Iterated conditionals. As ordinary as can be?

Report of the Nijmegen visit: Dec 9-13, 2011

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The goal of this project is to adjudicate between opposing theories about the meaning of conditionals using a combination of conditional probability evaluation and truth table evaluation tasks, based on the paradigm used in Politzer, Over & Bagartin (2010). Participants are presented with abstract iterated conditionals describing chips, and a betting vignette in which two speakers place a bet on a conditional. They are then asked to evaluate the probability of winning the bet, and the truth value of several truth-table conditions, chosen to maximize the differences in predictions between the theories. The study was piloted and data collected from several participants.

The aim of the meeting was (1) to analyze the findings from the pilot; (2) use them to improve the materials and procedure; (3) discuss options for statistical analyses of the results; (4) examine strategies for dissemination; and (5) discuss plans for further studies.

1. Analysis of findings

During the visit, we discussed the preliminary findings of our study. One thing that seems pretty robust is import-export: people treat the embedded form "if p, then if q, then r" the same as the non-embedded form "if p and q, then r" (the result of the correlation analysis is .93). Participants also spontaneously paraphrased the embedded form as "if p <u>and then</u> if q..." during post-test discussions. This could be indicative of the application of import, although it should not be forgotten that this pattern also has a distributed reading "if p then r and if q then r".

Our participants more or less fall into two groups (give or take the occasional noise): those who respond with the conditional probability, and correspondingly judge the truth-table cases as void; and those who give the probability of the conjunction between p, q, and r, and judge the truth-table cases as false.
This is what we expected given the findings of Politzer, Over & Bagartin (2010). We do not see anything like our predictions for T2 (the Stalnaker conditional), which were based on a count-the-features closeness computation. Answering according to this strategy is much more complex than answering according to the other theories, so it is expected, that if we find T2-participants, this will only be a marginally small group. The pilot sample was probably too small for the T2-predictions to emerge.

There was an interesting verbal response from one of the participants. Seemingly agitated, she said, 'But she [Mary] couldn't lose the bet, could she?' She was worried that she might have been 'wrong' by ticking the void response for the truth table task. Note that the response she felt compelled to reject – and hence we can surmise was a close runner-up – was the conjunctive one. This indicates a within-participant conflict between T3 (conditional probability) and the conjunctive pattern. You can also see this in her probability estimates.

2. Design of the experiment

We discussed options to carry on testing using an online platform rather than pencil and paper testing. On the basis of these findings, we decided to make three changes to the online materials:
- We decided to add TTT and TTF cases to the truth-table task. Without these cases, T3 responders should only ever answer "void", but they might get worried that it is wrong to answer each question with the same answer.
- As we assume that participants answer the probability task by counting the chips, probability will be measured as a proportion (x out of y) rather than as a percentage. It seems that this will make answering easier for the participants because then they do not have to work out that 1 out of 7 corresponds to 14% (for example). This is also how Politzer, Over & Baratgin (2010) set up their experiment.
- In the pilot, post-test discussions seem informative, so we want to add a comment section near the end of the online questionnaire, to see if we find more qualitative evidence for import-export.

3. Data analysis

During the visit, we also talked about how to analyze our data. Four new ideas for the analysis were discussed:
- The T2 procedure is a very unlikely psychological hypothesis: people have to look up all the worlds where the conditional is true and add them all up. Figuring out where the conditional is true involves judging the relative closeness of worlds, and this involves making decisions about ties (is a world where the chip is round, large and black closer to the actual world where the chip is square, large and white, than a world where the chip is round, small and white?). Because it is immensely implausible that people will actually do this, we assumed that, if the conditional is not void for people, this is because they simplify the official T2-strategy to "a count the features heuristics": compare the drawn chip to trivially true (TTT) case and the trivially false case (TTF): if it has more in common with TTT: respond "true", if it has more features in common with "TTF": respond false.
  However, for completeness, we will not only test our data for the count-the-features-T2 but also for official-T2.
- In order to compare results to Douven & Verbrugge (2011), who found that the probability of the embedded form is lower than the probability of the non-embedded form, we should separate out the conditional responders and run a t-test comparing the two forms. We ought to restrict attention to the conditional responders only, because for the conjunctive responders both forms simplify

to 'p & q & r', so equivalence between the two forms is not indicative of import-export. Individual regression analysis is the way to sort them out.

