$.

(WAT4) $Ac(A \to B)$ at least moderately correlates with $Pr(B|A)$.

The theses were tested by comparing their prediction with responses given by participants to questions concerning the acceptability and probability of a given conditional.

Surprisingly, only a weak correlation between the conditional probability and the acceptability of conditionals was found. The correlation was especially weak in the case of inductive conditionals. It was not enough to support AT or even two weaker versions of it. Just the weakest version (WAT4) was supported for all kinds of conditionals (inductive, deductive, and abductive). In the third experiment presented in the paper, participants were asked to judge the conditional probability of the consequent given the antecedent and the probability of the conditional. The results of the first experiment and the third experiment were compared. The comparison showed a significant difference between participants' judgments concerning the acceptability and the probability of conditionals. I will discuss this issue later on.

[9] See e.g., Over and Cruz (2018) or Evans and Over (2004).

QAT was, also, tested the first time by Igor Douven and Sara Verbrugge. The experiment was presented in Douven and Verbrugge (2012). The authors tested the predictions of QAT and the so-called Evidential Support Theory presented in Douven (2008):

"EST An indicative conditional ($A \to B$) is assertable/acceptable if and only if $Pr(B|A)$ is not only high but also higher than $Pr(B)$."

The idea behind EST is that a high conditional probability is not enough for a conditional to be acceptable, and positive relevance has to be included as an additional condition. Results show that QAT predicted judgments of speakers worse than EST, and especially poorly in the case of irrelevant and negatively relevant conditionals. This result was replicated in Krzyżanowska, Collins, and Hahn (2017).

A similar idea, of using irrelevant and negatively relevant conditionals, was adopted by Skovgaard-Olsen, Singmann, and Klauer (2016b). The authors tested the Equation and AT. The items include positively relevant and, crucially, irrelevant and negatively relevant conditionals. The results showed a significant correlation between the conditional probabilities and the probabilities of the positively relevant conditionals. At the same time, this was not the case for irrelevant and negatively relevant conditionals. There the probabilities of conditionals were much lower than the conditional probabilities. The results for acceptability were almost the same. The failure of AT is not that surprising if we take into consideration the failure of its qualitative version and the results from Douven and Verbrugge (2010), but the poor performance of the Equation is unexpected given the rich history of experiments that supported it. This result was replicated in experiments with different experimental designs. For example, the results of Krzyżanowska et al. (2017), Skovgaard-Olsen et al. (2016a), Vidal and Baratgin (2017) and Fugard, Pfeifer, and Mayerhofer (2011) all suggest the Equation (by itself) does not correctly predict the probability of conditionals in the case of irrelevant and negatively relevant conditionals. This interpretation of the results is controversial. First, it is not clear how it squares with the earlier results, and second, there is an alternative interpretation of the effect.

How should we explain this discrepancy between the results presented in Skovgaard-Olsen et al. (2016b) and earlier experiments supporting the Equation? The authors claim that previous studies do not include irrelevant or negative relevant conditionals and therefore cannot support the unrestricted version of the Equation. For example, all conditionals considered in Over et al. (2007) seem to be intuitively positively relevant one.[10] The case of Oberauer and Wilhelm (2003) is similar. The successful replications and the lack of irrelevant and negatively relevant conditionals in the stimuli used in the earlier experiments strongly suggest that the effect of the relevance on the assessment of the probability or acceptability is robust, and the support for the Equation provided by those experiments should be re-evaluated.

A defender of the Equation may claim that the effect of the relevance of conditionals is pragmatic, and therefore the unrestricted version of the Equation can still be preserved. This solution is somewhat supported by the results of Skovgaard-Olsen, Kellen, Krahl, and Klauer (2017) which suggests that the effect of relevance on the assessment of truth is much weaker than its effect on the acceptability or probability of conditionals. This suggests that the effect of relevance is pragmatic in nature. On the other hand, results of different experiments do suggest that relevance influence truth assessments, for example, Krzyżanowska et al. (2017) or Douven, Elqayam, Singmann, and Wijnbergen-Huitink (2017). The hypothesis that the effect is pragmatic was also tested directly in Skovgaard-Olsen, Collins, Krzyżanowska, Hahn, and Klauer (2019). The authors tested three hypotheses describing different pragmatic mechanisms generating the reason-relation part of the content of indicative conditionals responsible for the effect. Firstly, they checked if it is cancelable in the way conversational implicatures are, secondly, they tested if its projection behavior resembles that of presuppositions, and finally, they tested if it is treated as not-at-issue content which is believed to be one of the characterizing features of the conventional implicature. Surprisingly, the results of all three experiments were negative, which suggests that the reason-relation part of the content is not conversational implicature, presupposition, nor conventional implicature, and therefore, likely, not a pragmatic content. The authors in discussing their results point out that the features of conventional implicature (including it being not-at-issue content) are still very controversial and therefore, given the results of Skovgaard-Olsen et al. (2017) it is likely that the reason-relation part of the content of conditionals is conventional implicature. This, in the opinion of the authors, does not necessarily make it a part of the pragmatic content. Conventional implica-

[10]E.g., "If Adidas get more superstars to wear their new football boots then the sales of these boots will increase" or "If the cost of petrol increases then traffic congestion will improve".

ture has been classified both as part of pragmatic and semantic content by different authors in the relevant literature.[11] In light of that, it seems that the pragmatic origin of the effect of relevance on probability or acceptability of conditionals is not supported by the existing evidence.

