# Mind &/v Logic

**2. Rationality**

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rationality

- Many researchers maintain the belief that the laws of probability theory and logic at least approximately describe human inference. … According to Jean Piaget, cognitive development culminates in a set of logico-mathematical abilities that essentially reflect the laws of probability and logic. More recently, Lance Rips has argued for the existence of 'mental logic'. … Unlike their Enlightenment predecessors, however, these modern researchers see classical models as norms against which human reasoning can be evaluated rather than as codifications of it: when the two diverge, it is concluded that there is something wrong with the reasoning, not with the norms.

Chase et al. (1998), p. 206

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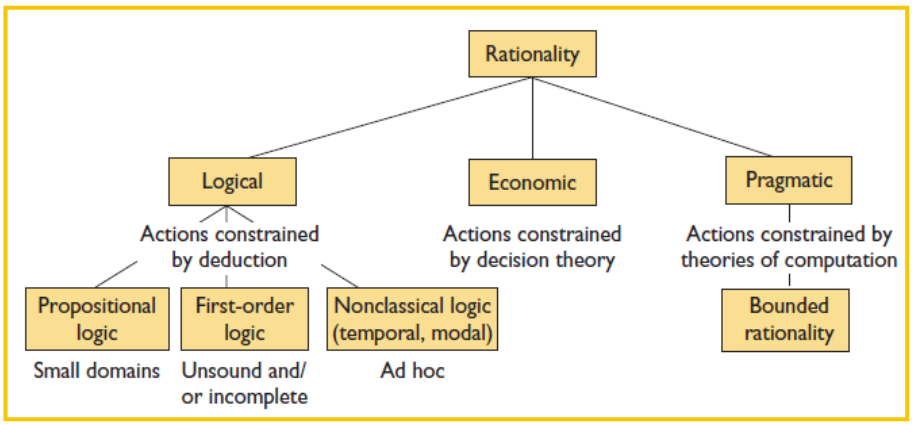
# Rationality types: a (very) general taxonomy




Huhns (2003)

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# Rationality & rules

- *normative* rules: reasoning as it should be, ideally
  - Modus Tollens: $\neg q, p \rightarrow q / \neg p$
  - Bayes' theorem: $P(D \mid S) = \frac{P(S|D)P(D)}{P(S)}$
- *descriptive* rules: reasoning as it is actually practiced
  - many people do not endorse Modus Tollens and believe that from $\neg q, p \rightarrow q$ nothing can be derived
  - in doing probabilistic calculations of the probability of a disease given a cluster of symptoms, even experts sometimes neglect the 'base rate' and put $P(D \mid S) = P(S \mid D)$
- *prescriptive*[2] rules: these are norms that result from taking into account our bounded rationality, i.e. computational limitations (due to the computational complexity of classical logic, and the even higher complexity ofprobability theory) and storage limitations (the impossibility to simultaneously represent all factors relevant for a computation).

Stenning & van Lambalgen (2008)

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# conditional reasoning 1

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# Material implication and equivalence

| $P$ | $Q$ | $P \rightarrow Q$ | $P \leftrightarrow Q$ |
|---|---|---|---|
| 1 | 1 | 1 | 1 |
| 1 | 0 | 0 | 0 |
| 0 | 1 | 1 | 0 |
| 0 | 0 | 1 | 1 |

Conditional (IF, THEN)

Bi-Conditional (IF AND ONLY IF)

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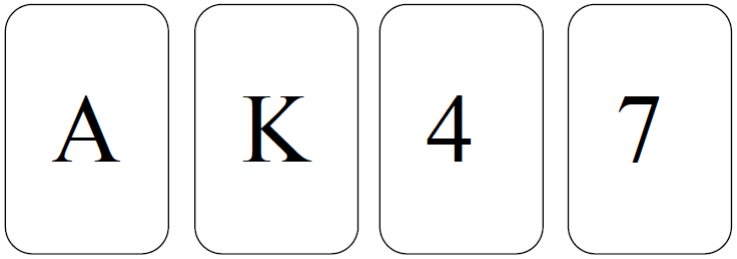
# The Wason Selection Task (Wason, 1966)

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# conditional reasoning 2

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## Argument forms

Any argument having one of the following forms is valid:

| | | | |
|---|---|---|---|
| $p \vee q$<br>$\sim p$<br>$q$ | disjunctive syllogism (DS) | $p \supset q$<br>$q \supset r$<br>$p \supset r$ | pure hypothetical syllogism (HS) |
| $p \supset q$<br>$p$<br>$q$ | *modus ponens* (MP) | $p \supset q$<br>$\sim q$<br>$\sim p$ | *modus tollens* (MT) |
| $(p \supset q) \cdot (r \supset s)$<br>$p \vee r$<br>$q \vee s$ | constructive dilemma (CD) | $(p \supset q) \cdot (r \supset s)$<br>$\sim q \vee \sim s$<br>$\sim p \vee \sim r$ | destructive dilemma (DD) |

Any argument having either of the following forms is invalid:

| | | | |
|---|---|---|---|
| $p \supset q$<br>$q$<br>$p$ | affirming the consequent (AC) | $p \supset q$<br>$\sim p$<br>$\sim q$ | denying the antecedent (DA) |

Hurley (2000) (with additions)

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# Wason (1968)

- **Abstract**
- Two experiments were carried out to investigate the difficulty of making the contra-positive inference from conditional sentences of the form, "if P then Q." This inference, that not-P follows from not-Q, requires the transformation of the information presented in the conditional sentence. It is suggested that the difficulty is due to a mental set for expecting a relation of truth, correspondence, or match to hold between sentences and states of affairs. The elicitation of the inference was not facilitated by attempting to induce two kinds of therapy designed to break this set. It is argued that the subjects did not give evidence of having acquired the characteristics of Piaget's "formal operational thought."

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# References


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