# Relevance and Conditionals:

# A Synopsis of Open Pragmatic and Semantic Issues

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*Abstract*. Recently several papers have reported relevance effects on the cognitive assessments of indicative conditionals, which pose an explanatory challenge to the Suppositional Theory of conditionals advanced by David Over, which is influential in the psychology of reasoning. Some of these results concern the "Equation" (P(if A, then C) = P(C|A)), others the de Finetti truth table, and yet others the uncertain and-to-inference task. The purpose of this chapter is to take a Birdseye view on the debate and investigate some of the open theoretical issues posed by the empirical results. Central among these is whether to count these effects as belonging to pragmatics or semantics.

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# 1. Introduction

The work of David Over has contributed to the immigration of the Suppositional Theory of conditionals from philosophy to the psychology of reasoning and to the effortless communication between the two disciplines within this subfield of psychology, more generally. According to the Suppositional Theory of conditionals, the word 'if' owes its distinctive character to its role in hypothetical thought by engaging the imagination to simulate possibilities (Evans and Over, 2004; Evans, 2007). For more than a decade of research, the Suppositional Theory of conditionals has become a widely accepted theory in the psychology of reasoning and has been gaining grounds over against the mental model theory, which remains a popular theory of other types of reasoning like spatial reasoning (Johnson-Laird, 2008).

The evidence for the Suppositional Theory encompasses three sources:

1) Direct investigations of the probability of indicative conditionals, which substantiate "the Equation" (P(if A, then C) = P(C|A)) (Oberauer and Wilhelm, 2003; Evans and Over, 2004).

2) The pattern of results known as "the defective truth table" effect, which corroborates the de Finetti truth table (Politzer, Over, and Baratgin, 2010; Baratgin, Over, and Politzer, 2013; Baratgin, Politzer, Over, and Takahashi, 2018), see Table 1.

3) Indirect evidence from the uncertain and-to-if inference task (Cruz, Baratgin, Oaksford, and Over, 2015).

Table 1. Truth Tables, Indicative Conditional

| A | C | ⊃ | De Finetti | Jeffrey |
|---|---|---|---|---|
| T | T | T | T | T |
| T | ⊥ | ⊥ | ⊥ | ⊥ |
| ⊥ | T | T | *void* | P(C\|A) |
| ⊥ | ⊥ | T | *void* | P(C\|A) |

In spite of all this support, the Suppositional Theory of conditionals has recently been challenged by a new-comer to the psychology of reasoning known as Inferentialism

(Spohn, 2013; Olsen, 2014; Douven, 2015; Krzyżanowska, 2015). Inferentialism holds that indicative conditionals express inferential relations, or reason relations. On the strong reading, Inferentialism makes reason relations part of the truth conditions of indicative conditionals ("Truth-Conditional Inferentialism", Douven, 2015; Krzyżanowska, 2015). In Skovgaard-Olsen, Singmann, and Klauer (2016a), a weaker probabilistic implementation of inferentialism was made through the Default and Penalty Hypothesis, which makes it part of the probability and acceptability assessment of indicative conditionals that participants evaluate whether a sufficient reason is expressed, which consequently makes missing-link conditionals, like the following, appear defective:

(1) If Niels Bohr read Kierkegaard, then Copenhell plays loud music.

Given that there is no obvious connection between biographical facts relating to Niels Bohr and facts about the Danish metal festival.


## 2. Data on Missing-Link Conditionals

In a series of experiments, my collaborators and I have reassessed each of these three sources of evidence for the Suppositional Theory of conditionals anew through the application of novel stimulus materials that factorially combine all permutations of prior probability and relevance levels of two conjoined sentences. The general idea behind these experiments was to test how robust the Suppositional Theory is under extreme conditions. To draw an analogy: for a researcher interested in examining rationality, it makes sense to study cases of irrationality to investigate the boundary conditions and limitations of human rationality. For a researcher interested in studying text comprehension, it is a valuable research strategy to study cases, where participants experience difficulties in deciphering the meaning of concatenated strings of words. Similarly, for researchers interested in studying relevance, and our use of conditionals to express reason relations, it is a sound research strategy to systematically investigate cases where relevance and reason relations break down.

