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Williamson's Abductive Case for the Material Conditional Account

Abstract. In *Suppose and Tell*, Williamson makes a new and original attempt to defend the material conditional account of indicative conditionals. His overarching argument is that this account offers the best explanation of the data concerning how people evaluate and use such conditionals. We argue that Williamson overlooks several important alternative explanations, some of which appear to explain the relevant data at least as well as, or even better than, the material conditional account does. Along the way, we also show that Williamson errs at important junctures about what exactly the relevant data are.

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Williamson [94] offers a bold new attempt to defend the material conditional account (MCA) of indicative conditionals.¹ According to this account, a conditional “If A, C” is true precisely if the corresponding material conditional is true, that is, precisely if A is false or C is true (or both). Long the established view among philosophers, the MCA is now generally believed to be empirically inadequate [23, 27, 56]. As a result, little is left of its erstwhile popularity. According to Williamson, however, we have been too quick in dismissing the MCA. In particular, he holds that we have failed to appreciate the role heuristics play in the use and interpretation of conditionals.

In much of his recent work (e.g., [92, 93]), Williamson has been concerned to argue that abduction (i.e., reasoning to the best explanation) is as central to philosophy—including logic and semantics—as it is to scientific methodology. For instance, in his (2017) he argues in favor of classical logic on the grounds that—in his view—it gives the best *overall* account of our deductive practices, even if there are nonclassical logics that may do a better job at accounting for some specific parts of those practices.

Williamson's case for the MCA can be seen as a sustained abductive argument: on balance, he argues, the MCA offers the best explanation of

¹Henceforth, we use “conditional” to refer to *indicative* conditionals, unless stated otherwise.

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the relevant data. In his 2020 book, Williamson especially focuses on data seemingly indicating that people tend to evaluate “If A, C” by first *supposing* that A is the case and then evaluating C under that supposition, but that at times they also simply accept a conditional because they are *told* that it is true (and the importance of these two heuristics for Williamson’s argument is reflected in the title of his book, *Suppose and Tell*). Abductive arguments can be no more compelling than the claim that the proffered explanation is the best indeed. Thus, prior to accepting the conclusion of an argument of this type, we should carefully consider the known rival explanations of the phenomena of interest, and should try to convince ourselves that we have not overlooked potentially superior explanations.

After questioning the plausibility of some of Williamson’s core assumptions, we look at three alternatives to the MCA that—we argue—explain the data about the use and interpretation of conditionals as well as, or even better than, the combination of the MCA and Williamson’s heuristics does, pointing out along the way that Williamson errs at important junctures about what exactly the relevant data are.

1. Williamson’s Heuristics

At the core of Williamson’s defense of the MCA are two heuristics, which we describe in this section.

1.1. The Suppositional Procedure

According to the MCA, the probability of $\lceil A \Rightarrow C \rceil$ equals the probability of $\lceil \neg A \vee C \rceil$.² One of the key problems for this account is that there is a wealth of experimental data showing that this equality is generally not respected in people’s probability assignments (see [27]). Williamson [94, Ch. 2] argues that this is not because the MCA is false, but because our primary way of prospectively assessing conditionals is via the Suppositional Procedure:

The Suppositional Procedure for assessing “If A, C” works as follows. First, suppose A. Then, on that supposition, develop its consequences by whatever appropriate means you have available: constrained imagination, background knowledge, deduction, If the development leads to accepting C conditionally, on the supposition A, then accept

²We use $\lceil A \Rightarrow C \rceil$ to represent “If A, C.”

the conditional “If A, C” unconditionally, from outside the supposition. If instead the development leads to rejecting C conditionally, on the supposition A, then reject “If A, C” unconditionally, from outside the supposition. Naturally, the firmness of the unconditional acceptance or rejection of the conditional will correspond to the firmness of the conditional acceptance or rejection of the consequent on the antecedent. [94, p. 18]

According to Williamson, this procedure should be thought of as a *heuristic*, a fast and frugal way of assessing conditionals which is reliable but not fail-safe.

Williamson [94, Ch. 3] further argues that the Suppositional Procedure implies (what he calls) the Suppositional Rule for credences, which dictates that we equate our unconditional probability for $\lceil A \Rightarrow C \rceil$ with our probability for C conditional on A:

$$\Pr(A \Rightarrow C) = \Pr(C|A), \quad \text{provided } \Pr(A) > 0. \quad (\text{EQ})$$

In the philosophical literature, this rule is more commonly known as “the Equation” (hence the label) and was advocated by Stalnaker [80] and others.

The Equation has been said to be intuitively obvious [82]. However, Lewis [48] famously showed that, on the assumption that conditionals express context-independent propositions, it leads to triviality. In particular, he derived from (EQ) that, for all A and C, $\Pr(C|A) = \Pr(C)$, or in other words, that a conditional’s component parts are always probabilistically independent of one another. That does not pose any problems for Williamson, however, given that he only sees (EQ) as a reliable heuristic, not as a condition to be satisfied by the semantics of conditionals.

We have two preliminary comments on Williamson’s first heuristic. The first is that there is actually reason to doubt that, from Williamson’s viewpoint, it can be a reliable procedure. To be reliable, it should typically lead people to assign an at least approximately correct probability to a conditional, at least in the kind of cases we tend to encounter in our daily lives. And it is easy to see that we should expect to encounter many large deviations from what according to the MCA the probabilities of conditionals should be if people follow the Suppositional Procedure. Consider this example. The chance for any person of dying from exposure to either heat or cold is smaller than .0001.³ As a result, both

³See <https://ourworldindata.org/causes-of-death>.

(1) If our friend Alice gets lost in Death Valley in July, she won't die of heat exposure.

and

(2) If your colleague Bob is left without clothes in the Arctic, he won't die of cold exposure.

are highly probable on the MCA; after all, $\Pr(A \supset C) = \Pr(\neg A \vee C) \geq \Pr(C)$.⁴ But (1) and (2) strike us as plain wrong and having a probability close to 0, which is surely the probability we arrive at if we follow the Suppositional Procedure. And note that examples like these can be multiplied almost at will.

Williamson is aware of this problem and thinks the fact that the probability assigned to a conditional via the Suppositional Procedure will never exceed what that probability should be according to the MCA shows that the former errs on the side of caution [94, p. 104]. Note, however, that this makes the Suppositional Procedure a cognitive bias rather than a reliable (though fallible) heuristic. Compare this procedure with abduction, for instance, which has been said to offer a heuristic for Bayesian reasoning: the latter is often too computationally demanding for limited beings like us, and the simpler procedure of inferring to the best explanation, which does not require any mental arithmetic, offers a shortcut, in that its epistemic effects tend to be close to the ones we would reach were we to follow the more complex Bayesian prescriptions [49, Ch. 7]. Or consider that young physicians are being taught, "Think horses, not zebras, when you hear hooves." The hooves will sometimes be from zebras alright, but nonetheless the heuristic will typically help the doctors arrive at a correct diagnosis—common things are common—while keeping them from wasting time and money on looking into more exotic possible causes of their patients' symptoms. By contrast, it is not just that the Suppositional Procedure *will* in many cases lead us to assign probabilities to conditionals very different from those we ought to assign them, according to the MCA; in many cases, it *must* do so, to prevent all sorts of disasters from happening. For example, assigning the MCA-prescribed probability to (1) might well lead us to give advice to Alice that borders on the criminal. So, not only is the Suppositional Procedure an unreliable heuristic, or cognitive bias; the MCA *requires* this bias to prevent it (the MCA, that is) from potentially causing disasters. People are known to suffer from cognitive biases, of course, but normally we think of those as

⁴Here, \supset symbolizes the material conditional.

standing in need of some kind of correction (e.g., young physicians are being hammered on attending to base rates). Might advocates of the MCA hold that we should keep it quiet that the Suppositional Procedure embodies a cognitive bias?

There is more. We can bet on conditionals, and Politzer et al. [65] report evidence indicating that people take fair betting quotients for conditionals to be given by the corresponding conditional probabilities, which is consistent with Williamson's idea that people assess the probabilities of conditionals via the Suppositional Procedure. Thus, if you are like most people, then if you deem it x percent probable that Alice will pass the exam on the supposition that she studies hard, you will find x cents a fair price to pay for a bet that pays one dollar if

(3) If Alice studies hard, she'll pass the exam.

turns out true. You might think that, because your probability of x for (3) will be less or equal to the probability of the corresponding material conditional that either Alice does not study hard or she passes the exam (or both), the Suppositional Procedure will in fact keep you from overpaying. But that would be to misunderstand the concept of a fair betting quotient. To assign a probability of x to (3) is to deem $x : (1 - x)$ a fair betting quotient for (3). That means that if we set the stake of a bet on (3) equal to one dollar, then you will regard as fair a bet that pays $-x$ cents if the conditional is false and pays $(1 - x)$ cents if it is true. By your current lights, the former is to happen with a probability of $1 - x$, the latter with a probability of x , meaning that your expected net gain equals $(1 - x)(-x) + x(1 - x) = 0$, which is precisely what makes you consider this bet to be fair.

Because you deem the bet fair, you are willing to take either side of it: given this payoff structure, you are just as happy to bet *on* (3) as you are to bet *against* it. Suppose you choose to do the latter. Then consider that, according to Williamson, your "current lights" are likely to be off. In particular, in view of the aforementioned fact that the probability of a material conditional is typically higher than the corresponding conditional probability, we may assume, without loss of generality, that your probability for the material conditional corresponding to (3) equals y , for some $y > x$. So, at least upon reflection, when you are made to rely on analytical thinking rather than on the heuristic embodied in the Suppositional Procedure, you should agree that, by your own considered judgment, the probability that you are to pay $(1 - x)$ cents equals y while the probability that you will receive x cents equals $(1 - y)$, making your expected net gain equal $-y(1 - x) + (1 - y)x = xy - y + x - xy = x - y < 0$. In other words, by your

own considered judgment, you expect to lose money. Once you see this, why would you like to keep to the Suppositional Procedure? You may reasonably think that, however much effort it is going to require, it is well worth getting rid of this cognitive habit.

