Operational and Evaluative Research

SESSION 7: DEMONSTRATING CAUSALITY

Objectives of the session

By the end of this session, participants will be able to:

- Understand the purpose, strengths and shortcomings of different research designs
- Distinguish between research designs that enable causally linking program activities to observed changes from others

Recap: What is OR?

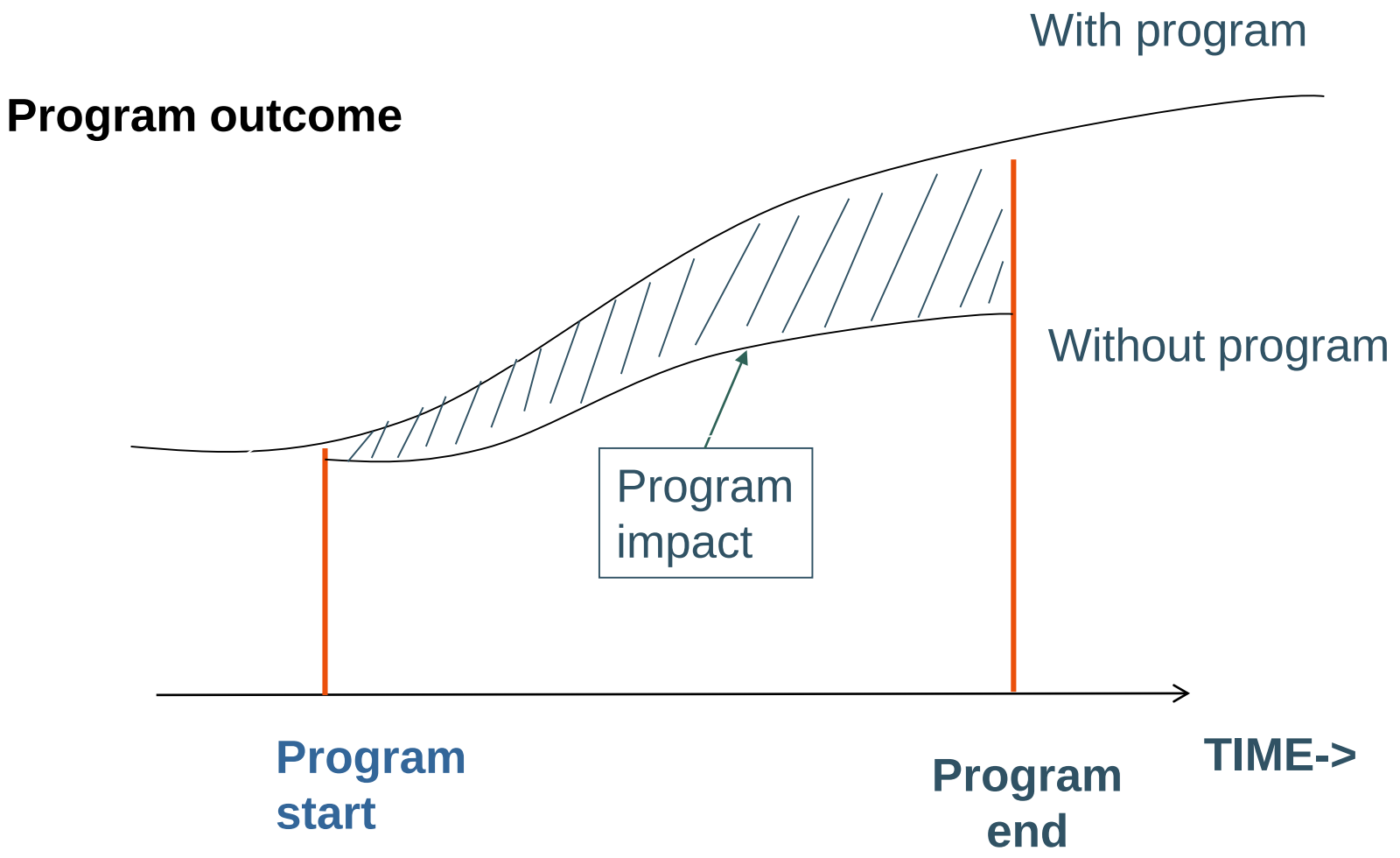
"The use of systematic research techniques for program decision-making to achieve a specific outcome". (WHO, 2003)

- It addresses specific problems within specific programs, not general health issues
- It addresses those problems that are under control of managers
- It utilizes systematic data collection procedures, both qualitative and quantitative, to accumulate evidence supporting decision-making;
- It requires collaboration between managers and researchers in identification of the research problem, development of the study design, implementation of the study and analysis and interpretation of results; and
- It succeeds only if the study results are used to make program decisions; publication alone is not a valid indicator of successful OR."

What is Program Impact?

To measure program impact, you should at least:

- Evaluate at start and end of program
- Make sure to rule out all other possible explanations (direct measurement or analytical exercise)



Why do we study causality?

We need to make decisions whether to:

- Continue the intervention
- Expand the intervention

Causality requirements

- A precedes B
  - A= Program/intervention
  - B= Change in outcome of interest
- B is present only when A is present
- We can rule out all other possible causes of B

Important!

