Overview of Experimental and Ex Post Facto Designs

Nasim
& Jenny

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- Overview
- Pre-Experimental Designs
- True Experimental Designs
- Quasi-Experimental Designs
- Ex Post Facto Designs
- Factorial Designs

Overview

- The designs that differ in the degree to which they have ***internal validity*** or the extent to which the independent variable is manipulated and confounding variables are ***controlled***.
  - Pre-experimental designs
  - True experimental designs
  - Quasi-experimental designs
- Study the possible effects of an ***environmental*** factor that has occurred before the study
  - Ex post facto designs
- Study the effects of two independent variables ***simultaneously***
  - Factorial Designs

Pre-Experimental Designs

- ***Not possible*** to show cause-and-effect relationships.
- Why?
  - The independent variable doesn't vary
  - Experimental or control group weren't created based on *equivalent* or *randomly* selected individuals.
- So, what is this good for?
  - Only for forming ***tentative/experimental hypotheses***
  - Should be followed up with more controlled studies

Design 1: One-Shot Experimental Case Study

Group	Time →	
Group 1	Tx	Obs

- An experimental treatment is introduced and the effects of the treatment is measured.
- One of the most ***primitive*** types of experiment
- ***Low*** internal validity, why?
  - Exposure to cold, damp ground(Tx) -> you caught cold (Obs)
  - If you walk under ladder(Tx) -> Bad Luck!(Obs)
- Drawbacks:
  - Many other variables involved.
  - You are seeing an event, then another, then ***you*** *are linking them* together as cause and effect.

Design 2:One-Group Pretest-Posttest Design

- A single group undergoes
  - A pre-experimental observation
  - The experimental treatment
  - Observed/evaluated again

Group	Time →		
Group 1	Obs	Tx	Obs

- Example:
  - An agronomist hybridizes two strains of corns, she finds that this hybrid strain is more disease resistant than its parent and better yield.
    - She measures the disease resistance of parent trains(Obs)
    - She develops a hybrid of two strains(Tx)
    - She measures the disease resistance level of the new generation(Obs)
- At least we know a change has taken place.
- Drawback: Many other variables might be involved!

Design 3: Static Group Comparison

- The experimental group is exposed to the treatment.

Group	Time →	
Group 1 (Experimental)	Tx	Obs
Group 2 (control)	____	Obs

- No attempt to obtain equivalent groups or examine their resemblance before the treatment.
- Then how do we know whether the treatment actually caused the difference we see between the groups?
  - Exactly! No way!

True Experimental Designs

- People or other units of study are ***randomly*** assigned to groups!
  - Guarantees that the difference between groups:
    - Is ***probably*** very small or due to chance!
- Why is random assignment beneficial at all?
  - Greater degree of ***control*** and as a result a greater ***internal validity !!!***

Design 4: Pretest-Posttest Control Group

- Both groups are carefully selected through ***randomization procedure***!

Random Assignment	Group	Time →		
	Group 1 (Experimental)	Obs	Tx	Obs
	Group 2 (Control)	Obs	____	Obs

- Then they are observed, subjected to experimental treatment and then observed again.
- The control group is isolated from the experimental group.
- Solves the issues of Pre-Experimental Designs:
  - We are *sure* whether a change happens after the treatment
  - Eliminate other possible explanations involved (confounding variables) about the change.
- Now, we have a ***reasonable*** basis to draw conclusions about cause and effect relationships!
- No wait!

Design 5: Solomon Four-Group Design

- An extension of Design 4
  - Proposed by Solomon in 1949

Random Assignment	Group	Time →		
	Group 1	Obs	Tx	Obs
	Group 2	Obs	___	Obs
	Group 3	___	Tx	Obs
	Group 4	___	___	Obs

- Solves the reactivity effect problem
  - ***Eliminates the pretest influence***
- enhances the ***external validity***
- It has a ***larger sample***
- ***Drawback:***
  - Needs ***more time*** and energy from the researcher

Design 6:Posttest-Only Group Design

- Some life situations defy pretesting.
  - Growing crops, thunderstorm or hurricane
- Pretesting might influence the results of an experimental manipulation.
- This is the solution:
  - The last two groups of Solomon four-group design.

Random Assignment	Group	Time →	
	Group 1	Tx	Obs
	Group 2	____	Obs

- Wait! Isn't it the same as Design 3 (static group comparison)?

Design 7: Within-Subject Designs aka repeated-measures Design

- All subjects receive all treatments (including control conditions)
  - Subjects : human, dogs, rats, etc.

Group	Time →	
Group	Tx a	Obs a
	Tx b	Obs b

- The treatments are administered very close in time or even simultaneously!
- In this experiment the various forms of treatment should be:
  - Localized
  - Unlikely to spread beyond targeted behavior
  - The two different treatments should be administered repeated and randomly with the presentation of two conditions evenly balanced.

Quasi-Experimental Designs

- Ok, I get it randomness is important!
- But, what if randomness is ***neither possible nor practical***.
  - Solution: quasi-Experimental Designs.
  - They do not control for all confounding variables, so they can't completely rule out alternative explanations for the observed results!
    - Solution: Take all those variables into consideration when interpreting the data.

Design 8: Nonrandomized Control Group Pretest-Posttest Design

- It's in between of Design 3 (static group comparison) and Design 4 (pretest-posttest control group)

Group	Time →		
Group 1 (Experimental)	Obs	Tx	Obs
Group 2 (Control)	Obs	___	Obs

  - Two groups with nonrandom participant assignment like design #3
  - Have pretreatments of design #4
  - ***No randomness***, no guarantee for group similarity, however initial observation can confirm they have the ***same dependent variable***.
  - We can reasonably conclude the cause and effect relationship exists if the treatment *influences on the dependent variable*.
  - We can at least rule our ***some*** alternative explanation.

