
Lecture 4: Research Approache

Lecture Objectives

- Theories in research
- Research design approaches
  - Experimental vs. non-experimental
  - Cross-sectional and longitudinal
  - Descriptive approaches
- How to compare alternative approaches

Qualities of Theories

- Parsimony - the preferred theory is the one which contains the least assumptions. Simple explanations are preferred over complex.
- Precision of predictions - predictions of behavior are more valuable if they are precise rather than general.
- Rigorous testing - a good theory will survive testing of its propositions; rigorous testing will seek to falsify the propositions rather than to confirm them.

Building a Theory

- Good theory building starts with a good question.
- Once you have identified an interesting question, pose an educated guess (hypothesis) that might explain the phenomenon.
- Break down your hypothesis down into independent variable(s) and a dependent variable.
- Choose concrete measures that approximate your independent and dependent variables

Types of Quantitative Designs

Control over the “independent variable”

(a) Experimental

(b) Quasi-experimental

(a) Non-experimental

Designs Key Features

Type of “group comparisons”

(a) Between Subjects

(b) Within Subjects

Designs Key Features

Number of “data collection points”

(a) Cross-sectional

(b) Longitudinal

Designs Key Features

Occurrence of “independent and dependent variable”

(a) Retrospective

(b) Prospective

(c) Descriptive

Designs Key Features

Type of “Setting”

(a) Naturalistic

(b) Laboratory

Designs Key Features

Experimental Design Characteristics:

(1) Manipulation – treatment/intervention

(2) Control – control group/experimental group

(3) Randomization – random assignment – no systematic bias

Quasi-Experimental

Types of quasi-experimental designs:

(a) Nonequivalent Control-group before-after design
(Pre-test Post-test)

(b) Time Series Designs
(one-group before-after design)

Non-Experimental Design

Types of non-experimental designs:

(a) Ex Post Facto
(Correlational research)

(b) Retrospective studies
(ex post facto investigations)

(c) Prospective studies
(case-control design)

(d) Descriptive
(descriptive correlation study)

Cross-Sectional Studies

- data collection at one point in time
- Appropriate for describing the status of a phenomena or relationships among a phenomena at a fixed point
- Retrospective studies are usually cross-sectional
- Weaker than longitudinal studies
- Main advantage – economical and easy to manage

Longitudinal Studies

- data collected over an extended period of time
- Main value – to demonstrate changes over time – temporal sequencing = causality
- *3 types*: (1) trend studies
  (2) panel studies
  (3) follow-up studies

Attrition – may cause problems

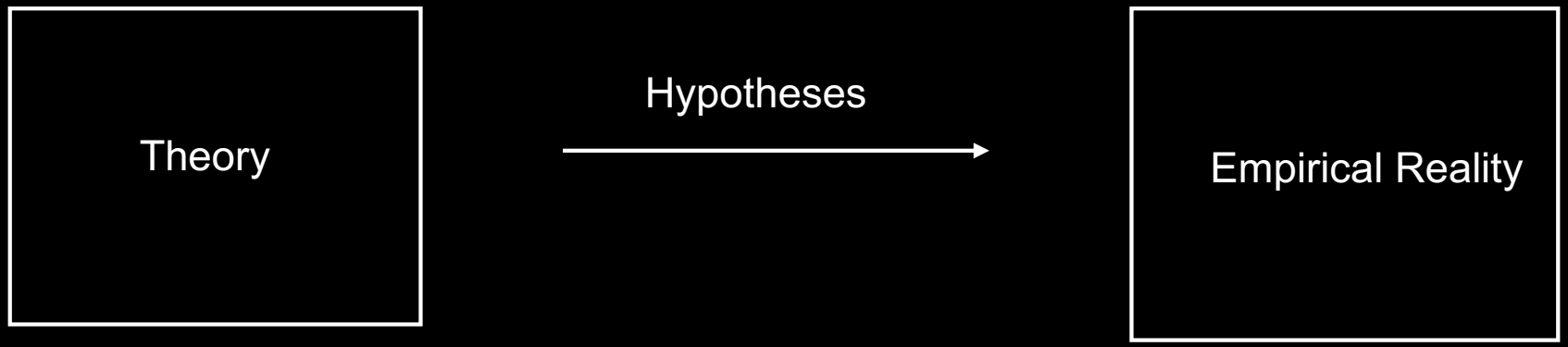
Selecting a research method for data collection

Experiment, Quasi-Experiment, Cross-Section, Longitudinal, Case study

Selecting a methods depends on:

- the research question/purpose
- the operational definition of the construct of interest (difference/associational)
- the required protocols for reliability and validity

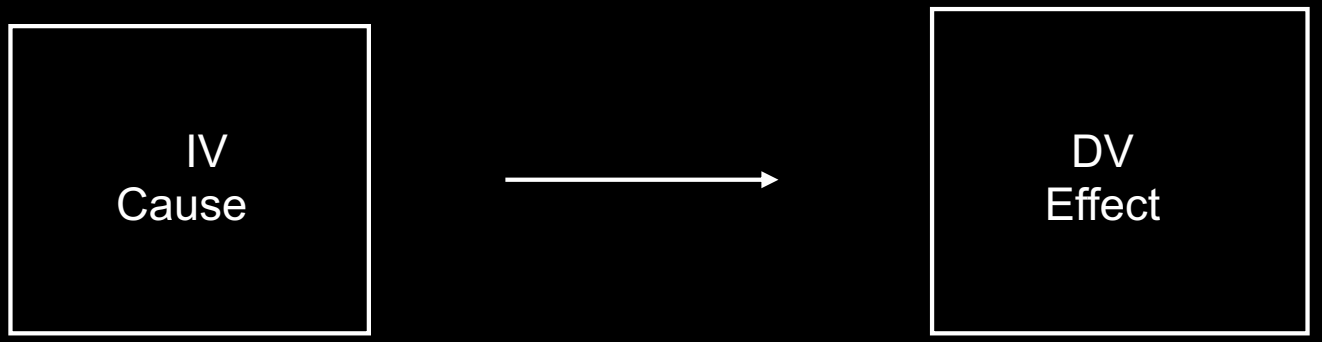
Testing Hypotheses



Hypotheses are predictions about what the data from an investigation can be expected to look like if the theory is correct

