# Deductive Reasoning

## Deductive Reasoning and Inductive Reasoning

"There has been a murder done, and the murderer was a man. He was more than 6 feet high, was in the prime of life, had small feet for his height, wore coarse, square-toed boots and smoked a Trichinopoly cigar." –Doyle

"Orr would be crazy to fly more missions and sane if he didn't, but if he was sane he had to fly them. If he flew then he was crazy and didn't have to; but if he didn't want to he was sane and had to." – Heller


## Deductive vs. Inductive Reasoning

Deductive Reasoning

- Concerned with beliefs licensing or being logically required by other beliefs
- Considers all possible states of affairs
- *Leads to conclusions that are necessary*
- Infallible Conclusions (when premises true)

Inductive Reasoning

- Concerned with beliefs supporting or being supported by other beliefs
- Considers most relevant states of affairs
- *Leads to conclusions that are probable*
- Fallible Conclusions (even when premises true)

## Logic & Reasoning

- Arguments often evaluated not only in terms of whether they are valid, but also whether they are empirically true
- Truth versus Validity
  - Premise 1: All doctors are professional people.
  - Premise 2: Some professional people are rich.
  - Conclusion: Some doctors are rich.
- Content Effects
  - Finding that people judge the same logical argument differently depending on what the topic is
  - But, laws of logic tell us which beliefs follow from other beliefs based on their *form*, not their content!
- Content effects may stem from fact that reasoning typically embedded in a context where truth *and* validity are important

## Formalization

- Some reasoning problems occur due to lack of clarity in how to map human understanding onto abstract symbols
- David Lewis
  - If J. Edgar Hoover had been born in Russia, then he would have been a communist.
  - If J. Edgar Hoover had been a communist, then he would have been a traitor.
  - Therefore, if J. Edgar Hoover had been born in Russia, then he would have been a traitor.
- Formalization
  - (Premise 1) If A, then B. A → B
  - (Premise 2) If B, then C. B → C
  - (Conclusion) If A, then C. A → C
- But
  - Presumes that in Premise 2, J. Edgar Hoover had been living in the US (L), and was head of the FBI (F), …and that he was a traitor to the US (C), not Russia.
  - A → B
  - B & (L & F) → C

## Relevance

- Relevance
  - Premise 1: If it is raining, the picnic will not be held.
  - Premise 2: It is raining.
  - Conclusion: Either the picnic will not be held or cats have 6 legs.
- Researchers rarely study which conclusions people find intuitively natural

## Conditional Reasoning

Modus Ponens
(1) P → Q
(2) P
(3) Therefore: Q

Modus Tollens
(1) P → Q
(2) ~Q
(3) Therefore: ~P

P: John gets B or better on final exam
Q: John passes the course

## Invalid Inferences

Denying the Antecedant
(1) P → Q
(2) ~P
(3) Therefore: ~Q

Affirming the Consequent
(1) P → Q
(2) Q
(3) Therefore: P

P: The object is square
Q: The object is blue.

## Can people do conditional reasoning?

Modus Ponens
Denying the Antecedant
Affirming the Consequent
Modus Tollens

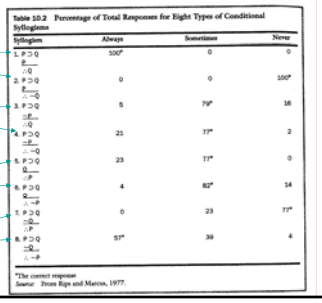

Table 10.2 Percentage of Total Responses for Eight Types of Conditional Syllogisms

| Syllogism | Always | Sometimes | Never |
|---|---|---|---|
| 1. P ⊃ Q, P, ∴ Q | 100* | 0 | 0 |
| 2. P ⊃ Q, Q, ∴ P | 0 | 0 | 100* |
| 3. P ⊃ Q, ~P, ∴ ~Q | 5 | 79* | 16 |
| 4. P ⊃ Q, ~P, ∴ Q | 21 | 77* | 2 |
| 5. P ⊃ Q, Q, ∴ P | 23 | 77* | 0 |
| 6. P ⊃ Q, ~Q, ∴ ~P | 4 | 82* | 14 |
| 7. P ⊃ Q, ~Q, ∴ P | 0 | 23 | 77* |
| 8. P ⊃ Q, ~P, ∴ ~P | 57* | 39 | 4 |

*The correct response
Source: From Rips and Marcus, 1977.

