Causality and Validity

EDP 612 Week 7

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Introduction
to Research

Experiments and Causation

Cause

- Variable that produces an effect or result
- Most causes are **inus** -

> A cause is an insufficient (**i**)
>
> but non-redundant (**n**)
>
> part of an unnecessary (**u**) but
>
> sufficient condition (**s**)

- A given event may have many different causes
- Many factors are required for an effect to occur, but they can rarely be fully known and how they relate to one another

Effect

- Difference between what did happen and what would have happened
- This reasoning generally requires a counterfactual

Counterfactual

- Knowledge of what would have happened in the absence of a suspected causal agent
  - Physically impossible
  - Impossible to simultaneously receive and not receive a treatment
  - Therefore, the central task of all cause-probing research is to approximate the physically impossible counterfactual

Causal Relationships

A causal relationship requires three conditions

1. Cause preceded effect (temporal precedence)
2. Cause and effect covary
3. No other plausible alternative explanations can account for a causal relationship

Cause, Effect, and Causal Relationships

- In experiments
  - Presumed causes are manipulated to observe their effect
  - Variability in cause related to variation in an effect
  - Elements of design and extra-study knowledge are used to account for and reduce the plausibility of alternative explanations

Causation, Correlation, and Confounds

- Correlation does not prove causation
- Correlations do not meet the first premise of causal logic (temporal precedence)
- Such relationships are often due to a third variable (i.e., a confound)

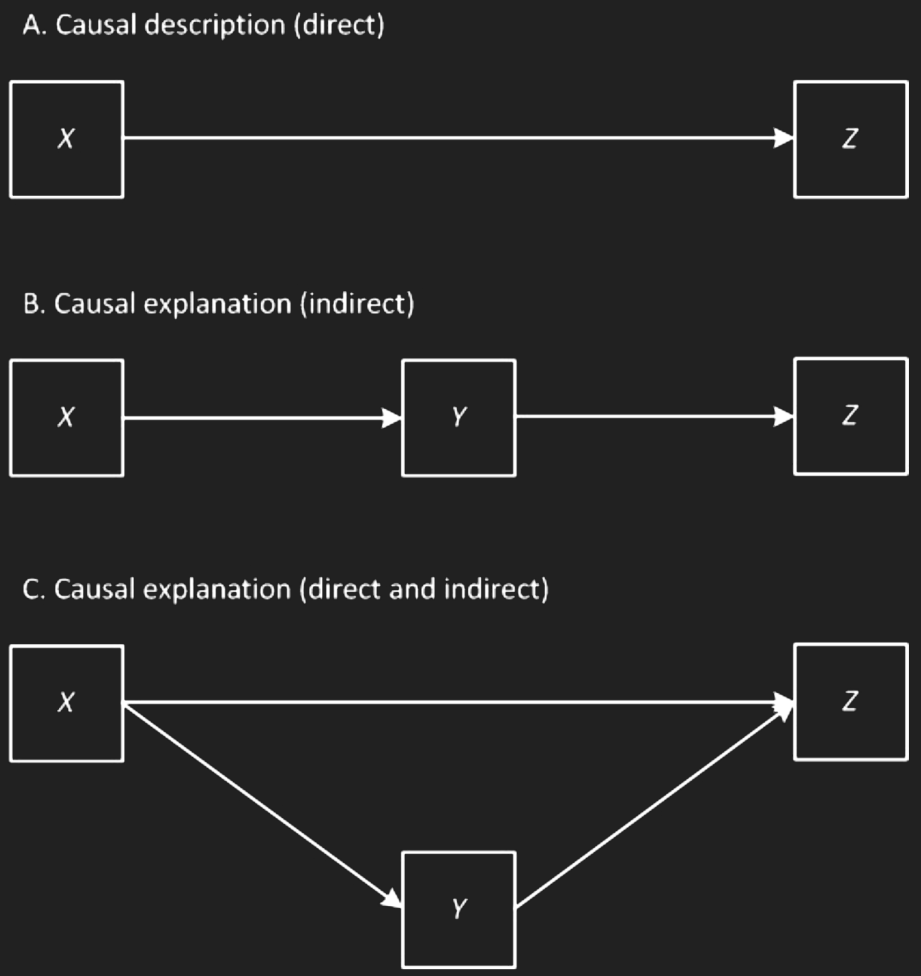
Manipulable and Nonmanipulable Causes

- Experiments involve causal agents that can be manipulated
- Nonmanipulable causes (e.g., ethnicity, gender) cannot be causes in experiments because they cannot be deliberately varied

Causal Description and Causal Explanation

- **Causal description**. identifying that a causal relationship exists between A and B
- **Molar causation**. the overall relationship between a treatment package and its effects
- **Causal explanation**. explaining how A causes B
- **Molecular causation**. knowing which parts of a treatment are responsible for which parts of an effect

