Issues in Reasoning about Iffy Propositions: "The" Interpretation(s) of Conditionals

Walter Schroyens (Walter.Schroyens@ugent.be)
Department of Psychology, University of Ghent
2, Henry Dunantlaan, Gent, Belgium

Abstract

Recent studies indicate that a vast majority of people judge the probability of a conditional <if A then C> as to the conditional probability of <A, given C> (Evans, Handley, & Over, 2003; Oberauer &Wilhelm, 2003). This means that in evaluating the applicability of a conditional people do not seem to take count of situations in which the antecedent event is false. This has been taken as evidence against the model theory (Johnson-Laird & Byrne, 2002). This theory, however, claims that the conditional interpretation in which false-antecedent cases are relevant is only one of many possible interpretations of 'if'. We present new evidence that confirms this flexibility of the interpretive system. When people are primed by thinking (a) about truth and the difference between the <if A then C> and <if A then possibly C> or (b) are invited to judge which situations are consistent with the conditional, they are more likely to select a probability estimate that takes count of the false-antecedent cases.

Introduction

Recent literature has questioned that accepting an utterance like "if someone punches you straight in your face, you will be in pain", <if A then C>, implies a situational tendency to reason in accordance with the belief that everything is possible, except one possibility: It becomes an impossibility that you will not be in pain when someone punches you straight in the face (not<A and not-C>). The most obvious possibility is that you will be in pain after having received a punch straight in the face, <A and C>. It is however also possible that nobody has punched you in the face, but that you are still in pain (i.e. a decent blow with a baseball bat also does the trick, <not-A and C>). Everything else being equal, it is also possible that you are not punched in the face, and that it does not hurt (a gentle kiss by a loved one is one such possibility, <not-A and not-C>). We present evidence showing that though far from the dominant interpretation, this interpretation of "if" is psychologically real.

To investigate the interpretation of conditionals, Evans et al. (2003) used the sentence-probability task.. In this task people evaluate how likely a conditional utterance of the form <if A then C> is true. This question is posed in the context of explicit information about the frequency of four truth contingencies. Given an antecedent <A> and a consequent event <C> there are four possible combinations in which the antecedent/consequent is true (T) or false (F). These contingencies are classically referred to as TT<A_C>, TF<A_not-C>,FT<not-A_C>, FF<not-A_not-C>. In the sentence probability task people are given frequency-information about these truth-table contingencies. For instance, imagine that in a set of ninety colored figure there are:

TT	50	Circles that are red.
TF	0	Circles that are yellow
FT	10	Triangles that are red
FF	30	Triangles that are yellow

You are then asked to judge the probability that the conditional "if it is a circle, then it is colored red" is true.

Evans et al. distinguished three hypotheses about the interpretation of if (see Table 1): The so-called conjunctive (AND), conditional probability (CP) and material-implication (MI) interpretation. These interpretations are defined as functions of the truth contingencies people would represent. For instance, a conditional <if A then C> interpreted as MI is only false when the consequent <C> does not follow from the antecedent <A>. This TF<A_not-C> contingency is a conceptual impossibility, if the conditional is true. Table 1 illustrates the probability of the conditionals when interpreted as AND, MI or CP. For instance, the likelihood of <if A then C> interpreted as <C given A> (i.e., CP) equals the proportion of TT<A_C> cases relative to True-antecedent cases (both TT<A_C> and TF<A_not-C>). This amounts to a probability of 50/50+0 in Example 1 (see Table 1). Table 1 also illustrates the decrease in both P(MI) and P(CP) with an increase of TF<A_not-C> cases.

Evans et al. (2003) found no evidence for MI and showed performance was best explained by AND and CP. The lack of any evidence for MI made Evans et al. claim to have "shown why the assumption of material implication embedded in the mental model theory of conditional reasoning (Johnson-Laird & Byrne, 1991, 2002) is unjustified" (p. 334). Schroyens and Schaeken (2004) already questioned Evans et al.'s representation of the model theory. They demonstrated that the evidence against MI is not inconsistent with the theory (also see, Johnson-Laird, 1994, 1995) and showed that neither

Table 1: Contingencies represented under different interpretations of *<if A then C>*.

