PSYC4418

Advanced Quantitative Methods in Psychology

Lecture, Textbook & Lab Notes

Lecture 1.1: Review

Research Designs — POWER

- power is major consideration in deciding research design (low = less chance of finding effect)
- *POWER* is the probability of rejecting the null hypothesis, when it is in fact false
- WS design is much more powerful than between
- Research design needs to first be specified to guide data collection; broad types:

1) Between subjects design

- participants tested only once on one or more DVs
  - Participants randomly assigned to groups 'naturally'
- common statistical analyses are:
  - Independent samples t-test
  - One way between subjects ANOVA
  - Factorial between subjects ANOVA
- requires large sample and effect sizes to achieve power of .80

2) Within subjects design

- participants are tested more than once on 1+ DVs
- Common statistical analyses are:
  - Paired samples t-test
  - One way within subjects ANOVA
  - Factorial within subjects ANOVA
- issues = e.g practice effects and fatigue effects

***3)* Mixed Designs**

- participants are tested more than once on 1+ DVs AND can also be categorised (grouped) across one or more IVs
- Common statistical analyses are:
  - Mixed design ANOVA
  - Also known as split-plot ANOVA
- more powerful than BS analysis but control group may not be possible

Complications: ETHICS

- participants must be treated equally — use *counterbalancing*
  - involves variation of presentation of conditions across WS design
  - Not everyone gets same condition ordering; half half
  - Method used to counteract order effects or time-related effects

Standard Error

- plays a substantial role in inferential statistics
- Fundamental basis of **standard error** is variability in point-estimate estimation across random *re-samples* drawn from a population

Confidence Intervals

- complicated to calculate CIs for *within* subject designs - *CIs too wide*
- must take into consideration the *shared variance* between conditions
- Shared variance between conditions reduces standard error of difference between means
- two types of adjusted (Reduced) standard deviations — individual and pooled

Individual Adjusted SDs

1. Estimate variances associated with conditions and covariance
2. Subtract covariance from variances
3. Square root adjusted variances
4. Transform raw scores into z scores
5. Transform z scores into adjusted scores with raw score means and adjusted SDs

Pooled Adjusted SDs

1. Conduct one way within subjects ANOVA
2. Square root the mean square error to obtain pooled adjusted SD
3. Transform raw scores into z scores
4. Transform z scores into adjusted scores with raw score means and pooled adjusted SD

Lecture 1.2: Factorial Repeated Measures ANOVA

- the simplest repeated measures design is 2X2
- two independent variables, with two levels each
- Office example - plant/no plant and tidy/messy (IVs) + comfort level (DV)

SPSS Interaction Effect

- presence of statistically significant interaction complicates interpretation of main effects
- Supplementary analyses needed to determine whether main effects can be interpreted or not
- statistically significant interaction implies that the magnitude of the difference between two or more means depends on the level of another independent variable
  - i.e the significant interaction implies that the Cohen's D value associated with one contrast is statistically significantly *different* to the Cohen's d value associated with another contrast

Main Effects in Presence of an Interaction

• need to conduct simple main effect analyses

• if these are statistically significant + in same direction across levels of the IV, then main effect can be interpreted

• use pooled error term for each of simple main effect analyses (DON'T memorise*)

- because factorial ANOVA interaction effect is based on pooled error term
  - mean square error
- SPSS does not allow for these analyses - researchers use 'quick and dirty' approach
  - METHOD 1: conduct series of paired samples t-tests
    - compare means — paired sampled t test OR add COMPARE command
  - METHOD 2: Convert Mean square Error into pooled standard error of difference between related means (must conduct remaining analyses on excel)
  - pooled SE_D = square root of MS_E / (N/2)

* Issue - pooled error term is 'averaged' across all four mean comparisons, therefore do not get same values across perspectives

* recommended to use **Bonferroni adjustment** when conducting several analyses on 1 sample with 3+ levels of IV in within subjects design

CHAPTER 10: Factorial Repeated Measures ANOVA

* important to understand how to appropriately decompose a significant interaction effect
- conceptual understanding - simple main effect Cohen's D values are unequal
- Technical and accurate way - described further in chapter
  - Use of pooled error term to take into account shared variance across conditions

