Symmetry and Incrementality in Conditionals

Florian Schwarz

Abstract A central debate in presupposition theory concerns the nature of presuppositions introduced by triggers in conditional sentences. While it is commonly assumed that triggers in the consequent of conditionals give rise (or at least can give rise) to conditional inferences, most traditional accounts assume that triggers in antecedents introduce a non-conditional presupposition. This view has been challenged by recent modular accounts, which argue that the basic projection pattern involves conditional inferences across the board, but that non-conditional inferences can come about due to a processing bias towards incrementality. This paper presents experimental results that further assess the availability of conditional presuppositions for conditional sentences containing a trigger in their antecedent. The study uses the covered box paradigm and manipulate the truth and falsity as well as the status of the presupposition in the visual contexts, as well as the order of the antecedent and the consequent in the linguistic materials. The results are in line with symmetric account, but are challenging for classic dynamic accounts. However, a recast version of the latter that ties together linear order and incremental context update would make it possible to understand the present results as a result of incrementality alone.

1 Introduction

One of the key properties of presuppositions is that they remain unaffected by various embedding operators, i.e., some of their embedded occurrences make contributions at the global level where other types of content would only have an effect at a level local relative to the embedding operator (Karttunen, 1973). Conditional sentences constitute a core case where this phenomenon, commonly labelled *pre-*

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supposition projection, occurs. Beyond the mere observation that presuppositions project out of conditionals, there are additional issues concerning the exact nature of the projected content. In particular, theories differ with regards to whether they take the presupposition itself to be conditional or not. Recent experimental work by Chemla and Schlenker (2012) argues for uniformly conditional presuppositions, which they see as supporting a symmetric account of presupposition projection, couched in a modular approach that integrates an additional incremental component based on left-to-right processing to account for the (limited, according to their evidence) presence of asymmetry.

The present paper reports new experimental work investigating the nature of presuppositions in conditionals further, using a different methodology and extending the range of cases looked at to conditionals with a final (as opposed to initial) *if*-clause. I begin by reviewing the basic theoretical issues and the details of the experimental work by Chemla and Schlenker (2012). Next I introduce the experimental paradigm used here and the design of the experiments. Taken together, the results provide further evidence for a symmetric view, while also showing that the effects of the incremental processing component are rather strong. An additional aspect of the results is a surprising difference between *if*-initial and *if*-final conditionals, which I suggest is due to a variation in strength of conditional perfection inferences, i.e., inferences that strengthen conditionals to bi-conditionals. Beyond the theoretical implications of the results, the paper also makes a methodological contribution by demonstrating the viability of a picture matching task including a covered box (Huang et al., 2013; Romoli et al., 2011) for the phenomena at hand.

1.1 Theoretical Background

As a detailed introduction to an analysis of presuppositions and their projection behavior goes beyond the scope of the present paper, my presentation of the basic facts will be tailored towards the expressions and constructions at play in the experiment below. (For a recent survey of the state of the art, see Beaver and Geurts, 2012, among many others).

The presupposition trigger *again* introduces, roughly speaking, a presupposition that an event of the sort characterized by the clause that *again* adjoins to has already occurred on a previous occasion, which may need to be sufficiently salient (or at least accessible) in the discourse context. For example, *again* in (1a) introduces the presupposition in (1b).

(1) a. John went to the movies again on Thursday.
    b. There is a (sufficiently salient) occasion prior to Thursday where John went to the movies.

As is characteristic of presuppositions, this part of the overall conveyed meaning of (1a) remains constant when the relevant clause is embedded under various operators:

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(2) a. It is not true that John went to the movies again on Thursday.
b. Did John go to the movies again on Thursday?
c. If John went to the movies again on Thursday, he went to a concert on Friday.

Note that the asserted content of the clause - that John went to the movies on Thursday - is no longer conveyed by any of these examples, in contrast with the presupposition, which is. Homing in on the case of conditionals, the construction of central concern to us, there is disagreement in the literature, however, as to what exactly is presupposed. In introducing this debate, it is helpful to first step back and consider cases where a presupposition trigger occurs in the consequent of a conditional:

(3) a. If John had company this week, he went to the movies again on Thursday.
b. If John went to the movies last weekend, he went to the movies again on Thursday

Notably, these sentences seem to differ in terms of their presuppositions, as only the first version presupposes a previous trip of John's to the movies. This difference is standardly attributed to the fact that only the latter explicitly introduces information in the antecedent that supports the presupposition of the consequent. One common approach to accounting for this, starting with early work by Karttunen (1974) and Stalnaker (1974), and later developed into dynamic theories of semantics (Heim, 1983, and following work), is to assume that presuppositions (and clauses more generally) are evaluated relative to the preceding context, which includes earlier parts of complex sentences. The explanation, in a nutshell, for the absence of the presupposition in (3b) is that the consequent (including its presupposition) is interpreted relative to a context that already has incorporated the antecedent. If the presupposition of the consequent follows from the antecedent, then the sentence as a whole therefore has no (substantive) presupposition. Another way of characterizing this line of analysis is that presupposition triggers in the consequent of a conditional give rise to conditional presuppositions (i.e., *if p then* $\underline{q}q'$, with a presupposition q, gives rise to the presupposition *if p then q*).