In Skovgaard-Olsen, Singmann, and Klauer (2016a) it was found that the Equation (P(if A, then C) = P(C|A)) only holds under the condition of positive relevance (where $\Delta P > 0$, for $\Delta P = P(C|A) - P(C|\neg A)$). In the case of negative relevance ($\Delta P < 0$), or irrelevance ($\Delta P = 0$), like the Niels Bohr example above, the strong relationship between P(if A, then C) and P(C|A) is disrupted, because participants tend to view natural language indicative conditionals as defective under these conditions.[1] Moreover, it was shown that these results generalize to evaluations of acceptability, when participants are instructed to judge the adequacy of the information provided in the context of a conversation. In contrast, the Equation was found to fit the probability and acceptability evaluations of concessive conditionals ('Even if A, then still C') remarkably well across all relevance conditions. But this nevertheless poses a problem since the Equation was formulated as a thesis about indicative conditionals and not as a thesis concerning concessive conditionals.

In Skovgaard-Olsen, Singmann, and Klauer (2016b), it was found that the latter results generalize to the uncertain and-to-if inference task, where participants assign probabilities to conjunctions and conditionals in arguments, and that empirical support could be found for the explications of reason relations and epistemic relevance in terms of $\Delta P$ used in these studies. Indeed, the absolute values of participants' conformity to P(if A, then C) ≥ P(A,C), which is normatively prescribed by the Suppositional Theory, showed a drop from 87% in the positive relevance condition to 54% in the irrelevance condition. And this was a drop that was not reflected in either participants' conformity to P(C|A) ≥ P(A,C) or P(Even if A, then still C) ≥ P(A,C), which both stayed constant at around 78% across relevance conditions. This finding presents supporters of the Suppositional Theory with a dilemma. The finding appears to show that either participants are less probabilistically coherent than it initially appeared in Cruz *et al.* (2015) or that a substantial part of the participants do not follow the Equation across relevance levels. In Skovgaard-Olsen, Kellen, Hahn, and

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[1]    Some of these findings have been replicated by Vidal and Baratgin (2017) using different methods (but see Cruz, Over, Oaksford, and Baratgin, 2016 and the reply in Krzyzanowska, Collins, and Hahn, 2017).

Klauer (2019b), further individual variation in these results was investigated by classifying participants into opposing profiles of probability and entailment judgments based on their case judgments and reflective attitudes. Here again it was found that the majority part of the participants did not follow the Equation across relevance levels.

Finally, in Skovgaard-Olsen, Kellen, Krahl, and Klauer (2017), truth, acceptability, and probability evaluations of 'if then', 'and', 'but', and 'therefore' sentences were investigated under different relevance conditions. It was found that the de Finetti truth table could account for maximally a third of the participants, which was in line with the results of a recent meta-analysis (Schroyens, 2010). However, the results do not yet tell us whether revising the Suppositional Theory by the Jeffrey table, where the value 'void' is replaced by conditional probabilities in the false antecedent cells (see Table 1), provides a better fit to the data (Over and Baratgin, 2017).

A further finding of Skovgaard-Olsen *et al.* (2017) was that support could not be obtained for the distinctive predictions of Truth-Conditional Inferentialism, according to which indicative conditionals should be true only when the antecedent is a good reason for the consequent. Instead, participants responded that both conditionals with negative relevance (e.g. "if you hit the brakes, the car will speed up"), and missing-link conditionals like (1) above, are true when the antecedent and consequents are both true.[2] In this, the results indicate that there is a strong dissociation between the influence of relevance on assessments of acceptability and probability compared to truth evaluations, when investigating 'and', 'but', 'therefore', and 'if then' sentences. These results were interpreted by Skovgaard-Olsen *et al.* (2017) as showing that there is a deeply entrenched modularization between the processes and/or representations tapped into by the experimental tasks reported.

