The QEDesigns

EDP 612 Week 7

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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-Experiments

- 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

Basic Design Elements and Notation

Assignment

- Random assignment
- Cutoff-based assignment
- Other nonrandom assignment
- Matching and stratifying
- Masking

Measurement

- Posttest observations
- Single posttests
- Nonequivalent dependent variables
- Multiple substantive posttests
- Pretest observations
- Single pretest
- Retrospective pretest
- Proxy pretest
- Repeated pretests over time
- Pretests on independent samples
- Moderator variable with predicted interaction
- Measuring threats to validity

Comparison Groups

- Single nonequivalent groups
- Multiple nonequivalent groups
- Cohorts
- Internal versus external controls
- Constructed contrasts
    - Regression extrapolation contrasts
    - Normed contrasts
    - Secondary data contrasts

Treatments

- Switching replications
- Reversed treatments
- Removed treatments
- Repeated treatments

Notation

Variable	Description
X	treatment
O	observation
R	random assignment
NR	nonrandom assignment
$\cancel{X}$	removed treatment
X_+	treatment expected to produce an effect in one direction
X_-	conceptually opposite treatment expected to reverse an effect
C	cutting score
---	non-randomly formed groups
$\cdots$	cohort

The Logic of Quasi-Experimentation

Rationale

- Quasi-experiments are often a necessity given practical and logistical constraints
- Greater emphasis on construct or external validity rather than cause-effect associations - ***least common***
- Funding, ethics, administration - ***somewhat common***
- The intervention has already occurred - ***most common***
- Sometimes they are the best alternative, even if causal inferences are weaker than is possible with other designs

Central Principles

- Identification and study of plausible threats to internal validity
- Careful scrutiny of plausible alternative explanations for treatment-outcome covariation
- Primacy of control by design
- Use carefully planned and implemented design elements rather than statistical controls for anticipated confounds
- Coherent pattern matching
- Complex (a priori) causal hypotheses that reduce the plausibility of alternative explanations
- Even so, great care must be taken when planning such studies as numerous threats that cannot be controlled are often operating

Designs without Control Groups

One-Group Posttest Only Design

X		O_2
Treatment	$\rightarrow$	Posttest

> Absence of pretest makes it difficult to know if change has occurred and absence of a control group makes it difficult to know what would have happened without treatment

> Known as a one-shot study

One-Group Pretest-Posttest Design

O_1		X		O_2
Pretest	$\rightarrow$	Treatment	$\rightarrow$	Posttest

> Adding a pretest provides weak information concerning what might have happened to participants had the treatment not occurred

> Known as a one-shot study

One-Group Pretest-Posttest Design with Double Pretest

O_1		O_2		X		O_3
Pretest	$\rightarrow$	Pretest	$\rightarrow$	Treatment	$\rightarrow$	Posttest

> Adding multiple pretests reduces the plausibility of maturation and regression effects

> Additional pretests can confirm maturational trends

One-Group Pretest-Posttest Design Using a Nonequivalent Variable

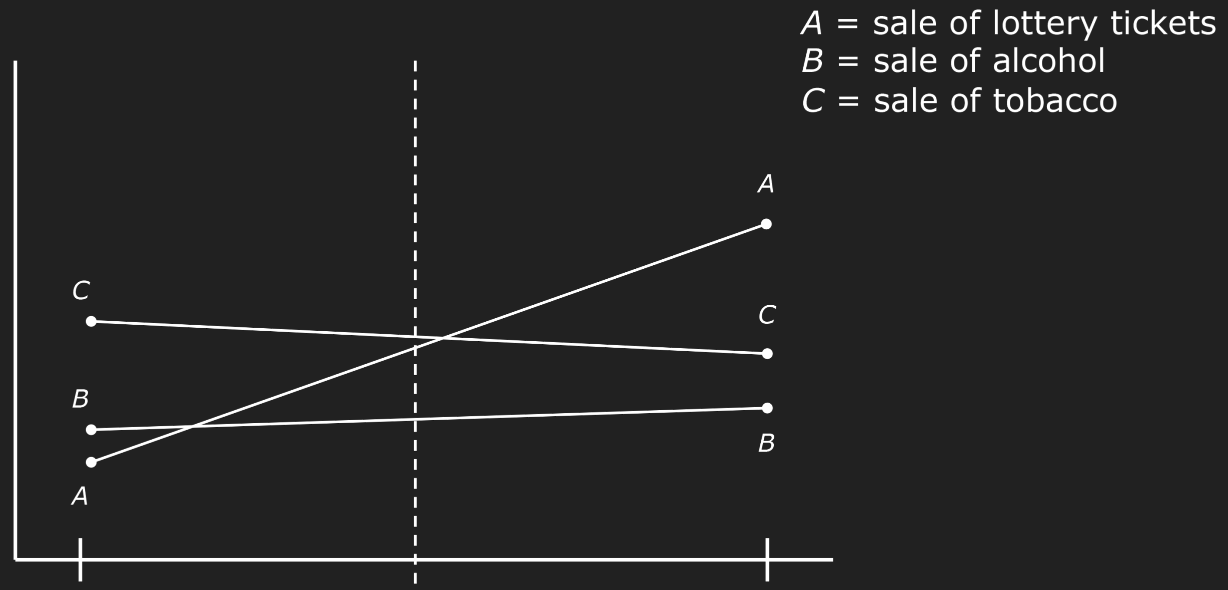
$\{O_{1A}, O_{1B}\}$		X		$\{O_{2A}, O_{2B}\}$
Pretest	$\rightarrow$	Treatment	$\rightarrow$	Posttest

> Measure A is expected to change because of treatment, B is not

> Both A and B are expected to respond to the same validity threats in the same way

Example

Lottery ticket sales in convenience stores after introduction of signs in store windows reading “did you buy your ticket?”