	Example			Interpretation		
	1	2	3	AND	CP	MI
TT	50	50	50	A and C	A and C	A and C
TF	0	10	25		A and not-C	
FT	10	5	5			Not-A and C
FF	30	25	10			Not-A and Not-C

Probability	TT / TT+TF+FT+FF	TT / TT+TF	TT+FT+FF / TT+TF+FT+FF
Example 1	50/90	50/50	90/90
Example 2	50/90	50/60	80/90
Example 3	50/90	50/75	65/90

Note. TT, TF, FT, FF: True/False antecedent/consequent

AND nor CP conflicts with an apposite treatment of the model theory. Briefly: the model theory claims that the interpretation of a conditional can but need not be MI. It is just one of many possible interpretations. For instance, Johnson-Laird and Byrne (2002, p. 650) argued that querying the probability of <if A then C> might easily be interpreted as a question for the conditional probability of <C> given <A> and Johnson-Laird (1994, 1995; Johnson-Laird et al., 1999) already demonstrated how such conditional probabilities can be computed.

The present paper sets out to demonstrate the flexible nature of the interpretation of if according to the model theory. That is, we aim to establish that MI is indeed one alternative interpretation of if. This challenges arguments against the model theory based on the claim that people never interpret the conditional as such (Evans et al., 2003; Evans, Over, Handley, 2005). Demonstrating that even in the sentence-probability task some people can have MI interpretations obviously does not affect the robust observation that CP interpretations are dominant in this task. It would however demonstrate the mistake in claiming that people will never make such an interpretation.

We believe interpretations are varied and variable in nature, and that an interpretation of a sentence is to be distinguished from its idealized meaning (Johnson-Laird & Byrne, 2002). Interpretations are dependent upon content and context, while a proposition's meaning abstracts such factors. One possible interpretation of the conditional is the Material Implication interpretation. Table 1 shows that the major difference in MI versus CP interpretations lies in the relevance of false-antecedent cases; FT<not-A_C> and FF<not-A_not-C>. The absence of MI interpretations in the studies of Evans et al. (2003) therefore indicates that the participants did not take count of these false-antecedent cases and treated them as irrelevant. Irrelevance, however, is not a fixed property or third truth-value (Sperber & Wilson, 1986). To yield performance in accordance with MI we only need to make the false-antecedent cases more relevant to the task at hand. If the model theory is right, then we should be able to engage the processes of pragmatic and semantic modulation such that people will arrive at a MI interpretation. Indeed, starting from a minimal initial-model representation/interpretation (there is no interpretation without representation), people reason towards one or the other representation/interpretation.

Experiment 1

We envisaged two ways of increasing the relevance of the false-antecedent cases. First, we asked one group to start with a truth-table task. In this task participants indicate for each of the four truth-contingencies whether they are possible or impossible when assuming a rule like "if the figure is a circle, then it is red" is true. Hence, as compared to a group who completed the sentence-probability task first, we expected to see an increase in MI responses. Indeed, it is a robust phenomenon that many people will judge FT<not-A_C> and FF<not-A_not-C> cases as being consistent with If A then C (see, e.g., Barrouillet & Lecas, 1998). Second, on a more explorative basis, we asked whether "if the figure is a circle, then it is red" is strictly speaking true about a set of colored figures. At the same time we also asked these subjects to indicate whether "if the figure is a circle, then it is red" or the tautological conditional "if the figure is a circle, then it is possibly red" gives the best description of the set of colored figures. The contrast between <if A then C> and <If A then possibly C> highlights the status of the TF<A_not-C> cases, which are impossible for the former and possible for the latter. Asking people to judge whether the conditional is strictly speaking true of the set of colored figures is also likely to increase the relevance of false-antecedent cases. Truth-table task studies (e.g. Barrouillet & Lecas, 1998) indeed show that almost all people judge a conditional as being falsified by TF (also see, Evans, 1983). If the conditional is only falsified by TF, then other cases would not falsify it and, hence, these other cases might be taken to contribute to its truthfulness or verisimilitude. In summary, we expect an increase in MI interpretations when the sentence-probability task is preceded by a truth-table task or a truth questionnaire. Both these priming tasks make people think more profoundly about what it means for a conditional rule to be true.

