Chapter 13

Reasoning: Thinking Through the Implications of What you Know

Induction: reasoning from observations to general rule

- E.g. seeing a lot of boobies (birds from Galapagos Islands) with blue feet & bills → conclusion that all boobies have blue feet and bills

Deduction: applying general rules in specific instances

- syllogisms

- Confirming evidence ambiguous; cannot prove hypothesis false
  - E.g. the more blue-footed, blue-billed boobies you see, the stronger is belief that all boobies have blue feet & bills
- Disconfirming evidence can prove hypothesis false

Scientists seek possibly disconfirming evidence

- try to prove hypotheses false or compare hypotheses which make different predictions

- Most ordinary thinking does not involve seeking disconfirming evidence

Wason's Task (1966, 1968)

- Ss given series of 3 numbers & had to discover the rule governing "Type A" series
- Ss proposed examples & E gave feedback
- 3 6 9

People tend to…

1) Seek confirmatory rather than disconfirming evidence
2) Rely on confirming evidence; ignore disconfirming evidence & don't change hypothesis
3) Don't question confirming evidence; do scrutinize disconfirming evidence and try to find flaws

People tend to…

1) Try to reinterpret disconfirming evidence
2) Forget disconfirming cases
3) Remember confirming evidence better than disconfirming

→ Belief perseverance

Wason's Study - 2

- Ss could not solve this simple problem because
  - they sought confirmatory evidence rather than disconfirming evidence
  - Ss failed to test alternative hypotheses

Memory for Disconfirming Evidence

- Fans betting on pro football games
- Gamblers all believed they had good strategies in spite of losses
- Remembered losses as 'flukes' or near wins
- Faith in strategy remained intact

→reinterpret disconfirming evidence

- Continued belief in presence of obvious, credible disconfirming evidence
- Ss judged whether suicide notes were real or fictional (made up by the experimenters)
- Ss given feedback which was unconnected to their performance
  - 'well above average' or 'well below average'
- Later, Ss were told that the feedback was bogus & had nothing to do with their performance

- Ss then asked to judge their own *social sensitivity* by answering questions
- Ss' judgements influenced by earlier feedback
- Ss maintained false belief induced by feedback in presence of info that feedback was bogus
  - Ss told they were above average rated their social sensitivity as above average & their ability to judge suicide notes
- Why does false belief (poor judgement) persevere?

- Ss receive credible feedback from E
- Search memory for information to **confirm** feedback → confirmation bias
- Activates memories consistent with feedback
- Don't search for disconfirming information
- Info from feedback discredited, but S has available info produced from memory to confirm feedback

- Some Ss given negative feedback search for disconfirming evidence for negative feedback
- → maintain positive self image

- Syllogisms: contain two premises, S has to produce (or select) conclusion that follows 'logically'
- 1) Categorical syllogisms

Some wuggles are smeech
Some furbles are smeech
▲ Some wuggles are furbles (False)

2) Linear Orderings

A is taller than B
B is taller than C
▲A is taller than C (True)

3) Conditional Reasoning: If … then

- Handout on using Venn Diagrams to represent categorical premises
- See section in text on Mental Models p. 425 (4th edition)

- Develop mental models (images?) to represent premises in categorical syllogism
  - Draw conclusion from mental model
  - Good problem solvers seek disconfirming evidence
  - Categorical premises can often be represented by more than one model – Venn diagrams
  - Need to consider all possible representations of combo of premises to determine validity of conclusion
- Some syllogisms can have 3 or 4 representations
  - the more possible representations, the more errors

- University students make many errors on logical problems

Belief bias

We tend to arguments as 'logical' when we agree with, believe, or desire the conclusions, but rate arguments as 'illogical' when we disagree with or don't believe the conclusions

- don't separate *logical* thinking from other knowledge
- Fail to distinguish logically sound arguments from beliefs

- Atmosphere Errors

Reflect matching strategy

If one or both premises contain "some" → bias towards conclusion containing "some"

If one or both premises are negative → bias towards negative conclusion

All A are B; All C are B → All A are C or All C are A

- Conversion errors
  - All A are B interpreted as meaning that All B are A.
    - Not true. A can be subset of B.
  - Some A are not B interpreted as meaning Some B are not A.
    - Not true. A can be superset of B or A & b disjoint.

- Rules of formal logic do not describe how humans typically think.
- So why do people think "illogically"?

Premise: If X is true, then Y is true.