Removed-Treatment Design

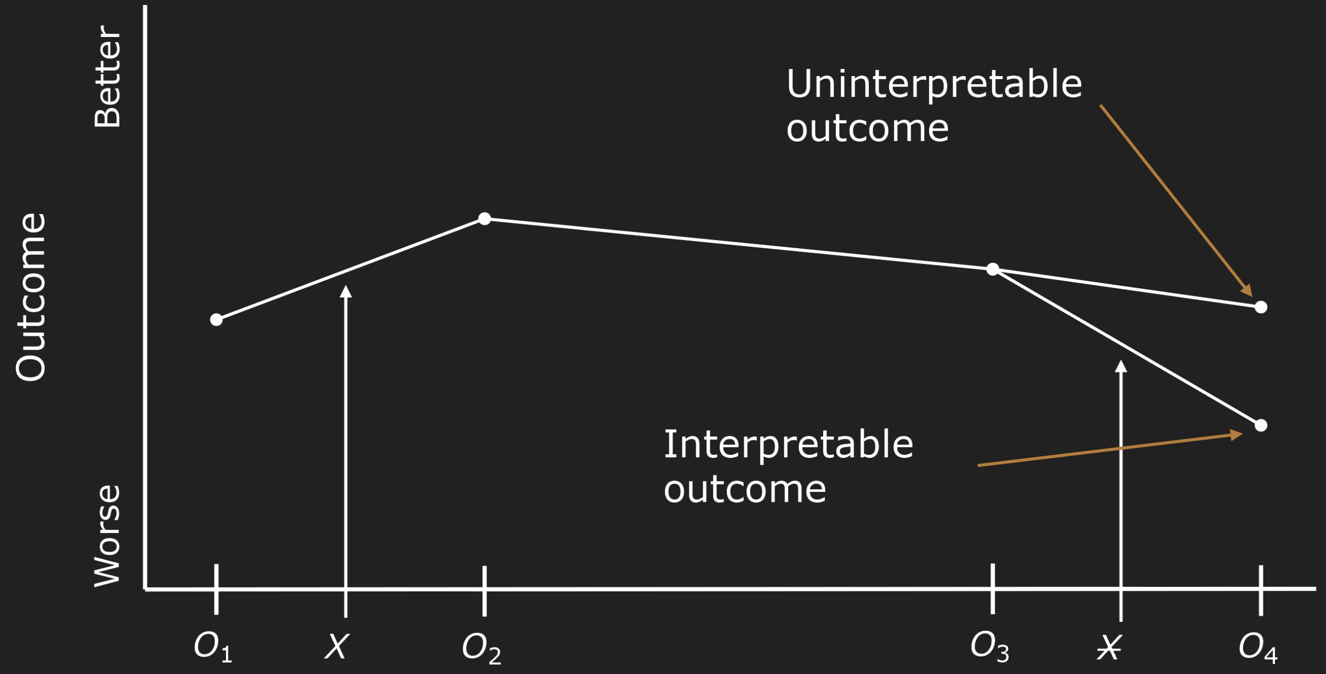
$$O_1 \qquad X \qquad O_2 \qquad O_3 \qquad \not{X} \qquad O_4$$

Pretest $\rightarrow$ Treatment $\rightarrow$ Posttest $\rightarrow$ Pretest $\rightarrow$ Removal $\rightarrow$ Posttest

> Demonstrates that outcomes rise and fall with the presence or absence of treatment

Example

Generally interpretable outcome pattern



Repeated-Treatment Design

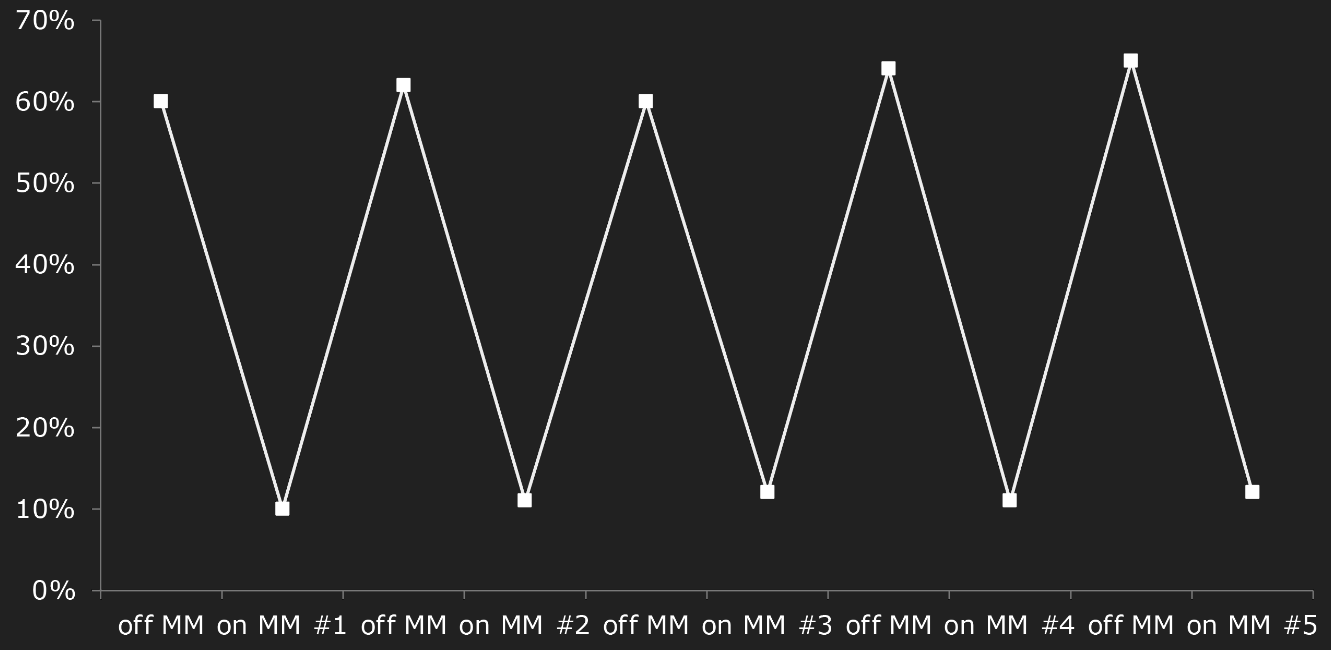
$$O_1 \qquad X \qquad O_2 \qquad \cancel{X} \qquad O_3 \qquad X \qquad O_4$$

Pretest $\rightarrow$ Treatment $\rightarrow$ Posttest $\rightarrow$ Removal $\rightarrow$ Posttest $\rightarrow$ Treatment $\rightarrow$ Posttest

> Few threats could explain a close relationship between treatment introductions and removals and parallel outcome changes

