

# Terminology

- **Deductive reasoning**
  - Using the principles of logic in situations where everything is known (certainty)
    - Propositional reasoning and syllogisms
    - e.g., Making predictions based on a theory
- **Inductive reasoning**
  - Reasoning from specific observations to make general conclusions
    - e.g., Based on data, reach conclusions about theories
- **Decision making**
  - Choices between two or more alternatives in situations of uncertainty

# Propositional Reasoning

- If he's a Dax he will have a Widget
  - He's a Dax
  - He's not a Dax
  - He has a Widget
  - He does not have a Widget

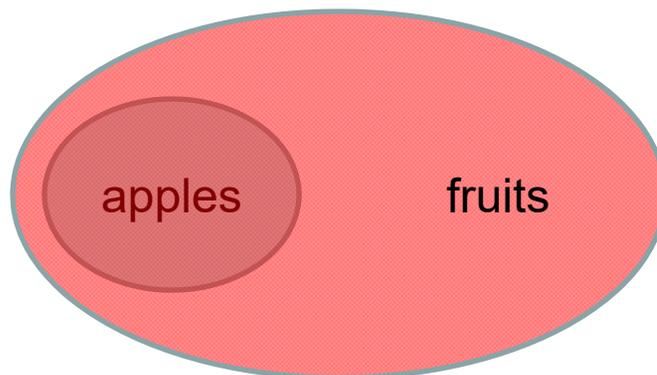


# Propositional Reasoning

## Propositional Calculus: The Four Kinds of Reasoning Tasks

Action taken	Portion of the Statement	
	Antecedent	Consequent
Affirm	Affirming the antecedent (valid) <b>modus ponens</b> <i>This is an apple; therefore this                      is a fruit.</i> 	Affirming the consequent (invalid) <i>This is a fruit; therefore this is an                      apple.</i> 
Deny	Denying the antecedent (invalid) <i>This is not an apple; therefore                      it is not a fruit.</i> 	Denying the consequent (valid) <b>modus tollens</b> <i>This is not a fruit; therefore this is                      not an apple.</i> 

Note: Each of these examples is based on the statement, "If this is an apple, then this is a fruit."



↑ antecedent      ↑ consequent

# Reasoning cont.

- People often make the affirming the consequent error
  - Sometimes this is a good bet, but not guaranteed
- Scientific hypothesis testing is denying the consequent
  - **Science can only disprove things**
    - If hypothesis X is true, then Y should be found
    - Y not found, so hypothesis X is false
- Negation makes it difficult to reason
  - If today is not Friday, then we will not have a quiz today
  - We will not have a quiz today
  - Therefore, today is not Friday
- People are better at concrete examples of everyday categories than abstract theoretical examples

# Reasoning cont.

- Belief-bias
  - People often make judgments based on prior beliefs and general knowledge, rather than the rules of logic
    - syllogism
      - some college professors are intellectuals
      - some intellectuals are liberals
      - some college professors are liberals
- Confirmation bias
  - People try to confirm hypotheses rather than disprove
    - Wason sequence task: “2-4-6”
    - Med students and even practicing doctors often choose tests that can only support rather than disconfirm their initial diagnosis
    - Finger print experts more likely to see a false match after learning that the suspect confessed



# Logic

- Wason's **four-card task**
- “If a card has a vowel on one side, then it must have an even number on the other side.”
- Which cards must be turned over to test this rule?
  - only 4% chose A and 7



Figure 12.9  
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If a person is drinking beer, they must be 21  
(73% chose the correct two)



Figure 12.10  
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# Utility Models of Decision Making

- Normative models
  - Ideal performance
- Descriptive models
  - What people actually do
- Expected Utility Theory (normative)
  - Multiply probability of each occurrence by the outcome (value or utility)
  - Expected Value if outcomes are money
  - Expected Utility can capture qualitative outcomes
    - Happiness, satisfaction, frustration, etc.



