Lecture 5:
Independent Groups Design

I. INTRODUCTION
A. Ways to Exert Experimental Control

- Designs employing experimental control minimize *error* variance and increase *systematic* variance, resulting in an internally valid study.
  - Error Variance: The statistical variability of DV scores caused by the influence of variables other than your IV(s).
  - Systematic Variance: The statistical variability of DV scores caused by the influence of your IV(s).
- Experimental control is an essential tool minimizing error variance and maximizing systematic variance.

I. INTRODUCTION
A. Ways to Exert Experimental Control

- Two ways to exert experimental control over the IV
- Between-Groups and Within-Groups Design
  - Between-Subjects Design: A different group of participants receive each level of the IV.
  - Within-Subjects Design: The same participants receive each level of the IV.

II. BETWEEN-SUBJECTS DESIGNS
B. Randomized Groups Design

- Randomized two-group is the simplest Independent Group design.
- Participants are randomly assigned to different levels of the IV.
  - Random assignment is meant to equalize any and all initial differences between groups.
    - This minimizes error variance between groups.
  - Then, the groups that are initially similar, are made different in a systematic way.
    - This maximizes systematic variance.
  - The influence of the IV on the DV is then measured.

II. BETWEEN-SUBJECTS DESIGNS
A. Randomized Two-Group Design

- In many cases the levels of the independent variable in these studies include…
  - Experimental group: Treatment, training, intervention, etc.
  - Control group: No treatment, training, or intervention etc..
- **Hypothesis**: On the basis of Theory X, participants who are randomly assigned to be given Intervention y will perform differently than participants who are randomly assigned not to be given Intervention y.

II. BETWEEN-SUBJECTS DESIGNS
A. Randomized Two-Group Design

- Schematically the design looks like the following:

Randomized Group Design

Group	Treatment	Test
Control		x
Experimental	x	x

II. BETWEEN-SUBJECTS DESIGNS
A. Randomized Two-Group Design

- Procedures for Random assessment:
  - From a random number table:
    - Even = Control, Odd = Experimental
  - **Block Randomization**: Assign pairs of participants to Experimental and Control conditions randomly.
- Thinking through the control group
  - Important for maximizing systematic variance
  - Which control would be best test a new Math Training program?
    - No Math training or a Standard Math Training

II. BETWEEN-SUBJECTS DESIGNS
B. Randomized Groups Design

- **Internal validity challenges of Random Groups Designs**
  - **Reactivity**: Unintended effects of the experimental arrangements on subjects responses.
  - **Confounding** of the IV with other (nuisance) factors associated with presenting, or assessing influence of the IV including …
    - Different experimenters.
    - Different times or rooms for assessing of DV as a function of IV.
- These problems address the possibility that extraneous variables are influencing the DV.

II. BETWEEN-SUBJECTS DESIGNS
B. Randomized Groups Design

- **Solution**: Balance or hold variables constant
  - **Hold constant**: Make sure that the same experimenter interviews Ss at the same time in each group. Holding variables constant decreases error variance, making the statistical test more sensitive, but the results less generalizable.
  - **Balance** times, rooms, and experimenters in each condition so that these variables are equally distributed across conditions. Balancing variables may increase error variance, making the statistical test less sensitive, but the results more generalizable.

II. BETWEEN-SUBJECTS DESIGNS
B. Randomized Groups Design

- Other Internal Validity Problems of RGD
  - **Selective Mortality**: Participants who withdraw differentially from the experimental and control conditions.
  - **Biased Selection**: Initial differences between the groups, due to the manner in which participants are selected and assigned to groups.
- Both theses problems related to limits in the randomization procedure.
  - Groups are not equal in characteristics.

II. BETWEEN-SUBJECTS DESIGNS
B. Randomized Groups Design

- **Solution**: Test to make sure that participants in the two groups are initially equal by adding a pretest to the study.

Pretest - Posttest Design

Group	Pre-Test	Treatment	Post-Test
Control	x		x
Experimental	x	x	x

II. BETWEEN-SUBJECTS DESIGNS
B. Randomized Groups Design

- **Regression**: Pre-posttest change from may be due to statistical regression of extreme pretest scores.
  - **Solution**: Make sure participants vary in initial DV level (low, medium, and high) and see who changes.
- **Instrumentation**: Pretest - posttest change may be due to the use of different instruments or changes in the fidelity of the instrument.
  - **Solution**: Use the same instrument and train coders prior to experiment.

II. BETWEEN-SUBJECTS DESIGNS
B. Randomized Groups Design

- **Maturation**: Pretest to posttest change may be due to time and not treatment influencing posttest performance.
  - **Solution**: Use multiple pretests to insure that the change is associated with the treatment.
- **History**: Change from pretest to posttest may be due to other experiences and not the treatment influencing posttest performance.
  - **Solution**: Carefully assess and control other influences.

