Reasoning

Reasoning

- Special case of thinking
  - Often involves certain principles of logic
- One or more goals in mind
  - Thinking is focused
- Use other information to draw inferences or conclusions
  - Create new information
  - Make implicit information explicit

Types of Reasoning

- Deductive
  - General to specific
  - No new information is added
  - Deductively valid conclusions
- Inductive
  - Specific to general
  - Conclusions might add new information
  - No guarantee conclusion is true

- Deductive reasoning
  - All mammoths eat fir cones
  - George is a mammoth
  - Therefore, George eats fir cones
- Inductive reasoning
  - George is a mammoth
  - George eats fir cones
  - Therefore, all mammoths eat fir cones

Propositional Reasoning

- Proposition
  - An assertion that is either true or false
    - Cognitive psychology is interesting
    - Joe is an alien
- Logical connectives

  &
    - Cognitive psychology is interesting & Joe is an alien

  V
    - Cognitive psychology is interesting V Joe is an alien

  ¬
    - Cognitive psychology is ¬ interesting

  →
    - Cognitive psychology is interesting → Joe is an alien

Propositional Reasoning

- Cognitive psychology is interesting →Joe is an alien
- Antecedent (P)
  - Proposition/ statement that comes first
    - Cognitive psychology is interesting
- Consequent (Q)
  - Proposition that follows
    - Joe is an alien

Propositional Reasoning

- Actions
  - Can affirm part of the sentence
  - Can deny part of the sentence
- Combinations of actions
  - Affirming the antecedent
  - Affirming the consequent
  - Denying the antecedent
  - Denying the consequent

Affirming the Antecedent

- Cognitive psychology is interesting →Joe is an alien
  - Cognitive psychology is interesting
  - Therefore Joe is an alien
- Valid (correct) conclusion
- Modus Ponens

  If P then Q.

  P

  Therefore, Q

Affirming the Consequent

- Cognitive psychology is interesting →Joe is an alien
  - Joe is an alien
  - Therefore Cognitive psychology is interesting
- Invalid (incorrect conclusion)
- Fallacy

  If P, then Q

  Q

  Therefore, P

Denying the Antecedent

- Cognitive psychology is interesting →Joe is an alien
  - Cognitive psychology is not interesting
  - Therefore Joe is not an alien
- Invalid conclusion (fallacy)

If P, then Q
Not P
Therefore, not Q

Denying the Consequent

- Cognitive psychology is interesting →Joe is an alien
  - Joe is not an alien
  - Therefore, cognitive psychology is not interesting
- Valid conclusion
- Modus Tollens

If P, then Q
Not Q
Therefore, not P

Difficulties with Negative Information

- Performance made worse by one or more negative premises
- Slower encoding and processing
- More error prone
  - Translating initial statement or conclusion into more accessible forms
    - "It is not true that today is not Friday."

Making an Illicit Conversion

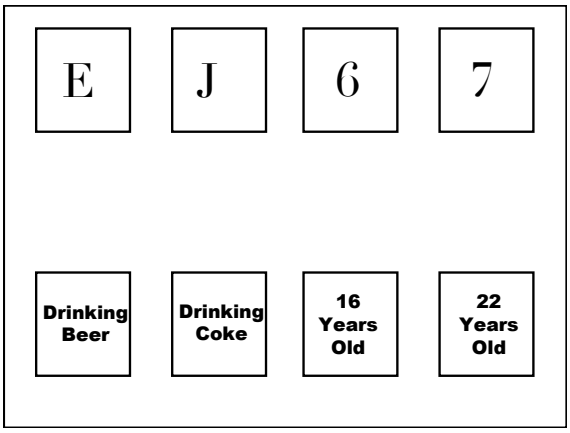
- Alter meaning of premise
- Assume "If P, then Q" is the same thing as "If Q, then P."
  - "If it rains, then the ground will be wet" ≠ "If the ground is wet then it has rained"
  - "If a student studied, then they will get good grades" ≠ "If a student gets good grades, then they have studied"

Difficulties with Abstract Reasoning

- Reasoning easier
  - Concrete examples about everyday categories
  - Propositions high in imagery
  - Use of diagrams
- Reasoning more difficult
  - Abstract items with arbitrary characteristics
  - If background knowledge interferes with logical principles

Believability Effects

- Few alternative explanations
  - Accept logic as valid
- Reinforces initial assumptions
  - Accept logic as valid
- Violates background knowledge
  - Make reasoning errors
- When a statement looks familiar
  - Not enough attention to reasoning process
  - Don't question invalid conclusion