Note that it is not even essential that you yourself come to think the Suppositional Procedure may lead to your financial ruin. Just supposing that your probabilities tend to track relative frequencies—so that, among other things, of all conditionals $\lceil A \Rightarrow C \rceil$ such that $\Pr(\neg A \vee C) = x$, a proportion of about x holds true—you will be an easy prey to malevolent bookies, for the reason just explained. So Williamson could have added a chapter to his 2020 book, informing us about our precarious predicament, which would have justified placing the book in the self-help corner.

Our second comment is that while Williamson is to be lauded for attending, not only to “linguistic data” distilled from the kind of vignette stories commonly used in analytic philosophy, but also to real data documented in the psychological literature on conditionals, he still gets the data to be accounted for badly wrong (as also pointed out in Berto, [6]). As Spohn [78] may have been the first to observe, psychological experiments using *realistic* materials tend to take for granted that, in conditionals, the antecedent is positively probabilistically relevant to the consequent, meaning that the materials of such experiments tend to consist of conditionals whose consequent is more probable on the supposition of the antecedent than it is unconditionally.⁵ Psychology of reasoning is mostly focused on normal cases—in the case of conditionals, how normal people evaluate, and reason with, normal conditionals—and the vast majority of conditionals we encounter in quotidian speech do satisfy the said condition. Nevertheless, Spohn wonders what the results of the experiments would have been had the participants been given conditionals *not* satisfying that condition. He is more than right to raise this question, given that (EQ) is meant to hold generally, regardless of the probabilistic relation between a conditional’s component parts. When Skovgaard-Olsen et al. [77] then did include among their materials realistic conditionals not satisfying the positive relevance condition, they found that participants’ probabilities for conditionals deviated significantly from

⁵Oberauer et al. [62] are a notable exception here, since their experiments did include conditions in which the antecedent was probabilistically irrelevant to the consequent. Arguably, however, they used unrealistic (abstract and pseudo-realistic) materials, so Spohn’s remark still holds.

their corresponding conditional probability assessments unless, in the participants' judgment, the conditional's antecedent was positively relevant to its consequent.

For most of the present paper, however, we go along with Williamson and assume, for the sake of the argument, that people evaluate the probabilities of conditionals in line with (EQ). Our aim, then, is to argue that there are better explanations for those data than is offered by the combination of MCA and Williamson's first heuristic.

1.2. Testimony

Gibbard [30] famously came up with a story in which—he argued—two different speakers appropriately express sentences of the form $\lceil A \Rightarrow C \rceil$ and $\lceil A \Rightarrow \neg C \rceil$, even though these sentences would seem to contradict each other. Gibbard's main target was Stalnaker's [79] possible-worlds semantics, according to which $\lceil A \Rightarrow C \rceil$ is true in world w precisely if C is true in the A -world closest to w . Given this semantics, Gibbard's pair of conditionals is inconsistent indeed. Gibbard concluded from this that conditionals do not express propositions.

Williamson (2000, pp. 89–91) disagrees with Gibbard's analysis and offers his own take on Gibbard's story:

There has been an accident at a dodgy nuclear power plant. Several warning lights are connected to a single detector beside the nuclear core. When the detector is working and detects overheating in the core, each light is red. When the detector is working and does not detect overheating in the core, each light is green. When the detector is not working, each light is red or green at random, independently of the others. A competent engineer, East, sees only the east light, which is red, and says:

(4) If the detector is working, the core is overheating.

Another competent engineer, West, not in contact with East, sees only the west light, which is green, and says:

(5) If the detector is working, the core is not overheating.

There is no presupposition failure; each engineer assigns the common antecedent a probability much greater than 0, though less than 1. Although both engineers have incomplete information, neither is in error. Indeed, by ordinary standards, East knows (4) and West knows (5), so (4) and (5) are both true.

.... now a central controller is trying to establish what the situation is. The two engineers are trustworthy, and the controller trusts them. They text in their reports to her. East's report is simply (4), and West's report is simply (5). The controller is a bureaucrat; she does not know how the two engineers came to their judgements. She simply accepts both reports. She even repeats them to herself. She then reasonably and correctly concludes (6) from (4) and (5):

(6) The detector is not working.

Williamson uses this story to argue for a conclusion rather different from Gibbard's, to wit, that conditionals express context-independent propositions and, more specifically, that they should be analyzed as material conditionals. His main argument is that a hearer who learns conditionals (4) and (5), which—note—are of forms $\lceil A \Rightarrow C \rceil$ and $\lceil A \Rightarrow \neg C \rceil$, can and should conclude (6), which is of form $\lceil \neg A \rceil$. And indeed, on the MCA, this follows immediately.

As Williamson notes, though, there is an apparent conflict with his first heuristic. After all, if the controller were to rely on that heuristic in the above case, she would have to accept that the core is overheating on the supposition that the detector is working but also, on the same supposition, that the core is *not* overheating. This is where Williamson's second heuristic comes into play. According to this heuristic—which he calls “Testimony”—conditionals can be accepted on the basis of other speakers' testimony, under normal conditions for testimony. Williamson takes Gibbard's story to show that Testimony can take precedence over the Suppositional Procedure. Because of that, the recipient of the apparently conflicting conditionals can accept both, which in Williamson's view is a fact about language use that any account of conditionals should be able to explain, together with the further fact that the recipient appears warranted to infer the negation of the antecedent shared by the conditionals. The MCA complemented with the two heuristics satisfies that condition, or so Williamson claims.

Our aim is not to challenge this claim per se, but rather to argue that Williamson has overlooked some alternatives to his own proposal that offer explanations at least as good as, or even better than, that proposal. Before considering these alternatives, however, we again want to comment on the empirical status of what Williamson takes to be the relevant *explanandum*. In particular, we would like to note that, to the best of our knowledge, there are no empirical data to support Williamson's assumption that people are likely to accept two conditionals with shared antecedent and contradictory consequents, no matter how trustworthy the source. Rather, as we will

show in the remainder of this section, there is recent empirical research on testimony that undermines this assumption.

Particularly relevant here is the work of Collins et al. [10], who investigated learning conditionals from testimony in a series of experiments on how people revise their beliefs in response to a testimony that if A, C. Additionally, these authors investigated how the belief change is affected by the characteristics of the speaker. In a subset of their experiments, the participants were provided with minimal contexts in which either an expert in a given field (e.g., a professor of medicine) or a novice (e.g., a medical student) asserted a conditional (e.g., "If a patient on this ward has malaria, then they'll make a good recovery"). The participants were then asked to rate the probability of the antecedent of the asserted conditional, the probability of its consequent, and the corresponding conditional probability of the consequent given the antecedent. In all studies, an assertion of a conditional increased the participants' probability rating of C conditional on A, and these conditional probability ratings were higher when the conditional was asserted by an expert than when it was asserted by a novice. Furthermore, the assertion of a conditional had no effect on $\Pr(A)$ and $\Pr(C)$ ratings when the participants did not have any information about A and C and so their prior probability ratings were close to the midpoint of the scale. In an additional experiment, Collins et al. found that when A and C were deemed highly unlikely before the conditional is asserted, learning $\lceil A \Rightarrow C \rceil$ increased both $\Pr(A)$ and $\Pr(C)$.

This pattern of responses cannot be easily reconciled with the MCA. For consider that if, in response to an expert testimony that if A then C, people revised their beliefs by adopting the corresponding material conditional, $\lceil \neg A \vee C \rceil$, Collins et al. [10] should have observed either a decrease in $\Pr(A)$ or an increase in $\Pr(C)$, or both. Instead, with the exception of the aforementioned cases of extremely low priors, they did not observe any shifts in the probabilities of A and C upon learning a conditional. And while the increase of $\Pr(A)$ in the case of very low priors might be explainable along pragmatic lines, to account for all the findings from Collins et al., we would need a separate pragmatic story explaining why $\Pr(A)$ does *not* decrease and yet another equally separate pragmatic explanation of why $\Pr(C)$ does *not* increase. Moreover, if what is conveyed via testimony is a material conditional, the shift in conditional probabilities of C given A can only be due to the Suppositional heuristic. Such a collection of independent pragmatic explanations for each of the observations would be an ad hoc fix. More importantly, it would be an ad hoc fix whose sole purpose would be to explain

why the participants are prevented from making any adjustments to their probabilities that would be in accordance with the MCA.

Williamson could respond that the experimental materials from Collins et al. [10] do not involve the kind of contexts in which the Suppositional Rule would be overruled by Testimony. After all, Gibbard's story involves two speakers who communicate (seemingly, at least) conflicting information. While, again to the best of our knowledge, there is no empirical research on people's belief change in such peculiar contexts, studies on (non-conditional) testimony cast doubt on the plausibility of the controller's reasoning, undermining the assumptions inherent in the setup of Williamson's version of the Gibbard story. In particular, research on the effect of source characteristics on learning from testimony [9] suggests a bi-directional relationship between the reliability of the source and the content of the message. That is, people not only believe the information asserted by an expert to a greater extent than when it is asserted by a novice, they also tend to revise their belief about the speaker's reliability when the testimony is unexpected. For instance, when a clinical nurse specialist (thus an expert) asserts that one of the best remedies against a severe cough is valium, which is an unexpected (low prior probability) claim, the perceived reliability of the speaker decreases (Experiment 1b). This effect was observed under different conditions of eliciting source reliability ratings. In their Experiment 3, Collins and colleagues asked the participants to rate the probabilities of a second, neutral claim asserted by the same speaker after the expected or unexpected claim. They found that the unexpectedness of the first claim had affected the participants' ratings for the second claim, indicating, again, that people revise their beliefs about the reliability of the speaker and, consequently, trust or mistrust their subsequent claims accordingly.

While the experiments by Collins et al. [9] did not involve conditionals, Williamson insists that there should be no difference in how conditionals and categorical statements are transferred via testimony. We are, therefore, justified in scrutinizing the assumptions he incorporated in his story in light of these results. What do they mean for Williamson's reconstruction of the controller's reasoning? After the controller received (4) from East, West's message, (5), is anything but expected. The two conditionals are, after all, at least seemingly contradictory. Williamson argues that in such a context, the controller's trust in the engineers' expertise would overrule her own judgment based on the adherence to the Suppositional Rule that accepting $\lceil A \Rightarrow C \rceil$ and $\lceil A \Rightarrow \neg C \rceil$ leads to accepting a contradiction, $\lceil C \wedge \neg C \rceil$, conditional on A. The results from Collins et al. [9] suggest, however, that something opposite might happen, namely, that the controller might revise

her belief in how reliable the two engineers are and, consequently, trust them less. She would then be unlikely to accept (4) and (5) just because she is being told so.