Example

Mean narcotics use over multiple Methadone maintenance on/off conditions



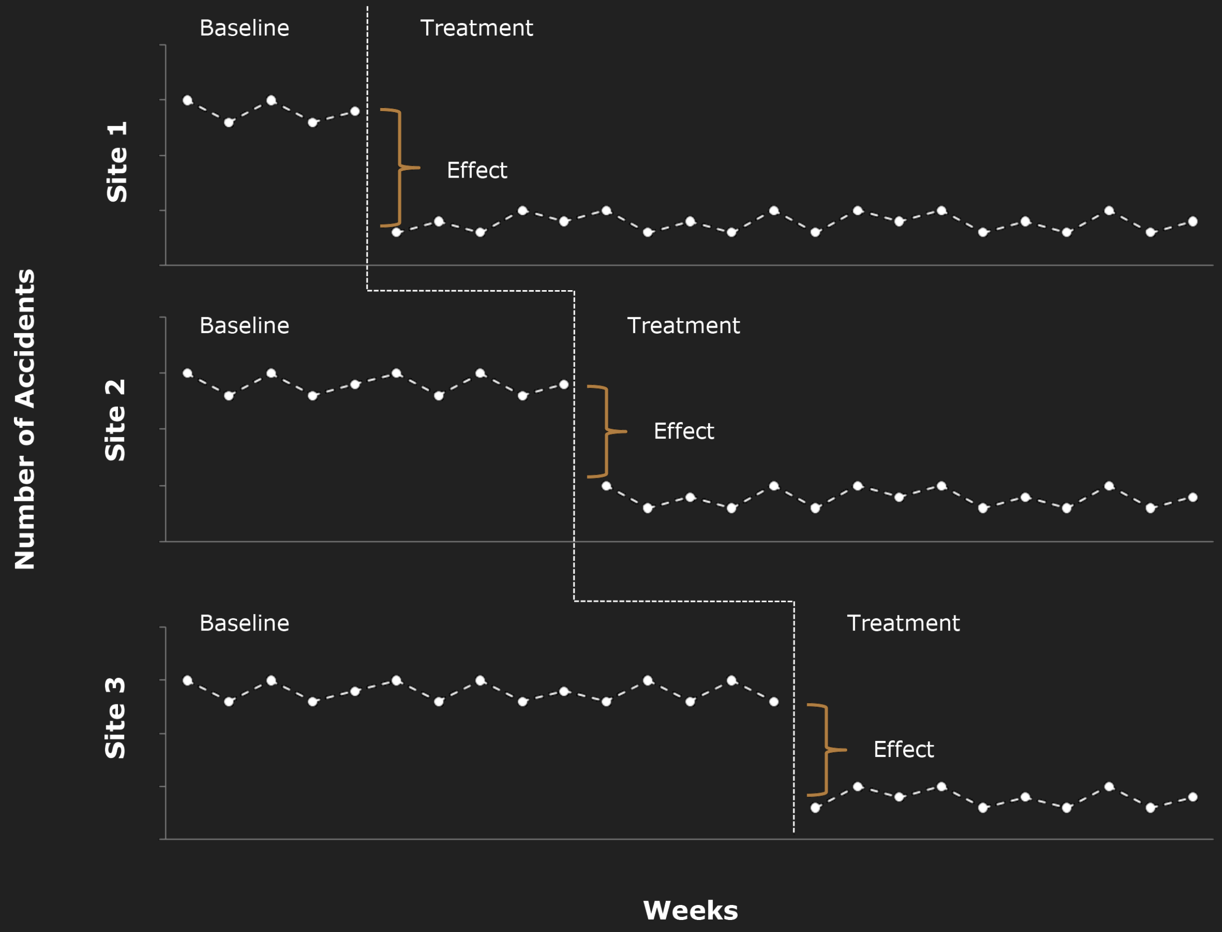
$A - B$ Designs

- Multiple-baseline design (a class of single-subject designs), or collection of $A - B$ designs, to assess the effects of an intervention across separate baselines
- Variables

> - A = baseline
> - B = treatment

- The intervention is introduced in a staggered manner and the baseline provides a predicted level of the dependent variable in absence of the treatment
- $A - B - A$ designs are sometimes called removal designs (i.e., the treatment is removed)

Example



Baseline
Treatment
Effect
Site 1
Baseline
Treatment
Effect
Site 2
Baseline
Treatment
Effect
Site 3
Number of Accidents
Weeks

Designs that use a Control Group but no Pretest

Posttest-Only Design with Nonequivalent Control Group

NR		X		O_1
------	------	------	------	------
NR				O_1
Non Random Assignment	$\rightarrow$	Treatment	$\rightarrow$	Posttest

> Unknown pretest group differences make it extremely difficult to separate treatment effects from selection effects

Posttest-Only Design using an Independent Sample Pretest

NR		O_1	¦	X		O_2
------	------	------	------	------	------	------
NR		O_1	¦			O_2
Non Random Assignment	$\rightarrow$	Pretest	$\rightarrow$	Treatment	$\rightarrow$	Posttest

> Assumes overlapping group membership
>
> Useful when
>
> > Pretest measurements may be reactive
> >
> > Cannot follow same groups over time
> >
> > When interested in studying intact communities whose members change over time

Case Control Studies

- Predominant method for many forms of epidemiological research
- Used to identify factors that may contribute to a condition by comparing subjects who have that condition (i.e., 'cases ') with those who do not have the condition but are otherwise similar (i.e., 'controls')
- Example: Famously used to determine the association between smoking and lung cancer

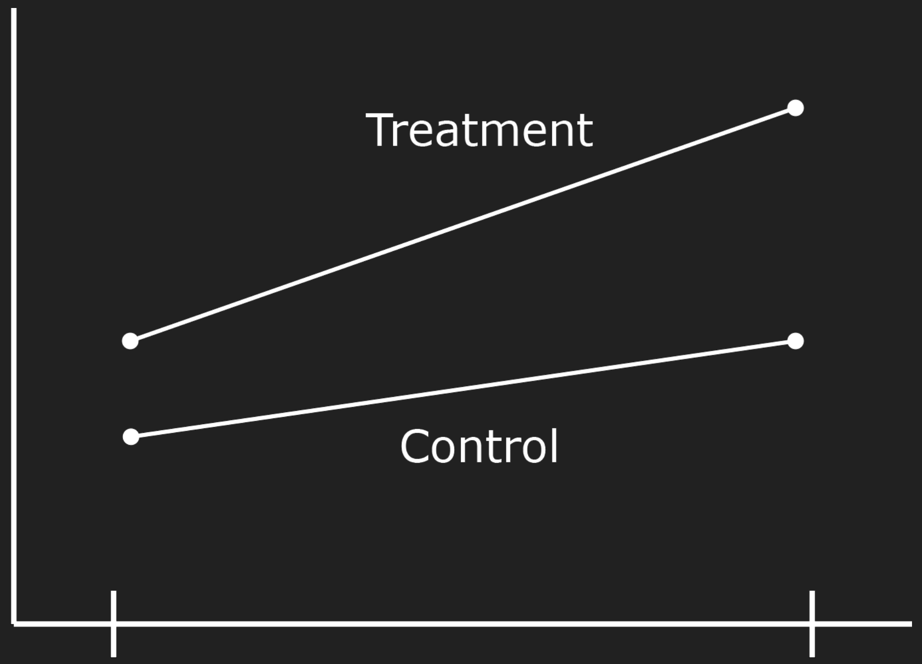
Untreated Control Group Design with Dependent Pretest and Posttest Samples

