Experimental, Quasi-Experimental, and Ex Post Facto Designs

JIAHAO DENG AND BRANDON MENG
The independent variable is the cause. Its value is independent of other variables in your study.

The dependent variable is the effect. Its value depends on changes in the independent variable.

Note: There can be multiple independent and dependent variables exist in an experiment.
Internal Validity
The **internal validity** of a research study is the extent to which its design and the data it yields allow the researcher to draw defensible conclusions about cause-and-effect and other relationships within the data.

- With internal validity, results are more convincing.
- Cause-and-effect can be concluded.
Suspect Study #1

- A Study how humor effects soda sales
- Group 1 sees a famous/unfunny actor describes the taste
  - Takes place during March, April, May
- Group 2 sees a humorous scenario involving teens spraying soda in the summer
  - Takes place during June, July, August
- Soda sales are higher during June-August
- Does humor sell soda? Does summer play a role?
Suspect Study #2

- A test concerning a new method of teaching reading to children
- Ask for volunteers from 30 teachers
- 14 receive training, 16 do not
- Test scores are higher for students using the new method
- Does this prove the new method is better?
- Are the volunteers different from the non-volunteers?
A study for the effects of classical music on typists
The psychologist meets with typists to explain the study
Each day for a month, music is played for the typists
At the end of the month, 30% increase in productivity
Does it matter that the participants know they’re in a study?
Does it matter that they know the hypothesis?
Confounding Variables
Hawthorne and Novelty Effects

- Participants will change their behavior if they know they're in a study.
- Some may change simply because they know they're being observed.
- Some may want to help researcher.
- The **Hawthorne Effect** is an example of reactivity.
- **Reactivity** is a change in behavior of a participant because they know they're being observed.
- Simple changes in an environment can cause behavior changes – **novelty effect**.
  - A change, when reverted, can also modify behavior.
Confounding Variables

- Compare two groups that may differ in ways in addition to intervention
- Assess only one group before and after intervention
- There are famously 7 potential threats to internal validity
  - History, Maturation, Testing, Instrumentation, Statistical Regression, Selection, Attrition
- There are also 7 ways to control for confounding variables
Potential Threats to the Internal Validity

- Certain intervention will change the states of confounding variables and thus pose threat to the internal validity.

1. **History**: Intervention changes the dependent variable after its pre-assessment but before the post assessment.
   - *Example*: A certain noteworthy accident happened and totally changed people's views on a political candidate

2. **Maturation**: A change in participants' characteristics or abilities is simply the result of the passage of time.
   - *Example*: Children might take normal developmental gains in eye-hand coordination

3. **Testing**: Taking a test at one time influences participants' performance during the experiment.
   - *Example*: Multiple choice can enhance the test-taking ability of a participant
Potential Threats to the Internal Validity

4. **Instrumentation**: A change occurs in how an assessment instrument is administered or scored from one time to the next.
   - *Example*: A testing equipment is broken during the experiment.

5. **Selection**: A bias exists in how members of different groups in a study chosen.

6. **Attrition**: Members of different groups drop out of a study at proportionally different rates.
   - *Example*: One group loses 5% of its members before the final assessment while the other group loses 30%.

7. **Statistical Regression**: Extreme performers during testing become mean scorers when tested again.
Controlling for Confounding Variables
#1 – Keep some things constant

- When a factor is the same for all, it cannot be the source of differences in results
- Participants may be selected to share characteristics
- Too much restriction can affect external validity
#2 – Include a Control Group

- In the typing example, music group couldn't be compared
- **Control group:** Participants that receive no treatment meaning minimal impact on dependent variable
- **Experimental/Treatment group:** Participants receive treatment, impacting dependent variables
- People in control may get placebo: fake treatment that seems impactful to participants but isn't. There are ethics:
  - Participants must know someone is getting a placebo
  - If placebo is for health treatment, participants should receive effective treatment after testing
  - If situation is life-threatening, the researcher must decide if anything can be gained from control and if that is worth human lives
#3 – Conduct a Double-Blind Experiment

- **Double-Blind Experiment**: participants and researchers are not told who is receiving real and fake treatment.
- Administrators do not tell researchers who receives what.
- Some make administer equally convincing treatments and placebos.
#4 – Randomly assign people to groups

- Random selection of participants increases the likelihood that sample results reflect population results.
- Randomly assigning people to groups is also beneficial.
- If certain qualities are difficult to keep consistent or measure, random group assignment helps.
- Random selection lets us say that groups are similar and differences between them are due to chance.
#5 – Use pretests to assess equivalence before treatment

- Random assignment may not be possible for predetermined groups (school, office, etc)
- Instead try to assess qualities to determine similarity of groups
- **Matched Pairs**: find pairs of people who share similar characteristics and place in different groups
  - Grouping by age, sex, IQ, etc
- Only rule out assessed variables that are deemed equivalent
Exposure to all experimental treatments