Confirmation Bias

- Letters/Numbers
  - "E" Card: 89%
    - Affirm antecedent
  - "7" Card: 25%
    - Deny consequent
- Tendency to look only for confirming evidence
  - Consumer preference
  - International politics
  - Courtroom

Content Effect

- Griggs & Cox (1982)
  - 75% selected appropriately with Beer/Age
  - 0% selected appropriately with Letters/ Numbers
- Contents of question
  - Cue retrieval of relevant experiences
  - Concrete examples facilitate reasoning
    - When not at odds with logic

Inductive Reasoning

- Believe something to be true to varying degrees
  - Studying usually results in better grades
  - I studied harder for Exam #3 than I did for Exam #2
  - Therefore I believe I will receive a better score on Exam #3 than I did on Exam #2
- Involves
  - Categorization
  - Formation of rules or hypotheses

Category Based Inductive Reasoning

- Category level information
  - Enables a rich set of inferences

Category Based Induction

- Powerful reasoning tool
- Allows us to project information between categories

If Tunas thrive in sunlight
How likely is it that Goldfish thrive in sunlight?

Category Based Induction

If Tunas thrive in sunlight
How likely is it that Goldfish thrive in sunlight?

- Tunas and Goldfish are similar in some respects
  - Perhaps they will be similar in terms of a novel property

Similarity Coverage Model

- Similarity Coverage Model
  - Osherson, Smith, Wilkie, Lopez, & Shafir (1990)
  - Mathematical model
  - Predicts degree of belief in inductive inference
- Categorical argument is strong
  - When premise increase degree of belief in conclusion
    - Similarity between premise & conclusion categories
    - Similarity between premise category and members of common lowest-level category

Premise-Conclusion Similarity

- Similarity between premise & conclusion
  - Robins have sesamoid bones
  - Therefore sparrows have sesamoid bones
- Greater belief

- "Blank" properties
  - Decrease reliance on background knowledge
  - Increase reliance on category structure

Premise-Conclusion Similarity

- Differences between premise & conclusion
  - Robins have sesamoid bones
  - Therefore birds have sesamoid bones
- Lesser belief

Typicality Effects

- Apples have circuloid cells
- Therefore fruits have circuloid cells

- Figs have circuloid cells
- Therefore fruits have circuloid cells

- Greater belief in inductions from category typical members

Typicality Effects

- Apples have circuloid cells
- Therefore pears have circuloid cells

- Apples have circuloid cells
- Therefore lemons have circuloid cells

Counter-Intuitive Predictions

- Greater belief
  - Bears have metaglobulin in their cells
  - Therefore mammals have metaglobulin in their cells
- Lesser belief
  - Bears have metaglobulin in their cells
  - Therefore rabbits have metaglobulin in their cells

- Bears are typical mammals
  - Are more similar to other mammals than they are to rabbits

Premise Diversity

- More Diverse = Greater belief
  - Bears have sesamoid bones
  - Birds have sesamoid bones
  - Therefore lizards have sesamoid bones
- Less Diverse = Lesser belief
  - Bears have sesamoid bones
  - Horses have sesamoid bones
  - Therefore lizards have sesamoid bones

Premise Diversity

- Disease A affects the white pine
- Disease A affects the weeping willows
- Disease B affects the paper birch
- Disease B affects the river birch
- Which disease is more likely to affect all trees, A or B?

- Typical undergraduates pick Disease A
- Itza Maya adults and tree experts pick B

Expert versus Novice Inductive Reasoning

- Experts reason about ecological relations and potential causal mechanisms

Reasoning with Non-blank Properties

- Anatomical feature
  - Brain continues to develop during the first third of its life
- Behavioral feature
  - It travels shorter distances in extreme heat
- Anatomical similarity
  - Bear – Whale
- Behavioral Similarity
  - Tuna - Whale

Heit & Rubinstein (1994)

- Anatomical Match – Anatomical Property
  - A bear's brain continues to develop during the first third of its life
  - Rate the probability that a whale's brain continues to develop during the first third of its life
- Anatomical Match – Behavioral Property
  - A bear travels shorter distances in extreme heat
  - Rate the probability that a whale travels shorter distances in extreme heat

- Behavioral Match – Anatomical Property
  - A tuna's brain continues to develop during the first third of its life
  - Rate the probability that a whale's brain continues to develop during the first third of its life
- Behavioral Match – Behavioral Property
  - A tuna travels shorter distances in extreme heat
  - Rate the probability that a whale travels shorter distances in extreme heat

Heit & Rubinstein (1994) Results