Causality and experiments

Does anyone belong to clicker numbers?
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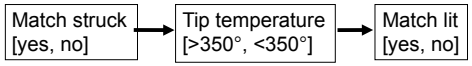
974232E7
89B44578
82A3DCFD

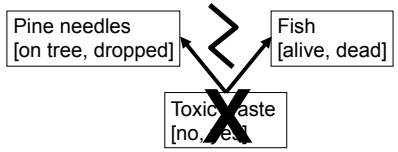
Review

- Diagramming causal relations
  - Variables as nodes (boxes)
  - Causal relations as arrows
- Not tracing the flow of activity, but causal relations
  - If there are conditions under which changing one variable will result in change of another variable, include a arrow between the variables
- Sometimes there are important intermediate causes such that a more ultimate cause only produces its effect through a more proximate cause



Review - 2

- Common cause
  - A positive correlation between two variables may be the result of a common cause for both



- If the causation is direct, there should be no way to screen off E from C

Review – 3

Common mistakes in causal reasoning

Ignoring a common cause

- You wake up with a fever. A few hours later you find red spots on your skin. You conclude that the fever must have caused the red spots.

Post hoc, ergo propter hoc

- You go to the doctor, the next day you feel better, therefore the doctor caused you to feel better

Confusing cause and effect

- Layoff of workers is cause of economy slowing down

Clicker Question

Which causal fallacy does this example illustrate?

Whenever the power goes out, your Dad starts beating on the wall. The power comes back on and he takes credit for getting it on again.

Ignoring a common cause
Post hoc, ergo propter hoc
Confusing cause and effect
None of the above

Clicker Question

What causal fallacy is illustrated in this example: Mindy has a car accident. When the police arrive, they find a lot of empty beer cans in the passenger seat. They conclude that the beers cans caused the accident.

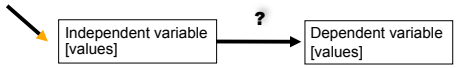
Ignoring a common cause
Treating coincidence as a cause
Post hoc, ergo propter hoc
Confusing cause and effect

The basic idea of an experiment

If the independent variable is the cause of the dependent variable, then a manipulation of the independent variable should produce a change in the value of the dependent variable

And if it were not the cause, we would not expect such a result from manipulation

Manipulation



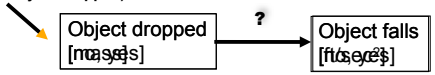
Experiments on regular deterministic systems

When there is no variance in the population being studied, statistical analysis is not necessary

The main danger is affirming the consequent

The key is to test a causal hypothesis in which you would not expect the effect to occur unless you were right about the cause.

Manipulation
(vary the object dropped)



Clicker Question

To avoid affirming the consequent, which premise should one use to confirm a hypothesis?

- If X is the cause of Y, then Y will change as X changes
- If X is the cause of Y, then Y will not change as X changes
- If X is not the cause of Y, then Y will change as X changes
- If X is not the cause of Y, then Y will not change as X changes

Variability in non-deterministic systems

Different systems of the same kind will vary in their responses depending on
- their particular composition (genetics, etc.)
- their particular history, etc.

The same system may respond differently on different occasions

Your reaction time will differ depending on
- how much sleep you have had
- what you have had to drink, etc.

Challenge: how to detect causal relations in the face of background variability (noise)?

Experiments on non-deterministic systems

Since complex systems
biological
cognitive
social
are not perfectly regular in their behavior

Researchers cannot simply do an experiment on one instance and draw a conclusion about the whole population
Must rather work with samples and draw conclusions based on statistical analysis
- Are the differences in the values of the dependent variable greater than expected by chance?

Confounding Variables

The reason different individuals behave differently is that among **extraneous variables**, some may be related to the effect of interest.

When such variables are or may be correlated with the putative cause and may be responsible for the effect produced in the study, they are called **confounds**

There are two kinds that are particularly important:

Subject variable confounds:
- Differences between subjects in the study

Procedural variable confounds:
- Differences in the way different groups are treated

If these variables are correlated with the independent variable and are also causes of the dependent variable, the experiment is **confounded**

Clicker Question

A confound is

- The dependent variable in an experiment
- An extraneous variable that may causally affect the independent variable
- An extraneous variable that may causally affect the dependent variable
- The independent variable in an experiment

Strategies for controlling confounding variables

Locking

- Most commonly used to control confounding procedural variables

Randomization

- Most commonly used to control confounding subject variables

Matching subjects

- A less preferred strategy for controlling confounding subject variables
  - Only works for known confounds