For cases such as (3a), these analyses predict a conditional presupposition as well, which may undergo some form of strengthening to account for the perceived unconditional presupposition. Note that this treatment has been subject to extensive debates in the literature, typically discussed under the label of the 'proviso problem' (see, e.g., Geurts, 1999; Beaver, 2001; Schlenker, 2008, 2009). We will put this debate aside, as our main focus is on presupposition triggers in the antecedent of conditionals, to which we turn now.[1]

Given the dynamic view just sketched, there is a crucial difference between conditionals (in canonical order) with presuppositions in the consequent and those in

[1] For recent experimental work on this issue, see Romoli et al. (2011), whose experimental evidence is argued to support a conditional presupposition.

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the antecedent. The latter have no preceding clauses within the same sentence, and their presupposition should thus be evaluated unconditionally relative to the discourse sentence in place prior to the overall conditional sentence. In particular, as noted above,

(2c) If John went to the movies again on Thursday, he went to a concert on Friday.

introduces the non-conditional presupposition that John had gone to the movies prior to Thursday. Intuitively, this seems to be the correct result (at least at first sight; see below for more detailed considerations), and therefore, the asymmetric perspective on presupposition triggers in the consequent and antecedent of conditionals has often been considered part of the success story of a dynamic view on presupposition projection.

However, recent years have seen a flurry of renewed theoretical interest in presuppositions, which has given rise to work questioning some basic tenets of (broadly speaking) dynamic accounts. One major challenge is based on the insight that there is a lack of explanatory adequacy, as the properties of the lexical entries of connectives utilized by dynamic semantics that are crucial in accounting for presupposition projection by no means follow from the basic setup of the theory. In other words, variants of the dynamic entries for connectives can be construed which predict unobserved projection behavior. Of particular interest to us in the body of work that has emerged from this observation is that various authors have challenged the notion that incrementality should indeed be hard-wired into the definitions of connectives, as is done on a Heim-style proposal.

In addition to the problem of explanatory adequacy, there has been substantial disagreement over the years about how exactly incrementality should be implemented for various operators and connectives. For disjunction, for example, several possibilities have been argued for. Beaver (2001), for example, proposes a non-conditional presupposition for triggers introduced in the first disjunct and a conditional one for triggers introduced in the second. In contrast, Geurts (1999) argues that triggers introduced on either side of *or* yield non-conditional presuppositions for the overall sentence.

One line of response to these issues has been to posit what is sometimes called a modular approach to presuppositions. The basic idea is that while incrementality has an obvious role to play in presupposition projection, it is not a hard-wired constraint that cannot be overcome, but rather a processing bias. In a nutshell, presuppositions prefer to be supported by information present in the context prior to them being expressed, but if support is introduced later, that is better than if there is no support at all. As far as projection is determined by the semantics of the various connectives, then, we end up with a symmetric account. Any asymmetry is introduced by the processing bias, which can be overcome at a cost.

To make this picture somewhat more concrete, let me briefly recapitulate Chemla and Schlenker's (2012) characterization of such a modular account. Following Fox (2008), they assume a supervaluationist framework, where the requirement for presuppositional acceptability is that a given sentence receive a classical truth value

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(true or false; as opposed to #) in every possible world (in the context). Specifically, for conditionals this line of thought goes as follows (assuming a material implication analysis for convenience): if evaluating a case with a presupposition trigger in the consequent and looking at a world where the presupposition is not met and in which the antecedent is true, we cannot determine whether the overall sentence is true or false, because of the undetermined truth value of the consequent (A true antecedent combined with a false consequent would make the conditional false, whereas with a true consequent, it would be true). If looking at a world where the presupposition is not met and the antecedent is false, however, the truth of the entire sentence is independent of the truth-value of the consequent, since any conditional with a false antecedent is true (on a material implication analysis). This yields the equivalent of the conditional presupposition posited by dynamic semantic accounts, namely that *if p, then* $\underline{q}q'$ (with *q* as a presupposition of the consequent) presupposes *if p, then q*. For presupposition triggers in the antecedent, we derive a conditional presupposition as well, however, in contrast with dynamic approaches. The reasoning is similar: if evaluating such a conditional in a world where the consequent is true, then the truth value of the antecedent doesn't matter - whether it's true or false, the entire conditional is true. But when the consequent is false, the truth-value of the antecedent is crucial, and if it cannot be determined due to its presupposition not being met, the truth-value of the entire conditional cannot be determined either (if the antecedent is true and the consequent is false, the entire conditional is false, but if the antecedent is false, the entire conditional is true). Thus, the type of alternative account we're considering predicts that *if* $\underline{p}p'$*, then q* presupposes that *if not q, p*. We thus end up with conditional presuppositions for both conditionals with a presupposition trigger in the consequent as well as ones with a trigger in the antecedent. Summing up the crucial contrast between dynamic and symmetric account schematically, we have the following predictions for the presuppositions of a sentence with a presupposition trigger in the antecedent:

(4) Sentence Type: If $\underline{p}p'$, q (with presupposition p of the antecedent)

Presupposition predicted by

a. dynamic account: p
b. modular account: if not q, p

As already mentioned, this is not the full story on the modular account, however. There is no denying that incrementality plays a role for presupposition evaluation. But rather than hard-coding it in the definition of connectives, a modular account can simply assume that incrementality arises as a processing bias. It sure is easier, the story goes, to have a presupposition supported in the preceding context, but if all else fails, support that's introduced later is better than no support at all. Dynamic accounts, which have a strict incremental component cannot allow for such later support (but see discussion for possible reconsiderations in this regard). For modular accounts, some processing cost is expected for such cases, but they are not ruled out categorically. Chemla and Schlenker (2012) present experimental results that they

argue favor the violable view of incrementality that modular accounts afford. I turn to a discussion of their results and their interpretation in the following section.