Finally, we may wonder if it is possible to restrict the Equation to make it consistent with the available evidence? It seems possible. A version of the Equation restricted to the positively relevant conditionals seems to be in line with the results of all the mentioned experiments. Such a version can look, for example, like this:

Equation+ If $\Delta P > 0$ then $P(A \to B) = P(C|A)$

All this seems to weaken the position of the unrestricted Equation. At the same time, it puts all the theses in a somehow similar position. All of them were initially regarded as intuitive and supported by introspective case-by-case examination. In light of the available empirical evidence, both QAT and AT seem to be empirically inadequate. QAT performs poorly (Douven and Verbrugge, 2012) in comparison to an EST. AT was disconfirmed by results of Skovgaard-Olsen et al. (2016b) which show that it fails in the case of the irrelevant conditionals, and by the results of Douven and Verbrugge (2010), which show that it is not supported in the case of the inductive conditionals. Similarly, the results which were considered to be evidence for the Equation are to some degree undermined by the results of Skovgaard-Olsen et al. (2016b) and considerations concerning the conditionals used in the studies.

3 Theoretical arguments

The theoretical studies concerning the Equation, AT and QAT have a longer history than the empirical ones. Still, it seems that there is not much theoretical justification for the three theses. Even some of their defenders seem to agree. For example, Douven (2015) says about the Equation:

[11] "The best candidate, instead, is most likely a conventional implicature. These findings suggest a new direction for the debate on whether relevance is part of the semantics or pragmatics of the conditional. A final judgment will rest on the definition of semantics and pragmatics, and on how conventional implicatures are categorized according to that definition." Skovgaard-Olsen et al. (2017) p. 69.

"While there is no known argument for this thesis showing that it has any normative force, to many the proposal does ring true, at least prima facie."

In this section, I will discuss the theoretical considerations presented for and against the Equation, ST, and QAT. I will start by discussing the Ramsey Test, which is commonly used to argue for the Equation or AT. Then I will move to trivialization proofs. I will discuss them with special attention dedicated to the two most popular ways to block them: denying that conditionals are propositions and postulating that the meaning of a conditional depends on the beliefs of the speaker. Finally, I will discuss the relationship between the semantics of conditionals and their probability.

3.1 Ramsey test

The Ramsey test was presented by Ramsey (1990):

"If two people are arguing 'If p will q' and both are in doubt as to p, they are adding p hypothetically to their stock of knowledge and arguing on that basis about q; so that in a sense 'If p, q' and 'If p, $\bar{q}$' are contradictories. We can say that they are fixing their degrees of belief in q given p."
(Ramsey, 1990 p. 155)

The test is very popular among philosophers and psychologists [12] and it is typically interpreted a as the procedure for evaluating acceptability or probability of indicative conditionals (see e.g., Gibbard, 1981, Edgington, 1995, or Bennett, 2003). and many cases in which its predictions are correct were considered and discussed.[13] Because of this intuitiveness, but also simplicity, the procedure served as a direct inspiration for three successful research programs: belief revision theory, possible world semantics for conterfactuals, and suppositional theories of indicative conditionals. The theories from the last group are typically committed to the Equation or AT. The Equation is a probabilistic reinterpretation of Ramsey test, and therefore, the argument from the one to the other is straightforward: If you accept the Ramsey test and conditionalization as a rule for belief revision, which is typically

[12] E.g., "Most theorists of conditionals accept the Ramsey test thesis for indicatives." Bennett (2003) p. 29.

[13] See e.g. Evans and Over (2004) p. 21-22.

accepted in this context (see e.g, Pettigrew, 2020), then you have to accept the Equation which is just its probabilistic reformulation.[14]

There are two problems with this argument. Firstly, the intuition behind the plausibility of both Ramsey test and the Equation seems to be exactly the same. The second is merely a reformulation of the first, and in all cases in which Ramsey test delivers a correct result, the Equation will give us just as satisfying an answer. Therefore, it seems that by appealing to the test we do not provide any independent evidence for the Equation.

Secondly, the close parallel between the Equation and the Ramsey test, and the empirical results which established limits of the Equation, point toward possible limits of the test. As we have seen in the previous section, the Equation seems to fail for the irrelevant and negatively relevant conditionals. The situation seems to be similar in the case of the Ramsey test; considers once again a negatively relevant conditional:

(4) If he smokes, he will not develop a lung cancer.

Let us say that the lifestyle of the person in question is perfect and he does not have any genetic predispositions to developing cancer, so even in the case he smokes the probability that he will develop cancer is really low, for example 1%. In such a case, if we conduct the Ramsey test on (4) we will get the conditional probability of 99% and therefore we should believe in (4). Still, because antecedent of (4) is negatively relevant for its consequent, (4) is hard to accept. The intuition that negatively relevant indicative conditionals are defective is supported by the results of experiments that test acceptability and probability of negatively relevant conditionals (e.g., Douven and Verbrugge, 2012, Skovgaard-Olsen et al., 2016b or Douven et al., 2017). This deficiency of the Ramsey test was considered, and the revised version of the test was proposed in Rott (1986).

To sum up, it seems that the intuitions behind the Ramsey test are the same intuitions that underline the Equation; therefore, appealing to the former does not provide any independent justification for the latter. Secondly, the plausibility of the Ramsey test may be restricted to positively relevant conditionals.

[14] See e.g., Bennett (2003) or Evans and Over (2004).

3.2 Triviality proofs

Triviality proofs show that accepting the Equation leads to unacceptable conclusions. For example, the first proof from Lewis (1976) showed that we can infer from the Equation that $P(A \to B) = P(B)$ which is generally false:

(5) $P(A \to B)$

(6) $P(A \to B|B)P(B) + P(A \to B|\neg B)P(\neg B)$

(7) $P(B|A, B)P(B) + P(B|A, \neg B)P(\neg B)$

(8) $P(B)$[15]

As we have already mentioned, the conclusion is clearly unacceptable. The two most popular ways to block the proof is to deny that conditionals are propositions (e.g., Bennett, 2003 or Edgington, 1995) or to postulate that the meaning of conditionals depends on the beliefs of the speakers (e.g., Douven, 2015 or van Fraassen, 1976).