Taken together with the acceptability evaluations from Skovgaard-Olsen *et al.* (2016a), the results in Skovgaard-Olsen *et al.* (2017) indicate that indicative conditionals behave like 'therefore' sentences in their probability and acceptability

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[2]     But see also the apparent support for Truth-Conditional Inferentialism in Douven, Elqayam, Singmann, & van Wijnbergen-Huitink (2018) using a different type of task.

evaluations, and opposite to 'but' sentences, with respect to the relevance manipulation. Yet in relation to the truth evaluations, 'and', 'therefore', and 'but' sentences did not differ across relevance conditions, and no evidence for a relevance effect on the true antecedent cells of the truth table of the indicative conditional could be found. Moreover, the consistent high confidence ratings of the participants did not indicate that they were in a state of conflict, when assigning truth values to sentences that contradicited their reason-relation readings. However, for the ⊥⊥ cell, a moderate relevance effect was found on the truth evaluation of the indicative conditional.

These results present a puzzle. On the one hand, it is possible to interpret the reported dissociation between truth evaluations and probability/acceptability evaluations as indicating a dissociation between semantic and pragmatic processing of content—with relevance almost exclusively affecting the latter. However, on this interpretation it is still odd that the strong probabilistic relevance effects reviewed above could be found on experimental tasks, which have been used by supporters of the Suppositional Theory to provide evidence in favor of a semantic theory (Skovgaard-Olsen *et al.,* 2016a). On the other, it is possible that some other explanation for the dissociation in Skovgaard-Olsen *et al.* (2017) can be found based on subtle differences in the experimental tasks.

According to Tonhauser and Matthewson (2015), it is commonly assumed that an linguistic expression uttered at a context c is acceptable iff: (1) it is syntactically well-formed, (2) felicitous, and (3) its truth conditions are compatible with c. (1) is beyond dispute for missing-link conditionals. Hence, most of the energy has been focused on (2) and (3), with proponents of the Suppositional Theory of conditionals diagnosing missing-link conditionals as unacceptable because their felicity conditions are not satisfied (possibly due to the violation of a Gricean maxim), and Truth-Conditional Inferentialism holding that missing-link conditionals instantiate a case, where the truth conditions are not compatible with the context of use.

Since the boundary between semantics and pragmatics will feature centrally in the interpretation of the abovementioned empirical results, the rest of this chapter is

focused on outlining some of the open theoretical issues raised by the data on missing-link conditionals.

# 3. Semantic and Pragmatic Factors

In deciding whether the dissociation reported in Skovgaard-Olsen *et al.* (2017) has implications for whether relevance is to be counted as a semantic or pragmatic factor, the following questions merit further investigation:

(I)     What interpretation of 'truth' do participants have when providing truth evaluations?

The importance of (I) can be illustrated as follows. Suppose that participants make truth value assignments based on an understanding of 'truth' as 'what can be proven in principle independent of whether it has actually been proven'. In that case, the truth table for negation would no longer be truth-functional inasmuch as there would be propositions for which both a proposition and its negation would be 'False'. Moreover, for this understanding of truth, '∨' and '⊃' would no longer be truth-functional, since it can be shown that the truth functionality of '∨' and '⊃' depends on the truth functionality of negation (McCawley, 1993: 107ff).

Indeed, many other ways of interpreting the notion of truth exist. In the philosophical literature (Künne, 2005), *realistic conceptions of truth* (e.g. the correspondence theory of truth, "truth is what corresponds to the facts") are contrasted with *epistemic concepts of truth* (e.g. the coherence theory "truth is what belongs to a maximally coherent set of beliefs" or "truth is what all investigators would agree on at the limit of an ideal inquiry"), *pragmatic theories* ("truth is what works"), and with *deflationary theories* (e.g. "the predicate 'true' is merely a convenient device for disquotating sentences, or a device for forming pro-sentences, which allows us to endorse assertions that we would not be able to endorse otherwise (e.g. "the next thing Pete says is true", "Everything the Pope says is true")).