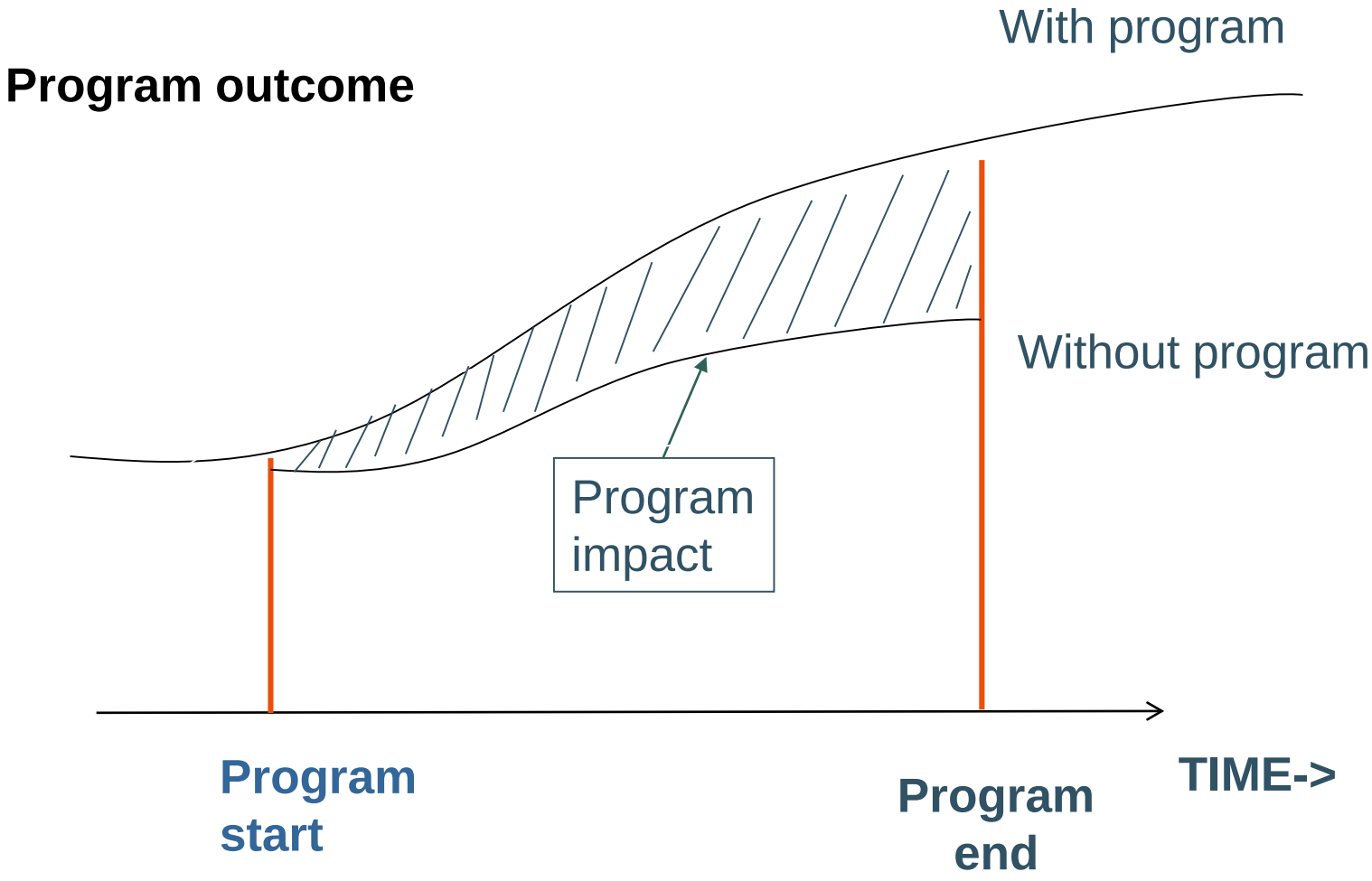
! Correlation is not causation

1. Correlation: X and Y are related
    - Change in X is related to a change in Y, and
    - Change in Y is related to a change in X
2. Necessary but not sufficient
3. Causation – if we change X how much does Y change
    - A change in X is related to a change in Y
    - Not necessarily the other way around

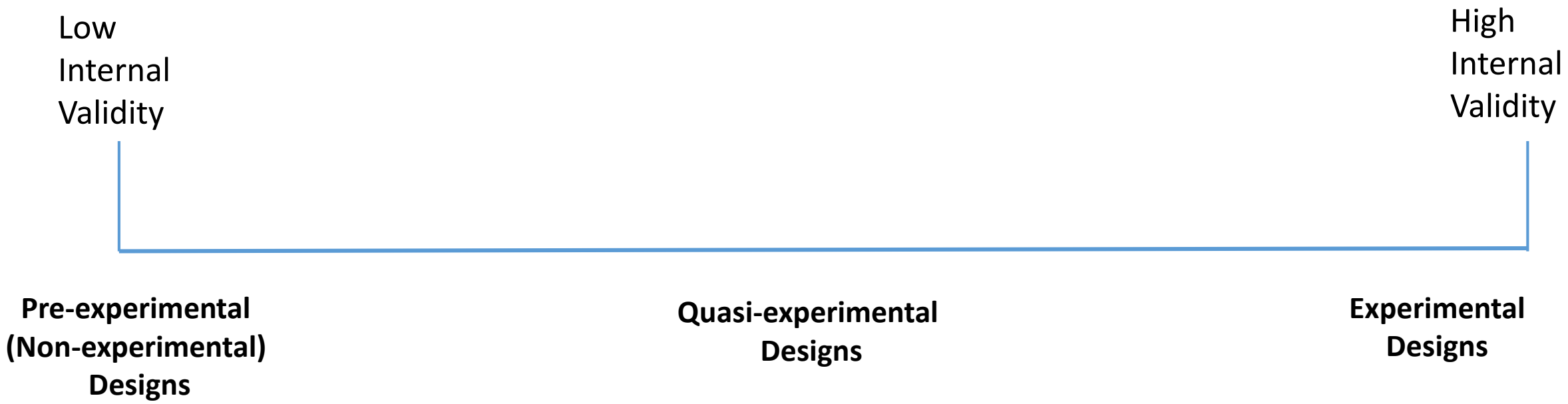
Program impact and causality

Internal Validity

1. Theoretical, conceptual or practical basis for the expected relationship
2. The program (A) precedes the changes in outcome (B) in time
3. Other explanations are ruled out
4. A statistically significant association exists between the program and the outcome
5. Outcome measures are reliable and valid



