Experimental, Quasi-Experimental, and Ex Post Facto Designs

Chapter 9
CS7123 Research Seminar
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Cause and Effect

We often want to know ***what leads to what?*** That is to *identify* Cause-And-Effect Relationships.

Experimental Studies

- The most convincing way to achieve that is to use an ***experimental design***.
- In such a design, a researcher considers many possible factors that might cause or influence a particular condition or phenomenon.
- The researcher then attempts to control for all influential factors ***except*** those whose possible effects are the ***focus of investigation***.

An Example to clarify

- we want to measure the performance of a newly invented algorithm ***A over an existing algorithm B.***

- To do so, we must discard all the possible external factors that might impact the performance. Example:
    - Difference in Problem set & size
    - Difference in Operating System
    - Difference in underlying Hardware Capacity etc

An Example to clarify (contd)

- That is we need to ensure both the algorithm was tested in equivalent environment and against same sets of problem.

- If the result shows A performs better than B in all the cases, we can conclude that A is better

- Again the essence is control of other ***unwanted external factors.***

Recap of Some Terminologies

- *Variable*: any quality or characteristic in a research investigation that has two or more values.
- *Cause-and-Effect Relationship*: the extent to which one variable (the cause) influences another variable (the effect).
- *Independent Variable*: a variable that the researcher studies as a possible cause of something else; the variable that the researcher directly manipulates.
- *Dependent Variable*: a variable that is potentially influenced by the independent variable; a variable that is influenced by and to some extent depends on the independent variable.

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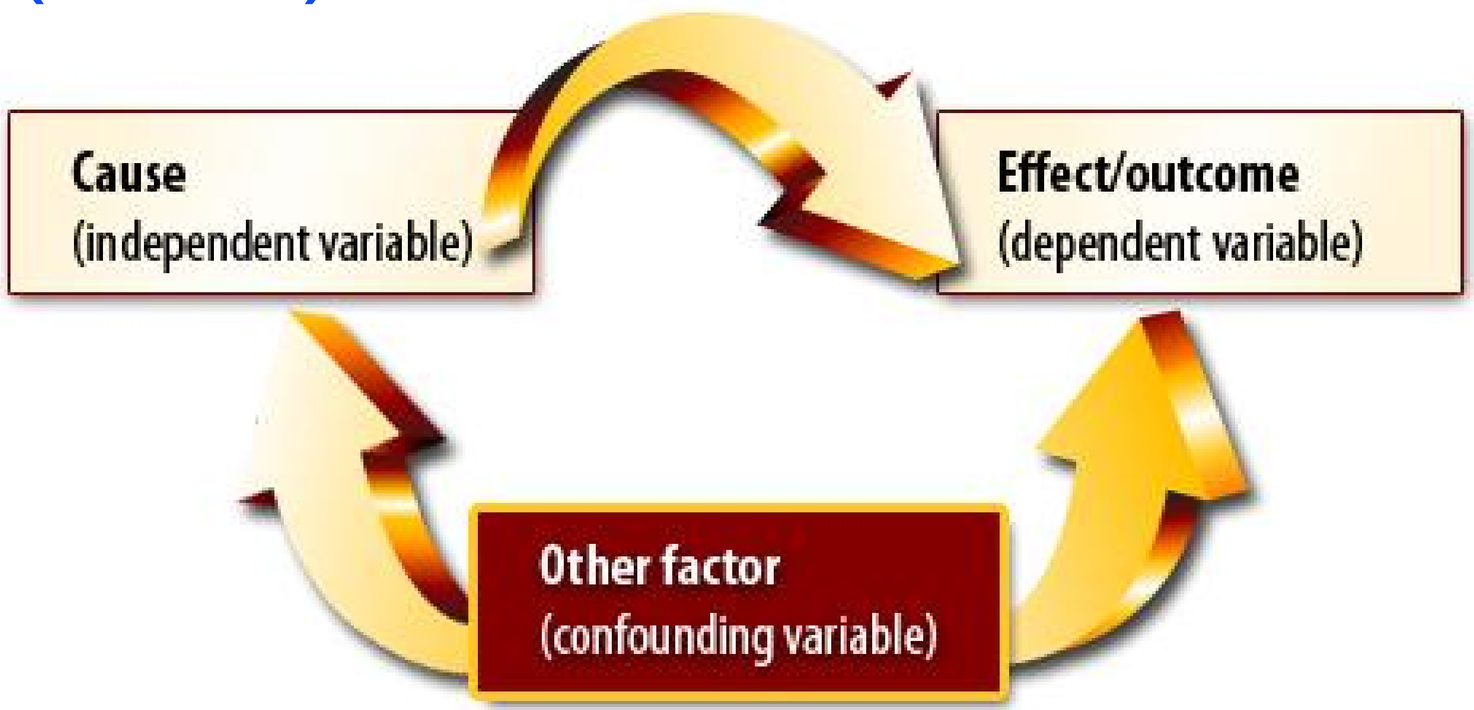