NR		O_1		X		O_2
------	------	------	------	------	------	------
NR		O_1				O_2
Non Random Assignment	$\rightarrow$	Pretest	$\rightarrow$	Treatment	$\rightarrow$	Posttest

> A selection bias is always present, but the pretest observation allows for determining the magnitude and direction of bias

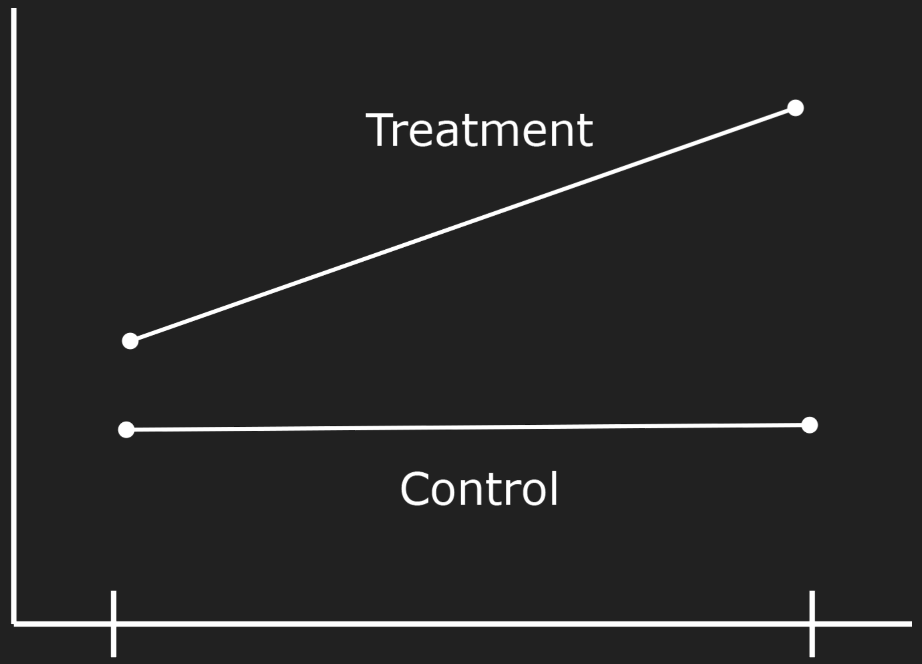
Outcome Pattern 1

> *Both groups grow apart at different average rates in the same direction*
>
> This pattern is consistent with treatment effects and can sometimes be causally interpreted, but it is subject to numerous threats, especially selection-maturation



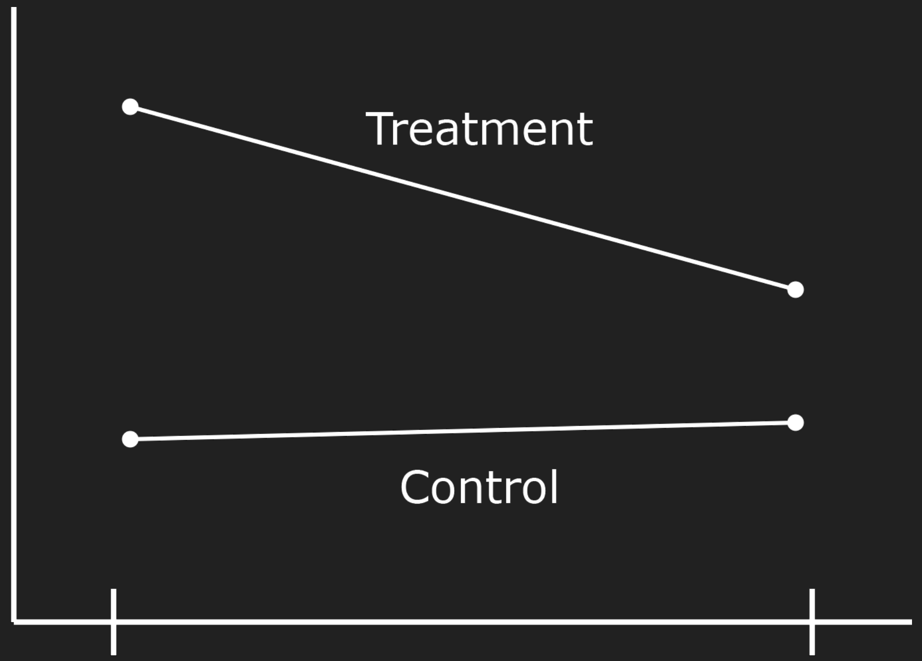
Outcome Pattern 2

> *Spontaneous growth only occurs in the treatment group*
>
> Not a lot of reliance can be placed on this pattern as the reasons why spontaneous growth only occurred in the treatment group must be explained (e.g., selection-maturation)



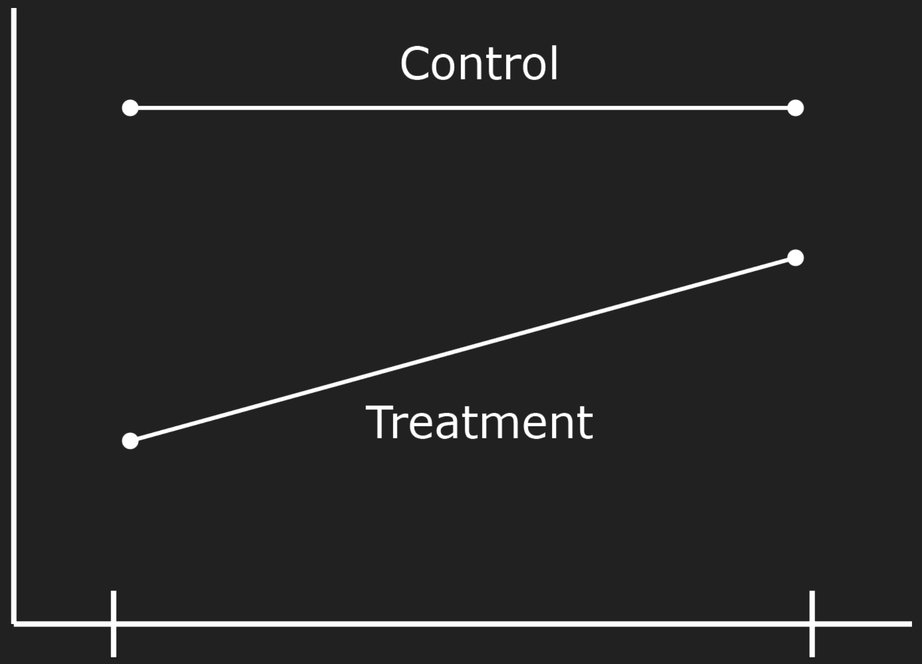
Outcome Pattern 3

> *Initial pretest differences favoring the treatment group diminish over time*
>
> Same internal validity threats as outcome patterns #1 and #2 except that selection-maturation threats are less plausible



