DIRECTIONAL BIAS

Draft of August 10, 2021

Matheus Silva

ABSTRACT

There is almost a consensus among conditional experts that indicative conditionals are not material. Their thought hinges on the idea that if indicative conditionals were material, $A \rightarrow B$ could be vacuously true when A is false, even if B would be false in a context where A is true. But since this consequence is implausible, the material account is usually regarded as false. It is argued that this point of view is motivated by the grammatical form of conditional sentences and the symbols used to represent their logical form, which misleadingly suggest a one-way inferential direction from A to B. That conditional sentences mislead us into a directionality bias is a phenomenon that is well-documented in the literature about conditional reasoning. It is argued that this directional appearance is deceptive and does not reflect the underlying truth conditions of conditional sentences. This directional bias is responsible for both the unpopularity of the material account of conditionals and some of the main alternative principles and themes in conditional theory, including the Ramsey's test, the Equation, Adams' thesis, conditional-assertion and possible world theories. The directional mindset forgets a hard-earned lesson that made classical logic possible in the first place, namely, that grammatical form of sentences can mislead us about its truth conditions. There is a case to be made for a material account of indicative conditionals when we break the domination of words over the human mind.

1. INTRODUCTION

The philosophical literature on conditionals is extremely specialised. Conditional experts can make entire research programs about a single type of sentence such as indicative conditionals, subjunctive conditionals, biscuit conditionals, or even-ifs. The literature can be also daunting for the non-initiated. The requirements necessary to master some of the latest developments may involve probability, semantic theory, pragmatics, epistemology, modal metaphysics, and even psychological research about conditional reasoning. But one thing that catches the eye is how the conventional wisdom among conditional experts is that the first logic taught to undergraduate students is wrong, since conditionals are believed to be non-material. In his extensive textbook about conditionals with 23 chapters, Bennett (2003) impatiently discusses the material account of conditionals in chapters 2 and 3 only to dismiss it with quick objections. Read (1992: 12) confidently asserts that his article 'puts another nail in the coffin of the truth-functionality thesis'. Rieger (2013: 3161) observes that the material account is perceived as 'the caveman theory of conditionals, with few merits beyond its simplicity'.

In this article, I will try to add my personal contribution in face of the prevalent scepticism among conditional experts. I will argue that the denial of the material account is motivated by the grammatical form of conditional sentences and the symbols used to represent their logical form, which misleadingly suggest a one-way inferential direction from the antecedent to the consequent. That conditional sentences mislead us into a directionality bias is a phenomenon that is well-documented in the literature about conditional reasoning. It is argued that this directional appearance is deceptive and does not reflect the underlying truth conditions of conditional sentences. This article will be divided as follows. Section 2 tries to pinpoint the precise nature of the so called 'paradoxes of material conditional'. The focus of this article will be on the counter-intuitive cases where the truth of the antecedent of a conditional is incompatible with the truth of the consequent. Section 3 presents some of the data that suggests a phenomenon known in the literature of conditional reasoning as directional bias. Section 4 tries to make a connection between this phenomenon and the negative reception of the material account among conditional experts. It is also defended that the directional bias motivated some of the main principles in conditional theory. Section 5 makes a case for a material account [1] with the argument that conditionals cannot be viewed as sui generis connectives. Instead, they should be viewed as truth-functional connectives alongside disjunctions and conjunctions, for the sake of coherence. Section 6 concludes.

2. PUZZLES AND 'PARADOXES'

But before I can lay out my strategy, it is necessary to understand what is the issue. The material account asserts that '$\rightarrow$' and '$\supset$' are logically equivalent. This implies that $A \rightarrow B$ will be false if A is true and B is false, but true in the remaining truth value combinations of A and B[2]. The idea that $A \rightarrow B$ will be false if A is true and B is false is reasonable. If I assert 'if John arrives late on the airport, he will miss the plane', but John gets late on the airport and do not miss the plane, what I asserted is false. But the other truth value combinations are puzzling, for they ensure that a conditional will be true either because its antecedent is false, or its consequent is true. This assumption has two implausible consequences. First, it implies that $A \rightarrow B$ can be true even if the truth of A leads to the falsity of B. Secondly, it implies that $A \rightarrow B$ can be true even if the truth value of A has no relevance to the truth value of B. Let's say the puzzling aspect of the first type involves the negative relevance of A to B, while the puzzling aspect of the second type involves the irrelevance of A to B.

The material assumption that a conditional will be true simply because its antecedent is false can be puzzling either due to the negative relevance of the antecedent to its consequent, or due to the irrelevance of the antecedent to its consequent. One example of negative relevance is the conditional 'If John drinks poison this afternoon, it will be good for his health'. This conditional will be vacuously true simply because John did not drink poison. This is implausible since in usual circumstances the act of drinking poison cannot be good for John's health since it leads to his death. The idea is that $A \rightarrow B$ cannot be true simply because A is false, given that B would be false if A were true. In this case, it seems that $A \rightarrow B$ cannot be vacuously true due to the falsity of A, if the truth of A is relevant to the falsity of B. One example of irrelevant antecedent is the conditional 'if the moon is made of cheese, two plus two equals four'. This conditional will be true simply because two plus two equals four. This is appalling since a false hypothesis about the constitution of the moon has no relevance to the truths of arithmetic.

The same puzzling aspects can occur if the conditional is true simply because its consequent is true. Suppose that I glance on the newspaper the results of a soccer match. Knowing that the match took place and accepting the material account, I feel confident to assert 'If the players broke their legs, the match was not cancelled'. This is counter-intuitive because in any circumstances where the players broke their legs (for instance, in a terrible accident),

[1] For further references on the attempts to defend the material account see Ajdukiewicz (1956), Allott & Uchida (2009a; 2009b), Clark (1971; 1974), Fulda (1989), Grice (1989), Hanson (1991), Lewis (1976), Jackson (1987, 2006), Mellor (1993), Noh (1998); Rieger (2006; 2015); Smith (1983); Smith & Smith (1988); and Williamson (2020). I will not discuss here the merits and problems of these attempts, since I will be focusing on my own explanation.

[2] I will adopt the notation where '$\rightarrow$' stands for natural language conditionals, and '$\supset$' stands for material conditional. I will use capital letters such as A, B, C for both propositional and formula variables. For simplicity of exposition, I will not use quotes to highlight the use-mention distinction when there is no risk of confusion—the context will make it clear which one is being used.

the match would be cancelled. The truth of the antecedent would lead to the falsity of the consequent. The other example already mentioned above, i.e., 'if the moon is made of cheese, two plus two equals four', can be also an example of conditional whose truth rests on the truth of the consequent even if the antecedent is irrelevant to the consequent.