1.2 Experimental Background

The seminal work by Chemla and Schlenker (2012) constituted a first attempt at getting experimental data to bear on the question of which of the two types of theories outlined above is more appropriate empirically. In addition to conditionals, they also considered disjunctions and sentences with *unless*. Their presupposition trigger of choice is *too* (or rather, it's french counterpart, *aussi*), and they lay out both a carefully worked out theoretical analysis of *too* and a host of cautious choices in the exact construction of their stimuli. For reasons of space, I have to refer the reader to their paper for further details, and will simply present the conditional versions of the sentences they investigated:

(5) a. ***too* in consequent**
If Anne decides to study abroad, her brother too will make a stupid decision.
(*literally:* . . . her brother will-make him too a decision stupid)

b. ***too* in antecedent**
If Anne's brother too does not make a reasonable decision, Anne will not decide to study abroad.
(*literally:* If the brother of Anne NE make not him too a decision reasonable, . . .)[2]

Their design is set up to compare presupposition triggers in the antecedent to ones in the consequent. To prevent any differences in asserted content from coming into play, one of the sentences is the contraposition of the other (*if p, q* is logically equivalent to *if not q, not p*). Based on the reasoning laid out above, both dynamic and modular accounts predict a conditional presupposition for (5a), namely *if Anne decides to study abroad, Anne will make a stupid decision.*[3] However, for (5b), the predictions come apart: a dynamic account predicts a non-conditional presupposition (that Anne will make a reasonable decision), whereas a modular account predicts a conditional one (that if Anne decides to study abroad, she will be making a reasonable decision).

In the main part of their study, they asked subjects to rate the robustness of paraphrases of these conditional and unconditional inferences based on the presupposition. For (5), the inferences were as follows:

[2] Recall that the actual experimental materials were in French, so any awkwardness of the English wording here should not be of any concern.

[3] This is under the assumption that *too* requires an antecedent of some sort, and that the link between the distinct predicates in the two clauses can be pragmatically inferred.

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(6) a. Unconditional inference:
Ann will make a reasonable/stupid decision.

b. Conditional inference:
Studying abroad would be reasonable/stupid of Anne.

These inference correspond to the question of whether the presupposition trigger in the one clause is seen as being supported by the other. Note that both the use of a paraphrased version of the conditional presupposition and the fact that the predicates in the two clauses are not identical ensures that there is no entailment relationship between the two inferences.

The results that Chemla and Schlenker (2012) report for the inference task seem to align rather well with the modular, symmetric account. For both versions of the conditionals (and also for the other conditions involving disjunctions in varying orders), subjects judged the conditional inference as more robust then the the unconditional one. This is unexpected for a dynamic account, as the second clause (5b) should not be able to play any role in supporting the presupposition in the first.

While much more could be said about the details of the experimental task and the materials utilized by Chemla and Schlenker (2012), two things are clear: first, the results constitute an impressive first instance of experimental support for a symmetric theory of presupposition projection, in contrast with the traditional role assumed for incrementality. But secondly, given the theoretical significance of the matter and the complexity of the issues and judgments involved, further experimental exploration of the general issue is warranted. In the following, I report two experiments that aim at further illuminating the extent to which conditional presuppositions are indeed what we are dealing with in conditionals containing a presupposition trigger in the antecedent.

2 Experiments on *Again* in Conditionals

While our approach also utilized an inferencing task, we aimed to test the relevance of the truth or falsity of the consequent of the conditional more directly. To do so, we employed visual contexts that allowed to control for precisely this. The overall task was a picture matching task, specifically one using the covered box paradigm. This paradigm has proven extremely useful for investigating subtle aspects of meaning (Huang et al., 2013; Romoli et al., 2011; Schwarz and Romoli, submitted), as it allows designs where subjects have to decide whether a given picture is compatible with any remotely possible interpretation of a sentence.

In the task we used for the present studies, participants were told that they have to identify suspects based on random bits of intercepted communication that provide limited information about the suspect's activities in the past week. They were shown three pictures, one of them 'covered', and told that they were to match the sentence they saw with a picture. The instructions explicitly stated that only one of the three pictures could be a match, so that they only should choose the covered box if they

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considered neither one of the overt pictures a match for the sentence. The crucial (overt) picture will be referred to as the 'target' below. The other overt picture was a distractor that never was compatible with the asserted content (in particular, it constituted a case where the antecedent of the conditional would be true and the consequent false). Thus, we were interested in the extent to which subjects resorted to choosing the covered box over the target picture.

The literal, truth-conditional content of the antecedent of the conditional always was false of the target picture. Assuming a material implication analysis, this means that the entire conditional was always true of it, at least as far as it's literal, truth-conditional meaning was concerned. We included the presupposition trigger *again* in the antecedent of the conditional, and varied whether the presupposition was met or not in the target picture. Therefore, whether or not subjects choose the target picture as a match will only hinge on whether they see it as compatible with the presupposition(s) introduced by the sentence. The truth and falsity of the consequent was also varied across experimental conditions, as we were interested in the impact of this factor on the sentence's presuppositionality.

