Research Methods

Critical Thinking & The Scientific Method

Critical thinking:
- Examines assumptions
- Discerns hidden values
- Evaluates evidence
- Assesses conclusions

Scientific Attitude
- Curiosity
- Skepticism
- Humility

Research Strategies

Differ along 3 main dimensions
- Research Design
  - Descriptive
  - Correlational
  - Experimental
- Setting
  - Field
  - Laboratory
- Data Collection Method
  - Self-report
  - Observation

Longitudinal - incorporates time

Research Ethics

A human subject's right to privacy must be protected

The risk of discomfort or harm to human subjects must be minimal

Debriefing subjects about the nature of a study is both sensitive and controversial

Routine measures to protect subjects include obtaining informed consent, letting subjects know they can opt out at any time, minimizing anonymity in results, and debriefing subjects about descriptions after the study ends

Statistics

Descriptive statistics
- Sample-specific, not generalized to broader population
- Used to organize, summarize, describe data
  - Measures of central tendency
  - Measures of variability

Correlation (measure of association)

Inferential statistics
- Attempts to generalize results of sample to broader population
- How likely are results due to chance alone?
- Inference depends on sample & population
- Used to test predicted relationships
- Some things that affect the observed effect
  - Size of effect
  - Number of observations (size of sample)
  - Variability of data
Critical Thinking & The Scientific Method

Critical thinking:

- Examines assumptions
- Discerns hidden values
- Evaluates evidence
- Assesses conclusions

Scientific Attitude

Curiosity  Skepticism  Humility
Variables

- Variable
  - Something that varies
- Dependent variable (outcome variable)
  - What you are trying to predict (e.g., test performance)
- Independent variable (predictor variable, experimental variable)
  - What predicts the dependent variable (e.g., study skills)
- Covariate (control variable, confounding variable)
  - Not focus of research, but might have an effect on observed relationships / results (e.g., age)
- Goal is to be parsimonious and thorough
  - Include important variables
  - Do not over-control the study by including all variables if they are not important
Research Strategies

Differ along 3 main dimensions

- Research Design
- Descriptive
- Correlational
- Experimental

- Setting
  - Field
  - Laboratory
- Data Collection Method
  - Self-report
  - Observation

Longitudinal - incorporates time
## Research Designs

<table>
<thead>
<tr>
<th>Research Method</th>
<th>Basic Purpose</th>
<th>How Conducted</th>
<th>What is Manipulated</th>
<th>Weaknesses</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Descriptive</strong></td>
<td>To observe and record behavior</td>
<td>Do case studies, surveys, or naturalistic observations</td>
<td>Nothing</td>
<td>No control of variables; single cases may be misleading</td>
</tr>
<tr>
<td><strong>Correlational</strong></td>
<td>To detect naturally occurring relationships; to assess how well these variables predict one another</td>
<td>Compute statistical association, sometimes among survey responses</td>
<td>Nothing</td>
<td>Does not specify cause and effect</td>
</tr>
<tr>
<td><strong>Experimental</strong></td>
<td>To explore cause and effect</td>
<td>Manipulate one or more factors; use random assignment</td>
<td>The independent variable(s)</td>
<td>Sometimes not feasible; results may not generalize to other contexts; not ethical to manipulate certain variables</td>
</tr>
</tbody>
</table>
Research Settings

Laboratory studies
  • Research conducted in a setting designed to help the data collection &/or control environmental conditions
    • Pros - more control means better able to test hypotheses
    • Cons - over-controlled setting might not match with real-world behavior

Field studies
  • Research conducted in a setting in which the researcher does not have control over the experiences that a subject has
    • Pros - better matches real-world behavior
    • Cons - lack of control makes it more difficult to test hypotheses (other variables may be impacting results)
Data Collection Methods

Self-report
- Questionnaire / survey
- Interview
- Introspection, recollection

Observation
- "Real-world" observation
- Tests (e.g., physiological measures such as heart rate)
- Media / historical study (e.g., twitter feeds)
Evaluating Methods

Avoiding Bias
- Bias (Non-random variability in results)
  - Can lead to incorrect conclusions about study results
- Sampling bias
  - Study participants (sample) unique, does not represent the larger population one wants to relate study results to (e.g., university students vs. all adults)
- Measurement bias
  - Measurement does not accurately and consistently measure what it is supposed to
- Want measurements that are both valid and reliable
  - Validity (measure what it is supposed to measure)
  - Reliability (measure is consistent)
- Expectancy bias
  - Researcher’s and/or participant’s behaviors bias observed results
  - Minimized by keeping researchers and participants unaware (blind) of what experimental condition they are in