Relationship

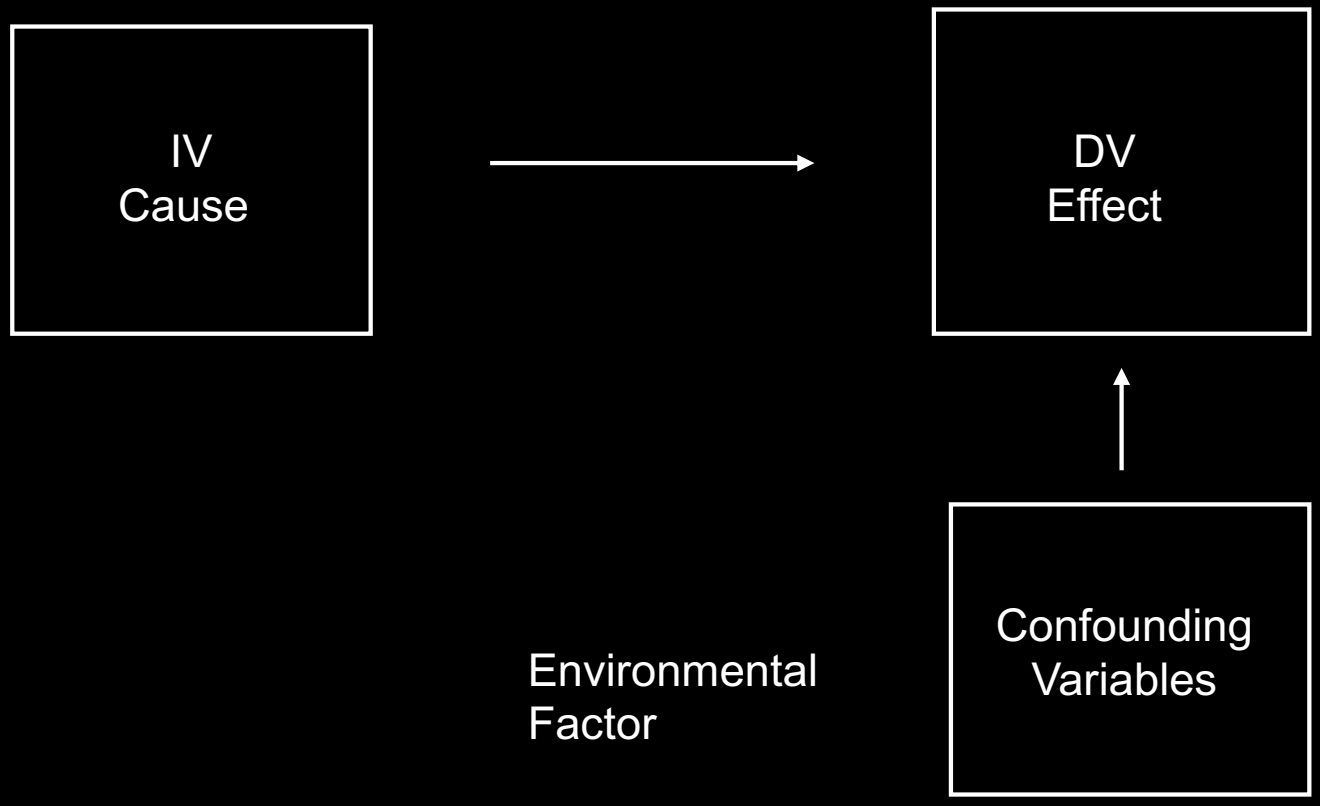
Examines cause-and-effect relationships



Traffic calming measure

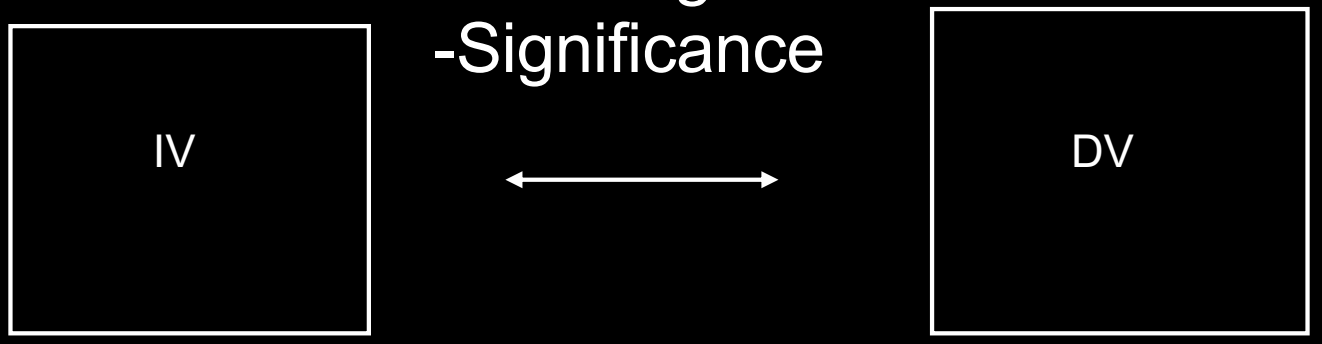
Increased security

Experiments



Association

Examines associations
-Direction
-Strength
-Significance



Land use pattern

Travel behavior

Explaining and Predicting Phenomena

Establishing Cause and Effect

Criteria for a causal relationship to exist:

- temporal precedence
- covariation of cause and effect
- no plausible alternative explanations

Independent and Dependent Variables

- Independent variable (IV) - the cause supposed to be responsible for bringing about change in behavior. The IV is changed by the experimenter in order to observe any consequent changes to behavior.