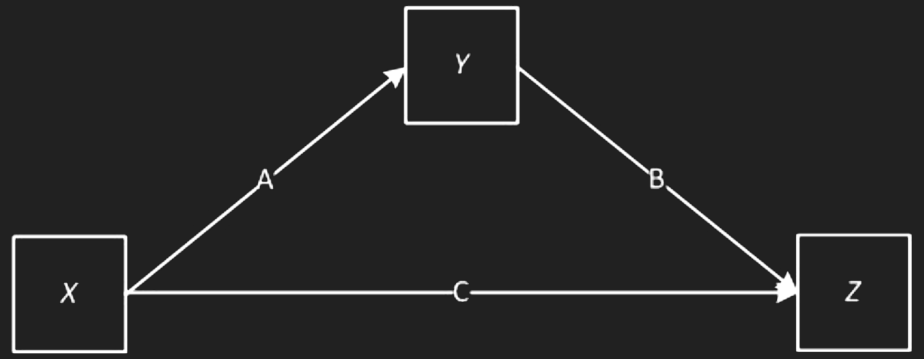
Causal Models



Causal Models

A. Moderator model

B. Mediator model



Modern Descriptions of Experiments

Randomized Experiment

- Units are assigned to conditions randomly
- Randomly assigned units are probabilistically equivalent based on expectancy (if certain conditions are met)
- Under the appropriate conditions, randomized experiments provide unbiased estimates of an effect

Quasi-Experiment

- Shares all features of randomized experiments except assignment
- Assignment to conditions occurs by self-selection
- Greater emphasis on enumerating and ruling out alternative explanations
    - ... through logic and reasoning, design, and measurement

Natural Experiment

- Naturally-occurring contrast between a treatment and comparison condition
- Typically concern nonmanipulable causes
- Requires constructing a counterfactual rather than manipulating one

Nonexperimental Designs

- Often called correlational or passive designs (i.e., cross-sectional)
- Statistical controls often used in place of structural design elements
- Generally do not support strong causal inferences

Experiments and the Generalization of Causal Connections

Most Experiments are Local but have General Aspirations

- Most experiments are localized
- Limited samples of **utos**

  > units (**u**)
  >
  > treatments (**t**)
  >
  > observations (**o**)
  >
  > settings (**s**)

- What Campbell labeled local molar causal validity

Construct Validity: Causal Generalization as Representation

- *Premised on generalizing from particular sampled instances of units, treatments, observations, and settings to the abstract, higher order constructs that sampled instances represent*

External Validity: Causal Generalization as Extrapolation

- *Inferring a causal relationship to unsampled units, treatments, observations, and settings from sampled instances*
- Enhanced when probability sampling methods are used
  - Broad to narrow
  - Narrow to broad

Approaches to Making Causal Generalizations

- Sampling
- Probabilistic
- Heterogeneous instances
- Purposive
- Grounded theory
- Surface similarity
- Ruling out irrelevancies
- Making discrimination
- Interpolation and extrapolation
- Casual explanation

Statistical Conclusion Validity and Internal Validity

Validity

- Approximate truthfulness of correctness of an inference
- Not an all or none, either or, condition, rather a matter of degree
- Efforts to increase one type of validity often reduce others

Statistical Conclusion Validity

Validity of inferences about the covariation between treatment (cause) and outcome (effect)

Internal Validity

Validity of inferences about whether observed covariation between A (treatment/cause) and B (outcome/effect) reflects a causal relationship from A to B as those variables were manipulated or measured

Construct Validity

Validity of inferences about the higher order constructs that represent sampling particulars

External Validity

Validity of inferences about whether a cause-effect relationship holds over variations in units, treatments, observations, and settings

Threats to Validity

- Reasons why an inference may be partly or wholly incorrect
- Design controls can be used to reduce many validity threats, but not in all instances
- Threats to validity are generally context-dependent

Internal Validity

- *Inferences about whether the observed covariation between A and B reflects a causal relationship from A to B in the form in which the variables were manipulated or measured*
- In most cause-probing studies, internal validity is the primary focus

Threats to Internal Validity (1/2)

- **Ambiguous temporal precedence**. Lack of clarity about which variable occurred first may yield confusion about which variable is the cause and which is the effect
- **Selection**. Systematic differences over conditions in respondent characteristics that could also cause the observed effect
- **History**. Events occurring concurrently with treatment that could cause the observed effect
- **Maturation**. Naturally occurring changes over time that could be confused with a treatment effect
- **Regression**. When units are selected for their extreme scores, they will often have less extreme scores on other variables, an occurrence that can be confused with a treatment effect

Threats to Internal Validity (2/2)

- **Attrition**. Loss of respondents to treatment or measurement can produce counterfactual effects if that loss is systematically correlated with conditions
- **Testing**. Exposure to a test can affect test scores on subsequent exposures to that test, an occurrence that can be confused with a treatment effect
- **Instrumentation**. The nature of a measure may change over time or conditions in a way that could be confused with a treatment effect
- **Additive and interactive threats**. The impact of a threat can be added to that of another threat or may depend on the level of another threat

Estimating Internal Validity in Experiments

- By definition randomized experiments eliminate selection through random assignment to conditions
- Most other threats are (should be) probabilistically distributed as well

Estimating Internal Validity in Experiments

- Only two likely validity threats (typically) arise from experiments
  - Attrition
  - Testing

Estimating Internal Validity in Quasi-Experime

- Differences between groups tend to be more systematic than random
- All threats should be made explicit and then ruled out one by one
- Once identified, threats can be systematically examined

That's it!

Any questions?