Internal validity continuum



The Basic Experimental Principle

- The intervention is the only difference between two groups
- This is achieved by random assignment to achieve equivalence between groups
  - This is necessary to demonstrate causality

Symbols

O = Observation measurement, subscript used to distinguish observation measurement (dependent variable)

X = Intervention program (independent variable)

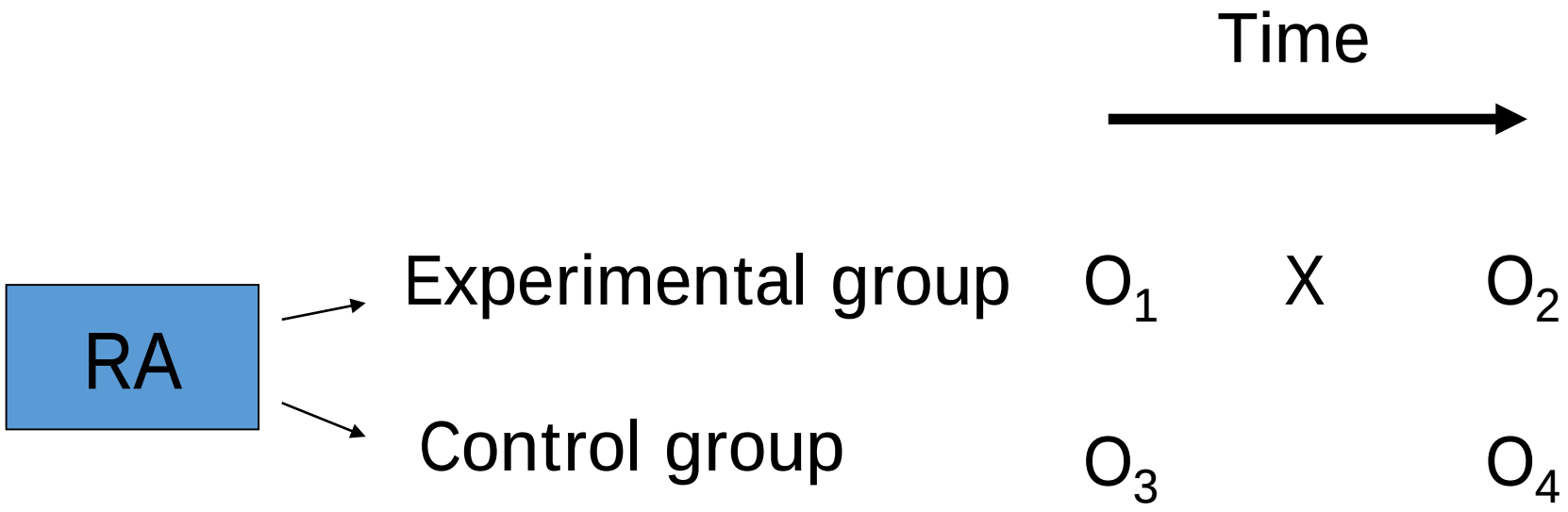
RA = Random Assignment to either experimental/intervention or control group