The first option involves accepting NTV: that the conditionals are not propositions and are therefore not truth-apt. If conditionals are not propositions, they cannot occur in Boolean combinations; therefore, for example, we cannot use the law of total probability on conditionals, and therefore, Lewis' proof is blocked.

But how plausible is NTV? Several arguments for this view have been presented, I will discuss one of them later on and all of them were, in my opinion convincingly, countered in Douven (2015). The rejection of the propositional view seems to be really costly, and these costs are rarely acknowledged.

First of all, one of the consequences of NTV is that conditionals no longer have a probability. The probability of a sentence is typically understood as the probability of this sentence being true; therefore if a sentence is not truth-apt, it is also not probability-apt. Because of that, we have to replace the Equation with AT. It describes the acceptability of conditionals, and therefore, does not require them to have probabilities.

Secondly, the NTV has a problem with explaining the way conditionals are regularly used as premises in reasoning. Typically, we understood the validity of reasoning as the preservation of truth. If one of the premises is

[15] Steps from (5) to (6) and from (7) to (8) are instances of probability rules, $P(x) = P(x|y)P(y) + P(x|\neg y)P(\neg y)$ and $P(x|y, \neg x) = 0$.

not truth-apt, there is nothing to be preserved. Therefore, NTV makes reasoning involving conditionals unexplainable, if one understands validity as truth preservation. This is an instance of the so-called Frege-Geach problem (see Kölbel, 1997). In general, the problem consists in the fact that a view that denies that expressions of a given class are truth-apt, has to explain possible occurrences of such expressions in truth-functional contexts (see e.g., Schroeder, 2008). To solve the problem one would have to propose an alternative, revisionary way of understanding the validity of reasoning. One such proposal, p-validity, was presented in Adams (1975) in which AT was also defended:

> "...an inference to be *probabilistically valid* (abbreviated p-valid) if and only if the uncertainty of its conclusion cannot exceed the sum of the uncertainties of its premises." (Adams, 1998 p. 131)

This proposal on its own will not help us with our problem. As we have seen above, one of the consequences of NTV is that conditionals cannot have probability, or at least not in the sense the truth-apt sentences do,[16] therefore p-validity cannot be directly used to assess the validity of arguments with mixed conditional and unconditional promises. Perhaps we can use some proxy-quantity, in place of the probability of conditionals, to compute p-validity? There seem to be two natural candidates, acceptability and conditional probability, but neither of them is unproblematic. As quoted above p-validity is defined in terms of uncertainty. Uncertainty of a sentence, according to Adams, equals 1 − probability of the sentence. In light of that, the acceptability cannot be used in computing p-validity as we have no idea if and how it relates to uncertainty. Additionally, acceptability is typically believed to have different properties than probability (therefore it can be used to avoid Lewis' trivialization), so it is not clear if we can extend the p-validity framework to incorporate acceptability. What about conditional probability? According to one of the interpretations of the theory presented in (Adams, 1975), the conditional probability differs significantly from (unconditional)

[16]In fact Adams (1975) claims that this natural interpretation of probability is not applicable to conditionals. He seems to be aware of how problematic consequences of NTV are, for example: "The author's very tentative opinion on the 'right way out' of the triviality argument is that we should regard the inapplicability of probability to compounds of conditionals as a fundamental limitation of probability, on a par with the inapplicability of truth to simple conditionals."Adams (1975) p. 35.

probability. In light of that, someone may assume that conditionals have conditional probabilities, without having truth values or unconditional probabilities. Adams (1975) seems to be using this assumption, when analyzing cases of inference with mixed premises (e.g., antecedent restriction). His framework delivers many plausible results concerning the validity of such inferences (e.g., he shows that contraposition is not generally valid). At the same time, this approach seems to be based on questionable foundations. As discussed in (Hájek, 2012), the Adams' conditional probability is in many respects dissimilar to (unconditional) probability. For example, in contrast to probability, Adams' conditional probabilities do not attach to the Boolean combination of sentences.[17] As we have seen, p-validity was defined in terms of (unconditional) probability and, as it stands, conditional probability cannot be used when we calculate it. Additionally, given the discussed differences, it is not clear if p-validity can be easily generalized to be able to incorporate the acceptability or conditional probability. This problem can be seen as a probabilistic version of the Frege-Geach problem, a probabilistic framework (e.g., Bayesianism or p-validity) that cannot accommodate conditionals that do not have a probability. Using p-validity to understand reasoning with mixed conditional and non-conditional premises is questionable if conditionals do not have truth values, and therefore probabilities.

Thirdly, accepting NTV makes it hard to make sense of conditionals embedded in truth-functional contexts like disjunction or conjunction, for example:

(9) Either he is in Rome, if he is in Italy, or he is in Bordeaux, if he is in France.[18]

According to NTV, conditionals are not the type of things that can occur in such contexts. The evaluation of the whole sentence requires its arguments to be true or false but according to NTV conditionals are neither. The defenders of AT developed elaborate ways of explaining away such sentences (see e.g., Edgington, 1995); at the same time, others come up with new examples harder to explain away (see e.g., Kölbel, 2000). The other way to solve this problem is to provide an alternative, non-truth functional analysis of contexts like disjunction or conjunction. Perusing this strategy

[17] Those differences were reasons why Lewis (1976) call Adams' conditional probabilities, " probabilities only in name".

[18] Example from Kölbel (2000).

may be challenging. In doing so, one not only goes against a well-entrenched understanding of logical connectives, but also for sake of completeness will have to provide a similar analysis for other truth-functional contexts in which conditionals can occur (e.g., It is true that $if A \to B.$ etc.).