Method

Design Three independent groups completed the sentence-Probability Task (PT), either as the first task (PT-TQ) or the secondary task presented after a Truth-Table task (TT-PT) or Truth Questionnaire (TQ-PT). The sentence probability task consisted of three problems that varied in their frequency of falsifying TF cases (0, 10 and 25 out of 90 exemplars; see Table 1).

Participants. All participants (N = 156) were first year psychology students at the University of Leuven who participated in partial fulfillment of a course requirement. Participants were randomly allocated to three groups, with 61, 53 and 42 participants in the PT-TQ, TT-PT and TQ-PT groups

Materials and Procedure. The sentence-probability task consisted of three problems (see Table 1). The frequencies of the colored figures corresponding to TT, TF, FF and FF were (a) 50,0,10,30 (b) 50,10,5,25 and (c) 50,25,5,10. For instance, it was said that "There are 50 CIRCLES that are RED; 10 CIRCLES that are NOT RED; 5 NON-CIRCLES that are RED; 25 NON-CIRCLES that are NOT-RED". Participants were given the conditional rule (e.g. "if the figure is a CIRCLE, then the figure is colored RED") and judged "the probability that the rule is true". That is, we did not explicitly specify that they had to judge the probability that the rule is true of an element (Evans et al., 2003) or subset of elements (Oberauer & Wilhelm, 2003) drawn from the set of colored figures. Participants answered by selecting one of the three relative frequencies corresponding to AND, CP and MI (see Table 1). Non-simplified relative frequencies were used: e.g., (50+10+30)/90 and not '1' formed the MI option in the TF=0 problem, as compared to 50/(50+0) for CP. With each of the non-simplified relative frequencies, a brief description was given.

The truth-table task probed for an evaluation of the four

truth contingencies as "possible, assuming the rule is true" or "impossible, assuming the rule is true". Participants had to assume that the rule was true and were informed that "if the rule is indisputably true, then there would not be a single colored figure that goes against the rule". They read that "a possible or permissible combination could occur if the rule were true" and that "an impossible or excluded combination should not occur if the rule were true".

The truth questionnaire contained two questions. It first probed participants to indicate whether a conditional like "if the figure is circle then the figure is red" is strictly speaking true or false about the set of colored figures. We also asked them to indicate whether the strict conditional "if the figure is a circle, then it is red" or the tautological conditional "if the figure is a circle, then it is possibly red" gives the best description of the given set of colored figures. When the truth-questionnaire (TQ) was given before the sentence-probability task (in the TQ-PT condition), this meant that the truth-questionnaire was given before each of the three sentence-probability problems.

Results and Discussion

Table 2 presents the relative proportion of selected sentence-probabilities for the three problems in the three experimental conditions. Table 2 confirms MI responses increase when participants first complete the truth-table task (2.7 vs. 13.2, Mann-Withney U = 1329, Z = 2.78, p < .01). It also shows that when people first judge whether the conditional is strictly speaking true of the given set of colored figures and choose between either <if A then C> or <if A then possibly C> as the best description, they similarly show an increase in MI evaluations (2.7 vs. 12.7, U = 1068 , Z = 2.56, p < .01). The proportions of MI interpretations differed significantly from zero, both when the truth-table task or the truth-questionnaire was presented first (p <.001). As can be seen in Table 2, though variable, the CP interpretation remains dominant throughout all conditions.

The TT, TF, FT and FF acceptance ratings in the truth-table task were 1.0, 0 and .83 and .924. Presentation order did not affect the truth-questionnaire. Combined over these two groups of participants we observed that .805, .058 and .048 responded that the conditional is "strictly speaking true" about the three frequency sets with respectively 0, 10 and 25 TF cases (see Table 1). The likelihood that <if A then C> was chosen as the best description of the sets was respectively, .796, .048 and .029. That is, when the conditional is logically false (as is the case when there are TF cases), the vast majority of people say that the conditional is strictly speaking false, and think that <if A then possibly C> rather then <if A then C> provides the better description of the frequency set.