Given the difference between symmetric and dynamic accounts discussed above, we get distinct predictions for the case where the consequent is false. In particular, a dynamic account predicts that the presupposition of the antecedent should be globally present independently from the truth or falsity of the consequent. Symmetric approaches, on the other hand, take the overall presupposition to be a conditional one, of the form *if not q, p* (based on the conditional *if* pp'*, q*). This predicts that it should only matter whether the target is consistent with $\overline{p}$ if the consequent is false. When it is true, it should not matter whether the target matches p or not.

In addition to looking at conditionals in canonical order (*if . . . , [consequent]*), we also looked at the reverse order (*[consequent], if . . .*). This allows for a more direct investigation of the role of incrementality. The symmetric account of Chemla and Schlenker (2012) does not deny that incrementality plays a role in presupposition projection. However it sees it as a mere processing constraint that can be violated. In conditionals in canonical order, they would plausibly still predict a difference between cases where the presupposition is met and ones where it is not, even if the consequent is true, since the truth of the consequent only enters the picture late in the game, as it were - in particular, after the presupposition in the antecedent has been processed. Conditionals in reverse order remove this processing obstacle, as the truth of the consequent is fully established prior to encountering the presupposition trigger. Note that this manipulation is different from the one used by Chemla and Schlenker, who employed contrapositions to vary whether the presupposition trigger appeared in the first or second clause. Their conditionals were always *if*-initial and varied whether the presupposition trigger appeared in the antecedent or the consequent, while we focus on cases with a trigger in the antecedent and vary whether the *if*-clause comes first or last.

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2.1 Materials & Design

Turning to the specific nature of our materials, we used figures of people together with a small calendar strip that included iconic representations of activities, destinations, and food items, which were explained to stand for the relevant activities (e.g., trips to, or consumption of, in the cases of destinations and food items) taking place on that day. Illustrations of the images used are provided in Figure 1. The sentence in (7a) illustrates the corresponding sentence in the canonical order, and (7b) the reversed variant.

(7) a. If John ate a banana again on Wednesday, he ate a strawberry on Friday.
b. John ate a strawberry on Friday, if he ate a banana again on Wednesday.
c. **Presuppositions:**
i. ↪ John ate a banana before Wednesday.
ii. ↪ If John didn't eat a strawberry on Friday, then he ate a banana before Wednesday.

On both types of accounts that we are considering here, the basic presupposition should be the same regardless of the order of sentences. For dynamic semantics, the dynamic update formula that gives rise to presupposition projection presumably should not be altered based on order.[4] On a symmetric account, order of course also does not affect the basic logical structure of the sentence, based on which the prediction about what conditionals on the whole presuppose remains constant. However, given the role of incrementality, there is room for acknowledging a difference, which will come into play specifically when a consequent in the initial clause position is true. In that case, any presuppositions in the antecedent can be ignored, and

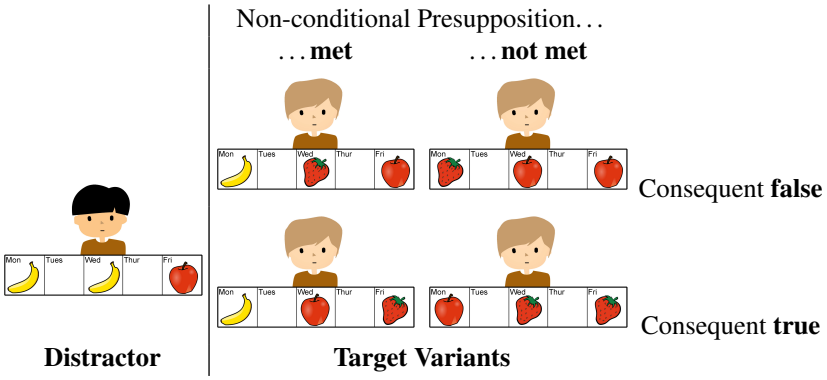

Fig. 1 Illustration of distractor and target pictures by condition (relative to the sentence in (7).

[4] In fact, as Schlenker (2010) notes (in footnote 6, pp. 388-389), dynamic accounts make correct predictions for reverse cases with a presupposition trigger in the consequent, such as *The bathroom is well-hidden, if there is a bathroom.* But this is so, of course, only to the extent that the standard update formula is used for both canonical and reverse orders.

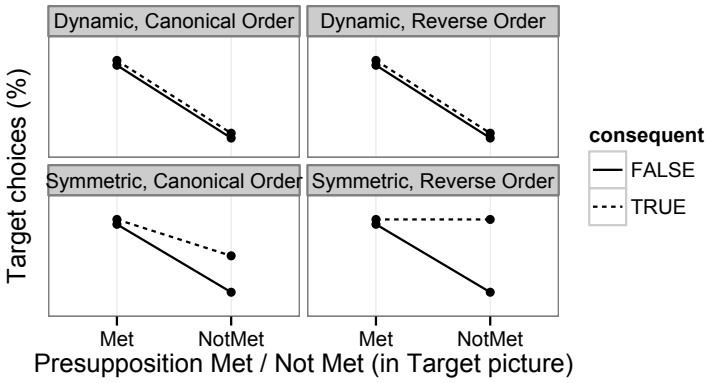

Fig. 2 Schematized predictions by condition and type of account.

given the clause-order, this is already known at the time the relevant presupposition triggers are encountered, and there shouldn't be any processing cost for this.

