Experimental Investigation of Conditional and Non-Conditional Presuppositions

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Abstract. Conditional sentences with a presupposition trigger in the consequent, \textit{if} $\phi$, \textit{then} $\psi$, show peculiar projection properties. That is, the entire sentence seem to presuppose that $p$ in some cases (non-conditional presupposition), and that $\phi \rightarrow p$ (conditional presupposition) in some other cases. We present three picture matching experiments to address two theoretical issues raised by this phenomenon. Experiments 1 and 2 address the Selection Problem, i.e. Which presupposition obtains when? The results indicate that the dependency of the presupposition $p$ on the antecedent $\phi$ affects the choice of the inference. Experiment 3 attempts to answer the Generation Problem, i.e. How are the two presuppositions derived?

Keywords: Presupposition, Presupposition Projection, Proviso Problem, Conditional

1 Introduction

A conditional sentence with a presupposition trigger in the consequent—represented as \textit{If} $\phi$, \textit{then} $\psi$, where $p$ is the presupposition triggered in $\phi$—shows an interesting projection behavior. Consider the examples below, modeled after [10]'s. Although their only difference is the antecedent, they give rise to different inferences.

(1) \begin{align*}
\text{If Paul is not tired, then he will read his Bible tonight} \\
& \quad \text{a. If Paul is not tired, then he has a Bible} \\
& \quad \text{b. Paul has a bible}
\end{align*}

(2) \begin{align*}
\text{If Paul is a devout catholic, then he will read his Bible tonight} \\
& \quad \text{a. If Paul is a devout catholic, then he has a Bible} \\
& \quad \text{b. Paul has a bible}
\end{align*}

Intuitively, (1) presupposes (1-b), rather than (1-a), while (2) presupposes (2-a). In some theories either (1-b) or (2-a) is in fact \textit{not} a presupposition but an extra inference of a different sort. To remain theoretically neutral, we will call
inferences like (1-b) *non-conditional inferences* and ones like (2-a) *conditional inferences*.

In this paper we present the results of three picture selection experiments. The first two primarily aim at answering the Selection Problem, i.e. What pragmatic factors affect the choice of the inference?, and Experiment 3 is an attempt to investigate the Generation Problem, i.e. How are the two inferences generated? The paper is organized as follows: in Section 2, we will introduce two theories of presupposition projection that explain the two kinds of inference in different ways. In Sections 3 and 4, we will report on Experiments 1 and 2. In Section 5, we will review [2], a judgment study on the Generation Problem, and in Section 6 present Experiment 3, which also investigates the Generation Problem, using the same experimental methods as Experiments 1 and 2.

## 2 Two Theories

In this paper, we focus on two major theories of presupposition projection that explain the conditional and non-conditional inferences in different ways. According to one theory, the conditional inference is the presupposition for all conditional sentences, and the non-conditional inference is derived from it. On the other hand, according to the other theory, the non-conditional inference is the default and the conditional inference arises in special cases.

### 2.1 Conditional Presupposition Theory

One type of theories, which we call the Conditional Presupposition Theory (CPT), assigns a conditional presupposition $\phi \rightarrow p$ to all conditional sentences of the form *if $\phi$, then $\psi$* ([1, 8, 6, 14, 15]). Thus the conditional inference $\phi \rightarrow p$ is straightforwardly accounted for in this theory. Conversely, however, the non-conditional inference $p$ needs to be explained.

[3] provides a way to derive a non-conditional inference $p$ from $\phi \rightarrow p$ by the mechanism of accommodation (cf. [20]; see [10, 16–19] for other accounts that postulate conditional presupposition). That is [3] proposes that given the presupposition $\phi \rightarrow p$, a stronger inference $p$ is made, when the plausibility of the common ground that will result by accommodating $p$ is higher than the plausibility of the common ground that will result by accommodating $\phi \rightarrow p$.

Let us illustrate this account with (1) and (2) above. Suppose the speaker has just uttered (1), which is by assumption associated with the conditional presupposition in (1-a). Assume also that the conditional presupposition was not already present in the common ground. Then the hearer has to accommodate (1-a), and will reason about what adjustment of the common ground the speaker intends her to make. If she simply accommodates (1-a), the common ground that the conversation will move to will be one where Paul has a Bible, if he isn’t tired, but might not have one, if he is tired. On the other hand, if the non-conditional presupposition (1-b) is accommodated, the common ground will be one where Paul has a Bible regardless of his being tired or not. The common sense
dictates that the latter is more plausible, and hence (1-b) is accommodated. By contrast, for (2), the common ground that will result from just accommodating the conditional presupposition (2-a), namely the one where Paul has a Bible only if he is a devout Catholic, is plausible enough, and hence the conditional inference is available.