- *Modus Ponens* (valid)
  - X is true. What follows? Y true.
- *Modus tollens* (valid)
  - Y is false What follows? X is false. (valid)
  - People have difficulty using *modus tollens* reasoning
    - If it is raining, there are clouds in the sky overhead.
    - There are no clouds in the sky overhead. Therefore it is not raining.

Premise: If X is true, then Y is true.

- *Affirming the Consequent*
  - If Y is true, then what follows?
  - X is true. (invalid)
    - If it is raining, then there must be clouds in the sky.
    - There are clouds in the sky.
    - Therefore it is raining. (Not necessarily so. There can be clouds without rain.)
- *Denying the antecedent*
  - If X is false, what follows?
  - Y false. (Invalid)
    - If it is raining, then there must be clouds in the sky.
    - It is not raining.
    - Therefore there are no clouds in the sky.

Conditional Reasoning

- Conditional vs. Biconditional Interpretation
  - Conditional: If X then Y means
    - X is true → Y is true (Modus Ponens)
    - If X is false → nothing follows.
    - If Y is false → nothing follows.
    - If Y is true →x is true (Modus Tollens)
    - **Formal logic requires conditional interpretation.**
    - **Ordinary thinking often does not.**

Conditional Reasoning - 2

- Biconditional: Y is true **<u>if and only if</u>** X is true.
  - Normal conversation - biconditional interpretation usually applies
  - If you eat your broccoli, you may have some cake.
  - Implication: Broccoli uneaten → No cake

- More errors with negative statements
  - E.g. If X is not true, then Y is not true.
- More errors with abstract then concrete

  E.g. If the weather is not good, John will not go for a hike.

  Vs. If not X then not Y
- Get belief bias effects
  - People likely to accept illogical but believable conclusion & reject logical but disbelieved conclusion

- 4 cards, letter on one side & number on other
- S sees: A 6 J 7
- Rule: If vowel then even number
- Which card(s) must be turned to test accuracy of rule?
- 46% of Ss turned over A (correct), and 6 (affirming the consequent).
- 33% turned over A only
- 96% gave wrong answer

- For conditional interpretation,

A → 6 (Modus Ponens)
J → ? Could be 6 or 7
6 → ? Could be A or B
7 → J Can't be A on other side (Modus tollens)

- Ss should turn over A and 7. Rule can be falsified
- Turning over J or 6 give no useful information
- Are Ss using biconditional interpretation? Need to turn over all 4 cards.

< 20% turned all cards

- Modus Ponens:

If P then Q. P is true. What follows? Ans: Q is true.
People good at this type of reasoning

- Modus Tollens

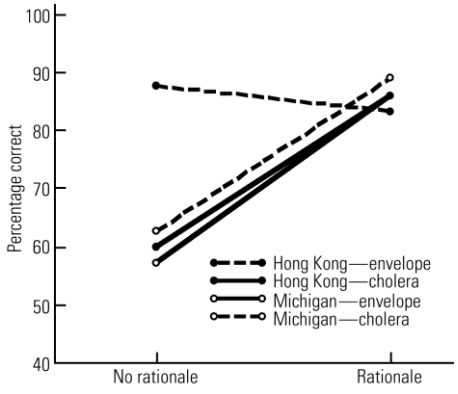
If P then Q. Q is false. What follows? Ans: P is false
If P is on Side 1, Q must be on Side 2. If Q is not on Side 2, P could not be on Side 1.
33% of Ss turned A card only → consistent with understanding *modus ponens* but not *modus tollens* rules.

- Doesn't explain Ss who turned A & 6

- Griggs & Cox:
- Rule: If person drinks beer, he or she must be 19.
- 4 cards: 1) beer, 2) 19, 3) coke, 4) 16
- 70% selected 'beer' & '16'
- Ss could not do vowel → even number version
- G & C's finding originally interpreted as concreteness effect

- Stamp problem: Envelop sealed or unsealed, 40- or 50-lira stamp
- Rule: If sealed, then 50-lira stamp
  - Actual postal regulation in Italy
    - Italian Ss performed very well on problem; British Ss did not.
- Stamp experiment performed in Michigan & Hong Kong. HK had similar postage rule; Michigan did not. Ss given rationale for rule or not.
- Ss given rationale or who were familiar with rule performed well on problem.

  → familiarity effect or concreteness?



- Wason 4-card task & categorical syllogisms → content effects
- If people reason according to rules of logic → should be no effect of content.