While no experimental results can entirely exclude the possibility that some people would reason as the controller does in Williamson's scenario, we found it important to stress that what Williamson takes to be an explanandum hinges on assumptions that can be easily questioned given the available empirical data. For now, however, even though Williamson's reconstruction appears implausible in light of the empirical literature, the remaining sections will, again for the sake of the argument, go along with Williamson's take on Gibbard's story.

2. Trivalent Semantics

De Finetti [14] and others following him (e.g., [3, 5, 31]) have proposed that "if" does express a binary truth-conditional connective, but that instead of a *two*-valued semantics, we need a *three*-valued semantics to state its meaning.⁶ With $V_w(A)$ giving the truth value (1, 0, or undefined) of A at world w , the proposal is that

$$V_w(A \Rightarrow C) = \begin{cases} V_w(C), & \text{if } V_w(A) = 1 \text{ (i.e., if } \ulcorner A \Rightarrow C \urcorner \text{ is defined),} \\ \text{undefined,} & \text{otherwise.} \end{cases}$$

According to this proposal, a conditional always expresses a conditional assertion: it asserts the consequent on the condition that the antecedent is true; else, nothing is asserted.⁷

Various authors have noted that, on this analysis, (EQ) almost immediately follows. Where $\llbracket A \rrbracket = \{v \in W : V_v(A) = 1\}$ and $\langle A \rangle = \{v \in W : V_v(A) \in \{1, 0\}\}$,

$$\Pr(A \Rightarrow C) = \frac{\Pr(\llbracket A \Rightarrow C \rrbracket)}{\Pr(\langle A \Rightarrow C \rangle)} = \frac{\Pr(\{w \in W : V_w(A \wedge C) = 1\})}{\Pr(\{w \in W : V_w(A) = 1\})} = \Pr(\llbracket C \rrbracket \mid \llbracket A \rrbracket).$$

⁶Huitink [32] argued for such a three-valued semantics, if we want to give a uniform treatment of if-clauses to provide a compositional analysis of embedded conditionals like "Harry usually drinks Butterbeer, if he is happy."

⁷The latter part, "else, nothing is asserted," is highly controversial. Stalnaker and Jeffrey [34] famously worked out an alternative proposal where $V_w(A \Rightarrow C) = \Pr(C \mid A)$, if $V_w(A) \neq 1$. On their analysis, it follows that the expected value of $\ulcorner A \Rightarrow C \urcorner$ is $\Pr(C \mid A)$. See Edgington [25] and Kaufmann [35] for further discussion of this proposal.

As Lassiter [45] shows, this does *not* give rise to a Lewis-style triviality result. For suppose φ is a complex sentence of the form $\ulcorner(A \Rightarrow C) \wedge B\urcorner$, with A, B, and C atomic sentences. On the assumption that conjunction behaves truth-conditionally according to Kleene's [36] three-valued logic, it immediately follows that $\Pr(A \wedge B) = \Pr(\llbracket A \wedge B \rrbracket) / \Pr(\llbracket (A \wedge B) \rrbracket)$. And from this assumption we derive that⁸

$$\begin{aligned} \Pr((A \Rightarrow C) \wedge B) &= \frac{\Pr(\llbracket A \Rightarrow C \rrbracket \cap \llbracket B \rrbracket)}{\Pr(\llbracket (A \Rightarrow C) \wedge B \rrbracket)} \\ &= \frac{\Pr(\{w \in W : V_w(A \wedge B \wedge C) = 1\})}{\Pr(\{w \in W : V_w(A) = 1\} \cap W)} \\ &= \Pr(\llbracket B \wedge C \rrbracket \mid \llbracket A \rrbracket). \end{aligned}$$

Lewis' original triviality result is based (i) on the assumption that conditionals express context-independent propositions, and that hence $\Pr(A \Rightarrow C)$ can be claimed to equal $\Pr((A \Rightarrow C) \wedge C) + \Pr((A \Rightarrow C) \wedge \neg C)$; and (ii) on the chain rule, which allows us to conclude that $\Pr(A \Rightarrow C) = \Pr(A \Rightarrow C \mid C) \Pr(C) + \Pr(A \Rightarrow C \mid \neg C) \Pr(\neg C)$. If we further assume that $\Pr(A \Rightarrow C \mid C) = 1$ and $\Pr(A \Rightarrow C \mid \neg C) = 0$,⁹ the trivializing conclusion that $\Pr(C \mid A) = \Pr(C)$ immediately follows from (EQ).

On the three-valued alternative, it is still the case that $\Pr((A \Rightarrow C) \wedge \neg C) = 0$:

$$\begin{aligned} \Pr((A \Rightarrow C) \wedge \neg C) &= \frac{\Pr(\llbracket A \Rightarrow C \rrbracket \cap \llbracket \neg C \rrbracket)}{\Pr(\llbracket (A \Rightarrow C) \wedge \neg C \rrbracket)} \\ &= \frac{\Pr(\{w \in W : V_w(A \wedge C \wedge \neg C) = 1\})}{\Pr(\{w \in W : V_w(A) = 1\} \cap W)} = 0. \end{aligned}$$

⁸There are other three-valued analyses of conjunction that would work as well here. For instance, one could use the so-called quasi-conjunction operator (see below), symbolized by $\&$: $\Pr((A \Rightarrow C) \& B) = \Pr((A \Rightarrow C) \& (T \Rightarrow B)) = \Pr((A \vee T) \Rightarrow ((A \supset C) \wedge (T \supset B))) = \Pr((A \supset C) \wedge B \mid A)$, hence $\Pr((A \Rightarrow C) \& \neg C) = \Pr((A \Rightarrow C) \wedge (T \Rightarrow \neg C)) = \Pr((A \vee T) \Rightarrow ((A \supset C) \wedge (T \supset \neg C))) = \Pr((A \Rightarrow (\neg A \vee C) \wedge \neg C)) = \Pr((A \Rightarrow (\neg A \wedge \neg C))) = 0$. Similarly, $\Pr((A \Rightarrow C) \& C) = \Pr((A \Rightarrow C) \wedge (T \Rightarrow C)) = \Pr((A \vee T) \Rightarrow ((A \supset C) \wedge (T \supset C))) = \Pr((A \Rightarrow (\neg A \vee C) \wedge C)) = \Pr(A \Rightarrow C)$. (Again, \supset symbolizes the material conditional.)

⁹Lewis in fact makes a stronger assumption, to wit, that $\Pr(A \Rightarrow C \mid B) = \Pr(C \mid A \wedge B)$.

Crucially, however, it need not be (and typically is not) the case that $\Pr((A \Rightarrow C) \wedge C) = 1$:

$$\begin{aligned} \Pr((A \Rightarrow C) \wedge C) &= \frac{\Pr(\llbracket A \Rightarrow C \rrbracket \cap \llbracket C \rrbracket)}{\Pr(\llbracket A \Rightarrow C \rrbracket \cap \llbracket C \rrbracket)} \\ &= \frac{\Pr(\{w \in W : V_w(A \wedge C \wedge C) = 1\})}{\Pr(\{w \in W : V_w(A) = 1\} \cap W)} \\ &= \Pr(\llbracket C \rrbracket \mid \llbracket A \rrbracket). \end{aligned}$$

Thus, on the three-valued analysis one does not use the chain rule. Rather, one concludes from $\Pr(A \Rightarrow C) = \Pr((A \Rightarrow C) \wedge C) + \Pr((A \Rightarrow C) \wedge \neg C)$ that $\Pr(A \Rightarrow C) = \Pr(C \mid A) + 0 = \Pr(C \mid A)$, as desired. Lassiter [45] shows that other triviality results can be resolved in a similar fashion.

In short, one can account for the empirical support for (EQ) while avoiding trivialization. Moreover, the current proposal allows us to maintain that conditionals can express context-independent propositions. To be sure, from this three-valued perspective, the proposition expressed by a sentence is not just a set of worlds or valuation functions in/under which the sentence has value 1; it must also be said which worlds, or valuation functions, attribute the value 0 to the sentence. (Once we know that, we also know in which worlds/valuation functions the sentence is undefined.) Alternatively, we can say that the proposition expressed by a sentence is a pair consisting of (i) the worlds where the sentence is true and (ii) the worlds where the sentence is undefined. In the latter case, we can say that the proposition expressed by A is the pair $\langle \llbracket A \rrbracket, W \setminus \llbracket A \rrbracket \rangle$.

Still, to offer a viable alternative to Williamson's proposal—and still granting that Williamson is right about what the relevant data are—there is a second desideratum that should be fulfilled: we should be able to explain how $\ulcorner A \Rightarrow C \urcorner$ and $\ulcorner A \Rightarrow \neg C \urcorner$ together license the inference to $\ulcorner \neg A \urcorner$. For this, we need a notion of logical consequence. It is not easy to come up with a three-valued notion of logical consequence that also pertains to conditionals. The standard notion of preservation of value 1, for instance, immediately gives rise to the false prediction that from $\ulcorner A \Rightarrow C \urcorner$ we can conclude $\ulcorner A \wedge C \urcorner$. What works better is the following notion of logical inference:

$$\Gamma \models^3 \varphi \quad \text{iff} \quad \forall v, \forall \gamma \in \Gamma : v(\gamma) \leq v(\varphi).$$

But this proposal is still not quite satisfactory, if only because it does not license the inference from $\ulcorner A \Rightarrow A \urcorner$ and $\ulcorner \neg A \Rightarrow C \urcorner$ to $\ulcorner \neg A \Rightarrow C \urcorner$, which appears pre-theoretically valid.