- Use participants as their own control
- Any independent variable that is varied for each participant is called a within-subjects variable (also called repeated-measures variable)
- If you're testing lecture style vs information retention, test all groups with lectures of each style

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<thead>
<tr>
<th>Group</th>
<th>First Part</th>
<th>Middle Part</th>
<th>Last Part</th>
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<tbody>
<tr>
<td>Group 1</td>
<td>Attention</td>
<td>Imagery</td>
<td>Control</td>
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<tr>
<td>Group 2</td>
<td>Control</td>
<td>Attention</td>
<td>Imagery</td>
</tr>
<tr>
<td>Group 3</td>
<td>Imagery</td>
<td>Control</td>
<td>Attention</td>
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#7 – Statistically Control for Confounding Variables

- Some researchers can control for known confounding variables
- Partial correlation, analysis of covariance, structural equation modeling
- Statistical control is not a substitute for design control
Types of Design

- Different kinds of research designs have emerged. Each has their own extent to which they modify independent variables and control for confounding variables. Therefore, each has their own degree of internal validity.
- 5 kinds general kinds of possible designs are discussed:
  - Pre-experimental, true experimental, quasi-experimental, ex post facto, and factorial.
  - Note: Tx=treatment, Obs=Observation, ____=Nothing occurs, Exp=experience that some have/haven’t had.

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<tbody>
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Pre-Experimental Designs
One-shot Experimental Case Study

- A treatment is introduced and then observation is made to determine the effect of treatment
- Low internal validity
  - Effects may be results of preconditions or from environment
- Many misconceptions start with these kinds of studies
- If a child walks on grass and then is sick, did the grass cause sickness? Perhaps it was cold

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<tr>
<td>Group 1</td>
<td>Tx</td>
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One-Group Pretest-Posttest Design

- Pre-experimental assessment, treatment, post-experimental assessment
- Test pests on corn before treatment, treat, test pests on corn after treatment
- Change can be recorded, but effects are still hard to determine

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<td>Group 1</td>
<td>Obs</td>
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Static Group Comparison

- Uses an experimental and control group
- Give treatment to experiment, no treatment to control
- After treatment, assess each group and compare
- No attempt at equivalent groups or examination of similarity

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<td>Tx</td>
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<td>Group 2</td>
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</table>
True Experimental Designs
Control-Group Pretest-Posttest Design

- Two groups with one being experiment and another one is control group.
- The groups are randomly assigned.
- Assessment are taken once before experiment and once after.
- Solve two issues:
  - See if a change happened after treatment.
  - Eliminate most other possible explanations.

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<thead>
<tr>
<th>Random Assignment</th>
<th>Group</th>
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<tr>
<td></td>
<td>Group 1</td>
<td>Obs</td>
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<td>Group 2</td>
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</table>
The pre-experiment assessment could influence the result. (confounding variable)
We treat the assessment as another variable.
Create 4 groups to analyze this effect.
Improves generalizability by allowing for more group comparison
In some situations, it is impossible to do pre-experiment assessment
- Thunderstorm, crop growth, etc

Random Assignment is absolutely critical, otherwise this is only a static group comparison

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<td>Group 2</td>
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Within-Subjects Design

- A subject is a more general term than participant
  - Rats, dogs, etc
- All participants receive treatment and control conditions
  - Ideally, two different treatments
  - Administered in close proximity
- The treatment should not "spread" beyond targeted behavior
- Study difference between treatments

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<tbody>
<tr>
<td>Group 1</td>
<td>TxA</td>
<td>ObsA</td>
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<td></td>
<td>TxB</td>
<td>ObsB</td>
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Quasi-Experimental Designs
Quasi-Experimental Designs

- Randomness is important in design
- Sometimes, true randomness is not possible
- Not all confounding variables can be controlled, so some alternative explanations cannot be ruled out
Nonrandomized Control-Group Pretest-Posttest Design

- Compromise between static group and control group pre/post test
- No random group assignment, so no guarantee of similar group structure
- Addition of preassessment can confirm if two groups are similar, at least with respect to the dependent variable
- Using matched pairs can strengthen design

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<td>Obs</td>
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If we take a series of observations, we can notice any trends
- Called Baseline Data
If, after treatment, the observations change, we could reasonably conclude that the treatment caused the change
- The discovery of penicillium was found this way
  - Alexander Flemming observed a culture on a plate. After introducing penicillin, the nearby mold disappeared
Control-Group Time-Series Design

- Similar to the previous design, but a control group is added that doesn't receive treatment
- Slightly improved internal validity
- If an outside event caused the change rather than the treatment, we would expect those changes to occur in the control group as well