- The variable that is affected by the IV is the dependent variable (DV) - the outcome of the change brought about by changes in the IV. During the experiment the DV value is measured.

Experimental error (confound)

- To examine the effect of IV on DV, all other variables (which may affect the DV) must held constant

- Experimental error (confound) is the effect of the DV produced by any variable in an experiment other than the IV

Research Approaches

General Purpose	Explore relationships between variables				Describe variables
General Approach	Experimental		Non-Experimental		Descriptive
Specific Approach	Randomized Experimental	Quasi-Experimental	Comparative	Associational	Descriptive
Specific Purpose	Determine Cause	Examine Cause	Compare Groups	Find Associations	Summarize Data
Type of Hypothesis	Difference			Relate variables	Descriptive
Statistics	Difference Inferential Statistics e.g. ANOVA			Associational Inferential Statistics (eg. Correlation, Multiregression	Descriptive Statistics Eg, Histograms, Means etc.

Research question/purpose

- Determine Cause
- Examine Causality
- Compare groups
- Find Associations
- Summarize Data

Internal validity

Degree of control

Degree of complexity

Research Vocabulary

Random Assignment (R): Where everyone you are interested in generalizing results to has an equal chance of inclusion in the sample based in some type of mathematical calculation.

Treatment (X): Whatever the researcher modifies or manipulates; the independent variable.

Outcome (Dependent Variable): What the researcher is interested in measuring; the response to treatment or lack of treatment.

Pretest: (O1): The measurement of the variable of interest (dependent variable) before treatment.

Posttest: (O2): The measurement of the variable of interest (dependent variable) after treatment.

Experimental Group: The group that receives the treatment.

Control Group: The group that doesn't receive the treatment; used to compare against the experimental group to see the treatment's effect.

Experimental Design

- Experimental methods allow high degrees of control which in turn help to establish the presence of the three conditions necessary for causal inferences to be drawn

- While other designs can identify relationships, experimental designs can determine that one variable (the independent variable) actually caused the changes observed in another (the dependent variable).

- However there are limits on the use of these designs. Manipulation of the independent variables is sometimes impossible. Assigning subjects to groups is not ethical. In addition, the control over extraneous variables required in an experiment can sometimes limit the generalizability of the findings.

Experimental Research

- True experimental designs
- Quasi-experimental designs

Experiments

- Experiments are used to investigate causal relationships between variables, and therefore assist us in the prediction of phenomena.

- Experiments allow us to systematically manipulate variables, to meet conditions for causal inference.

- To make an inference of causation, we need to demonstrate that a manipulation of the independent variable occurs before, and is associated with changes in the dependent variable, when other extraneous contributing factors are held constant or balanced out.

Key Features

- Random assignment of individuals or entities to the levels or conditions of the study
- Control biases at time of assignment
- Ensure only independent variable(s) differs between conditions
- Emphasis placed on maximizing internal validity by controlling possibly confounding variables
- Creation of highly controlled conditions may reduce external validity

Group Experiments

The basic experiment involves a group which receives the "treatment", and a group which does not (‘control group’).

The two groups are treated identically except that the control group does not receive the experimental treatment.

Providing you have adequately controlled extraneous variables, any differences you observe between the subsequent Responses of the two groups should be due to the effect of manipulating the independent variable.

Experiments

To do this we need to manipulate the independent variable.

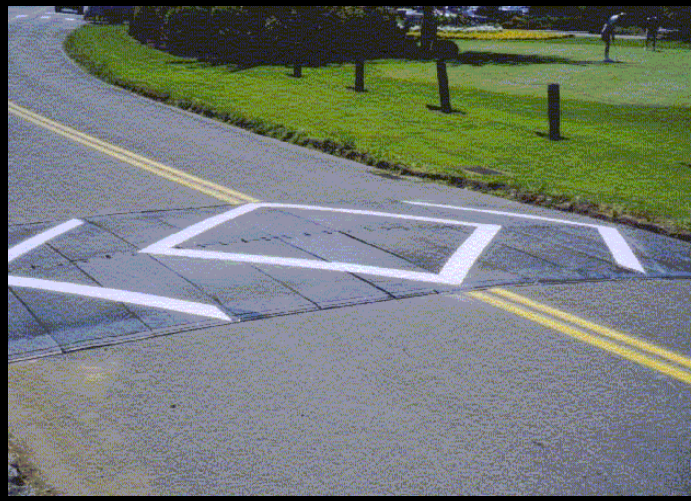
- Example: introducing traffic calming at intersections will reduce traffic accidents.
- We need to hold other factors constant
- Example, environmental conditions, size, pavement, etc.
- We need to balance those things that we can't hold constant

Experimental and control conditions: An example

Do traffic calming measures increase traffic safety?

CONTROL

EXPERIMENTAL

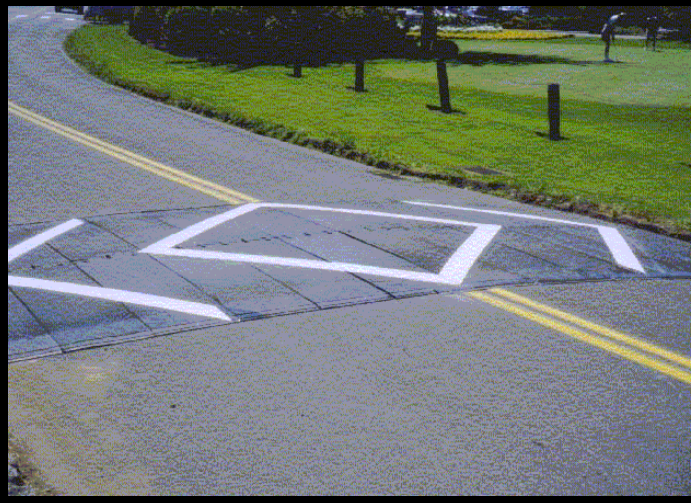


EXPERIMENTAL

Why this is not a good control?