Making confounding variables into studied variables

Procedural variable confounds

When you conduct a manipulation, generally more than one thing will be changed

- These variables will then be correlated with the independent variable but with respect to the independent variable being tested are **extraneous**
- If one of the other variables is causally related to the effect of interest, it rather than the variable you are considering may be the cause—**confound**

Confounding Procedural Variables

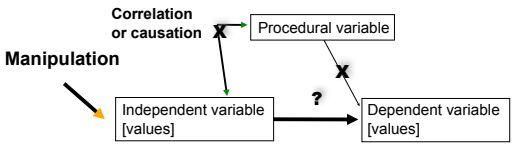
The president of the AGL corporation wanted to get his workers to be more productive

She found that when each employee was presented with a jar of jellybeans, productivity increased

Was it the jellybeans that caused the increased productivity? Or was it:

Novelty of the situation
Attention from the president
Desire to reciprocate

Controlling confounding procedural variables



Strategy: break the correlation—thereby breaking the effect of the confounding variable

Commonly achieved via **locking**

Clicker Question

What method(s) could you use to eliminate the effects of the confounding procedural variables in the jellybean case (e.g., novelty of situation, attention from president, desire to reciprocate)?

Random assignment
Lock the value of each variable
Match subjects on the values of each variable
Make the variable a factor in the experiment

Demand characteristics can create procedural confound

People may change their behavior when they are being studied (recall: Reactivity Bias)
- People want to be liked (or not!)
- People want to be helpful (or not!)
- People want you to think they're a good/clever person
- People want to be thought of as intelligent and normal (not crazy, stupid or obsessed)

Problem if subjects figure out the point of an experiment

Solutions:
- Keep subjects blind as to the point of the experiment or what is being studied (single-blind experiment)
- Make sure procedure is locked so all subjects are affected the same

Experimenter Bias Can Create Procedural Confound

Danger that experimenters will see what they want to see (a former of observer bias)
- Mendel's data is too perfect—there should be more variability
  - Most likely explanation is that he did not deliberately cheat (remember, he was a monk!)
  - but he reported the best cases and subjectively biased his counting of plants

Keep the data-tabulator blind as to which group different subjects are in
- Double-blind study

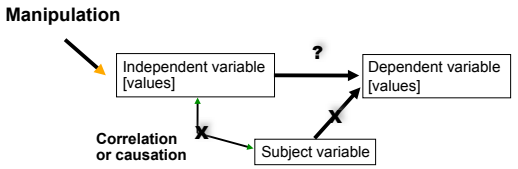
Subject variable confounds

Subjects in an experiment may have different values on other variables than the independent variable
- People of different ages sleep different amounts
- Women might be affected differently than men

If these aren't the independent or independent variable, these variables are extraneous

If there is a correlation between these variables and the independent variable,
- they, rather than the variable you are focusing on, may be what produce the change in the dependent variable
  - Such variables are confounds

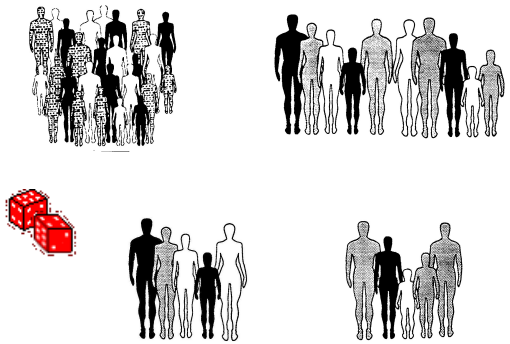
Controlling confounding subject variables



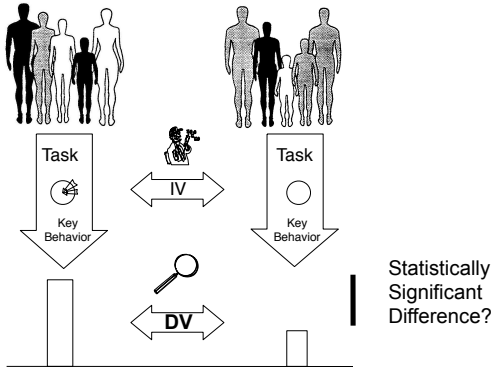
Strategy: break the correlation—thereby breaking the effect of the confounding variable

Random assignment of subjects is a strategy for breaking the correlation

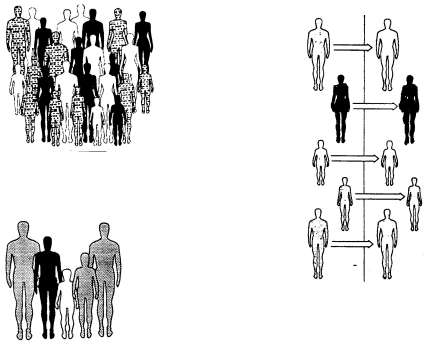
Controlling subject confounds: ***Between subjects*** randomization