Time = the passage of time

 = separation of 2 groups that have not been randomly assigned

A. Experimental Designs

1. Pre-test-Posttest with Control Group Design



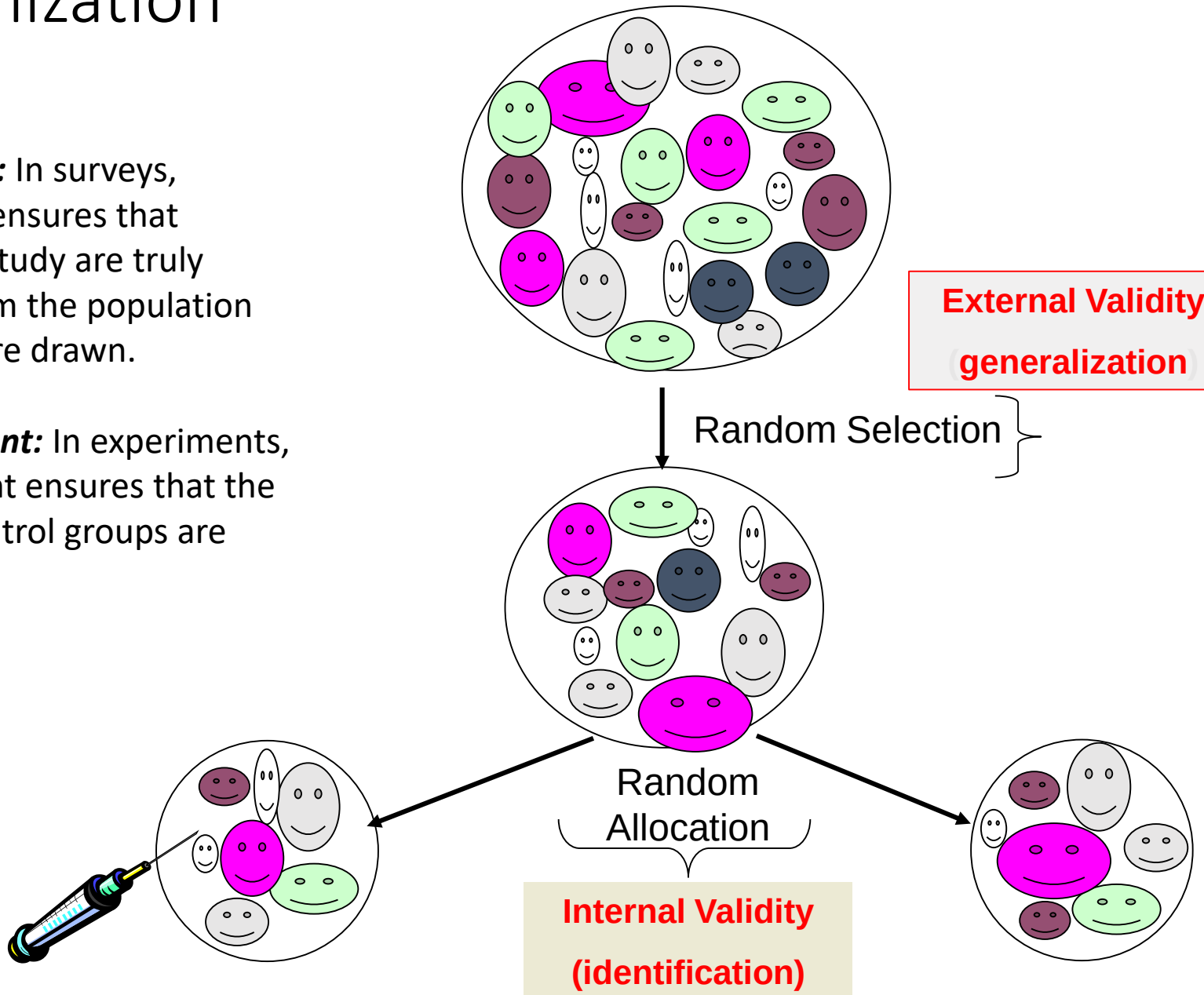
Experimental Designs (Ctd): Steps

1. Identify people or groups, some of which could get the intervention.
2. Pre-test everyone.
3. Randomly assign the people or groups to either the control group or the experimental group.
4. Deliver the intervention to the experimental group. The control group may receive an alternative intervention or nothing at all.
5. Post-test both groups with the same instrument under the same conditions.

Randomization

Random sampling: In surveys, random sampling ensures that individuals in the study are truly representative from the population from which they are drawn.

Random assignment: In experiments, random assignment ensures that the Treatment and control groups are truly comparable.



Causal comparisons

$$O_1 = O_3$$

Baseline condom use intervention area = baseline condom use control area

$$O_1 \neq O_2$$

Baseline condom use intervention area ≠ follow-up condom use intervention area

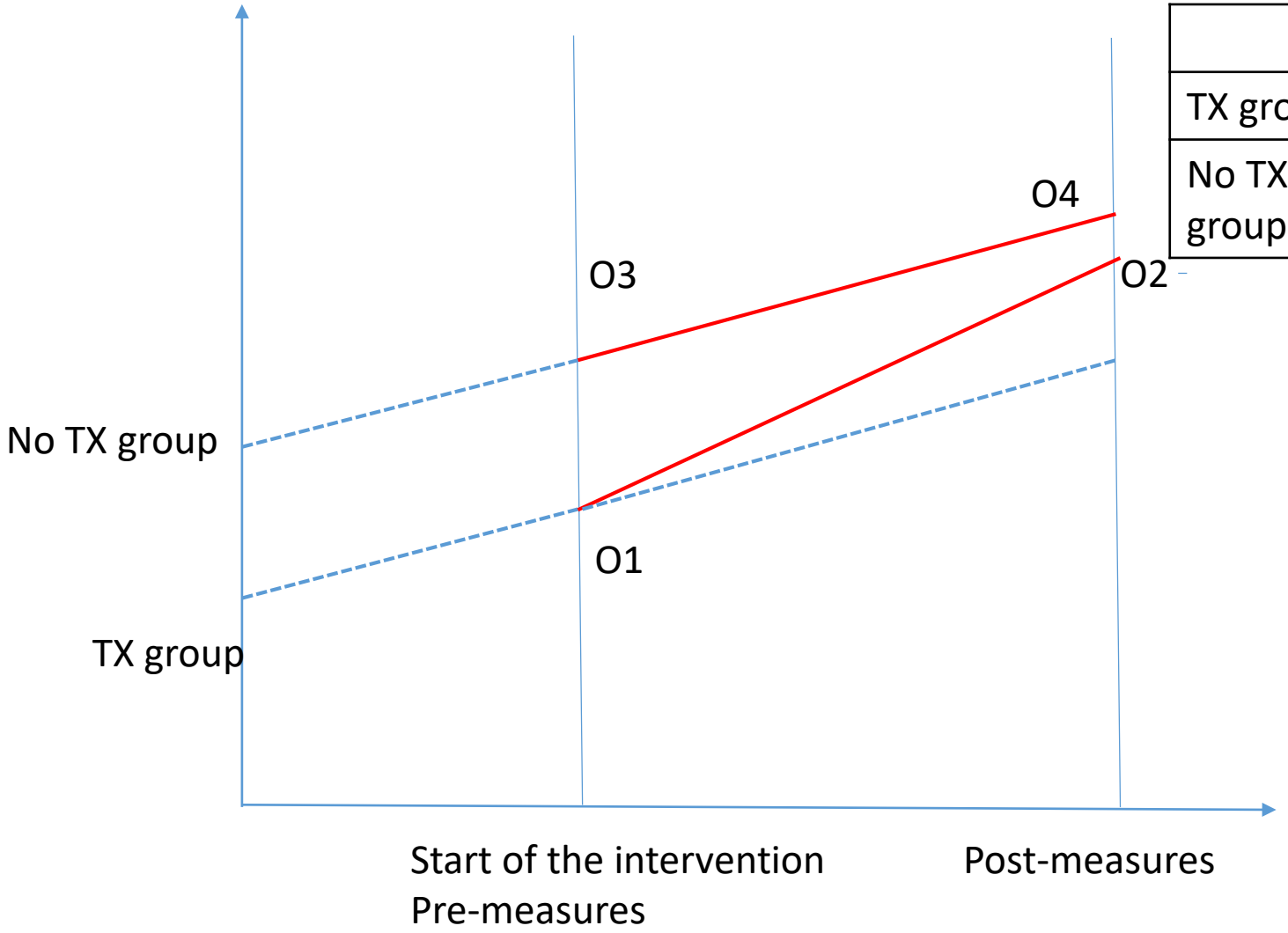
$$O_2 \neq O_4$$

Follow-up condom use intervention area ≠ follow-up condom use control area

$$O_3 = O_4$$

Baseline condom use control area = follow-up condom use control area

<u>Program effects</u>: $(O_2 - O_1)-(O_4 - O_3)$



	After	Before	Differences
TX group	O2	O1	O2-O1
No TX group	O4	O3	O4-O3

If the TX group did not receive the intervention: O1+(O4-O3) as the counterfactual

