The Puzzle of Conditionals with True Clauses: Against the Gricean Account

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Abstract

Indicative conditionals, that is sentences of the form "If p, then q," belong to the most puzzling phenomena of language. On the majority of accounts of indicative conditionals, the truth of p and q suffices for "If p, then q" to be true or highly acceptable. Yet, many conditionals with true clauses, even if there is a meaningful connection between them, sound odd. The most common reaction to this phenomenon is to attribute the oddity of conditionals with true clauses to natural language pragmatics. We present an experimental study investigating how the presence or absence of a connection between the clauses affects the assertability of conditionals and conjunction expressing generic and specific kind of content. The results refute the standard pragmatic explanation.

Keywords: indicative conditionals; conjunctions; relevance; specific content; generic content; assertability

Introduction

Indicative conditionals[1] are sentences that we use to express hypothetical thoughts. They are central to our reasoning, planning, and problem solving. We entertain them when making everyday decisions ("If I add too much chilly to the curry, John will complain"), discussing public policies ("If we lower taxes, we will not have sufficient resources to fund social security benefits"), or doing science ("if we do not curb carbon output, sea levels will rise dangerously").

Conditionals are usually defined as sentences of the form "If p, then q," such as:

(1) If Dora studied physics, then she knows how to solve differential equations.

Intuitively, the antecedent of a conditional, p ("Dora studied physics"), expresses a condition under which q, the consequent ("Dora knows how to solve differential equations"), occurs or from which it can be inferred. Assuming that it is true that Dora studied physics and that she knows how to solve differential equations, and given that a degree in physics is a good reason to believe that a person can solve differential equations, (1) is rendered true on any account that allows conditionals to be true or false at all, and highly acceptable on those accounts that deny conditionals their truth aptness (that is, accounts that do not view conditionals as statements that are 'true' or 'false,' in the same way that questions or commands are not true or false). But what if both p and q are true, yet there is no connection between them, that is, one cannot

infer q from p nor p makes it more likely that q? Let us suppose that Dora can solve differential equations, and that she also plays basketball. The fact that Dora is a basketball player does not allow us to predict anything about Dora's mathematical skills. The two facts do not seem to be connected at all, yet on many prominent accounts of conditionals, the sentence (2) is rendered true or, at least, highly acceptable:

(2) If Dora plays basketball, then she knows how to solve differential equations.

This is due to the fact that the majority of the prominent theories of conditionals validate the *Principle of Conjunctive Sufficiency*, often simply referred to as the *Principle of Centering*, which allows us to infer "If p, then q" from the conjunction of p and q.

Centering has recently attracted attention in psychology of reasoning (Cruz et al. 2016), because this is an inference rule that distinguishes between some of the most popular philosophical and psychological accounts of conditionals, such as the Mental Models Theory (Johnson-Laird & Byrne 2002) and the suppositional theory (Adams 1975; Edgington 1995; Evans & Over 2004; Cruz et al. 2016), on the one hand, and the 'inferentialist' approach on which a connection between a conditional's antecedent and its consequent belongs to the literal, semantic meaning of a conditional, on the other hand. This connection may be defined in different ways, for instance, as a whole variety of inferential relations (Krzyżanowska et al. 2013, 2014) or in terms of probabilistic relevance (Skovgaard-Olsen et al. 2016b,a), but on no 'inferentialist' account of conditionals will a sentence like (2) be acceptable unless one can show that there is some kind of relationship between basketball and maths.

This is not to say that proponents of the 'centering' theories do not find sentences like (2) strange. They do, but assume that the oddity of missing-link conditionals can be explained in terms of pragmatics, that is, the aspect of language that allows speakers to infer the intended meaning of linguistic expressions even where it is different than what is literally said. For instance, "Some students passed the exam" pragmatically *implicates* that not all of them passed, although, from a purely logical point of view, it is consistent with "All students passed the exam" (Bott & Noveck 2004). Along these lines, (Over et al. 2007, p. 92) make the following observation. Anyone who takes the natural-language conditional to

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[1]Throughout this paper, we will use the term "conditionals" to refer specifically to indicatives.

be probabilistic—its meaning exhausted by the Equation, i.e. $Pr(\text{"If } p, q\text{"}) = \Pr(q\,|\,p)$—can argue that:

> the use of a conditional *pragmatically suggests*, in certain ordinary contexts, that p raises the probability of q or that p causes q.

