

Reasoning & Logic

Psy 20

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Logic: Drawing valid inferences from premises

Are people logical?

Fundamental philosophical question.

Also basic for q's about optimality of behavior

(e.g. hallmarks of western civ-- science, public debate & democracy, juries!)

Theoretical approaches:

Abstract-rule theories (psycho-logic)

Probabilistic interpretation

Domain-specific rule theories (e.g., social contracts, cheating detection)

Mental model theories

Conditional reasoning

If it is raining, then Dominique gets wet (If P then Q).

What are valid inferences?

Modus ponens: P.....therefore Q

Modus tollens not-Q.....therefore not-P

Invalid (occasional mistakes e.g. Table 10.1):

Affirming the consequent Q.....therefore P

Denial of the antecedent not-P.....therefore not-Q

Why are these mistakes common?

Abstract rule theory:

Rules are used.

Errors results from comprehension/miscoding of language

E.g. Gricean "cooperativeness" in language--
assume speaker "cooperates" by "using" background
knowledge & speaking efficiently

E.g. "It might rain today"
"I'm leaving..." "...Who is he?"

--> conditionals interpreted as biconditionals

... "If it is raining, D gets wet"
means "If and only if it is raining, D gets wet"

--> error of affirming the consequent

Abstract rule theory blames errors on comprehension
mistakes (misunderstandings)

Probabilistic interpretations

Maybe people assume logical connections are probabilistic
 $P \rightarrow Q$ means P and Q are co-related

	Q	-Q
P	.40	.10
-P	.20	.30

$$\text{prob}(Q|P) = .40/.50 = .80$$

$$\text{prob}(-Q|-P) = .30/.50 = .60 \quad (\text{denial of antecedent})$$

$$\text{prob}(P|Q) = .40/.60 = .67 \quad (\text{affirmation of consequent})$$

$$\text{prob}(-P|-Q) = .10/.40 = .25$$

can explain high rates of "error"

and modus ponens more "natural" than modus tollens

Wason 4-card selection task

Many errors of affirming the consequent in "testing"
if-then rule

Realistic materials help (envelope checking, 92% correct) but not all
Checking ID in a bar
--> schemas matter.

"pragmatics" : "potentially apply to a wide range of content domains" "are constrained by particular inferential goals and event relationships of certain broad types" (Cheng-Holyoak)

e.g. permissions To do X you must satisfy condition Y
 $X \rightarrow Y$ means $\text{not-}Y \rightarrow \text{not-}X$

Can drink --> satisfy "over 21"

obligations

If you satisfy condition Y, someone owes you X
 $Y \rightarrow X$ means $\text{not-}X \rightarrow \text{not-}Y$

Evol'y view: Cavepeople learned to cheating-detect

HKong/Michsubjects on envelope/cholera probs
"recent" experience >> cave experience?

revisionist view (Oaksford-Chater)

think of $P \rightarrow Q$ as one hypothesis, others are worth testing

choose information which best distinguishes $P \rightarrow Q$
from other hypotheses

can explain cheating-detection & more general effects

Quantifier reasoning

What about "some", "all", "none"-- categorical syllogisms
Frequent mistakes. Why?

Atmosphere hypothesis

too willing to accept false conclusions
when "atmosphere" of conclusion matches premises

what follows? mental model:

athlete

athlete

beachcomber = clerk

beachcomber = clerk

(beachcomber)

(clerk)

responses:

None of the athletes is a clerk

None of the clerks is an athlete

There is no valid conclusion

Some of the clerks are not athletes

JUDGMENT & DECISION MAKING

Psy 115
Prof Camerer

How do people judge probabilities?

Heuristics-and-biases approach: (Tversky-Kahneman)

People probably use rule-of-thumb "heuristics"
Heuristics can be discovered by the "biases"
(systematic departures from laws of probability)
they produce

Representativeness

Many situations call upon judgments of how well one thing
represents another

a. How representative is the numerical value X of the statistical process M ?

X =three men, all 5'10" tall, M =American men

b. How representative is an instance X of class M ?

X = robin, M =birds

c. How representative is the subset X of the class M ?

X = population of Florida, Illinois M = population of USA

d. How representative is the effect X of causal system M ?

X = lung cancer , M =smoking

Rep'ness (cont'd)

- Biases in probability judgment occur when the representativeness of X to M is used to judge $P(X|M)$.

E.g., robins are more likely (than crows, chickens) because they are more representative of "bird"

- Representativeness has a psycho-logic of its own. Often violates statistical principles:

1. Law of small numbers

Short sequences should be representative of the statistical process that generated them.

Example: Coin flip exercise.

Systematic misperception of randomness

--> Truly random sequences seem to have "momentum"

So...misplaced faith in the "hot hand" in basketball, baseball.

Rep'ness (cont'd)

2. Underweighting of base rates

Jack is a 45-year old man...

E= engineer, L=lawyer

Bayes' rule prescribes close relation between $P(E|Jack)$ and "base rate" $P(E)$.

$$P(E|Jack)P(Jack)=P(E \& Jack) = P(Jack|E)P(E)$$

$$\rightarrow P(E|Jack)=P(Jack|E) P(E)/P(Jack)$$

If base rate $P(E)$ is higher, judged $P(E|Jack)$ should be higher too.

Two conditions, high $P(E) = .70$ low $P(E)=.30$

$$P_{high}(E|Jack)=\frac{P_{low}(E|Jack)}{P_{low}(E|Jack) + (.09/.49)[1-P_{low}(E|Jack)]}$$

Caltech: $P_{high}(\cdot) = .532$ $P_{low}(\cdot) = .383$

Representativeness has no special role for base rates.

$P(E|Jack)$ judged based on how representative Jack is of the class of engineers

Other examples:

- probability of obscure major
- Is she from Tibet or China?
- Is he/she an actor or a teacher?

med school: "If you hear hoofbeats, it's a horse not a zebra"

Rep'ness (cont'd)

3. Regression toward the mean

P(extreme observation in t+1 | extreme observation in t)
seems high

examples: movie sequel grosses
"sophomore slump" in record sales
Sports Illustrated performance
pilot performance in Israeli army

No! Extreme observations likely to be followed by
less extreme observations

4. Conjunction fallacy

Linda the feminist bank teller

$P(B \& F) \leq P(F), P(B)$

But Linda seems more representative of the class B & F
than of the class B.

--> Violations of conjunction rule

Caltech: 20 0 violations

22 1 violation (usually $P(B\&F) > P(B)$)

3 2 violations

--> Adding detail to a scenario may make it seem more likely

Availability

Judge probability of X by how easily instances of X can be retrieved.

-- recency effect (earthquake insurance purchase rises after major quake)

-- Is r more likely to occur as 1st or 3rd letter?

-- Fault tree bias: Probability of "all other causes" too low

(Mickey Rourke, Body Heat: 50 things you forget...)

-- Illusory correlation: Perceived correlations depend on strength of associative bond.

Association may overwhelm statistical evidence

Gay men draw big muscles in Draw-A-Person test.

Paranoids draw big eyes.

Fueled by confirmation bias: Overweight +/+ cell

(Secret to perceived success of astrology, horse trainer Wayne Lukas)

-- Egocentric biases of credit/blame.

Married couples: What % of fights do you start?

What % of chores do you do?

Both add to 110%