Program Impact= (O2-O1)- (O4-O3)

Inferential Statistics

- Used to demonstrate the reliability of differences between groups
    1. Chi Square
    2. T Test
    3. F Test

Limitation of Random Assignment: factors that may lead to making invalid conclusions

Randomized experimental designs generally eliminate most threats to internal validity, except:

1. Attrition (drop out, lost to follow up)
2. Contamination.
3. Instrumentation effect: occurs when a questionnaire is changed between the two measurements
4. Testing effect: occurs because study participants remember questions that were asked at pretest and “perform better” at posttest as they are now familiar with the questions.

Summary Features

Experimental (Pre- and Post- test with Control Group)

<table>
<tr><td rowspan="2">RANDOMLY ASSIGN PEOPLE FROM THE SAME TARGET POPULATION TO GROUP A OR GROUP B</td><td>TARGET GROUP A</td><td>ASSESS TARGET GROUP A</td><td>IMPLEMENT PROGRAM WITH TARGET GROUP A</td><td>ASSESS TARGET GROUP A</td></tr>
<tr><td>CONTROL GROUP B</td><td>ASSESS CONTROL GROUP B</td><td></td><td>ASSESS CONTROL GROUP B</td></tr>
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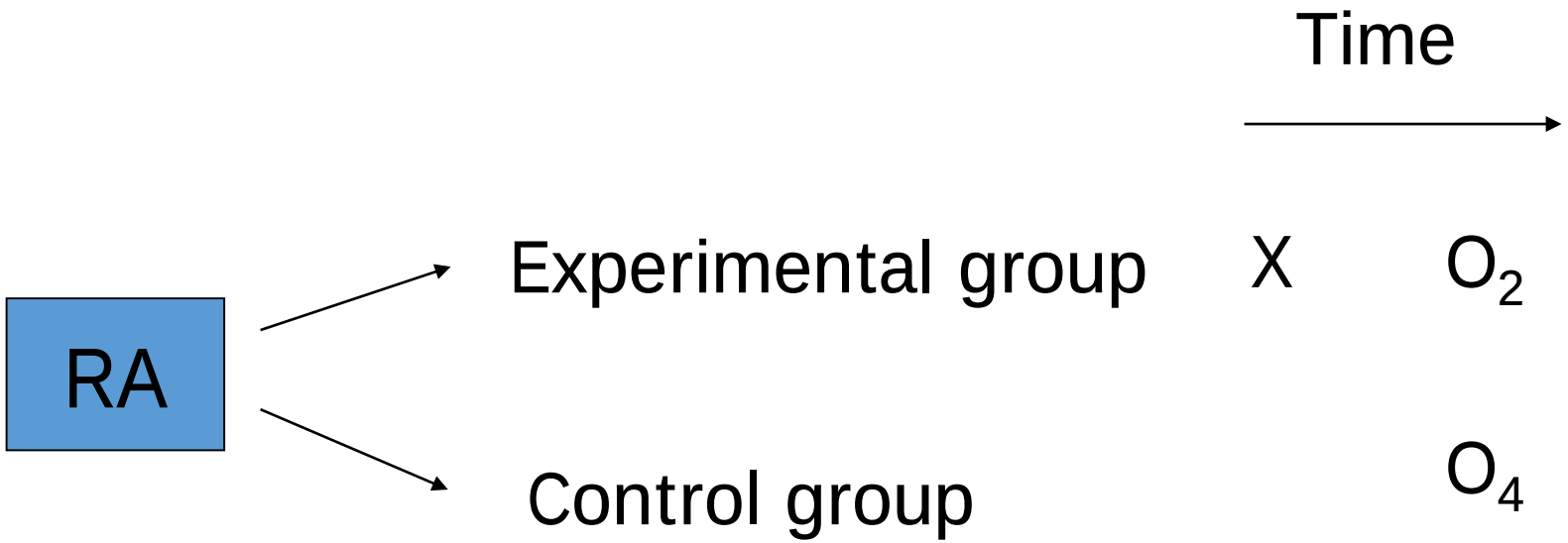
A. Experimental Designs

2. Posttest Only Control Group Design



A. Experimental Designs (Ctd)

- The posttest-only control group design is very useful when the goal is only to compare outcomes rather than the change in outcome.
- Often used when faced with serious time or budget constraints, unavailable pre-test data, concerns with testing effect
- Drawbacks: can't determine the extent of change in intervention group and not sure of how well the randomization worked

Threats to internal validity

Randomized experimental designs generally eliminate most threats to internal validity, except attrition (drop out, lost to follow up), contamination.