A similar take on the connection between p and q can be found in the Mental Models literature. On this account, a language user interprets an assertion by constructing mental models (Johnson-Laird & Byrne 2002, p. 653). On the most recent version of Mental Models Theory, the *core meaning* of a natural language conditional refers to a set of possibilities equivalent to the material interpretation of a conditional (p. 665). However, what kind of possibilities a language user envisages when interpreting a sentence is susceptible to the processes of semantic and pragmatic modulations. In particular:

> modulation can establish an indefinite number of different temporal, spatial, and coreferential relations between the antecedent and consequent of a conditional. (Johnson-Laird & Byrne 2002, p. 660)

But what kind of pragmatic mechanisms are responsible for the oddity of missing-link conditionals? The most famous pragmatic explanation of why some conditionals, and especially those that are true due to the truth of their consequents, appear odd was proposed by Grice (1989). He argued that:

> To say that "$p \supset q$" is to say something logically weaker than to deny that p or to assert that q, and is thus less informative; to make a less informative rather than a more informative statement is to offend against the first maxim of Quantity, provided that the more informative statement, if made, would be of interest. There is a general presumption that in the case of "$p \supset q$," a more informative statement would be of interest (Grice 1989, p.61).

On this account, a sentence such as (2) is simply unassertable in a context in which its antecedent and consequent are known to be true, because a stronger statement, namely "Dora knows how to solve differential equations" is available and should have been asserted instead. Note, however, that even if an appeal to the maxim of Quantity explains why sentences like (2) are not felicitous things to say, it does not illuminate the fact that speakers seem to interpret conditionals as if their clauses were somehow connected. Moreover, it also does not allow us to distinguish between sentences such as (2) and those conditionals with true clauses that are, intuitively, perfectly fine, like (1).

Both (1) and (2) consist of a true antecedent and true consequent. The only difference between them is that there is an inferential connection between doing physics and possessing certain mathematical skills, whereas playing basketball, as far as we know, has no bearing on the latter at all. The truth of p and q is clearly not enough for a conditional to be a reasonable thing to say or to accept, but neither does it suffice to render a conditional unassertable at all.

Connecting antecedents and consequents

In the case of what we will label in the following as a TT conditional, that is, a conditional whose antecedent and consequent are (known to be) true, the connection between the clauses cannot be translated directly into 'possibilities' in the way envisaged by Mental Models Theory, or into the notion of the probabilistic relevance, understood in terms of the Δp rule, if the conditional probability, $\Pr(q|p)$, is understood as the ratio of $\Pr(q \wedge p)$ to $\Pr(p)$ (Over et al. 2007; Oberauer et al. 2007; Skovgaard-Olsen et al. 2016b). On this widespread probabilistic approach, p is said to be *positively relevant* for q if $\Delta p > 0$, where Δp is defined as a difference between $\Pr(q\,|\,p)$ and $\Pr(q\,|\,\neg p)$. However, when both p and q are known to be true, $\Pr(p) = \Pr(q) = \Pr(q|p) = 1$, whereas $\Pr(q|\neg p)$ is undetermined since $\Pr(\neg p) = 0$, and hence Δp cannot be calculated. Another, related, measure of probabilistic relevance is the difference between $\Pr(q|p)$ and $\Pr(q)$ (cf. Skovgaard-Olsen et al. 2016a). $\Pr(q\,|\,p) > \Pr(q)$ ensures that the antecedent has a probability-raising effect on the consequent. However, when both p and q are known to be true, $\Pr(q) = \Pr(q\,|\,p)$. In that case, p is probabilistically irrelevant for q just because $\Pr(q)$ cannot be raised any higher. Yet, as the example (1) illustrates, the clauses of a TT conditional may seem connected anyway, hence probabilistic relevance defined in this way is insufficient to capture the intuition behind that connection. By the same token, Johnson-Laird and Byrne's (2002) suggestion that the core meaning of the conditional is that the "antecedent describes a possibility, at least in part, and the consequent can occur in this possibility." (p. 650), is of no help with TT conditionals, as true states of affairs are necessarily 'possible,' so that the notion of possibility is insufficient to distinguish between 2 and 1.

