Missing-link conditionals: pragmatically infelicitous or semantically defective?

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Abstract: According to virtually all major theories of conditionals, conditionals with a true antecedent and a true consequent are true. Yet conditionals whose antecedent and consequent have nothing to do with each other—so-called missing-link conditionals—strike us as odd, regardless of the truth values of their constituent clauses. Most theorists attribute this apparent oddness to pragmatics, but on a recent proposal, it rather betokens a semantic defect. Research in experimental pragmatics suggests that people can be more or less sensitive to pragmatic cues and may be inclined to differing degrees to evaluate a true sentence carrying a false implicature as false. We report the results of an empirical study that investigated whether people's sensitivity to false implicatures is associated with how they tend to evaluate missing-link conditionals with true clauses. These results shed light on the question of whether missing-link conditionals are best seen as pragmatically infelicitous or rather as semantically defective.

Keywords: conditionals, experimental pragmatics, logical/pragmatic responders, semantics

1 Introduction

Conditionals are sentences that have, or can plausibly be rephrased to have, the form "If φ, then ψ".[1] They are among the most puzzling phenomena of language, and are being studied by researchers from a variety of fields, including philosophy, linguistics, psychology of reasoning, and computer science. Few would want to claim that, among the extant accounts of conditionals, any is

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1 In this paper, we are strictly concerned with indicative conditionals, leaving subjunctive conditionals aside. The difference between these two main classes of conditionals is notoriously difficult to make precise. See Von Fintel (2012) for useful discussion.

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fully satisfactory. Indeed, based on decades, or even centuries, of theorizing about conditionals, one could easily come to the conclusion that, when it comes to such accounts, we will always be forced to make some trade-off between material and formal adequacy.

This paper focuses on a particularly striking example of a principle that may appear to require such a trade-off, to wit, the so-called Principle of Conjunctive Sufficiency (CS), sometimes also referred to as "Centering." According to this principle, we are licensed to infer a conditional from the conjunction of its antecedent and consequent. While validated by all main accounts of conditionals, CS appears problematic from a pre-theoretic viewpoint, given that, intuitively, it would seem that there has to be some kind of connection between a conditional's antecedent and consequent for that conditional to be true. Conditionals that lack such a connection—so-called missing-link conditionals (Douven 2017b)—tend to strike us as odd, regardless of the truth values of their clauses.

Little is known, however, about whether laypeople's judgments accord with this intuition, or whether these judgments are rather in line with what one would predict them to be purely based on the main accounts of conditionals. In this paper, we aim to shed new light on the question of whether, judging from ordinary people's responses, the intuition that there should be some kind of connection between a conditional's clauses for it to be true is best seen as informing the semantics or rather the pragmatics of conditionals. In other words, our main research question is whether common linguistic usage suggests that missing-link conditionals are theoretically best classified as pragmatically infelicitous or rather as semantically defective.

2 Theoretical background

Suppose CS is a valid inferential principle, so that "If φ, then ψ" can be inferred from the conjunction of φ and ψ.[2] Then any conditional whose antecedent and

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2 To be entirely precise, one should distinguish between *one*-premise CS, which allows us to infer a conditional from the conjunction of its two clauses, φ and ψ, and *two*-premise CS, which is an inference of the conditional from the truth of φ and the truth of ψ. On most accounts of conditionals, the two versions of CS are equivalent. However, they do not need to be psychologically equivalent since an agent who believes that φ and who believes that ψ may fail to realize that s/he is warranted in believing their conjunction.

consequent are known to be true should be evaluated as true.[3] So in particular the following sentences should be deemed true by anyone with rudimentary knowledge of arithmetic, geography, and biology:

(1)   a. If 2 plus 2 is 4, then Paris is the capital of France.
       b. If 17 is a prime number, then there are at least three polar bears living within the Arctic circle.
       c. If giraffes are African mammals, then they do not eat antelopes.

Yet these sentences—examples of missing-link conditionals—strike most people as odd.

Their oddness seems to stem from the fact that their constituent clauses are not connected with each other in any intuitively plausible way. The mathematical truth that $2+2=4$ has nothing to do with the contingent fact that Paris is the capital of France. Similarly for (1b) and (1c).

While most agree that missing-link conditionals are strange things to say, the *status* of the antecedent–consequent link that these sentences lack and that "normal" conditionals have is a matter of some controversy. The controversy concerns the question of whether the said link is part of the semantic content of a conditional or whether it is best conceived of as a purely pragmatic phenomenon.