Confounding Variables:

account for differences in two or more groups that are not attributable to the particular treatment or intervention being studied.

Internal Validity

- The extent to which its design and the data it yields allow the researcher to draw legitimate conclusions about cause-and-effect and other relationships.

  For Example:

  - A new method of teaching science was invented and was deployed on a class for a semester. Also, another teacher continued using the old method in another class. After the end of the semester, a test was taken which shows the students of new method performs better.

- ***Can we conclude that the new method is better than the old one?***

... (contd)

Can we conclude that the new method is better than the old one?

Answer : ***NO***

There might be several factors that can produce this result.

- The Teachers might be different: One is female, the other is male
- They have different personalities, educational backgrounds, teaching styles and so on.
- Even the two groups of students may be different. One might be reading in a higher grade and have more intelligence and motivation.
- There could be several other dissimilarities.

"Five thousand hours, and his vital signs are still strong."

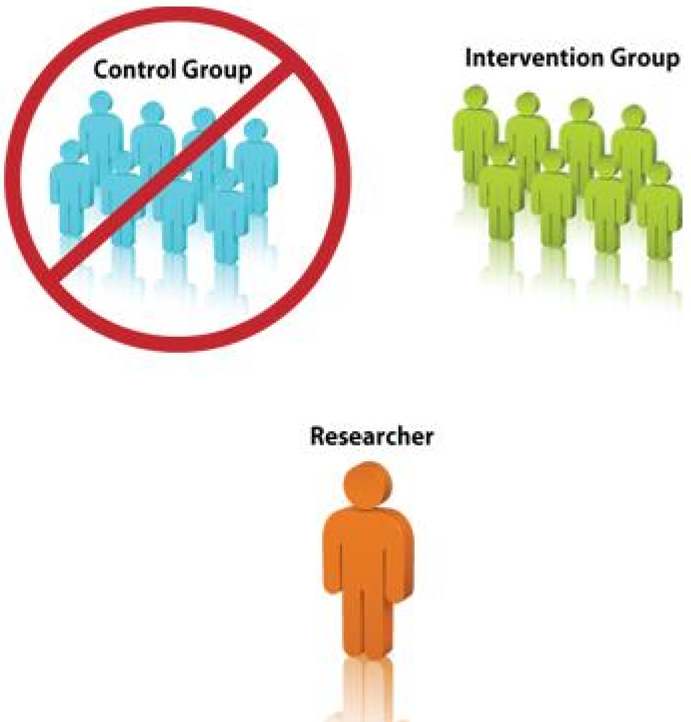
Controlling Confounding Variables

1) Keep some things constant.
2) Include a control group.
3) Randomly assign people to groups.
4) Assess equivalence before the treatment with one or more pretests.
5) Expose participants to all experimental conditions.
6) Statistically control for confounding variables. (discussed in chapter 11)

Control Group vs Experimental Group

Control group is a group that receives either no intervention or a neutral intervention that should have little or no effect on the dependent variable.

The researchers then compare the performance of this group to an ***Experimental group*** - also known as a ***Treatment Group*** - that participates in an intervention.



Categories of Experimental Designs

- In true experimental research, the researcher manipulates the independent variable and examines its effects on another, dependent variable.

- A variety of research designs have emerged that differ in extent to which the researcher manipulates the independent variables. Five major categories of Experimental Designs are:

1) Pre-Experimental Designs
2) True Experimental Designs
3) Quasi-Experimental Designs
4) Ex Post Facto Designs
5) Factorial Designs

1. Pre-Experimental

In Pre-Experimental design, it is not possible to show cause-and-effect relationships because

1) the independent variable doesn’t vary ***or***
2) experimental and control groups are not comprised of equivalent or randomly selected individuals.