Some of these problems can be avoided when conditional probability, rather than unconditional probability, is treated as the primitive notion, and thus $\Pr(q\,|\,p)$ is *not* calculated from $\Pr(p \wedge q)$ and $\Pr(p)$ (e.g. Popper 1959; de Finetti 1970/1990). One may also consider a counterfactual notion of relevance, that is, e.g., Δp calculated as if p was not known to be true.[2] In our experimental design, we assume an intuitive, pre-theoretic notion of the connection, which does not depend on any particular operationalisation of the notion of relevance.

What antecedents and consequents are about

In order to understand the semantics and pragmatics of conditionals, one should arguably turn to the way conditionals are actually used in everyday language. Linguists have sought to provide extensive overviews of different types of conditionals

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[2] cf. *Strong Ramsey test*, proposed by Rott (1986), according to which "If p, then q" is acceptable if and only if q is acceptable under the supposition of p but not acceptable under the supposition of $\neg p$.

Jenny enters the room of her 14 year old son, Tom, to persuade him to clean up his room a bit. She even offers him her help. While sorting through the papers on Tom's desk, Jenny notices a math test with an "F" on it, which, apparently, Tom has concealed from her. Tom notices what his mother found and decides to divert her attention to something else.

Tom: "Oh, look, my plant has dried up completely."
Jenny: "Did you water it at all?"
Tom: "Well, no..."

In this context, would it *make sense* for Jenny to *say* the following?

	Definitely no	No	Leaning towards no	Undecided	Leaning towards yes	Yes	Definitely yes
If you didn't water your plant, you failed your math test.	○	○	○	○	○	○	○
You didn't water your plant and you failed your math test.	○	○	○	○	○	○	○

Figure 1: Example vignette used in the experiment.

(see, e.g, Declerck & Reed 2001, for a comprehensive corpus based analysis). Such overviews reveal that conditionals can be characterised and classified in many different ways. Consideration of those differences suggests that the broad category of 'indicative conditional' (as in, 'in the indicative mood' as opposed to the 'subjunctive mood', e.g., I would, I could, etc.) which is the theoretical focus of the majority of psychological and philosophical work is far too broad. The way a conditional is interpreted and evaluated may be affected by the kind of content expressed by its clauses, even where the content is broadly 'indicative'. Among others, the content of a clause may be specific, that is, the clause can be about a specific object (a token) known to all participants of the conversation, e.g. "this book," or generic, concerning a type of an object, e.g. "a book." Consequently, we can distinguish between generic and specific conditionals:

Generic (type):

(3) If a book is hardcover, it is expensive.

Specific (token):

(4) If this book is hardcover, it is expensive.

As noted by Declerck & Reed (2001, p. 2), the unacceptability of conditionals with true antecedents:

is due to the fact that a speaker cannot process a fact as a supposition, except in 'inferential' conditionals, i.e., in conditionals expressing a conclusion Q that is drawn from a premise P.

We investigate whether there is a difference in how people process generic and specific content, and consequently, if the two types of content may have an effect on people's assertability judgements. Additionally, we hypothesise that the presence or absence of an inferential connection may make the conditional assertable, even if the antecedent is true and hence difficult to process as a supposition.

The present experiment

We investigated whether people's assertability judgements depend on what a conditional is about. More specifically, we were interested in two factors that may be expected to affect people's evaluations of a conditional: the presence of an inferential connection between antecedent and consequent, and the kind of content the conditional expresses. We compared how people evaluate conditionals with how then evaluate conjunctions consisting of the same true clauses, such as:

Conditional: If you didn't water your plant, you failed your math test.
Conjunction: You didn't water your plant and you failed your math test.

Our test followed a $2 \times 2 \times 2$ factorial design. Sentence type (conditionals vs. conjunctions) was manipulated within subjects. Type of content (generic: type vs. specific: token) and the inferential connection (presence: C+ vs. absence: C-) were manipulated between subject. These are examples of conditionals belonging to each of the resulting four groups:

Token C+ If you didn't water your plant, it dried up.
Token C- If you didn't water your plant, you failed your math test.
Type C+ If you don't water a plant, it dries up
Type C- If you don't water a plant, you fail math tests.