According to all prominent philosophical and psychological theories of conditionals— including the material conditional account (Grice 1989; Rieger 2013; Rieger 2015), Stalnaker's semantics (Stalnaker 1968; Stalnaker 1975), and the suppositional theory (see note 3; also Adams 1965; Adams 1975; Bennett 2003; Edgington 1995; Evans and Over 2004; Over et al. 2007)—the link belongs to the realm of pragmatics. Over the past years, however, the idea that instead it is part of the "core meaning" of the conditional has gained some popularity. On theories proposed by, among others, Douven (2016), Krzyżanowska et al. (2013; 2014), Skovgaard-Olsen et al. (2016b), and Spohn (2013), for a conditional to be true, there must be some sort of inferential or reason-giving connection between

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3 This assumes that conditionals are such things that can be true or false at all, an assumption not shared by all theories of conditionals. However, on the main "non-propositional" account of conditionals a version of CS still holds. This account, developed by Ernest Adams, replaces the traditional notion of validity with that of *p*-validity, where an argument is *p*-valid if and only if we can make its conclusion as probable as we like by making its premises probable enough (this is rough; see Adams 1965 for details). The crucial assumption in Adams' account is that conditionals satisfy the so-called Equation, according to which the probability of a conditional equals the probability of the conditional's consequent given its antecedent. Given this assumption, it can easily be shown that all instances of CS are *p*-valid arguments.

its component parts (see also Sztencel 2018; for valuable discussion, and Douven et al. 2018; Vidal and Baratgin (2017); for some first experimental results). For instance, according to the position that Douven (2016) and Krzyżanowska et al. (2013; 2014) have dubbed "inferentialism," a conditional "If φ, then ψ," then is true in a conversational context C if and only if, relative to the set Σ of background premises accepted in C,

1. there is a compelling argument from Σ ∪ {φ} to ψ;
2. there is no argument, or no equally compelling argument, from Σ alone to ψ.

Here, it is important to note that for an argument to be *compelling* in the inferentialist's sense, it need not be *conclusive*. In particular, the inferential connection the truth of the conditional requires need not be deductive, but may be inductive (roughly, of a statistical nature) or abductive (roughly, based on explanatory considerations; see Douven 2017a; Douven and Mirabile 2018), or it may involve a combination of the aforementioned types of inference.

Naturally, on an inferentialist view of conditionals, CS is not valid: a conditional can have a true antecedent and a true consequent without there being any inferential connection between them. As a result, conditionals such as those in (1) are neither true nor acceptable according to inferentialists.[4]

Psychologists of reasoning have traditionally been interested in which inferential principles people do and do not obey. So, we might consult the literature from that field in the hope to find some evidence either for or against CS, which might then help settle the debate about the status of the link that a conditional seems to convey. If it were found that, in their truth evaluations, people tend to comply with CS, even when the conclusion is a conditional lacking a natural link between antecedent and consequent, then that would support the claim that that link is best thought of as pragmatic, whereas if the data showed that people tend to violate CS, at least in cases where there is no link between the antecedent and the consequent of the conditional that serves as a premise, then that would support the opposite claim that the link is best thought of as semantic.

It turns out that, so far, CS has received scant attention in the psychological literature. Moreover, the results of the few studies that did look specifically at the possible impact of a connection between antecedent and consequent on the interpretation of the conditional point in different directions. For instance, Oberauer et al. (2007b) failed to find an effect of probabilistic relevance on people's probability judgments of conditionals, while Over et al. (2007) and

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4 In some (probably) bizarre contexts, one might be able to reasonably argue for some kind of inferential connection between their antecedents and consequents; in those contexts, the conditionals in (1) could be true or acceptable after all.

Douven and Verbrugge (2012) did find such an effect—a weak one in the case of the former study, a stronger one in the case of the latter—where these studies operationalized the notion of probabilistic relevance in terms of the Δp rule[5]:

$$\Delta p = Pr(\psi|\varphi) - Pr(\psi|\neg\varphi)$$

The shortcomings of these studies have been recently pointed out by Skovgaard-Olsen et al. (2016b), who incorporated the whole spectrum of *positive relevance, irrelevance*, and *negative relevance* in their design.[6] One key finding of Skovgaard-Olsen et al.'s research was that the Equation, according to which Pr ("If φ, then ψ") = Pr($\psi \mid \varphi$), holds only when the conditional's antecedent is positively relevant to the consequent.

While the aforementioned studies looked at possible *probabilistic* connections between antecedent and consequent, there are some still more recent studies that tackled the question of the descriptive adequacy of CS head-on. Again, no unanimous answer emerged from these studies. For instance, Cruz et al. (2016) and Politzer and Baratgin (2015) found evidence that people's responses accord with CS, whereas the study by Skovgaard-Olsen et al. (2016a) casts doubt upon the generality of those results. Finally, Vidal and Baratgin (2017) found that people tend to violate CS when presented with missing-link conditionals.

Of course, reports of relatively massive violations of CS, such as that in Vidal and Baratgin (2017), are bad news for the advocates of CS. In response, these advocates have turned to pragmatics in an attempt to explain-away such—from their perspective—untoward results, the idea being that people violate CS, when they do, because they mistake true but odd conditionals for false ones. Yet, so far none of those theorists has been able to offer a *detailed* explanation of how the apparent oddness of missing-link conditionals might result from the violation of particular pragmatic principles.[7]

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5 Douven and Verbrugge (2012) actually used a slightly different characterization of probabilistic relevance which however for the purposes of their paper is equivalent to the characterization used in the other two studies.

