1 ❑ Of relationships –
Correlation vs. *Causation*

✓Definitions
- Covariation/correlation
- Contingency
- Causation

2 ❑ Covariation/correlation

✓If two events or features tend to occur together (co-occur), then they are said to *covary* or to be *correlated*.

✓Examples
- Lightning and thunder
- Blond hair and blue eyes
- Going to a classroom and hearing a professor give a lecture.

✓Question – are these things causally related?

3 ❑ Correlation/covariation, cont.

✓Correlation is a broad concept that also includes situations in which the two correlated factors are "continuous"

✓Examples
- Height and weight are positively correlated (r = .79)
- Systolic bp and diastolic bp are positively correlated (r = .81 in adults)
- Score on standardized test for math and SES are positively correlated (r = .4 in high school).

4 Contingency

- ✓An event, B, is said to be "contingent" on another event, A, if there is a greater likelihood that B will occur after A has occurred than when A hasn't occurred.
- ✓Formally
  - P(B|A) should be higher than P(B|not A)

5 Examples of contingent relations

- ✓Rain is much more likely in the presence of dark clouds than in their absence.
- ✓Getting a good grade on an exam is much more likely after you've attended class and studied the material than if you haven't.
- ✓A piece of metal is more likely to rust after being exposed to water than when it's not.
- ✓Question – are these things causally related?

6 Causation

- ✓Metaphysical causality
  - Immanuel Kant
  - The "God's eye view" – what is *really* going on….

7 Causation, cont.

- ✓Psychological causality
  - Hume's cues to causality
    - Covariation
      - The cause should covary with the effect (correlation)
    - Temporal priority
      - The cause should precede the effect in time

- Temporal contiguity
  - The cause and its effects should be close together in time.
- Spatial contiguity
  - The cause and its effects should occur near one another in space

8 Psychological causality, cont.

- Neo-Humean
  - Not covariation – contingency
    - The effect should depend on the occurrence of its causes
- The experimental method is built around these cues to causality.
- Advanced correlational methods (e.g., time-lagged panel designs, partial correlation) were proposed to better incorporate these cues into correlational designs.

9 Judgment of covariation/correlation

✓How do you judge covariation?

- Depends on the kind.
  - Event covariation
    - If two things co-occur, then they covary.
    - Problem – tendency to ignore the times when one occurs without the other or when neither occurs.
      - » These other data points are just as important (discussed later).
  - Correlation between continuous variables

10 Correlation

✓Jennings, Amabile, & Ross (1982)

- Subjects were given three types of data.
  - Sets of 10 simple numbers.
  - Sets of drawings of 10 men of various heights holding walking sticks of various heights.
  - Sets of audiotapes of alphabet letters and musical notes of varying dimensions.

11 Jennings et al. (1982): Results

- ✓Lots of variability
- ✓Great difficulty identifying all but the most obvious correlations.
- ✓Estimates did not differ significantly across data types.

12 ❒ Factors that influenced correlational judgment

- ✓People tend to rely on a few extreme cases (Jennings et al.)
  - The shortest and tallest guys, the shortest and longest notes.
- ✓Concrete and vivid data points are most influential.
- ✓First few and last few data points are most influential
  - Primacy and recency effects.

13 ❒ Kareev,Lieberman, & Lev (1997)

- ✓Found that correlation detection was more accurate with much smaller sample sizes.
  - Too many samples overwhelmed short term memory capacity.
  - Correlations were positively biased (Kareev, 1995).

14 ❒ Predictive task

- ✓Subjects are asked to predict one value from another rather than to judge their correlation (DeLosh, Busemeyer, & McDaniel, 1997).
  - This is a non-verbal task.
  - Recall that use of base rates was higher in a prediction

task than in a verbal assessment task.

✓Performance is much better and captures the relationship very well.

15 Illusory correlation

✓When theories or biases determine your assessment of correlation.

- Based on your expectations and biases
  - Chapman & Chapman (1971) Rorschach inkblot and DAP interpretation.
  - Theories will strongly affect your use of available data and can completely override that data (Chapman & Chapman, 1971; Jennings et al., 1982)

16 Chapman & Chapman (1967)

✓People viewed various word pairs such as bacon-tiger.