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<thead>
<tr>
<th>Group 1</th>
<th>Time -&gt;</th>
<th>Obs</th>
<th>Obs</th>
<th>Obs</th>
<th>Obs</th>
<th>Tx</th>
<th>Obs</th>
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<tr>
<td>Group 2</td>
<td></td>
<td>Obs</td>
<td>Obs</td>
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<td>Obs</td>
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Reversal Time-Series Design

- Within-subjects approach as a way of minimizing probability of outside effects causing changes
- The treatment is sometimes present, sometimes not but with regular assessments
- An example is provided of 'liking' a friends post on facebook vs how often they post

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<td>Group 1</td>
<td>Tx</td>
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<tbody>
<tr>
<td>FB Friends</td>
<td>Like</td>
<td>Count Posts</td>
<td></td>
<td>Count Posts</td>
<td>Like</td>
<td>Count Posts</td>
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**Alternating-Treatments Design**

- Similar to previous, but with different treatments
- In between phases of not treating, change treatments
- Over a long time, we would hopefully see different effects from different treatments

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<tbody>
<tr>
<td>Group 1</td>
<td>Tx1</td>
<td>Obs</td>
<td>___</td>
<td>Obs</td>
<td>Tx2</td>
<td>Obs</td>
<td>___</td>
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Multiple-Baseline Design

- Based on the assumption that the effects of a single treatment are temporary/limited
  - Won’t work if treatment is expected to have long-lasting results
- If a treatment stands to benefit the participants, it may be more ethical to include all
- Perform a simple time-series design, but have differing baselines

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<tbody>
<tr>
<td>Group 1</td>
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<td>Baseline</td>
<td>Treatment</td>
<td>Baseline</td>
<td>Treatment</td>
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<td>Obs</td>
<td>Tx</td>
<td>Obs</td>
<td>Tx</td>
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<tr>
<td>Group 2</td>
<td></td>
<td>Baseline</td>
<td>Treatment</td>
<td>Baseline</td>
<td>Treatment</td>
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<td>Obs</td>
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<td>Obs</td>
<td>Tx</td>
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Example

- Would playground safety instruction decrease risky behavior
- People observed children’s behavior before and after instruction
  - This was done double-blind
- In 2nd/3rd case, the risky behavior was reduced following the training
- First graders did not see much improvement. May be due to external factors like instructors first time
Single-Case Intervention

- **Single-case Intervention**: a reversal time-series, alternating treatment, and multiple baseline design might be used with a single individual or group.
- Example shows a combo reversal and multiple-baseline design.
- Other cases with multiple groups called multiple-case intervention research.
Ex Post Facto Designs
Ex Post Facto

- Used in situations where it is impossible or unethical to manipulate certain variables.
- **Ex Post Facto Designs**: (ex post facto means after the fact) Research identifies events that have already occurred or conditions that are already present and then collects data to investigate a relationship between those factors and subsequent behaviors
  - Ex-Hurricane
- Independent and dependent variables can clearly be identified
- However, there is no modification of independent variables
- The "cause" has already occurred
Simple Ex Post Facto Design

- Timing is critical as it determine what you are studying
  - For illness, time can change symptoms
  - Called Experience (EXP) since it was not an issued treatment

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<tr>
<th>Group</th>
<th>Time --&gt;</th>
<th>Prior Events</th>
<th>Investigation Period</th>
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<tbody>
<tr>
<td>Group 1</td>
<td>Exp</td>
<td>Obs</td>
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<td>Group 2</td>
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<td>Obs</td>
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Factorial Designs
Two-Factor Experimental Design

- **Factorial Design**: two or more independent variables are tested
- Here, only two independent variables are studied
- Treatments related to the two variables may occur simultaneously or sequentially
- Similar to the Solomon four-group design
- Study not only variables, but interaction of variables

<table>
<thead>
<tr>
<th>Random Assignment</th>
<th>Treatment Related to variable 1</th>
<th>Treatment Related to Variable 2</th>
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<tbody>
<tr>
<td>Group 1</td>
<td>Tx1</td>
<td>Tx2</td>
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<tr>
<td>Group 2</td>
<td>Tx1</td>
<td>___</td>
<td>Obs</td>
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<tr>
<td>Group 3</td>
<td>___</td>
<td>Tx2</td>
<td>Obs</td>
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<tr>
<td>Group 4</td>
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<td>Obs</td>
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Combined Experimental And Ex Post Facto Design

- Studies how two manipulation variables can influence a particular dependent variable and how a previous experience might interact with such manipulation.
- In this case, experience acts as a moderating variable that modifies treatment.
- Two groups are selected from population based on prior experience (ex post facto part).
- There are many combinations of experimental and ex post factor designs.
  - Ex: Within-subjects+Ex post facto (maps vs degree study).

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<th>Prior Events</th>
<th>Investigation Periods</th>
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<td>Group 1b</td>
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<td>Group 1</td>
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<td>Group 2a</td>
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<td>Group 2b</td>
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