- We need to calculate the expected value of each bet, for the truth-table responses, especially the TFT ones. If people expect a great return on a bet and they expect that the bet is likely not to be called-off, then in case it is called-off, they might experience this as a loss (even though they get their money back). In our sample items, the maximum profit is only ever £2, so we do not expect that the expected value will have a huge effect on our data, but to be on the safe side, we should see whether our bets have different expected values and whether this affected the answering patterns.
- We should think about further possible response patterns on the truth table task: What will our participants say in the TFT case? That "if p then if q then r" is V, as the general de Finetti table prescribes, or that "if p then if q then r" is F? The case for the latter judgment could be made by referring to the standard definition of validity for three valued logic. According to that definition, inferring a conclusion c from a premise p is invalid when there are cases in which p is T and c is V. If the conditional reflects validity in this sense, then a conditional should be F when it has a T antecedent and a V consequent.

4. Dissemination

We have made plans for disseminating the results of the project. We will submit an abstract to the International Conference of Thinking 2012 http://www.ict2012.bbk.ac.uk/. We will give us the opportunity to discuss our work with leading researchers in the new paradigm psychology of reasoning.

5. Future plans

Finally, we have talked about seeking further funding to explore iterated conditionals. Some ideas about what we could do:

- Look at conditional inference, to gain more insight into how iterated conditionals are actually processed. We might compare Modus Tollens for the embedded and the non-embedded forms:

$$
\begin{array}{llll}
M \rightarrow (A \rightarrow J) & (M\&A) \rightarrow J & (M\&A) \rightarrow J & M \rightarrow (A \rightarrow J) \\
\underline{A \rightarrow \text{-}J} & \underline{A \rightarrow \text{-}J} & \underline{\text{-}J\qquad} & \underline{\text{-}J\qquad} \\
\text{-}M & \text{-}M & \text{-}(M\&A) & \text{-}(M\&A)
\end{array}
$$

If there is nothing special about the embedded form $M \rightarrow (A \rightarrow J)$, then the acceptance rate of Modus Tollens should be quite high (comparable to that for simple conditionals). If, on the other hand, people change the inference pattern by reducing the first premise to $(M\&A) \rightarrow J$, they are no longer applying Modus Tollens when assessing the inference.

- Look at realistic materials. It is very important to make the materials sound as naturally as possible. We do not want to do this the same way Douven & Verbrugge (2011) did it ("suppose p, now consider: if q then r" vs. "suppose p and q, now consider r"), because they end up comparing highly context-dependent conditionals to far less context dependent categorical sentences. We think about substituting one of the "ifs" with an "even if" or an "unless":

1. If a Republican wins, then it will be Anderson, unless it is Reagan.
2. If John drank, then even if it was one ounce, he would be fired.
3. If John drank and it was only one ounce, then he would be fired.

Note that 2 and 3 do not mean quite the same, which could provide a handle on tackling the question whether people reduce the embedded form to the non-embedded form. Additionally, a T2 strategy seems less implausible for such materials, as the closeness-measure is more obvious (for instance, the amount of alcohol John drinks).

- Look at the effect of independence: do people find "if p, then if q then r" odd in case p&q does not raise the probability of r? If yes, this might be evidence for import (treating "If p, then if q, then r" as "if p and q, then r"). Independence is interesting in its own right, too, being intimately connected to the philosophy of science.

References:

Douven, Igor & Sara Verbrugge 2011. Triviality undone. Unpublished manuscript. University of Groningen/University of Leuven.

Politzer, Guy & David Over & Jean Baratgin (2010). Betting on conditionals. Thinking & Reasoning 16(3).