→ Appears that reasoning not done in the abstract, but in context

- reasoning influenced by knowledge of social rules, understanding of specific concrete situations (liquor laws, postal regulations, immigration & visa requirements)

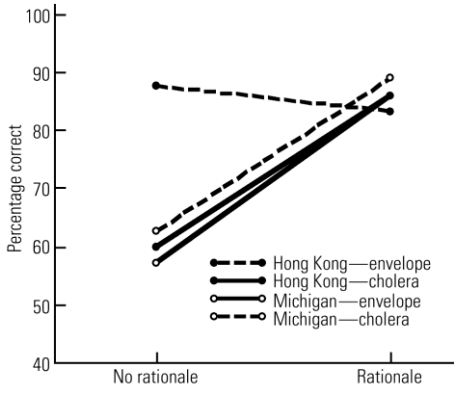
- Permission & Cheating
- Beer & Stamp problems involve permission, people attempt to gain goal (drink beer, lower postage rate, entry to country) without meeting condition (19 years old, envelope open, cholera vaccination)
- Being able to detect cheaters important in societies → evolutionary advantage

Cause and effect: If you turn the switch, the light will come on. If you touch the hot stove, you will be burned. If you don't study, you will fail your exam.

- Obligation: If I invite you to dinner, you should bring me a gift.
- Permission: If you want to enter the country, you must have a visa. If you drive a car, you must have a license.

- If problem activates pragmatic reasoning schema, should get good performance even with abstract problem.
- Abstract rule: If "entering" on one side, must have cholera listed on other side.
- Some Ss given a rationale: Cholera outbreaks in various parts of world. If you want to enter the country, must be vaccinated against cholera.

  → Activates permission schema
- Ss given rationale which activated schema performed much better than Ss not given rationale



- If you overeat, you will get fat.
  Overeating sufficient to produce obesity, but not necessary. (You could eat well but not exercise or you could have an endocrine problem.)
- If you have 3 years experience, you may apply for a promotion.
  Experience necessary but not sufficient (You must want the job.)

- We reason differently about necessary & sufficient conditions.
- Sufficiency condition triggers conditional interpretation → more "correct" reasoning
  - A sufficient but not necessary for B, → B does not necessarily imply A
- Necessary condition: If A necessary for B → truth of B implies A true as well
  - If A then B, B is true, ▲A is true

- Truly abstract conditional reasoning:
  Modus ponens: If A then B, people understand If not B, then not A
  Modus tollens: If A then B; B is true; ▲ A is true
- Concrete reasoning strategies – pragmatic reasoning schemata
  permission, obligation, causality
- Broader reasoning schemata: necessary vs. sufficient
- Other strategies: atmosphere effect, conversion, using other knowledge sources (belief bias)

- Want to maximize *expected utility* of choice
- Decisions have costs (money, inconvenience, pain) and benefits (pleasure, reduction of pain or inconvenience, approval from friends)
- *Subjective utility* – the value for the individual
  - individuals have different goals. (car as status symbol vs car as mode of transportation)
  - Utility of outcome evaluated wrt goal
- Trade-offs between costs & benefits

- *Expected utility* = probability * utility of each outcome
  - calculate expected utilities & chose alternative with highest total utility
  - Trade offs – buy smaller house in better area; take harder course because Medical School considers it in admissions policy
- Utility Theory: make choices by maximizing expected utility

- See Reisberg p. 430

- Consider outbreak of Asian flu; 600 deaths expected
- Positive Frame (Fig 13.7, page 430 of text)
  - Program A: 200 people saved
  - Program B: 1/3 chance of saving 600, 2/3 chance of saving no one
  - Expected outcome: 200 people saved
- Negative Frame
  - Program A: 400 people die
  - Program B: 1/3 chance no one dies; 2/3 chance 600
- Outcomes identical for two frames

Framing of Outcomes - 2

- You are given $300 to play a game. You must choose between
  - A sure gain of $100
  - 50% chance of $200 gain & 50% chance of gaining nothing.
- You are given $500. You must choose between
  - A loss of $100
  - 50% chance of losing nothing & 50% chance of losing $200.

- For positive frame (in terms of lives saved, sure gain)
  - 72% chose A (certainty)
- For negative frame (in terms of deaths)
  - 78% chose B (chance of saving more lives)
- People are inconsistent, choice depending on frame
- Positive frame (emphasizes gains)
  - → people are risk averse
- Negative frame (emphasizes losses)
  - → people are risk seeking

Note: Framing effects not consistent with utility theory.

- Evidence can be framed in positive fashion (cures, goals) or negative (deaths, goals against)
- Question can be framed in positive or negative fashion
- Example of parent custody case : Which parent would you award (deny) custody?