In terms of the concrete predictions of each account, we thus end up with the following picture: a dynamic account predicts that regardless of order and truth or falsity of the consequent, the target should be chosen more frequently when the presupposition in the antecedent is met in the target picture, i.e., a main effect of the presupposition factor. It does not predict an interaction, nor a main effect of the truth-value of the consequent. A symmetric account with an incremental processing component, on the other hand, predicts that both the order of the clauses and the truth-value of the consequent should affect frequency of target choices, in addition to the presupposition factor. While the predicted effect of the latter is the same as on the dynamic account when the consequent is false, this is expected to disappear, or at least to decrease, when the consequent is true. Moreover, the case where consequent is true and the presupposition is not met (on the bottom right of Figure 1) is expected to lead to more frequent target choices than the one where the consequent is false and the presupposition is not met (as on the top right version of the target in Figure 1). Finally, based on the assumed processing cost of having a presupposition depend on material introduced later in the sentence, there still may be an advantage for the condition where the presupposition is met and the consequent is true over the one where it is not met (with a true consequent). But this effect should disappear once the clause-order is reversed. The symmetric account thus predicts an interaction between the presupposition factor and the truth-value of the consequent for both clause orders. Based on the effect of incrementality, this is expected to be more pronounced in the reverse order, which would furthermore be reflected in an interaction between clause order and the presupposition factor for the true-consequent conditions from both sub-experiments. These predictions are summarized schematically in Figure 2.

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A total of 24 items with target picture versions corresponding to the four variants in Figure 1 were created, and for each item, there were sentence versions in canonical and reverse order. In addition to the experimental materials, there also were two types of fillers, as well as items from another unrelated sub-experiment. The fillers were conditionals similar to the experimental items. A first group of 12 fillers consisted of cases where both the antecedent and the consequent were true with respect to the target picture. Half of these contained the presupposition trigger *again*, whose presupposition was satisfied in the target picture. A second set of 12 fillers consisted of conditionals (without *again*) where both the antecedent and the consequent were false with respect to the target picture. These provided a useful check on subjects' willingness to choose targets in case the antecedent was false (more on this in the data treatment section below). Finally, there were 24 sentences that were experimental items (from an unrelated sub-experiments) and fillers containing the presupposition trigger *stop* (half of which contained negation).

2.2 Procedure & Participants

Given the necessary setup of having conditionals whose antecedent was false (as far as literal, truth-conditional content is concerned), we provided rather detailed instructions to ensure that participants are clear on the fact that conditionals can strictly speaking be seen as consistent with situations in which the antecedent is false. To further motivate subjects and given them a concrete sense of what their task is, we couched the experiment in a guessing game, where the subjects played the role of a detective. Thus, after signing a consent form, subjects were seated in front of a computer screen and read the following instructions.

(8) You are going to play a guessing game, in which you take on the role of a detective that is trying to identify suspects based on very partial information about what their activities are during a certain week. You will see three pictures showing different people and the things they did throughout the week. You have intercepted one sentence of communication by other people talking about the suspect's activities, which is from some time during the week in question. You assume that the source is reliable and that the sentence is true.

Based on that sentence, your task is to identify the one picture that is consistent with what the sentence says. Note that there will always be only one such picture. One complication of the game is that one of the pictures will be blocked from your view, so that you can only guess what it depicts. But since there always will be only one picture that's consistent with the sentence, if none of the pictures that are visible are consistent with the sentence, then the hidden picture has to be the one, and you should choose it.

A further complication is that while sometimes it is straightforward to match one of the pictures with the sentence, other times this will involve a more

> indirect relationship between the two.
>
> [Illustrations of true-true and false-true conditional-picture pairs]
>
> Throughout the experiment, remember to evaluate the sentence and your options very carefully, so that you can be sure to identify the right person. Otherwise, you might lose your detective badge!
> At the same time, though, you also should trust your gut feeling and go with what seems right to you, without over-thinking it for too long.
> Let's do a couple of practice trials so that you can try out how this works!

After the initial instructions, the types of pictures used in the experimental stimuli where used to illustrate two cases of conditionals as paired with candidate pictures. The first case illustrated a basic, simple match, where both the antecedent and the consequent were true in the target picture. The second illustrated a case where the antecedent was false but the consequent true in the target picture, and it was explained in some detail why such a picture is not really inconsistent with the conditional at hand. Distractor pictures, where the antecedent was true and the consequent was false, were also discussed in both cases to further ensure they properly understood the nature of the task. There was a total of three practice trials. The first involved a simple match, i.e., a case where both the antecedent and the consequent were true of the target picture. The second and third practice trials involved conditionals where both the antecedent and the consequent were false of the target picture. Subjects received feedback on the correctness of their picture choice after the second practice trial (with a 'correct' indication when they chose the target, and an 'incorrect' indication otherwise). Subjects were free to ask any general questions during the instructions, but did not receive any feedback during the experiment.