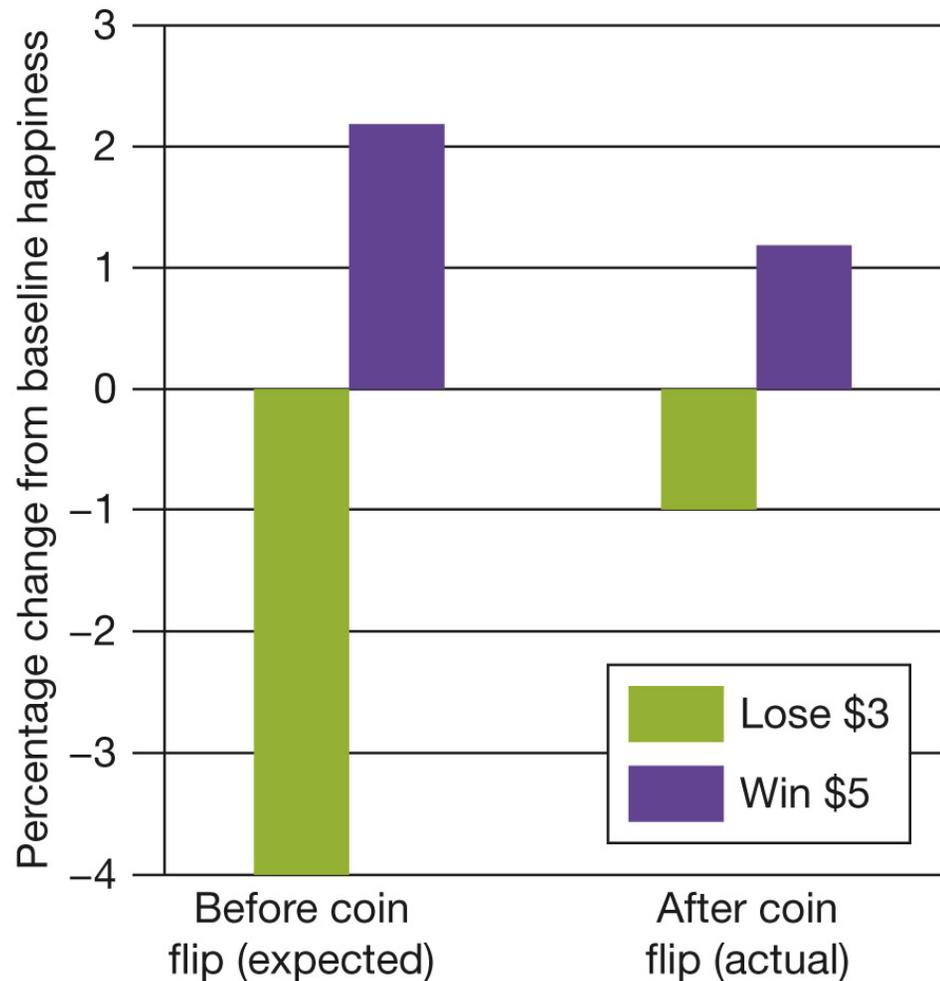
# Expected Utility Theory

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<i>Major</i>	<i>Probability of Success</i>	<i>Utility</i>		<i>Expected Utility</i>
		<i>For Success</i>	<i>For Failure</i>	
Art	.75	10	0	7.50
Asian studies	.50	0	-5	-2.50
Biology	.30	25	5	11.00
Chemistry	.45	30	4	15.70
Economics	.15	5	-10	-7.75
English	.25	5	0	1.25
French	.60	0	-5	-2.00
German	.50	0	-5	-2.50
History	.25	8	0	2.00
Mathematics	.05	10	5	5.25
Philosophy	.10	0	-5	-4.50
Physics	.01	0	0	0.00
Psychology	.60	35	-20	13.00
Religion	.50	5	-5	0.00
Sociology	.80	5	-25	-1.00

# Inaccurate Prediction of Utility

People overestimate their future feelings.



# Descriptive Models

## Biases, Heuristics, and Fallacies

- Availability heuristic
  - more instances come easily to mind = greater probability
  - example 1: Consider the letter K. Is it more likely to be the first or the third letter in a word?
    - it's easier to think of words beginning with K
      - kangaroo, kitchen, kale
    - more difficult to think of words with K as the third letter
      - acknowledge, ask
  - example 2: Ann, Bob, Dan, Beth, Gary, Heidi, Jen, Laura, Terri, and Valerie volunteer for a committee.
    - how many different two-person committees can be formed?
    - how many different eight-person committees can be formed?

