Even if after If then conditionals

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Abstract

This study evaluates how people represent "even if" conditionals when they have to integrate them with previous "if then" conditionals and also make an inference. The terms in the premises were ordered to facilitate their integration (Figure 1: If A then B; Even if B C). In half the cases, the "even if" conditional was expressed with a negation instead of an affirmation (If A then B; Even if not B C). Participants had to infer what followed, given A or C. Previous results showed that in comprehension tasks, where information had to be integrated, counterfactual conditionals seemed to be represented with just one situation (B and C). By contrast, when people had to make inferences with these conditionals, they seemed to represent two situations. In any case, counterfactual seem to be represented with two situations (B and C, and not B and C). In our task, people had to do both: to infer and to integrate. Results showed that the use of negations and the direction in the inference had an effect on the endorsed inferences, but the two factors did not interact. The need to integrate premises did not block access to the two "even if" situations in an inference task.

Keywords: semifactual conditionals; directionality; mental models.

Introduction

Some previous results have shown that when people make inferences with a semifactual conditional, they represent two mental models. For example, the conditional "Even if it had been raining she would have gone to the party": people seem to represent the factual case "It was not raining and she went to the party" and the hypothetical case "It was raining and she went to the party" (see Moreno-Ríos, García-Madruga & Byrne, 2008). Semifactual conditionals are similar to counterfactual conditionals, but with different initial representations: given "If A had been the case then B would have been the case" people think about two possibilities from the outset, noting one as the 'facts' (not-A and not-B) and the other as 'imagined' (A and B) possibilities (Johnson-Laird & Byrne, 2002). Forinstance, if we take the above example: "If it had been sunny then she would have gone to the party" we see that this sentence suggests, on the one hand, the representation that really "It was not sunny and she did not go to the party" and, on the other hand, the possibility that "It was sunny and she went to the party". Results with reasoning tasks are consistent with the two initial representations proposed. However, priming studies (Santamaría, Espino & Byrne, 2005) evidenced that when people read an "even if A B" semifactual, they are primed to read a subsequent 'not-A and B' conjunction more quickly than when they have read a factual "if A then B" conditional, whereas they read 'A and B' just as quickly after reading the semifactual as after the factual conditional. Unexpectedly, these authors found that "if" counterfactuals did not prime the 'not-A and not-B' possibility more than "even if" semifactuals. That happened only with counterfactual conditionals and not with semifactual conditionals (see also, Gómez-Veiga, García-Madruga & Moreno-Ríos, 2010). Gómez-Veiga et al. (2010) proposed that it is possible that the comprehension tasks lead to a less exhaustive representation than inference tasks with only one part of the information. One possible cause is that in the comprehension task, the conditional information must be integrated with the information given previously. That is, the comprehension task could induce a simpler strategy to avoid the working memory load using just one of the two mental models.

In the present study, we use an inference task with a semifactual "even if" conditional preceded by a related "if then" conditional. We study how people make inferences integrating the information given by the premises. We chose the simplest way of ordering the terms in the premises: Figure 1 (If A then B; Even if B C). Figure 1 has been shown to be the easiest configuration of terms in premises to facilitate integration with conditional premises (e.g., Bara, Bucciarelli & Johnson-Laird, 1995). Also, we include sentences with a negation in the first term of the "even if" conditional. If people represent only the terms, the integration is not possible in this condition. For example, consider "If the sky was overcast it was raining" (If A then B), "Even if it had not been raining she would have gone to the party" (Even if not B C). People can consider the simple situation of "not raining" mentioned in the "even if" conditional, or they can also think of the actual situation: "It was raining and she went to the party". Different responses are expected depending on whether people manage to consider all the representations derived from the "if then" and "even if" conditionals (see Table 1, Complete representation) or just a set of possible situations (some mental models), as assumed by the mental model theory (see Table 1, Initial representation).

Some studies on the integration of premises with different relational statements in deduction (e.g., Oberauer, Hörnig, Weidenfeld & Wilhelm, 2005; Oberauer & Wilhelm, 2000)

have shown that the directionality in the inference is a factor that depends on the inner directionality represented in the mental models, and this could influence the conclusion (see Oberauer et al., 2005). Oberauer and Wilhelm (2000), using picture verification tasks (sentence-picture), found that "if then" conditionals have an inherent forward directionality: people seem to process "if A then B" in a preferred order, from A to B. Inferences based on A or on not A are faster and easier than those based on B or not B.

Table 1: Some possible sets of representations of the premises. Every line represents a mental model. The symbol ¬ means "negation". The "*" symbol for "even if" representation is the hypothesised model (simplest representation of "even if").