At present it is unknown which understanding of the notion of 'truth' participants bring to bear on the truth table task. It is unknown whether the different truth tables elicited by participants reflect different notions of truth or diverging interpretations of the conditional. And it is moreover unknown whether participants understand the notion of truth in the same way as the semantic theory they are being tested according to.

Interestingly, Oberauer *et al.* (2007) found that the same group of participants that tended to conform to the de Finetti table in a ternary truth table task tended to conform to the material implication (⊃) in a binary truth table task—although the two theories stand as diametrically opposite in the literature. It is thus possible that participants interpret the truth values differently in the two experimental paradigms.

Arguably, the truth table of the material implication sounds most plausible, if one interprets the truth value as indicating consistency.[3] Accordingly, the material implication treats the conditional as true in the false antecedent cells, because the falsity of the antecedent is *consistent* with the truth of the conditional. This might account for the fact that the material implication is useful in mathematical and logical contexts, where the goal is to keep inconsistency at bay. In line with this idea of the material implication as especially useful for mathematics and deductive logic, Rescher (2007: 43) points out that what makes the material implication appropriate for these contexts is the following link between implications and deducibility that it establishes for demonstratively true instances: $p \vdash q$ iff $\vdash p \supset q$.[4]

In contrast, the de Finetti truth table seems to be most plausible if 'true' is interpreted as 'verification' and 'falsity' is interpreted as 'disconfirmation'. In this context, it is interesting to observe that in some experiments cited in favor of the de Finetti truth table (like Evans *et al.,* 2007), the instructions explicitly ask for whether a truth table cell "conforms" to a conditional rule, "contradicts" it or "is irrelevant" to it, rather than for the truth or falsity of the conditional *simpliciter*.

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[3]    I thank Christoph Klauer (p. c.) for discussion.

[4]    However, as Rescher (2007: 44) points out, a *demonstrated* true material implication in mathematics and deductive logic is in fact a strict implication, $\Box(p \supset q)$.

Usually, issues pertaining to competing notions of truth are not even discussed in the psychological literature. Elqayam's (2003) insightful discussion of the impact of conflicting notions of truth on the knights-knave paradigm is an exception. Another exception is the emphasis on so-called pleonastic or pragmatic uses of truth in which the notion is merely a convenient way of expressing endorsement of, or agreement with, a sentence (Edgington, 2003; Over, Hadjichristidis, Evans, Handley, & Sloma, 2007). On this notion, the truth predicate may be applied even to expressions of subjective taste without indicating an ontic commitment concerning corresponding facts (Politzer *et al.*, 2010).

(II) What is the relationship between (a) the semantic values invoked by a given semantic theory and (b) what the participants are evaluating in a given experimental paradigm?

Semantic values are theoretical entities that are introduced primarily to serve the explanatory roles of accounting for compositionality and entailments. The semantic values invoked by some semantic theories have very little to do with our intuitive judgments on truth and falsity. For instance, semantics for the indicative conditional and other connate epistemic expressions exist, which pose constraints on probability distributions as semantic values (e.g. Yalcin, 2012; Moss, 2015). Yet constraints on probability distributions do not themselves impose truth conditions that can be interpreted as representing ways that the world can be. For instance, even the constraint that $P(A) = 1.0$ means that A is *certain* according to the doxastic state represented by P, rather than that A is an independent fact about the world.

Moreover, as Dever (2006) explains, Fregean truth-conditional semantics has been generalized in a number of ways which render the relationship between semantic values and truth *simpliciter* less direct. In intensional possible-worlds semantics, truth conditions are specified in terms of truth-at-a-world to account for non-truth-functional operators such as modalities (and conditionals, on some views). In two-dimensional semantics, like Kaplan's (1989) semantics of indexicals, truth is indexed both to a context and to a world-time pair, which means that both the

semantic content of an expression and its truth value can vary with different contexts of use. In MacFarlane (2014) and Lasersohn (2017), this idea is generalized to relativize truth conditions of subjective content like taste judgments to both a context of use and a context of assessment. In dynamic semantics still other semantic values are invoked. In dynamic semantics it is typically the context-change potential of linguistic expressions to modify an information state that is emphasized rather than their ability to represent how the world is, and discourses as a whole are treated as having truth conditions rather than individual sentences (Rotschild and Yalcin, 2016).

