Multiple-Group Designs

- Simplest of the experimental designs
- Two-group design

  X_1 O_1

  X_2 O_1

  - Major advantage is control through random assignment
  - Tricky to ensure control was exercised over all factors irrelevent to the study
- Compare group means on DV's of interest with t-test or ANOVA

Control issues in multi-group designs

- Bias in assignment of subjects
  - Volunteer for treatment
  - Subjects are members of larger social units which must remain intact
- Addressing assignment bias
  - Testing for pretest equivalence
  - Matching procedures (ex post facto design)
- Nonrandom subject loss
  - Dropout or noncompletion of treatment is not a random event

Fixed vs. random effects

- Fixed effect
  - IV is discrete or findings will not be extended beyond the IV values included in the study
- Random effect
  - IV is continuous or findings will be extended to values not in the design
- With continuous IV's, one can choose to treat as fixed or random effect
- In the social sciences, IV's are usually considered fixed
- Replication is important for testing the same hypothesis using somewhat different operationalizations of the IV's and instruments for the DV's

Multiple-Group Posttest Design

- Expansion of the two-group design with an IV that can have any number of values or levels

$X_1 \quad O_1$

$X_2 \quad O_1$

$. \quad\quad .$

$. \quad\quad .$

$. \quad\quad .$

$X_n \quad O_1$

- Advantage that more levels of IV can be compared, and more control groups can be included
- Compare group means on DV's of interest with ANOVA
  - Within-group vs. between-group variance

Multiple-Group Pretest-Posttest Design

- Expansion of the two-group design with an IV that can have any number of values or levels

  O_1 X_1 O_2
  O_1 X_2 O_2
  . .
  . .
  . .
  O_1 X_n O_2
- Advantage is demonstrating the level of DV both before and after treatment; i.e., change
- Introduces the possibility for instrument reactivity
- Difference scores are problematic due to (a) compounding of error and (b) regression to the mean

Ex Post Facto Design

- Patchwork procedure to make a pseudo-experimental design out of a non-experimental design
- Match on several critical variables subjects in two or more groups, and analyze data from matched subjects only

  X_1 $O_{1\ \text{Match}}$

  X_2 O_1
- Problems
  - Cannot match for every possible variable, and can never know for certain which variables are most crucial
  - Shrinkage in sample size
- Improvement over the two-group design with no random assignment
- Most critical variable for matching would be a pretest on the DV itself

Multiple-Group Time Series Design

- Multiple measurements of the DV on two or more groups representing levels of the IV

  O_1 O_2 O_3 X_1 O_4 O_5 O_6

  O_1 O_2 O_3 X_2 O_4 O_5 O_6

- Number of measurements determines the type of analysis to be used
- Simplest time series is when there are two or more levels of IV, and treatments are applied in the middle of a series of observations of the DV

Multiple-Group Time Series Design

- Advantage: allow determination of trend in the DV before and after treatment
- Issues
  - Sensitive to instrument reactivity
  - Autocorrelation—with repeated measurement, those occurring more closely in time tend to be more highly correlated than those occurring more distally, which biases statistics
- MANOVA and other procedures

Factorial Designs: 2 X 2

- Two independent variables, each taking on two level or values
- Allows for the additional of variables which may be used as
  - Controls of confounding factors
  - Additional aspects to be studied
- Main effect: the independent effect of a particular variable
- Interaction effect: the joint effect taking into account both variables

Factorial designs

- Between-subjects design: different subjects in each cell
- Within subject design: same subjects found in more than one cell
  - Reduces error variance due to idiosyncratic differences among subjects
  - Creates the problem that treatments are confounded with presentation order and with retesting
- Counterbalancing: control for order effects
- Orthogonal designs: equal sample sizes across cells; IV's are totally independent and uncorrelated
- Nonorthogonal designs: unequal sample sizes across cells; IV's become dependent and correlated
  - Requires specialized statistical procedures

Solomon Four-Group Design

- Combination of the 2 X 2 factorial design with the additional feature that it tests for instrument reactivity

O_1 X_1 O_2

X_1 O_2

O_1 X_2 O_2

X_2 O_2

Offers all the advantages of the factorial design with the additional feature that it tests for instrument reactivity

M x N Factorial Design

- Factorial design expanded where the IV's have any number of levels within practical limits
- Design decisions difficult because of potential for compromised precision
- Analyze using multiple regression instead of ANOVA
  - Should be model driven, where order of entry of variables is specified

Higher Order Factorial Design

- Theoretically, it is possible to have any number of IV's in a design
- Advantage: allowing joint effects of IVs to studied
- Disadvantage: the complexity that comes with size
  - Cells quickly grow
  - Each higher order introduces another level of interaction, which are difficult to analyze and interpret

Hierarchical Design

- Nested or hierarchical variable: when subjects are members of preexisting groups or classifications, and entire groups are assigned to treatment conditions
  - E.g., students who are nested in classes that are assigned to treatments
- Recently developed statistical methods (e.g., hierarchical linear modeling) can deal with such designs

Designs with Concomitant Variables

- Concomitant variables: variables that can be identified as potentially related to the DV, and which might account for error variance in the design
- Address by
  - Blocking: equal number of subjects at each level of the concomitant variable and an equal number in each cell of the design (e.g., sex, intelligence, race/ethnicity, etc.)
  - ANCOVA, a statistical means of adjusting for the covariate in a design
- Blocking vs. ANCOVA
  - ANCOVA is somewhat more precise, but is sensitive to violations in statistical assumptions
  - Blocking is simpler to use and understand, and less sensitive to violations of assumptions

Multivariate Designs

- Multivariate designs involve multiple DV's
- Use multivariate statistical procedures which analyze all DV's simultaneously
  - MANOVA
    - Examines whether there is a significant effect for all DV's simultaneously
    - If there is a multivariate effect, follow-up with univariate analyses to determine
      - Which DV's are responsible for it
      - How the DV's are interrelated