However, the inference *is* validated by Adams’ [2] original analysis of probabilistic entailment, $\Gamma \models^p \varphi$, which demands that, for all probability functions Pr , if all elements of Γ are given a high probability by Pr , then φ cannot be assigned a low probability by Pr .¹⁰ Adams’ notion of probabilistic entailment is well behaved and can be given a simple axiomatization, which in fact coincides with that of system **P**, the basic system of non-monotonic logic [38]. And this notion of entailment can be given a three-valued interpretation as well, by making use of Schay’s [72] notion of conjunction, nowadays generally known as “quasi-conjunction.” On Adams’ analysis, sentences of the form $\ulcorner A \Rightarrow C \urcorner$ have, as mentioned above, no truth value. As a result, the conjunction of two conditionals has, in general, no truth value either. However, their quasi-conjunction does, where this new operator—symbolized by $\&$ —is defined as follows (see note 8):

$$(A \Rightarrow C) \& (B \Rightarrow D) =_{\text{df}} (A \vee B) \Rightarrow ((A \supset C) \wedge (B \supset D)).$$

Note that we can extend this new conjunction operator to factual formulas A by replacing A by the (from the current perspective) trivially equivalent conditional $\ulcorner \top \Rightarrow A \urcorner$. For instance, from this perspective, $\ulcorner A \& (A \Rightarrow C) \urcorner$ is equivalent to $\ulcorner (\top \vee A) \Rightarrow ((\top \supset A) \wedge (A \supset C)) \urcorner$, which in turn is equivalent to $\ulcorner \top \Rightarrow (A \wedge (A \supset C)) \urcorner$, as desired.¹¹

Now we can redefine the entailment relation \models^3 more appropriately, as follows:

$$\begin{aligned} \Gamma \models^3 \psi & \quad \text{iff} \quad \exists \{\varphi_1, \dots, \varphi_n\} \subseteq \Gamma : \forall v : \text{if } v(\varphi_1 \& \dots \& \varphi_n) = 1, \\ & \quad \text{then } v(\psi) = 1, \\ & \quad \text{and if } v(\psi) = 0, \text{ then } v(\varphi_1 \& \dots \& \varphi_n) = 0. \end{aligned}$$

Dubois and Prade [24] show that this notion of inference coincides with that of system **P**, and thus with Adams’ notion of probabilistic entailment.¹² How this helps to account for the data motivating Williamson’s second heuristic can be immediately read off from Table 1, which shows that from the two

¹⁰Or more precisely, $\varphi_1, \dots, \varphi_n \models_p \psi$ iff for all probability functions Pr , if for all i , $\text{Pr}(\varphi_i) \geq 1 - \epsilon$, then $\text{Pr}(\psi) \geq 1 - n\epsilon$, for any (small) ϵ .

¹¹The new conjunction behaves a lot like the standard \wedge , but there is one important difference. When its parts are not factual, the new conjunction may not probabilistically entail them: the quasi-conjunction of $\ulcorner A \Rightarrow C \urcorner$ and $\ulcorner \neg A \Rightarrow C \urcorner$ is $\ulcorner (A \vee \neg A) \Rightarrow ((A \supset C) \wedge (\neg A \supset C)) \urcorner$, which is equivalent simply to C . Thus, $(A \Rightarrow C) \& (\neg A \Rightarrow C) \models^p C$. But we do not want to say that C probabilistically entails either $\ulcorner A \Rightarrow C \urcorner$ or $\ulcorner \neg A \Rightarrow C \urcorner$, since that would reconstitute the paradoxes of the material conditional.

¹²For an elaborate recent discussion of various notions of logical consequence using a three- or more-valued de Finettian analysis of indicative conditionals, see Égré et al. [26].

Table 1. Truth table for quasi-conjunction and the argument by testimony. (The asterisk designates indeterminacy.)

A	C	$A \Rightarrow C$	$A \Rightarrow \neg C$	$(A \Rightarrow C) \& (A \Rightarrow \neg C)$	$\neg A$
1	1	1	0	0	0
1	0	0	1	0	0
0	1	*	*	*	1
0	0	*	*	*	1

conditionals uttered in the kind of situation described in Gibbard's story one can conclude $\neg A$, that is, $(A \Rightarrow C) \& (A \Rightarrow \neg C) \models^3 \neg A$.¹³ Thus, again the data give no reason to believe that conditionals are best analyzed in terms of the MCA.

3. Context-Dependence and Granularity

In this section, we take a different perspective on the challenge of explaining, without committing to the MCA, the data that led Williamson to propose his two heuristics. In particular, we assume here that the content of a conditional is context-dependent and show how this can account both for Gibbard's problem and for the intuition that the probability of a conditional goes by the corresponding conditional probability.

3.1. Gibbard's Problem

Gibbard [30] argued that while *subjunctive* conditionals can express context-independent propositions and should be analyzed in terms of Stalnaker's [79] and Lewis' [47] similarity account, *indicative* conditionals are more closely related to the epistemic states of the agents who utter them, and should be analyzed via the Ramsey test. The latter suggestion can be implemented in two ways. Either we follow Adams [1,2] and claim that by uttering an indicative conditional we do not express a proposition but instead make a conditional assertion, or we still demand that indicative conditionals always express propositions and that those conditionals are to be handled via the Ramsey test, but that we give up the assumption that the conditional has

¹³In terms of probabilistic entailment, for any $\epsilon \in [0, 1]$, if $\Pr(C|A) \geq 1 - \epsilon$ and $\Pr(\neg C|A) \geq 1 - \epsilon$, then $\epsilon = 0.5$, and thus $\Pr(A) \geq 1 - 2\epsilon = 0$.

a fixed interpretation. While Gibbard [30] argued in favor of the former approach, Stalnaker [81] famously suggested something along the latter lines.

Stalnaker [81] argued that not only subjunctive conditionals but also indicative conditionals express propositions, and that both should be handled by the selection-function-based analysis proposed in Stalnaker [79]. However, the relevant selection function, and thus the meaning of a conditional on Stalnaker's proposal, is going to depend on what is presupposed: the selected A-world for any $\neg A$ -world in context \mathcal{K} that represents what is presupposed should be an A-world in \mathcal{K} . A straightforward way to account for this intuition is to say that the proposition expressed by $\lceil A \Rightarrow C \rceil$ with respect to \mathcal{K} is $\left\{ w \in W : f_w^{\mathcal{K}}(A) \subseteq C \right\}$, where $f_w^{\mathcal{K}}(A) = f_w(A \cap \mathcal{K})$, provided $A \cap \mathcal{K} \neq \emptyset$, and with f a Stalnaker selection function. But we have implicitly assumed that context \mathcal{K} represents what is *presupposed* in the *actual* world. Gibbard's example suggests that for the analysis of indicative conditionals we should not look at the presupposition state, but rather at the speaker's information state.

But in Williamson's story we would like to conclude $\neg A$, that the detector is not working, even if we do not know much about the information states of the engineers who uttered conditionals (4) and (5). Luckily, by standard Gricean reasoning there are two things we can assume: (i) that the engineers were justified to assert the respective conditionals, and (ii) that both were uncertain whether A holds. If we assume that \mathcal{K}_v^4 and \mathcal{K}_v^5 are the belief states in world v of the ones that uttered $\lceil A \Rightarrow C \rceil$ and $\lceil A \Rightarrow \neg C \rceil$, respectively, then $f^{\mathcal{K}_v^4}$ and $f^{\mathcal{K}_v^5}$ are their corresponding selection functions. This means, according to the present proposal, that $f_v^{\mathcal{K}_v^4}(A) \subseteq C$ and $f_v^{\mathcal{K}_v^5}(A) \subseteq \neg C$. Now, the hearer can reason as follows.

Initially, there are three possibilities for all concerned:

- w_1 : the detector is working and the core is overheating, $A \wedge C$;
- w_2 : the detector is working and the core is not overheating, $A \wedge \neg C$;
- w_3 : the detector is not working, $\neg A$.

Assuming that the engineers were justified to assert as they did by their information states, their belief states can be represented in all the worlds above by $\langle \{w_1, w_3\}, f \rangle$ and $\langle \{w_2, w_3\}, g \rangle$, respectively (with $f = f^{\mathcal{K}_v^4}$ and $g = g^{\mathcal{K}_v^5}$), where the two selection functions obey the preservation principle with respect to the information state to which they belong, meaning that $f_{w_3}(A) = \{w_1\}$ and $g_{w_3}(A) = \{w_2\}$.

In the analysis so far, the propositions expressed by East and West are context-dependent: they depend on what East and West know. To see how, nevertheless, we can conclude from a neutral, third-person perspective that $\neg A$ holds (perhaps by an inference to the best explanation; see also Section 4), we only need to note that there is only one (type of) world consistent with what both East and West know that is consistent with both types of information they learned and in which the conditionals $A \Rightarrow C$ and $A \Rightarrow \neg C$ are true, to wit, world w_3 . And in that world, A is false, whence we conclude that $\neg A$ is true. Importantly, we can conclude this without assuming that conditionals are to be analyzed as prescribed by the MCA. Moreover, we can derive this conclusion even though we have assumed that the proposition expressed by each conditional is context-dependent (see van Rooij, [84], for more on this).

But the assumption is likely to raise another concern, namely, that for communicative purposes it seems necessary that what is expressed by a conditional is context-*independent*. And what could this context-independent meaning be, given that on the current analysis what is expressed by a conditional depends on the knowledge or belief of the speaker?

First off, we are not sure one must accept the presupposition that communicative success requires context-independence. Suppose conditionals are context-dependent. As long as the relevant contextual information is available, what could be the problem? And both in conversations and in written text, we are typically able to provide the relevant contextual information. However, even if the contextual information is *unavailable*, it is not clear that communication must break down; we should be able to successfully communicate at least something. Take, for instance, "He then took a knife and murdered her." Only in a context will it be clear who "he" and "her" refer to and which time "then" refers to. Nevertheless, outside any specific context, we still get that a man murdered a woman, probably using a knife. That is a lot. Indeed, one could start a crime novel, effectively creating suspense, by letting someone overhear a conversation that starts with the said sentence.

More generally, it appears to us that communication works in imperfect ways, that we get a bit of information here, a bit of information there, and that sometimes we go back to something we picked up earlier and realize that we can make more sense of it given additional information we received later. That is probably not something we can easily model given any of the current formal semantics, but that does not make the picture any less realistic.