6 Positive relevance corresponds to the condition that $\Delta p > 0$, negative relevance to the condition that $\Delta p < 0$, and irrelevance to the condition that $\Delta p = 0$.

7 The first and perhaps still best attempt to this effect is to be found in the philosophical literature, specifically in Grice's writings. Grice (1989: 61), who advocates the material account according to which conditionals have the truth conditions of their material counterparts, acknowledges that there is an "Indirectness Condition" associated with 'If φ, then ψ", which he describes as the condition "that φ would, in the circumstances, be a good reason for ψ," or "that ψ is inferable from φ"(Grice 1989: 61). But this condition, Grice claims, is a conversational implicature, and not part of the meaning of "if." He takes it to follow from a combination of the maxims of Quality and Quantity. Without going into the details of his argument, we note that it rests on the assumption that, in normal conversational settings, "$\varphi \supset \psi$", where $\supset$ is the

Johnson-Laird and Ruth (2002), working in the Mental Models framework, are exemplary in this respect when they write that they "do not deny that many conditionals are interpreted as conveying a relation between their antecedents and consequents" but that "the core meaning alone does not signify any such relation." Rather, in their view that relation results "from the modulating effects of semantics and pragmatics" (651). Unfortunately, we are then told no more about modulation than that it "can establish an indefinite number of different temporal, spatial, and coreferential relations between the antecedent and consequent of a conditional" (660). That, we submit, is not nearly enough to explain how pragmatics prevents us from accepting missing-link conditionals like the ones in (1), whose antecedents and consequents we know to be true.

We find similarly sketchy explanations of the unassertability of missing-link conditionals coming from the so-called New Paradigm psychology of reasoning. See, for instance, this passage from Over et al. (2007:92; notation slightly altered for uniformity of reading):

> An Adams conditional [i.e., a conditional satisfying the Equation] is not equivalent to an explicit statement that φ raises the probability of ψ, ... nor that φ causes ψ ... . A conditional probability $\Pr(\psi \mid \varphi)$ can be high when φ does not raise the probability of ψ and when φ does not cause ψ. For example, $\Pr(\psi \mid \varphi)$ can be high simply because $\Pr(\psi)$ is high. Does this mean that supporters of the view that these conditionals are Adams conditionals cannot account for the weak negative effect of $\Pr(\psi \mid \neg\varphi)$ in the current studies? [This is the effect mentioned above.] Not necessarily, for they can argue that the

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material conditional operator, is not sufficiently informative to be of interest: "No one would be interested in knowing that a particular relation ... holds between two propositions without being interested in the truth-value of at least one of the propositions concerned ..." (Grice 1989: 61). We further note that Grice takes this assumption to be self-evident; in particular, he provides no support for it in terms of any pragmatic principles. To us, the assumption seems plain false. Suppose we know χ to follow from $\neg\varphi$ and also from ψ. Then we can easily imagine how "$\varphi \supset \psi$" might be valuable information for us, while at the same time we would take no further interest in knowing the truth-values of φ and ψ. Independently, we believe Grice's argument for claiming that the Indirectness Condition is a conversational implicature to fail as well. According to Grice, the condition is an implicature because it is cancellable. While "If you put that bit of sugar in water, it will dissolve" does suggest that there is a connection between putting the bit of sugar in water and that bit dissolving, Grice (1989: 60) holds, he claims that this suggestion can be blocked by adding: "though so far as I know there can be no way of knowing in advance that this will happen." We agree that this comment would have the effect of undoing the suggestion, but in our view, that is only so because it takes back the conditional as a whole. It is not as though the comment cancelled the suggestion of a link between antecedent and consequent while leaving in place an assertion of "put that bit of sugar in water $\supset$ it will dissolve," which is what would have to be the case for Grice's argument to work. See also Douven (2008; 2017a).

> use of a conditional pragmatically suggests, in certain ordinary contexts, that φ raises the probability of ψ or that φ causes ψ.

Again, however, it is not made clear in virtue of which particular pragmatic principle or principles a conditional would suggest that its antecedent causes, or raises the probability of, its consequent.

Cruz et al. (2016) offer a welcome exception to the usual handwaving at pragmatics to neutralize intuitions or results seemingly running counter to CS. According to Cruz and colleagues, people may hesitate to endorse CS in a probabilistic setting—which, as New Paradigmers have rightly emphasized, is the kind of setting in which we normally reason—when the clauses of the conditional pertain to different topics. Although these authors, too, do not elaborate all that much on the details of their claim, it can be reasonably interpreted as the suggestion that the oddness of missing-link conditionals is due to the absence of a relevant *discourse coherence relation* between antecedent and consequent, given that, as linguists generally agree, discourse coherence relations are expected to hold between any two consecutive elements of discourse (see, e.g., Kehler 2002; Asher and Lascarides 2003).