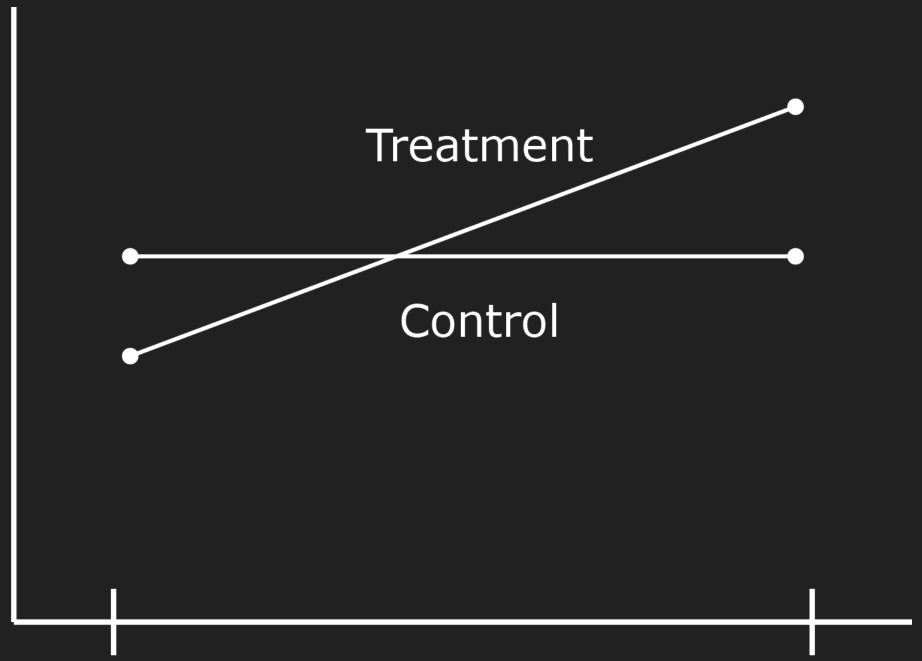
Outcome Pattern 4

> *Initial pretest differences favoring the control group diminish over time*
>
> Subject to numerous validity threats (e.g., selection-instrumentation, selection-history), but generally can be causally interpreted



Outcome Pattern 5

> *Outcomes that crossover in the direction of relationships*
>
> Most amenable to causal interpretation and most threats cannot plausibly explain this pattern



Modeling Selection Bias

- *Simple matching and stratifying*
  - Overt biases with respect to measured variables/characteristics
- *Instrumental variable analysis*
  - Statistical modeling of covariates believed to explain selection biases
- *Hidden bias analysis*
  - Difference with respect to unmeasured variables/characteristics
  - Sensitivity analysis (how much hidden bias would need to be present to explain observed differences)
- *Propensity score analysis*
  - Predicted probabilities of group membership
  - Propensities then used for matching or as covariate

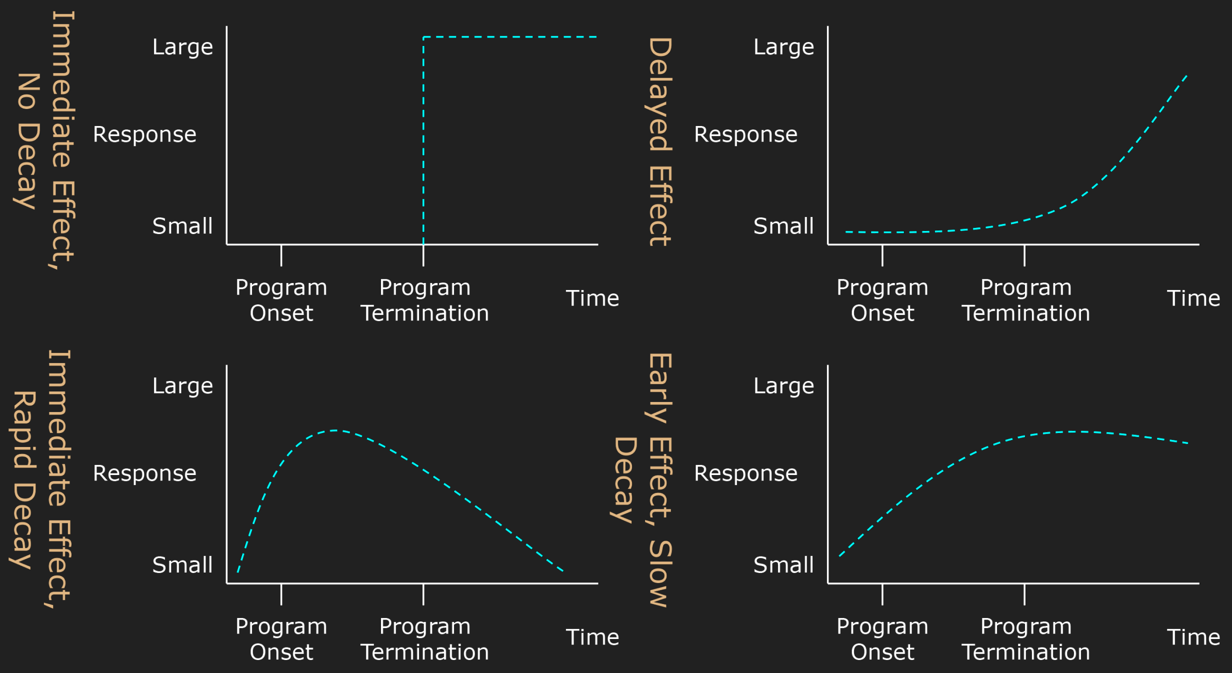
Interrupted Time-Series

A large series of observations made on the same variable consecutively over time

- Observations can be made on the same units (e.g., people) or on constantly changing units (e.g., populations)
- Must know the exact point at which a treatment or intervention occurred (i.e., the interruption)
- Interrupted time-series designs are powerful cause-probing designs when experimental designs cannot be used and when a time series is feasible

