The psychology of conditionals
Class 2
Significant early experiments

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Assumptions and belief

Traditional psychology of reasoning was assumption-based and binary. Bayesian approaches are belief-based and probabilistic.

In the tradition, participants were asked to assume that given premises were true and then to state what necessarily followed.

Bayesian approaches note that almost all inference in everyday life and science is from uncertain premises. Such inferences are from degrees of belief to degrees of belief in a dynamic process of belief revision and updating.

A traditional question about logical validity: Modus Ponens (MP)

If Macron is not in the Élysée Palace, then he is in Paris.
Macron is not in Élysée Palace.
Therefore, Macron is in Paris.

Suppose you are a participant in an experiment and are asked whether the above MP inference is logically valid or invalid.

Modus Tollens (MT) and dynamic reasoning

If Macron is not in the Élysée Palace, then he is in Paris.
Macron is not in Paris.
Therefore, Macron is in the Élysée Palace.

Most participants in an experiment would not endorse the above inference as valid.

Are they committing a logical fallacy, or giving the context a dynamic interpretation?

Contraposition

If Macron is not in the Élysée Palace, then he is in Paris. Therefore, If Macron is not in Paris, then he is in the Élysée Palace.

Some psychologists have confused MT and contraposition, and have asked their participants about contraposition when the experiment was supposed to be about MT.

Contraposition is invalid, and MT valid, in Stalnaker / Lewis conditional logic and in probability logic.

Endorsement of MP at ceiling

If it is Tuesday, then Macron is at the Élysée Palace.
Today is Tuesday.
Macron is at the Élysée Palace.

Everyone endorses the above instance of MP.

MP with an extra premise

If it is Tuesday, then Macron is at the Élysée Palace.
If there is an EU summit, then Macron is in Brussels.
Today is Tuesday.
Macron is at the Élysée Palace.

The endorsement rate of MP falls with this example.
This is an example of suppression (Byrne, 1989).

Suppression and uncertainty

If today is Tuesday, then Macron is at the Élysée Palace.
If there is an EU summit, then Macron is in Brussels.
Today is Tuesday.

The endorsement rate for MP can fall when an extra conditional premise is added to the standard MP premises.

The natural way to interpret the use of the second conditional above is as a correction of the use of the first. Imagine that the above is part of a dialogue between two people. Then the use of the second conditional would create uncertainty about the first conditional, causing uncertainly about the MP conclusion.

An extra premise is not needed

If today is Tuesday, then Macron is at the Élysée Palace.
Today is Tuesday.

Traditional instructions in the psychology of reasoning ask the participants to assume that the premises hold. Stevenson & Over (1995) asked their participants, however, to imagine that they were listening to a conversation when they were given the premises for MP, and the endorsement rate fell.

The speaker who asserts the first sentence above may not have certain knowledge about Macron, and even the second speaker might be mistaken about which day of the week it is.

Levels of expertise

Student: "If the patient has typhoid, he will recover quickly."
Professor: "If the patient has cholera, he will recover quickly."

Fact: "If the patient has cholera, he will recover quickly."
Student: "The patient has cholera."
Professor: "The patient has typhoid".

There is more suppression when the Professor corrects the student than when the student corrects the Professor.

More or less uncertainty is transmitted to the conclusion, given the relative expertise of the speakers.

Transmitting uncertainty

If today is Tuesday, then Macron is at the Élysée Palace.
If there is an EU summit, then Macron is in Brussels.
Today is Tuesday.

The endorsement rate for MP can fall when an extra conditional premise is added to the standard MP premises.

But is it correct here to speak of the "suppression" of MP? Our confidence in the conclusion should certainly go down, in a dynamic process of belief revision, but that is because the second premise makes the first uncertain.

Tversky & Kahneman (1983)

Linda is single, outspoken, and intelligent. She majored in Philosophy at university, was concerned with social justice, and was anti-nuclear. Rank the following in probability:

Linda is a bank teller.

Linda is a social worker.

Linda is a feminist and a bank teller.

Linda is a farmer.

The conjunction / Linda fallacy

Participants in experiments tend to judge P(f & t) > P(t), when they make judgments about Linda's qualities.

Tversky & Kahneman noted that judging P(f & t) > P(t) is incoherent because of the logical relation between *f & t* and *t*. It is logically valid to infer *t* from *f & t*, and thus P(f & t) > P(t) should not hold. Here we could speak of the "suppression" of &-elimination as a valid inference.

See Cruz et al. (2015).

Linda many years later

Linda is single, outspoken, and intelligent. She majored in Philosophy at university, was concerned with social justice, and was anti-nuclear. Now in 2019, she has just bought an electric farm tractor. Rank the following in probability:

Linda is a bank teller.

Linda is a social worker.

Linda is a feminist and a bank teller.

Linda is a farmer.

Judgments about Linda in 2019

Linda is a bank teller: Extremely unlikely

Linda is a social worker: Quite unlikely

Linda is a feminist and a bank teller: Extremely unlikely

Linda is a farmer: Highly likely

In the above P(t) and P(f & t) have both been "suppressed" in belief revision, but as long as P(f & t) remains ≤ P(t), the inference of &-elimination has not been "suppressed".