These results are known as the paradoxes of material conditional, but they are not paradoxes in the strict sense of the term, i.e., an inference that is apparently valid with acceptable premises, but lead to a conclusion that is apparently false or contradictory. Rather, they are paradoxes in the etymological or ordinary sense of the term, i.e., they are statements that are contrary to accepted opinion, or more simply, they are counter-intuitive and implausible aspects of the material account. If the paradoxes of material conditional are just the counter-intuitive aspects of the material account, it could be argued that *any counter-intuitive aspects* of the material account are paradoxes of material conditional. Clarence Lewis presented third and two paradoxes of the material conditional in his 'Interesting Theorems in Symbolic Logic'. In fact, if we consider that we can formulate infinite inferential and propositional forms according using classic logic, it would not an exaggeration to claim that there are an infinite number of classical inferential forms that can be built upon these counter-intuitive aspects and, therefore, an infinite number of paradoxes of the material conditional.

But this characterisation of the problem does not do justice to the way the notion have been previously discussed in the literature. When most conditional experts talk about the paradoxes of material conditional, what they have in mind are cases where the antecedent of a conditional has a negative relevance to its consequent. The assumption that a conditional can be true when its antecedent is irrelevant to its consequent is usually perceived as a non-issue, since it is widely accepted that conditionals are true when A and B are true, even if they are irrelevant to each other[3]. Besides, other counter-intuitive aspects of the material account have their own nicknames, e.g., the switches paradox, the barber shop paradox[4], etc. Since each case have its own particularities, there is nothing to gain by classifying each and every counter-intuitive aspect of the material account as paradoxes of the material conditional. Thus, what we will refer by paradoxes of material conditional in this article are the cases where $A \rightarrow B$ is vacuously true, but seem false because the truth of A is relevant to the falsity of B.

Notice that the material assumption that a conditional is true simply because its antecedent is false or its consequent is true *can have* counter-intuitive consequences, but this is not always the case. Dutchman conditionals such as 'If John's speaking the truth, I'm a Dutchman', are asserted precisely because the speaker thinks that the antecedent is false, but are not puzzling. Even-if conditionals such as 'Even if it rains, the match will not be cancelled' are asserted because the speaker assumes that the consequent is true, but are not counter-intuitive. The problem, accuses the critics, is not that the material account can never be intuitive, but that it can be counter-intuitive in some cases, and these cases are so implausible that the material account must be fundamentally wrong. The fact that they are artificial or contrived is irrelevant. They should not be tolerated.

But while these results seem intolerable, it is undeniable that the material account has some advantages, such as simplicity and generality. It also provides an elegant explanation of

[3] McGlynn (2012: 276–277). There are exceptions though. Some philosophers will propose systems of logic built around the notion of relevance—see Anderson & Belnap (1975), Anderson et al. (1992), Mares (1994), and Read (1988). There are also other approaches to conditionals that are more informal and metaphysically-minded, but also regard relevance as a necessary element for its truth conditions by means of a notion of conditionality—see, for example, Anjum (2008) and Sanford (2006). I will leave to another opportunity the discussion of whether $A \rightarrow B$ can be true when A is irrelevant to B.

[4] The switches paradox is discussed by Armstrong (1970); Corcoran & Wood (1973); Gogol (1972); Parks (1972) and Settle (1973). The barber shop paradox is discussed by Baker (1955); Burks & Copi (1950); and Gillon (1997). These problems will not be discussed here.

conditionals truth conditions that is also in consonance with the truth-functional nature of the remaining connectives ('or', 'and', and 'only if'). Therefore, if there is a possibility of rescuing the material account from these counter-intuitive consequences, we should give it a try.

3. WHERE DID IT ALL GO WRONG

It seems that $A \rightarrow B$ cannot be vacuously true due to the falsity of A alone, or at least it not if B would be false in circumstance where A would be true. But this impressions rests on the il-considered assumption that the inferential passage from A to B suggested by the grammatical form of conditional sentences is a reliable indicator of its truth conditions. That the grammatical form of conditional sentences invite inferences is one of the marked differences of conditionals in relation to categorical propositions. In logic textbooks, the standard example of a conditional sentence is 'If A, then B', and other less usual examples include 'B because A', 'B given A', 'There is no B, unless there is A' and 'Since A, B'. All these forms suggest an inferential passage from A to B. It is also usual to name the subordinate clause, A, as 'antecedent', and the main clause, B, as 'consequent', which naturally predispose us to think that B comes after A. The very name of the sentence in natural language, i.e., 'conditional', suggests that A must be a condition for B, which makes us think that B must be inferable from A. These sentences were also called 'hypotheticals' in the past. The name may now be in disuse, but it was also motivated by the directional and grammatical form of conditional sentences, since the term 'if' apparently indicates that the antecedent is assumed as a hypothesis used in an inference directed to the consequent.

This inferential passage is also suggested by the symbols used to represent the logical form of conditionals. This happens because our conventions regarding the logical form of conditionals are already imbedded with grammatical induced prejudices, as is attested by the fact that logical symbols used to represent conditional operators ('$\rightarrow$', '$\supset$', '$\Rightarrow$', etc.) point in a direction from A to B. The importance attributed to the directional inferential form of conditionals explains why the unpopularity of the material conditional is not extended to other truth-functional connectives. The grammatical form and the logical symbols used to represent the other connectives, e.g., disjunctions ('A or B', '$A \vee B$'), conjunctions ('A and B', '$A\&B$', '$A \wedge B$') and biconditionals ('A if and only if B', '$A \equiv B$', '$A \leftrightarrows B$'), do not suggest any inherent directionality[5]. In the biconditional case there is still a vestige of directionality since the biconditional can be read as a conjunction of conditionals 'If A then B and if B then A', but there is no one-sided directionality effect, because the two conditionals suggest opposite directionalities.

That conditional sentences invite inferences from the antecedent to consequent and mislead us into a directionality bias is well-documented in the literature about conditional reasoning[6]. This effect explains why forward inferences such as *modus ponens* are processed faster than backward inferences such as *modus tollens*[7], why people tend to consider *modus tollens* unnatural or invalid, but not *modus ponens*[8], and why conditional sentences are processed faster when there is no discrepancy between the linguistic directionality suggested by the grammatical form and the temporal order of the events they describe[9].

---

[5] Oberauer & Wilhelm (2000: 1710); Oberauer et al. (2005: 1237).
[6] Evans (1977); Evans & Beck (1981); Evans & Newstead (1977); Evans et al. (1993); Rips & Marcus (1977); Braine (1978); Oberauer & Wilhelm (2000).
[7] Evans (1977); Rips & Marcus (1977); Braine (1978).
[8] Evans et al. (1993); Wason & Johnson-Laird (1972); Rips & Marcus (1977); Rumain et al. (1983).
[9] Evans & Newstead (1977); Roberge (1982).