Finally, we asked participants to evaluate the extent to which given sentences are reasonable things to utter in given contexts by means of two different questions:

Assertability: "In this context, to what extent would it be natural for X to assert the following sentences?"

Sensibleness: "In this context, would it make sense for X to say the following?"

Methods

Participants

244 individuals participated in the online survey on the MTurk platform (`https://www.mturk.com/`). We removed four participants who did not complete the survey and three participant whose reported first language was not English. Of the remaining 237 participants, 115 were female. The mean age of the participants was 33.97 (range 18-63). All participants received a small remuneration for their time and effort.

Materials and procedure

Each participant has been randomly assigned to one of the four groups: Type C+, Type C-, Token C+, Token C-. Participants in each group were presented with 8 blocks, one at a time. The order of presentation was randomised. Each block contained a vignette consisting of a conversational context followed by two sentences: a conditional and a conjunction, presented in randomised order. There were four types of vignettes. Each participant saw each vignette twice: once followed by the question about the "assertability" of the two sentences, and once followed by the question about their "sensibleness." Figure 1 shows an example Token-C- item used in the experiment.

Results

The data on 'sensibleness' mirrored exactly the pattern of responses to the 'assertability' question. Therefore, for brevity's sake, we report only the analysis of the latter question, the descriptive statistics for which are reported in Table 1, below.

Table 1: Descriptive statistics for 'assertability.'

		Type		Token	
		C+	C-	C+	C-
Conditionals	mean	5.51	2.52	3.92	1.48
	sd	0.94	1.08	1.35	0.74
Conjunctions	mean	3.79	4.59	5.98	6.04
	sd	1.48	1.30	0.79	1.01

As figure 2 suggests, the absence of an inferential connection makes both type and token TT conditionals unassertable, although the presence of connection does not seem to be enough to make a token conditional assertable. By contrast, the presence or absence of a connection has little effect on the assertability of token conjunctions. When there is no connection at all, conjunctions are judged to be more assertable than conditionals. At the same time, while token C+ conjunctions seem to be more assertable than token C+ conditionals, type C+ conjunctions are less assertable than type C+ conditionals.

We performed analyses in R (R Core Team, 2016) using functions from Wilcox (2016) and the WRS2 package (Mair, Schoenbrodt, & Wilcox 2016). The robust analyses used 20% trimmed means. This difference between type and token is confirmed by significant 2-way interaction in a robust mixed ANOVA ('bwtrim' function) between the variables type/token and conditional/conjunction, both with an inferential connection (C+) ($Q = 111.74$, $p < .001$) and without (C-) ($Q = 68.11$, $p < .001$). We thus conducted further statistical analyses separately for token and type materials.

Token A robust mixed ANOVA produced significant main effects of Sentence Type, $Q = 485.34$, $p < .001$, and Connection, $Q = 83.94$, $p < .001$, and a significant interaction, $Q = 77.98$, $p < .001$. Simple-effects analyses comprise robust t-tests. We compared the effect of sentence type separately for items with and without a connection using robust paired-samples t-tests (the yuend function). When there was a connection, conjunctions were rated on average 2.11 higher than conditionals; this difference was significant, $t(26) = 8.66$, $p < .001$, $r = .89$. When there was no connection, conjunctions were rated on average 4.94 higher than conditionals; this difference was significant, $t(35) = 23.83$, $p < .001$, $r = .94$. We explored the effect of the connection for each type of sentence, using robust independent-samples t-tests (the 'yuen' function). For conditionals, ratings were on average 2.67 higher with a connection than without; this difference was significant, $t(43.78) = 12.25$, $p < .001$, $r = .90$. For conjunctions, ratings were on average .16 higher without a connection than with; this difference was not significant, $t(57.79) = .80$, $p = .43$, $r = .11$.[3]

In sum, the token data showed that conjunctions were rated consistently higher than conditionals. Conditionals were rated higher with a connection; conjunctions non-significantly higher without one.