Types of Effects

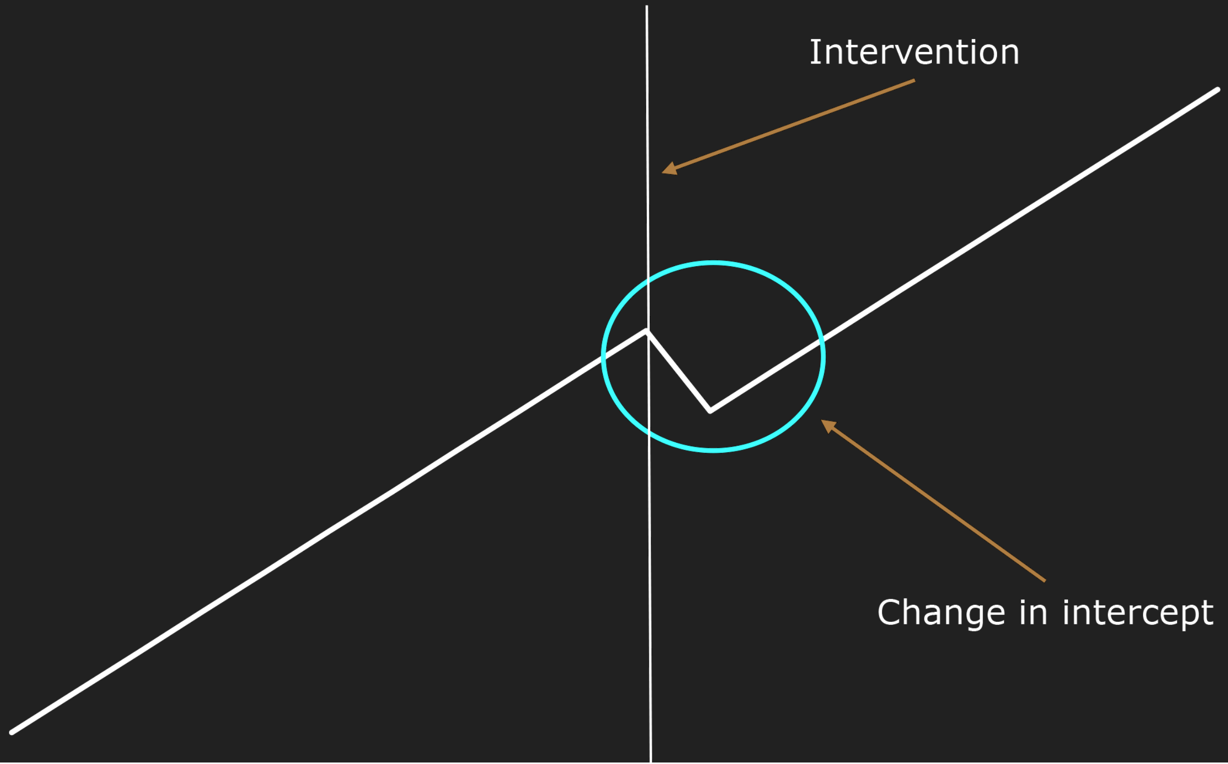
- Form of the effect (slope or intercept)
- Permanence of the effect (continuous or discontinuous)
- Immediacy of the effect (immediate or delayed)
- Independence of observations
    - (Most) statistical analyses assume observations are independent (one observation is independent of another)
    - In interrupted time-series, observations are autocorrelated (related to prior observations or lags)
    - Requires a large number of observations to estimate autocorrelation
- Seasonality
    - Observations that coincide with seasonal patterns
    - Seasonality effects must be modeled and removed from a time-series before assessing treatment impact

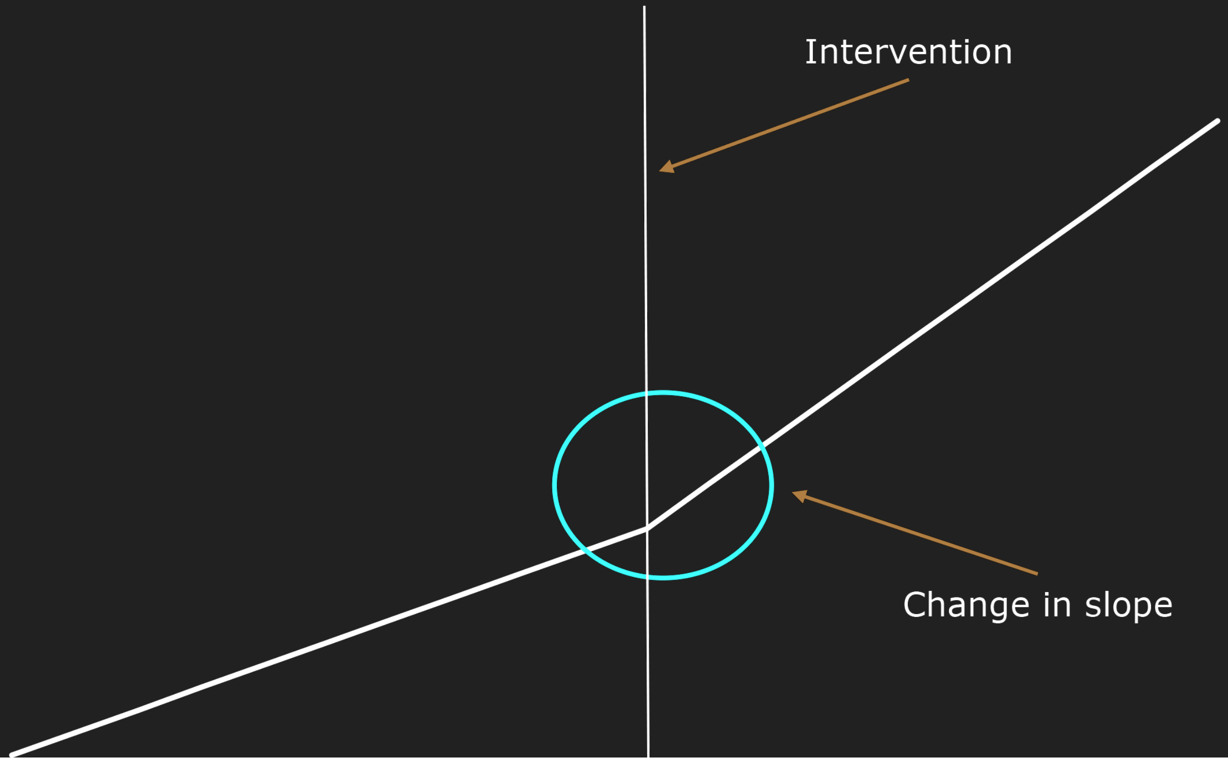

Immediate Effect, No Decay
Large
Response
Small
Program Onset
Program Termination
Time
Delayed Effect
Large
Response
Small
Program Onset
Program Termination
Time
Immediate Effect, Rapid Decay
Large
Response
Small
Program Onset
Program Termination
Time
Early Effect, Slow Decay
Large
Response
Small
Program Onset
Program Termination
Time