Such designs are helpful only for forming <u>*tentative hypothesis*</u> that should be followed up with <u>*more controlled studies.*</u>

1.1 One-Shot Experimental Case Study

- The one-shot experiment case study is probably the most primitive type of experiment that might conceivably be termed “research”.
- An Experimental Treatment (Tx) is introduced, and then a measurement (Obs)- a posttest of some sort - is administered to determine the effects of the treatment

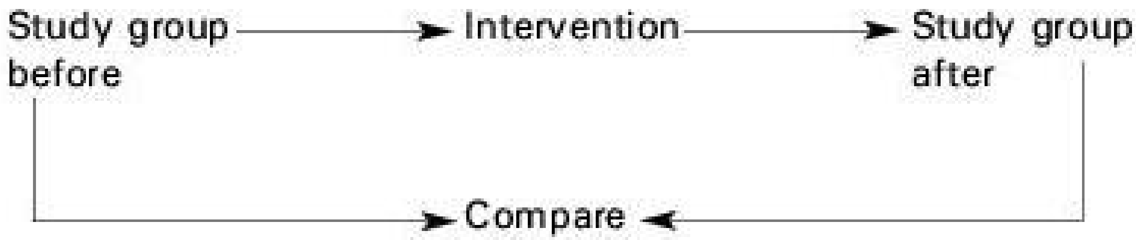
.

Group	Time ->	
Group1	Tx	Obs

Low Validity

- The design has low internal validity because it is impossible to determine whether participants performance on the posttest is the result of the experimental treatment per se.

1.2 One-Group Pretest-Posttest Design



Group	Time ->		
Group1	Obs	Tx	Obs

- A single group undergoes a pre-experimental observation or evaluation , then is administered the experimental treatment, and finally is observed or evaluated again after the treatment.

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<u>example:</u>

suppose an elementary school teacher wants to know if simultaneously reading a story and listening to it on audiotape will improve the reading skills of students in his class.

1) He gives his students a standardized reading test.
2) Then has them simultaneously read and listen to simple stories every day for eight weeks.
3) And then administers an alternate form of the same standardized reading test.

If the students test scores improve over the eight-week period, the teacher might conclude - perhaps actually, but perhaps not - that the simultaneous-reading and listening intervention was the cause of the improvement.

1.3 Static Group Comparison

- The static group comparison involves both an experimental group and a control group.
- An experimental group is exposed to a particular experimental treatment; the control group is not.
- After the treatment, both groups are observed and their performance compared.

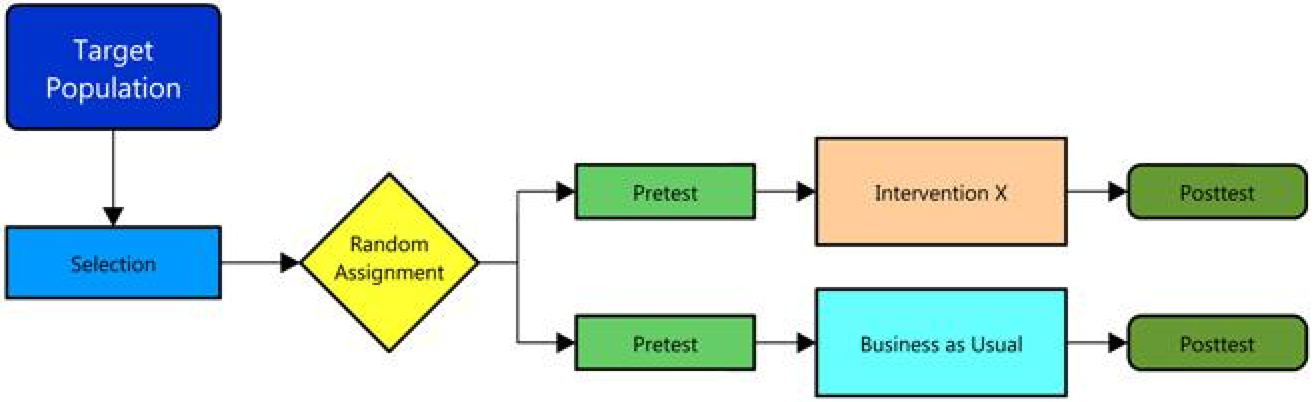
Group	*Time ->*	
Group1	Tx	Obs
Group2	-	Obs

Drawbacks of static group comparison

- No attempt is made to obtain ***equivalent*** groups or even to examine the groups to determine whether they are ***similar*** before the treatment. Thus, we have no way of knowing <u>*if the treatment actually cause any observed differences between*</u> the groups.

