Experiments

Outline

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- Control variable
- Internal vs external validity
- Independent samples designs
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  - Confounds
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Experiment

- Experiment – a type of research in which the researcher manipulates one or more variables, measures one or more variables and holds the value of all other variables constant
- Allows statements of causality
Independent Variables

✧ Independent variable (IV) -- the thing that is manipulated in an experiment
✧ Factor -- a variable that the researcher wants to see how it influences the DV
✧ all IVs are factors; not all factors are IVs
✧ A person’s gender could be a factor, but could not (ethically) be an IV
✧ Level -- the value that an IV / factor takes on

Condition (or treatment) -- the sum of all the treatments that an individual receives at a given time
✧ In single factor experiments, level and condition are identical
✧ In multi-factor experiments, level and condition are different

Conditions vs. Levels

<table>
<thead>
<tr>
<th>Context Present</th>
<th>Abstract Passage</th>
<th>Concrete Passage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Context Present</td>
<td>Abstract Passage / Context Present</td>
<td>Concrete Passage / Context Present</td>
</tr>
<tr>
<td>Context Absent</td>
<td>Abstract Passage / Context Absent</td>
<td>Concrete Passage / Context Absent</td>
</tr>
</tbody>
</table>
Dependent Variable

- The variable that the researcher measures
- Hopefully its value depends on the level of the IV

Control Variables

- All variables that are neither IVs nor DVs should be control variables
- Their values should be held constant
- If all variables that are neither IVs nor DVs are held constant, then any change observed in the DV must be due to the IV
- In practice, only variables that are likely to influence the DV if they are allowed to vary are called control variables

Internal Validity

- Internal validity is the extent to which alternative explanations of the results can be ruled out
- Partially related to making sure all important control variables have been controlled
External Validity

- External validity is the extent to which the results of the study apply to other situations, populations, times, etc.
- How generalizable are the results?
- Typically, studies high in internal validity are low in external validity and vice versa
- Why?

Independent Samples Designs

- An *independent samples design* occurs when each participant in the experiment experiences exactly one condition
- Historically referred to as a *between-subjects design*

<table>
<thead>
<tr>
<th>Condition</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
</table>

- Because each person participates in a single condition, there is no possibility of a carry-over effect
- Carry-over effect – participation in one condition influences participation in one or more other conditions
Independent Samples Designs

- Increased error variance
  - Why?
  - Is that good or bad?
  - How to overcome

Independent Samples Designs

- Participants attributes can become confounded with the IV
  - Confound – the value of a variable (that should be a control variable) co-varies with an IV
  - Example
  - Are confounds good or bad?
  - How to overcome...

Random Assignment

- Each participant is randomly assigned to a condition
  - As long as sample size is sufficiently large, this greatly reduces the likelihood that participant attributes will be confounded with an IV
  - Why?
Block Random Assignment

- If there are X conditions in the study, take the first X participants and randomly assign one participant to each condition
- Take the next X participants and randomly assign one to each condition
- Repeat

Advantages?
- Sample size per condition
- Time of participation

Matching

- Makes the groups approximately equivalent on one or more variables
  - Measure a variable that would likely influence the DV if left uncontrolled
  - Sort participants on that variable
  - Block random assign participants to condition based on value of the variable
  - Randomly assign participants with the highest X scores, one to each of the X conditions

Matching

- Samples are no longer independent
For each hypothesis / prediction
- State the hypothesis / prediction
- Give descriptive statistics that are relevant to the hypothesis / prediction
- Describe the inferential statistic that will be used to test the hypothesis / prediction
- Give the values associated with the inferential statistic
- State whether the data support the hypothesis / predictions or not

Results

Participants who received contextual knowledge of a passage ($M = 15.1, SD = 4.8$) should have a higher recall of the passage than those who did not have the context ($M = 10.0, SD = 3.1$). Consistent with the prediction, a one-tailed independent samples $t$ test revealed a reliable difference, $t(14) = 2.500$, $p = .013$, Cohen’s $d = 0.538$, $\alpha = .05$.

Results Style

- Follows immediately after Method
- For us (a single study), level one heading of Results
- Report descriptive statistics to one more decimal place than measured (we measured recall to the nearest integer; report to nearest tenth)
- Report inferential statistics to three decimal places
## Results Style

- Numbers that can be larger than 1, but are between 0 and 1 (exclusive) should be reported without a 0 before the decimal point
  - $SD = 0.61, t(14) = 0.123$
- Numbers that cannot be larger than 1 should be reported without a 0 before the decimal point
  - $r = .653, p = .012, \alpha = .05$

## Tables

- If more than approximately four means or standard deviations are to be reported, consider using a table or figure
  - Tables are good for giving precise values
  - Figures are good for showing trends or relations

### Table 1

*Descriptive Statistics for Recall*

<table>
<thead>
<tr>
<th></th>
<th>No Context</th>
<th>Context</th>
</tr>
</thead>
<tbody>
<tr>
<td>$M$</td>
<td>10.03</td>
<td>15.10</td>
</tr>
<tr>
<td>$SD$</td>
<td>3.14</td>
<td>4.78</td>
</tr>
</tbody>
</table>

*Note.* The values are for the number of idea units recalled.
Tables

- Start the table with the table number
- Give the table title in italics and title case
- The body of the table should be single spaced with a line above and below the values in the table
- If appropriate, give a note to the table at the bottom (double spaced)

Tables

- Every table has a number
- Cite each table in the text
  - Table 1 gives the means and standard deviations for each condition
  - The T in Table is always capitalized
  - The table number is always numeric
- Tables go after the footnotes page
  - If there are no footnotes, tables go after the reference section

Figure 1. Mean number of idea units recalled for each condition. The error bars represent the 95% confidence intervals
Figures

- Every figure has a number
- Cite each figure in the text
  - Figure 1 gives the means and confidence intervals for each condition
  - The F in figure is always capitalized
  - The figure number is always numeric
- Figures use a san-serif font such as Arial
- Include a figure caption beneath the figure
- Figures go after tables in the manuscript