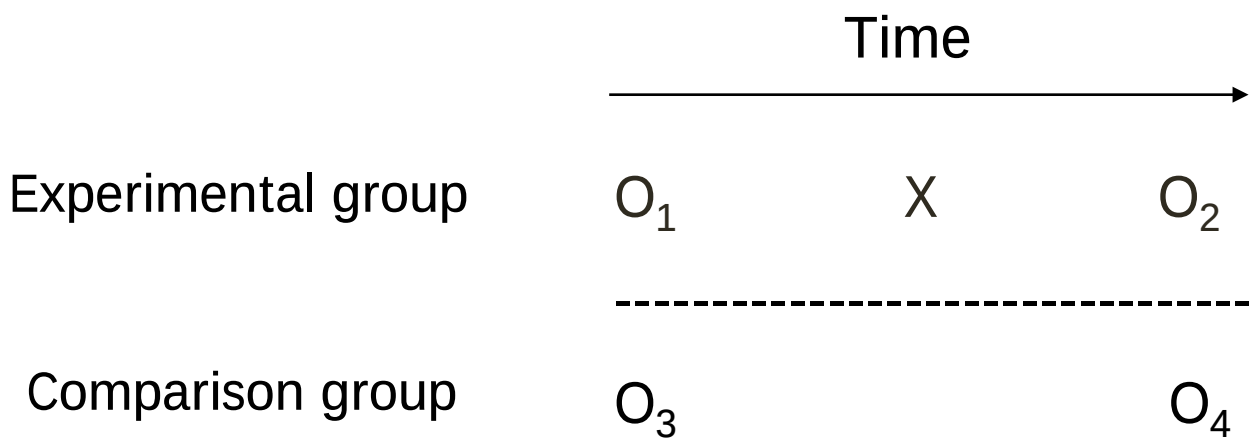
- **History**: events can occur during the lifetime of a project and can either increase or decrease the expected outcomes (between pre and post-test measurements). These events are called history effects.
- **Maturation**: Over time, people change. In longitudinal study, respondents become more experienced, more knowledgeable, and, of course, older. In other words, people mature over time. The maturation process can produce changes that are independent of the changes a program intervention is designed to produce (older, wiser, healthier)

Threats to internal validity

- **Testing**: earlier measurements can affect the results of later measurements. Participants get familiar to the questions and change in the measurement reflect that. Testing can be an important confounding factor when changes in knowledge or behavior are being studied over time
- **Instrumentation**: Whenever a measurement instrument (such as a questionnaire) is changed between the pretest and the posttest, this change is likely to result in an effect that is independent of any effect caused by the intervention.
- **Selection**: A very common threat to validity occurs whenever the people selected for the control group differ greatly from the people selected for the experimental group.

B. Quasi-experimental Designs

1. Pretest-Posttest Non equivalent Comparison Group Design



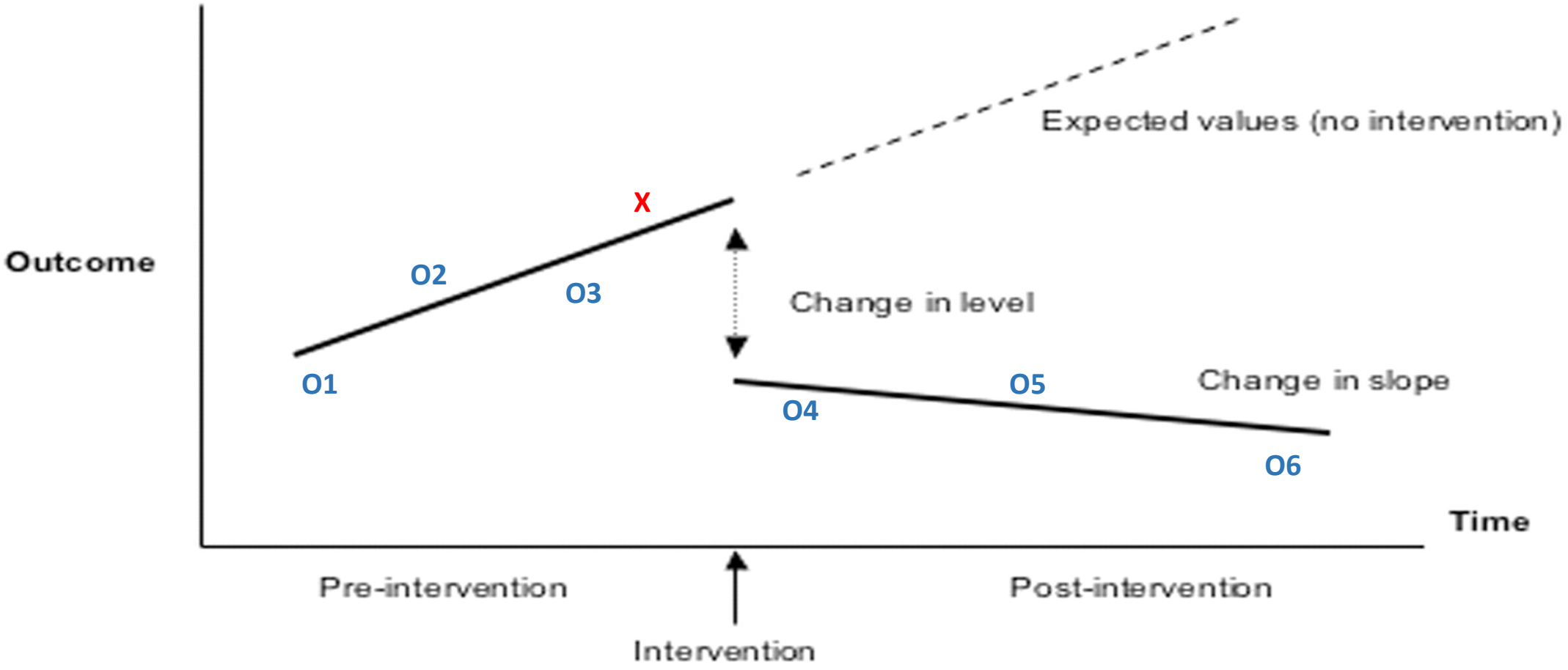
Main threats to validity: Selection, testing, instrumentation