However, a recent study by Krzyżanowska et al. (2017) found that discourse coherence violations are not sufficient to explain the oddness of missing-link conditionals. This study compared how participants evaluate the assertability of a conditional in a conversational context with the assertability of that conditional's consequent stated separately in the same context with the antecedent previously asserted. Unsurprisingly, when there was no common topic in the discourse-coherence-theoretic sense, both conditionals and conversational exchanges were generally deemed highly unassertable by the participants. When the clauses were on the same topic, however, and hence constituted a coherent fragment of discourse, the participants' assertability ratings diverged depending on whether the antecedent was positively relevant or irrelevant for the consequent. While the common topic sufficed to make the conversational exchanges assertable, conditionals were only judged assertable when the antecedent was positively relevant for the consequent and unassertable when it was irrelevant. This finding puts considerable pressure on Cruz et al.'s explanation of the unassertability of missing-link conditionals.

In short, it is still very much an open question whether the connection that conditionals seem to convey is a semantic or rather a pragmatic feature of that type of sentences, relevant results being all over the map. In this paper, we consider a new possible approach to determining whether a phenomenon belongs to the realm of semantics or to that of pragmatics, and then apply it

to the question of the status of the link between a conditional's antecedent and consequent.

3 Study

Ever since Grice (1989) introduced the distinction between what is said and what is implicated, *conversational implicatures* have attracted a lot of attention both in philosophy and in linguistics (see Levinson 2000 and references given there). One of the most frequently discussed and best understood types of implicature is that of *scalar implicatures*.

A scalar implicature may arise whenever a given notion can be placed on a scale, on which related notions are ordered according to some parameter of interest Although a sentence referring to a higher point on the scale, say n, entails the truth of a sentence referring to any lower point of the same scale, k ($k < n$), usually when someone asserts a sentence pointing at k, they communicate that a corresponding sentence pointing at n is not true. For instance, the quantifiers *some* and *all* constitute such a scale. Whenever an English speaker asserts the sentence:

> (2) Some of my students are interested in logic.

a hearer will immediately infer that not all of the speakers' students are interested in logic. What distinguishes an implicature as the kind of content which is inferred pragmatically rather than semantically entailed is their defeasiblility. After a moment of reflection, the speaker may felicitously add, "Actually, all of them are interested in logic," cancelling thereby the implicature. By contrast, a speaker who would add, "Actually, I don't have any students," after asserting (2), would appear incoherent.

This defeasibility of pragmatic inferences is one of the main reasons why it is commonly assumed that the presence of an implicature should not affect the truth-conditional content of a sentence. However, people who have never received any training in logic might be susceptible to pragmatic cues in their assessments of truth values and thus evaluate a true sentence carrying a false implicature as false. For instance, in a context in which it is known that all laptops are computers, a layperson may hesitate to accept the true but pragmatically infelicitous sentence "Some laptops are computers" as true. This suspicion has been confirmed by numerous psycholinguistic experiments, which have led some researchers to suggest that people can be roughly equally divided into "pragmatic" and "logical" responders, where people belonging to the first

group judge true sentences carrying false implicatures typically as false, while people belonging to the latter judge them typically as true (Bott and Noveck 2004; Spychalska et al. 2016).

This distinction between logical and pragmatic responders, if it is robust, points at a new possibility of determining whether a given linguistic phenomenon belongs to the realm of semantics or to that of pragmatics; in particular, it seems to offer a method for testing whether the connection that is typically felt to exist between a conditional's antecedent and consequent belongs to the semantics or to the pragmatics of conditionals. For then, if the connection between antecedents and consequents is not part of the truth-conditional content of a conditional, but is instead pragmatically inferred, we should be able to observe individual differences in people's evaluations of missing-link conditionals, depending on those people's sensitivity to pragmatic cues. More specifically, we would then expect logical responders to evaluate missing-link conditionals with true clauses as true, while pragmatic responders should be inclined to reject these sentences as false.

Inspired by this possibility, we designed a study comparing people's evaluations of non-conditional sentences that, according to the standard view on semantics and pragmatics, are true but carry false implicatures, with the same people's evaluations of missing-link conditionals with true clauses.

3.1 Method

3.1.1 Participants

There were 319 participants in this study. All were from Australia, Canada, New Zealand, the United Kingdom, or the United States. The participants were recruited through Crowd-Flower, where they were linked to the Qualtrics platform, via which the study was administered. We removed participants who returned incomplete response sets, non-native speakers of English, and the fastest and slowest 2.5 percent responders. This left us with 218 participants for the final analysis. Of these remaining participants, 142 were female; 147 indicated that they had a college education, 65 indicated high school as their highest education level, and 6 indicated a lower education level. The mean age of these participants was 33 ($\pm$10) years. On average, the participants spent 704 ($\pm$655) seconds on the study. The excluded participants did not differ significantly in age, gender, or education level from the participants retained for the analysis.