The directionality bias is a strong evidence of linguistic influences on the comprehension processes of conditional sentences. The inference from A to B is more natural, because it is congruent with the directionality and inferential passage suggested by the grammatical form. The directionality of conditionals is reinforced by the use of the world 'if', which indicates the supposition needed for the affirmative forward inference, and the use of the word 'then', which stress that the consequent can be inferred from this assumption. People may not think about the possibility that the antecedent is false, because it seems unnatural or irrelevant to the directionality of the grammatical form.

The directional bias is motivated by the misleading grammatical and logical form of conditionals and it is behind the counter-intuitive aspects of the material account. Consider again the conditional 'If John drinks poison this afternoon, it will be good for his health'. This conditional will be vacuously true simply because John did not drink poison, but this is implausible since in usual circumstances the act of drinking poison cannot be good for John's health since it leads to his death. But the question we need to ask ourselves is why are we considering a circumstance where John drinks poison if the antecedent is actually false? The answer is that we are prone to the directional bias associated with the inferential form of conditional sentences. Since we would not infer that John would be healthy from the assumption that he drinks poison, we think that the conditional is false even if the antecedent is actually false.

It would not be an exaggeration to argue that the directional bias also motivated directly or indirectly some of the main principles and themes in conditional theory. For instance, it is arguable that it motivated the Ramsey's test, according to which the analysis of a conditional must proceed with the following steps: 'First, add the antecedent (hypothetically) to your stock of beliefs; second, make whatever adjustments are required to maintain consistency (without modifying the hypothetical belief in the antecedent); finally, consider whether or not the consequent is then true'[10].

The directional rationale behind this test for the acceptance of conditionals can also be interpreted as saying that the acceptance of an indicative conditional for any given subject, S, with S's probability of B conditional on A. This led us to Adams' thesis, which claims that the acceptability of $A \rightarrow B$ is measured by the conditional probability of B given A[11]. If the acceptability of the conditional mentioned is replaced by probability of truth, we will have what is known as the equation, which asserts that the probability of $A \rightarrow B$ is measured by the conditional probability of B given A[12].

It is also easy to demonstrate that one the main alternatives for the material account are directly inspired in the Ramsey's test, thus inheriting its directional bias. Stalnaker (1968: 102) interprets the test as providing the conditions in which we decide whether or not we believe a conditional statement (belief conditions), which he then considers as an inspiration for the conditions in which a conditional statement is true or false (truth conditions). Stalnaker (1968: 102) makes this transition using the concept of a possible world, which is intended as providing the ontological analogue of a stock of hypothetical beliefs. $A \rightarrow B$ is true (false) just in case B is true (false) in the possible world in which A is true, and which otherwise differs minimally from the actual world. By shaping the truth conditions of conditional statements in terms of the Ramsey's test, Stalnaker ensures that the formal logic will be hostage of the directional bias and related intuitions, with all that that entails.

---

[10] Stalnaker (1968: 102). The original formulation of the test was presented by Ramsey (1929: 143), hence the name.

[11] Adams (1965: 172).

[12] Jeffrey (1964: 702–703). Both Adam's thesis and the equation assume that $\Pr(A) > 0$, and conditional probability of B given A is defined as $\Pr(A\&B)|\Pr(A)$.

The Ramsey's test and the Adam's thesis are obvious sources of inspiration for the hypothesis that conditionals are acts of conditional assertion. The idea is that there is no assertion of $A \rightarrow B$, because the conditionals is not a proposition, but an assertion of B given the assumption of A, and an assertion of nothing when A is false[13]. This position is usually known as conditional-assertion theory, but sometimes is also named as suppositional view, since conditional statements are interpreted as the expression of a supposition. The suppositional view was first suggested by Quine (1950: 19)[14], and has its champion in Dorothy Edgington (1986; 1995), who adjusted the probabilistic logic of Ernest Adams (1965; 1975) in order to present a compelling alternative logic where conditionals can be interpreted as mere conditional assertions[15].

There are also attempts that result from a compromise between the suppositional view and the intuition that conditionals have truth conditions. In this interpretation, $A \rightarrow B$ is true if A and B are true; false if A is true and B is false, but has no truth value when A is false[16]. This view was suggested earlier by Stalnaker (1975: 137, fn. 2). In this hypothesis, the assertion of B given the assumption of A generates a proposition with truth values when A is true. Otherwise, any talk about the truth value of the conditional is meaningless.

Finally, there also those philosophers that influenced by the directional form treat conditionals as similar to arguments. Mackie (1973: 81) suggested that conditionals are condensed arguments, an idea which he called *the logical powers account*. Thus, to accept 'if *A* then *B*' is to be willing to infer that *B* given the acceptance of *A*. In this sense, the conditional 'If it rains, the street is wet' would express an inference we would be willing to perform given the assumption that it rains, and not a belief about a proposition. Ryle (1950) defended a similar view by suggesting that conditional sentences are like inferential tickets. To accept 'if *A* then *B*' is to find out that one is entitled to argue that '*A*, therefore *B*', given the condition that the premise *A* is obtained. The reasoner does not actually need to make the inference she is entitled to, in the same way that an owner of a railway ticket does not need to use it to travel, even though she would be entitled to[17].

Other philosophers also wanted to highlight conditionals' relation with arguments, but were cagier about its precise nature. For instance, Hare (1970: 16) merely hinted at this idea when he said that 'to understand the 'If ... , then' form of sentence is to understand the place that it has in logic (to understand its logical properties). It is, in fact, to understand the operation of *modus ponens* and related inferences'. Strawson (1986) also proposed that 'if *A*, then *B*' conventionally implies the existence of a ground-consequence relation between the two propositions means the same as '*A*, so *B*'[18]. The hypothesis is that if '*A*, so *B*' is a conventional argument-form, 'if *A*, then *B*' might be called the conventional quasi-argument-form, and that the only difference between the two is that the premises of a quasi-argument-form are 'entertained rather than asserted'[19]. Strawson thinks that this would explain why we may hesitate to call conditional statements true, and prefer to call them 'reasonable or well-founded'[20].

One way to make this relation between conditionals and arguments more precise is to claim that the acceptance of $A \rightarrow B$ is measured by our willingness to employ it on a *modus ponens*. Jackson (1987: 26–31) endorses this view by arguing for the importance of *modus*

---

[13] Appiah (1985); Barker (1995); DeRose & Grandy (1999); Edgington (1995; 1986).
[14] Quine credited Philip Rhinelander with the idea.
[15] For a brief history of the first steps in the development of a suppositional theory, see Milne (1997: 197–201).
[16] McDermott (1996).
[17] Ryle (1950/2009: 312).
[18] Strawson (1952: 35; 1986: 233).
[19] Strawson (1986: 241).
[20] Strawson (1952: 83).

ponens as condition for the assertibility of conditionals using the concept of robustness: $A \rightarrow B$ is acceptable when B is robust with respect to A, i.e., when $\Pr(B)$ is high and would remain high after learning that A. In this sense, $A \rightarrow B$ would only be acceptable when it can be employed on a *modus ponens* inference.