B. Quasi-experimental Designs

2. Single Time Series Design

- Control for maturation and partially for history threats
- Still exposed to instrumentation and testing threats

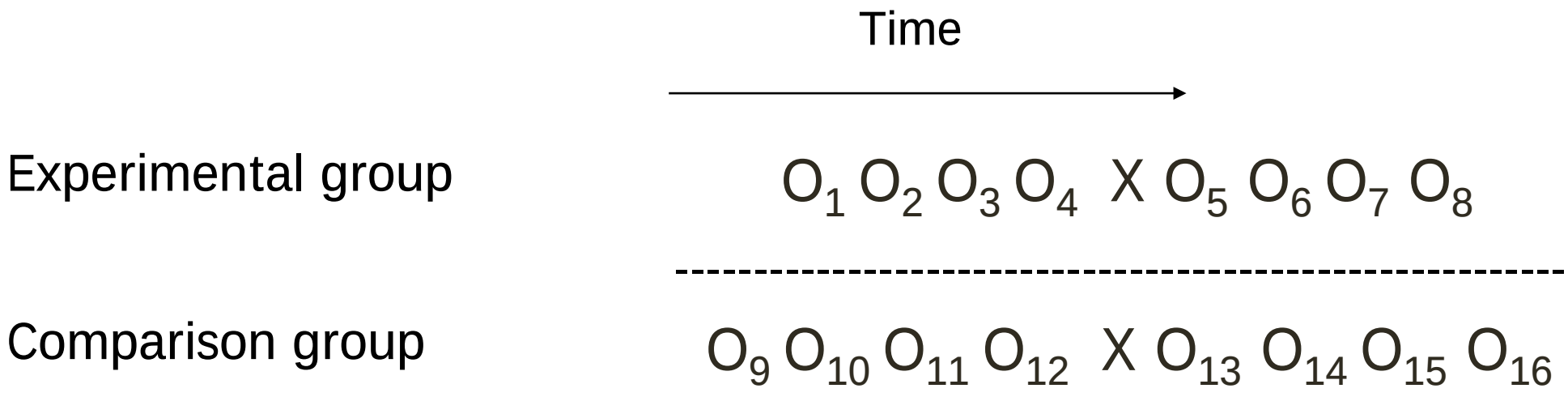
ILLUSTRATION



- Control for maturation, testing and partially for history threats
- Still exposed to instrumentation, attrition threats

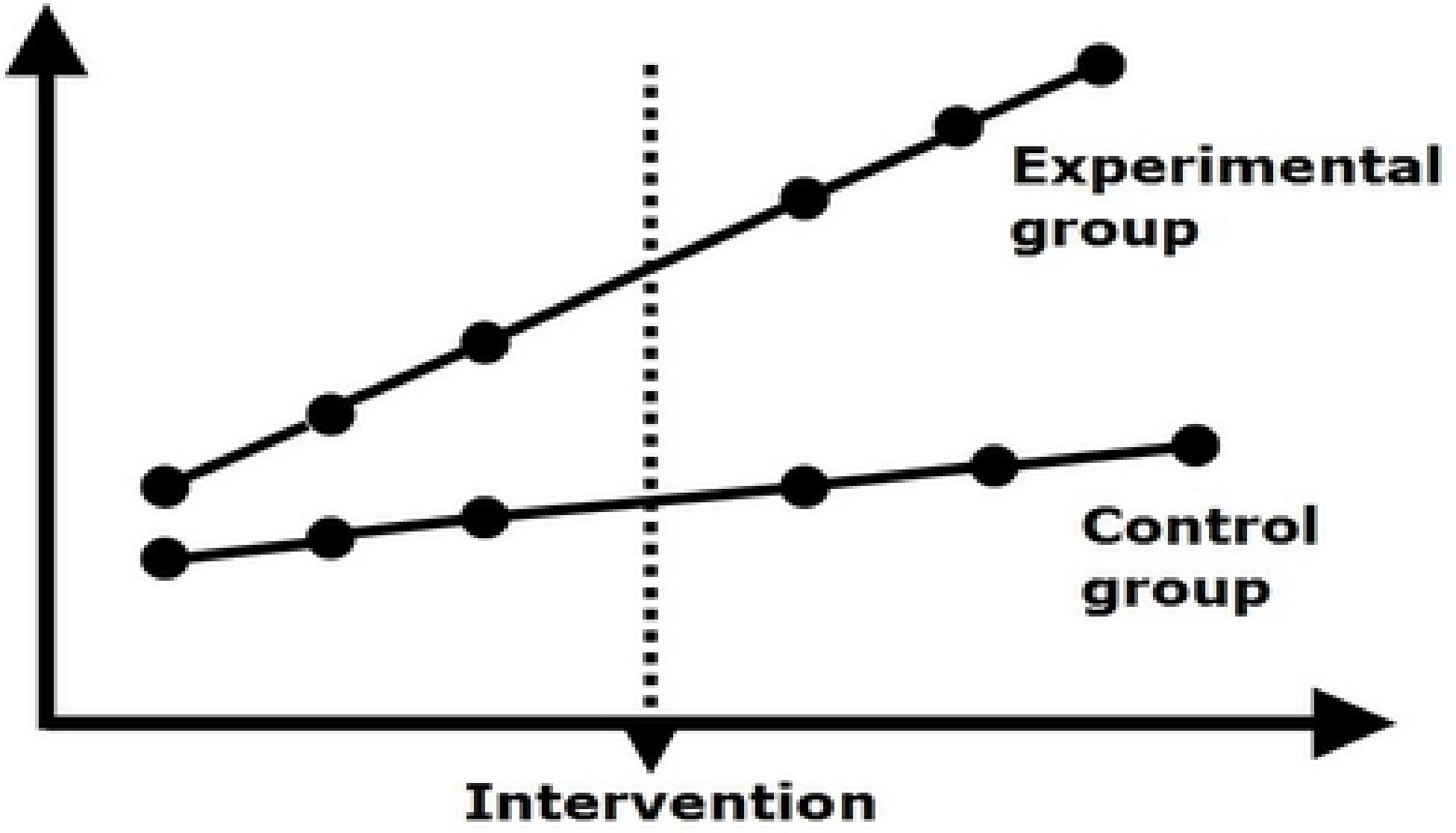
B. Quasi-experimental Designs

3. Multiple Time Series Design



Control for history threat from single time series
However, introduces selection threat