All these problems seem to suggest that conditionals behave as truth-apt propositions. It is also suggested by the reaction of participants of the experiment asked to assess truth values or probabilities of conditionals. They perfectly well understand both questions about truth-values (see e.g., Douven, Elqayam, Singmann, and van Wijnbergen-Huitink, 2020 or Krzyżanowska et al., 2017) and probabilities of conditionals (e.g., all the articles which test the Equation) and do not seem to be confused by either of them. This is, once again, unexpected if conditionals are not propositions, consider for example asking somebody about the truth-value of a question. In light of that, denying that the conditionals are propositions is both unintuitive and costly.

The second popular way to dodge triviality was explored in Douven (2015) (after van Fraassen, 1976). The prove uses a generalized version of the Equation, GSH:[19]

GSH $P(A \to B|C) = P(B|A, C)$

It was used to infer (7) from (6). Lewis derives GSH from three assumptions. The first assumption claims that the considered class of probability functions is closed under conditionalization. The second assumption is the Equation, and the third is that the interpretation of the natural language indicative conditionals does not depend on the belief states of the speaker. I will refer to this assumption as the independence assumption or IA. Both Douven (2015) and van Fraassen (1976) argue against the assumption in order to save the Equation.

Van Fraassen believes that the source of Lewis' assumption is his metaphysical view, so-called modal realism. According to modal realism, possible worlds are real and objective in the sense in which the actual world is. If we combine modal semantics, which defines the meanings of conditionals in terms of the properties of possible worlds, with modal realism, the meanings of conditionals do not depend on our beliefs but on the objective properties of possible worlds. Van Fraassen claims that, if we adopt a less realistic notion of possible worlds, the assumption loses its appeal. If possible worlds

[19]The Equation is sometimes called Stalnaker hypothesis, therefore its generalized version is called Generalized Stalnaker Hypothesis (GSH).

are not objective and in some sense depend on our beliefs, then the meanings of conditionals will also depend on them.

Douven (2015) discusses the IA in more detail. He gives three arguments against it, and attacks some of the arguments, which were presented for it. I will start by discussing his three arguments:

Firstly, some of the popular and promising semantic theories proposed for conditionals suggest that IA is false. The two theories mentioned by the author are Stalnaker style modal semantics which uses the notion of similarity between possible worlds and inferentialist semantic.

Stalnaker semantics can also be interpreted in a way in which it supports IA. The realistic interpretation held, according to Van Fraassen, by Lewis is an example of such interpretation. More importantly, Stalnaker semantics is inconsistent with the Equation (see e.g., Stalnaker, 1976). Therefore appealing to it in order to attack IA and defend the Equation is not a convincing strategy.

The inferentialist semantics presented in Krzyżanowska, Wenmackers, and Douven (2014) seems to be a very promising theory. Its main claim is:

Definition 1 "A speaker S's utterance "If p, q" is true iff (i)q is a consequence—be it deductive, abductive, inductive, or mixed-of p in conjunction with S's background knowledge, (ii) q is not a consequence—whether deductive, abductive, inductive, or mixed—of S's background knowledge alone but not of p on its own, and (iii) p is deductively consistent with S's background knowledge or q is a consequence (in the broad sense) of p alone."(Krzyżanowska et al., 2014 p. 5)

If we consider this formulation, it is not clear why inferentialist semantic supports rejection of IA. The meanings of conditionals are here relative to the knowledge but not to the beliefs of the speaker. The authors explain that it would be counter-intuitive to treat as true conditionals whose consequences were inferred from antecedents with the use of false beliefs.

Douven (2015) presents a different version of the theory (see also Douven et al., 2020 and Douven, Elqayam, and Krzyżanowska, this volume):

Definition 2 "a conditional is true in a given context iff the consequent follows via a number of steps from the antecedent, possibly in conjunction with contextually accepted background premises where, first, the steps are valid in deductive, inductive or abductive sense, and second the consequents does not follow (in the same generalized sense) from the premises alone." (Douven, 2015 p. 38)

According to him the belief sensitivity of conditionals is imposed by this version of the semantics because the acceptability of potential background premises depends on the beliefs of the speaker or evaluator. This dependence causes the second formulation of inferentialist semantics to collide with IA, but it also makes the proposal vulnerable to the problem which motivated the phrasing of the first formulation.

If the speaker or the evaluator is liberal in accepting the background premises, for example, he accepts as premises all beliefs of the speaker, then his false beliefs can be a basis for true conditionals.

For example, let us assume that I believe that the moon is made of cheese and all my beliefs are acceptable premises for my conditionals. It is known to all of my interlocutors that I share this preposterous belief. It is easy to see that according to the Definition 2 a conditional:

(10) If we bring the moon to the surface of the earth, we will end the world hunger.

uttered by myself is true. Still, it seems to me that none of my sane interlocutors would agree to it. The fact that they know that I believe that the moon is made of cheese seems to make no difference for their assessment of (10) uttered by me. This seems to suggest that the Definition 2 is too permissible in the way it relates the truth of a conditional to the beliefs of the speaker or evaluator.

Secondly, Lindström (1996) proposed rejecting IA as a way out of the so-called Gärdenfors' Paradox (Gärdenfors, 1986). The paradox shows that no non-trivial belief system can at the same time satisfies both the Ramsey Test and the following Preservation Condition:

"(P) If a proposition B is accepted in a given state of belief K and A is consistent with the beliefs in K, then B is still accepted in the minimal change of K needed to accept A."(Gärdenfors, 1986 p. 82)

(P) seems to be a very natural assumption while the Ramsey Test, as we have seen, is a popular procedure for testing conditionals. Lindström shows that we can have both if we drop IA. As we have already noted, appealing to the Ramsey test, of which the Equation is a probabilistic reformulation, to defend the Equation seems not to give us a lot of additional independent evidence. Secondly, the empirical evidence concerning the effects of relevance on the probability of conditionals suggests that the intuitiveness of the Ramsey test may be limited, so despite its popularity, it may not be worth preserving.

