

From Conditional to biconditional?

Juan Esteban Cortés Aravena
Universidad de Talca
Becario Doctoral Conicyt
Curicó, Chile
jcortes@utalca.cl

Abstract

Reasoners accept conditional inferences in a different way depending on the content of the premises. We describe the results of an experiment that evaluate causal and neutral content. They had to performed a conditional task with three different types of inferences: (1) contrapositive: If A then B, does it follow that therefore If A then B and if not B then not A; (2) obverse: If A then B, does it follow that therefore If A then B and if not A then not B; and (3) converse: If A then B, does it follow that therefore If A then B and if B then A. The experiment shows that the content of the premises affects the acceptance of the neutral conditionals, including those with a contrapositive inference. The findings show that conditional propositional inferences with neutral content tend to a conditional interpretation, and those with causal content tend to a biconditional interpretation. This experiment has been done under the study of Conditional perfection phenomenon.

Key words: Conditional Perfection, mental models, biconditional.

Introduction

The study of human reasoning by means of inferential hypothesis has been an area of inquiry inside psychology, philosophy and linguistics; a human science inquiry. Its mayor

foci have been on the use, the purpose, and the description of psycho-philo-linguistic factors. All these areas of scientific research have been working on solving-problem activities, intelligence tests, conditional reasoning, and creative reasoning. Many experiments have been set up in order to hypothesize about possible algorithmic explanations (how) and computational explanations (why and what) as well. In this research, conditional inferences are considered to be a key factor to explain deductive reasoning activity and its characteristics. Every human being is able to formulate speculations and hypothetical situations using conditional statements, where at least two elements are connected under special inferential conditions, and this ability helps us to follow deductive reasoning without noticing it. It is also well known that subjects don't necessarily follow formal rules in communicative events, moreover, they may intentionally flout them. There is some evidence that support the idea that we usually violate formal logical rules, and according to these violations a non-valid inference should be evaluated in its natural tendency. An interesting phenomenon related to deductive reasoning tasks and the way how subjects process information has been called Conditional Perfection (CP). In simple words, it is when a conditional proposition is evaluated as a biconditional interpretation. A preliminary formula is the following: when $A \rightarrow B$ is understood as $A \rightarrow B \wedge B \rightarrow A$: where ' \rightarrow ' represents a conditional, and ' \wedge ' represents a conjunction. CP has been seriously studied for more than sixty years, and there are still some discrepancies based on the initial theoretical accounts (Geis & Zwicky, 1971; van der Auwera, 1997; L. Horn, 2000) which state that CP is a conversational implicature with a distortion on the maxims of cooperation; relevance and quantity maxims. This phenomenon had initially been considered a fallacy, i.e. an argument

that involves an invalid, rather than a valid form of reasoning (this is the strictly logical usage), but, as it has been shown, it has a systematic regularity in human reasoning. In our proposal, it will be treated as part of natural language, that means, not as a loose error but as an inevitable natural process. We argue that there are other possible explanations for this phenomenon, for instance, theory of mental models and the results obtained by Bob van Tiel and Schaeken, W. (2016) support the idea that CP is better understood not as a scalar implicature depending on the quantity maxim (Moldovan, 2009; Geis & Zwicky, 1971), but that it is better understood as an heuristic iconic mental representation with low cognitive effort based on disabling conditions and alternative causes which are fleshed out in an analytical process.

Conditional Perfection (Cp)

In philosophy, the studied utterances used to understand the Conditional Perfection (CP) are suspected of being a problem related to people's tendency to use a denial of the antecedent (DA) as a correct strategy to obtain a valid conclusion in conditional propositions. This is considered to be wrong in a material interpretation mainly because using a DA reduces the possibility to draw a direct conclusion due to the fact that there are two possible consequents, i.e., *B* and *not B*. CP is defined by Auwera (1997) as a phenomenon that can be characterized as follows: "*if* is often understood to mean *only if*". This is explained in this way because biconditional interpretation accepts as valid the use of DA. Also, Auwera (1997) classifies the tendency of CP as a problem in the pragmatics of conditionals. The example given by this researcher is a typical first conditional statement as a Modus Ponens. Besides,

it is perfectly noticed that the following example is a promise, i.e., a positive inducement (Couto et al., (2017).