The order of trials during the experiment was randomized, constrained in such a way that no more than two subsequent items would come from the same sub-experiment (or filler group). Positioning of the target and distractor pictures as well as the covered box was counter-balanced across items. Participants made their selection via mouse-click.

The canonical and reverse versions of the conditional sentences were treated as a between subjects factor. In other words, we effectively ran two sub-experiment, each with 24 critical items. The clause-order of the conditional fillers was adjusted to match that of the experimental items. A total of 65 undergraduate students from the University of Pennsylvania, all native speakers of English, participated in the study for course credit. 34 of them saw the experimental items with conditionals in canonical order, and 31 in reverse order.

2.3 Results

2.3.1 Data Treatment

Responses were coded as to whether they corresponded to the target picture, the distractor picture, or the covered box. For statistical purposes, we created a binary response variable that was set to 1 whenever subjects chose the target, and to 0 when they didn't.

As laid out above, a crucial element of the design employed was that subjects understood that when evaluating a picture with regard to its consistency with a stated conditional, the antecedent of the conditional being false strictly speaking provides no grounds for judging the two to be inconsistent. This was highlighted in the introduction to the experiment, but we were also able to test the extent to which subjects were able to follow these instructions by looking at the fillers where both the antecedent and the consequent of the conditional were false with respect to the target picture. As it turned out, there was a bi-modal distribution amongst subjects in this regard. While about two thirds of the subjects (23 in the canonical order group and 24 in the reverse order group) generally chose the target picture for these 12 items (92% and 93% of the time respectively) - in line with the provided instructions-, roughly a third of the subjects (9 and 10 in the respective groups) did not in general do so (only 12% and 11% of the time in the respective groups). Naturally, the subjects in the latter group also did not select the target picture in the experimental conditions, even when the presupposition was met. In the analyses that follow, we only report results from subjects that selected the target picture for at least 7 out of the 12 items in this filler group.

2.3.2 Statistical Analysis

The mean target choice proportions by condition and sentence type are presented in Figure 3. As is immediately apparent, the results are quite different in the two cases. I first present statistical analyses for the different clause-orders separately, and then proceed to some comparisons between the two. We conducted mixed effect model logistic regression analyses using the *lmer*-package in R (Bates, 2005). Interaction analyses used centered values for the factor levels, whereas simple effects were calculated with the appropriate treatment coding. I provide estimates, standard errors, and p-values for each analysis.

Starting with the conditionals in canonical order, a 2×2 interaction analysis did not find a significant interaction but revealed main effects of both presupposition ($\beta = 1.28$, SE$= 0.27$, $p < .001$) and truth-value of the consequent ($\beta = 0.75$, SE$=$ 0.26, $p < .01$), with higher target choice proportions when the presupposition was met and when the consequent was false. Planned comparisons between the relevant individual conditions furthermore confirmed that these effects were present at each level of the respective other factor (all p's $< .05$, with the exception of the simple

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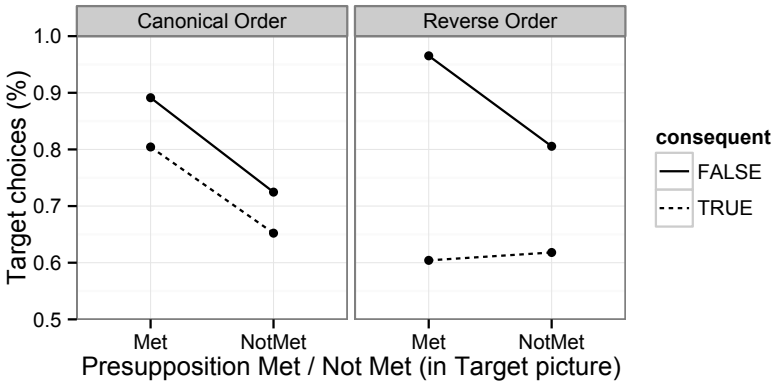

Fig. 3 Proportions of Target choices by condition.

effect of the truth-value of the consequent when the presupposition was not met ($p = 0.07$)).

At first sight, this result seems very much in line with a dynamic account. There is a uniform effect of whether or not the presupposition is met, regardless of whether the consequent is true or false. The main effect of the truth-value of the consequent could plausibly be seen as being due to the effect of pragmatic strengthening of the conditional, also known as conditional perfection (more on this below). Note in particular, that a symmetric account would lead us to expect the opposite result for the conditions where the presupposition is not met in the target picture. If the consequent is true, this should be no obstacle for choosing the target picture on the basic symmetric account. And while there may be a processing bias against that, target choices in this condition still would be expected to be more frequent than when the consequent is false and the presupposition is not met, which is inconsistent with the basic presupposition assumed by the symmetric account. However, this initial description of the results for the canonical order conditionals needs to be revised in light of the outcome for the reverse order conditionals, to which we turn next.

In the data from the reverse conditionals, there is a significant interaction ($\beta = 2.41$, SE$= 0.64$, $p < .001$), such that while the presupposition factor has the same effect as in the canonical order conditionals when the consequent is false, it does not seem to have any effect when it is true. There also were significant main effects of the truth-value of the consequent ($\beta = 2.69$, SE$= 0.34$, $p < .001$) and the presupposition factor ($\beta = 1.10$, SE$= 0.32$, $p < .001$), though the latter clearly is dominated by the interaction and thus not generally interpretable. This picture is furthermore confirmed by planned comparisons, which revealed significant simple effects for all pairwise comparisons (p's $< .001$) except for the two conditions where the consequent was true.