Table 2: Percentage frequency of probability judgments in line with a conjunction (AND), material implication (MI), or conditional probability (CP) as a function of the whether the probability task (PT) was presented first (PT-TQ; N=61), or second after the Truth-Table task (TT-PT; N = 53) or a Truth-Questionnaire (TQ-PT; N = 42).

	Group		
Set	TQ-PT	TT-PT	PT-TQ
P(TF) =0/90			
AND	28.57	22.64	29.51
MI	19.04	16.98	3.28
CP	52.38	60.38	67.21
P(TF)=10/90			
AND	19.05	20.75	19.67
MI	7.14	15.09	3.28
CP	73.81	64.15	77.05
P(TF)=25/90			
AND	21.43	24.52	19.67
MI	11.90	7.54	1.64
CP	66.76	67.92	78.69

Experiment 2

Experiment 1 showed that the vast majority of our participants accepted the false-antecedent cases as possible. We nonetheless observed only a minority of MI interpretations in the sentence-probability task. However, something being possible according to a rule does not make this rule true, even though it does make this rule less likely to be false (which is tantamount to saying it makes the rule more likely to be true). As noted by Johnson-Laird and Byrne (2002, p. 652): "the judgment of the truth or falsity of assertions containing connectives, such as conditionals and disjunctions, is a meta-ability. That is, it calls for a grasp of the metalinguistic predicates true and false, which refer to relations between assertions and the world (see, e.g., Jeffrey, 1981). In contrast, a task that taps directly into the interpretation of assertions is to judge what is possible."

Saying that something is more likely to be true is not the same as saying that it is true. Any (philosophy of) science student knows that corroboration is distinct from verification. It is only in the sense of corroborating (i.e., not falsifying) a rule that false-antecedent cases make a rule more truthful, i.e., less likely to be false. Whereas falsity can be established by a single observation, categorical truth can not: verity is not verisimilitude. It is only within a closed world, where one has exhaustive information about all truth-table cases (vs. just one, or one type of truth-table case), that one can judge whether a rule is categorically true. Philosophy of science has taught us that most of our empirical generalizations can never be established as categorically true. We can only assume them to be categorically true. For instance, we have good reasons to believe that if the next morning comes, the sun will rise. But, then again, it might not. However unlikely, the next observation (and in non-closed world there always is a next observation) might always bring a falsification.

These theoretical considerations suggest that to further increase the likelihood of MI interpretations one could make the sentence-probability task coherent with the meta-linguistic insights participants are assumed to have -- and need to have -- to bridge the gap between knowing what is possible, and the import of these possibilities on the verisimilitude/truthfulness (vs. verity/truth) of a conditional. However, there is a simpler way of testing whether the possible-to-truthfulness gap plays a significant role in the difficulty of reasoning towards an MI interpretation. We can altogether bypass the tricky implications of the law of the excluded middle (something is either true or false) and the paradoxes of verification. Asking for the probability that the rule is false (vs. true) of a card accomplishes this. Reasoners only need to consider the impossible (not the possible) to satisfy the demands of the task. Hence one avoids the paradoxical problem of seeing how the possibility of "a white dove", FF<not-A_not-C> corroborates "if it is a raven, then it is black", <If A then C>. Moreover, in this situation, the

computational task is simpler. Consider Example 2 in Table 1. Coming to the "not true" MI estimate of 10/90 requires less computation than the "true" estimate: 50+5+25/90. Indeed, one need not consider the false-antecedent cases.

Method

Design. The sentence-probability task was primed or non-primed by presenting it after or before a probability-based truth-table task and inference task. The sentence-probability task presented a logically true or false rule and probed for true or false probability ratings.

Table 3: Percentage frequencies of selections of probability judgments of logically true vs. false conditional utterances according to the Conditional Probability (CP), Material Implication (MI), Material Equivalence (ME) and the Conjunction (AND), as a function of whether the probability judgments were completed before (non-primed) or after (primed) a conditional inferences task and truth-table task.