Moreover, recent developments in metasemantics make sharp distinctions between the explanatory role of *(intentional) content*, as the notion figures in mental causation and folk-psychological explanations of behavior, and *semantic values*, as the theoretical entities needed to account for our linguistic competence relating to various facts about compositionality, entailment, and truth values etc. (Yalcin, 2014, 2018).

In addition to these developments in what kind of theoretical entity can play the role of semantic values in formal semantics, there is the added complexity in interpreting truth table data that there is some precedence in the linguistic literature for not taking intuitive judgments of truth and falsity at face value.

For instance, von Fintel (2004) and Abrusán and Szendrői (2013) have argued that intuitive judgments on presupposition failures[5] as true or false are influenced by pragmatic factors such as the possibility of verification and need not represent the sentences' actual semantic values. Instead, it is argued that it is more decisive whether the semantic values assigned would allow us to construct a systematic theory of the compositional behavior of the linguistic expressions in question. Accordingly, in Winter (2016: 20), it is made an empirical adequacy condition of theories in formal semantics that they agree with intuitive *entailment* judgments rather than with intuitive truth judgments. This suggests that the tendency in the psychology of reasoning to focus on the truth table task as decisive evidence for or against a semantic theory may turn out to be problematic.

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[5] E.g. 'the Danish Pope is in his midsixties' carries the false presupposition that there is a Danish Pope.

In Tonhauser and Matthewson (2015) an attempt is made to rank different types of tasks based on the extent to which they lead to robust, replicable, and transparent pieces of data. Their tentative rank order looks as follows:

$$\text{Translation} < \left\{ \begin{array}{c} \text{Paraphrase} \\ \text{entailment judgment} \\ \text{ambiguity judgment} \end{array} \right\} < \text{truth value judgment} <^? \left\{ \begin{array}{c} \text{acceptability judgments} \\ \text{implication judgments} \\ \text{similarity judgments} \end{array} \right\}$$

As they point out, one problem with truth value judgments is that untrained participants may find it difficult to properly distinguish the truth conditions of a sentence from its felicity conditions and conversational implicatures. Thus a 'False' response by an untrained participant is argued to be ambiguous between whether the sentence is interpreted as infelicitous, pragmatically odd (due to a conversational implicature) or literally false.[6]

Interestingly, Tonhauser and Matthewson (2015) are even less optimistic about entailment judgments, because they suspect that these cannot be performed reliably without linguistic training. It is also found problematic that entailment judgments are less immediate and require antecedent linguistic analysis on the part of participants and that they are to be performed without regard to the context of use. Yet, as Tonhauser and Matthewson also note, some of these problems may be circumvented by asking for judgments of contradictions for negations of entailments, since inconsistency judgments seem to be more immediate. In Skovgaard-Olsen (2019), a novel dialogical entailment task probing participants' acceptance of entailments was introduced based on this idea to avoid previously identified pitfalls in the measurement of participants' entailment judgments (Evans, 2002).

In contrast, Tonhauser and Matthewson (2015) show a preference for acceptability, implication and similarity judgments, because they rely on rich contexts and do not presuppose prior linguistic training. However, one problem with this stance

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[6]     Note that this will not help explain the results in Skovgaard-Olsen *et al.* (2017) for Truth-Conditional Inferentialism, however. The problem there was not so much the occurrence of 'False' responses by participants, but rather the lack of 'False' (or: 'Neither nor') responses in the true antecedent cells for the negative relevance and irrelevance conditions.

is, of course, that it becomes hard to dissociate the semantic content from the pragmatically enriched meaning.

(III)   To avoid a free-license in invoking pragmatics as an explanation of divergences from the semantic theory (such as the divergences from the Suppositional Theory reported in Section 2), mechanisms that give rise to the pragmatic phenomena need to be posited, which give rise to predictions that can be tested independently.