In contrast with the finding for the canonical order conditionals, the presence of an interaction is very much in line with the predictions of symmetric accounts that integrate an incremental processing component. In particular, the processing cost that comes with having to wait for the truth value of the consequent in the canonical order is no longer present in the reverse order. Thus, we no longer predict a difference for the two conditions where the consequent is true, since the presupposition should not matter either way on this type of account. For a dynamic account, on the other hand, the interaction is entirely unexpected, as it predicts exactly the same outcome for both clause-orders.

A final statistical analysis looked at the results from the two sub-experiments together, focusing on the conditions where the consequent is true. Here we again find a significant interaction ($\beta = 1.62$, SE$= 0.80$, $p < .05$), as well as a significant main effect of presupposition ($\beta = 0.925$, SE$= 0.40$, $p < .05$ (which is again dominated by the interaction). The presence of this interaction is again entirely in line with the predictions of symmetric accounts, which assume a processing cost to be present in the canonical order, but not in the reverse order. It is entirely unexpected, however, from the point of view of a dynamic account, which assumes a global presupposition to be present regardless of clause order and truth or falsity of the consequent.

2.3.3 Discussion

At first sight, the results from the two sub-experiments seem to be add odds with one another. The first experiment, with initial *if*-clauses, seems to neatly fit with dynamic accounts in that presuppositionality has an effect regardless of truth or falsity of the consequent. Furthermore, the fact that the condition with a true consequent and an unmet presupposition displayed fewer target choices than the one with a false consequent and an unmet presupposition is inconsistent with the prediction of symmetric accounts, which assume that effectively no presupposition enters the picture if the consequent is false.

The second sub-experiment, on the other hand, exhibits an interaction, just as predicted by a symmetric account. This result is not captured by a dynamic account, as the order of the clauses should not matter. However, the exact nature of the outcome for the second experiment seems at least partly at odds with the predictions of a symmetric account as well. In particular, while we expected an increase in target choices when the consequent was true and the presupposition not met, as compared to the canonical order, we actually see a decrease in target choices when the consequent is true and the presupposition IS met.

But once we consider an additional factor that might be coming into play to affect the results, the aspects of the results that are problematic for symmetric accounts may get an alternative explanation, thus leaving the symmetric account unchallenged (or at least fully consistent with the present data). The additional factor that I want to suggest is at play concerns the strength of conditional perfection. I spell this out in the following subsection, and briefly discuss results from a follow-up experiment that at least provides tentative support in this direction.

2.4 Follow-up study on Conditional Perfection

Starting from work by Geis and Zwicky (1971), it is commonly assumed that conditionals often end up being pragmatically strengthened to bi-conditionals. This (at least in part) accounts for the intuitive oddity of judging conditionals with a false antecedent and a true consequent to be true. This is, of course, highly relevant for our data, as the conditions where the presupposition is supposed to matter on all accounts are precisely instances of this distribution of truth-values (relative to the target image). The hypothesis I want to explore is that a) the presence of conditional strengthening will lower the frequency of Target choices in the conditions where the antecedent is false and the consequent is true; and b), that conditional strengthening has a stronger presence in conditionals where the *if*-clause is final than when it is in the initial position.

This hypothesis would help to explain the initially inconsistent seeming experimental results discussed above, in the following way: In the *if*-initial results, the fact that the true consequent condition where the presupposition is not met is lower than the corresponding false-consequent condition could be due to the presence of conditional strengthening. This, together with the assumption that the effect of incrementality is rather strong, could make the results from this study fully consistent with a symmetric account. The predicted interaction apparently has no room to show up, as it were, due to the presence and strength of the other factors. As for the results for the *if*-clause-final sentences, the interaction is already as expected on a symmetric account. The fact that the conditions with a true consequent exhibit lower Target-choice frequencies could be attributed to the hypothesized increased strength of conditional perfection with final *if*-clauses.

To test this hypothesis, a follow-up study was conducted with items almost entirely parallel to the experiments above, but without *again*. The only other change was that we simplified the task by leaving out the distractor picture, thus having subjects choose between the target and the covered box. The comparison thus is between conditionals where both the antecedent and the consequent are false, which is consistent with conditional strengthening, and ones where the antecedent is true and the consequent is false. Relative to the pictures illustrated above, this schema would give the following sentences:

(9) a. If John ate a banana on Wednesday, he ate a strawberry on Friday.
b. John ate a strawberry on Friday, if he ate a banana on Wednesday.

Data from 40 subjects was collected. As in the first set of experiments, the condition where both the antecedent and the consequent were false served as a test of whether or not subjects were able to implement the instructions with respect to the compatibility of conditionals with pictures relative to which their antecedent was false. There were 8 subjects in the *if*-initial group and 4 in the *if*-final group that did not choose the target picture over half of the time in this condition, and which thus were excluded from the analysis.