	P(Not True)				P (True)			
	CP	MI	ME	AND	CP	MI	ME	AND
TRUE Context: P(TF)=0								
No Prime	40.0	44.0	0.0	16.0	44.0	36.0	0.0	20.0
Primed	35.5	35.5	3.2	25.8	25.8	38.7	3.23	32.3
FALSE Context: P(TF)=10/90								
No Prime	60.0	24.0	4.0	12.0	64.0	0.0	4.0	32.0
Primed	41.9	35.5	0.0	22.6	32.3	19.3	0.00	48.4

Participants. All participants (N = 56) were first year psychology students at the University of Leuven who participated in partial fulfillment of a course requirement. Participants were randomly allocated to the two groups, with 25 and 31 subjects in the non-primed and primed groups.

Materials and Procedure. The sentence-probability task consisted of two problems. The frequencies of the colored figures corresponding to TT, TF, FF and FF were (a) 50, 0, 5, 35 (b) 40,10,5,35. Participants were also given the option to select the sentence-probability under a bi-conditional or Material-Equivalence interpretation (ME). Under such an interpretation, the FT<not-A_C> contingency also falsifies the conditional. The two priming tasks were presented on a single page, either before or after the page with the two problem sets for the sentence-probability task. (The order of individual problems within the priming and primed tasks was counterbalanced). The experiment was run in a single collective session.

Results and Discussion

Table 3 presents the relative proportion of selected sentence-probabilities. First, the priming effect was in line with that observed in Experiment 1.The overall effect, however, was not statistically significant (Z = .444). As can be seen in Table 3, the present experiment's priming effect depended on the type of rule. It only reached significance when there were exceptions to the rule (.275 vs. .120; U = 296.5, Z = 1.784, p < .05, one-tailed). The absence of a significant effect on the logically true rule seems due to the high level of MI interpretations (40%), even when participants were not primed. This is even higher than was observed in primed conditions of Experiment 1. The reason for this might be that both 0/50 and 0/90 amount to 0. The former is the CP probability, whereas the latter is the MI probability. Since both end up as 0, participants might not have differentiated between the two. We could also take the high MI interpretations at face value. That is, the present study reinforces the main conclusion of Experiment 1; it shows that MI is psychologically real.

In Experiment 1 participants evaluated the probability that the rule was true. Strictly speaking, the rule cannot be true of a set that includes FT cases. Ideally, the task should consequently also have included a zero-probability option, which it did not when there were FT cases. Experiment 2, however, repeats the main priming-effect in these conditions with a sentence-probability task that asks to evaluate the probability that the rule is true of an element from the set of coloured figures. Hence, it annuls a potential suspicion about the validity of the result of Experiment 1.

Second, and most importantly, there was a main effect of question type. There were more MI selections when people evaluated the probability that the rule was not true, as compared to the probability that the rule was true (.348 vs. .241, T = 63.5, Z = 1.807, p < .05 one-tailed). This effect neither interacted with the order of presentation (primed vs. non-primed; Z = 0.272), nor with the presence of exceptions to the rule (Z = 1.376). As was the case for the priming effect, the question-type effect was only reliable when there were exceptions to the rule (i.e, TF=10; 303 vs. .107; T = 27.0, Z = 2.343, p < .05). That is, when there are exceptions to the rule we have a main effect of both the type of question (.303 vs. 107) and the prime (.275 vs. .120). When there are no exceptions, we have high MI rates throughout.

The question-type effects corroborate (i.e., fail to falsify) and hence increase the acceptability of our hypothesis that people have difficulty coping with the paradoxes of verification and do not fully grasp the idea that something that does not falsify a rule (or hypothesis) makes this rule more truthful (though not necessarily true). False-antecedent cases are considered possible, and therefore do not make the rule false. This does not mean that they make the rule true; it only means that these possible cases make the rule more truthful in the sense of a failed falsification of this rule. Avoiding these complexities about truth, by asking people to judge the probability that the rule is false, effectively increases the sentence-probability judgement in line with a MI interpretation. The question-type effect is particularly strong, given that it was established in a within-subjects design, which gives the best chance of rejecting our hypothesis. Participants first judged the probability that the rule is not true and on the next line were asked to judge the probability that the rule is true. One would think that if they select 10/90 as the "not-true" sentence-probability, they would simply take 1-[10/90], i.e., 80/90 as the corresponding "true" sentence-probability. The question-type effect seems to be strong enough to counter this simple heuristic, at least when there are exceptions to the rule.