As an independent justification for the rejection IA, Lindström presents the certeris paribus cases. These are cases in which we cease to accept a conditional after we have learned some additional evidence. An example of such a case is:

(11) If I pass today's exam, I will go for a beer afterward.

which is true, or at least acceptable, about me. But it ceases to be the case if I learn that I have another, very hard exam tomorrow. Lindström claims that when I learn about the second exam, (11) changes its meaning. If (11) conveys the second meaning it is false while if it has the first meaning (the meaning it had before I learned about the second exam), it is, still, true. This explanation of the ceteris paribus cases seems to have an unintuitive consequence. Let us consider a discussion between me and my friend: she knows about the second exam of which I am still unaware. We disagreed about (11). According to Lindström's proposal, we talk past each other, because each of us means different things by (11). This is unintuitive.

Finally, Douven (2015) points out that similar proposals were made for different expressions (e.g. taste predicates, modal operators). This is undoubtedly true but as far as I know, neither of these proposals is uncontroversial (see e.g., Hirvonen, Karczewska, and Sikorski, 2019). Even if it was the case that these proposals were uncontroversial, it is not clear why their success should tell us anything about conditionals. It is possible, and maybe even plausible, that IA may be false, for example, in the case of taste predicates for reasons absent in the case of conditionals.

It seems that the postulated relativity should be reflected in the way we use conditionals. As far as I know, the only reported phenomenon which can suggest it is the so-called Gibbard phenomenon. Consider the following story:

"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." (Gibbard, 1981, p. 231.)

Now according to Gibbard, if both conditionals are true, they would together with the so-called conditional non-contradiction rule:

CNC $\neg((A \to \neg B) \wedge (A \to B))$

lead to inconsistency. Both conditionals are based on true beliefs and the support for them seems to be symmetrical. Therefore, there is no reason why we should ascribe to them different truth values or judge either of them false. Gibbard concludes that both conditionals are acceptable, and the existence of such pairs is an argument for NTV. There seems to be a problem with this argument. The observation that in this situation both conditionals are acceptable is in tension with the Equation (and even more so with QAT).[20]

It is easy to see that according to the Equation, it cannot be the case that both $(A \to B)$ and $(A \to \neg B)$ are highly probable at the same time. Therefore, it is the case that two acceptable conditionals of these forms cannot have, at the same time, a high probability (>50%). That seems to show that using the example to argue for NTV to defend the Equation or AT is misguided.

The phenomenon is very controversial; many different interpretations were proposed. For example, Lycan (2003) denies that the support for both conditionals is symmetrical and therefore claims that just one of them is true. Finally, following Krzyżanowska et al. (2014), one can claim that the meaning of conditionals depends on the beliefs of the speaker. In the case described by Gibbard, it is clear that both Zack and Jack based their conditionals on

[20] It is also discussed in Jackson (1987): "When A is consistent, there is something quite generally wrong with asserting both $(A \to B)$ and $(A \to \text{not-}B)$. We cannot assert in the one breath 'If it rains, the match will be cancelled' and 'If it rains, the match will not be cancelled'. This conforms nicely with [AT]; for, by it, we have $As(A \to B) = 1 - As(A \to \text{not-}B)$, from the fact that $P(B/A) = 1 - P(\text{not-}B/A)$. Thus, the fact that $(A \to B)$ and $(A \to \text{not-}B)$ cannot be highly assertible together when A is consistent is nicely explained by [AT] as a reection of the fact that $P(B/A)$ and $P(\text{not-}B/A)$ cannot both be high when A is consistent. Indeed, [AT] explains the further fact that $(A \to B)$ and $(A \to \text{not-}B)$ have a kind of 'see-saw' relationship. As the assertibility of one goes up, the assertibility of the other goes down."

different beliefs based on different evidence. Because of that, both conditionals, despite their superficial form, are not in any tension and therefore not inconsistent even when combined with CNC; they are based on different beliefs and therefore they express different relations. This interpretation of the phenomenon, in fact, supports rejections of IA.

It seems to me that it is unclear if natural language speakers are willing to accept the Gibbard-like pairs of conditionals. Even If they were, it is even less clear how to interpret this phenomenon. In light of that, this argument does not make IA significantly less plausible.

At the same time, it should be noted that rejection of IA can have potentially unwelcome consequences. For example, as noted by Lewis (1976), it is not clear whether we can explain a disagreement about conditionals if their meaning is relative in the proposed way (in line with our discussion of (11) above). It was countered by Douven (2015) that it is not necessary for the disagreement that the arguing parties interpret the proposition in question in exactly the same way. On the other hand, it seems that we should agree with Lewis that it may be hard to account for disagreement on the basis of the theory which makes the meaning of conditionals relative to opaque features[21] of the speaker (her beliefs). As we have seen, in the case of Definition 1 and Definition 2 it is not clear if such explanation which does not run into other problems is available.

Finally, it seems that rejecting IA would be in tension with the Equation. The Equation claims that the probability of a conditional depends just on the conditional probability of its antecedent given its consequent and not on any other factors. If we reject IA, we claim that the meaning of a conditional and therefore its truth condition depends on some other factors, namely the beliefs of the user. If we assume that the probability of a sentence is determined by its truth condition, which seems to be a natural assumption, then it seems that meaning relativized to beliefs does not correspond well to a probability which is not explicitly relativized.

A number of other triviality proofs were proposed, for example, Carlstrom and Hill (1978), Milne (2003) or Fitelson (2015).[22] As far as I know, all of these proofs are blocked by NTV but not by rejecting IA. For example, in order to block a triviality proof from Hájek (1989), Douven has to claim that

[21] Those are features that are not necessarily known to all of the participants of the conversation and therefore should not be included into the conversational common ground.