There are so many theories inspired in the same directional aspect of conditional sentences that even a schematic exposition of every one of them would be an impossible task. It is sufficient to consider, however, that this is directional intuition motivated by the form of conditional sentences has sufficient generality[21] to be considered the major reason for the departure from the material account.

The task then is to explain how $A \rightarrow B$ can be true even if the truth of A leads to the falsity of B, or to put in other words, why it is a mistake to assume that $A \rightarrow B$ can only be true if B is true when A is true. This semantic belief rests on the assumption that the inferential passage from A to B is a reliable indicator of its truth conditions. The inferential passage on its turn is suggested by the grammatical form of conditional sentences and the symbols used to represent their logical form. Therefore, if the grammatical form of conditional sentences and the symbols used to represent their logical form turn out to be misleading about its inferential uses, the inferential passage will not be a reliable indicator of its truth conditions. If we manage to prove that this inferential passage will not be a reliable indicator of its truth conditions, then the belief that $A \rightarrow B$ cannot be true if the truth of A leads to the falsity of B is unjustified, and the paradoxes of the material conditional are explained away. The material account will be secured.

4. AN IRRESISTIBLE MISTAKE

The directional form of conditional sentences engendered an illusion that has been proven irresistible to conditional experts. Being bitten by the bug of directional bias, they can't see conditional as just another truth-functional connective that joins propositions to produce complex propositions. This fatal mistake suggests a way of checking the truth value of a conditional in the form of the Ramsey's test. The assumption is that in order to accept $A \rightarrow B$ we need to consider whether we would be willing to infer B from the assumption of A. Since conditional sentences can be used to express previsions or hypothesis, it is natural to think that the hypothetical inference suggested by Ramsey is a way of testing whether these previsions and hypothesis are correct. I want to know whether a flood will occur in the city centre in case of a storm. In other words, I want to know whether the conditional 'if there is a storm, it will occur a flood in the city centre' is true, even though the antecedent is still false. It seems reasonable that the process of adding the assumption that there is a storm to your belief system,

---

[21] Perhaps the only alternative hypothesis not motivated by the directional bias is the restrictor account, according to which 'if' mark restrictions on quantification. This view was originally suggested by Lewis (1975) in 'Adverbs of quantification', and have been developed ever since by Heim (1982) and Kratzer (1981, 1986). In his seminal article, Lewis considered sentences where a conditional is embedded under an adverb of quantification, for instance, 'Whenever it rains, it pours'. Lewis (1975: 16) suggested that 'whenever' plausibly works as a quantifier over times or situations and the entire 'if'-clause, 'it rains', acts as a restrictor on the quantification. Thus, the sentence 'Whenever it rains, it pours' can be paraphrased as 'In all situations in which it rains are situations in which it pours'. Thus, the function of 'if' is to mark that 'It rains' is a restrictor of the situational quantifier 'whenever'. This explanation involving conditionals under adverbs of quantification can be extended to conditionals under modals such as 'probably', 'necessarily', and 'must', which can be interpreted as quantifiers over possible worlds that are also restricted by the 'if' clause.

This explanation has its share of problems. It does not provide a unified analysis of conditionals, since it was designed to explain conditionals under adverbs of quantification and modal operators. Kratzer (1981, 1986) argued that even bare conditionals without explicit modal operators have an implicit necessity operator such as 'necessarily', but this seems farfetched.

making the necessary adjustments to preserve coherence, and then considering whether there it is a flood in the city centre, is a way of testing whether the conditional is acceptable or not. Or, to put in other terms, the hypothetical assumption of A can be interpreted as an opportunity to test a prediction about the relation between A and B, which is expressed by $A \rightarrow B$. If B is true under the hypothetical assumption of A, the prediction is confirmed. If B turns out to be false under the hypothetical assumption of A, the prediction is refuted.

This explanation, however, inverts the order of acceptance, for we are only able to decide whether we are willing to infer B from A if we already have independent reasons to accept the conditional in the first place. If we didn't have any reasons to accept the conditional, how would we know if B should be inferable from A? The test is circular, because the conditional will only pass the test if it is already accepted in the first place. This problem is mostly ignored if we have in mind only trivial conditionals whose truth values are obvious. Because I know that matches can be lightened when they are struck in normal conditions, it seems plausible that I accept the conditional 'If this match is struck, then it will light' if I would be willing to infer that it light given that is struck. But that is only because I already accept the conditional for independent reasons. For the same reason, it is plausible to think that I would refuse the conditional 'If this match is plunged into water, it will light', but only because I already know that the conditional is false due to independent reasons.

Another consequence of the directional bias is the almost exclusive focus on a *modus ponens* mindset that completely ignores the inferential role of conditionals on *modus tollens* arguments. The question whether $\neg A$ is inferable from $\neg B$ is equally important, since if $\neg B$ is true, $\neg A$ must be false; otherwise, $A \rightarrow B$ would be false. If we ignore the form and consider the conditional's actual logical powers, we could reasonably say that $A \rightarrow B$ can also invite a denial of A when B is false. Ignoring this simple fact can result in counter-examples since some conditionals are only employable on a *modus tollens*, e.g., 'If John's speaking the truth, I'm a Dutchman'. This conditional can be perfectly reasonable when John is lying, but it is not employable in a *modus ponens*. If it turns out that John is speaking the truth, I won't infer that I'm a Dutchman. Instead, I would abandon the conditional altogether. Brian Ellis also emphasised the importance of *modus tollens* suing conditionals with the form 'if H then e', in which H is the hypothesis to be tested, and e is a theoretical prediction that follows from the hypothesis (Ellis, 1984: 59). Ellis somewhat popperian argument points to the fact that knowing whether the prediction e is false is also important, since it implies by *modus tollens* that the hypothesis is false. In this case, the importance does not lie in showing that the conditional is true, but in determining whether the hypothesis is false or not according with the truth values of the consequent.

This hypothesis receives independent support from a celeb experiment devised by Peter Wason (1966). Suppose you have four cards in front of you, and each one of these cards has a letter on one side and a number on the other side. The visible side of the four cards are A, J, 2 and 7. The task is that we should decide which cards to turn over in order to determine the truth value of the following conditional: 'If there is a vowel on one side of the card then there is an even number on the other side.' In the experiment most participants turn over the card with an A, and some choose the card displaying a 2, but only a few choose the card with a 7. This is an indicative of confirmation bias because if there were a vowel on the other side of the 7, the conditional would be falsified. Thus, the directional bias is associated with a confirmation bias.

The use of conditionals in reductio inferences are also a counter-example to the directional thinking. Consider the following informal proof that there are infinite prime numbers with two conditionals: If there is a N which is the biggest prime number, there is a prime number bigger than N. If there is a N which is the biggest prime number, there is no prime number bigger than N. Therefore, there is no N which is the biggest prime number[22]. The purpose of this argument is to infer the falsity of the common antecedent from the contradictory conclusion that follows from the acceptance of both premises. Another counter-example is the cheating wife example. The conditional 'If my wife is fooling me, I will never know' is acceptable, because my wife is too smart to get caught. However, if I discover that she is fooling me, I would not infer that I would never know; I would rather abandon the conditional.