- 1 If you mow the lawn, I'll give you five dollars.

According to this view, in this case, the speaker is not just uttering the literal meaning, but it is uttered some extra meaning. This author states that there might be three possible interpretations:

- 2 If you don't mow the lawn, I won't give you five dollars (if not A, then not B).
- 3 Only if you mow the lawn will I give you five dollars. (only if A, then B).
- 4 If and only if you mow the lawn will I give five dollars. (if and only if A, then B).

This conditional case is known as the Perfection of the Conditional, transforming a conditional statement or argument into a biconditional interpretation. Auwera (1997) states that case 1 will 'invite' the inferences 2, 3, and 4. They have 2 characteristics, they seem fairly general, and they don't seem to be language-dependant. That means: *If A, then Q*. The main inquiry we have here is what happened with the consequent when the antecedent is denied (DA) or when the consequent is affirmed (AC). As we know, in a conditional truth table the conditional sentences accept 3 alternatives truth table combinations, which are the following conjunctions: 1) *A & B*; 2) *not A & B*; 3) *not A & not B*. So, when the antecedent is denied it is possible to state two possibilities: B and *not B*. As a consequence, there are only two valid inferences; modus ponens and modus tollens. This is not the case in the biconditional interpretation which eliminates the second alternative (2) *not A & B*; as a result, there is only one possibility left for *not A*, which is *not B*. For this reason, there are more valid inferences, that means that MP, MT, AC and DA should be accepted.

In certain conditional tasks, subjects tend to logically infer that a simple conditional, under specific context, can be a biconditional. That means that the individuals tend to eliminate the alternative *not A & B*. Our idea is that this movement is related to the content of the sentences. However, Moldovan (2009) will appeal to a Gricean account of the pragmatics of conditionals to support his conclusion. Using the theory of Analysis, he “deals with the problem of how to identify and reconstruct an argument that is put forward in a text or oral discourse” (p. 2). The *fallacy of denying the antecedent* (DA) has been studied also in order to avoid fallacies in the hypothesis stated by researchers, as well as in their conclusions. As it was stated before, 55% of the subjects will answer that this is a valid inference. It would be interesting to find out in which context this happens. At least, the mental model’s theory predicts that DA and AC are considered correct when there is a modulation in the interpretation processes. That is to say that subjects are able to evaluate the content of the arguments and according to this evaluation they accept or reject possible conclusions. This will be evaluated in our experiment.

Mental Models Theory

The main purpose of this research is to identify how MMT could support a possible explanation to the phenomenon of CP, reviewing some of the most prototypical examples given by researchers. We state that as CP is a conditional assertion, the MMT should study CP under the same principles as this theory has been studied. The main principles of the theory are:

1. “Mental models represent *possibilities*: each model captures a distinct set of possibilities to which the current description refers.

2. Mental models are *iconic*: the structure of a model corresponds to the structure of what it represents.
3. The principle of truth: mental models represent only what is true, not what is false, in each possibility. They yield rapid intuitions. In contrast, fully explicit models represent what is false too, but their construction calls for deliberation and access to working memory.” (Johnson-Laird, 2004, p. 198; Khemlani et al., 2014, p. 4).

In all this research, the conditional reasoning form *If A then B* is considered to be the cornerstone of deductive reasoning (Quinn & Markovits, 1998; De Neys, Schaeken, D’Ydewalle, 2002). This means that even though subjects create speculations and hypothetical situations performing conditional inferences, where at least premises and conclusions are connected under special conditions (plans, advice, threatening, promises, facts, laws, counterfactual statements, etc.), it is difficult for users (laymen or naïve users) to be aware of all the possible combinations underlying this deductive processes. Conditional Perfection, ‘invited inference’ or biconditional strengthening (for this case they are the same) are interesting phenomena related to the performance of deductive reasoning and human’s information process tasks.