But grant, for the nonce, that successful communication does require context-independence. Would that spell trouble for our previous analysis? No, because we can easily make it context-independent by abstracting away from the information state of the speaker. On the above analysis, the information state crucially determines the nature of the selection function: the selection function captures everything of the information state that is relevant to what is expressed by a speaker. Thus, we can think of the selection function as the *context* relative to which we have to determine whether what is expressed by $\lceil A \Rightarrow C \rceil$ is true or false at a world. To determine the context-independent meaning expressed by a conditional we do as we always do in such cases: we abstract away from the context. More in particular, we think of the meaning of a conditional as a function from contexts to truth conditions—that is, sets of worlds—which in this case is a function from selection functions to sets of possible worlds. Equivalently, we think of the context-independent meanings of conditionals as sets of pairs $\langle f, w \rangle$ consisting of a selection function f and a world w , and indeed, such pairs make conditionals true or false. In our analysis of Williamson’s scenario, the meanings of (4) and (5) are $\{\langle f, w_1 \rangle, \langle f, w_3 \rangle\}$ and, respectively, $\{\langle g, w_2 \rangle, \langle g, w_3 \rangle\}$.

3.2. Context-Dependence and Conditional Probability

Van Fraassen [82] showed that we can account for the intuition that the probabilities of conditionals satisfy (EQ), maintain that conditionals express propositions, and yet avoid Lewis’ triviality result by making the meaning of a conditional context-dependent. Pre-theoretically, for any $\neg A$ -world w , the probability that the A -world closest to w is a C -world is just $\Pr(C|A)$ and thus depends on probability function \Pr . By making the meaning of the conditional context-dependent in this way, $\lceil A \Rightarrow C \rceil$ expresses a different proposition with respect to different probability functions, such as $\Pr(\cdot|C)$ and $\Pr(\cdot|\neg C)$. It is important to observe that van Fraassen does not assume that $\Pr(A \Rightarrow C|B) = \Pr(C|A \wedge B)$.

But van Fraassen’s idea was not just to make the meaning of the conditional context-dependent; he also made meanings *more fine-grained*. He showed that Stalnaker’s constraint can be saved if we take meanings to be more fine-grained than sets of possible worlds as standardly understood, that is, more fine-grained than functions from atomic propositions to truth-values. He instead modeled possibilities as *sequences* of worlds, where such a sequence contains as extra information what is the closest A -, B -, C -, and so on, world for each of the $\neg A$ -, $\neg B$ -, $\neg C$ -, and so on, worlds. Alternatively, we can assume that meanings are sets of *possibilities*, that is, pairs like $\langle w, f \rangle$,

consisting of a world (thought of as a function from atomic propositions to truth-values) and a selection function. Such a selection function also contains the extra information about which worlds are the closest A-, B-, C-, and so on, worlds to w . Following Stalnaker [79], we assume that $f_w(A)$ picks out a unique world and say that $V_{\langle w, f \rangle}(A \Rightarrow C)$ equals 1 if $f_w(A) \in C$, and equals 0 otherwise. Then

$$\Pr(A \Rightarrow C) = \sum_{\langle w, f \rangle} \Pr(\langle w, f \rangle) \times V_{\langle w, f \rangle}(A \Rightarrow C).$$

By two Stalnakerian constraints on selection functions— $f_w(A) \in \llbracket A \rrbracket$, and $f_w(A) = w$ if $w \in \llbracket A \rrbracket$ ¹⁴—and the assumption that for each $\neg A$ -world there are equally many selection functions as there are A-worlds (for simplicity, all with the same probability), it follows that $\Pr(A \Rightarrow C) = \Pr(C|A)$, without giving rise to Lewis' triviality result.

To illustrate, suppose that (i) $W = \{w_1, w_2, w_3\}$, (ii) $F = \{f, g\}$, (iii) $\llbracket A \rrbracket = \{w_1, w_2\} \times F$, and (iv) $\llbracket C \rrbracket = \{w_1, w_3\} \times F$. The selection functions are such that $f_{w_1}(A) = w_1 = g_{w_1}(A)$, $f_{w_2}(A) = w_2 = g_{w_2}(A)$ (by strong centering), and $f_{w_3}(A) = w_1$ and $g_{w_3}(A) = w_2$.¹⁵ This model has $|W| \times |F| = 6$ possibilities, three of which make $\ulcorner A \Rightarrow C \urcorner$ true: $\langle w_1, f \rangle$, $\langle w_1, g \rangle$, $\langle w_3, f \rangle$. Thus, $\Pr(A \Rightarrow C) = 1/2 = \Pr(C|A)$. This model also shows that Lewis' triviality result can be avoided, for

$$\begin{aligned} \Pr(A \Rightarrow C|C) &= \frac{\Pr((A \Rightarrow C) \wedge C)}{\Pr(C)} \\ &= \frac{|\{\langle w_1, f \rangle, \langle w_1, g \rangle, \langle w_3, f \rangle\}|}{|\llbracket C \rrbracket|} = \frac{3}{4} \neq 1. \end{aligned}$$

On a slightly richer model, where there is also a world where neither A nor C is true, it would be the case that $\Pr(A \Rightarrow C|\neg C) \neq 0$. Thus, it does not always hold that $\Pr(A \Rightarrow C|C) = 1$ and $\Pr(A \Rightarrow C|\neg C) = 0$, meaning that the crucial conclusion of Lewis' triviality result—that $\Pr(C|A) = \Pr(C)$ —does not go through.

Thus, if we represent what is expressed by a conditional as a set of pairs each consisting of a world and a selection function, we can on the one hand preserve the intuition that conditionals express context-independent propositions, and on the other hand infer $\neg A$ from two conditionals $\ulcorner A \Rightarrow C \urcorner$

¹⁴Van Fraassen does not share Stalnaker's assumption that if $f_w(A) \subseteq C$ and $f_w(C) \subseteq A$, then $f_w(A) = f_w(C)$.

¹⁵This is a simplification. To be precise, we should say that $g_{w_3}(A) = \langle w_2, g \rangle$.

and $\lceil A \Rightarrow \neg C \rceil$ that are assumed to be justifiably asserted in their respective contexts of utterance. Meanwhile, we can still account for the intuition underlying (EQ), by making a move very similar to what we have done to account for the Gibbardian puzzle: the content of what is expressed by a conditional is context-dependent. In short, we can do the work that Williamson's two heuristics are supposed to do, but without having to commit to either, or to the MCA.

While this is appealing, triviality results come in a variety of flavors, and some of these results are *not* based on the assumption that what is expressed by a conditional is a context-independent proposition. In fact, Williamson [94, Ch. 3.3] proves a triviality result that does not rely on the assumption that conditionals express propositions. This triviality result would even be problematic for Adams, Gibbard, and others who argued that all there is to conditionals is their conditional probability. Crucially, Williamson's triviality proof is not based on (EQ) but on the stronger

$$\Pr(A \Rightarrow C|B) = \Pr(C|A \wedge B), \quad \text{provided } \Pr(A \wedge B) > 0. \quad (\text{SEQ})$$

At first, it sounds like (SEQ) should certainly be adopted if one takes conditionals to be context-dependent: the worlds selected should, if possible, be elements of the context. But if B is assumed, and thus part of the context, the selected A-worlds should also be B-worlds. And (SEQ) would seem to follow from that in conjunction with Stalnaker's centering constraint. However, what our model shows is that $\Pr(A \Rightarrow C|C) = 3/4 < 1 = \Pr(C|A \wedge C)$.

How can it be that (SEQ) does not hold if, on our analysis, $\lceil (A \Rightarrow C) \wedge B \rceil$ really looks at the intersection of $\lceil A \Rightarrow C \rceil$ with B? Why does this not guarantee (SEQ)? The reason is that, in our analysis, we did not follow Stalnaker's suggestion that in a context in which the background knowledge consists of B, the most similar A-possibilities must be $A \wedge B$ -possibilities if $A \cap B \neq \emptyset$, that is, the selection function must be *preservative* in the sense that selected possibilities are to be consistent with the background context, if possible. Although $\langle w_3, f \rangle \in \llbracket B \rrbracket$, in context B, $f_{w_3}(A)$ should only select A-possibilities that are consistent with B. And it does not do that.¹⁶

¹⁶To see this, consider again our above example, where $\langle w_3, f \rangle \in \llbracket (A \Rightarrow C) \wedge B \rrbracket$. If we assumed the preservation principle, $\langle w_3, f \rangle$ would not be in $\llbracket A \Rightarrow C \rrbracket$ given B, because $f_{w_3}(A) = w_1$, and in context B world w_1 cannot be chosen anymore as the closest A-world, simply because w_1 is incompatible with B. So, what we would have to do to take preservation seriously is to assume that, in context B, $\lceil A \Rightarrow C \rceil$ expresses a context-dependent proposition, $\lceil A \Rightarrow^B C \rceil$. The "proposition" $\llbracket A \Rightarrow^B C \rrbracket$ is not simply the context-independent set $\{\langle w_1, f \rangle, \langle w_1, g \rangle, \langle w_3, f \rangle\}$, but rather it should be such that only B-worlds can be chosen as the closest A-worlds. However, none of the elements in

4. Inferentialism

Recent years have seen the revival of a semantics of conditionals whose core idea is that, for a conditional to be true, its consequent must be *inferrible* from its antecedent. The idea goes back at least to the Stoic philosopher Chrysippus [37], and we find it in the works of later philosophers as well. For instance, Mill [54] writes that

When we say, If the Koran comes from God, Mahomet is the prophet of God, we do not intend to affirm either that the Koran does come from God, or that Mahomet is really his prophet. Neither of these simple propositions may be true, and yet the truth of the [conditional] may be indisputable. What is asserted is not the truth of either of the propositions, but the inferribility of the one from the other. (p. 91)

Mill's idea was later endorsed by Ramsey [67]:

In general we can say with Mill that "If p , then q " means that q is inferrible from p , that is, of course, from p together with certain facts and laws not stated but in some way indicated by the context. (p. 156)

And still later, related ideas were proposed by Ryle [71] and Mackie [51] in philosophy and by Braine and O'Brien [8] in psychology.

Most of the aforementioned authors meant the idea of a conditional's consequent being inferrible from its antecedent to be interpreted as the consequent following *deductively* from the antecedent.¹⁷ As Krzyżanowska et al. [43] point out, however, on that interpretation the idea is hard to maintain, given that there appear to be conditionals that strike us as true even though their consequent does not strictly follow from their antecedent. For instance, we may accept as true that if the taxi is late, we will miss our plane, although there are circumstances imaginable under which we would not miss the plane in the event the taxi is late.