3.1.2 Materials and procedure

The survey consisted of three parts, the third asking a number of demographic questions. The materials for the first part consisted of 47 sentences. Participants were asked to evaluate these sentences as True or False. Our test items included 5 instances of true sentences carrying false *scalar* implicatures and 2 instances of true sentences carrying false *order* implicatures. These items are given in Table 1. Among the test items were also 12 conditionals with true clauses. Six of these were "normal" conditionals whose antecedents and consequents were connected in a reasonable way, and 6 were instances of missing-link conditionals; see Table 2. Again, the participants were asked to evaluate these conditionals as either True or False. All remaining items (30 in total) were filler items.

Table 1: Pragmatic control items used in the study.

type	label	item
scalar	patches	Some patches are blue.[a]
	violins	Most violins are musical instruments.
	roses	Some roses are flowers.
	kangaroos	Most kangaroos are animals.
	laptops	Some laptops are computers.
order	toast	The tiger looks for the bread in the toaster and the boy puts a piece of
	noise	bread into the toaster.[b]
		The mother is angry and the boy makes a lot of noise.[c]

a Participants were shown a series of 5 color patches, all of which were blue. *b* Participants were shown a comic strip in which a boy first puts a piece of bread into the toaster and then a tiger looks for the bread in the toaster. *c* Participants were shown a comic strip in which a boy makes a lot of noise and then, because of that, his mother gets angry.

The items that involved either a comic strip or a series of color patches (see the notes to Table 1) appeared on a separate screen of the survey; all other items appeared in groups of 6 per screen. The order in which the screens appeared was randomized per participant.

In the second part of the survey, participants were asked to evaluate a further 24 sentences. These sentences were the antecedents and consequents of the 12 conditionals that were used in the first part. The participants were asked to indicate for each of those 24 sentences whether they thought it was True or False, although here they could also say that they did not know.

Table 2: Conditionals used in the study.

type	label	item
link	Jolie	If Angelina Jolie was born in 1975, she turned 40 in 2015.
	Obama	If Michele is Barack Obama's wife, she is the wife of the President of the United States.[a]
	birds	If birds are animals, some animals can fly.
	Belgium	If Belgium is ruled by a king, it is a kingdom.
	Canada	If French is one of the official languages in Canada, some Canadians speak French.
	Europe	If Amersfoort is in the Netherlands, it is in Europe.
no link	Hemingway	If Ernest Hemingway won a Nobel Prize in literature, 89 is greater than 2.
	Pitt	If Brad Pitt is a famous actor, Venice is in Italy.
	Rowling	If Joanne K. Rowling wrote fantasy books, "Harry Potter and the Sor-Sorcerer's Stone" was a box office hit.
	Japan	If Japan is in Asia, horses have four legs.
	London	If London is the capital of the United Kingdom, there are two consonants in the word "book."
	Spaniards	If Spaniards eat tapas, taco is a popular Mexican dish.

a The survey was run while Barack Obama was still in office.

The 24 sentences were presented in two groups of 12, appearing on two screens. The order in which these screens appeared was again randomized per participants.

3.2 Results

Tables 3 and 4 give a first summary of the responses. Table 3 already gives some reason for doubting that we will find a clean split between logical and pragmatic responders: while for the scalar items the responses were roughly equally

**Table 3:** Percentage True responses to the pragmatic control items.

item	T (%)	item	T (%)
patches	56.9	laptops	55.0
violins	54.1	toast	72.0
roses	52.3	noise	86.7
kangaroos	53.7		
Mean			61.5

Table 4: Responses to conditionals and their antecedents and consequents.

type	item	antecedent			consequent			conditional	
		T (%)	F (%)	? (%)	T (%)	F (%)	? (%)	T (%)	F (%)
link	Jolie	52.8	3.2	44.0	58.3	3.7	38.1	95.4	4.6
	Obama	95.0	2.3	2.8	96.3	1.8	1.8	97.7	2.3
	birds	90.4	6.4	3.2	93.1	4.6	2.3	94.5	5.5
	Belgium	50.5	5.0	44.5	48.6	9.2	42.2	83.5	16.5
	Canada	92.2	3.2	4.6	95.9	1.8	2.3	93.1	6.9
	Europe	56.0	3.7	40.4	54.1	3.7	42.2	87.6	12.4
	Mean	72.8			74.4			92.0	
no link	Hemingway	74.8	3.2	22.0	95.9	3.7	0.5	62.4	37.6
	Pitt	96.3	2.8	0.9	93.1	4.1	2.8	62.8	37.2
	Rowling	89.9	2.8	7.3	91.7	3.2	5.0	60.6	39.4
	Japan	91.7	4.1	4.1	97.2	2.3	0.5	61.9	38.1
	London	75.7	9.6	14.7	77.5	17.9	4.6	51.4	48.6
	Spaniards	74.8	0.9	24.3	91.7	2.8	5.5	53.7	46.3
	Mean	83.9			91.2			58.8	

divided between True and False, there were many more True than False responses for both order items.