Transmitting uncertainty coherently

When we reason from our degrees of belief, and not from given assumptions, our degrees of confidence in our conclusions can go up or down as we receive more information.

This dynamic process of belief revision is what should happen. It is rational as long as it is coherent, meaning that it conforms to probability theory.

In this series of talks, we are primarily interested in whether people's conditional reasoning is coherent.

The selection task (Wason, 1966)

In a selection task, participants are shown a conditional, of the general form *if p then q*, and four cards. Each card has *p*, or *not-p*, on one side, and *q*, or *not-q*, on the other side. Only one side of each card can be seen, showing *p*, *not-p*, *q*, and *not-q*.

The participants are asked to indicate just those cards which need to be turned over to find out whether the conditional, or "rule", was true or false, or violated or not violated.

We now see this task as an exercise in dynamic reasoning, and give it a Bayesian analysis.

The abstract task

In abstract indicative selection tasks, the first studied (Wason, 1966), the conditionals used were like this:

"If there is an A on one side, then there is a 3 on the other side."

The four cards would have only one side up and show:

A D 3 7

Which card or cards should be turned over to find out whether the conditional is true?

The abstract task results

"If there is an A on one side, then there is a 3 on the other side."

The four cards would have only one side up and show:

A D 3 7

People generally solve this task by choosing the A card alone, or the A and 3 cards. Wason argued that the "correct" answers are the A and 7 cards, reasoning by MP and MT.

The deontic task

In one of the first deontic tasks studied (see Wason & Johnson-Laid, 1972), the conditional used was:

“If a letter is sealed , then it has a 5 pence stamp on it.”

The four cards were envelopes, with only one side visible. One was sealed, one was unsealed, one had a 5 pence stamp on it, and one had a 4 pence stamp on it.

The deontic task results

“If a letter is sealed , then it has a 5 pence stamp on it.”

The four cards were envelopes, with only one side visible. One was sealed, one was unsealed, one had a 5 pence stamp on it, and one had a 4 pence stamp on it.

The participants were asked to select just those envelopes which could reveal whether the rule was violated. They tended to pick the sealed envelope, and the one with the 4 pence stamp on it.

Costs, benefits, and cheating

Cosmides (1989) saw deontic conditionals as social contracts of the form, *if you take a benefit, you (must) pay the cost*. She argued that people got this version of the task right because they had a dedicated module for identifying cheaters.

Ken Manktelow & I pointed out that a deontic selection task does not have the same logical form as an indicative task.

We showed that participants also did well where the conditional in the selection task was a prudential conditional: "If you clean up spilt blood, then you must wear rubber gloves" (see Evans & Over, 2004).

The Bayesian analysis of deontic tasks

A Bayesian, decision theoretic analysis can be given of deontic tasks. People look for cases, in dynamic reasoning, where there is some probability that they will suffer a serious cost.

Being cheated is a cost, and so is getting serious illness. And not doing one's job properly can lead to serious costs.

There are also costs / benefits in the investigation of indicative conditionals. It costs time, effort, and money to investigate hypotheses. This is why scientists need grants. But there are of course epistemic and other benefits in investigating hypotheses.

The raven's example of belief updating

This is a classical case in the philosophy of science about how we would look for confirmation of a hypothesis, trying to increase our degree of belief in it:

"If a bird is a raven then it is black."

This hypothesis gets significant confirmation when a raven is found that is black. It gets insignificant confirmation when a non-black thing is found to be a non-raven, like a red herring. It is also grossly inefficient to look among non-black things for a possible falsifying case. It is much better on Bayesian grounds to look for ravens (Oaksford & Chater, 1994) for belief revision.

The non-ravens

“If a bird is a raven then it is black.”

Something that is black and a raven seems intuitively relevant to the above. But another thing that is black and a non-raven, e.g. a lump of coal, is apparently totally irrelevant.

Any non-raven - the red herring - appears totally irrelevant to the above, neither confirming nor disconfirming it.

These intuitions have some support from selection task results.

More on the ravens

Suppose we are considering this singular conditional (see Cruz & Oberauer, 2014, on general conditionals):

"If the next bird we see is a raven (r), then it will be black (b)."

Supposing the intuition is correct that P(if r then b) = P(b|r), we could assess P(b|r) by recalling the ravens we have seen and noting whether they were black, giving us the number of black ravens out of the number of ravens we can recall.

For that dynamic process of belief revision, the non-ravens, the *not-r* instances, are totally irrelevant.

Another look forward

The psychological question is whether people judge that *not-p* cases are irrelevant to assessing P(if p then q).

Traditional research on truth tables established a result that is an important step to answering this question. This result was called *the defective truth table*, and it will be the topic at the start of our next class.

If *not-p* cases are irrelevant to assessing P(if p then q), then P(if p then q) = P(q|p), and a Bayesian account should be given of when people are coherent in reasoning from degrees of belief to degrees of belief.