The only way to correct the directional bias and its exclusive focus on *modus ponens* is by conceding that other inferences that involve conditionals are equally relevant to its understanding. The idea then is that to understand 'if' is to understand its logical powers, but with no exclusive focus on *modus ponens*. The problem, however, is that conditionals' logical powers will vary according to different theories. If one of conditionals' logical powers is exportation, then conditionals are material. The suggestion to look at conditional's logical powers does not really tell us nothing we didn't already know. It is uninformative.

The logical powers suggestion also does not explain how conditionals inferential employability works. What happens is that our inferential dispositions are determined by the reasons that lead us to accept $A \rightarrow B$. When I accept 'If he's speaking the truth, I'm a Dutchman', I am not willing to infer that I am a Dutchman if it turns out that he was telling the truth, because the conditional was asserted under the assumption that the antecedent is false. In this case, we accept $A \rightarrow B$ only when we are willing to infer $\neg A$ from $\neg B$, not B from A. When I accept the conditional 'If my wife is fooling me, I will never know', I am not willing to infer that I will never know that she is fooling me given that I just found out that she is fooling me. In this case, I have good reasons to accept $A \rightarrow B$, but these reasons imply that the conditional cannot be employed it on a *modus ponens* or a *modus tollens*. Other examples of conditionals that do not involve any inferential employability are: 'If he felt embarrassed, he showed no signs of it', 'If you are hungry, there is still food in the kitchen' and 'The show was quite a success, if I may say so myself'.

That we can't read too much into the directional form of a conditional sentence is also evidenced by the fact that a conditional and its corresponding disjunction can both express the same inferential disposition, while our biased intuitions about conditionals and disjunctions' truth conditions remain unmoved. The inferential dispositions we have when we accept $A \rightarrow B$, are the same inferential dispositions we have when we accept $\neg A \vee B$, even if this is not suggested by its propositional form–see the table below.

$\boldsymbol{A \rightarrow B}$	$\boldsymbol{\neg A \vee B}$
modus ponens	*disjunctive syllogism*
If Oswald did not kill Kennedy, someone else did. Oswald did not kill Kennedy. Thus, someone else killed Kennedy.	Either Oswald killed Kennedy, or someone else did. Oswald did not kill Kennedy. Thus, someone else killed Kennedy.
modus tollens	*disjunctive syllogism*
If Oswald did not kill Kennedy, someone else did. No one else killed Kennedy. Thus, Oswald killed Kennedy	Either Oswald killed Kennedy, or someone else did. No one else killed Kennedy. Thus, Oswald killed Kennedy

[22] Jackson (1987: 53).

If $\neg A$ v B is accepted when we have the same inferential disposition associated with the acceptance of $A \rightarrow B$, but its truth does not require that we should be willing to infer B from A, then the truth of $A \rightarrow B$ does not require that we must be willing to infer B from A. Someone could object that the argument begs the question, since $A \rightarrow B$ and $\neg A$ v B are only equivalent if conditionals are material, but the argument only requires that conditionals and disjunctions can have equivalent inferential employability, which is a trivial assumption. The fact that their inferential employability equivalence suggests that they are logical equivalent is only an additional evidence for the material account.

These examples show that there is more to the inferentially of conditionals than it meets the eye. Not only there is no direct relation between inferential employability and the directional form of conditional sentences, as there is also a relation between the inferential employability of a conditional and the reasons to accept it. But a conditional's potential employability on *modus ponens* is a contingent and epistemic phenomenon related to our reasons to accept it. To pretend that it is an important truth about conditionals determined by their directional form betrays a lack of understanding of its mechanism, and to confuse its truth conditions (semantic aspect) with our inferential dispositions (pragmatic aspect). But we should not infect logic with pragmatics.

These counter-examples against the inferability suggested by the directional bias can also be adapted in a similar criticism against its pretensions of providing the truth conditions of conditionals. The assumption that in $A \rightarrow B$ is only true if we would be willing to infer B from the assumption of A incorrectly predicts that the following conditionals are false in most circumstances: 'If he's speaking the truth, I'm a Dutchman', 'If my wife is fooling me, I will never know', 'If he felt embarrassed, he showed no signs of it', 'If you are hungry, there is still food in the kitchen' and 'The show was quite a success, if I may say so myself'. This assumption also implies that disjunctions are not truth-functional since disjunctions can have the same inferential uses of conditionals, despite their forms being different, e.g., 'Either Oswald killed Kennedy, or someone else did.' and 'If Oswald did not kill Kennedy, someone else did'. This is a problem for the directional approach, since it is widely accepted that disjunctions are truth-functional. It goes without saying that these counter-examples also work against any theory that is motivated by the directional bias, whether we are talking about a version of the possible world theory, the suppositional view, etc.

The directional bias can also be criticised for limiting the discussion to a propositional-oriented mindset, thus preventing intuitions about predicate logic from having any meaningful role. This way of thinking ignores that one of the main reasons to think that conditionals must be material is the fact that classical predicate logic leads to an unexpected link between quantifiers and conditionals. If a general statement such as 'Every F that is G is H' implies that 'If a is F, a is G', the falsity of the conditional can only be sufficient for the falsity of the general statement if the conditional is material. For instance, given that everyone studying French is studying German and Anna is one of the students, we can infer that if Anna is studying French, then she is studying German[23]. The intuitions motivated by the grammatical form of conditional sentences are completely negligible if it is predicate logic that serves as basis for our thinking about conditionals.

The directional mindset also forgets another hard-earned lesson that made classical logic possible in the first place, namely, the principle that the grammatical form of sentences can mislead us about its truth conditions. Frege's *Begriffsschrift* was only made possible by replacing the misleading distinction between subject and predicate for a highly abstract distinction between function and argument. The first was suggested by the grammatical form

[23] This example is presented by Rieger (2013: 3166–7). Sanford (2003: 48–49) presents a similar argument, which he attributes to Frege. Barker (1997) also presents a similar argument, but formulated in terms of assertability.

of sentences, but the latter was borrowed from mathematics for logical purposes. This change provided a formula language that abstracted from inessential grammatical features and helped us 'break the domination of words over the human mind'. The contrast with the prevalent approach among conditional experts could not be more drastic. Conditional experts not only take the grammatical form of conditional sentences at face value, but also use them as the corner stone of their logic systems. This is a terrible mistake. As the saying goes, those who do not remember the past are condemned to repeat it.

