Research Methods in Psychology

Chapter 6:
Independent Groups Designs

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Why Psychologists Conduct Experiments?

What is your ideas?

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Why Psychologists Conduct Experiments?

- **Testing**
  - Hypotheses derived from theories are true or not?
  - Treatments and programs are effective or not?
- **Explaining**
  - Examine the causes of behavior
- **Multi-method approach**
  - Investigating convergent validity for research findings across methods.

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Experimental Research

- **An experiment must include**
  - Independent variable (IV)
  - Dependent variable (DV)

- **Independent Variable**
  - ✓ Manipulated (controlled) by experimenter
  - ✓ At least 2 conditions (levels)
  - "Treatment" and "Control"

- **Dependent Variables**
  - ✓ Measured by experimenter.
  - ✓ Used to determine effect of IV
  - Typically researchers measure several dependent variables to assess effect of IV.

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What is Internal Validity?

☺ Internal validity allows us to make a causal inference ☺

- When differences in performance (**DV**) can be attributed unambiguously and clearly to effect of independent variable (**IV**).

- **3 conditions for causal inference**
  - Covariation (changing together).
  - Time-order relationship (first one then second one).
  - Eliminate alternative causal explanations (confoundings)

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Control Techniques of internal validity

☺ An Experiment **free of confoundings** has internal validity ☺

1. Manipulation
- IV: participants in the conditions have different experiences/ as researcher we determine how many level must be manipulated?

2. Holding conditions constant
- IV is only factor that differs systematically across groups.
  - All participants listen to same story.
  - All completed the same questions after the story

3. Balancing
- Random assignment to conditions balances subject characteristics, on average.
- Groups are equivalent prior to IV manipulation.
- All subject variables are balanced.

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Threats to Internal Validity

- **Ability to make causal inferences is threatened when:**
  1. Intact groups of subjects are used.
  2. Extraneous variables are not controlled.
     - We can prevent by Hold conditions constant.
  3. Selective subject loss occurs.
     - Mechanical subject loss not a problem
  4. Demand characteristics and experimenter effects are not controlled.
     - Use placebo-control and double-blind procedures

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Independent Groups Designs

- Different individuals participate in each condition of the experiment.
  - No overlap of participants across conditions
- Three types
  - Random groups design
  - Matched groups design
  - Natural groups design

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Random Groups Designs

- Individuals are randomly assigned to conditions of the IV.
- We can have a causal inference:
  - ✓☺ If groups are equivalent at the beginning of an experiment (through balancing) and conditions are held constant.
  - ✓☺ If any differences among groups on dependent variable are caused by the manipulated independent variable.

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Random Groups Designs

- **Block randomization**
  - Each block is a random order of all conditions in the experiment.
  - Randomly assign subjects is based on one block at a time.
  - **- A B C D E**
  - **- B A D C E**
  - - .....

☺ Advantages ☺

- ✓Creates groups of equal size
- ✓Controls for time-related events that occur during course of experiment

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Analysis and Interpretation of Experimental Findings

- **Why We use statistical analysis?**
  - To claim **IV** produced an effect on **DV**
  - To avoid the alternative explanation that can produced any possible effect.

- **What is Replication ?**
  - Repeat experiment and see if same results are obtained in the second time.
  - Best way to determine whether findings are reliable.

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Analysis of Experimental Designs

- **Three steps**
  - **Check the data**
    - Errors? outliers?
  - **Describe the results**
    - Descriptive statistics such as means, standard deviations, effect size.
  - **Confirm what the data reveal**
    - Inferential statistics

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Analysis of Experiments

- **Descriptive Statistics**
  - **Mean (central tendency)**
    - Average score on DV, computed for each condition.
    - Not interested in each individual score, but how people responded on average in a condition
  - **Standard deviation (variability)**
    - Average distance of each score from the mean of a group
    - Not everyone responds the same way to an experimental condition

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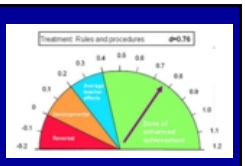
Analysis of Experiments



- **Effect size**
  - Measure of strength of relationship between the IV and DV
  - Cohen's *d*

$$\frac{\text{difference between treatment and control means}}{\text{average variability (standard deviation) for all participants' scores}}$$

Guidelines for interpreting Cohen's *d*:

small effect of IV:	*d* = .20
medium effect of IV:	*d* = .50
large effect of IV:	*d* = .80

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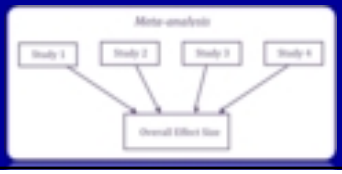
Analysis of Experiments

- **Meta-analysis**
  - **Summarizes** effect sizes across many experiments that investigate same IV or DV.
  - **Chooses** experiments based on their internal validity and other criteria.
  - **Allows** researchers to gain confidence in general psychological principles



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Analysis of Experiments

- **Confirm what the data reveal**
  - Use **inferential statistics** to determine whether the IV produced a reliable effect on the DV.
  - Avoid whether findings are due to **chance** (error variation).