The TT, TF, FF and FT acceptance ratings in the truth-table task were .95, .11 and .89 and .80, which did not differ as a function of presentation order. The inference-acceptance rates for Modus Ponendo Ponens ("A therefore C"), Affirmation of the Consequent ("C therefore A), Modus Tollendo Tollens ("not-C therefore A") and Denial of the consequent ("not-A therefore not-C) were respectively .96, .07, .14 and .55. In another replication of an aspect of Experiment 1, we observed that .80 and .08 responded that the conditional is "strictly speaking true" about the two frequency sets with respectively 0 and 10 TF cases. The likelihood that <if A then C> was chosen as the best description of the sets was respectively .875 and .089.

General Discussion

The most direct import of our results is simple. We have shown that some people at least sometimes interpret a conditional in line with Material Implication. In such an interpretation of <if A then C> people accept that everything is possible, except that <A> is not followed by <C>. Though the Material-Implication interpretation is made in a minority of cases, comprehensive theories of human reasoning need to account for the possibility that people can have such an interpretation of 'if'. In doing so, they will have to specify or explain the conditions under which particular interpretations are more likely. Interpretations of ordinary conditionals depend on the content of the problems and their interpretative context. 'The' interpretation of 'if' does not exist.

The possibility of MI interpretations shows that Evans et al. (2003; Evans and Over, 2004; Evans et al., 2005) are mistaken to criticize the model theory for its adherence to MI, for which they had found no evidence. They also show that their own theory is incomplete to the extent it denies the psychologically reality of Material-Implication interpretations. We do not need to present this theory in detail. We have shown that Evans et al.'s (2003) data were too limited in scope as regards the range of possible interpretations. Their theory is based on these data and explicitly eschews the possibility of MI interpretations. It is a fortiori too limited as regards the interpretational process it proffers. Of course, this present limitation need not denote a fundamental flaw of the hypothetical-thinking model. It can easily be extended to incorporate (in a consistent way) the idea that the irrelevancy of false-antecedent cases is not a fixed third truth-value but a variable interpretation of their relevancy. Our findings show that most people think false-antecedent cases are possible (e.g., FF was considered possible by 92.4% of the participants in Experiment 1) and that priming the sentence-probability task with the possibility-based truth-table task seems to make these false-antecedent cases appear somewhat more relevant.

The model theory has received many criticisms because of its adherence to the Material-Implication hypothesis. These critiques are annulled by distinguishing the interpretation of a conditional from its presumed meaning. The so-called core-meaning principle is part of the theory of meaning and states that when one assumes that the proposition <if A then C> is true, everything except the falsifying TF,<A_Not-C> contingency is possible (Johnson-Laird & Byrne, 2002, p. 650). One important aspect of the core-meaning principle is its focus on so-called basic conditionals. Basic conditionals are:"[conditionals] with a neutral content that is as independent as possible from context and background knowledge, and which have an antecedent and consequent that are semantically independent apart from their occurrence in the same conditional" (Johnson-Laird & Byrne, 2002, p. 649). This makes clear that the core meaning forms an idealization conveyed by making an abstraction of the specific content and context of utterance: "Meaning as model theoretic interpretations are idealizations – abstract theoretical fictions, though nonetheless useful for all that" (Johnson-Laird, 1983, p. 182). As an idealization, the core-meaning assumption therefore does not license inferences about the prevalence of particular interpretations.