[22] For discussion see: Hájek and Hall (1994).

no finite model can represent a rational agent belief states's (Douven, 2015). Discussing the plausibility of this assumption goes beyond this scope of the paper.

It is hard to consider the triviality proofs conclusive arguments against the Equation. The two discussed ways to block the proofs, despite their problematic consequences, are available, and they are hardly the only ones (see e.g., Bradley, 2000 or Sanfilippo, Gilio, Over, and Pfeifer, 2020 which I will briefly discuss in the next subsection). On the other hand, as far as I know, none of these ways can be considered especially attractive and therefore the triviality proofs show, at the very least, that sticking to the Equation is costly.

Hájek (2012) argued that AT is also susceptible to a triviality proof analogous to one he presented in Hájek (1994) against the Equation. He points there that a plausible conceptualization of the acceptability has to share features with probability which made it susceptible to his argument.

3.3 Truth conditions and Probability

What is the relation between the truth conditions of a sentence and its probability? Let us start by considering sentences that are not truth-apt and therefore have no truth conditions. In such cases attributing probability to such sentences seems to be a category mistake. As we have already seen, it seems nonsensical to ascribe probabilities to questions (e.g., "Should I open the window?") or commands(e.g., "Open the window!"), uncontroversial and prototypical examples of non-truth-apt sentences. If a sentence S in question is truth-apt, as I already hinted, a natural and straightforward interpretation seems to be:

SP The probability of S is the probability of it being true.

This interpretation of the relation between semantics and probability seems to be uncontroversial to the point that, as far as I know, no alternative has been explicitly proposed.[23] SP captures the relation between the probabilities of complex sentences and their components, for example, the general probability rule for disjunction: $P(A \text{ or } B) = P(A) + P(B) - P(A$

[23]Adams (1975) reject SP for conditionals but as far as I understand, he does not provide an alternative. At the same time, his theory is usually interpreted as describing the acceptability of conditionals rather than their probability.

and B) reflects its truth conditions: (A or B) is true iff (A) is true or (B) is true.

Is the relation the same in the case of conditionals? It seems so. If we adopt the NTV view we are in the first case and, as we have already shown, we have to retreat from the Equation to AT, which does not claim anything about the probability of conditionals. Therefore SP is trivially fulfilled; no truth and no probability. Otherwise, we have to explain how it is possible that conditionals do not have truth values but have probabilities.

Propositional semantics also adheres to SP. For example, the authors of Johnson-Laird and Byrne (2002) defend the mental model theory according to which the truth conditions of natural language conditionals are those of material implication: ($A \to B$) is true iff (A) is false or (B) is true. Consequently, they propose a fitting probability definition: $P(A \to B) = P(\neg A$ or $B)$. So, the relation between semantic properties and probability of conditionals conforms to SP, and therefore the theory, despite its other well-described shortcomings (see e.g., Bennett, 2003), provides a coherent picture of truth and probability.

In light of that, it is interesting to see if there is a semantic theory that can provide a basis for the Equation, or conversely what semantic properties are suggested by it.

The best candidate seems to be trivalent semantics proposed by de Finetti.[24] The theory is part of a more general subjective Bayesian theory of reasoning. In his de Finetti (1980) he divided knowledge into three levels. *Level 0* describes the objective knowledge and is well described by the bivalent logic. *Level 1* describes categorical knowledge as possessed by humans and therefore it includes the third logical value *uncertain*, which represents a given individual being uncertain about a given sentence. Finally, *Level 2* is human knowledge represented in a graded numerical way. De Finetti's three-valued semantics for conditionals is a part of a description of *Level 1*. According to it, a conditional is true if both antecedent and consequent are true, is false if the antecedent is true and consequent is false, and it is uncertain or void if the antecedent is false. The semantics is often justified by the analogy between the conditionals and conditional bets (for more details, see Egré, Rossi, and Sprenger, this volume and Over and Cruz, this volume). A conditional bet is called off if its condition is not satisfied, similarly a conditional is void if its antecedent is false (see Table 1). The semantics is supported by the results of

[24]See Baratgin et al. (2018) for discussion.

experiments in which participants tend to produce so-called defective truth tables, that is ones in which conditionals with false antecedents are judged to be devoid of value (see e.g., Baratgin et al., 2018 or Over and Baratgin, 2017). On the other hand, the semantics performed poorly in other experiments, for example, Skovgaard-Olsen et al. (2019) or Douven et al. (2020).

What do these truth conditions tell us about the probability of conditionals? In the words of Over and Cruz (2018):

> "The probability of the conditional *if p then q* for de Finetti is the probability that $p\&q$ holds given that the conditional makes a non-void assertion, that p holds, and this probability is of course the conditional probability of q given p, $P((p\&q)|p) = P(q|p)$."

As we see the semantics implies the Equation. But there seems to be a hidden assumption used in the derivation of probability. Consider the following example:

	A	B	Conditional bet (B if A)	$(A \rightarrow B)$	$P(w^n)$
w^1	1	1	win	1	0.25
w^2	1	0	loss	0	0.25
w^3	0	1	called off	v	0.25
w^4	0	0	called off	v	0.25

Table 1: An example of a conditional bet and the corresponding conditional

The probability of each of the situations $(w^1, ..., w^4)$ is 0.25. If we use the trivalent truth conditions to calculate the probability of $(A \rightarrow B)$, we will get 0.25. The conditional is true just in w^1, it is false in w^2 and void in w^3 and w^4. So the probability that $(A \rightarrow B)$ is true equals 0.25. At the same time, $P(B|A)$ in the described situation will be 0.5. In order to equate the probability of $(A \rightarrow B)$, derived by means of the truth conditions with $P(B|A)$, we have to condition on the conditional not being void or, in other words, ignore the cases in which antecedent is false and therefore the conditional is void during the assessment of probability. Is this assumption justified? w^3 and w^4 seem to be just as legitimate cases as w^1 or w^2 and it is not clear why we should ignore them.