# Availability cont.



- Memory effects and availability
  - Media: cause of death (Lichtenstein, 1978)
    - Tornadoes / extreme cold
    - Homicide / stomach cancer
    - Food poisoning / smallpox vaccination
    - Floods / asthma
  - Availability of memories can be manipulated
    - 2 versus 10 critical comments about the course (Fox, 2006)
  - People often use a **sense of familiarity** to estimate
    - e.g., population of Israel versus Cambodia
  - The **recognition heuristic** is used when one thing is recognized while another is not
    - e.g., population of Venice versus Cuiaba

# Representative Heuristic

- an event is judged to be more likely if it appears to be representative of the underlying process
- coin toss example
  - which sequence is more probable?
    - 1) H T T T H T H H H T
    - 2) H H H H H T T T T T
    - 3) H H H H H H H H H H
- Sample size (gambler's fallacy or small-sample fallacy): the belief that a small sample will reflect what is expected on average
- Tversky and Kahneman (1983) – Conjunction fallacy
  - Linda is 31 years old; she's single, outspoken, and very bright. She majored in philosophy. As a student, she was deeply consumed with issues of discrimination and social justice, and also participated in anti-nuclear demonstrations.
    - Bank teller
    - Bank teller and active in the feminist movement



# Base-rate Neglect

## (A) *Personality sketch of Tom W.*

Tom W. is of high intelligence, although lacking in true creativity. He has a need for order and clarity, and for neat and tidy systems in which every detail finds its appropriate place. His writing is rather dull and mechanical, occasionally enlivened by somewhat corny puns and by flashes of imagination of the sci-fi type. He has a strong drive for competence. He seems to have little feel and little sympathy for other people and does not enjoy interacting with others. Self-centered, he nonetheless has a deep moral sense.

## (B) *Estimated base rates of nine areas of graduate specialization, and summary of similarity and prediction data for Tom W.*

<b>Graduate Specialization Area</b>	<b>Mean Judged Base Rate (in %)</b>	<b>Mean Similarity Rank</b>	<b>Mean Likelihood Rank</b>	
Business administration	15	3.9	4.3	<b>5.9</b>
Computer science	7	2.1	2.5	<b>1.5</b>
Engineering	9	2.9	2.6	<b>2.6</b>
Humanities and education	20	7.2	7.6	<b>14.4</b>
Law	9	5.9	5.2	<b>5.3</b>
Library science	3	4.2	4.7	<b>1.3</b>
Medicine	8	5.9	5.8	<b>4.7</b>
Physical and life sciences	12	4.5	4.3	<b>5.4</b>
Social science and social work	17	8.2	8.0	<b>13.9</b>

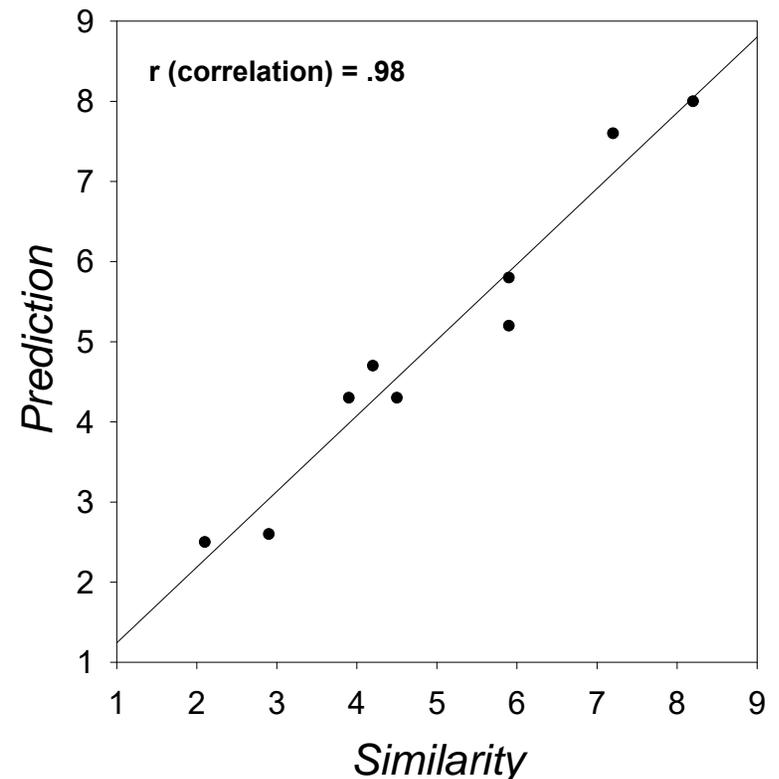
normative  
(multiply)



**SOURCE:** Kahneman and Tversky (1973, p. 238).

# Base Rate Neglect cont.

- Kahneman and Tversky (1973) asked different undergraduates to give
  - base rate: best guess at the percentages
  - similarity: rate the similarity of personality sketch to each field
  - prediction: which field is this person most likely to go into?
- Prediction matched similarity almost perfectly, with no influence of base rates