- Word on the left was either bacon, lion, blossoms, or boat.
- Word on the right was either eggs, tiger, or notebook.
- All pairs occurred equally often.

✓People later said that bacon and eggs co-occurred 47% of the time.

17 de Jong et al. (1992)

✓Presented treated and untreated spider phobics with 72 pictures (including some spiders).

✓Each of the pictures was randomly followed by a tone, mild shock, or nothing.

✓Untreated spider phobics way overestimated the correlation between spider pictures and shocks in

their study.

18 Tversky & Redelmeier (1996)

- ✓Weather doesn't affect arthritis pain
- ✓Recruited 18 patients with arthritis and followed them for 15 months.
- ✓They also obtained local weather reports on temperature, barometric pressure, and humidity.
  - No correlation between the patients' symptoms and the weather, no matter what aspect of weather they looked at.

19 Tversky & Redelmeier (1996), cont.

- ✓Second experiment involving students
  - Generated sequences of random numbers and labeled one sequence "arthritis pain" and another "barometric pressure."
  - They asked 97 college students if they saw evidence in the data that pain was correlated with barometric pressure.
  - The students found patterns when there were none to be found.

20 Illusion of control

- ✓Langer's (1975) football card matching study
- ✓People bet more before they throw dice than after they've thrown them, but outcome not yet disclosed (Strickland, Lewicki, & Katz, 1966).

21 Summary

- ✓We see relationships where none exist.
  - This gives rise to an illusion of control.
- ✓We miss relationships that do exist.

- ✓But, when we rely on non-verbal assessments (e.g., a predictive learning task) with constant feedback, we can be very accurate.

22 Correlation does not equal causation

- ✓Issue of directionality
  - – Negative correlation between drinking and GPA
    - Does drinking more decrease GPA?
    - Do people who do well in school find fewer reasons to drink?
- ✓Issue of third factors
  - – Is their a 3rd factor that causes one to drink more and do poorly in school?

23 Examples of real relationships

- ✓In China, there's a negative correlation between the number of toasters owned and the number of children in a family.
  - – Are toasters a good form of birth control?
  - – No – higher SES families tend to have fewer children and to have more money for toasters.

24 Example 2

- ✓There is a moderate correlation between milk consumption and cancer incidence across societies (relative wealth of societies).
  - – Any health practice that increases longevity will likely be causally related with the incidence of cancer in a society.

25 Example 3

- ✓Small negative correlation between death rates and divorce rates

- More divorces, lower death rate
- Third factor: age distribution
  - Older married couples are less likely to divorce and more likely to die than younger couples.

26 Example 4

✓New Hebrides Islands: body lice are considered a sign of good health.

- When people got sick, their temperatures rose which caused lice to go elsewhere.
- Both "good health" and lice depart because of third cause: fever.

27 Judgment of contingency

✓A directional concept

- If B's occurrence depends on A's occurrence, this does not imply that A's occurrence depends on B's occurrence.
- Example
  - Getting pregnant depends on your having sex.
  - But having sex doesn't depend on your getting pregnant.

✓Contingency is more important to accurate causal judgment than covariation is.

28 How should we judge contingency?

✓2 x 2 contingency table

✓Where a,b,c, and d represent frequency each event type

29 ΔP (delta P)

✓Recall that judging the contingency between two events, A and B, involves comparing P(B|A) and

P(B| not A).

- This difference is called
- ΔP = P(B|A) - P(B|not A)

✓Delta P is a normative method for identifying contingency.

30 Finding ΔP from 2 x 2 table

✓P(B|A) = a / (a+b)

✓P(B|not A) = c / (c+d)

✓ΔP = a / (a+b) - c/(c+d)

31 Example

✓You see 24 cards indicating the outcome of experiments on the efficacy of a certain fertilizer on plant growth

- 10 show fertilizer followed by growth
- 5 show fertilizer followed by non-growth
- 6 show no fertilizer followed by growth
- 3 show no fertilizer caused by non-growth

32 Example, cont.

✓2 x 2 contingency table

✓ΔP = a / (a+b) - c/(c+d)

✓ΔP = 10/15 - 6/9 = 0

33 Positive and negative contingencies

✓Positive contingencies (positive ΔP)

- Increase likelihood of another event.
  - Examples: eat lots of sweets - gain weight, flip switch - lights turn on, studying - pass class.