Footnote 16 continued

$\llbracket A \Rightarrow C \rrbracket = \{\langle w_1, f \rangle, \langle w_1, g \rangle, \langle w_3, f \rangle\}$ takes a B-world to be the closest A-world, even though $\llbracket A \rrbracket \cap \llbracket B \rrbracket \neq \emptyset$. The only A-world in B is w_2 , and w_2 makes C false. As a result, $\llbracket A \Rightarrow^B C \rrbracket = \emptyset$ and

$$\Pr(A \Rightarrow^B C | B) = \frac{\Pr((A \Rightarrow^B C) \wedge B)}{\Pr(B)} = \frac{0}{\Pr(B)} = 0 = \Pr(C | A \wedge B).$$

¹⁷For Chrysippus and Mill, this is less clear; see Barnes et al. [4, p. 107 f] and Skorupski (1989, p. 73 f), respectively.

That examples like this one are easy to come by may explain why the idea that conditionals embody inferential connections never really caught on. But as also argued in Krzyżanowska et al. [43], there is nothing in the idea itself that commits one to reading “inference” as meaning *deductive* inference.¹⁸ A more plausible interpretation—according to these authors—is that the consequent is inferrible from the antecedent in the sense that a compelling case can be made for the consequent starting from the antecedent and whatever background assumptions are available in the context of evaluation, where a compelling argument need not consist only of deductive steps, and indeed need not contain any deductive steps at all, but may include or consist only of inductive steps (roughly, steps based on statistical considerations; Kyburg and Teng [44]), abductive steps (roughly, steps based on explanatory considerations; Douven [17]), and perhaps other inferential steps as well (e.g., steps based on analogical considerations; see Carnap, 1980; Paris & Vencovská, 2018; Douven et al. [18]).

In more detail, the new proposal—which goes by the name “inferentialism”—is that conditionals are intimately connected to inference, as follows: A conditional $\lceil A \Rightarrow C \rceil$ is true precisely if there is a compelling argument from A plus contextually determined background premises to C, with A being pivotal to that argument (i.e., with A removed, the argument for C would no longer be compelling).¹⁹ The intuitive understanding here is that anyone justified in believing A becomes justified to believe C as soon as she becomes justified to believe $\lceil A \Rightarrow C \rceil$ (e.g., on the basis of testimony), supposing her being informed that if A, C, does not undermine whatever justifies her belief in A.²⁰

There is already robust empirical support for the thought that inferential connections (including nondeductive ones) play a central role in how people

¹⁸See also Krzyżanowska [39], Douven [15, 16], Vidal and Baratgin [91], Douven et al. [19, 22], Iacona [33], Rostworowski et al. [68], Sikorski [74].

¹⁹For work on the logic of the inferential conditional, see Crupi and Iacona [11, 12], Raidl et al. [66], and Iacona [33].

²⁰Related proposals are to be found in Rott [69, 70], Oaksford and Chater [57–61], van Rooij and Schulz [85], and Berto and Özgün [7]. Oaksford and Chater as well as van Rooij and Schulz analyze the connection between a conditional’s component parts in terms of causality. It may be difficult to experimentally distinguish between these authors’ proposals and inferentialism for everyday conditionals, given that both inductive and abductive considerations tend to rest on causal relations (e.g., most explanations are causal explanations, and regularities that warrant inductive inferences are often grounded in some causal mechanism). However, Douven et al. [22] found evidence for inferentialism using in their materials only abstract conditionals, where causal relations cannot underlie the inference.

evaluate conditionals. Douven et al. [22] were able to accurately predict truth ratings of conditionals on the basis of the perceived strength of the inferential connection between those conditionals' component parts, and the re-analysis in Douven et al. [23] of those data showed the same truth ratings to be better explained by inferentialism than by any of the standard semantics of conditionals (such as the MCA and Stalnaker's possible-worlds semantics), which assign no role to such connections. Furthermore, Mirabile and Douven [55] found that endorsement rates for Modus Ponens and Modus Tollens were more accurately predicted by the strength of the inferential connection between the major premise's component parts than by the probability of that premise's consequent given its antecedent (see also Fernbach & Erb [28]). For further evidence, see Krzyżanowska et al. [40], Vidal and Baratgin [91], Krzyżanowska and Douven [41], Stewart et al. (2021), Douven et al. [18], and Rostworowski et al. [68].²¹

What does inferentialism entail for (EQ) and for the triviality result that threatens it? To start with the latter, we recall that it crucially hinges on both $\Pr(A \Rightarrow C|C) = 1$ and $\Pr(A \Rightarrow C|\neg C) = 0$. From an inferentialist perspective, however, both are to be rejected. The mere fact that C is true does not make it certain that there is a compelling argument from A plus background knowledge to C, where A is indispensable. In fact, it leaves that question wide open. Similarly for the assumption that $\Pr(A \Rightarrow C|\neg C) = 0$.

More importantly, however, while we mostly went along with Williamson's take on what the data relevant to (EQ) are, inferentialism was in part motivated by the finding that the data are in fact *not* what Williamson assumes them to be. As seen in Section 1.1, Skovgaard-Olsen et al. [77] showed that people do *not* in general evaluate the probabilities of conditionals in accordance with (EQ), not even approximately. Further support for this finding comes from two experiments reported in Douven et al. [21]. The materials of these experiments consisted of conditionals with differing inferential connections between their antecedent and consequent. Next to the "normal" ones, whose consequent did follow (in an informal sense) from their antecedent, there were ones without any inferential connection, and ones whose antecedent rather supported the *negation* of their consequent. For present purposes, these authors' two main results were the following: (i)

²¹Recently, Lassiter [46] offered a pragmatic account of the connection between antecedents and consequents in terms of discourse coherence relations. This proposal, however, offers an explanation of only *some* of the above cited findings, and, to the best of our knowledge, it has not been experimentally tested yet.

Conditional probabilities fairly accurately predicted people's probability assignments to the normal conditionals, but they predicted not accurately at all the probability assignments to the other conditionals. (ii) Participants' judgments of the strength of the inferential connection between antecedent and consequent—how strongly they agreed the consequent followed from the antecedent—accurately predicted their probability assignments to all conditionals alike, not just the normal ones, where moreover those judgments were a much better predictor than conditional probabilities even for the normal conditionals. In a different context (concerning the semantics of “because”) and using very different materials, Sebben and Ullrich [73] also found that inferential connections predicted probabilities of conditionals more accurately than conditional probabilities did.

Inferentialism can also account for our intuitions in Gibbard cases. In Williamson's version of the scenario, the two expert engineers, East and West, assert that from the assumption that the detector is working, together with their background knowledge, it can be inferred that the core is overheating, in the case of East, and that it is not overheating, in the case of West. Indeed, for East, the supposition that the detector is working together with his background knowledge that the East light is red strongly supports the conclusion that the core is overheating. Analogously, for West, the supposition that the detector is working together with his background knowledge that the West light is green strongly supports the conclusion that the core is not overheating. There is nothing problematic, then, in judging both (4) and (4) to be true, despite their jointly inconsistent consequents, since there is nothing surprising about two arguments, one for and one against a certain conclusion, to be equally compelling if they start from different background premises.²²

So far, the inferentialist reconstruction of Gibbard conditionals parallels our discussion of the scenario in terms of the possible-worlds semantics (see Section 3.1). Here, too, the controller can infer the negation of the antecedent from (4) and (4), even if she does not know, as Williamson insists, upon what kind of evidence East and West base their assertions. When she receives two apparently conflicting conditionals from the two trustworthy engineers, she can easily grasp that East's evidence led him to infer, from the assumption that the detector is working, that the core is overheating. At the same time, West's evidence together with the same assumption leads to the conclusion that the core is *not* overheating. Given that the controller is said to fully trust the engineers, she should easily come to the realization that East and

²²See Krzyżanowska et al. [43] for a similar take on the Gibbard scenario.

West derived their conclusions about the state of the core from different sets of premises. Even though she does not know what these premises are exactly, she has enough information to make an inference to the best explanation and conclude that the detector must be faulty. After all, the role of a detector in a nuclear plant is to provide evidence about the state of the core. The two engineers seem to have received incompatible data, and a faulty detector is the most likely culprit.²³

Some might say that a comparison between inferentialism and the MCA does not come out in favor of the former entirely, given that of these two accounts, only the latter validates Modus Ponens (MP). It is certainly true that, given inferentialism, MP is invalid. After all, there can be a compelling argument from A to B while A is true and B false, for the simple reason that an argument can be compelling without being conclusive. This might seem a serious problem for inferentialism, given how almost automatically we use this rule in our reasoning.

As Krzyżanowska et al. [43] point out, however, this is not really a problem for inferentialism. For—these authors argue—just consider that, *almost always*, when we have a compelling argument from A to B, and A is true, then B holds true as well. Indeed, it would be deeply troubling if this were not so, for, as Schurz and Hertwig (2019) convincingly argue, in practice we rely on compelling-but-inconclusive arguments much more frequently than on deductively valid ones. But then MP should be highly truth-conclusive as well, supposing an inferentialist take on the conditional operator, which in turn would explain why people tend to rely on this inference rule. And, to reiterate a point made by McGee [52] for different purposes, it would be unreasonable to think that our intuitions about validity are sensitive to the difference between a rule of inference that is guaranteed to preserve truth and one that preserves truth virtually always.