CONTROL

EXPERIMENTAL



EXPERIMENTAL

Levels of IV

The IV is a variable that is changed (manipulated) by the experimenter.

- The change produce at least two levels (conditions) of the IV.
- The DV produced by different levels of the IV are compared
- If the DV produced by two conditions differ, the IV is said to affect the DV

Experimental and Control Conditions

- Different levels of the IV are provided by the existence of separate experimental and control conditions.
- The control condition receives no treatment, and serves as a base-line against to compare the experimental condition.
- The experimental condition is the intervention condition. It represents changes to the levels of the IV away from the level set in the control condition.

Experimental Design

- Independent subjects design

  different participants are randomly assigned to different levels of IV.

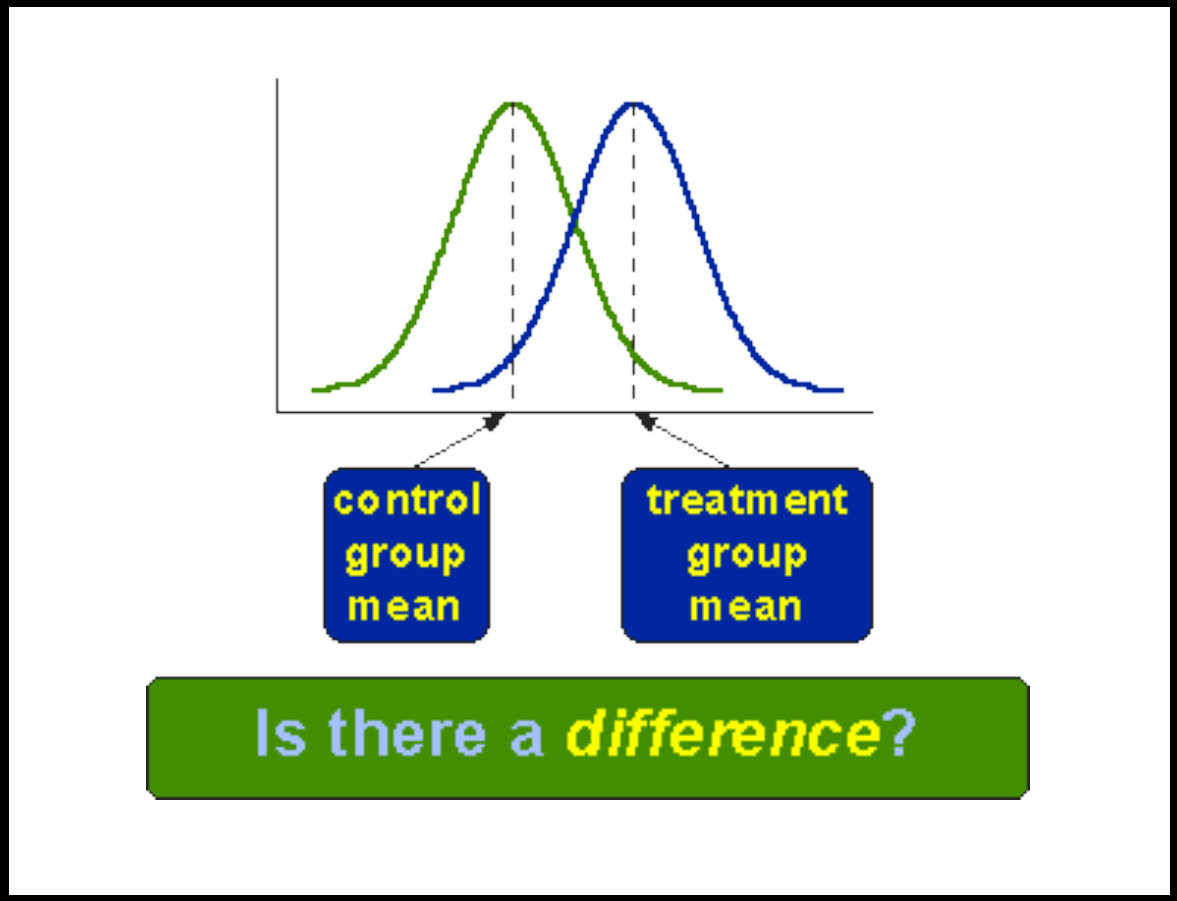
- Repeated measures design

  participants take part in all levels of the IV.

- Matched subjects design

  Participants are matched on the basis of pre-test scores of a variable relevant to the study and then assigned to different IV levels.

t-test and one-way Analysis of Variance (ANOVA)



Between-Group Designs

A. Post-only design

B. Pre and post design

C. Multiple Levels of single IV

D. Multiple Experimental and Control Groups

E. Multiple IVs (Factorial design)

Within-Group Designs/ Repeated Measures

- Each subject is presented with two or more experimental conditions
- Comparisons are made between conditions within the same group of subjects

Advantages of Experiments

1. Isolation of the experimental variable

2. Allows for (relatively) easy replication

3. Establishing causality

4. Control - A true experiment offers the ultimate in control

5. Longitudinal analysis - The experiment offers the opportunity to study change over time.

Disadvantages of Experiments

1. Artificial environment

2. Experimenter effect - The experimenter's expectations can affect the results of the experiment.

3. Lack of control - Placing subjects in a laboratory may alter the very behavior the experimenter is trying to study.

4. Sample size - The larger the group, the more difficult it is to control extraneous variables.

Summary: Experiment

- Aim to measure the effect of IV on DV
- Involve experimenter's intervention
- Should control for experimental error (confounding variables)
- Comparing the DV produced by at least two levels (conditions) of IV

