Psychology 2020 Introduction to Psychological Methods

Unit 5

Conducting Complex Experiments

Experimental Designs

- All experimental designs involve:
  - The manipulation of an independent variable by assigning various "levels" of this variable to the participants.
  - Holding extraneous variables constant (usually through randomization or direct experimental control).
  - Measuring changes in the dependent variable.

Internal Validity

- Can we say that changes in one variable caused the observed changes in the other variable?
- A study has internal validity to the extent that you can conclude that changes in the independent variable caused the changes in the dependent variable.

Confounding Variables

- Recall that experiments control for third variables and thus have greater internal validity.
- Confounding occurs when the experiment fails to control for external "third" variables.
- Confounding also occurs if the effects of more than one independent variable are intertwined.

Basic Experiments

- Basic experiments provide the following:
  - Random assignment to conditions
  - Experimental control of all other variables
- Examples of two basic experimental designs
  - Posttest-only design
  - Pretest-Posttest design

Posttest-only Design

R	X	O
R		O

- All participants are randomly assigned to one of two groups. (R indicates random assignment)
- One groups gets the independent variable (X) the control group does not.
- Any difference in the dependent variable (O) should be due to the effect of the independent variable.

Pretest-Posttest Design

R	O_1	X	O_2
R	O_1		O_2

- Participants are randomly assigned (R) to one of two groups and each group is given a pretest (O_1).
- One group is administered the IV (X) and the control group is not.
- Both groups are given the posttest (O_2).
- Any differences from pre to posttest are attributed to the independent variable (X)

Experimental Design Practice

- A researcher was interested in studying the effect taking a course in child development had on the ways parents handle particular childrearing issues. She decided to show the participants 4 short videos of children doing particular things (two discipline related and two related to teaching a new skill) and then have them describe what they would do as a parent in each situation.
  - Operationally define the independent and dependent variables in terms of how you will measure each.
  - Design a posttest-only experiment
  - Design a pretest-posttest experiment

Advantages

- Pretests allow the experimenter to assess the similarity of the two groups.
- Pretests are sometimes necessary to select participants that meet the requirements of the research question.
- Pretests allow the experimenter to assess the effects of mortality (participants dropping out of the study before is ends) on the posttest results.

Disadvantages

- Pretests may time consuming and awkward to administer.
- Pretests may sensitize the participants to what is being studied and influence what they do during the experiment.

Your Childrearing Experiment Example

- Relate the advantages and disadvantages of pretests to your two experiments.
- Which design do you think is better for the question the researcher wants to answer about the effectiveness of a child development class on childrearing practices? Why?

Solomon Four-Group Design

Control

R		O_2
R	O_1	O_2

Experimental

R		X	O_2
R	O_1	X	O_2

- Participants are randomly assigned (R) to one of four groups
- Two groups are given Pre & Post-test and two groups are given only the Post-test.
- The IV (X) is given to a Pre/Post-test group and a Post-test only group, the other two groups are control groups.
- Any differences between the two control groups or the two experimental groups is attributed to the Pre-test.

Assigning Participants

- Independent Groups Design
  - Sometimes referred to as a between-subjects design
  - Participants are assigned to only one condition in the experiment
- Repeated Measures Design
  - Sometimes referred to as a within-subjects design.
  - All participants receive all conditions of the experiment.

Independent Groups Designs

- Simple Random Assignment
  - Most popular design
  - Participants are randomly assigned to one condition of the experiment
- Matched Pairs Design
  - Participants are first matched on some variable critical to the research question.
  - Each member of the matched pair is then randomly assigned to one condition of the experiment.

Matching Example

- Suppose the Dependent Variable (DV) is performance on a cognitive task and the Independent Variable is level of distraction (background sounds).
- Since people probably differ on cognitive abilities, test for cognitive ability and match participants according to their test scores.
- Next, randomly assign one participant of each matched pair to the experimental and control groups.
- This insures that our groups are similar on cognitive ability before we administer the Independent variable.
- It should be easier to detect effect of the IV on DV with matched groups.

Repeated Measures Design

- All participants receive all conditions of the experiment.
- Advantages:
  - Fewer participants needed – important if participants are costly to obtain and/or they require training during the experiment.
  - Easier to detect the effect of IV on the DV because subjects act as their own controls.

Order Effects with the Repeated Measures Designs

- Order effects refer to the changes in the dependent variable produced by the sequence of the experimental conditions rather than the independent variable manipulation.
  - *practice effects*
  - *fatigue effects*
  - *contrast effects*

Practice Effects

- Improvements in performance that are produced by experience with the previous independent variable conditions.
- Practice effects confound our interpretation of the overall effect of the independent variable because later conditions may appear stronger than earlier conditions when in fact they are not stronger.

Fatigue Effects

- A deterioration in performance as the experiment progresses because the participant becomes bored, tired or distracted.
- Fatigue effects confound our interpretation of the overall effect of the independent variable because later conditions may appear weaker than earlier ones when they are not.

Contrast Effects

- When the response in one condition is altered because of the conditions in the preceding condition.
- Contrast effects confound our interpretation of the results because the amount of change in our dependent variable was not completely the result of the independent variable but based on the order of the conditions.

Controlling Order Effects

- *Counterbalancing* the order of conditions
  - Complete counterbalancing repeats the experimental conditions across subjects in all possible orders.
  - For example with an experiment with three conditions ABC, you would need the orders of BCA, CBA, ACB, CAB, BAC for complete counterbalancing.