Further evidence against the existence of such a split is obtained by counting, per participant, the number of pragmatic control items, given in Table 1, that the participant judged False. Given that these items were all
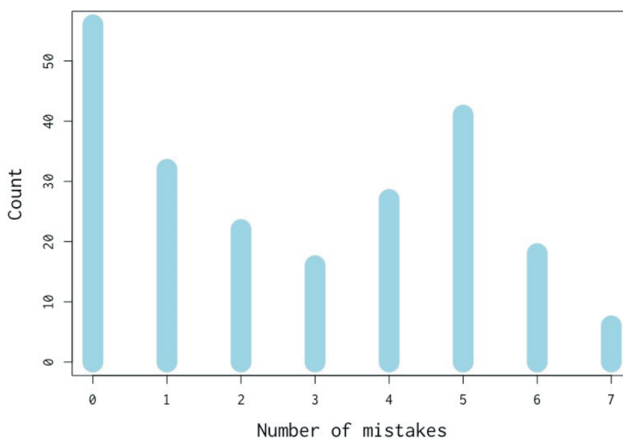
Figure 1: Counts of numbers of pragmatic/semantic mistakes.

true, we can think of this count as the number of "pragmatic/semantic mistakes," and so as measuring the participant's inclination to mistake pragmatic clues—the false implicatures the control items carry—as semantic. Figure 1 plots these counts. Spychalska et al. (2016) defined "logical responders" as participants who made no more than 30 percent pragmatic/semantic mistakes, and "pragmatic responders" as participants who made at least 70 percent pragmatic/semantic mistakes. While in their study, virtually all participants fell into one of those two categories, our data show that 20 percent of participants made between 30 and 70 percent pragmatic/semantic mistakes, and so can be classified neither as logical nor as pragmatic responders.

Comparing the average percentage of True responses for the missing-link conditionals with that for the "normal" conditionals, both given in Table 4, is a first indication that the presence or absence of a link has a large effect on how people evaluate conditionals, and precisely the kind of effect that inferentialism and related positions would have one expect. For note that the average percentage is much lower for missing-link conditionals, and this is so even though the average percentages of True responses for the antecedents and consequents are quite a bit higher in the case of the missing-link conditionals than in the case of the normal conditionals.

To confirm this first impression statistically, we looked at all 218 (number of participants) × 12 (number of conditionals) evaluations of conditionals and counted the cases where the antecedent and consequent of a given conditional had both been evaluated as True by a participant, which amounted to 1944 or 74.3 percent of all the evaluations. We then further looked at whether the participant had evaluated that conditional as True or as False. It turned out that, for conditionals with a link, there were 877 TTT cases (cases where a participant evaluated a conditional's antecedent and consequent, and also the conditional as a whole, as True) and only 31 TTF cases (cases where a participant evaluated a conditional's antecedent and consequent as True but the conditional as False). By contrast, for missing-link conditionals there were 629 TTT cases and 407 TTF cases. A McNemar test revealed that the percentage of the True evaluations among conditionals whose antecedent and consequent were evaluated as True differed significantly between normal and missing-link conditionals: $\chi^2(1) = 540.01$, $p < 0.0001$. Following a procedure recommended in Pearson (2011), we calculated the odds ratio to be 18.31 (95 % CI [12.53, 26.75]), which means that the odds of being evaluated as True for conditionals whose antecedent and consequent are both evaluated as True is 18 higher given the presence of a link between the clauses as compared to a link being absent. Following Chinn (2000), this odds ratio can be said to correspond to a

value for Cohen's of 1.61, which is conventionally interpreted as indicating a very large effect.

We finally turn to the question of the relation between participants' tendency to mistake pragmatic clues for semantic, as measured by counting the number of their False responses to the items in Table 1, and their evaluations of the conditionals, in particular of the missing-link conditionals. We already know that the thought to compare how logical and pragmatic responders evaluate missing-link conditionals is too simplistic, for the clean cut between two types of responders this presupposes proved not to exist.

This is not a problem for our current purposes, however. For, as Figure 1 suggests, we can put our participants on a scale, according to whether they are more or less inclined to interpret pragmatic clues as semantic, and we can then regress numbers of False responses the participants gave to missing-link conditionals on numbers of pragmatic/semantic mistakes. If the link between antecedent and consequent that a conditional suggests is due to the pragmatics, and not to the semantics, of conditionals, then we would expect participants to be more inclined to evaluate missing-link conditionals as false the higher they score on the pragmatic/semantic mistakes scale.