5. CONDITIONALS ARE NOT SUI GENERIS

A sound methodological principle is that a plausible logical system should explain closely related phenomena by the same fundamental principles[24]. The material account satisfies this requirement with ease, since it is a particular case of the same semantics used for other connectives, such as disjunction and conjunction. It does no matter what is the connective, the truth-functional principle is the same. The fact that the directional bias treats conditionals as a sui generis connective should be considered a hindrance, not an advantage. Instead of inferring the logical properties of conditionals from their grammatical form, we need to think in terms of the properties that *all connectives* must have. Connectives not only have truth values, but they are truth functional, and can be embedded. Conditionals need to have the same properties if they are to be integrated into a unified account of connectives.

It does not seem likely that among the connectives only conditionals would be associated with an inference of some sort. If there are no reasons to think that connectives such as 'or' or 'and' are inferences, why 'if' should be any different? A full-fledged material account has none of these problems and ensures that logic system's principles are uniform by providing the same principles of truth condition for 'and', 'or' and 'if'. The only reason to think that conditionals are any different is the excessive importance attributed to the directional form of 'if', which suggests that its truth is determined by an inferential passage from one its constituent propositions to the other.

It seems clear that 'and', 'not', and 'or' are functions from proposition(s) to a further proposition. When 'and' and 'or' take two propositions, they form a new proposition from them. But 'ifs' seem different, because they can be used to assert an inferential relation from one proposition to another. What most theories motivated by this intuition do is that they try to preserve the functional thinking while assigning an inferential element to it. 'ifs' take A and B to form $A \rightarrow B$ (functional thinking), but then add that its semantic value must be determined by an inferential passage (directional thinking), whether this passage it is considering the truth value of B in the closest-A world, or a conditional assertion of the second proposition under the assumption of the first proposition, or any other hypothesis inspired by this assumption.

Jackson (2006: 1–2) tried to dismiss the difference between conditionals and the other connectives by arguing that it makes perfect sense to assume that all connectives are truth-functional if this is in accordance with the way they are used to represent reality. We represent the reality by dividing the possibilities between those that are in accord with how things are being represented to be and those that do not. It is plausible to think that 'A and B' represents the reality correctly if the way things fall in the intersection of the way A represents things to be and the way B represents things to be. It is also plausible to think that 'A or B' represents the reality correctly if the way things are falls in the union of the way A represent things to be and how B represent things to be. A similar reasoning would apply to 'If A then B' if it is equivalent to 'not-A, or A and B', and the we accept the classical accounts of conjunction and

[24] Ellis (1984: 50–51).

disjunction, since it makes sense that we should be able to say how things are lies outside how things are according to *A*, or inside how things are according to '*A* and *B*'.

But this argument has a problem. It only convinces us that material conditionals are in accordance with the way we represent reality by means of its corresponding disjunction: 'not-*A*, or *A* and *B*'. The argument therefore has an implicit admission of defeat, since it assumes that the only connectives that plausibly represent reality are disjunctions and conjunctions. However, it should be noted that this problem is not exclusive of the material account since *all conditional sentences* have a directional form that intuitively does not fulfils a representational role in language, but only an inferential role. But how can we say that this inferential appearance is an illusion?

Notice that besides the relation between the reasons to accept a complex proposition and our disposition to employ it in an inference, there is also a relation between the reasons to accept a complex proposition and its logical form on one hand, and how intuitive are the truth conditions of this complex proposition on the other hand. The truth conditions of disjunctions are intuitive because they reflect our usual reasons to accept a disjunction. The idea that one of both alternatives represented in a disjunction must be true is reflected on its truth table, i.e., the disjunction is true if one of its disjunctives is true. With conditionals, however, this relationship is broken, since our usual reasons to accept a conditional involve a relation between the antecedent and the consequent, but the material truth conditions require a mere combination of truth values involving the antecedent and the consequent. Thus, the impression that conditionals are not truth-functional is caused by a mismatch between the reasons typically used to assert conditionals and their actual truth conditions.

But the reasons typically used to accept conditionals should not reflect their truth conditions. First of all, as the previous section showed, the inferential use of a conditional is a variable feature that reflects our particular reasons to accept it (Dutchman conditionals, the cheating partner example, etc.), and some conditionals have no particular inferential use (biscuit conditionals, etc.). It is implausible to think that such contingent feature would be a core feature of a conditional's truth conditions. Thirdly, a disjunction can also be used to assert a relation between the disjuncts. Suppose that the butler and the gardener are the main suspects of a murder. In this context, the assertion of the disjunction 'Either the butler did it, or the gardener did it', is motivated by a relation between both disjuncts. If the butler is not the murder, the gardener is, or, inversely, if the gardener is not the murder, the butler is. Fourthly, conditionals are connected to disjunctions and conjunctions in inferences that even the critics of the material account would recognise as intuitively valid. It is uncontroversial that $A \rightarrow B$ implies $\neg(A\&\neg B)$, which on its turn implies $\neg A$ v B, by De Morgan. Now, these simple inferences become mysterious if conditionals are radically unlike conjunctions and disjunctions.

Perhaps the recurrent mistake of assuming that *A* and *B* are asserted when they are embedded in complex propositions is another factor that explains the impression that 'if' has an exceptional character. It seems plausible to think that the assertion of '*A* and *B*' is the result of the assertion of *A* followed by the assertion of *B;* the assertion of '*A* or *B*' is the result of an indecision between the assertion of *A* or *B*. But these are obvious mistakes. What is asserted in each case is the conjunction and disjunction of *A* and *B*, not each proposition individually. The conditional assertion theory falls in the same trap since it interprets 'If *A*, then *B*' as the assertion of *B* given the assumption of *A*, because it mistakes the assertion of a complex proposition with the assertion of each embedded proposition. What is interesting about this mistake is that it shows how conditional experts can condone a way of thinking that they would not accept regarding other connectives, despite the structural similarities and the intuitive, but ultimately fallacious, appeal.

We can only guess how different conditional theories would be if the predominant notation severed the conditional connective from its misleading grammatical form. In the beginning of the twenty century, Henry Sheffer (1913) defined all truth-functional connectives using one single connective, the stroke '|', which reads as 'not both … and …', and it is logically equivalent to the negation of a conjunction. Using the stroke, we can say that $\neg A$ is logically equivalent to $A|A$, $A\&B$ is logically equivalent to $(A|B)|(A|B)$, $A \vee B$ is logically equivalent to $(A|A)|(B|B)$, and $A \supset B$ is logically equivalent to $A|(A|B)$. Now, if due to some sort of historic accident, things were different and the Sheffer's stroke were the norm used to interpret connectives, then the material implication would be represented by $A|(A|B)$. Now, $A|(A|B)$ does not indicate any sort of inferential passage from A to B, and would be less susceptible to the usual interpretations. Of course, this would not eliminate the problem completely, because the intuitions motivated by the grammatical form would still need to be dealt with.