## Conditional vs. Bi-conditional

| P | Q | P→Q | P←→Q |
|---|---|---|---|
| T | T | T | T |
| T | F | F | F |
| F | T | T | F |
| F | F | T | T |

If you pick up your toys, I'll read you a story.
If our quarterback is injured, then our team will lose.

## Conditional vs. Bi-conditional

| P | Q | P→Q | P←→Q |
|---|---|---|---|
| T | T | T | T |
| T | F | F | F |
| F | T | T | F |
| F | F | T | T |

Affirming the Consequent
(1) P → Q
(2) Q
(3) Therefore: P

## Conditional vs. Bi-conditional

| P | Q | P→Q | P←→Q |
|---|---|---|---|
| T | T | T | T |
| T | F | F | F |
| F | T | T | F |
| F | F | T | T |

'Affirming the Consequent'
(1) P ←→ Q
(2) Q
(3) Therefore: P

On the biconditional reading of "if", 'Affirming the Consequent' is a valid inference schema!

## Conditional vs. Bi-conditional

| P | Q | P→Q | P←→Q |
|---|---|---|---|
| T | T | T | T |
| T | F | F | F |
| F | T | T | F |
| F | F | T | T |

Denying the Antecedant
(1) P → Q
(2) ~P
(3) Therefore: ~Q

## Conditional vs. Bi-conditional

| P | Q | P→Q | P←→Q |
|---|---|---|---|
| T | T | T | T |
| T | F | F | F |
| F | T | T | F |
| F | F | T | T |

'Denying the Antecedant'
(1) P ←→ Q
(2) ~P
(3) Therefore: ~Q

On the biconditional reading of "if" 'Denying the Antecedant' is a valid inference schema.

## *Modus Ponens* vs *Modus Tollens*

- *Modus Ponens* is easy
- *Modus Tollens* is hard
  Use of causal schemas

## "If" Interpretation

- Depends on causal schemas associated with content of argument
- Example that biases ←→
  (1) If the horses had been to the waterhole, we would see their tracks.
  (2) We see no tracks.
  (3) Therefore: The horses have not been to the waterhole.

  (2a) We see their tracks.
  (3a) Therefore: The horses have been to the waterhole.

## "If" Interpretation

- Depends on existence of alternative explanations for Q
  (1) If the horses had been to the waterhole, then the food we left out would be gone.
  (2) The food we left out is not gone.
  (3) Therefore: The horses have not been to the waterhole.

  (2a) The food we left out is gone.
  (3a) Therefore: The horses have been to the waterhole. (?)

## Causal Schemas & Conditional Reasoning

- If-then argument form not equivalent to cause-effect relations
- Cause-effect relations affect "if" interpretation and ease of *modus tollens*
- Ready alternatives for Q
  "If" P then Q = P→Q
- No ready alternatives for Q
  "If" P then Q = P←→Q

## Conditional Reasoning in Hypothesis Testing

- Difficulty w/modus tollens inferences seen in performance on hypothesis testing tasks
- Confirmation Bias – tendency to look for evidence that confirms hypothesis rather than falsifying evidence

## Wason Selection Task

| E | 4 | 7 | F |
|---|---|---|---|

If a card has a vowel on one side, it has an even number on the other.

50% E

46% E & 4

4% E&7

## Wason Selection Task

| P | Q | ~Q | ~P |
|---|---|---|---|

P (correct)

Q affirming the consequent

~Q (correct)

~P denying the antecedant