In commenting on the findings from Skovgaard-Olsen *et al.* (2016a), Over and Cruz (2017) suggest that the effect might be pragmatic and not semantic, because there is some evidence that relevance also affects conjunctions and disjunctions. The implicit assumption is that if relevance is supposed to be part of the semantic content of indicative conditionals, then it should serve to distinguish the content of indicative conditionals from the semantic content of other connectives.

In Skovgaard-Olsen *et al.* (2017), disjunctions were not investigated. But the results on the probability assignments to conjunctions indicate that while the probability assignments are somewhat higher for the positive relevance condition ($\Delta P > 0$), there is no evidence for an analogous defect to the one reported in Skovgaard-Olsen *et al.* (2016a), which would make participants assign low probabilities to 'A & C' in the irrelevance ($\Delta P = 0$) and negative relevance conditions ($\Delta P < 0$). Skovgaard-Olsen, Collins, Krzyżanowska, Hahn, and Klauer (2019a) also find that while reason-relation readings of conjunctions can be attributed to conversational implicatures based on the results of a cancellation task, the same account does not apply to conditionals.

Moreover, based on Table 2 below, the conjecture could be made that disjunctions are most probable for negative relevance items. This is especially pronounced for the 'either… or…' formulation, which can be read as exclusive disjunction. But even for a reading of '… or …' based on inclusive disjunctions, the negative relevance formulations that present the two disjuncts as alternatives seem to be more probable than the positive relevance formulations (see Table 2). At any rate,

disjunctions do not seem to exhibit the negative relevance defect that was documented for indicative conditionals in Skovgaard-Olsen *et al.* (2016a). If so, then disjunctions have a distinct relevance profile from indicative conditionals.[7]

Table 2. Stimulus Materials, Mark Scenario illustrated with Disjunctions

**Scenario**: Mark has just arrived home from work and there will shortly be a great movie on television to which he has been looking forward. Mark is quite excited because he recently bought a new TV with a large screen. He has a longing for popcorn, but his wife has probably eaten the last they had while he was gone.

|    | Positive Relevance | Negative Relevance | Irrelevance |
|----|---|---|---|
| HH | (Either) Mark presses the on switch on his TV OR his TV will be turned on | (Either) Mark lacks an appointment with the repairman OR his TV will work. | (Either) Mark is wearing socks OR his TV will work. |
| HL | (Either) Mark looks for popcorn OR he will be having popcorn. | (Either) Mark presses the on switch on his TV OR his TV will be turned off. | (Either) Mark is wearing socks OR his TV will malfunction. |
| LH | (Either) the sales clerk in the local supermarket presses the on switch on Mark's TV OR his TV will be turned on. | (Either) Mark pulls the plug on his TV OR his TV will be turned on. | (Either) Mark is wearing a dress OR his TV will work. |
| LL | (Either) Mark pulls the plug on his TV OR his TV will be turned off. | (Either) Mark refuses to look for popcorn OR he will be having popcorn. | (Either) Mark is wearing a dress OR his TV will malfunction. |

*Note*. 'HH': P(A) = high, P(C) = high. 'HL': P(A) = high, P(C) = low, etc. Skovgaard-Olsen *et al.* (2016b).

But irrespective of how this empirical issue is resolved, **(III)** still suggests that if the Relevance Effect reported in Skovgaard-Olsen *et al.* (2016a) on the probability ratings of indicative conditionals is to be declared a pragmatic effect, we need to require that a suitable mechanism be specified which will lead to new predictions.