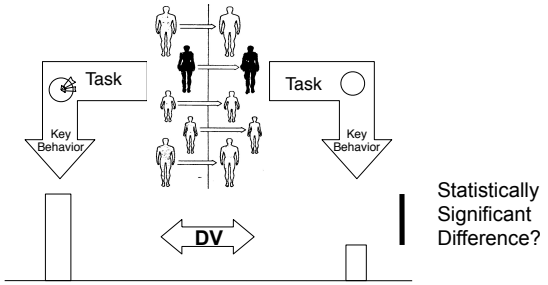
Manipulate independent variable



Controlling subject confounds: **Within subjects** design



Subjects serving as own control



Between-subject design

GOOD NEWS:

- Participants are not "contaminated" in one condition as a result of having participated in the other

BAD NEWS:

- Requires a larger number of participants
- Runs the risk of non-equivalence of subject groups

Within-subjects designs

GOOD NEWS:
- Requires a smaller number of participants
- Rules out any differences between subjects

BAD NEWS:
- Potential "contamination" of participants' behavior from previous trial: *carryover effect*
- Subjects might learn from one condition and that could alter their behavior in the second condition
  - *Practice effect*
  - *Fatigue effect*

These are additional confounds that must be controlled for.

Clicker Question

A within-subjects design

Uses participants as their own controls
Requires fewer participants than a between subjects design
Runs the risk of a carryover effect
All of the above

Counterbalancing

Goal: eliminate confounds in within-subjects design

Within subject counterbalancing
Reversing order: ABBA
Across subject counterbalancing
–Complete: every possible sequence of conditions—requires n!
–Partial
- Random
- Latin Square:
  - each condition appears once and only once in a given ordinal position
  - no two conditions are juxtaposed in the same order more than once

Order 1:	A	B	D	C
Order 2:	B	C	A	D
Order 3:	C	D	B	A
Order 4:	D	A	C	B

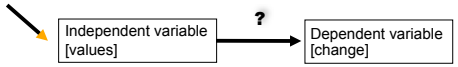
Pretest—Posttest Design

There is always a danger in an experiment that the members of the two (or more) groups being studied already differ on the dependent variable

Best control is to focus on change, not raw value of the dependent variable

Pretest: measure the dependent variable before the intervention
Posttest: measure the dependent variable after the intervention
Change = Posttest – Pretest

Manipulation



Limitations of pretest-posttest design

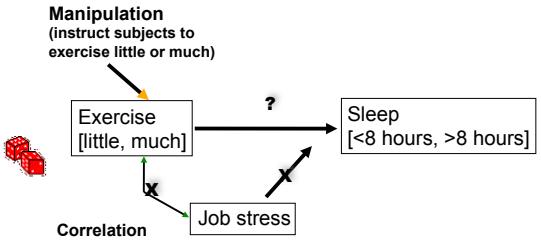
Just measuring change in one group using a pretest and a posttest allows for confounds

- Time has elapsed and subjects have gotten older (maturation)
- Events occurring between the pretest and posttest could affect the dependent variable (history)
- Experience with previous test may change performance
- Pretest and posttest may vary in difficulty

Use of pretest-posttest does not obviate the need for a control group

Example: Exercise and sleep

Is there a causal relation between exercise and sleep?



Example: alcohol and running speed

Alcohol [no, yes] → ? → 100 yard dash speed [seconds]

Between subjects or within subjects

Between-subjects design
- Different subjects would be used for the no-alcohol and alcohol condition, and each would be tested only once

Within-subjects design
- Each subject would be tested both under the no-alcohol and alcohol condition

Between subjects

Jim	**Roger**
Angela	**Shane**
Megan	**Sara**
Peter	**Jessica**

Within subjects

Jim	———	**Jim**
Angela	———	**Angela**
Megan	———	**Megan**
Peter	———	**Peter**

Counterbalance

Alcohol condition	rest	No-alcohol condition
Jim **Angela**		**Jim** **Angela**
No-alcohol condition	**rest**	**Alcohol condition**
Megan **Peter**		**Megan** **Peter**

Internal validity

An experiment is internally valid if it was in fact the manipulation of the independent variable that produced the change in the dependent variable

- Are the effects on the dependent variable due solely to the manipulation of the independent variable?
- Was there a confounding subject variable that did not get controlled?
- Was there a confounding procedural variable that did not get controlled?

Clicker Question

Which of the following is not a threat to internal validity
- The independent variable is only a contributory cause
- The existence of a confounding procedural variable
- The existence of a confounding subject variable
- All of the above

Planning an experiment

Say the color the following words are written in

Blue	**Pink**
Brown	**Yellow**
White	**Orange**
Red	**Green**

Does it seem harder to name the colors when the words name a different color?