If alternative theories do not offer a uniform explanation of closely related phenomena, suppositional theories in particular do even less since they treat conditionals as conditional assertion acts instead of propositions with truth conditions. This implies, among other things, that conditionals cannot be embedded. Lewis objects that this consequence would require too much work and disregard the knowledge we already have about the phenomenon:

> I have no conclusion objection to the hypothesis that indicative conditionals are non-truth-valued sentences …. I have an inconclusive objection, however: the hypothesis requires too much of a fresh start. It burdens us with too much work still to be done, and wastes too much that has been done already. … We think we know how the truth conditions for compound sentences that have such conditional as constituents? We think we know how the truth conditions for compound sentences of various kinds are determined by the truth conditions of constituent subsentences, but this knowledge would be useless if any of those subsentences lacked truth conditions. Either we need new semantic rules for many familiar connectives and operators when applied to indicative conditionals-perhaps rules of truth, perhaps special rules of assertability like the rule for conditionals themselves-or else we need to explain away all seeming examples of compound sentences with conditional constituents[25].

The hypothesis that conditionals lack truth conditions is drastic and goes against the way we explain the semantics of logic operators. If the operators 'or', 'and' or 'not' have truth conditions, why conditionals should be singled out from the group as an exceptional case? This hypothesis only works by isolating conditionals from other connectives. The inferences with disjunction and conjunction are severed and we are left with half-truth-functional logic ('not', 'or', 'and') and half revisionary semantics (directional 'if'). The material account, on the other hand, provides a truth-functional semantics through and through. It does not 'waste what we know' about the other operators, and it's close to its connective partners. If conjunctions and disjunctions are truth function of two propositions, so are conditionals. The semantics must be universally applicable account to every connective. Treating conditionals as sui generis operators are a step backwards compared to the truth functional thinking. We need a uniform account of connectives.

[25] Lewis (1976: 305).

6. WHERE DO WE GO FROM HERE

It was argued that there is a strong bias from ordinary language is distorting our understanding of logic, by dissociating conditionals from a more systematic understanding of connectives. It is understandable that experts should continually study and improve our understanding of logic, but it is imperative that we take a step back from this extremely narrow specialisation and try to see the bigger picture.

In a sense, the theorisation about conditionals as a distinctive area of research, or at least a significant part of this research, was always at odds with the assumption that conditionals are material, since one of the main motivations for the logical analysis of conditionals is the assumption that the material conditional used in classical logic cannot capture the truth conditions of the different conditional sentences used in natural language. Thus, it is understandable, but unfortunate, that the material account became increasingly unpopular as the area expanded.

This prevalent scepticism towards the material account, however, does not rest on solid foundations. The directional form of a conditional is not a reliable indicator of its inferential use, much less of its truth conditions. Consequently, any pretensions to build an entire logical system by focusing on this directional intuition and its related meagre diet of examples, would result in a misguided semantics that unnaturally serves the relation of conditionals from the other connectives and predicate logic. It is limiting to think about conditionals in these terms. The counter-examples against the material account are rendered harmless because they are all dependent on this directional thinking.

REFERENCES

Adams, E. (1965). The Logic of Conditionals. *Inquiry*, 8(1–4), 166–197.

Adams, E. (1975). *The Logic of Conditionals* - An Application of Probability to Deductive Logic, (Ed.) D. Reidel Publishing Company, Dordrecht-Holland, Boston-U.S.A.

Ajdukiewicz, K. (1956). Conditional sentence and material implication. *Studia Logica*, 4(1), 135–153.

Allott, N; H. Uchida (2009a). Classical logic, conditionals and "nonmonotonic" reasoning. *Behavioral and Brain Sciences* 32(1), 85.

Allott, N; H. Uchida (2009b). *Natural language indicative conditionals are classical*. UCL Working Papers in Linguistics, 1–17. URL: http://www.ucl.ac.uk/psychlangsci/research/linguistics/publications/wpl/09papers/allott.

Anderson, A., Belnap, N. (1975). *Entailment*: The Logic of Relevance and Necessity, Vol. I, Princeton University Press.

Anderson, A., Belnap, N., Dunn, M. (1992). *Entailment*: The Logic of Relevance and Necessity, Vol. I, Princeton University Press.

Anjum, R. (2008). *Three Dogmas of 'If'*., Enhet i Mangfold, A. Leirfall & T. Sandmel (eds), Oslo: Unipub: 5–16.

Appiah, A. (1985). *Assertion and Conditionals*. Cambridge: Cambridge University Press.

Armstrong, R. (1970). The Switches Paradox, *Philosophy and Phenomenological Research*, 30(3), 421–427.

Baker, A. (1955). Incompatible Hypotheticals and the Barber Shop Paradox. *Mind, New Series*, 64(255), 384–387.

Barker, S. (1995). Towards a Pragmatic Theory of 'If'. *Philosophical Studies* 79 (2), 185–211.

Barker, S. (1997). Material implication and general indicative conditionals. *The Philosophical Quarterly,* 47(187), 195–211.

Bennett, J. (2003). *A Philosophical Guide to Conditionals*. Oxford: Clarendon Press.

Braine, M. (1978). On the relation between the natural logic of reasoning and standard logic. *Psychological Review*, 85(1), 1–21.

Burks, A., Copi, I. (1950). Lewis Carroll's Barber Shop Paradox. *Mind, New Series*, 59(234),219–222.

Clark, M. (1971). Ifs and Hooks, *Analysis*, *32*(2), 33–39.

Corcoran, J; Wood, S. (1973). The Switches "Paradox" and the Limits of Propositional Logic. *Philosophy and Phenomenological Research*, 34(1), 102–108.

DeRose, K., Grandy, R. (1999). Conditional Assertions and "Biscuit" Conditionals. *Noûs* 33(3), 405–420.

Edgington, D. (1995). On Conditionals. *Mind*, 104(414), 235–329.

Edgington, D. (1986). Do Conditionals Have Truth Conditions?. *Crítica: Revista Hispanoamericana de Filosofía*, 18(52), 3–39.

Ellis, B. (1984). Two Theories of Indicative Conditionals. *Australasian Journal of Philosophy*, 62(1), 50–66.

Evans, J. (1977). Linguistic factors in reasoning. *Quarterly Journal of Experimental Psychology*, 29, 297–306.

Evans, J., Beck, M. (1981). Directionality and Temporal Factors in Conditional Reasoning. *Current Psychological Research*, 1(2), 111–120.

Evans, J., Newstead, S. (1977). Language and reasoning: A study of temporal factors. *Cognition*, 5(3), 265–83.

Evans, J., Newstead, S. & Byrne, R. (1993). *Human reasoning*: The psychology of deduction. Hove: Erlbaum: Psychology Press.

Fulda, J. (1989). Material Implication Revisited, *The American Mathematical Monthly,* 96(3), 247–250.

Gillon, B. (1997). Contraposition and Lewis Carroll's Barber Shop Paradox. *Dialogue*, 36, 247–251.

Gogol, D. (1972). On the Switches Paradox. *Philosophy and Phenomenological Research*, 32(3), 410–411.