Since Grice (1989) has a maxim of relevance, which Grice never elucidated further than "Be relevant!", it is tempting to invoke it to account for relevance effects on indicative conditionals. However, it should be noted that relevance can be assessed at different levels and that whereas Grice's maxim concerns the contribution of complete speech acts to a conversational context, the epistemic notion of relevance used in Skovgaard-Olsen *et al.* (2016a, b) concerned the internal relationship between

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[7] One might object to this by taking the meaning of disjunctions to be characterized by or-introduction, which holds that a disjunction may be introduced in a proof whenever one of the disjuncts is true. In response, it could be argued that negative relevance is a conventional implicature of disjunctions which does not affect their truth-conditional content. Finally, that there should be a relationship between negative relevance and disjunctions is already suggested by the fact that there are acceptable instances of inferences from 'A or C' to 'if non-A, then C' (Skovgaard-Olsen, 2016).

two components in a sentence. That these evaluations of relevance can come apart is nicely illustrated by the example 'If it snows in July, the Government will fall' introduced in Douven (2015). The point is that although this conditional violates the expectation that the antecedent is positively relevant for the consequent, there may nevertheless be a rhetorical point in making this assertion, which makes the assertion relevant as a speech act in the conversation. More specifically, the speaker may be interpreted as making the rhetorical point that it is so obvious that the consequent will hold no matter what happens (and thus even under such absurd circumstances as it snowing in July). In Douven (2017) an argument is moreover made that the other Gricean maxims of informative and non-misleading conversation do not put us in a better position to account for the influence of relevance on our assessments of indicative conditionals. Finally, when examining whether the reason-relation reading is cancellable without contradiction, Skovgaard-Olsen *et al*. (2019a) could not find evidence of this general property of conversational implicatures for indicative conditionals.

Alternatively, other roles that have been assigned to pragmatics could be considered. As an example, Carston (2002) argues at some length that the semantic content of sentences in itself only suffices to provide a schema for a proposition and that processes of pragmatic interpretation apply even before a truth-conditional content has been determined (by resolving reference assignments, ambiguities etc.). However, given that relevance was found only to moderately affect the truth evaluations of indicative conditionals in the ⊥⊥ cell in Skovgaard-Olsen *et al.* (2017), it is unlikely that relevance assessments is a factor that enters directly into determining the propositional content of conditionals.

At this stage, further experiments are needed to determine whether support can be found for other pragmatic accounts or whether relevance is part of the probabilistic, semantic content of indicative conditionals. In Skovgaard-Olsen *et al.* (2019a) a range of experiments of this kind are reported, but much remains to be done.

# Argument for Semantic Defect

In Skovgaard-Olsen (2016) arguments were presented for counting relevance part of the semantic content of indicative conditionals. Here I would like to focus on a particular argument. The argument focuses on the cognitive utility of the linguistically encoded content of normal conditionals and points out that missing-link conditionals are semantically defective, because they have a literal content that prevents them from fulfilling this cognitive role. In stating the argument, it was pointed out that the defect of missing-link conditionals could not be limited to violations of Gricean norms, because Gricean norms pertain to conversational contexts, and missing-link conditionals are prevented from fulfilling the cognitive role of normal conditionals even in individual reasoning. In particular, it was pointed out that the appeal to indicative conditionals as "inference tickets" that give interlocutors the right to infer the consequent from the antecedent is blocked for missing-link conditionals both in conversational contexts and in individual reasoning.

Here I would like to extend this argument by pointing to further aspects of the cognitive role of conditionals in individual reasoning which are blocked for missing-link conditionals, because they require conditionals to express reason relations. Now functional arguments that posit that the core, semantic meaning of a class of expressions is determined by its distinctive cognitive role may not be the primary focus for the type of linguistically motivated, formal semantics advocated in Yalcin (2014, 2018). But functional considerations are of central concern for semantic theories advanced in psychology (in particular in the psychology of reasoning), and thus for the integration of formal semantics with psychology in cognitive science.

As explained above, according to the Suppositional Theory of conditionals, the word 'if' is to be understood through its role in hypothetical thought of initiating imagination and simulation of possibilities (Evans and Over, 2004; Evans, 2007). This type of mental simulation is thought to play a central role in entertaining hypotheses, forecasting future events, and supporting decision-making by imagining the

consequences of alternative courses of action (Evans, Handley, Neilens, and Over, 2007). All of these mental processes are without doubt central to human thought.