Planning an experiment - 2

BLUE	GREEN	YELLOW
PINK	RED	ORANGE
GREY	BLACK	PURPLE
TAN	WHITE	BROWN

How might we test the claim that it is the meaning of the word that makes it harder to say the color it is written in?

Operationalize the notion of being hard to read
- Slower reaction time when incongruent words
- More errors when incongruent words

Identify a sample population
- College undergraduates in psychology courses

Pick study design
- Between subject
- Within subject

Controlling subject variable confounds

BLUE GREEN YELLOW
PINK RED ORANGE
GREY BLACK PURPLE
TAN WHITE BROWN

What subject variables might you have to worry about as confounds?

How to control for these confounds

If between subject
- Randominze

If within subject
- Counterbalance

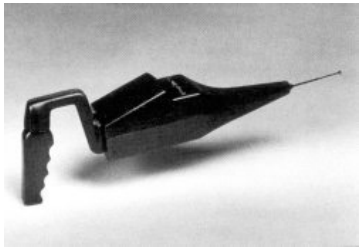
Controlling for procedural variables

BLUE GREEN YELLOW
PINK RED ORANGE
GREY BLACK PURPLE
TAN WHITE BROWN

What procedural variables should be controlled to avoid confounds?
- Context of presentation
- Illumination of the stimuli
- Length of words
- Familiarity and frequency of words

Need to lock these variables so that they do not vary across conditions

A miracle device?



Detect human beings hidden in building or behind objects from almost two football fields away!

The DKL LifeGuard

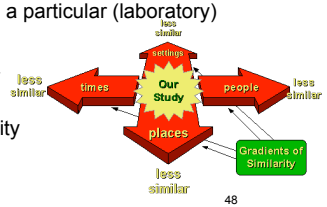
According to the company can detect human heartbeat
- Range of up to 500 meters (540 yards)
- No effective electronic or other countermeasures
- No natural and synthetic material it cannot penetrate
- No battery or any power sources required!
- Repeatability of 99%
- Can penetrate:
  - 10-meter wide earthen barrier
  - 10 feet of water
  - concrete walls, steel bulkheads
- Can distinguish a man, woman or child from any other animal, even a gorilla or an orangutan
- Requires only one day of operator training
- Work as well in darkness as in daylight
- Like no other technology on the market today.... literally in a league of its own.

Double-blind test

- Five large plastic packing crates were set up in a line a 30-foot intervals
- A DKL representative, using the DKL LifeGuard Model 2, tried to detect which of the five crates contained a human being
- On preliminary tests in which the operator knew which crate contained the person, the DKL LifeGuard found the person 10 out of 10 times
- In the real, double-blind test, the operator found the person 6 out of 25 times (and took much longer to find the person)

External Validity

To what extent can you generalize the results of your study?
- Are they specific to a particular sample?
  - College sophomores or the general population
- Do they only apply in a particular (laboratory) setting?
- Do they generalize beyond the details of the manipulation
  - Ecological validity



Population Generalization

Will a study using one population generalize to another population?

- Will a study of college sophomores generalize to middle-aged adults?
- Will a study of chronically depressed patients generalize to patients who are acutely depressed?
- Will a study of captive raised dolphins generalize to wild dolphins?
- Will a study on mice generalize to humans?

Setting Generalization

Will a study conducted in one laboratory or clinical setting generalize to the setting of interest?

- Will results obtained in a flight simulator generalize to an actual cockpit?
- Will results obtained in an outpatient setting generalize to a psychiatric hospital?
- Will results obtained in a laboratory generalize to customers in a store?

Manipulation Generalization

Will a result obtained with one task generalize to other tasks or stimuli?

- Will studies of perceiving visual illusions generalize to perception of ordinary objects?
- Will a survey of consumer attitudes generalize to consumer behavior?

Assessing External Validity

Don't assume that the answer to external validity questions is negative

Must make a plausibility judgment in assessing external validity

- Is the target population different from the studied population in ways that are likely to matter for the causal claim?
- Is the target setting different from the studied setting in ways that are likely to matter for the causal claim?
- Is the manipulation used in the experiment different from the target process in nature in ways that are likely to matter for the causal claim?

Example: Rats and Saccharine

1977 Canadian study which fed pregnant rats up to 20% of their body weight per day in saccharine showed an increase in bladder tumors

Saccharine was banned in Canada and the FDA was about to ban its use in the US
when Congress intervened

Assessing external validity:

- Are rats relevantly like humans
- Is eating in the laboratory like eating at home, etc.?
- Is feeding up to 20% of body weight like eating as part of diet?