As can be seen from the summary of results in Table 1, there were fewer target choices in the *if*-final condition with a false antecedent and a true consequent

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	Target Choice %		Reaction Times	
	False-False	False-True	False-False	False-True
if-initial	97.2	83.3	7178	8010
if-final	93.8	71.8	7364	9498

Table 1 Proportion of Target Choices (in %) by condition and Reaction Times (in ms) for Target Choices by condition.

than in the the *if*-initial one, but this difference did not reach statistical significance. However, reaction times also yielded an interesting pattern of results that point in the direction of the hypothesis. In particular, target choices were significantly slower in the False-True condition than in the False-False condition for *if*-clause final sentences ($p < .05$), but not for *if*-clause initial ones.[5]

To relate the follow-up results directly to the initial experimental data, we also conducted an interaction analysis for target choice proportions comparing the conditions where the presupposition of *again* was met and the follow-up conditions, with the presence of *again* and clause order as factors. If the results for the sentences without *again* in terms of the frequency of target choices for both clause orders were different, this would undermine the usefulness of the hypothesis that conditional strengthening has a stronger presence in *if*-clause final conditionals for explaining the original data. However, there was no significant interaction to that effect, which leaves the hypothesis as a viable option for explaining the relative low frequency of target choices for the *if*-clause final sentences with true consequents from the original study.

In sum, the follow-up study provides some tentative evidence in favor of the suggested hypothesis, and does not yield any indications to the contrary. While further work is needed to establish this possibility more firmly, it does seem that the symmetric approach has a viable option for explaining all of the data from the original study, while dynamic accounts would seem to be at a loss, as things stand, to account for the presence of an interaction for the *if*-clause final sentences.

3 General Discussion & Conclusion

Following up on Chemla and Schlenker (2012), we investigated the effect of clause-order on the interpretation of presuppositions in the antecedent of conditionals.

[5] But note that the corresponding interaction did not reach significance, though there was a significant main effect of condition. As a side note, it's interesting that we here seem to have a case where a literal interpretation - i.e., one without conditional strengthening taking place - yields slower response times than a pragmatically enriched one. This is, of course, in contrast with results on scalar implicatures, where responses based on pragmatically strengthened interpretations have generally been found to be slower. We leave further exploration of this for future research.

More specifically, we tested the prediction of symmetric accounts that the truth or falsity of a consequent of such sentences would affect the presuppositionality of the sentence as a whole. We utilized an inferencing task quite different from that in Chemla and Schlenker (2012), using a version of the covered box picture matching task. Furthermore, we directly manipulated the linear order of the antecedent and the consequent in the conditional, which had not been previously done.

The main finding is that the position of the *if*-clause indeed has an effect on the presuppositionality of the entire sentence, in combination with the truth of the consequent. When the consequent is true, symmetric accounts indeed predict there to be no presupposition based on the core projection mechanism alone. However, given the role of incrementality in processing, the presupposition may still exhibit some presence when the true consequent follows the *if*-clause, as the presupposition is evaluated at that point relative to the preceding context. But when the true consequent precedes the *if*-clause, we're factoring out this processing effect. This is indeed what we find: whether or not the presupposition is met in the *if*-clause final conditionals with a true consequent does not affect the frequency of target choices, in contrast with all the other conditions.

While the relevant interaction for the *if*-clause final sentences was exactly in line with the predictions of a symmetric account, the low level of target choices in the relevant conditions presented a new puzzle. I suggest that this can be attributed in terms of an increased strength of conditional perfection for such conditionals, and presented a first bit of tentative evidence along these lines. If this hypothesis indeed can hold its ground, the symmetric account ends up being entirely consistent with the results from the main studies reported here. Classic dynamic accounts, on the other hand, cannot account for the interaction for the *if*-clause final sentences. Note, however, that it may be perfectly possible to consider a variant of a dynamic account that takes linear order into consideration. For example, Beaver and Geurts (2012) spell out a possibility along these lines, by suggesting that the context change potential of logical operators should be represented in terms of negation and conjunction, where the order of the conjuncts reflects linear order. While such a proposal would have to be evaluated more generally in light of both the present results and more general projection data (see also Footnote 4 above for a potential problem for such an account), it seems like a welcome possibility for tying together incrementality and linear order on a dynamic account. From such a perspective, the present results would then not necessarily be a reflex of symmetry, but could simply be seen as resulting from the ever-present effect of incrementality. Note, however, that the results from Chemla and Schlenker (2012) are still not straightforwardly captured by such an account, as they find evidence for subjects seeing conditional inferences to be more robust even when the presuppositional support is introduced later. It is all the more important to assess to what extent their results generalize to other tasks and methodologies, and ongoing work in my lab is pursuing precisely this point.

In closing, it is worth noting that given the novel application of the experimental paradigm used here, further questions arise that will need to be looked at more closely in future work. In particular, it is noteworthy that even in the conditions

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where the presupposition is not met (and where all accounts predict a presupposition to be present for the entire sentence), subjects chose the Target around 60% of the time, even though it was inconsistent with the presupposition. In light of the present data, we can only speculate what exactly this hight acceptance rate is due to. It could, in principle, reflect cases of global accommodation, local accommodation, or be based on subjects ignoring the presupposition altogether in their response behavior. Experimental techniques such as the ones used here should be able to settle the issue of which of these possibilities are indeed behind the present results, but we have to leave this issue for future work. For present purposes, the fact that we get significant variation in proportions of target choices between different conditions suffices entirely to evaluate the predictions of the accounts under consideration.

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