Main Effects and Interaction on SPSS
- in a 2x2 factorial RM ANOVA there is no possibility to violate the assumption of sphericity
- Only assumption to consider are those related to paired samples t-test
- In SPSS, use 'general linear model' utility
  - <u>'test of within subjects effects'</u> table contains key results about main effect and interaction
  - *main effect partial eta squared values from here are *<u>not</u> interpretable*
- interactions best represented in graph - non parallel element reflects significant interaction
- *Interaction implies that magnitude of difference between two IV levels are unequal across two IV levels of another IV.*
- Describe statistically significant interaction as consistent with observation of simple main effect t test values that are statistically different from each other
- Interaction error term is based on mean square error of interaction — convert this to pooled standard error using formula

Simple Main Effect Analyses
- used to determine if significant main effect can be interpreted in presence of significant interaction — two approaches here:

1) Conventional paired samples t test (quick and dirty)
   - conduct paired samples t test at each level of interacting IV
   - if in both significant and in same direction, main effect can be interpreted
2) Paired sample t-test contrasts with pooled error term — more accurate + helps understanding true nature of interaction
   - based on more observations, therefore more accurate

* 2 x *K* factorial ANOVAS: decompose by performing 2x2 factorial RM ANOVAs

Cohen's D for Omnibus Main Effects
- should always estimate and report corresponding standardised effect size estimates
- 3+ means = eta squared or partial eta squared
- SPSS does not report SDs with main effect means (only reports SE)
  - convert using formula ***SD = SE X square root of N***

LAB 1: Factorial Repeated Measures ANOVA

<u>This lab:</u>

1. How to create accurate 95% confidence intervals for within-subjects design data based on adjusted standard deviations.
2. How to conduct a 2x2 factorial repeated measures ANOVA.
3. Decompose a 2x2 interaction to demonstrate that the ANOVA interaction effect is consistent with difference between relevant paired-samples t-tests (based on an unpooled error term).
4. How to conduct simple main effect analyses with unpooled (quick and dirty) standard error terms to potentially support the interpretation of a main effect from a factorial repeated measures ANOVA

+ Memorise one formula to calculate CIs for factorial RM ANOVA interaction

Paired Sample T Test **(Task 1, 2, 3)**

- test difference between two within subjects means; testing null hypothesis that two means =
- Each PP measured twice across 2 conditions
- <u>Example data</u>: money at time 1 or 2 + processing speed performance

1. Isolate cases: data —> select cases —> if condition is satisfied —> If ___ = 0 —> Continue
2. Run paired sample t test: Analyse —> compare means —> paired samples t test
    1. Place two variables you are comparing into variable 1 and 2 slots —> Continue

* Look at last table "Paired samples Test" - t value, p value, correlation (table 2)

Line Chart

- line chart with unadjusted confidence intervals

1. Deactivate isolation of cases
2. Create Line chart: Graphs —> Legacy Dialogues —> Line —> Simple —> Summaries of Separate Variables —> Define
    1. Place two variables of interest into Line Represents Box
    2. Options —> Display Error bars —> Continue

Adjusting CIs **(Task 4, 5)**

- in order to reflect the power of within subjects design (i.e positive correlation across conditions), the SDs need to be adjusted (reduced)
- then, with adjusted SDs, the raw data can be transformed accordingly (individual method)
    - Allows for creation of adjusted CIs and line charts (after adjusting; make new line chart to check CI overlap)

1. Estimate variances and covariances: Analyse —> Scale —> Reliability Analysis
    3. Place variables into 'items' box
    4. Click statistics —> inter-item covariances (top right) —> Continue * look at last table
    5. Subtract covariance from each of the variances using calculator
    6. Square root adjusted variances to give adjusted SD
2. Transform variable raw scores into z scores: Analyse —> Descriptive Stats —> Descriptives
    1. Place variables into 'Variables' box and select 'save as standardised variables'
        * 2 new variables created - represents two variables as z scores
        1. Transform —> compute variable; ***mean + z score * adjusted SD*** based on table