A further central role of conditional reasoning is in argumentation, where reason relations can be expressed by means of conditionals, which are often compared to 'condensed arguments' (Rescher, 2007; Krzyżanowska, 2015).

Now when Inferentialism puts the emphasis on conditionals' role in expressing reason relations is it then committed to denying the central role of conditionals in hypothetical thought as emphasized by the Suppositional Theory? No, because missing-link conditionals are just as useless in explanatory reasoning, forecasting, and decision-making as they are in argumentation. When considering alternative explanatory hypotheses, predicting the future, and computing consequences of alternative courses of action, the agent needs to make assessments of which propositions are probability raising, or probability lowering, for other propositions. Because hypothetical thought is unbounded in that it can transcend the here-and-now and consider even remote possibilities (of which there are an infinite number), propositions that do not make a probabilistic difference to the propositions of interest need to be set aside as irrelevant. It is a sign of rationality in hypothetical thought that probabilistic dependencies are respected even if the basis of the reflection may depart from the actual course of events.

This point should be evident. But to illustrate, suppose the color of the socks of Stalin stood in the center of explanatory reasoning aimed at resolving why Operation Barbarossa turned out to be an utter failure, that the color of the socks of Angela Merkel was used to predict the outlines of the next European treaty, or that the prime minister of a European country used the color of the socks of other European leaders to calculate the consequences of alternative courses of actions guiding his/her decision-making. The thought is so absurd that it is hard even to entertain.[8]

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[8]    It is, of course, possible to restore sense in such examples by creating elaborate scenarios, where factors that initially appear irrelevant turn out to be relevant after all. But what this shows is that probabilistic dependence is so important to us that we invest cognitive effort into restoring it.

This illustrates that the mental processes of suppositional reasoning are only useful as long as only hypotheses are considered that preserve probabilistic dependencies. In the Default and Penalty Hypothesis the conditional probability is per default computed in the positive relevance condition as a way of assessing the sufficiency of the reason relation (Skovgaard-Olsen *et al.*, 2016a). As long as only probability raising scenarios are considered, the Ramsey test is an effective mental algorithm for engaging in hypothetical thought. However, if there are no constraints on which hypotheses the Ramsey test is applied to, then it will not in itself help us explain past events, predict the future, or decide among alternative courses of action.

In Rescher's (2007: 75) words: "conditionals effectively summarize the result of hypothetical inferences". And in making hypothetical inferences we are, of course, constrained by probabilistic dependencies that govern all other types of thought.

However, even if such reflections suggest that irrelevance is a semantic defect of conditionals, because irrelevance prevents conditionals from playing the cognitive role in individual reasoning and conversational contexts, which pertains to the core meaning of these constructions, the jury is still out on empirically determining its precise nature. In Skovgaard-Olsen (2016), it was tentatively suggested that epistemic relevance could be thought of as part of the sense-dimension of meaning characterizing its cognitive role.[9] In Skovgaard-Olsen *et al.* (2017), a stark dissociation between the effect of relevance on probability and truth evaluations of indicative conditionals is reported. Since presuppositions and conventional implicatures are distinguished by whether there is a dependence on their failure for the truth conditions of the sentences in which they occur (Potts, 2007, 2015), the arrow currently points in the direction of conventional implicatures. This conjecture receives further support by the results in Skovgaard-Olsen *et al.* (2019a), where evidence against both a conversational implicature hypothesis and a presuppositional account of relevance effects is reported. If the reason-relation reading of conditionals is generated by a conventional implicature, then it would have to be part of a secondary

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[9]　But it would have to be on an expanded notion of sense (*Sinn*), whereby it did not play a role in determining reference (*Bedeutung*), as in Frege (1892).

layer of meaning that is lexically encoded as part of the default meaning of natural language conditionals, which potentially coexists with a further layer (like the one posited by the Suppositional Theory of conditionals). However, the data pattern that emerges is complex and may introduce a need for revision of the notion of conventional implicatures with regard to their status of being not at-issue content, as Skovgaard-Olsen *et al*. (2019a) further argue.

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