Type A robust mixed ANOVA produced a non-significant main effect of Sentence Type, $Q = 1.79$, $p = .19$. The main effect of Connection was significant, $Q = 40.21$, $p < .001$, as was the interaction, $Q = 134.85$, $p < .001$. As above, simple effects of sentence type comprised robust paired-sample t-tests. With a connection, conditionals were rated on average 1.79 higher than conjunctions; this difference was significant, $t(35) = 6.46$, $p < .001$, $r = .83$. Without a connection, conjunctions were rated on average 2.28 higher than conditionals; this difference was significant, $t(35) = 9.20$, $p < .001$, $r = .87$. As above, simple effects of connection comprised robust independent-samples t-tests. For conditionals, ratings were on average 3.15 higher with a connection than without; this difference was significant, $t(65.41) = 14.98$, $p < .001$, $r = .90$. For conjunctions, ratings were on average .92 higher without a connection than with one; this difference was significant, $t(68.26) = 3.20$, $p = .002$, $r = .10$.

In sum, the type data showed that, when there was a connection, conditionals were rated higher than conjunctions. When there was no connection, conjunctions were rated

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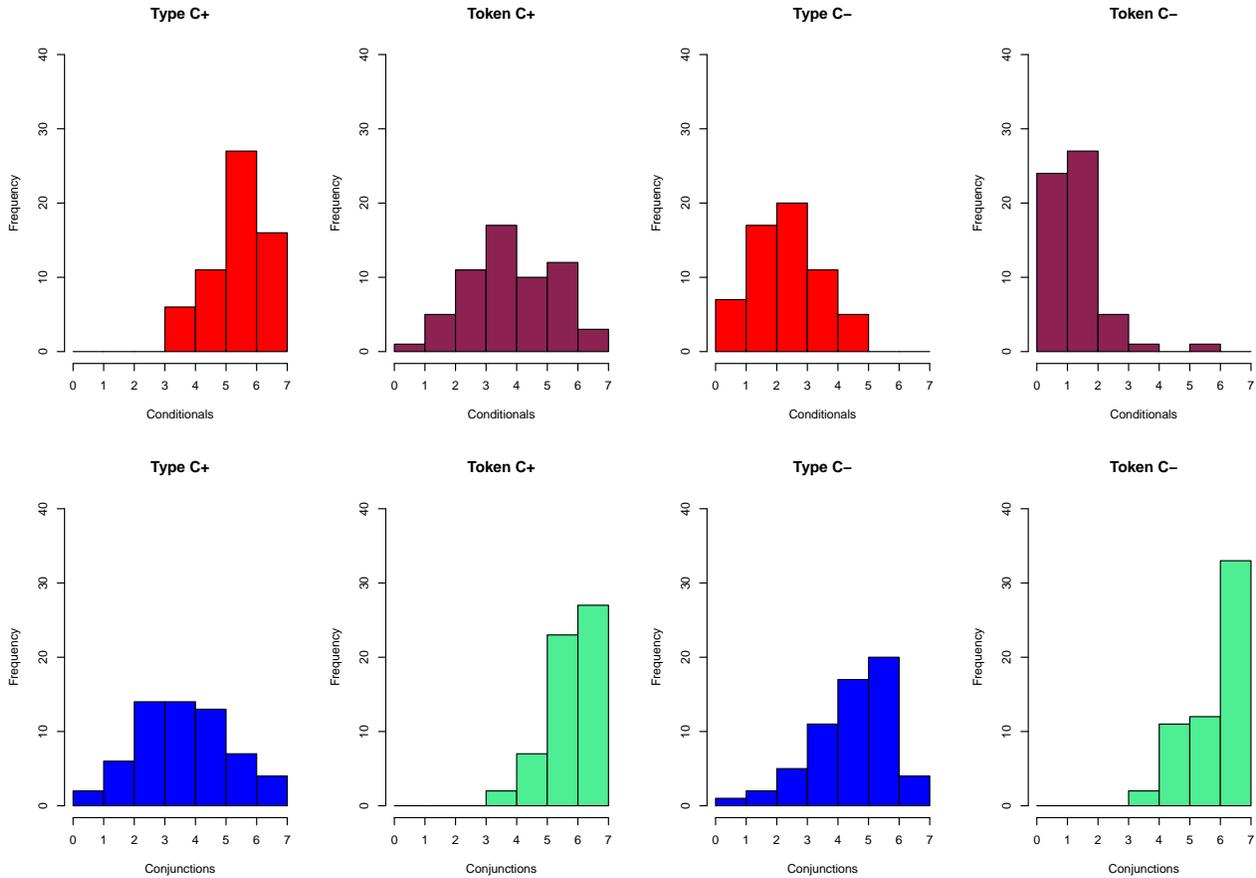[3] In the "sensibleness" data, this effect was also significant, $t(61.65) = 2.86$, $p = .006$, $r = .35$.