2. True Experimental Design

- Compared to pre-experimental designs, experimental designs offer a great degree of control and greater internal validity.
- People or other units of study are assigned always randomly. Such ***random assignment*** guarantees that any differences between the groups are probably quite small and, in any case, are due entirely to chance.



2.1 Pretest-Posttest Control Group Design

Solves 2 Major Issues

	Group	Time ->		
Random Assignment	Group1	Obs	Tx	Obs
	Group2	Obs	-	Obs

- This design, simple as it is, solves two major problems associated with pre-experimental designs.
- We can
  1) determine whether a change takes place after the treatment, and, if so, we can
  2) eliminate most other possible explanations (in the form of confounding variables) as to why the changes has taken place.
- Thus we have a ***reasonable basis*** on which to draw a conclusion about ***cause-and-effect*** relationship.

2.2 Solomon Four-Group Design

A variant of the previous design which is independent of any bias during the pretest phase.

	Group	Time ->			
Random Assignment	Group1	Obs	Tx	Obs	Compare
	Group2	Obs	-	Obs	
	Group3	-	Tx	Obs	Compare
	Group4	-	-	Obs	

2.3 Posttest-only Control Group Design

- Some life situations defy pretesting.

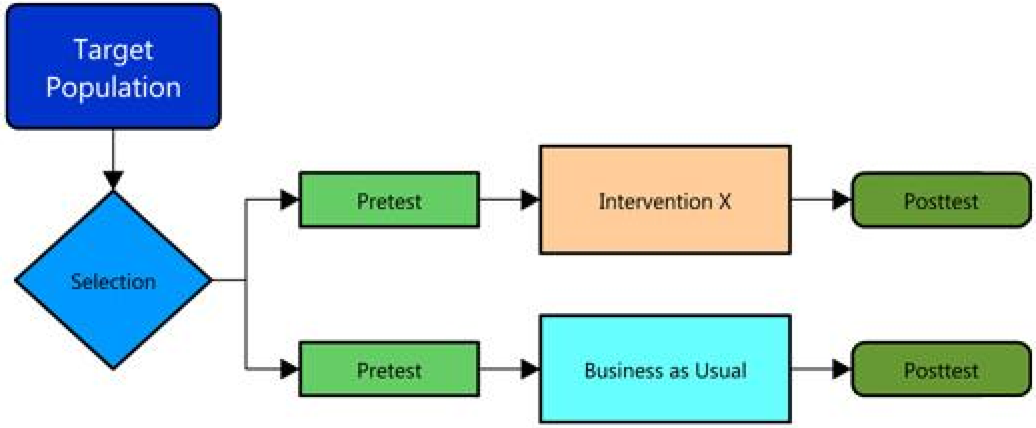
Ex: pretest the forces in a thunderstorm or a hurricane.

- Also, sometimes it might be difficult to locate a suitable pretest or the very act of pretesting can influence the results of the experimental manipulation.
- In such circumstances, the posttest-only control group design offers a possible solution.
- Random assignment to groups is , of course, critical in posttest-only design.

	Group	Time ->	
Random Assignment	Group1	Tx	Obs
	Group2	-	Obs

3. Quasi-Experimental Designs

- The quasi-experiment is a type of experimental design in which the researcher has limited leverage and control over the selection of study participants.
- Specifically, in quasi-experiments, the researcher does not have the ability to randomly assign the participants and/or ensure that the sample selected is as homogeneous as desirable.
- Accordingly, the ability to fully control all the study variables and to the implication of the treatment on the study group(s) may be limited.
- Never-the-less, quasi-experiments still provide fruitful information for the advancement of research



example

- An example of a quasi-experiment that does not provide random grouping of participants maybe an *<u>investigation of the impact of IT use policy training on employee's IT misuse</u>* in an organization.
- It may very well be that the researcher has no control over which group of employees will receive the training and which group will not as these are based on departments. However, prior research may have indications that employees' computer experience and age have direct implication on employee's IT misuse in an organization.
- Furthermore, it is very likely that the researcher has very little control over the distribution of the moderator variables (i.e. employees' age and computer experience in this example) between the two groups that may have significant implications for the measure of IT misuse.
- While being able to measure IT misuse before the training and after the training, comparing experimental and control groups, even if participants were not randomly distributed, may provide some good indications about the implications of the training, given that the employees' computer experience and age were measured and showed no significant mean differences between the two groups.