Affirmative condition	Initial representation	Complete representation
If A then B	A B	A B ¬A B ¬A ¬B
Even if B C	B C* ¬B C	B C ¬B C ¬B ¬C

Negative condition	Initial representation	Complete representation
If A then B	A B	A B ¬A B ¬A ¬B
Even if not B C	¬B C* B C	¬B C B C B ¬C

Another basic result in deductive research is that reasoning with negative propositions is harder than with affirmative propositions (for example, see Evans, Newstead & Byrne, 1993). Therefore, we would expect an increase in the number of errors and nothing follows responses for the backward inferences than the forward ones, and the same for inferences with negative premises. Therefore, inferences could be influenced in an additive way by directionality and by the negation, but they will be determined by the predicted representations of the premises and their integration.

Predictions

We evaluate whether people create double representations to make inferences from semifactual conditionals when they have to integrate this information with a previous "if then" conditional. Different predictions are obtained according to whether people are able to look for all the alternatives, just consider one alternative from each conditional or represent two mental models from "even if" conditionals. Table 2 shows the different predictions for each condition.

Table 2: Conclusions predicted for inferences after the integration of premises. See text for description. The inference can be endorsed when the end terms (A and C) can be connected and lead to one unique conclusion. In other cases, the correct conclusion is "nothing follows". Parentheses are used when middle terms do not match.

Forward/ backward inferences	Double represt.	Simple represt.	Complete represt.
Affirmative Given A, then C?	C A B, B C	C A B, B C	C A B, B C
Affirmative Given C, then A?	A A B, B C	A A B, B C	Nothing follows A B, B C ¬A B, B C ¬ A¬B, ¬B C
Negative Given A, then C?	C A B, B C	Nothing follows A B, (¬B C)	Nothing follows A B, B C A B, B ¬C
Negative Given C, then A?	A A B, B C	Nothing follows A B, (¬B C)	Nothing follows ¬A ¬B, ¬B C ¬A B, B C A B, B C

There are three columns for each of the three possibilities for representing "even if" (as shown in Table 1): two possibilities, one possibility and all the possibilities. The first two rows represent predictions for affirmatives and the second two for negative "even if". In every case, for forward inferences (given A, what follows? C, not C or nothing follows) and for backward inferences (given C, what follows? A, not A or nothing follows). For example, the first column shows the prediction if people construct a double representation for "even if" conditionals. In the third row we can find predictions for a negative "even if" in a backward inference. Therefore, the structure is: If A then B; Even if not B C; given A, what follows? People will conclude "C", because there is one and only one way to connect a representation from "if then" (AB) and another

from "even if" (BC) (see Table 1). However, if people represent "even if" with just one mental model (see Table 2, second column third row), they cannot match the terms between the representations of the two premises (AB, not BC) and the prediction of the conclusion is "nothing follows". The same conclusion, but for a different reason, is predicted if people can access all the situations consistent with the conditionals (see Table 2, third column, third row). In this case, there are two possible ways to connect the representations, which lead to different conclusions (AB, BC and AB, B not C).

If we consider the polarity (affirmative and negative) and the directionality (forward and backward) we can make predictions about the endorsed inferences depending on the set of mental models represented. In general, following previous studies, we would expect the directionality (inherent to conditionals) and polarity (difficulty in processing negative propositions) to have an effect on the difficulty in making inferences. In addition, the nature of the representation should influence the frequency of endorsed inferences. If people represent the two mental models for "even if", no interaction is predicted between polarity and directionality. If people represent just one initial model from every conditional, one effect of polarity will be found in the "nothing follows" conclusion. Finally, if people were able to represent a complete set of possibilities, we would predict an interaction between directionality and polarity in the inferences endorsed (more in affirmative; actually only one in the forward direction condition) and in the "nothing follows" conclusion.

Method

Participants

Participants were 51 students from Granada University, enrolled in the second year of a psychology degree, who took part for course credits. All participants were native Spanish speakers without any previous training in logic.

Materials

Thirty two syllogisms were constructed, half of them (those of interest in this experiment) with the following structure: Eight syllogisms with the form "If A then B; Even if there had been B there would have been C", and another eight that included a negation in the second premise "If A then B; Even if there had not been B there would have been C". Sixteen other fillers were included with a different structure "If C then B; Even if there had been/not been B there would have been A". The sentences were about professions. For example:

Premise 1. "If there was a biologist then there was a lawyer"

Premise 2. "Even if there had been a lawyer there would have been an engineer"

Premise 3. "There was a biologist, therefore…"

Conclusions. Response 1. "There was an engineer", Response 2. "There was not an engineer", Response 3. "Nothing follows".