Quasi-Experimental Approach

- Primary purpose is to empirically test the existence of causal relationship among two or more variables
- Employed when random assignment and experimental control over IV is impossible
- Key Features:
  - Other design features are substituted for randomization process
  - Quasi-experimental comparison base:
  - Addition of non-equivalent comparison groups
  - Addition of pre- and post-treatment observations

Strengths (Quasi)

- Approximation of experimental design, thereby allowing causal inference
- Garner internal validity through statistical control, not experimental
- Use where experimental designs are impractical or unethical

Limitations (Quasi)

- Uncertainty about comparison base: Is it biased?
- Statistical control based on known factors. If unknown or unmeasureable, threat to validity
- Data collection schedule and measures very important

Research Design

0_t = Observation in time t of experimental group

X = Treatment

0_c = Control group

Research design with limited power

- POST-TEST ONLY

X O_1

- POST-TEST WITH CONTROL GROUP

X O_1

O_2

Research designs with causal power

- PRE-TEST POST-TEST

O_1 X O_2

- PRE-TEST POST-TEST WITH CONTROL GROUP

O_1 X O_2

O_1 O_2

Research designs with more causal power

- CONTROL WITH MORE OBSERVATION IN THE PRETEST

O_1	O_2	O_3	X	O_4
O_1	O_2	O_3		O_4

Experimental Design

- True experimental design: Subjects are randomly assigned to at least 2 comparison groups
- Purpose is to compare 2 or more groups that are formed by random assignment
- The groups differ solely on the basis of what occurs between measurements (ie, intervention)
  - Changes from pretest to posttest can be reasonably attributed to the intervention
- Most basic is the pretest-posttest control group design (randomized controlled trial, RCT)

Experimental Design

Example:

- Researchers conducted an RCT to study the effect of different levels of physical exercises on obese population. They studied 35 volunteers.
- Participants were randomly assigned to an exercise group, which met three times per week for 10 weeks, or a control group which met 2 times per week for an interactive health education program.
- The outcome variables were: bmi and weight loss, and other indicators using standardized instruments.
- Pretest and posttest measures were taken for both groups and differences were compared.

Research design with more power (time series)