2.2 Bridging Theory

Under the second theory, which we call the Bridging Theory (BT), the projection mechanism directly generates the non-conditional inference without recourse to a conditional presupposition. ([5, 13]). The conditional inference is also derived by the projection mechanism with an aid of a ‘bridging’ inference. Importantly this theory does not posit conditional presupposition at all.

This approach formalizes the presupposition accommodation as integration of the presupposition into the discourse structure. It is crucially assumed that the representation of a conditional sentence \( \text{if } \phi, \text{ then } \psi \) has two places where the presupposition \( p \) can be integrated. One is the global position in which case the sentence means \( p \text{ and if } \phi, \text{ then } \psi \). This captures the non-conditional inference. The other possibility is the local position within the consequent, in which case the sentence means \( \text{If } \phi, \text{ then } p \text{ and } \psi \). The conditional inference is entailed thus captured by this resulting meaning.

It is also assumed that the former strategy is generally preferred, and the second strategy becomes possible only in certain contexts. More specifically, [5] suggests that the latter becomes possible in the presence of a ‘bridging’ inference that \( \text{if } \phi, \text{ then usually } p \) (see also [9, 11]).

For an illustration, let us consider the examples (1) and (2) again. For (1), no bridging inference is readily available, and since the global option is preferred by assumption, the non-conditional inference \( p \) obtains. On the other hand for (2), a bridging inference that devout Catholics usually have a Bible makes the local reading a plausible reading.

2.3 What Our Experiments are About

For the rest of this paper, we will report on three experiments conducted on Amazon Mechanical Turk (AMT). The main purpose of Experiments 1 and 2 is to test the hypothesis that the conditional inference \( \phi \rightarrow p \) is more likely to arise when the presupposition \( p \) in the consequent is dependent on the antecedent \( \phi \). This hypothesis is in principle compatible with both theories introduced above. Under the first theory, the high probability \( P(p|\phi) \) encourages accommodation of \( \phi \rightarrow p \), and under the second theory, it licenses the bridging inference that if \( \phi \) then usually \( p \), enabling local accommodation. These two experiments also establish an experimental method, which Experiment 3 deploys to tackle the Generation Problem.

\[3 \text{www.mturk.com/mturk/welcome}\]
3 Experiment 1

3.1 Design

Experiment 1 employs a picture matching task where participants read two sentences and are asked to pick a picture that best matches what the sentences say. In each trial the first sentence is a conditional sentence, and the second sentence is a mono-clausal declarative sentence.

There is one between-subject factor with two levels, Dependent and Independent. The critical items in Dependent involve a conditional sentence with a presupposition dependent on the antecedent, while those in Independent involve conditional sentences with a presupposition independent from the antecedent.

The conditional sentences for the critical items were constructed based on an independent norming study that was also conducted on AMT. In the norming study, participants saw pairs of a sentence describing a temporal state of a hypothetical monster, and a yes/no question. The question asks how likely the state makes the monster possess a certain property (e.g. Does that make it more likely that he has wings?), and the responses were given on a 5-point Likert scale. The sixteen items with the highest and lowest average scores are used to construct the critical conditional sentences in Experiment 1.

Each participant of Experiment 1 was randomly assigned one of the two conditions, and saw sixteen trials in total: four critical trials, four control trials and eight filler trials. The target and control trials involve conditional sentences with a possessive noun phrase that are constructed based on the norming study. They are followed by a confirmation of the antecedent (control trials) or a denial of the antecedent (critical trials). Which four items are critical is counterbalanced so that each subject saw either version but never both. The sentences of a critical/control item from each condition are given in (3) and (4).

