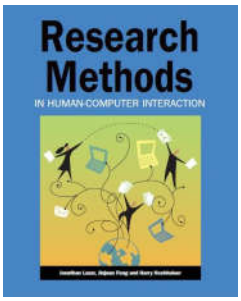
BIRZEIT UNIVERSITY

Chapter 3

Experimental Design



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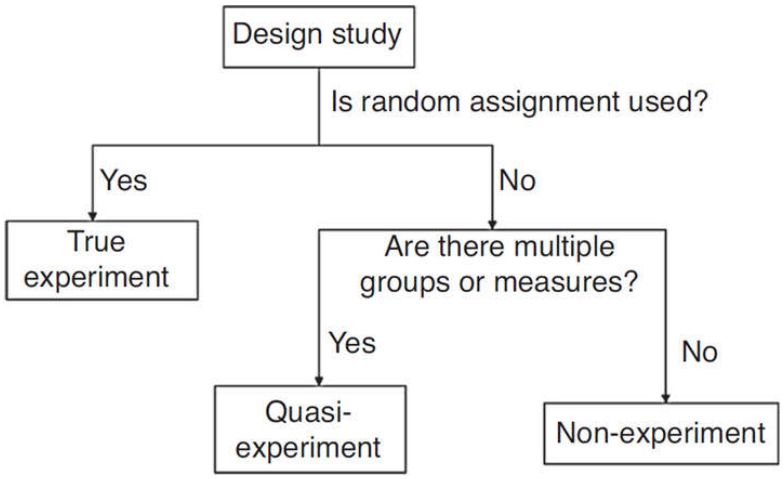
Overview

- What needs to be considered when designing experiments?
- Determining the basic design structure
- Investigating a single independent variable
- Investigating more than one independent variable
- Reliability of experimental results
- Experimental procedures

Three Groups of Studies

❖ **Experiments**, **quasi-experiments**, and **non-experiments**:



Characteristics of True Experiments

❖ A true experiment:

- Is normally based on at least one hypothesis
- Have multiple conditions
- The dependent variable can be quantitatively measured
- Uses statistical significance tests
- Thrives to remove biases
- Is replicable

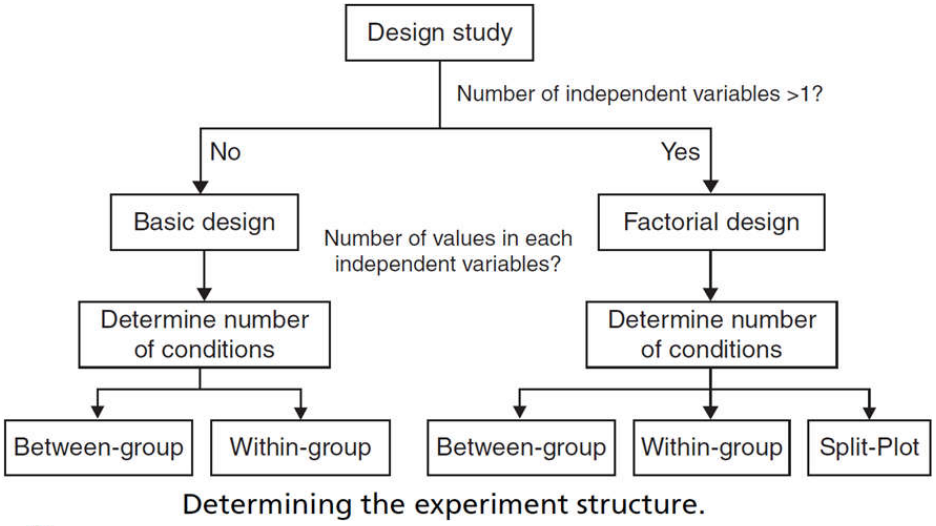
Factors to Consider

- Research hypothesis:
  - Clearly defined
  - Appropriate scope
- Dependent variables:
  - Easy to measure
- Independent variables and conditions:
  - Easy to control

Basic Design Structure

- Two basic questions:
  - How many independent variables do we want to investigate in the experiment?
  - How many different values does each independent variable have?

Basic Design Structure

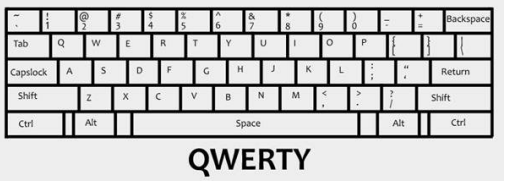


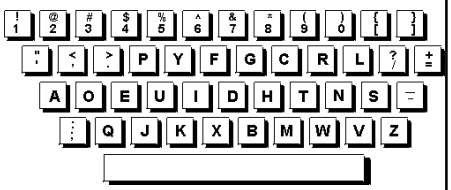
Determining the experiment structure.