- **Two types of inferential statistics**
  - Null Hypothesis Significance Testing
  - Confidence intervals

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Analysis of Experiments

- **Null Hypothesis (*H0*) Significance Testing**
  - ✓ H0 indicates lack of any relation between our research variables.
  - ✓ Statistical procedure to determine whether mean difference between conditions is greater than what might be expected due to chance (error variation).
  - ✓ Effect of an IV on the DV is statistically significant when the probability of the observed results being due to chance is low.
  - ✓ $p < .05$

	True state of the world	
Decision	H_0 False	H_0 True
Reject H_0	Correct decision	Type I error
Retain H_0	Type II error	Correct decision

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Analysis of Experiments

H_0: $\mu_{Drugs} = \mu_{Placebo}$

H_1: $\mu_{Drugs} \neq \mu_{Placebo}$

☺ **Steps for Null Hypothesis Testing**

(1) Assume the null hypothesis is true.
- The population means for groups in the experiment are equal

(2) Use sample means to estimate population means.

(3) Compute the appropriate inferential statistic.
- ***T*-test:** test the difference between two sample means.
- ***F*-test:** test the difference among three or more sample means.

(4) Identify the probability associated with the inferential statistic
- ***P*-value** is printed in computer output or can be found in statistical tables.

(5) Compare the observed probability with the predetermined *level of significance* (*alpha*), which is usually $p < .05$

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Analysis of Experiments

- If the observed *p* value is **greater than 0.05**, do not reject the null hypothesis of no difference.
- Conclude IV **did not** produce a reliable effect

- If the observed *p* value is **less than 0.05**, reject the null hypothesis of no difference.
- Conclude IV produced a reliable effect

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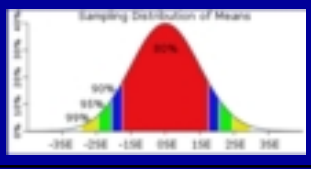
Analysis of Experiments

- **Confidence intervals**
  - Sample means estimate population means
  - Confidence interval for a mean provides the range of values that contains the true population mean.
    - with some probability, usually 0.95



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Analysis of Experiments

- **Compute confidence interval around sample mean in each condition.**
  - If confidence intervals **do not overlap**, we gain confidence that the population means for the conditions are different that is, the IV has an effect.
  - If confidence intervals **overlap slightly**, we are uncertain about the true mean difference.
  - If intervals overlap such that the mean of one group lies within interval of another group, we conclude the population means do not differ.

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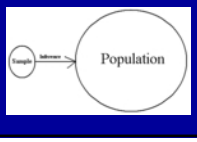
External Validity

- **External validity**
  - Extent to which findings from an experiment can be generalized to describe individuals, settings, and conditions beyond the scope of a specific experiment.
    - Any single experiment has limited external validity
    - External validity of findings increases when findings are replicated in a new experiment



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External Validity

- **Questions of external validity**
  - Is it possible to the same findings occur
    - In different *settings*?
    - In different *conditions*?
    - With different *participants*?

✓ Research with college students is often criticized because of **low external validity**.
✓ Theory testing: Sample often doesn't matter

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External Validity

- **How can we increase external validity?**

1. Include characteristics of situations, settings, and population to which researchers seek to generalize
2. Field experiments
3. Partial replications
4. Conceptual replications

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Additional Independent Groups Designs

- **Matched Groups Design**
  - Random assignment requires large samples to balance subject characteristics.
  - Sometimes only small samples are available.
  - In matched groups design:
    - Researchers select 1 or 2 individual differences variables for matching

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Matched Groups Design

- **Procedure**

1. Selecting a matching variable
   - It must be related to outcome or dependent variable.
2. Match pairs of identical or similar scores.
   - Depending on number of conditions
3. Randomly assign participants within each match to the different IV conditions.
4. Groups not equivalent for all individual differences variables.

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Natural Groups Designs

- **Natural Groups Designs**
  - Psychologists often ask questions about how individuals differ, and how these individual differences are related to important outcomes.
- **Individual differences (subject variables)**
  - We match groups based on characteristics or traits that vary across individuals (e.g., male, female)

✓ We **can't** randomly assign participants to these groups.

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Natural Groups Designs

- **Natural groups designs**
  - ✓Classify individuals into groups based on subject variable, then measure DVs.
  - ✓Select individual differences IVs
  - ✓Correlational research
  - ✓Describe and predict using relationships between natural groups variable and DVs
  - ✓Improve causal inferences: study individual differences variables in combination with manipulated IVs.

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