What happens when logic and psychology meet?

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Core Logic

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What happens when logic and psychology meet?

Two perspectives on the matter:

- a psychologist's: the role of logic in thinking
  cf. idea, from antiquity, that 'man is the rational animal'
- a philosopher's: the role of thinking in logic
  cf. origins of logic in analysing argument structure

History of the psychology of reasoning

Isolated early studies:

- Wilkins (1928), Woodworth and Sells (1935)
- Bloom and Broder (1950)
- Wason (1968)

. . . and then it becomes a *bona fide* field of study - with attendant disagreements, controversies, camps

Mental models vs mental logic

In the **mental logic** corner, we have

- Braine (1978): based on natural deduction for propositional logic
- Rips (1994): based on natural deduction for predicate logic

In the **mental models** corner, we have

- Johnson-Laird (1983): based on model construction
- Byrne (1989): anti-logical nature of model building

Current approaches

- Bounded rationality (Gigerenzer)
- Evolutionary psychology (Tooby & Cosmides)
- Bayesian approaches (Oaksford & Chater)

Summary of empirical findings in syllogistic reasoning

- **Validity**
  - valid syllogisms are easier than invalid ones
- **Belief bias**
  - believability of conclusions interferes with reasoning
- **Response bias**
  - reluctance to answer 'no valid conclusion'

Empirical findings (contd)

- **Atmosphere effect**
  - a negative premise increases the chance of a negative conclusion
  - a particular premise is more likely to result in a particular conclusion
- **Illicit conversion**
  - only 'some' and 'no' are symmetric
- **Term ordering** and **figure effects**
  - more likely to order terms one way or other
  - AC preferred over CA, unless premises in form BA, CB for instance

Here's an example of **belief bias** at work (Oakhill et al., 1989):

Some of the women are not beautiful
All of the beautiful people are actresses

Some of the women are not actresses

vs

Some of the actresses are not beautiful
All of the beautiful people are women

Some of the actresses are not women

Here's an example of **belief bias** at work (Oakhill et al., 1989):

Some of the women are not beautiful
All of the beautiful people are actresses

Some of the women are not actresses

Conclusion believable but invalid yet **46%** draw it

vs

Some of the actresses are not beautiful
All of the beautiful people are women

Some of the actresses are not women

Conclusion unbelievable and invalid - only **17%** draw it.

What's going on?

Standard argument:

People are sensitive to content as well as form.
Logical inference is based solely on form.
People are not reasoning according to logic.

What's *really* going on?

Hidden equivocations in the standard argument:

- Grammatical form = logical form
- Natural language connectives = classical logic connectives
- Interpretative process in natural language is fixed, as it is in logic

These are assumptions we are not entitled to make! We should not assume natural language sentences can be translated into propositional or predicate logic without losing any of their 'logical' properties.

Classical logic has been immensely successful. But this very success has enshrined certain formats and procedures, that also have drawbacks. For instance, many themes suffer from what may be called 'system imprisonment'. We have to discuss the behaviour of [say] negation inside specific formal systems, such as propositional or predicate logic - even though these systems do not correspond to meaningful distinctions in the 'open space' of actual reasoning.

van Benthem (2000)

Problem: what's the logic of natural language?

Solution:

- Balance judgement with attention to meaning-making processes
- See for e.g.
  - material must make sense: Fillenbaum (1978),
  - task construal: Stenning & van Lambalgen (2001),
  - familiarity with 'test' genre: Scribner & Cole (1981)

Meaning making (1)

How do people understand conditionals? (Fillenbaum,1978)

- **paraphrasing** varies according to meaning:
  - contingent universals overwhelmingly get paraphrased as simple statements
  - in contrast to promises, positive and negative threats
- but similarities in the **inferences admitted**: in all cases the vast majority of subjects said the *obverse* (*'If not-p, then not-q'*) followed
- observed what he calls **pragmatic normalisation**, in which paraphrases change features of the original sentence to make more sense of it

Meaning making (2)

How do people construe their task?

- Premises as random sentences or as discourse? (Byrne, 1989 cf. Stenning and van Lambalgen, 2005)
- Logic cued by 'cheater detection'? (Cosmides, 1989)
- Co-operative or adverserial communication? (Stenning & Cox, 2003)

Meaning making (3)

What about the culture of the psychology lab?

- Studies with illiterate subjects suggest that reasoning on basis of given premises is not something done naturally but must be learnt at school (Scribner & Cole 1981)
- Studies with school-going children indicate that sensitivity to verbatim/paraphrase distinction develops alongside literacy skills (Olson, 1994)
- What is learnt is not the skill (reasoning logically) but rather appropriate contexts for use of the skill.

Genuine cognitive differences

Compare

1. All of the atheists are bankers
   All of the bankers are chess players

   What follows?

with:

2. None of the atheists are bankers
   All of the bankers are chess players

   What follows?

What's the difference?

Where logic and psychology meet

- there are certainly non-logical factors influencing performance on logical reasoning tasks, but
- we're still figuring out exactly where the lines should be drawn - not all of these factors are the reasoner's responsibility
- and maybe empirical results can tell us about the logic of natural languages.