- ✓Negative contingencies (negative ΔP)
  - Decrease likelihood of another event.
    - Examples: hitting brake to avoid accident, use inhaler to minimize asthma attacks, brush teeth to avoid cavities, hire guards to prevent crime.

34 What people do

- ✓Many studies report that people
  - Overemphasize the information in cell a (big time)
  - De-emphasize the b and c cells
  - Almost completely ignore cell d.
- ✓Many judgments are almost exclusively driven by the a cell.
  - Confirmatory bias
- ✓Casinos aid this bias by emphasizing 'a' cell

35 The ignoring of d-cell information

- ✓Hattori and Oaksford (2007) argue that is often a good strategy to ignore d because the number of instances of d is usually very large.
- ✓So, if ΔP = a / (a+b) - c/(c+d) and d is very large, this value approaches a/(a+b).
  - This equation (and variations considered by H&O) often does a good job of describing people's behavior on causal judgment tasks.

36 Good contingency judgment…

- ✓Although our retrospective judgments of contingency are often susceptible to judgment biases, our behavior can reflect good sensitivity to reigning contingencies.

37 ❑ Remember the Goal:
Identifying causal relationships.

- ✓Contingency plays a central role in the identification of causality.
- ✓Identifying causality is critical to predicting and controlling the future.

38 ❑ Examples of everyday causal attribution

- ✓Identifying what's causing your computer to crash.
- ✓Diagnosing diseases
- ✓Judging the efficacy of a game strategy
  - – My solitaire strategies.

39 ❑ Superstitious behavior - misperception of causality

- ✓Skinner (1947) – superstitious behavior in the pigeon.
  - – A pigeon will often develop some response such as turning, twisting, pecking near the locus of the discriminative stimulus, flapping its wings, etc.
  - – Behavior is due to "spurious correlations" created when reinforcement rate is high.

40 ❑ Superstition in sports

- ✓Wade Boggs, five time winner of the American League batting title and third baseman for the 1996 World Champion Yankees, believes he hits better after eating chicken, and therefore ate only the chicken the day of a game.

- Note – his reinforcement rate is high.

41 More superstitions in sports...

- ✓Michael Jordan is a very superstitious guy and he always played for the Chicago Bulls with his North Carolina's shorts under the Bulls uniform for luck.
  - Again, note the high rate of reinforcement.

42 Non-athletes and superstition

- ✓Michael Crichton, a bestselling author, will eat the same thing for lunch every day while working on a new novel.
  - Again - a highly successful author.

43 Judging the efficacy of interpersonal strategies

- ✓People are often reluctant to convey explicit negative reactions to another's interpersonal strategies.
  - Consequence? People don't get information from all four cells – only two.
  - Use strategy - # positive reactions and # negative reactions?
  - Don't use strategy - # positive reactions and # negative reactions?

44 Ineffective health practices

- ✓People can't try different treatments for the exact same symptoms.
- ✓They rarely try not treating a disease to see the outcome.

- Thus, they often don't get information on two of the cells of the 2 x 2 table.

✓Even if they do withhold treatment, these cases are less salient than when they tried something.

45 Causal chains - Causal primacy

✓When there are a chain of events that produce the effect, people seem to attribute more causality to the first event than to the last.

- The first event is seen as the "trigger" or "root cause"
- This affects legal decision making - jurists are more likely to attribute blame to first link in chain (Johnson, et al, PSPB, 1989).
- BUT, when initiating event is distal and chain less obvious, last link in chain can reign supreme.
  - Sports inferences about blame.
  - May rest on inability to *simulate* different outcome when change made early in this type of chain.

46 Summary

✓Causality is not directly "perceived" but is "inferred."

- Spatial and temporal contiguity, high contingency, and the absence of alternative causes all contribute.

47 Summary, cont.

✓Contingency can be directly assessed via the ΔP rule.

- But, this is a normative rule that we violate by emphasizing the "a" cell more than others.
- And, we may not have access to the effect-absent cells (e.g., MJ hasn't had many bad games).

48 Summary, cont.

- ✓ We often rely on simple associative mechanisms that are present in animals to infer causality.
  - But, rule-based reasoning can influence this.
- ✓ Causes interact, although we often behave as if they don't.