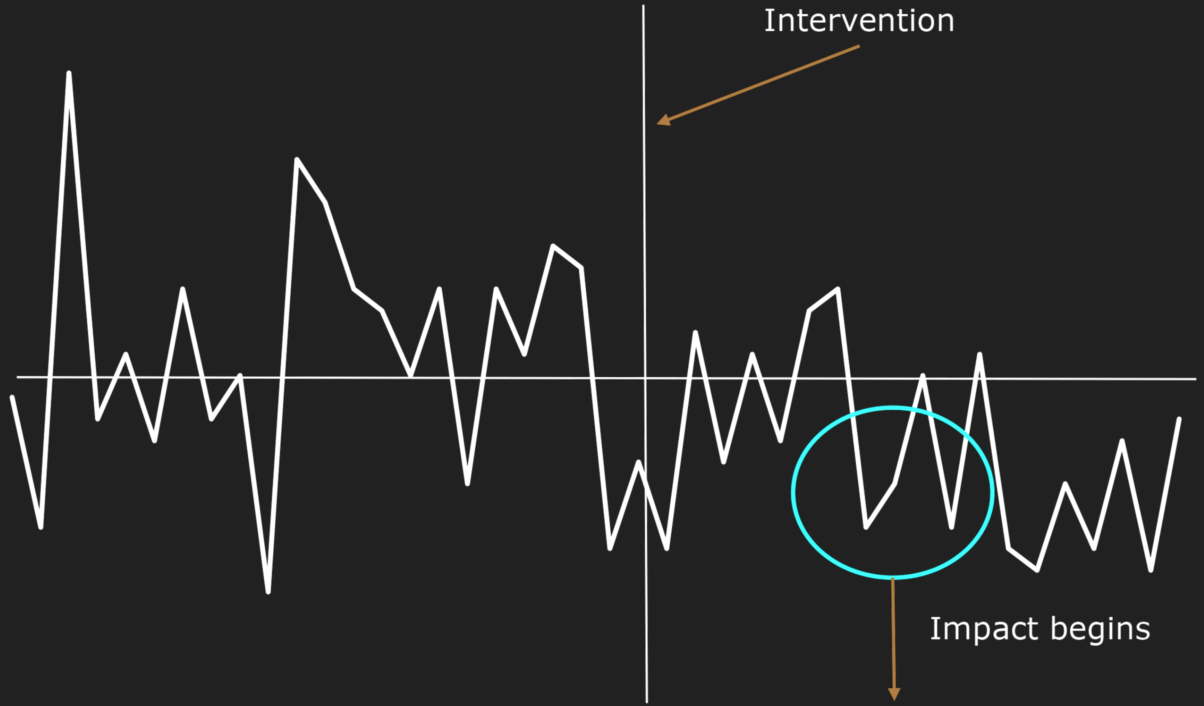
$$O_1 \quad O_2 \quad O_3 \quad O_4 \quad O_5 \quad X \quad O_6 \quad O_7 \quad O_8 \quad O_9 \quad O_{10}$$

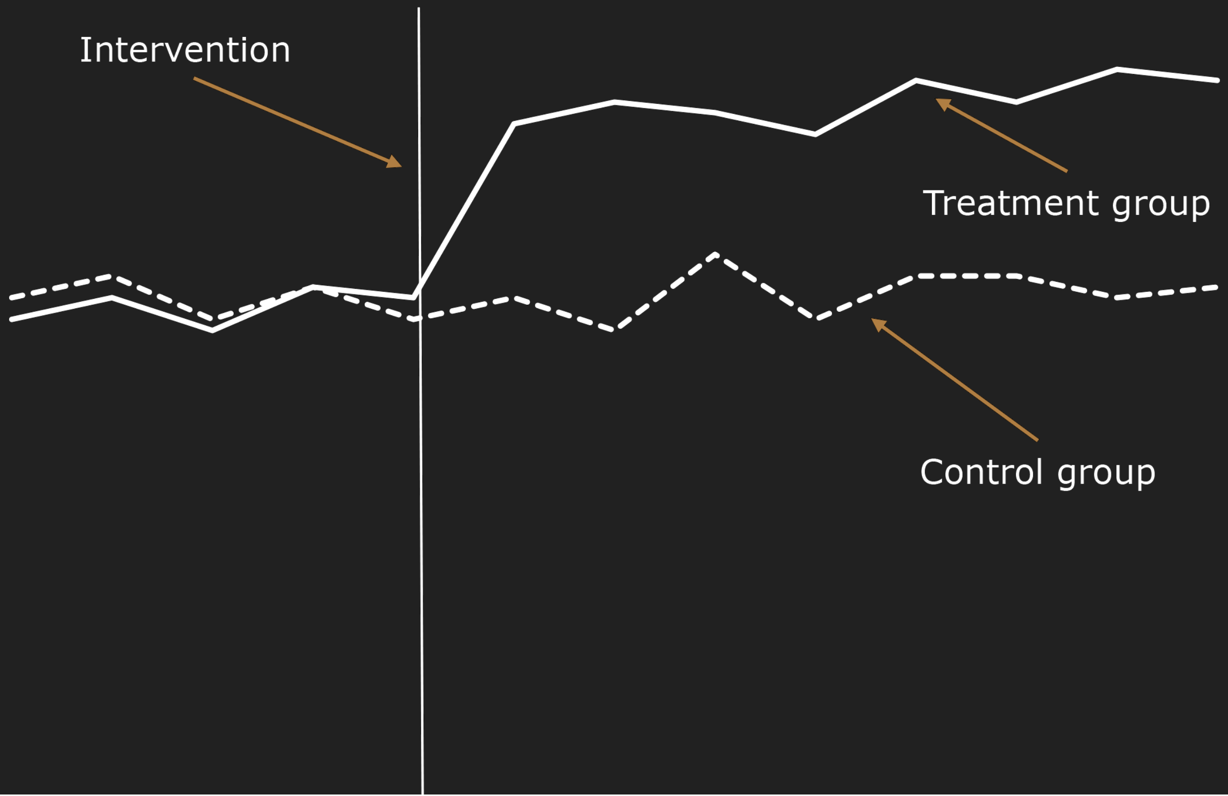
Prettest $\longrightarrow$ Pretest $\longrightarrow$ Pretest $\longrightarrow$ Pretest $\longrightarrow$ Pretest $\longrightarrow$ Treatment $\longrightarrow$ Posttest $\longrightarrow$ Posttest $\longrightarrow$ Posttest $\longrightarrow$ Posttest $\longrightarrow$ Posttest