(3) **Dependent**

If Googlemorph is flying, then his wings are big and strong.

a. And Googlemorph is flying. (Control)

b. But Googlemorph is not flying. (Critical)

(4) **Independent**

If Googlemorph is drinking orange juice, then his wings are big and strong.

a. And Googlemorph is drinking orange juice. (Control)

b. But Googlemorph is not drinking orange juice. (Critical)

Each item has four kinds of picture. In the non-filler items, the four pictures depict the following four monsters: (A) a monster (TTT) that satisfies all of the antecedent, the presupposition and the consequent; (B) a monster (TTF) that satisfies the antecedent and the presupposition but not the consequent; (C) a monster (FTF) that falsifies the antecedent and the consequent, but satisfies the presupposition; and (D) a monster (FF-) that falsifies the antecedent and presupposition (and as a result the consequent is undefined). The pictures for the trials in (3) and (4) are as in Fig. 1.
The predictions are as follows. In the critical trials, the antecedent of the conditional If $\phi$, then $\psi$, is denied by the second sentence $\neg\phi$, which makes the monsters TTT (A) and TTF (B) incompatible with the sentences. Crucially, if the conditional sentence has a non-conditional inference $p$, FTF (C) is the only compatible choice, while if it has a conditional inference $\phi \rightarrow p$, both FTF (C) and FF- (D) are compatible with the sentences. Under the hypothesis that conditional inferences are more likely when the presupposition is dependent on the antecedent, FF- is predicted to be chosen more often in Dependent than in Independent.

3.2 Results and Discussion

The data from 128 native speakers of English (61 participants in Dependent; 67 in Independent) are summarized in Fig. 2. Additional 5 non-native speakers of English, and 10 participants whose accuracy rate for the filler items is less than 80% are excluded from the analysis. They are all paid $0.15 for their participation.

As expected under the hypothesis, FF- (D) was chosen significantly more often in Dependent than in Independent (Mann-Whitney U: $U = 2647.5, Z = 3.22, p < .01$). Moreover it is also observed that in both conditions, FTF (C) is chosen more often than FF- (Wilcoxon Signed Rank: Dependent: $W = 300.5, Z = −2.85, p < .001$; Independent: $W = 70, Z = −6.2435, p < .001$).

These results demonstrate that participants are more likely to make conditional inferences when the presupposition is dependent on the antecedent, as expected under the hypothesis. Also at first sight, the preference for FTF (D) seems to suggest that the conditional inference was dispreferred in both conditions, but one limitation of the design of Experiment 1 is that the conditional inference is in principle compatible with both FF- (C) and FTF (D). Therefore, while it is certain that a selection of FF- (C) is due to the conditional inference,
there is no direct way to know how much of FTF (D) choice is due to which
inference. Experiment 2 is designed to overcome this limitation.

4 Experiment 2

4.1 Design

Experiment 2 is identical to Experiment 1 except that it employs the ‘covered
box’ task of [7]. The covered box task is a variant of picture selection task where
one of the pictures is covered and cannot be seen. In our experiment participants
were asked to select the covered picture only if none of the visible ones matched
the sentences.

In the critical trials of Experiment 2, FTF (C) is covered. Given that the non-
conditional inference is only compatible with this picture while the conditional
inference is compatible with both FTF (C) and FF- (D), we expect that every
time the non-conditional inference is obtained, the covered picture is selected,
and furthermore that every time the conditional inference is obtained, FF- is
selected.

In control and filler trials the correct choice was half of the time visible and
half of the time under the box. The items were counterbalanced in the same way
as in Experiment 1.

4.2 Results and Discussion

The data from 121 native speakers of English (59 in Dependent; 62 in Indepen-
dent), none of whom participated in Experiment 1, are analyzed. Additionally 8
participants who were not native speakers of English and 18 participants whose
accuracy rate for the filler items was less than 80% are excluded from the anal-
ysis. All are paid $0.15 for their participation.

As in Experiment 1, we observe that FF- was chosen significantly more often
in Dependent than in Independent (Mann-Whitney U: \( U = 2219, Z = 2.26, p <
.05 \)), further corroborating the hypothesis. However, unlike in Experiment 1,
FF- was selected more often than the covered box in both conditions (Wilcoxon
Signed Rank: Dependent: \( W = 1583.5, Z = 6.72, p < .001 \); Independent: \( W = 1222.5, Z = 5.98, p < .001 \). Critically, participants selected the covered box consistently in control conditions (Dependent: \( M = 86.1\% \); Independent: \( M = 83.9\% \)). The results are summarized in Fig. 3, where CB stands for the covered box.