In light of that, at the very least, it is not clear if the assumption necessary for connecting trivalent semantics and Equation is justified. Perhaps the "void" value can be interpreted in a way that implies that a conditional does not have an objective truth value in false antecedent cases, and therefore these cases should not contribute to the calculation of its probability (see Over and Cruz, 2018, and Over and Cruz, this volume).

If the assumption is granted, the resulting theory has many attractive features. An example of such theory is a recent version of the trivalent semantics combined with Equation presented in Sanfilippo et al. (2020).[25] The theory does not validate the import-export principle:

IE $P(B \to (A \to C)) = P((A \land B) \to C)$

assumed in Lewis' proof, and because of that, is not susceptible to this version of trivialization. Additionally, the authors show that their theory can be generalized to deal with iterated and nested conditionals. Because of these features, it is clearly a promising proposal (see also Over and Cruz, this volume, and Pfeifer, this volume). On the other hand, IE is often regarded to be plausible and therefore wanted (see e.g., Egré et al., this volume). Secondly, as we have seen there are versions of triviality arguments that do not use the import-export principle; an example of such proof was proposed in Hájek (1989).

It seems worthwhile to consider how those theoretical considerations square with the results of psychological experiments. As we have seen, there is growing empirical evidence suggesting that the Equation holds only for the positively relevant conditionals. De Finetti semantics, combined with the discussed assumption, supports the unrestricted Equation and therefore accepting it commits us to the pragmatic explanation of results of, for example, Skovgaard-Olsen et al. (2016b). At the same time, it is unclear if and how the semantics can be modified in order to support the qualified version of the Equation. Perhaps combining the truth conditions defined by de Finetti's truth tables with the additional requirement of positive relevance would be a way to construct such a theory. As far as I know, this step has not been taken in the literature. Therefore it seems that we are dealing here with a curious situation in which empirical and theoretical considerations pull in opposite directions. The unrestricted version of the Equation is theoretically

[25] Sanfilippo and his coauthors also assume that void cases do not play the role in assessing the probability of conditionals: "This value $[P(C|A)]$ does, of course, depend on subjective mental states, which concern the uncertainty on C (when A is assumed to be true), and the effect of these on conditional probability judgments." Sanfilippo et al. (2020) p. 4.

justified by the corresponding semantics, but not supported by the totality of empirical results, while it is not clear if the restricted version supported by the empirical evidence can be supported by any semantics theory.

The situation is a bit more complicated in the cases of QAT and AT. That is so because it is not clear what the relation is between the truth and the acceptability of a given sentence. In light of that, it seems that if we are to have any theoretical justification for QAT or AT, it will come from their relation to the Equation.

3.4 Probability and Acceptability

In this section, I will discuss the possible conceptual relation between all three theses.

The relation between probability and acceptability is a well-discussed topic in philosophy. The most straightforward way to relate the two notions is the Lockean Thesis:[26]

LT A proposition φ is acceptable iff the probability of φ is high.

From the Equation and LT we can deduce QAT. The intuition behind LT seems, also, to supports AT. If categorical acceptance coincides with high probability then, it seems natural that, if there is something like graded acceptability, it will coincide with probability. But what if we accept the NTV and therefore deny that conditionals have probabilities? It seems that in such a case we have to reject LT in order to be still able to claim that conditionals have acceptability at all. If we endorse any other theory of acceptability[27] it seems that we are losing the theoretical basis for QAT and AT. In this place, we should also point out another controversial issue, namely the differences in our intuitions concerning the acceptability and the probability of conditionals. Results from Skovgaard-Olsen et al. (2016b) found no significant differences between assignments of acceptability and probability to conditionals made by participants. This suggests that $P(A \to B) = ac(A \to B)$. On the other hand, Douven and Verbrugge (2010) found a significant difference in the case of inductive and abductive conditionals. A possible explanation is that Skovgaard-Olsen et al. (2016b) used causal, non-inferential conditionals while Douven and Verbrugge (2010) used inferential conditionals. If so, it

[26]LT seems to be quite popular, see e.g. Foley (2009).

[27]Alternative theories are usually more complex see e.g. Proust (2012).

may be the case that there is a difference in intuitions concerning acceptability and probability is restricted to the inferential conditionals. It seems that more evidence should be collected in order to settle this issue. Replicating both experiments may be a good first step.

4 Conclusion

I will conclude by judging how the theses stand against the presented evidence, then I will discuss the proposed and possible alternatives to the three theses.

How do the three theses (the Equation, AT and QAT) stand against the presented evidence? Let us start with the theoretical considerations. All three seem to be in a similar situation. There seem to be no strong theoretical arguments for any of them. The intuitions behind the Ramsey test seem to be the same intuitions that initially make the theses plausible. Therefore appealing to the test does not give us additional reasons to believe it. The Equation is supported by de Finetti's three-valued semantics, if we ignore the void cases when we consider the probability of conditionals. QAT is supported by the Equation if we accept LT and unsupported otherwise. AT seems to be, to some degree, supported by QAT.

At the same time, we have strong arguments against the Equation in the form of triviality proofs. Neither of the proofs is conclusive, given the possible ways to dodge them. On the other hand, they convinced some philosophers to abandon the Equation (e.g., Stalnaker, 1976) and showed that sticking to it is costly. For example, we have to abandon IA which, as I tried to show in the third section, is plausible. A triviality argument of similar strength was also presented against AT. I am not aware of any comparable theoretical arguments against QAT.

As we have seen, all three theses were traditionally regarded as descriptively true, but the results of the empirical studies seem to paint a different picture. The situation is more complicated in the case of the Equation than in the case of AT and QAT. QAT and AT attracted much less attention than the Equation but, as far as I know, they were not supported by the results of any of the relevant studies. AT was disconfirmed by Skovgaard-Olsen et al. (2016b) which showed that it fails in the case of the irrelevant and negatively relevant conditionals, and Douven and Verbrugge (2010) which showed that it is not supported in the case of inductive conditionals. QAT performs poorly (Douven and Verbrugge, 2012) in comparison to EST.