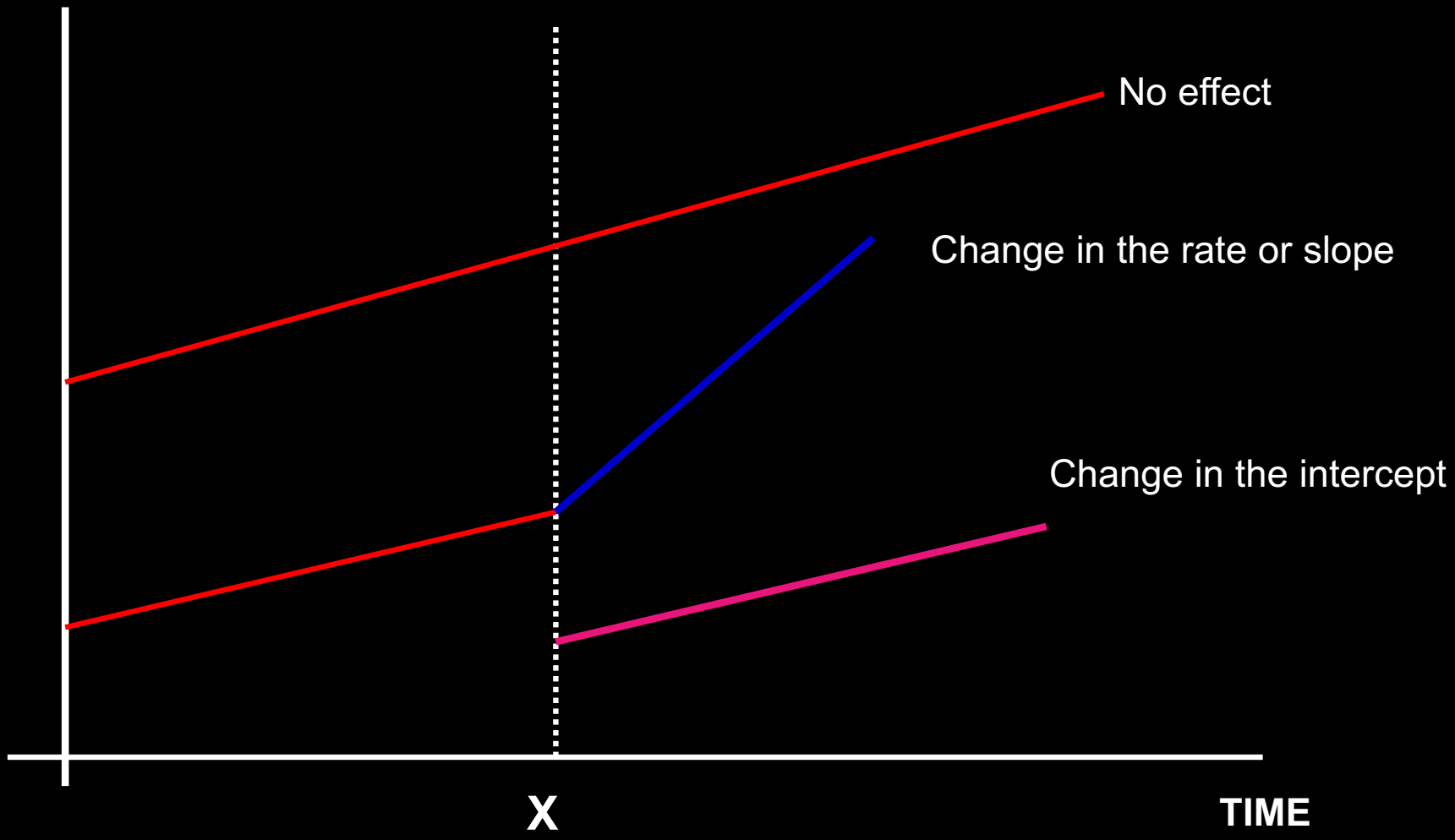
- Pre-test post-test

O_1	O_2	O_3	X	O_4	O_5	O_6

- Pre-test post-test with control group

O_1	O_2	O_3	X	O_4	O_5	O_6
O_1	O_2	O_3		O_4	O_5	O_6

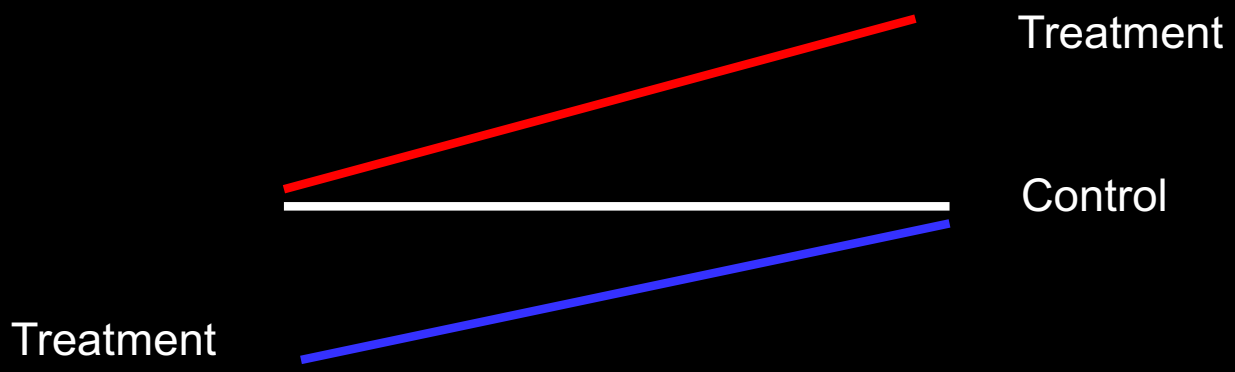
Changes to look for



Change to Look for

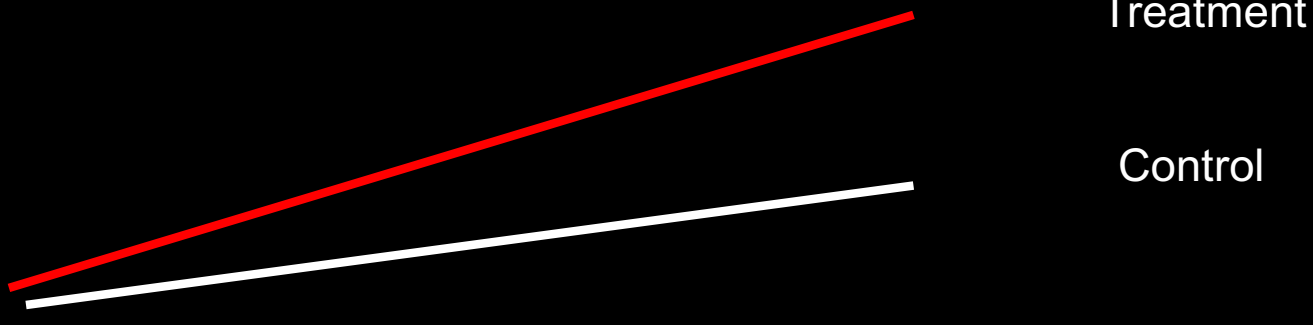
- Convergence-Divergence

Positive change in the treatment group without change in the control group



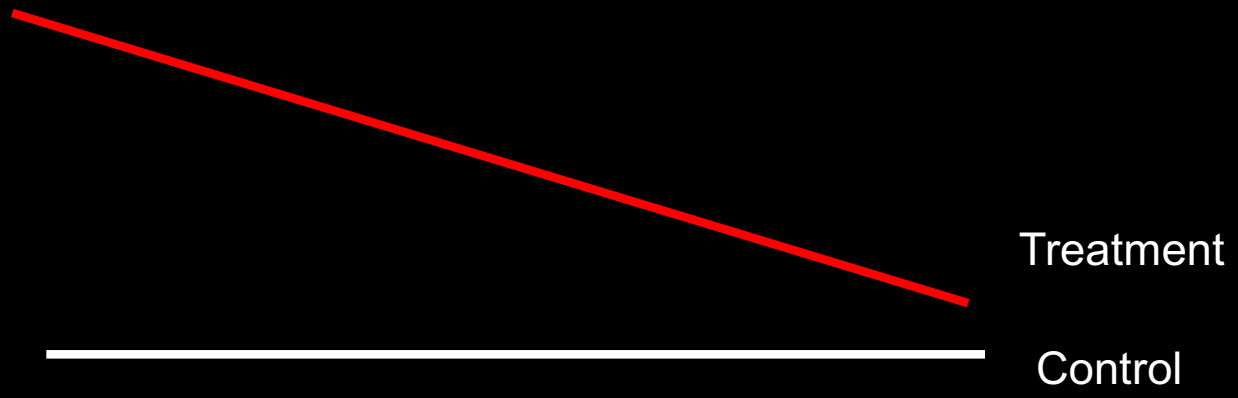
Divergence

- Positive increments at a different rate



Convergence

- The treatment group catches up with the control group



Efficacy vs. Effectiveness

- Efficacy: the benefit of an intervention compared to a control or standard program under controlled, randomized conditions
  - Randomized controlled trial (RCT) design often used
- Effectiveness: the benefit of an intervention under less controlled ‘real world’ conditions
  - Quasi-experimental design often used