3.1 Nonrandomized Control Group Pretest-Posttest Design

Group	Time ->		
Group1	Obs	Tx	Obs
Group2	Obs	-	Obs

- To show that two groups are equivalent with respect to the dependent variable prior to the treatment, thus eliminating initial group difference as an explanation for post treatment differences.
- Key difference with the experimental design that the test and control groups are not totally equivalent due to lack of randomness.

3.2 Sample Time-Series Experiment

- A time-series design consists of making a series of observations, introducing an intervention or other new dynamic into the system, and then making additional observations.
- If ***substantial change*** is observed in the ***second series of observations*** compared to the ***first series***, we might reasonably conclude that the *cause of the change was the factor introduced into the system.*

Group ***Time ->***

Group1	Obs	Obs	Obs	Obs	Tx	Obs	Obs	Obs	Obs

3.3 Control Group, Time Series Design

- a variation of previous design with introduction of control group.
- Has greater internal validity

Group ***Time ->***

Group1	Obs	Obs	Obs	Obs	Tx	Obs	Obs	Obs	Obs
Group2	Obs	Obs	Obs	Obs	-	Obs	Obs	Obs	Obs

4. Ex Post Facto Designs

- In many situations, it is either unethical or impossible to manipulate certain variables in order to investigate their potential influence on other variable
- *For example*: a researcher cannot intentionally infect people with a potentially deadly new virus, withhold instruction, ask parents to abuse their children.
- In Ex Post Facto Design, The researcher identifies events that have already occurred or conditions that are already present and then collects data to investigate a possible relationship between these factors and subsequent characteristics or behaviors.
  - like correlational research, ex post facto research involves looking at existing circumstances;
  - like experimental research, ex post facto research has clearly identifiable independent and dependent variables;
  - unlike experimental research, ex post facto research involves no direct manipulation of the independent variable – the presumed "cause" has already occurred.

4.1 Simple Ex Post Facto Design

- Simple Ex Post Facto design is similar to static group comparison.
- Important difference with the static group comparison is one of timing : in this case, the ***treatment*** in question occurred long before the study began;
- Hence, we call it an ***experience*** rather than a treatment because the researcher has not be responsible for imposing it.

Group ***Time ->***

	Prior Event(s)	Investigation Period
Group1	Exp	Obs
Group2	-	Obs

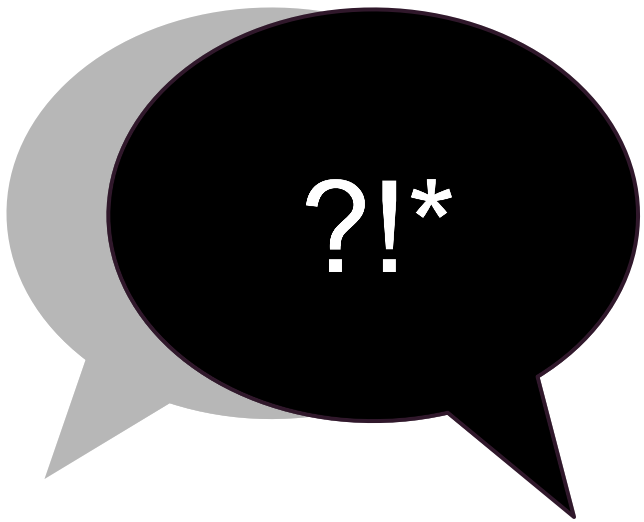
5.Factorial Design

- Examination of the effects of two or more independent variables in a single study.
- Randomized Two-Factor Experimental Design

Group **Time ->**

		Treatments related to the two variables may occur simultaneously or sequentially		
		Treatment related to Var1	*Treatment related to Var2*	
Random Assignment	Group1	Tx1	Tx2	Obs
	Group2	Tx1	-	Obs
	Group3	-	Tx2	Obs
	Group4	-	-	Obs

Questions?



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