II. BETWEEN-SUBJECTS DESIGNS
B. Randomized Groups Design

- **Testing**: Change from pretest to posttest may be due to pretest experience and not the treatment influencing posttest performance?
  Interactions
  - Biased selection x maturation: Participants in the experimental group while no different than those in the control group at the pretest, undergo more spontaneous change.
  - Pretest x treatment: The pretest improves the efficacy of the treatment for the experimental group, suggesting an influence of the pretest on posttest performance.

II. BETWEEN-SUBJECTS DESIGNS
B. Randomized Groups Design

- **Solution**: Solomon Four-Group Design which controls the effect of the pretest on the posttest.

Solomon Four Group Design

Group	Pre-Test	Treatment	Post-Test
Control 1	x		x
Experimental 1	x	x	x
Control 2			x
Experimental 2		x	x

II. BETWEEN-SUBJECTS DESIGNS
B. Other Between-Subjects Design

- **1. Matched Groups Design**
- All the Random Groups designs assume that participants are randomly assigned to groups.
  - Sometimes you want to use another procedure than randomizing to insure the initial equality between groups.
- A **Matched groups design**: Pairs of participants in the control and experimental groups are selected for being equal on relevant dimensions (e.g. IQ) and then the two are randomly assigned to conditions.

II. BETWEEN-SUBJECTS DESIGNS
B. Other Between-Subjects Design

- Kinds of Matched Groups Design
  - Matched-pairs design (2 group version)
  - Matched multigroup design (multiple group version)
    - Members of the control and experimental groups are NOT the same, but there is a match between participants in each level of the IV.
- Strengths:
  - Effective control for certain extraneous variables
    - Students matched on age, sex, student status, Math and English ACT scores.

II. BETWEEN-SUBJECTS DESIGNS
B. Other Between-Subjects Design

- Problems:
  - **Practice effects**.
    - Particularly if the matching task is from the same class of tasks as is the dependent variable.
  - **Narrow subject selection criterion**:
    - By matching participants on selection criterion (e.g., age, sex, student status, ACT scores), you may have to sample extensively in order to get two groups. The groups may not be representative of the population, severely limiting generalization.
  - **Limited statistical power**

II. BETWEEN-SUBJECTS DESIGNS
B. Other Between-Subjects Design

- **2. Natural Group Design**
- When the levels of the IV are subject-variables not experimentally manipulated variables (e.g., gender)
  - No causal inferences can be made only contingency or correlational relations can be analyzed.
  - But one can remove some but not all the extraneous variables statistically, through a special correlation procedure.

II. BETWEEN-SUBJECTS DESIGNS
C. Special Cases

- **1.** Placebo and double-blind experiments.
- Placebo Control: Participants are told that they are receiving a treatment, which they are not.

Placebo Control Study

Group	Pre-Test	Treatment	Post-Test
Control	x		x
Experimental	x	x	x
Placebo	x	p	x

II. BETWEEN-SUBJECTS DESIGNS
C. Special Cases

- Double-Blind: When neither participants not experimenters know which condition the participants are in.
  - Such manipulations control for demand characteristics and experimenter effects which are types of reactivity threats to Internal Validity.
    - Demand Characteristics: Participants using cues in the experimental condition to figure out how to act.
    - Experimenter's Effect: Experimenters generating cues to participants which explain how to behave in a condition.

II. BETWEEN-SUBJECTS DESIGNS
C. Special Cases

- **2. Yoked Control Group**
  - Control group in which the treatment given a member of the control group is matched exactly with the treatment given a member of the experimental group.
- Three Studies using yoked control.
  - Reasoning Study (Kuhn & Ho, 1990)
    - Experimental: Selected problems to solve
    - Yoked Control: Solved same problems but did not select them.
    - Self-directed activity more effective in problem-solving.

II. BETWEEN-SUBJECTS DESIGNS
C. Special Cases

- Three Studies
  - Executive Monkey Study (Brady, 1958)
    - Experimental: Monkey learned to press lever to avoid shock (executive monkey)
    - Yoked Control: Monkey wired to the same apparatus and received the same number of shocks as the executive monkey but had no control.
    - While Executive Monkeys developed more ulcers, the study did not involve the random assignment of monkeys to conditions. Executive monkeys were faster in learning the contingency and more prone to ulcers!

II. BETWEEN-SUBJECTS DESIGNS
C. Special Cases

- Three Studies
  - Kittens raised in darkness (Held and Hein, 1963)
    - Experimental: Dark raised kittens allowed to walk in apparatus with interesting visual stimulation.
    - Yoked Control: Dark raised kittens who experienced the same visual stimulation as the experimental kittens but without motor coordination. This is because the yoked controlled kittens were being pulled along in a wagon attached to the other kitten.
    - Held and Hein (1963) found that the passive kittens showed defects in spatial orientation, suggesting the importance of motor coordination