It is also worth mentioning here the work on MP reported in Mirabile and Douven [55]. Consistent with previous experiments by other authors, Mirabile and Douven found endorsement rates of conclusions of MP argument to be close, but not equal, to 100 percent. But while previous authors had attributed to noise their finding that endorsement rates were not quite at ceiling, Mirabile and Douven showed that the likelihood that a participant would endorse the conclusion of an MP argument could be predicted by measuring the participant's judgment of the strength of the inferential

²³For a more elaborate response in line with these remarks, see Krzyżanowska and Douven [42].

connection between the component parts of the major premise of the MP argument, further in support of inferentialism.²⁴

Furthermore, Over and Cruz [63] have recently criticized inferentialism for being too narrow in scope, limited to standard indicative conditionals, and excluding, for instance, non-interference conditionals (“If hell freezes over, Emma will not marry Jim,” or “If there will be war, there will be war”), Dutchman conditionals (“If John passes the exam, I’m a Dutchman”), speech act conditionals (“If you’re hungry, there are cookies on the table”), and also having nothing to say about concessive conditionals (i.e., “even if” conditionals, which are sometimes also expressed without “even”). Over and Cruz favor a probabilistic semantics of conditionals. But other authors might want to cite Over and Cruz’ critique of inferentialism in their defense of the MCA.²⁵

It is certainly true that, as originally presented, inferentialism only meant to deal with normal indicative conditionals, explicitly excluding from its scope the said types of “nonconditionals” [29, 50] or “unconditionals” [53], and simply admitting that concessives had not (yet) been covered. Meanwhile, however, some steps have been taken toward extending the theory. See, for instance, van Rooij and Schulz [88] for an inferentialist analysis of speech act conditionals. And as an inferentialist account of concessives, Douven et al. [19] propose to define “[Even] if A, B” to be true iff there is a compelling argument for B from background premises alone and also from those premises revised (in the manner of Alchourrón, Gärdenfors, & Makinson, 1985) with A; in other words, for a concessive to be true, there should be

²⁴Although most empirical work on conditional reasoning has focused on Modus Ponens, and to a somewhat lesser extent Modus Tollens, logicians have discussed the validity of many further principles of conditional reasoning. One that is particularly relevant to the debate about inferentialism is the principle called “Conjunctive Sufficiency” (CS), or also “And-to-If,” according to which from $\lceil A \wedge B \rceil$ we are licensed to infer $\lceil A \Rightarrow B \rceil$. From the perspective of the MCA, this principle is of course valid: if both conjuncts are true, then, a fortiori, the conditional’s consequent is true, and then, finally, the conditional as a whole is true, supposing the MCA to give the truth conditions of the conditional. By contrast, inferentialists will have to say that CS is invalid. After all, the truth of the conjunction does nothing to guarantee or even make likely that there is a compelling argument from either conjunct to the other. So far, experimental results concerning CS point in different directions. Cruz et al. [13] and Skovgaard-Olsen et al. [76] report data in support of CS. On the other hand, data reported in Douven [15], Douven et al. [23], Krzyżanowska et al. [40] go against CS. Finally, Skovgaard-Olsen et al. [75] found that some of their participants tended to respond in line with CS while other participants’ responses violated the principle. There is clearly a need for more empirical work on CS.

²⁵This is granting, for the sake of the argument, that those authors will be able to show that the MCA can adequately handle all the mentioned types of conditionals.

a compelling argument from its antecedent together with background knowledge to its conclusion, where the antecedent is a non-essential component of the argument. The same authors also propose an inferentialist account of non-interference conditionals. According to them, a non-interference conditional “If A, B” is true iff there is a compelling argument from background knowledge alone to B, also from background knowledge revised by A to B,²⁶ as well as from background knowledge revised by the negation of A to B.²⁶ As Douven and colleagues note, these new proposals are still to be subjected to empirical testing. Given, however, that there is very little empirical work on the said types of conditionals in general, that is hardly an objection against inferentialism.²⁷

5. Conclusion

Williamson made a courageous attempt to rekindle interest in the once popular MCA, according to which the semantics of natural language conditionals is given by the truth table of the material conditional. The popularity of the MCA had faded for a number of reasons, but chief among those was certainly the piling up of experimental results seemingly militating against it. Central to Williamson’s new defense is the claim that at least an important part of the apparently recalcitrant data are due to our reliance on heuristics. Once this is recognized, the MCA actually best explains the data about how people use and evaluate conditionals. Or so Williamson claims.

Every abductive argument carries the risk that the truth is not among the possible explanations we consider [17, 83]. But while we can never completely eliminate that risk, at least we can make an effort to reduce it. Williamson has not done so. Without committing to any of the alternatives to the MCA discussed in this paper, we have argued that, granting the data are what Williamson takes them to be, each of the three alternatives we looked at explains those data at least as well as, or even better than, the MCA does. Moreover, we saw that Williamson is actually misinformed about what the

²⁶See also van Rooij and Schulz [86, 87, 90] for an inferentialist proposal for the analysis of generic sentences.

²⁷For further details, and also for discussion of some open questions facing inferentialism, see Douven et al. [19, 20].

relevant data are. For these reasons, we believe his attempted defense to fail.²⁸

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References

- [1] ADAMS, E. W., *The Logic of Conditionals*, Reidel, Dordrecht, 1975.
- [2] ADAMS, E. W., *A Primer of Probability Logic*, CSLI Publications, Stanford, 1998.
- [3] BARATGIN, J., D.E. OVER, and G. POLITZER, Uncertainty and the de Finetti tables, *Thinking & Reasoning* 19:308–328, 2013.
- [4] BARNES, J., S. BOBZIEN, and M. MIGNUCCI, Logic, in K. Algra, J. Barnes, J. Mansfeld, and M. Schofield, (eds.), *The Cambridge History of Hellenistic Philosophy*, Cambridge University Press, Cambridge, 1999, pp. 77–176.
- [5] BELNAP, N.D., Restricted quantification and conditional assertion, in H. Leblanc, (ed.), *Truth, Syntax and Modality*, North Holland, Amsterdam, 1973, pp. 48–75.
- [6] BERTO, F., Williamson on indicatives and suppositional heuristics, *Synthese*, in press, 2022.
- [7] BERTO, F., and A. ÖZGÜN, Indicative conditionals: Probabilities and relevance, *Philosophical Studies* 178:3697–3730, 2021.
- [8] BRAINE, M.D.S., and D.P. O'BRIEN, A theory of if: Lexical entry, reasoning program, and pragmatic principles, *Psychological Review* 98:182–203, 1991.
- [9] COLLINS, P.J., U. HAHN, Y. VON GERBER, and E.J. OLSSON, The bi-directional relationship between source characteristics and message content, *Frontiers in Psychology* 9:18, 2018.
- [10] COLLINS, P.J., K.H. KRZYŻANOWSKA, S. HARTMANN, G. WHEELER, and U. HAHN, Conditionals and testimony, *Cognitive Psychology* 122:101329, 2020.

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- [11] CRUPI, V., and A. IACONA, The evidential conditional, *Erkenntnis*, 2020, <https://doi.org/10.1007/s10670-020-00332-2>
- [12] CRUPI, V., and A. IACONA, Three ways of being non-material *Studia Logica* 110:47–93, 2022.
- [13] CRUZ, N., D. OVER, M. OAKSFORD, and J. BARATGIN, Centering and the meaning of the conditional, in *The Annual Meeting of the Cognitive Science Society Proceedings*, pp. 1104–1109, 2016.
- [14] DE FINETTI, B., Foresight: Its logical laws, its subjective sources, in H.E. Kyburg, and H.E. Smokler, (eds.), *Studies in Subjective Probability*, Wiley, New York, pp. 55–118, 1937/1964.
- [15] DOUVEN, I., *The Epistemology of Indicative Conditionals*, Cambridge University Press, Cambridge, 2016.
- [16] DOUVEN, I., How to account for the oddness of missing-link conditionals. *Synthese* 194:1541–1554, 2017.
- [17] DOUVEN, I., *The Art of Abduction*, MIT Press, Cambridge, MA, 2022.
- [18] DOUVEN, I., S. ELQAYAM, P. GÄRDENFORS, and P. MIRABILE, Conceptual spaces and the strength of similarity-based arguments, *Cognition* 218:104951, 2022.
- [19] DOUVEN, I., S. ELQAYAM, and K.H. KRZYŻANOWSKA, Inferentialism: A manifesto, in S. Kaufmann, D.E. Over, and G. Sharma, (eds.), *Conditionals: Logic, Linguistics, and Psychology*, Palgrave Macmillan, London, in press, 2023a.
- [20] DOUVEN, I., S. ELQAYAM, and K.H. KRZYŻANOWSKA, The experimental philosophy of logic and formal epistemology, in M. Bauer, and S. Kornmesser, (eds.), *Compact Compendium of Experimental Philosophy*, De Gruyter, Berlin, in press, 2023b.
- [21] DOUVEN, I., S. ELQAYAM, and P. MIRABILE, Inference strength predicts the probability of conditionals better than conditional probability, *Journal of Memory and Language* 123:104302, 2022.
- [22] DOUVEN, I., S. ELQAYAM, H. SINGMANN, and J. VAN WIJNBERGEN-HUITINK, Conditionals and inferential connections: A hypothetical inferential theory, *Cognitive Psychology* 101:50–81, 2018.
- [23] DOUVEN, I., S. ELQAYAM, H. SINGMANN, and J. VAN WIJNBERGEN-HUITINK, Conditionals and inferential connections: Toward a new semantics, *Thinking & Reasoning* 26:311–351, 2020.
- [24] DUBOIS, D., and H. PRADE, Conditional objects as non-monotonic consequence relationships, *IEEE Transactions on Systems, Man, and Cybernetics*, 24:1724–1740, 1994.
- [25] EDGINGTON, D., The mystery of the missing matter of fact, *Proceedings of the Aristotelian Society* 65:185–209, 1991.
- [26] ÉGRÉ, P., L. ROSSI, and J. SPRENGER, De Finettian logics of indicative conditionals part 1: Trivalent semantics and validity, *Journal of Philosophical Logic* 50:187–213, 2021.
- [27] EVANS, J.St.B.T., and D.E. OVER, *If*, Oxford University Press, Oxford, 2004.
- [28] FERNBACH, P.M., and C.D. ERB, A quantitative causal model theory of conditional reasoning, *Journal of Experimental Psychology: Learning, Memory, and Cognition* 39:1327–1343, 2013.