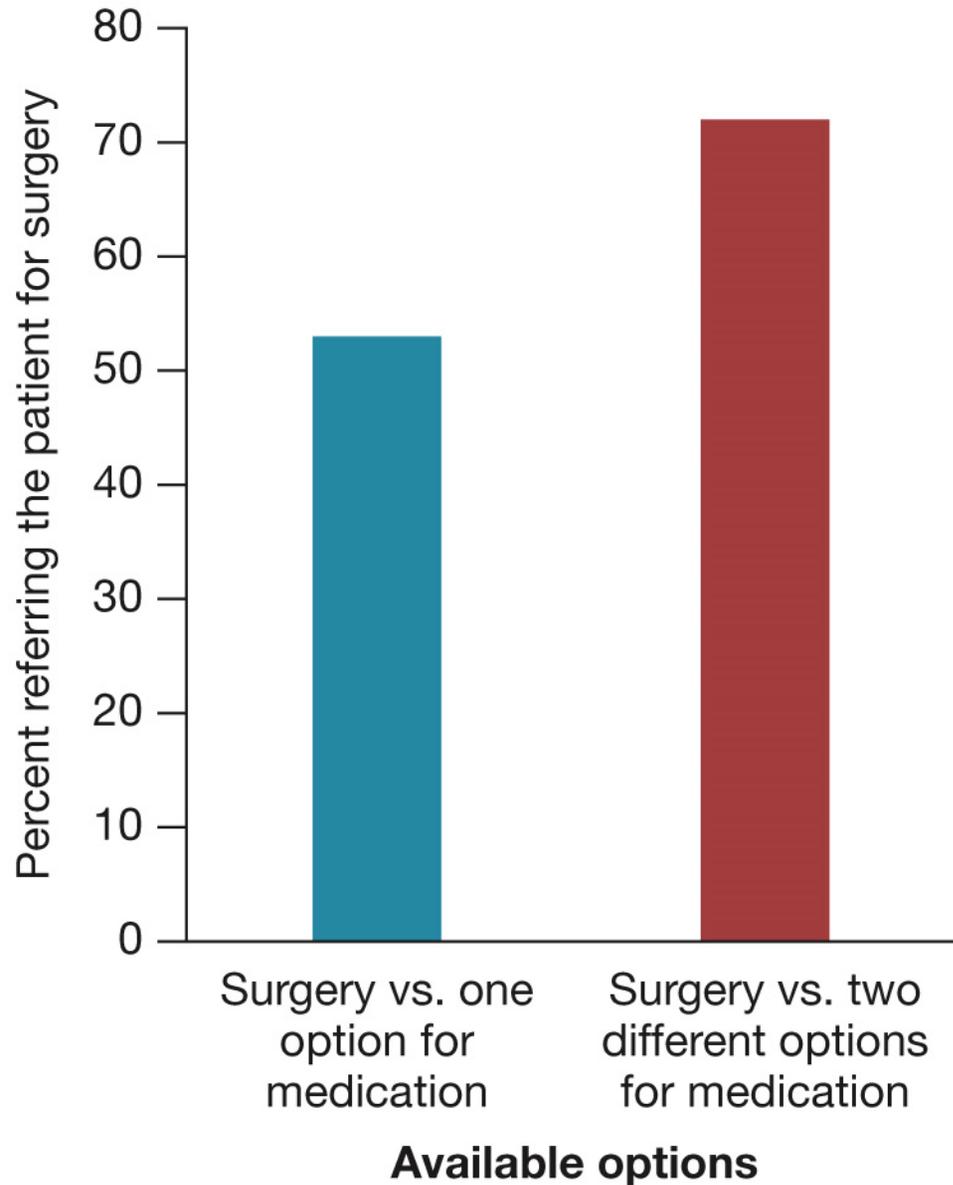


# Framing Effects

- the wording of a problem can affect decisions
  - the initial description sets the ‘frame’
- an example (Tversky & Kahneman, 1981)
  - a disease is expected to kill 600 people
    - Problem 1
      - Treatment A: save 200
      - Treatment B: save all 600 with 1/3 chance, but with 2/3 chance no one saved
    - Problem 2
      - Treatment C: 400 die
      - Treatment D: 1/3 chance no one dies, but 2/3 chance 600 die
- Prospect Theory (losses hurt more than gains)
  - Risk Averse (gain focus): A (72%) vs B (28%)
  - Risk Taking (loss focus): C (22%) vs D (78%)



# Framing Effects cont.



Increasing the number of choices can increase the attractiveness of a choice