The results of Experiments 1 and 2 support the hypothesis that the dependency of the presupposition on the antecedent affects the choice of the inference. Furthermore, we observe in Experiment 2 that FF- (D) is preferred to the covered picture not only in Dependent but also in Independent. Recall that FF- (D) is only compatible with the conditional inference. Thus it is suggested that the conditional inference is available in both conditions. Furthermore, provided that FTF (C) was the preferred choice in both conditions in Experiment 1, it is suggested that the conditional and non-conditional inferences are both available in both conditions ([12] for further discussions on the difference between the two experiments).

How do the two theories explain the difference between the two experiments? CPT can straightforwardly explain them, as it postulates conditional presuppositions. Specifically conditional presuppositions are always available, and non-conditional inferences obtain after strengthening them. In Experiment 2, participants were asked to choose FF- (D) whenever the conditional presupposition is available, and consequently it was chosen more often than in Experiment 1. BT can explains the results of Experiment 1 straightforwardly. That is, a bridging inference is more readily available in Dependent and hence more conditional inferences are obtained. The results of Experiment 2 are also explained by assuming that the experimental task highly encouraged local accommodation by forcing participants to consider the possibility of implausible bridging inferences.

Experiment 3 is an attempt to test the predictions of the two theories using the experimental method that we have just established. Before presenting it, we will review a previous study on the same issue and discuss the differences from our study.
5 A Previous Experimental Study

[2] experimentally tested the predictions of CPT and BT. In order to tease apart their predictions, [2] used the additive presupposition trigger too (in French) that is argued to resist local accommodation. Assuming that local accommodation is unavailable, only the non-conditional inference is available under BT, while CPT still can generate the two inferences.

The task of their experiment is an inferential task. Participants were shown conditional sentences like (5-a) (in French), and asked to judge whether the conditional and non-conditional inferences in (5-b) and (5-c) are robust inferences of (5-a) on a continuous scale from no to yes.

(5) a. If Ann decides to study abroad, her brother will also make a reasonable decision
    b. Studying abroad will make a reasonable decision for Ann
    c. Ann will make a reasonable decision

They observe that the conditional inference is rated significantly higher than the non-conditional inference ($M = 87\%$ Yes vs. $M = 58\%$ Yes, $F(1, 17) = 32, p < .001$). From this they conclude that these results favor CPT.

In the next section, we report on our third experiment that is also designed to test the existence of conditional presupposition, but there are several differences between our experiment and [2]'s. Firstly, the experimental task employed by [2] is an inference judgment task which requires metalinguistic introspection on the participants’ part, while our experimental method on the other hand is a picture selection task which is less metalinguistic. Although we have to leave the comparison of two methods for future work, it is of interest to show the validity of a different experimental method. Secondly, [2]'s logic crucially depends on the assumption that the (French) additive presupposition trigger resists local accommodation. We do not make this assumption in our experiment, and instead test whether the conditional presupposition $\phi \rightarrow p$ shows regular projection properties as predicted by CPT.

6 Experiment 3

6.1 Design

Under CPT, the conditional inference is a presupposition and is expected to project just like other presuppositions. Notice that this effect can only be seen when the sentence is embedded in a non-veridical context, and we employ conditional antecedents as our non-veridical context. Given that it is highly unnatural to embedded a conditional in another conditional, we use conjoined sentences of the form $\phi$ and $\psi_p$, for which CPT predicts a conditional presupposition $\phi \rightarrow p$ and BT does not. Thus our test sentences are of the form If $\phi$ and $\psi_p$, then $\chi$ for which CPT predicts a conditional presupposition $\phi \rightarrow p$, given the assumption that the antecedent of a conditional passes up the presuppositions it contains.
BT, on the other hand, predicts either \( p \) (global accommodation) or \( (\phi \land p) \rightarrow \psi \) (local accommodation), and hence \( \phi \rightarrow p \) is not predicted.

We used the items in Independent of the previous experiments to construct critical items for Experiment 3, in order to avoid conditional inferences solely based on common knowledge. One of the conditionals so constructed is in (6).

(6) If Googlemorph is drinking orange juice and his wings are big and strong, then he can join the team

As in the previous two experiments, each trial has two sentences and a set of four pictures. In the critical items, the first sentence is a conditional sentence with a sentential conjunction in the antecedent as described above. There is one between-subject factor with two levels, Confirmed and Denied, and the second sentence is either a confirmation (in Confirmed) or denial (in Denied) of the first conjunct in the antecedent of the first sentence.