- See Reisberg, p 432

- Parent A:
  - Average income
  - Average health
  - Average working hours
  - Reasonable rapport with child
  - Relatively stable social life
- Parent B:
  - above-average income
  - Close relationship with child
  - Very active social life
  - Lots of work-related travel
  - Minor health problems

- Example of parent custody case : Which parent would you award (deny) custody?
  - award: Parent B preferred 64% to 36%
  - deny: Parent B denied custody 55% vs 45% for A
- Decision reversed depending on wording of question.
- Not consistent with Utility Theory

- Maybe people don't maximize utility; they try to find reasons to justify choice.

  → *reason-based choice*
- Consider factors that make argument compelling or persuasive

- Scenario A:
  - Sony disc player on sale for $99
  - Choice: buy Sony or continue to shop
- Scenario B:
  - Sony disc player on sale for $99
  - Top-of-the-line Aiwa disc player for $169
  - Choice: buy Sony, buy Aiwa, or continue to shop

Results:

- In Scenario A, 66% would buy Sony, 34% would shop further
  - People prefer to buy Sony than to shop further
- In Scenario B, 27% chose Sony, 27% chose Aiwa, 46% chose to shop further.
  - People prefer to shop further than to buy Sony
- Findings don't make sense in Utility terms
- Do make sense in terms of reasons
  - A → easy to justify buying Sony
  - B → no good reason to chose Sony over Aiwa or v.v. so choose to shop further

Medical treatment

- A: Drug or surgery
  - 53% of doctors referred patient for surgery without drug treatment
- B: Drug A, Drug B or Surgery
  - 72% referred patient for surgery
  - No reason for preferring one drug → surgery

Nature of Reasoning

- Confirmation Bias – e.g. custody case

  Award custody → focus on factors justifying custody award – close relationship, high income

  Deny custody → focus on factors justifying denial of custody – extensive travel, social life

- Representativeness & Availability Heuristics

  Preference – Which restaurant, movie, activity?

  May selectively remember good or unpleasant things & decide on basis of limited or biased selection

Factors affecting decision making - 3

Emotional Factors

- Affect Heuristic – How good or bad will I feel?
  - Trade your bicycle for a new improved version vs. trade wedding ring for new model
- Regret
  - try to minimize later regret about decision
  - try to justify decision to ourselves

Factors affecting decision making - 4

Damasio: Emotional experience important when making decision

- Anticipated events produce emotions & physiological reactions (*somatic markers*)
- Orbito-frontal cortex involved in evaluating & interpreting emotional reactions
- Patients with orbito-frontal damage and normal control Ss compared on card- choice task.
- Card stack had either both high payoffs & high losses, or both small payoffs & small losses

Factors affecting decision making - 5

- Damasio, cont'd
- Normals minimized risk & chose from low payoff-low loss deck.
- Patients favored risky deck.
- Normal Ss showed emotional arousal before turning over a card; patients did not.
- Patients didn't anticipate emotional response & didn't experience bodily reactions (somatic markers) → didn't learn

Anticipating Our Own Future Values

- People not good at estimating future feelings
  - Underestmate ability to adapt to new circumstances
  - Assume that what annoys or pleases us now will annoy or please us in future

Conclusion

- Think of Utility Theory as normative theory – theory of how we *should* make decisions
- Reason-based decisions – place emphasis on how we will feel.
  - Often utility theory → immoral decisions (e.g. maximize one's own financial gain at cost to others)
- Reason-based decisions – defensible as *normative* theory – a theory of how we actually behave. Moral decisions treated differently & utility theory doesn't apply

Factors Affecting Decision Making

1) Separate accounts

People think about gains & losses as being in separate accounts → calculator example in text.

Buy headphones for $125 & calculator for $15

Or by headphones for $15 & calculator for $125

Calculator $5 off and nearby store

People more likely to go to nearby store in 1st case.

Factors affecting decision making - 2

Separate accounts

2 students at casino. $25 entry fee. One finds $25 before going in; the other finds $25 after paying entry fee.

both students offered $25 bet with 50% chance of winning or losing $25

Which student more likely to place a bet?

Most Ss say 2nd student more likely to bet.

$25 used by Student A for entry fee; $25 still 'available' to B

- Report 75% hit rates for free throws vs 25% miss rates → Ss judge first player more highly
- Ratings or preferences higher if evidence presented positively than negatively

→ Framing effects not consistent with Utility theory

- Judgements based on something other than actual probabilities