To investigate this question, we fitted a linear model with number of missing-link conditionals judged False as dependent variable and number of pragmatic/semantic mistakes as independent variable. The model showed a significant effect of the independent variable, although the effect was very modest, the slope for the variable being 0.22 (SE = 0.07, $p = 0.001$), meaning that, on average, an increase of roughly 5 pragmatic/semantic mistakes is accompanied by one additional missing-link conditional judged True. Most importantly, the model had an adjusted R^2 value of only 0.046, meaning that less than 5 percent of the variability in the data is explained by the independent variable. That is not nearly enough to show that when missing-link conditionals receive False judgments, that is because people mistake their putative pragmatic infelicity for a semantic shortcoming.[8]

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8 A reviewer pointed out that the True responses to the scalar implicature items, such as "Some roses are flowers," do not necessarily mean that those participants are more logical and less sensitive to pragmatic cues than those who evaluated such sentences as false. Some of the True responders might have relied on their general world knowledge about—in the case of the above example—crystal formations called "desert roses," plastic toy roses, sculptures of roses, or other such exceptional cases. This is a valid point, and, in future research, we intend to pay more attention to individual differences and possible misinterpretations of our stimuli. For now, we note that the ratio of True and False responses we observed is consistent with previous studies on scalar implicatures, in which abstract materials prevented participants from relying on their general knowledge about the world.

In the face of missing-link conditionals, CS seems an unwelcome consequence of the main accounts of conditionals. Advocates of those accounts have tried to attribute the oddness of missing-link conditionals, and concomitantly that of CS, to the pragmatics instead of to the semantics of conditionals. If this attribution were correct, however, one would expect people more inclined to make pragmatic/semantic mistakes to be also more inclined to judge missing-link conditionals with true clauses as False. And we found hardly any evidence that that is the case, thereby undercutting a main of line of defense of standard accounts of conditionals.

4 General discussion

Our results clearly show that people do not generally comply with CS, and that violations of CS are particularly to be expected for missing-link conditionals: the presence of an intuitively plausible link between a conditional's clauses seems to be a key determinant for whether or not people will evaluate that conditional as True.

Nevertheless, the percentage of responses in our data that were in accordance with CS is not low, not even for missing-link conditionals. It could thus be said that, like the previous relevant research mentioned in Section 2, our results point in different directions. On the one hand, the violations of CS pose a serious problem for all main accounts of conditionals except for inferentialism (and related semantics). On the other hand, the relatively high endorsement rate for missing-link conditionals with true clauses clearly challenges inferentialism. We claim, however, that the findings are better news for inferentialism than for the standard accounts of conditionals.

First let us note that, even when taken at face value, the outcomes from our study do *not* pose *more* of a problem for inferentialism than for those theories that validate CS. After all, if people tend to reject many missing-link conditionals as false even if they deem their antecedent and consequent true, that puts considerable pressure on the view that CS is endorsed as *valid* by natural language speakers. Of course, people might reject missing-link conditionals on pragmatic grounds, but there proved to be no evidence to support this thought.

Still, the question is whether inferentialism can maintain the position that the presence of an inferential connection between a conditional's antecedent and its consequent is necessary for the *truth* of a conditional, given that missing-link conditionals received quite a number of True responses in our data. The inferentialist can respond to this result in a couple of different ways, which moreover are not mutually exclusive, but may all contribute to explaining-away the prima facie problematic result.

To begin with, one of the most robust findings in psychology of reasoning is that around 40 percent (in some studies even close to 50 percent) of adult participants seem to interpret conditionals as conjunctions; among children as grown as 9 years old this even appears to be the predominant interpretation (Barrouillet and Lecas 1999; Barrouillet et al. 2000; Evans et al. 2003; Caroline and Barrouillet 2014; Barrouillet and Gauffroy 2015). Assuming a similar percentage of conjunctive responders among our participants, something like $0.4 \times (877 + 31) \approx$ 363 of the combinations of TTT + TTF responses given to normal conditionals will have come from such responders, and something like $0.4 \times (629 + 407) \approx 414$ of the combinations of TTT + TTF responses given to missing- link conditionals will have come from such responders as well. Naturally, by the nature of conjunction, all conjunctive responders who evaluated the antecedent and consequent of a given conditional as True will then also have evaluated the conditional as true, so the conditional (i. e., non-conjunctive) responders account for about 877 − 363 = 514 of the TTT responses to normal conditionals and for about 629 − 414 = 215 of the TTT responses to missing-link conditionals.