ILLUSTRATION



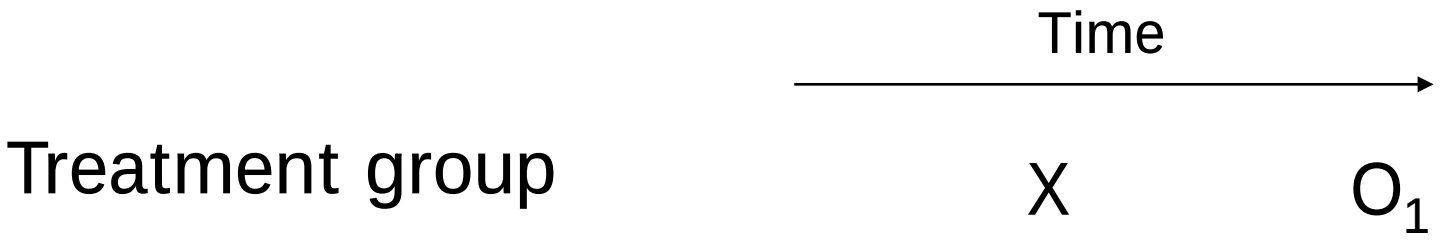
B. Quasi-Experimental Design – Times Series Ctd.

Steps

1. Select a program outcome that can be measured repeatedly
2. Decide who will be in the experimental group. Will it be the same group of people measured many times, or successive groups of different people?
3. Collect at least three measurements at regular intervals prior to the intervention
4. Check the implementation of the intervention
5. Continue to collect measurements at least through the duration of the program.

C. Non-experimental Designs

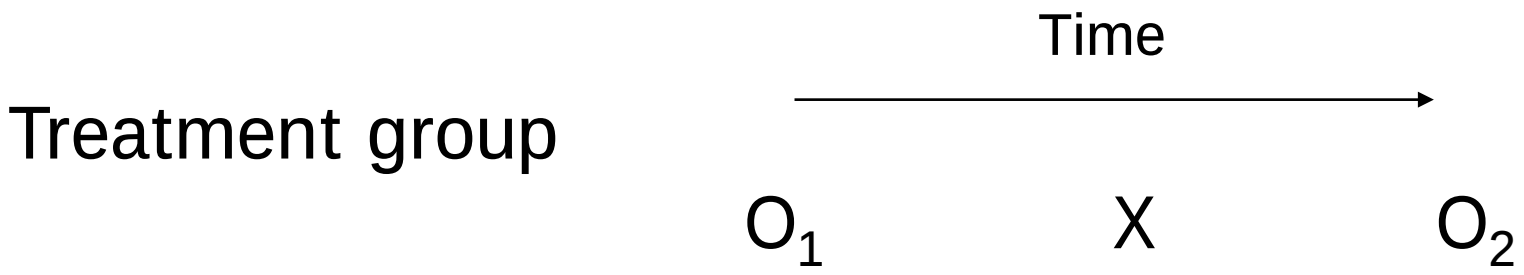
1. One-Group Posttest-Only Design



Main threats: History, Maturation

C. Non-experimental Designs- Ctd

- 2. One-Group Pre-test Posttest-Only Design (Before and after)



Main threats: History, Maturation, Testing, Instrumentation

C. Non-Experimental Design - Ctd.

Before and After: In this method of evaluation, only people who are participating in the program get the pre- and post-test

Steps

1. Pre-test everyone in the program.
2. Deliver the intervention.
3. Post-test the same individuals.

   This design does not provide any information about what kinds of results might have occurred without the program and is the weakest in terms of scientific rigor

Summary Features

I. Non-experimental (One-Group, Post-Only)

II. Non-experimental (One-Group, Before and After Program)

Summary Features of Different Study Designs

True experiment	Quasi-experiment	Non-experimental
Partial coverage/ new programs	Partial coverage/ new programs	Full coverage programs
Control group	Comparison group	--
Strongest design	Weaker than experimental design	Weakest design
Most expensive	Less expensive	Least expensive

As a conclusion

- Important elements to consider when selecting a design:
  - Ethical issues: IRB process
  - Practical, Financial and administrative issues: high cost, limited time, few staff/personnel, availability of units of study!! Real world conditions are not always ideals!
  - Technical issues: capacities are important. Don’t hesitate to look for someone who can help!

Group Assignment 1

Each group will search for an article that utilizes one of the research design discussed in class and will discuss

1. The design applied in the paper: the advantages and disadvantages
2. Why is it the best design for this research question
3. Interpret the results.

Groups will share the selected paper ahead of time and prepare a presentation to be done in class.

Group assignment 2

1. Identify a researchable problem in our work environment.
2. Generate potential solutions and select one to implement as a strategy/intervention
3. What study design would you choose to assess the impact of your intervention on your outcome of interest and why?
4. What outcome indicator(s) would you use?
5. What threats to validity would you be most concerned about in choosing your study design?

Group Assignment 2

- Instructions:
  - Group size:
  - Submission 4 weeks from the day of receiving the
  - Submission requirements: FONT: Times New Roman 12; 1.5 line spacing; title page with list of group members student ID number; submit word document save as “OER Assignment 2, Group X”