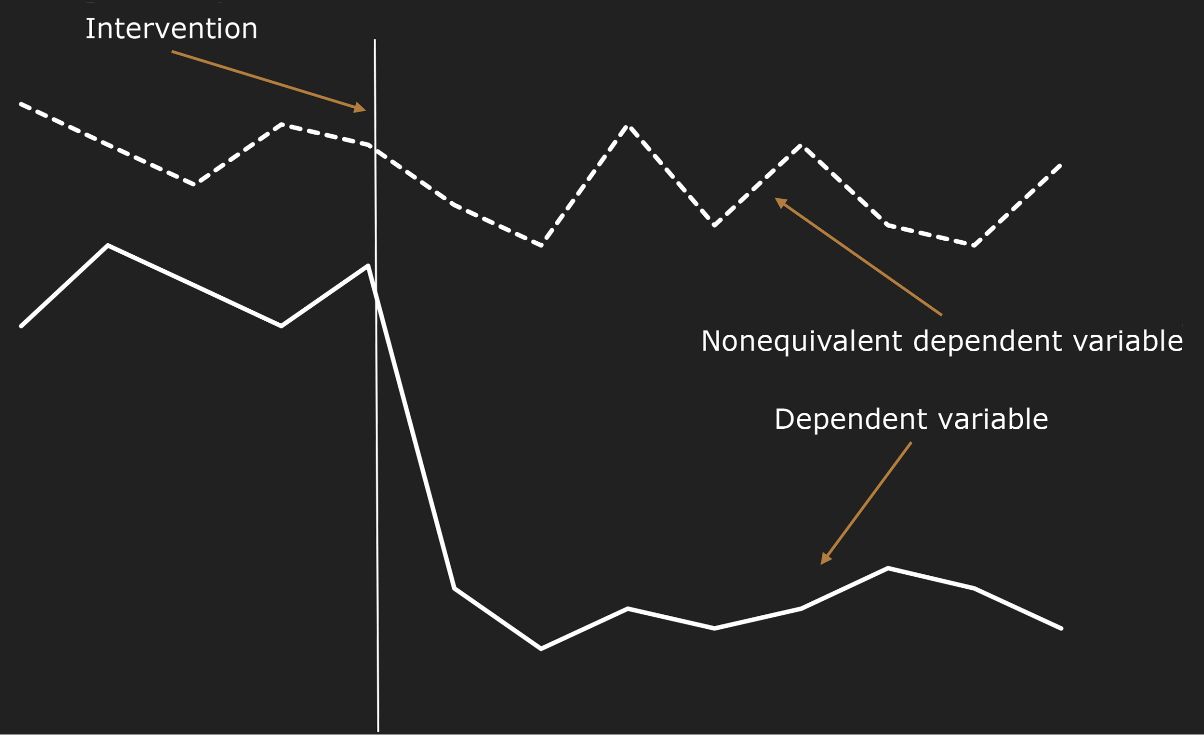
> The basic interrupted time-series design requires one treatment group with many observations before and after a treatment

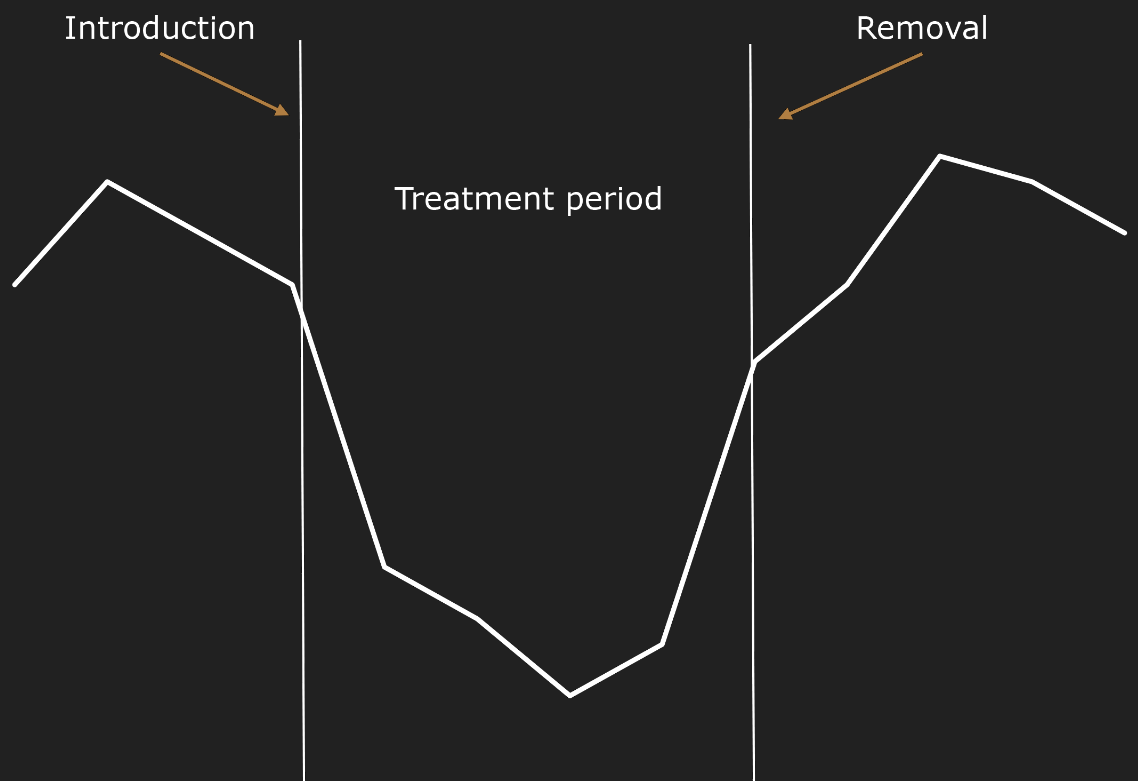

Intervention
Change in intercept


Intervention
Change in slope


Intervention
Impact begins


Intervention
Treatment group
Control group


Intervention
Nonequivalent dependent variable
Dependent variable


Introduction
Removal
Treatment period

That's It!

Any questions?