Grice, P. (1989). Indicative Conditionals. In: Studies in the way of words. Cambridge: Harvard University Press.

Hanson, W. (1991) Indicative Conditionals Are Truth-Functional. *Mind*, New Series, 100(1), 53–72.

Hare, R. (1970). Meaning and speech acts, *Philosophical Review*, 79(1), 3–24.

Heim, I. (1982). *The Semantics of Definite and Indefinite Noun Phrases*. Ph.D. thesis, University of Massachusetts, Amherst.

Jackson, F. (1987). *Conditionals*. Oxford: Basil Blackwell.

Jackson, F. (2006). Indicative Conditionals Revisited. Seminar at the Chinese University of Hong Kong. URL: http://phil.arts.cuhk.edu.hk/~phidept/TCIVP/jackson/indicative.pdf.

Jeffrey, R. (1964). If (Abstract). *Journal of Philosophy*, 61, 702–703.

Kratzer, A. (1981). The notional category of modality. In H.-J Eikmeyer and H. Reiser (eds.), *Words, Worlds, and Contexts*, pages 38–74. Walter de Gruyter.

Kratzer, A. (1986). Conditionals. *Chicago Linguistics Society*, 22(2), 1–15.

Lewis, C. (1913). Interesting theorems in symbolic logic. *The Journal of Philosophy*. Psychology and Scientific Methods, 10(9), 239–242.

Lewis, D. (1973). *Counterfactuals.* Oxford: Blackwell Publishers.

Lewis, D. (1975). Adverbs of quantification. In Edward L. Keenan (ed.), *Formal Semantics of Natural Language*. Cambridge University Press.

Lewis, D. (1976). Probabilities of Conditionals and Conditional Probabilities. *Philosophical Review*, 85 (3), 297–315.

Mackie, J. (1973). *Truth, probability and paradox*: studies in philosophical logic. USA: Oxford University Press.

Mares, E. (1994). Why We Need a Relevant Theory of Conditionals. *Topoi*, 13, 31–36.

McDermott, M. (1996). On the Truth Conditions of Certain 'If'-Sentences. *Philosophical Review* 105: 1–37.

McGlynn, A. (2012). The problem of true–true counterfactuals. *Analysis* 72(2), 276–285.

Mellor, D. (1993). How to Believe a Conditional. *The Journal of Philosophy* 90(5), 233–248.

Milne, P. (1997). Bruno de Finetti and the Logic of Conditional Events, *British Journal for the Philosophy of Science* 48 (2): 195–232.

Oberauer, K., & Wilhelm, O. (2000). Effects of directionality in deductive reasoning: I. The comprehension of single relational premises. *Journal of Experimental Psychology*: Learning, Memory, and Cognition, 26 (6), 1702–1712.

Oberauer, K., Hörnig, R., Weidenfeld, A. (2005). Effects of directionality in deductive reasoning: II. Premise integration and conclusion evaluation. *The Quarterly Journal of Experimental Psychology* 58 (7), 1225–1247.

Parks, R. (1972). Note on the Switches Paradox. *Philosophy and Phenomenological Research*, 32(3), 408–409.

Quine, W. (1950). *Methods of Logic.* New York, Holt, Rheinhart and Winston.

Ramsey, F. P. (1929). General Propositions and Causality. In: Braithwaite, R. B. (Ed.), The foundations of mathematics and other logical essays (pp. 237–255), London: Routledge & Kegan Paul, 1950.

Read, S. (1992). Conditionals Are Not Truth-Functional: An Argument from Pierce. *Analysis*, 52(1), 5–12.

Read, S. (1988). *Relevant Logic - A Philosophical Examination of Inference*, Basil Blackwell.

Rieger, A. (2006). A simple theory of conditionals. *Analysis*, 66(3), 233–40.

Rieger, A. (2013). Conditionals are material: the positive arguments. *Synthese*, 190(15), 3161–3174.

Rieger, A. (2015). Defending a Simple Theory of Conditionals. *American Philosophical Quarterly*, 52(3), 253–260.

Rips, L; Marcus, S. (1977). Suppositions and the analysis of conditional sentences. In M.A. Just & P.A. Carpenter, (Eds.), *Comprehension processes in comprehension*. Hillsdale, NJ: Lawrence Erlbaum Associates Inc.

Roberge, J. (1982). Linguistic Factors in Conditional Reasoning. Quarterly Journal of Experimental Psychology, 34(2), 275–284.

Rumain, B., Connell, I., & Braine, M.D.S. (1983). Conversational comprehension processes are responsible for reasoning fallacies in children as well as adults. *If* is not the biconditional. *Developmental Psychology*, 19, 471–481.

Ryle, G. 1950. 'If', 'So', and 'Because'. In: *Collected Papers*, Vol. 2: Collected Essays 1929-1968. Routledge, 2009.

Sanford, D. (2003). *If P, Then Q:* Conditionals and the Foundations of Reasoning. 2nd ed. London: Routledge.

Sanford, D. (2006). *Epistemic Requirements of Inference, Truth-makers for Conditionals, and Stand-offs*. University of Connecticut, Conditionals Conference, 1–32.

Settle, T. (1973). The Switches Paradox: Which Switch?, *Philosophy and Phenomenological Research*, 33 (3), 421–428.

Sheffer, H. (1913). A Set of Five Postulates for Boolean Algebras with Application to Logical Constants. *Transactions of the American Mathematical Society*, 14(4), 481–88.

Smith, N. (1983). On Interpreting Conditionals. *Australian Journal of Linguistics*, 3, 1–24.

Smith, N., A. Smith. (1988). A Relevance-theoretic Account of Conditionals. In Larry M. Hyman; Charles N. Li, eds., *Language, Speech and Mind*: Essays in Honour of Victoria A. Fromkin, pp. 322–352. London: Routledge.

Stalnaker, R. (1968). A theory of conditionals. In Nicholas R. (Ed.), *Studies in logical theory*. Oxford: Basil Blackwell.

Stalnaker, R. (1975). Indicative Conditionals, *Philosophia*, 5(3), 269–86.

Simons, L. (1965). Intuition and Implication. *Mind*, 74(293), 79–83.

Strawson, P. (1986). 'If' and '⊃'. In *Philosophical Grounds of Rationality*: Intentions, Categories, Ends, vol. Grandy, R. and Warner, R. (eds) Clarendon Press.

Strawson, P. (1952). *Introduction to Logic Theory*. London: Metheuen & CO. LTD.

Wason, P. C. (1966). Reasoning. In Foss, B. (Ed.), *New Horizons in Psychology*. Harmondsworth: Penguin Books.

Wason, P., Johnson-Laird, P. (1972). *Psychology of reasoning*: Structure and content. Cambridge, Mass. Harvard University Press.

Williamson, T. (2020). *Suppose and Tell - The Semantics and Heuristics of Conditionals*. Oxford: OUP.