Design 9: Simple Time-Series Design

Group	Time →								
Group1	Obs	Obs	Obs	Obs	***Tx***	Obs	Obs	Obs	Obs

1. Measuring the dependent variable on several occasions (a series of observations).
2. Introducing the intervention and then observing again.
3. If the second series of observations have considerable change, we conclude was the introduced factor into the system.

- The first set of observations is referred to as ***baseline***.
- Weakness:
  - A confounding variable known as ***history***. An event in the outside world happens *accidentally at the same time* and if it is the main cause of change, then the conclusion is erroneous!

Design 10: Control Group, Time-Series Design

- A variation of design #9, but with ***higher validity***
- Solves the *history* problem, how?
  - If an outside event is the cause of any change, it should influence both groups, then the change caused by the treatment will be distinctive!

Group	Time →							
Group 1 (Experimental)	Obs	Obs	Obs	Obs	Tx	Obs	Obs	Obs	Obs
Group 2 (Control)	Obs	Obs	Obs	Obs	___	Obs	Obs	Obs	Obs

Design 11: Reversal Time-Series Design

Group	Time →							
Group 1	Tx	Obs	____	Obs	Tx	Obs	____	Obs

- A ***within-subject*** approach
- **Minimizes** (**doesn't eliminate** entirely) the probability that outside events are causing the observed changes.
- The intervening experimental variable is sometimes present, sometimes absent.
- We measure the dependent variable in regular intervals.
  - We should see consistent changes after the administration of treatment.

Design 12: Alternating Treatments Design

- A variation of reversal time series design involves two or more different ***forms*** of treatments.
- The sequence is pursued over a long time span, we would presumably see the effects of both treatments.

Group	Time →											
Group 1 (Experimental)	Tx_a	Obs	___	Obs	Tx_b	Obs	___	Obs	Tx_a	Obs	___	Obs

- Drawbacks of design 11 and 12:
  - Each single treatment has a *temporary* and *limited* effect. So, these designs won't work for long-lasting effects.

Design 13: Multiple Baseline Design

- It is helpful when the ***effects of treatments are long-lasting***.

Group	Time →					
	baseline		Treatment			
Group 1	___	Obs	Tx	Obs	Tx	Obs
	Baseline				Treatment	
Group 2	___	Obs	___	Obs	Tx	Obs

- If an experimental factor is beneficial for all participants, and ethical consideration discourages you to have a control group, we can use this method and ***apply the treatment in a different time*** (the time interval selection can be random).
- There's still the possibility of having some confounding random variables.
- Design #11, #12 and #13 can also be used for single individuals instead of groups which is known as ***single-subject*** design.

Ex Post Facto Designs

- Sometimes it is unethical or impossible to manipulate certain variables to investigate their potential influence on the dependent variable.
  - Example: Introduce a new virus, ask parent to abuse their children etc.
    - Experimentation is not feasible!
- Solution?
- Ex Post Facto Design, "Ex post Facto" means after the fact. This method identifies the ***previous events*** and ***present conditions***, then ***collects data*** to *investigate a possible relationship* between these factors and subsequent behaviors.
- Correlational designs
  - Similar: Involves looking at existing circumstances
- Experimental designs
  - Similar : It has identifiable dependent and independent variables
  - Difference: No direct manipulation of independent variables
- Problem
  - No way of controlling confounding variables and alternative explanations, thus, no firm conclusions, but uses data analysis to pursue truth.
  - Medicine uses this method widely.

Design 14: Simple Ex Post Facto Design

- Similar to design #3, The only difference is one of ***timing***.
  - The treatment occurred a long time ago before the study , so we call it ***experiment***.
  - Researcher hasn't been responsible for imposing it.

Group	Time →	
	Prior event(s)	Investigation period
Group 1	Exp	Obs
Group 2	___	Obs

- This type of design is common for studying
  - The ***environmental effects*** such as child abuse, malnutrition, television viewing habit, etc.
  - Potential influences of ***pre-existing (hereditary) characteristics*** e.g. mental illness, gender etc.
- Can we draw firm conclusions?
  - The most we can conclude is that certain behaviors are ***associated*** with the conditions.
  - Other confounding variables might be involved, then no firm conclusion.

Factorial Designs:
Design 15: Randomized Two-Factor Design

- Here the effect of ***two or more independent variable*** is investigated.
- It is a more generalized form of Solomon four-group design.

Random Assignment	Group	Time →		
	Group 1	Tx_1	Tx_2	Obs
	Group 2	Tx_1	___	Obs
	Group 3	___	Tx_2	Obs
	Group 4	___	___	Obs

- This method not only allows us to determine the effects of independent variables but also whether they ***interact*** in some way as they influence the dependent variable.
  - If Group 1 outperforms Group 1,2 and 3, we can say both variables are necessary to bring about the effect.

Factorial Designs:
Design 16: Combined Experimental and Ex Post Facto Design

- Combines elements of experimental research and ex port facto research.
- Divides the sample based on the participants' previous experiences or conditions (***ex post facto***), then the researcher randomly assigns the participants into on of the two treatment groups (***experimental***).

Group	Time →				
Group 1	$\boldsymbol{Exp_a}$	Random Assignment	Group 1a	Tx_a	Obs
			Group 1b	Tx_b	Obs
Group 2	$\boldsymbol{Exp_b}$	Random Assignment	Group 2a	Tx_a	Obs
			Group 2b	Tx_b	Obs

- It helps the researcher find out
  - How an experimental manipulation may influence a particular dependent variable
  - How a previous a pre-existing characteristic may interact with the manipulation.