Figure 2: Distribution of the responses to the 'assertability' question.

Discussion

Our data clearly show that knowing that p and q are true is not sufficient for "If p, q" to be assertable. The presence of an inferential connection between p and q is not sufficient either, yet it is necessary for a conditional to be assertable. However, the presence of a connection does not seem to affect the assertability of conjunctions in a similar way. In fact, conjunctions in which conjunct are inferentially connected tend to be rated lower than those without a connection. Our findings pose a problem for all theories of conditionals that treat the intuition that conditionals are about connections solely as a pragmatic aspect of their meaning. Our results undermine the standard pragmatic account of the oddity of missing link conditionals. On this account, asserting a TT conditional is a violation of the Maxim of Quantity, because when both p and q are known to be true, one is justified in asserting a stronger, more informative statement. That is, one should assert the conjunction of p and q. As our data clearly show, when an inferential connection is present, generic conditionals are more

assertable than generic conjunctions which cannot be reconciled with the standard, Gricean account.

A Gricean explanation of these findings can follow two different paths: One can reject the most fundamental principles of Gricean pragmatics by denying that informativeness guides people's assertability judgements. Another, less costly, option is to rethink the semantics of conditionals and accept the possibility that the connection between antecedents and consequents is an important part of their meaning. On the latter approach, the connection should be taken as an additional piece of information conveyed by a conditional, but not by a conjunction. Our findings suggest that we need an account that renders conditionals more informative than conjunctions (on their standard, truth-functional interpretation).[4] Neither Mental Models nor the suppositional account of conditional can follow the latter path, however. Johnson-Laird & Byrne (2002, p. 651) deny that a relation between p and q is part of the core meaning of a conditional: the logic of a conditional on this interpretation is essentially the logic of

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[4]Note that, in the context of our experiment, the differences in people's assertability judgments could have only resulted from the semantics of the evaluated sentences, since the conversational contexts remain constant.

material implication. Although Johnson-Laird & Byrne admit that content of the clauses of a conditional (semantic modulation) and contextual factors (pragmatic modulation) influence the interpretation of a conditional, the only thing that these mechanisms do is constrain the set of possibilities a speaker envisages when interpreting a sentence. On Mental Models theory, when p and q are known to be true, the interpretation of a conditional and the interpretation of a conjunction do not seem to be distinguishable at all. Apart from vague appeals at 'pragmatic modulations,' Mental Model theory has no way to explain our findings.

The data are no less problematic for the suppositional account. First of all, as observed earlier, none of the standard probabilistic measures of relevance is applicable when both clauses of a conditional are known to be true, if conditional probability is understood in accordance with Kolmogorov's axioms. Second, even if we grant the supporters of the probabilistic interpretation of a conditional that the relevance of p for q, however it is formalised, is pragmatically implicated, this account does not have the means to explain the discrepancy between type and token TT conditionals.

Token conditionals are sentences such as "If you didn't water your plant, it dried up" or "If this book is hardcover, it is expensive." Although a hard cover (p) is a good evidence that the book costs a lot (q), i.e., one can infer q from p together with some general knowledge about the world, the conditional sounds strange to many respondents. In the same context, a generic conditional "If a book is hardcover, it is expensive" is evaluated as assertable. This discrepancy might be due to the fact that the specific antecedent, which refers to a particular book that is directly available to conversational partners, is considered a fact and hence, as suggested by Declerck & Reed (2001, p. 2), is more difficult to process as a supposition from which one is to make an inference (cf. Elder & Jaszczolt 2016 on the notion of *remoteness*). By contrast, the generic antecedent "a book is hardcover" requires an additional inferential step to be evaluated as true (if something is true about this book in front of us, it is also true about *a book*), hence the evidence for the truth of the antecedent can be considered inferential and not direct.

Most fundamentally, however, our results suggest that an adequate account of the conditional and of reasoning with conditionals will have to engage more seriously with the circumstances in which conditionals can and cannot be used in everyday language.

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