- [29] GEIS, M.L., and W.G. LYCAN, Nonconditional conditionals, *Philosophical Topics* 21:35–56, 1993.
- [30] GIBBARD, A., Two recent theories of conditionals, in W.L. Harper, R. Stalnaker, and G. Pearce, (eds.), *If*, Reidel, Dordrecht, 1981, pp. 211–247.
- [31] GILIO, A., and G. SANFILIPPO, Conditional random quantities and compounds of conditionals, *Studia Logica* 102:709–729, 2014.
- [32] HUITINK, J., Quantified conditionals and compositionality, *Language and Linguistics Compass* 4:42–53, 2010.
- [33] IACONA, A., Valid arguments as true conditionals, *Mind*, in press, 2023.
- [34] JEFFREY, R., and R. STALNAKER, Conditionals as random variables, in E. Eells, and B. Skyrms, (eds.), *Probability and Conditionals*. Cambridge University Press, Cambridge, 1994, pp. 31–46.
- [35] KAUFMANN, S., Conditional predictions, *Linguistics and Philosophy* 28, 181–231, 2005.
- [36] KLEENE, S. C., *Introduction to Metamathematics*, North-Holland, Amsterdam, 1952.
- [37] KNEALE, W., and M. KNEALE, *The Development of Logic*, Oxford University Press, Oxford, 1962.
- [38] KRAUS, S., D. LEHMANN, and M. MAGIDOR, Nonmonotonic reasoning, preferential models and cumulative logics, *Artificial Intelligence* 44:167–207, 1990.
- [39] KRZYŻANOWSKA, K. H., *Between “If” and “Then.”*, Ph.D. thesis, University of Groningen, 2015.
- [40] KRZYŻANOWSKA, K. H., P.J. COLLINS, and U. HAHN, True clauses and false connections, *Journal of Memory and Language* 121:104252, 2021.
- [41] KRZYŻANOWSKA, K. H., and I. DOUVEN, Missing-link conditionals: Pragmatically infelicitous or semantically defective? *Intercultural Pragmatics* 15:191–211, 2018.
- [42] KRZYŻANOWSKA, K. H., and I. DOUVEN, Williamson on conditionals and testimony, *Philosophical Studies* in press, 2023.
- [43] KRZYŻANOWSKA, K. H., S. WENMACKERS, and I. DOUVEN, Rethinking Gibbard’s river-boat argument, *Studia Logica* 102:771–792, 2014.
- [44] KYBURG, H.E., and C.M. TENG, *Uncertain Inference*, Cambridge University Press, Cambridge, 2001.
- [45] LASSITER, D., What we can learn from how trivalent conditionals avoid triviality, *Inquiry* 63:1087–1114, 2020.
- [46] LASSITER, D., Decomposing relevance in conditionals, *Mind & Language*, in press, 2022.
- [47] LEWIS, D.K., *Counterfactuals*, Blackwell, Oxford, 1973.
- [48] LEWIS, D.K., Probabilities of conditionals and conditional probabilities, *Philosophical Review* 85:297–315, 1975.
- [49] LIPTON, P., *Inference to the Best Explanation*, 2nd ed., Routledge, London, 2004.
- [50] LYCAN, W., *Real Conditionals*, Oxford University Press, Oxford, 2001.
- [51] MACKIE, J.L., *Truth, Probability and Paradox: Studies in Philosophical Logic*, Oxford University Press, Oxford, 1973.
- [52] MCGEE, V., A counterexample to Modus Ponens, *Journal of Philosophy* 82:462–471, 1985.

- [53] MERIN, A., Unconditionals, Unpublished manuscript, available at <http://semanticsarchive.net/Archive/WUwZTk5M/unconditionals.pdf>, 2007.
- [54] MILL, J.S., *A System of Logic: Ratiocinative and Inductive*, 8th ed., Longmans, Green, Reader, & Dyer, London, 1843/1872.
- [55] MIRABILE, P., and I. DOUVEN, Abductive conditionals as a test case for inferentialism, *Cognition* 200:104232, 2020. <https://doi.org/10.1016/j.cognition.2020.104232>.
- [56] OAKSFORD, M., and N. CHATER, *Bayesian Rationality*, Oxford University Press, Oxford, 2007.
- [57] OAKSFORD, M., and N. CHATER, Causation and conditionals in the cognitive science of human reasoning, *The Open Psychology Journal* 3:105–118, 2010.
- [58] OAKSFORD, M., and N. CHATER, Dynamic inference and everyday conditional reasoning in the new paradigm, *Thinking & Reasoning* 19:346–379, 2013.
- [59] OAKSFORD, M., and N. CHATER, Probabilistic single function dual process theory and logic programming as approaches to non-monotonicity in human vs. artificial reasoning, *Thinking & Reasoning* 20:269–295, 2014.
- [60] OAKSFORD, M., and N. CHATER, Causal models and conditional reasoning, in M. R. Waldmann, (ed.), *The Oxford Handbook of Causal Reasoning*, Oxford University Press, Oxford, 2017, pp. 327–346.
- [61] OAKSFORD, M., and N. CHATER, Integrating causal Bayes nets and inferentialism in conditional inference, in S. Elqayam, I. Douven, J.St.B.T. Evans, and N. Cruz, (eds.), *Logic and Uncertainty in the Human Mind*. Routledge, London, 2020, pp. 116–132.
- [62] OBERAUER, K., A. WEIDENFELD, and K. FISCHER, What makes us believe a conditional? *Thinking & Reasoning* 13(4):340–369, 2007.
- [63] OVER, D.E., and N. CRUZ, Indicative and counterfactual conditionals in the psychology of reasoning, in S. Kaufmann, D.E. Over, and G. Sharma, (eds.), *Conditionals: Logic, Linguistics, and Psychology*, Palgrave Macmillan, London, in press, 2021.
- [64] OVER, D.E., C. HADJICHRISTIDIS, J.St.B.T. EVANS, S.J. HANDLEY, and S.A. SLOMAN, The probability of causal conditionals, *Cognitive Psychology* 54:62–97, 2007.
- [65] POLITZER, G., D.E. OVER, and J. BARATGIN, Betting on conditionals, *Thinking & Reasoning* 16:172–197, 2010.
- [66] RAIDL, E., A. IACONA, and V. CRUPI, The logic of the evidential conditional, *Review of Symbolic Logic*, <https://doi.org/10.1017/S1755020321000071>, 2021.
- [67] RAMSEY, F.P., General propositions and causality. causality, in D.H. Mellor, (ed.), *Philosophical Papers*, Cambridge University Press, Cambridge, 1929/1990, pp. 145–163.
- [68] ROSTWOROWSKI, W., N. PIETRULEWICZ, and M. BĘDKOWSKI, Conditionals and specific links: An experimental study, *Synthese*, in press, 2023.
- [69] ROTT, H., Ifs, though and because, *Erkenntnis* 25:345–370, 1986.
- [70] ROTT, H., Difference-making conditionals and the relevant Ramsey test, *Review of Symbolic Logic* in press, 2019.
- [71] RYLE, G., “If,” “so,” and “because”, in M. Black, (ed.), *Philosophical Analysis*, Cornell University Press, Ithaca, NY, 1950, pp. 323–340.
- [72] SCHAY, G., An algebra of conditional events, *Journal of Mathematical Analysis and Applications* 24:334–344, 1968.

- [73] SEBBEN, S., and J. ULRICH, Can conditionals explain explanations? A modus ponens model of B because A. *Cognition* 215:104812, 2021.
- [74] SIKORSKI, M., Rethinking the acceptability and probability of indicative conditionals, in S. Kaufmann, D.E. Over, and G. Sharma, (eds.), *Conditionals: Logic, Linguistics, and Psychology*, Palgrave Macmillan, London, in press, 2023.
- [75] SKOVGAARD-OLSEN, N., D. KELLEN, U. HAHN, and K.C. KLAUER, Norm conflicts and conditionals, *Psychological Review* 126:611–633, 2019.
- [76] SKOVGAARD-OLSEN, N., D. KELLEN, H. KRAHL, and K.C. KLAUER, Relevance differently affects the truth, acceptability, and probability evaluations of “and,” “but,” “therefore,” and “if then.” *Thinking & Reasoning* 23:449–482, 2017.
- [77] SKOVGAARD-OLSEN, N., H. SINGMANN, and K.C. KLAUER, The relevance effect and conditionals, *Cognition* 150:26–36, 2016.
- [78] SPOHN, W., A ranking-theoretic approach to conditionals, *Cognitive Science* 37:1074–1106, 2013.
- [79] STALNAKER, R., A theory of conditionals, in J.W. Cornman, (ed.), *Studies in Logical Theory*, Oxford University Press, Oxford, 1968, pp. 98–112.
- [80] STALNAKER, R., Probability and conditionals, *Philosophy of Science* 37:64–80, 1970.
- [81] STALNAKER, R., Indicative conditionals, *Philosophia* 5:269–286, 1975.
- [82] VAN FRAASSEN, B.C., Probabilities of conditionals, in W.L. Harper, and C.A. Hooker, (eds.), *Foundations of Probability Theory, Statistical Inference, and Statistical Theories of Science*, Reidel, Dordrecht, 1976, pp. 261–301.
- [83] VAN FRAASSEN, B.C., *Laws and Symmetry*, Oxford University Press, Oxford, 1989.
- [84] VAN ROOIJ, R., *Attitudes and Changing Contexts*, Springer, Berlin, 2006.
- [85] VAN ROOIJ, R., and K. SCHULZ, Conditionals, causality and conditional probability, *Journal of Logic, Language and Information* 28:55–71, 2019.
- [86] VAN ROOIJ, R., and K. SCHULZ, A causal semantics of IS generics, *Journal of Semantics* 37:269–295, 2020a.
- [87] VAN ROOIJ, R., and K. SCHULZ, Generics and typicality: A bounded rationality approach, *Linguistics & Philosophy* 43:83–117, 2020b.
- [88] VAN ROOIJ, R., and K. SCHULZ, Why those biscuits are relevant and on the sideboard, *Theoria* 87:704–712, 2021a.
- [89] VAN ROOIJ, R., and K. SCHULZ, Causal relevance of conditionals—semantics or pragmatics? *Linguistic Vanguard*, in press, 2021b.
- [90] VAN ROOIJ, R., and K. SCHULZ, A causal power theory of generics, *Topoi* 40, 131–146, 2021c.
- [91] VIDAL, M., and J. BARATGIN, A psychological study of unconnected conditionals, *Journal of Cognitive Psychology* 29:769–781, 2017.
- [92] WILLIAMSON, T., Semantic paradoxes and abductive methodology, in B. Armour-Garb, (ed.), *Reflections on the Liar*, Oxford University Press, Oxford, 2017, pp. 325–346.
- [93] WILLIAMSON, T., *Doing Philosophy*, Oxford University Press, Oxford, 2018.
- [94] WILLIAMSON, T., *Suppose and Tell: The Semantics and Heuristics of Conditionals*, Oxford University Press, Oxford, 2020.

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