A subset of the pictures used in the previous experiments are used in Experiment 3. The pictures depict the following four monsters: (A) a monster that satisfies both antecedent and presupposition (TT); (B) a monster that satisfies the antecedent but not the presupposition (TF); (C) a monster that satisfies the presupposition but not the antecedent (FT); (D) a monster that satisfies neither (FF). We employ the covered box method again. In Confirmed TT is covered, while in Denied FT is covered.

Each participant was randomly assigned one of the conditions and saw 6 critical trials and 8 filler trials. In the instructions they are told that the following hypothetical situation: we are recruiting various monsters to create a team, and their task is to pick the monster that the sentences are about, and also to tell us whether the monster can join the team by choosing Yes, No, or I don’t know. In half of the critical trials, the consequent of the conditional is then s/he can join the team and in the other half then s/he can’t join the team. The second additional task here is included to make the conditional relevant.

The predictions of the two theories are as follows. According to CPT, participants access a conditional inference \( \phi \rightarrow p \) in all cases. In Confirmed it will be concluded that \( p \), since \( \phi \) is asserted by the second sentence. On the other hand in Denied where \( \neg \phi \) is asserted, nothing will be inferred from it. Therefore, given the logic of the covered box task, the covered box should be chosen in Confirmed, while FF should be chosen in Denied. By contrast, according to BT, there should not be any difference between the two conditions, as the second sentence is predicted to be irrelevant for the projection of \( p \) in the first sentence. Given the results of Experiment 2, it is expected that the overt picture is preferred.

6.2 Results and Discussion

The data from 82 native speakers of English (40 in Confirmed, 42 in Denied) are summarized in Fig. 4. Additional 5 non-native speakers and 38 subjects who answered than 80% of the filler items correctly are excluded from the analysis. They are all paid $0.20 for their participation.
We observe that the covered box is chosen more often in Denied than in Confirmed (Mann-Whitney U: $U = 6300, Z = -3.2012, p < .01$). Also the overt picture is preferred in Confirmed (Wilcoxon Signed Rank: $W = 14, Z = -3.87, p < 0.001$) but not in Denied (Wilcoxon Singed Rank: $W' = 71.5, Z = -1.53, p = 0.135$).

Fig. 4. Results of Experiment 3

The observation that the covered box was chosen more in Denied than in Confirmed is the exact opposite of what CPT predicts. Furthermore contrary to BT’s predictions, there is a significant difference between the two conditions. These results are quite puzzling, but we would like to point out here two potential confounds of the experimental design we employed.

Firstly, it is conceivable that the covered box task encouraged local accommodation (cf. Experiment 2), which gives rise to the interpretation $\text{If } \phi \text{ and } p \text{ and } \psi, \text{ then s/he can(not) join the team}$. In Confirmed, this makes TF compatible with the sentences, accounting for the preference for the overt picture in this condition.

Secondly, what does account for the difference between the two conditions, which is not predicted by any theory? Although we do not have a full explanation for this data point for now, it seems that this might reflect participants’ tendency to require the truth of at least one of the possible properties of the monsters mentioned in the antecedent. That is, in Confirmed, as the first conjunct is confirmed, the conditional sentence is a relevant statement for determining whether the monster can join the team. However in Denied, as the first conjunct is denied, the conditional sentence is not directly relevant. This asymmetry might be responsible for the significant different between the two conditions.

7 Conclusion and Further Directions

To recapitulate, we have presented three picture selection experiments. Experiment 1 and 2 experimentally verified the hypothesis that the dependency between the antecedent and the consequent plays a role in the selection of the inference,
as previously suggested in the Literature. This address the Selection Problem. Also they establish the validity of the picture selection method in investigating presupposition projection. Experiment 3 was our attempt to test the theoretical predictions of CPT and BT, but two confounds were identified that limited the interpretation of the results.

For further directions, several amendments to Experiment 3 are conceivable. For example, presupposition projection from a different non-veridical context such as It is not the case that $\phi$ and $\psi_p$ is worth testing, as it eliminates the additional complications Experiment 3 had. However, a potential confound that needs to be taken care of is that this construction facilitates local accommodation, as remarked by [1] among others, and also indicated by the preliminary results of another experiment we conducted. So in order to address this latter problem we could follow [2]'s idea and use a strong trigger to block local accommodation.

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