Controlling Order Effects

- The *Latin Squares* technique of counterbalancing uses a limited set of orders to:
  - Insure that each condition appears at each ordinal position.
  - Each condition precedes and follows each condition one time.

Controlling Order Effects

- The *Randomized Blocks* technique presents blocks of trials in randomized orders to each subject.
  - A trial is one presentation of the basic experimental task (such as one presentation of an English word with three choices of Chinese symbols, one of which is the correct translation).
  - A block is composed of several trials (such as 5 presentations of 3 different English words for a total of 15 presentations per block)
  - A second block might consist of 15 presentations of the Chinese symbol with three choices of English words.
  - The order of the presentation of these blocks would be randomized across participants.

Controlling Order Effects

- Adjusting the *Time Interval* and activities between conditions to control for order effects.
  - A rest period between conditions often prevents fatigue effects.
  - Doing an unrelated task between conditions often prevents contrast effects.
  - Long time intervals between conditions are needed for testing drug effects (time is needed for the effect of each level of the drug to wear off).

Choosing the Best Design

- Repeated Measures Designs
  - Use when
    - You only have a small number of available participants.
    - You need greater control over participant differences between conditions
  - Do not use when
    - You don't have much time and participants might drop out of the study over time.
    - You can't control for order effects.
    - The variables under study are not usually encountered in the "real world" repeatedly in some order.
    - The variables under study produce relatively permanent changes in behavior.

Choosing the Best Design

- Independent Groups Designs
  - Use when
    - You need to get all the data in a relatively short period of time.
    - The independent variable produces relatively permanent changes in behavior.
  - Do not use when
    - Large numbers of participants are not available for the study
    - Experimental control of participant differences can not be arranged.
    - The variables being studied are of interest only when individuals are exposed to several levels in some sequential manner.

Class Discussion

- Read activity question 3 on page 164 and answer the following questions.
  - What are the independent and dependent variables?
  - What type of design is described?
  - What are the confounds of the experiment and how could these be avoided by revising the experimental design?

Complex Experimental Designs

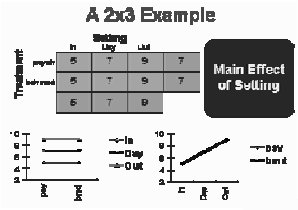
- Increasing the number of levels of a single independent variable.
  - Provides more information about the exact form of the relationship between the IV and the DV.
    - To reveal a curvilinear relationships (monotonic and nonmonotonic) requires at least three levels of the IV.

Complex Experimental Designs

- Increasing the number of independent variables.
  - Factorial designs include two or more independent variables with each independent variable having two or more levels.
    - 2 X 2 means two independent variables with two levels for each.
    - 2 X 3 X 2 means three independent variables with two having two levels and one having three levels.

Interpretation of Factorial Designs

- Main effects
  - The effect of each independent variable across all levels of the other independent variables.
- Interaction effects
  - The individual effects of each level of an independent variable at each level of the other independent variables.



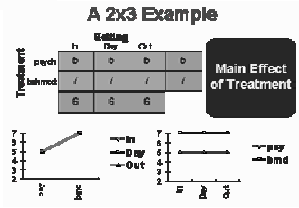
DV = Severity of disorder symptoms rated on a scale of 1 (not severe) to 10 (very severe).

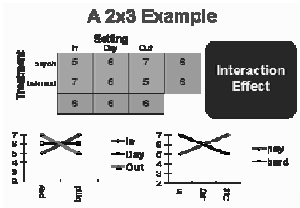
The scores in the boxes are the results of the treatments in the various settings.

Examples provided by William M. Trochim, Cornell University

IV A = **Treatment**
Level 1 = Psyc Therapy
Level 2 = B-Mod

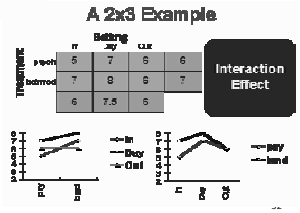
IV B = **Setting**
Level 1 = Inpatient
Level 2 = Day Patient
Level 3 = Out Patient





Examples provided by William M. Trochim, Cornell University

All variables show interaction effects because the lines are not parallel as in the previous examples.



IV X PV Design

- Independent variable and and participant variable designs have both manipulated variables (IV) and nonmanipulated variables (PV).
- These types of designs are appealing because they allow one to study the interaction of participant variables (i.e. personality, learning history, gender, etc.) with other variables of interest to the experimenter (i.e. drug effects, teaching methods, or other environmental variables).

Assigning Participants in Factorial Designs

- ***Independent groups***
  - One group for each combination of levels of the independent variables.
  - A 2 X 2 design, 4 groups with 10 participants in each group or 40 participants total.
- ***Repeated Measures***
  - All subjects get all combinations of the independent variables.
  - A 2 X 2 design, 4 groups with the same 10 participants in each group.
- ***Mixed Factorial Design***
  - Some variables are repeated and some are not with each subject.

Class Activity

Do the assigned sample question on the handout and answer the following questions:

- Identify the design (e.g., 2 X 2 factorial).
- Calculate the total number of conditions.
- Identify the manipulated (independent) variable(s).
- Is this an IV X PV design? If so, identify the participant variable(s).
- Is this a repeated measures design? If so, identify the repeated variable(s).
- Identify the dependent variable(s).