One Group Posttest Only Design

P T_2

P = Program or intervention (GMA)

T_2 = Posttest (Seattle)

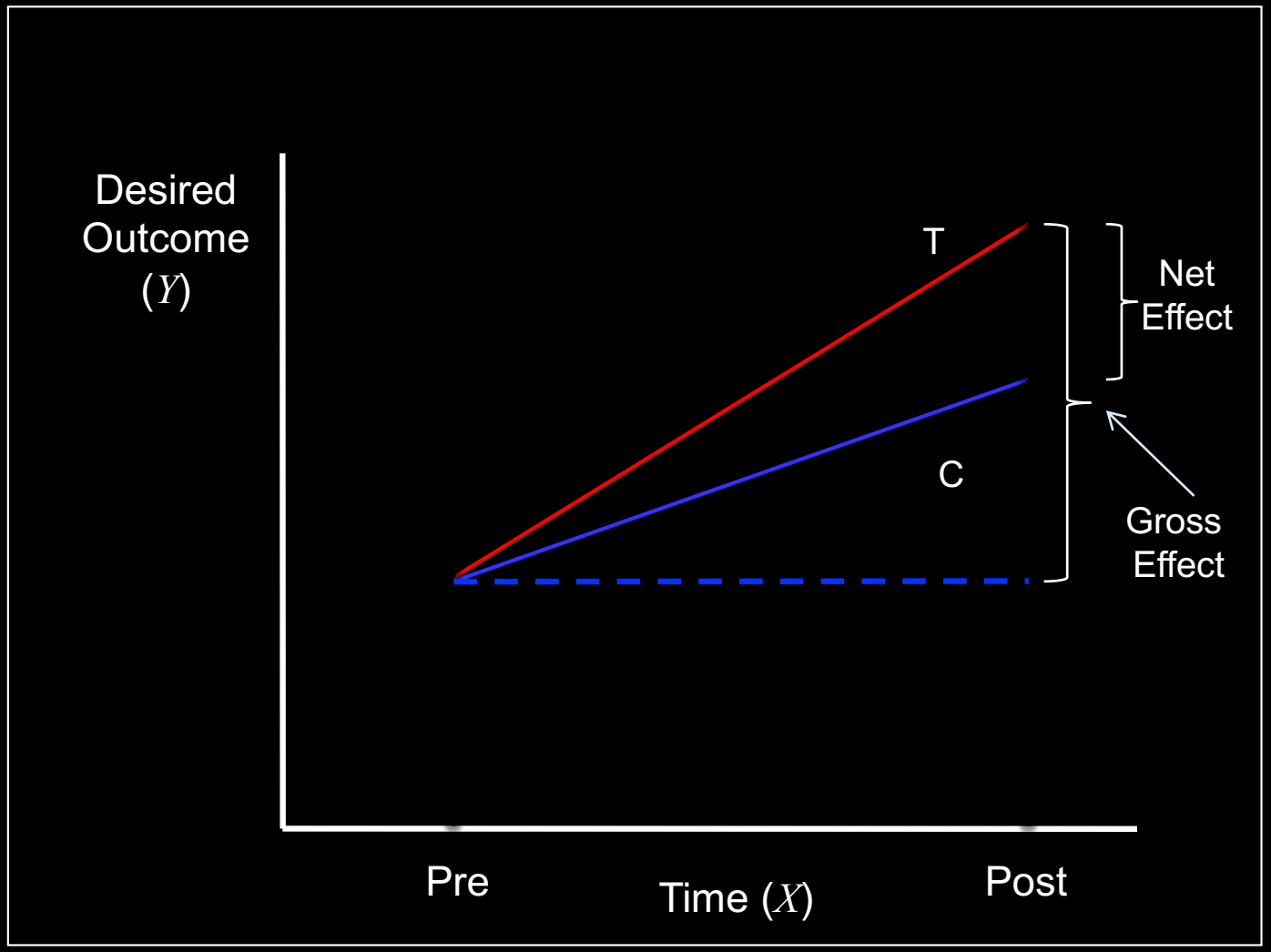
Before and After Design

One group pretest-post-test design

T_1 ***P*** ***T_2***

T_1 = Pretest (treatment group)
T_2 = Posttest (treatment group)
P = Program or intervention

How much of the effect is due to the program?