Note that while correcting for conjunctive responders increases the percentage of violations of CS (so the TTF responses) among the combinations of responses that can be brought to bear on the question of the validity of that rule (so the combinations with True judgments of both the antecedent and the consequent) from 3 percent to 6 percent for normal conditionals, for missing-link conditionals the corresponding increase is from 39 percent to 65 percent! Of course, these are just estimates, based on percentages of conjunctive responders found in previous studies, and further research is needed to determine if the relatively high endorsement rate for CS can be indeed explained by participants' tendency to interpret conditionals as conjunctions.[9] Still, whatever the exact numbers would be if we were able to identify the conjunctive responders among our participants, it is clear that the picture for inferentialism and related

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9 To that end, one could proceed, following Evans et al. (2007) or Oberauer et al. (2007a), by asking participants to rate (i) the probability of conditionals, (ii) the probabilities of conjunctions of these conditionals' antecedents and consequents, and (iii) the corresponding conditional probabilities. Conjunctive responders would be those participants whose probability judgments for conditionals are predicted by their probability ratings for conjunctions, rather than by the corresponding conditional probabilities. Note, however, that such a procedure cannot be directly applied to our design, given that we focused on conditionals whose antecedents and consequents are evaluated by participants as true. When that is the case, the participants' estimates of the probability of the conjunction and of conditional probability should both equal 1 (on the assumption that conditional probability is calculated on the basis of the ratio formula).

positions looks much better simply knowing *that* conjunctive responders are quite prevalent in the general population than it looked initially.

Admittedly, the above correction still leaves us with something in the order of 35 percent of TTT responses for the missing-link conditionals, and by itself, inferentialism cannot account for that. As said, however, there is more than one response available to the finding of TTT responses for missing-link conditionals. A particularly promising line of defense appeals to the so-called Principle of Charity, which implores us to interpret speakers as self-consistent and rational truth-tellers (Davidson 1967; Davidson 2001). It may be taken as one of the *predictions* of inferentialism that when an interpreter encounters a conditional, she will *assume* that the antecedent is relevant for the consequent of that conditional, that there is an inferential connection between them (see, e.g., Skovgaard-Olsen et al. 2016b on the Default and Penalty Hypothesis). When this assumption is violated, the interpreter has two options available. One is to judge the conditional as pragmatically infelicitous or even nonsensical. It is questionable if one can evaluate a nonsensical sentence as true or false at all, hence, given that a third option was not available, the participants of our experiment who failed to interpret the missing-link conditionals as sensible sentences were facing an impossible choice and may have responded randomly.

Another option is to evaluate the missing-link conditionals in the most charitable way. For instance, a participant who is supposed to evaluate "If Japan is in Asia, horses have four legs," even if they find the sentence odd, might decide that it must be a perfectly fine conditional just because otherwise they would not have been asked to evaluate it as true or false. The participant will probably (and reasonably) assume that the task they are asked to carry out is feasible, which it would not be if the sentence does not make sense at all. The participant may then decide that, according to the speaker—which in this case would be the experimenter—there is a connection between Japan being in Asia and the fact that horses have four legs, even if they cannot figure out what that connection is. That will incline the participant to evaluate the conditional as True, even on the supposition of inferentialism.

There is a third way in which inferentialists can respond to the TTT responses for the missing-link conditionals. Inferentialism holds that, for a conditional to be true, there must be an inferential connection between its antecedent and consequent. So, in interpreting a conditional, people may be expected to go through some kind of inferential process: they will try to ascertain whether the consequent follows—in a not necessarily deductive sense—from the antecedent. But then it is also reasonable to except the evaluation of conditionals to be sensitive to the same biases that are known to affect inferential processes in general. Probably the best-known among

those is the so-called belief bias, which inclines people to let their inferences be influenced by their prior beliefs. Researchers have found time and again that people are more willing to infer to a given conclusion, or to judge that inference as valid, the stronger their prior belief in the conclusion (Evans et al. 1983; Klauer et al. 2000). The degree to which participants are subject to this bias differs across studies, and is also known to depend on the materials used. Douven et al. (2018) found clear evidence of belief bias in their work on conditionals: the more strongly participants were convinced of the consequent, the more likely they were to evaluate the conditional as a whole as true, all else being equal. The materials from Douven et al. (2018)'s studies were rather different from ours, and we cannot, on the basis of their findings, attribute to belief bias a definite number of TTT responses to missing-link conditionals, so cases where the True judgment of the conditional is simply due to the fact that the consequent (the conclusion) was judged True. Nevertheless, belief bias was such a strong finding in Douven et al. (2018), emerging from all four of their experiments, that it is safe to assume that the same bias did play a role in our results as well.

While the inferentialist appears to be in a good position to account for the responses in our data that seem to go against her position, we do not see how advocates of the main semantics of conditionals might be equally successful in explaining-away the numerous violations of CS present in the same data. That may just be a lack of imagination on our part, of course. Also, it is to be emphasized that we think of the present study as being mainly exploratory. We intend to follow up the work by studies focusing more on individual difference in general, and making a greater effort to identify conjunctive responders in particular. Moreover, our materials consisted of a relatively small number of items. Future work will present participants with both a richer variety of pragmatic control items and a richer variety of conditionals. Therefore, we postpone till a later date a more definite verdict on whether the data reported in the foregoing constitute more of a problem for inferentialism or for the main accounts of conditionals.[10]

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