When one is asked to evaluate the probability that a conditional like "if the figure is a circle, then it is red" is true about a set of colored figures, we are not dealing with a basic conditional. The sentence-probability task forces people to make their interpretation dependent upon the contextual information. A per se abstract or 'knowledge-lean' conditional becomes very specific and concrete, i.e., knowledge-rich when one is given information about the exact frequency of all possible figures that might be relevant to the conditional. Hence, by definition, it is no longer a basic conditional. It might even be considered a 'hyper-real' conditional: In real life we hardly ever have the luxury of having exact frequency information about the possibilities present in the world surrounding us.

The core-meaning principle does not deal with ordinary conditionals in daily parlance. It deals with *basic (i.e., idealized* conditionals and finds its basis more in other arguments that are generally more logico-philosophical and linguistic in nature. For instance, a central argument in favor of an idealized Material Implication is that <if A then C> can not mean the same thing as neither <if and only if A then C> nor <if A then possibly C>. They are indeed different sentences. This 'semantic occamism' argument (Bennett, 2003) favors a difference in the meaning of <if A then C> versus <if A then possibly C>. They are not the same utterances. Hence they can not mean exactly the same, though this does not imply that <if A then C> might not be interpreted as <if A then possibly C>. Indeed, it will be recalled that when there were TF<A_not-C> cases, the bulk of our participants selected <if A then possibly C> and not <if A then C> as the best description, and the other way round when there we no TF cases.

An idealization still finds its source in reality. That is, as an idealization, the core-meaning assumption has some explanatory import. We have worked with the general principle that when we approach the idealization, e.g., by imposing contextual constraints that bring us nearer to the idealized language game, we should observe behavior that more closely approaches the strictures and implications of that language game. That is, the comparative contrast identifying <if A then C> as meaning something different from <if A then possibly C> or <if and only if A then C> can also steer people towards the MI interpretation. Schroyens and Byrne (1998) observed, for instance, that when <if A then C> is contrasted with <if and only if A then C>, people are more likely to reason in accordance with a consequence of this contrast, i.e., the consequence that with <if A then C> there might be FT<not-A_C> situations in which <C> occurs

without <A> being the case. Politzer (1981) observed a similar contrast-induced increase of so-called material implication patterns in the truth-table task. The effect of asking participants to first complete the truth-questionnaire similarly induced a comparative contrast between <if A then C> and <if A then possibly C>. We accordingly observed that more participants solved the sentence-probability task in accordance with the presumed core meaning of <if A then C>. Analogously, when logical validity is stressed by explicating the notion of necessary inferences (vs. possible inferences) and/or highlighting the hypothetical truth of logical valid inferences, we see an increase in deductive rationality (Schroyens et al., 2003).

The idealization hypothesis also grounded the present research. First, the core-meaning principle makes an abstraction of the implicit-model principle, by which people initially only consider the TT<A_C> contingency and not the false-antecedent contingencies. We used a possibility-based truth-table task to prime consideration of false-antecedent cases and accordingly observed a statistically significant increase in material-implication interpretations akin to the core-meaning. Second, the core-meaning assumption makes an abstraction of people's capacity to deal with the paradoxes of verification that follow from considering the implications of what is possible vis-à-vis what is true. Experiment 2 showed that bypassing these complicating and complicated idealizations effectively increases the likelihood of seeing performance in accordance with Material Implication.

General summary. We have shown that people sometimes have an interpretation of <if A then C> that corresponds to the core meaning of the conditional in the model theory. This vindicates the model theory (Johnson-Laird & Byrne, 2002), which explicitly claims that the MI interpretation is one of many possible interpretations. Our findings show that any theory of conditionals needs to specify a comprehension theory that mirrors the highly flexible nature of our interpretation vs. idealized meaning of "if".

In conclusion, we should abandon the quest for 'the' interpretation of conditionals and the introduction of theoretical oppositions about 'the' interpretation. Instead we should pose research questions that allow us to comprehend and model the flexible nature of the interpretational processes, which any theory has to do. The idealization-hypothesis and the associated difference between meaning and interpretation that is made by mental-model theorists has shown to be a helpful guide in delineating conditions in which people are more or less likely to demonstrate behavior reflecting a particular interpretation.

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