Comparative Group Design

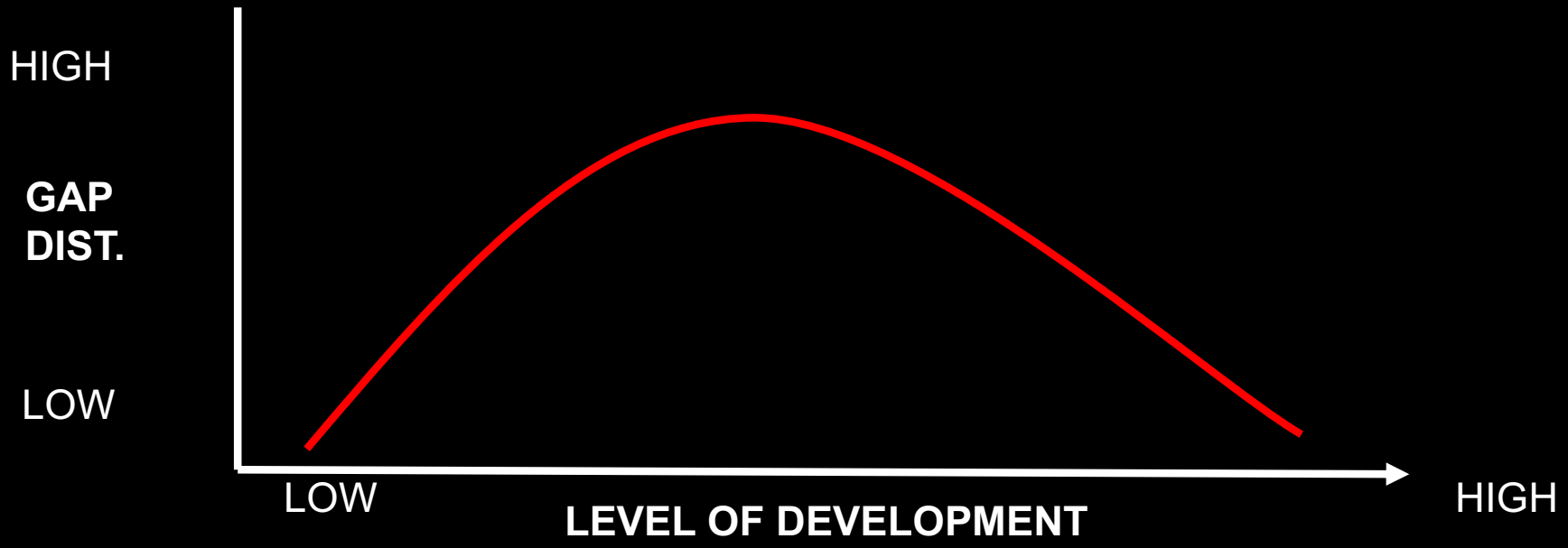
- T1 = Pretest (treatment group)
- T2 = Posttest (treatment group)
- P = Program or intervention
- C1 = Pretest (comparison group)
- C2 = Posttest (comparison group)

Non Experimental Studies

- Cross sectional studies
- Panel (somewhat rare)
- Longitudinal (pooled time series)
- Case (s) study

Development and Income Distribution

Economic development theory suggests that as countries get richer income distribution worsens but eventually income distribution improves after a certain threshold.



Non Experimental Research

- Cross-sectional: The researcher would take a sample of countries with different levels of development (low, medium, high) and analyze the match between the theory and facts.
- This approach is the weakest to determine causality, but strong in generalizing.

Non Experimental Research

- Longitudinal: The researcher would select a country or countries that have move from lower to higher levels of development (eg. USA, Canada, etc.) and determine whether income distribution over time followed the trend suggested by the theory

- Causality can be inferred but lacks detail about the true causes as well as weak on generalization.

Panel Studies

- Between cross-sectional and longitudinal, there are panel studies.
- These studies only measure a few time periods and are similar to a pretest/post-test type format.
- These studies are rare and are usually used when data is missing for pooled time series studies.

Correlational method: advantages and limitations

Advantages

- measure associations between naturally occurring variables
- indicate existence of relationship

Disadvantages

- difficult to control confounding variables
- cannot indicate causal relationship

Correlation coefficient

- measure the patterns and the strength of the correlation
- highly consistent patterns produce a large value (approaching +/-1.0)
- unrelated patterns produce a small value (approaching 0.0)
- positive correlation has a correlation coefficient between 0.0 and +1.0
- negative correlation has a correlation coefficient between 0.0 and –1.0

The direction of the relationship

- positive correlation

  X and Y are changed in the same direction

- negative correlation

  X and Y are changes in the opposite directions

Pearson's Product-Moment (pearson's r)

Parametric test

- both X and Y are quantitative variables with interval or ratio scales
- measures the extent to which changes in the amount of X are related to changes in the amount of Y

Spearman Rank-Order (rs)

- non-parametric test
- either X or Y (or both) are quantitative variables with ordinal scales
- examines the rank orders and measures the degree to which ranks on X are systematically related to ranks on Y

Experiments vs. Correlation Methods

- consists of IV and DV
- is there a difference in performance (DV) between the groups (levels of IV)?
- involve experimenter's intervention
- control confounds

- measures of association
- is there a relationship between variable X and variable Y?
- involve no intervention
- limited control of confounds

Case Studies

- The researcher will take a case (s) study and analyze in depth what factors (policies, institutions, political systems, culture, etc.) are associated with improving income distribution in a given country.

- Why income distribution is better in Chile than in Mexico and Brazil despite having the same level of development?

- Improves details and understanding of causes and effect but lacks generalization.

Required protocols for reliability and validity

- Reliability: A measurement has high reliability if it gives the same result every time the same property is measured under the same conditions.
- Internal Validity: The design takes into account a clear causal relationship and allows for the control of the confounding variables.
- External Validity: The sample and the conditions, under which the study is carried out are representative of the population and situations to which the results apply.

Reliability

- Inter-observer reliability: a variable is measured reliably when two observers can obtain similar values of the variable
- Test-retest reliability: a variable is measured reliably when measurements on two separate tests are similar
- Experimental reliability: an experimental finding is reliable when other experiments can repeatedly demonstrate (replicate) that effect
- Measurement error: the inconsistency and variability associated with an estimate of a test's reliability can be called measurement error

Internal Validity

- How well the study is designed and conducted.
- Effects of an experiment are due solely to the experimental conditions
- Extent to which causal conclusions can be drawn
- Random allocation of participants to experimental conditions is a method of controlling for confounding variables.

External validity

- The extent to which the results obtained in a given study would also be obtained for different participants and under different circumstances (real world)
- Dependent upon sampling procedure

How to chose a research design?

- Does it adequately test the hypothesis?
- Does it identify & control extraneous factors?
- Are results generalizable?
- Can the hypothesis be rejected or retained via statistical means?
- Is the design efficient in using available resources?