Conclusiones

In our study, we have investigated the difference between causal and neutral content in indicative inferences, and the results are consistent with the literature. Causal content will tend to a biconditional interpretation and the neutral content will have a conditional interpretation. The results show that conditional reasoning is influenced by the content of the

conditional sentences, for each of the inferences: obverse, $t(29) = 5.066$, $p < .001$, $d = .925$; converse, $t(29) = 4.014$, $p < .001$, $d = .733$; and contrapositive, $t(29) = 6.021$, $p < .001$, $d = 1.009$. Subjects were able to discriminate the semantic differences within propositions. Mainly, this is because the subjects can flesh out alternative conditions to the causes or counterexamples to the consequences. Most of the literature in conditional perfection has been done related to pragmatic inferences such as promises, warnings and threatening content, where it is clear the biconditionality. So, we can state that causal conditionals can be included in this tendency list as a biconditional interpretation too, and that it is possible to identify differences between causal and neutral conditional.

Something that called our attention was the increasing acceptance of modus tollens (contrapositive) in causal content, but the decreasing acceptance in neutral content. This may be explained because there are no strongly associated disablers or counterexamples available in causal inferences, that means that there is possible to get access to conditions that may prevent the effect from occurring despite the presence of the cause. At the same time, there is a suppression effect for modus tollens acceptance in neutral content conditionals, this has been well documented (Byrne and Espino, 1999). So, it is easier for subjects to find counterexamples or disabling conditions when the meaning of the sentences is not connected, or the context is not related.

In the case of reasoning with conditionals involving causal content, the acceptance of modus tollens was higher than AC and DA, for example, in our results there is significant difference between the contrapositive and converse ($t(29) = 6.185$, $p = .001$, $d = 1.129$), and there is no difference between contrapositive and obverse ($t(29) = 2.083$, $p = .046$) which

have both negative sentences. This might be explained because modus tollens is more sensible to the disablers and the affirmation of the consequent is more sensible to the alternative conditions. It is also important to mention the possible difference related to the argument form (i.e. AC, DA, or MT) and the possible significant difference.

Pragmatic studies have not considered the results of serious cognitive researches that have given robust explanations of how people reason with conditional statements. We agree with Moldovan (2009) in his argument that CP should no longer be understood just as a material invalid inference that allows the speaker to make logical mistakes. Following this argumentation, CP should be understood as a natural phenomenon because people tend to behave with this perfective aspect when facing with certain contextual situations, for example, when promising or threatening. Moldovan's idea is that CP is a scalar implicature, nevertheless, the study done by van Tiel (2016) is a good evidence to suggest that CP is better explained as a linguistic phenomenon similar to low-cognitive cost inferences, like metaphors and ironies. They are processed rather different than scalar implicatures, i.e. throughout a parallel mechanism where the syntactic and semantic content are processed at the same time. Consequently, a conditional solve-problem task is analyzed with good results faster than scalar implicatures. Also, we cast doubt on Moldovan's examples because he has included examples that are not psychologically accurate according to the age of the subjects that are reasoning. We can state that the examples are not consisting with developmental psychological experiments that state that kids will interpret conditional sentences as biconditionals no matter the content of them because they flesh out only the initial model A & B (Gauffroy & Barrouillet, 2014).

A good explanation to this evidence can be done by the Mental Model theory. The mental models are able to connect human reasoning with the performance of natural language, that means that the areas of human science involved in the explanation of CP should be aware of how people understand not just semantic content but also pragmatic performance. That means to understand assertions, to represent them, and reason with them in context. This non-extra cognitive effort can be established by the speakers because according with this theory both, conditional and biconditional, have the same initial mental model, this is to say that A & B together are the only possible model, and in a fleshing out process it is possible to evaluate more information.

When considering cognitive studies for the analysis of conditional perfection, it is not necessary to apply a Gricean explanation with maxims of conversation (i.e. giving importance to the amount of information when violating the maxim of quantity). Instead of explaining conditional perfection by means of maxims of conversation it is better to use cognitive explanations with factors related to working memory, alternative conditions, disabler causes, the content of the sentences, the age of the subjects, and the strength of the association between the arguments.

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