Procedure

All the sentences were presented on a computer screen. Each premise and the conclusion were shown on a separate screen and participants decided by pressing the space bar when to turn to the next statement. After the two conditionals had been presented, a third premise was shown: A in half the trials (and C in the backward condition trials). After that, a screen with three options was shown, with C, not C and nothing follows (A, not A, and nothing follows in the backward condition trials). Participants had to press keys 1, 2, or 3 to choose their respective responses.

Results

An analysis of variance (ANOVA) for repeated measures was carried out by participants with the following factors: Directionality (forward and backward) and Semifactual polarity (affirmative and negative). The same analyses were carried out for endorsed inferences (given A, C is accepted and given C, A is accepted) and for nothing follows responses. Results are shown in Table 3.

Table 3: Percentage of endorsed inferences (given A, then C in the forward condition, and given C, then A in the backward condition) and nothing follows responses for affirmative "even if" and negative "even if" in the second premise.

Direction of inference	Forward		Backward	
Semifactual polarity	Affirmative	Negative	Affirmative	Negative
Endorsed inferences	68 (3.3)	59 (4.2)	50 (4.2)	40 (3.7)
Nothing follows inferences	22 (3.4)	22 (3.0)	39 (4.2)	37 (3.9)

* The values in brackets show standard deviation.

The analysis of nothing follows shows only effect of directionality but no other effects ($F(1,50)=12.98$; $\eta_p^2=.19$; $p<.001$). More inferences were endorsed for forward than for backward conditions ($F(1,50)=10.6$; $\eta_p^2=.17$; $p<.01$) and for affirmative than negative conditions ($F(1,50)=5.4$; $\eta_p^2=.4$; $p<.05$), but again, they did not interact ($F(1,50)=.01$; $\eta_p^2=0$; $p<.9$). The lack of this interaction is consistent with the double representation of "even if" conditionals.

Discussion

The task used in this study required not only inferring from a conditional but also integrating information before doing so. The frequency of correct responses is low. The working memory capacity, motivation and other factors could have influenced this overall frequency. In any case, we were able to contrast our prediction because the frequency of the inferences in the different conditions varied.

The present study shows that people seem to use two mental representations with "even if" conditionals when they have to integrate this information with other information given previously by a conditional. These results are obtained when the terms in the two conditionals are arranged so that they can be easily connected (Figure 1). A main result seems to stand out clearly. The conclusions in the negative forward and backward conditions (If A then B; Even if not B C) were not blocked. In fact, no differences in the "nothing follows" responses were obtained in this condition regarding the affirmative control condition (If A then B; Even if B C).

Also, we could see that there was an effect of the direction and of the negation in the acceptance of the inferences, but not an interaction between the two factors. That is, the representation alone cannot entirely explain the results of this study. These effects are consistent with previous studies: the forward directionality of "if then" conditionals (see Oberauer et al., 2005) and the effect of negations in reducing the endorsed inferences (Evans et al., 1993). When we introduce a negative proposition, it becomes more difficult to understand the sentences (higher working memory load) and the errors will increase. For example, people could conclude not A when actually they should conclude A. Actually, this kind of error was more frequent for negative sentences, but no differences were obtained for "nothing follows" conclusions.

Oberauer et al. (2005) maintain that the directionality of the conditionals must be represented in the conditional. In our case, only when the direction of the inference matches the direction in the mental model is the inference easier. The present results are consistent with this proposal.

Moreover, the present results do not imply that people always construct a double representation when they make inferences and integrate "if then" and "even if" conditionals. For example, results could be different when the order of the terms makes it more difficult to integrate the premises (for example using a different figure). Also, the time for reading the premises and the time for the conclusion could inform us about the principles that are operating in the integration of premises. For example, at this point we do not know whether "even if" could lead to the apodosis as the "relatum" or if it is the protasis as happens with "if then" clauses.

This is a preliminary study and we cannot prove that the present results can be generalised to conditionals with other content (such as advice, promises, obligations, etc.). The content and the context of conditionals have been shown to influence the mental representation accessed in deduction (see Johnson-Laird & Byrne, 2002; Handley & Feeney, 2004). Also, we used an evaluation of conclusions task, but not a generation of conclusions task. We do not expect that if instead we had used, for example, a generation of conclusion task, it would have led to different initial representations. However, again, this question has not been tested at this point in the research.

The present results are part of a research project that studies how premises are integrated and how we represent semifactual expressions.

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