Typing Example

- Null hypothesis:

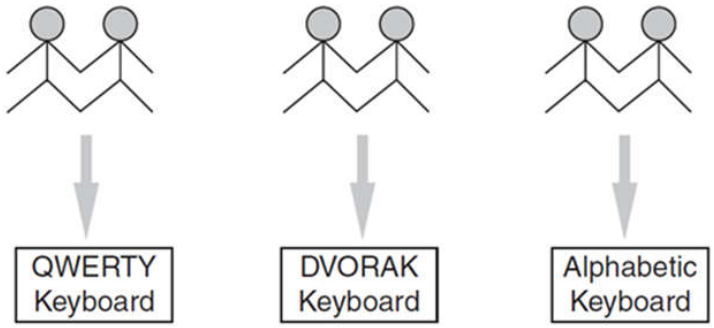
There is no difference between used keyboard type on typing speed.





Investigating one IV - Between Group Design

- Also called "**between subject design**"
- One participant only experience one condition



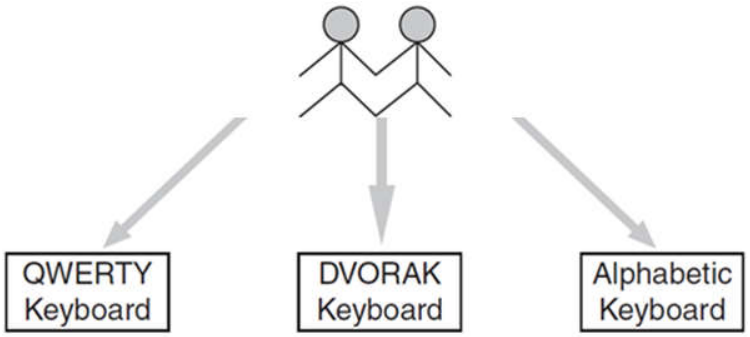
Between-group design.

Between Group Design

- Advantages:
  - Cleaner, better control of **learning effect**
  - Requires shorter time for participants
  - Less impact of fatigue and frustration
- Disadvantages
  - Impact of individuals difference
  - Harder to detect difference between conditions
  - Require larger sample size

Investigating one IV – Within Group Design

- Also called "**within subject design**"
- One participant experience multiple conditions



Within-group design.

Within-Group Design

- Advantages:
  - Requires smaller sample size
  - Easy to detect difference between conditions
- Disadvantages:
  - Learning effect
  - Takes longer time
  - Larger impact of fatigue and frustration

Investigating one IV - Between Group vs. Within Group

- Between-group design should be taken when:
  - Simple tasks
  - Learning effect has large impact
  - Within-group design is impossible
- Within-group design should be taken when:
  - Learning effect has small impact
  - Small participant pool

More than One IV

- Factorial design divides the experiment groups or conditions into multiple subsets according to the independent variables.
- Can study interaction effects.
- Number of conditions:

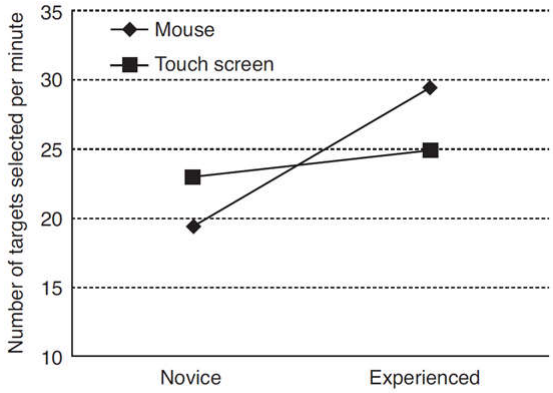
$$C = \prod_{a=1}^{n} Va$$

More than One IV

- Three options of factorial design:
  - Between group design
  - Within group design
  - Split-plot design
- Split-plot design:
  - Has both a between-group and a within-group component

Interaction Effect

- The differing effect of one **IV** on the **DV**, depending on the particular level of another **IV**



Interaction effects.

Reliability of Experiments

- **Random errors:**
  - Also called '**chance errors**' or '**noises**'
  - Cause variations in both direction
  - Occur by chance
  - Can be controlled by a large sample size
- **Systematic errors:**
  - Also called '**biases**'
  - Always push actual value in the same direction
  - Can never be offset no matter how large the sample is

Reliability of Experiment Results

- 5 major sources of system errors:
  - Measurement instruments
  - Experimental procedures
  - Participants
  - Experimenter behavior
  - The experimental environment

Lifecycle of an Experiment

- Identify a research hypothesis
- Specify the design of the study
- Run a pilot study to test the design, the system, and the study instruments
- Recruit participants
- Run the actual data collection sessions
- Analyze the data
- Report the results

Experiment Session Procedure

- Ensure the systems or devices being evaluated and the related instruments are ready for the experiment
- Greet the participants
- Introduce the purpose of the study and the procedures
- Get the consent of the participants
- Assign the participants to a specific experiment condition according to the pre-defined randomization method

Experiment Session Procedure

- Participants complete training task
- Participants complete actual tasks
- Participants answer questionnaires (if any)
- Debriefing session
- Payment (if any)