The Equation has a long tradition of good performance in empirical studies. On the other hand, the results of Skovgaard-Olsen et al. (2016b) strongly suggest, that it fails in the cases of irrelevant and negatively relevant conditionals. The result was conceptually replicated by a few subsequent studies. At the same time, as is point out in Skovgaard-Olsen et al. (2016b), the experiments which confirmed the Equation did not include irrelevant on negatively relevant conditionals and therefore did not use a representative sample of conditionals. This seems to undermine them and together with results of Skovgaard-Olsen et al. (2016b) suggests that overall the unrestricted Equation is not empirically adequate. There is some evidence suggesting that the effect of relevance is pragmatic in nature (e.g., Skovgaard-Olsen et al., 2017) but different studies suggest that it is not the case (e.g., Krzyżanowska et al., 2017 or Douven et al., 2017). In light of all that, it seems that we have neither theoretical nor empirical reasons for accepting the theses beyond their initial intuitiveness. Therefore, it seems that their role in the future study of indicative conditionals should be rethought.

On the other hand, I did not show that any of the theses is false. Conclusive arguments against them, as far as I know, do not exist and maybe never will. Specifically, someone impressed with the intuitiveness of any of the theses may treat it as a desideratum to be satisfied by a successful theory of conditionals. Even in such cases, the tension between them and some of the empirical findings and involved theoretical costs should remain clear.

Now we can discuss alternative proposals. I will start with the Evidential Support Theory proposed by Douven (2008). As we have seen, the core of the theory is the Evidential Support Thesis(EST):

"EST An indicative conditional "If A, B" is assertable/acceptable if and only if $Pr(B|A)$ is not only high but also higher than $Pr(B)$."(Douven and Verbrugge, 2012 p. 484)

This is a counterproposal to QAT. In Douven and Verbrugge (2012), it was shown that EST predicts intuitions of natural language users much better than QAT. This is a clear advantage of EST and a good reason to prefer it over QAT. On the other hand, as it stands now, this approach also lacks theoretical justification.

EST is not supported by the Equation in a way in which QAT is and, as far as I know, it is not supported by any proposed semantics for conditionals.

Perhaps further work on inferentialist semantics can provide a theoretical basis for EST.

As we have seen, EST is empirically more successful than QAT because it classifies irrelevant and negatively relevant conditionals as not acceptable. Consequently, it seems natural that users of language will judge the acceptability and the probability of conditionals as lower in such cases. Skovgaard-Olsen et al. (2016b) showed that this is true. If so, maybe we can restrict the Equation and AT to be more in line with this finding. As we have seen a restricted version o both may look for example:

Equation+/AT+ If $\Delta P > 0$ then $P/ac(A \rightarrow B) = P(C|A)$

The Equation+ and AT+ are more consistent with the available empirical evidence than the original theses. Because of the restriction, they are not undermined by the results of Skovgaard-Olsen et al. (2016b), but AT+ is still undermined by the results of Douven and Verbrugge (2010).

What about their theoretical position? Once again we lack any theoretical motivation for both theses. The situation is even worse in the case of the Equation+. There is nothing in it which would block a triviality proof analogous to Lewis' restricted to the positively relevant conditionals. The result of the proof will be that for all positively relevant conditionals $P(A \rightarrow B) = P(B)$. This is just as unacceptable as the original unrestricted result. The bottom line here seems to be that if the Equation is proposed for any kind of conditionals we can make Lewis-like argument for these conditionals. $P(A \rightarrow B) = P(B)$ is true for irrelevant conditionals, but the Equation restricted just to them would be both uninteresting and empirically inadequate (as suggested by the results of Skovgaard-Olsen et al., 2016b).

Let us move to theoretical considerations concerning conditionals. Can they point us toward a new definition of probability (or acceptability)? Triviality proofs do not give us clear help concerning the probability and acceptability of conditionals. They provide us with a purely negative lesson concerning the Equation (and AT), and it seems hard to predict which of the alternative proposals will be susceptible to analogous triviality proofs.

Perhaps a more promising and natural approach is to start with the truth conditions proposed by some of the plausible semantics, and on the basis of that, work out corresponding probability conditions. Most of the popular semantic theories postulate complex and subtle truth conditions which translate into similarly complex definitions of probability.[28] For example, if we combine, the already presented inferentialist semantics (for more on this semantics and the debate about it, see Douven et al., this volume, and Over and Cruz, this volume), with SP we will get:

IP The probability of "If p, q" uttered by a speaker S is the probability that (i)q is a consequence—be it deductive, abductive, inductive, or mixed-of p in conjunction with S's background knowledge, (ii) q is not a consequence—whether deductive, abductive, inductive, or mixed—of S's background knowledge alone but not of p on its own, and (iii) p is deductively consistent with S's background knowledge or q is a consequence (in the broad sense) of p alone.

It is easy to see that IP is less elegant and harder to test than the Equation. At the same time, it is directly justified by the inferentialist semantics. That alone puts IP in a better theoretical position than the Equation and perhaps it is enough to make it worth further studies. Can it accommodate the existing evidence concerning the probability of conditionals? Can we construct trivialization arguments against it or perhaps show that it is impossible? Answering those questions goes well beyond the scope of this paper. On the other hand, I hope that this example shows that there are promising alternatives to the Equation and further investigation of such alternative proposals is justified.

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[28]As we have seen the material implication theory is an exception. It provides us with truth conditions that can be easily translated into the definition of probability. Sadly, both the definition of probability and truth conditions proposed by the material implication theory are unintuitive.

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