Reliability and Validity

Reliability
- If you conduct the study again, will you get the same results?
- Similar terms -
  - Replicability
  - Reproducibility

Validity
- Is it what you think it is?
  - Internal Validity
    - The degree to which a cause-effect relationship between two variables has been unambiguously established, or the degree to which a study allows unambiguous causal inference.
  - External Validity (Generalizability)
    - The degree to which a study ensures that potential findings apply to settings and samples other than the one being studied.
  - Ecological Validity
    - The degree to which an effect has been obtained under conditions that are typical for what happens in everyday life
Avoiding Bias

• Bias (Non-random variability in results)
  • Can lead to incorrect conclusions about study results
• Sampling bias
  • Study participants (sample) unique, does not represent the larger population one wants to relate study results to (e.g., university students vs. all adults)
• Measurement bias
  • Measurement does not accurately and consistently measure what it is supposed to
  • Want measurements that are both valid and reliable
    • Validity (measure what it is supposed to measure)
    • Reliability (measure is consistent)
• Expectancy bias
  • Researcher's and/or participant's behaviors bias observed results
  • Minimized by keeping researchers and participants unaware (blind) of what experimental condition they are in
Reliability and Validity

Reliability
If you conduct the study again, will you get the same results?
Similar terms -
• Replicability
• Reproducibility

Validity
Is it what you think it is?

Internal Validity
• The degree to which a cause-effect relationship between two variables has been unambiguously established, or the degree to which a study allows unambiguous causal inferences.

External Validity (Generalizability)
• The degree to which a study ensures that potential findings apply to settings and samples other than the ones being studied.

Ecological Validity
• The degree to which an effect has been obtained under conditions that are typical for what happens in everyday life.
Reliability

If you conduct the study again, will you get the same results?

Similar terms -

• Replicability
• Reproducibility

Estimating the Reproducibility of Psychological Science

- Replicated 100 experimental and correlational studies published in three psychology journals using highly
  advanced designs, large and statistically significant
  - Replication effects were half the magnitude of original
    effects
  - 70% of original studies had significant results
  - 46% of replication efforts were at the 95% confidence interval of the replication effect size
  - 50% of replication efforts were unable to have
    replicated the original result and had
    confidence intervals of original and
    replication results with small replications
  - 100% of confidence was being practiced by the
    strength of original evidence thus by characteristics of
    the original and replication teams
A REPRODUCIBILITY CRISIS IN SCIENCE?
Estimating the Reproducibility of Psychological Science

- Replicated 100 experimental and correlational studies published in three psychology journals using high-powered designs and original materials when available.
- Replication effects were half the magnitude of original effects
  - 97% of original studies had significant results ($p < .05$)
  - 36% of replications had significant results
  - 47% of original effect sizes were in the 95% confidence interval of the replication effect size
  - 39% of effects were subjectively rated to have replicated the original result; and, if no bias in original results is assumed, combining original and replication results left 68% with significant effects.
- Replication success was better predicted by the strength of original evidence than by characteristics of the original and replication teams.

Validity

Is it what you think it is?

Internal Validity
• The degree to which a cause-effect relationship between two variables has been unambiguously established, or the degree to which a study allows unambiguous causal inferences.

External Validity (Generalizability)
• The degree to which a study ensures that potential findings apply to settings and samples other than the ones being studied.

Ecological Validity
• The degree to which an effect has been obtained under conditions that are typical for what happens in everyday life.
Research Ethics

A human subject’s right to privacy must be protected

The risk of discomfort or harm to human subjects must be minimal

Deceiving subjects about some aspect of a study is both common and controversial

Routine measures to protect subjects include obtaining informed consent, letting subjects know they can quit at any time, ensuring anonymity in results, and debriefing subjects about deception after the study ends.
# Research Ethics

A human subject’s right to privacy must be protected

The risk of discomfort or harm to human subjects must be minimal

Deceiving subjects about some aspect of a study is both common and controversial

Routine measures to protect subjects include obtaining informed consent, letting subjects know they can quit at any time, ensuring anonymity in results, and debriefing subjects about deception after the study ends.
Statistics

Descriptive statistics
- Sample-specific, not generalized to broader population
- Used to organize, summarize, describe data
  - Measures of central tendency
  - Measures of variability

Correlation (measure of association)

Inferential statistics
- Attempts to generalize results of sample to broader population
  - How likely are results due to chance alone?
  - Inference depends on Sample & Population
- Used to test predicted relationships
- Some things that affect the observed effect
  - Size of effect
  - Number of observations (size of sample)
  - Variability of data
Measures of Central Tendency

Mean ('average')
  • Sum of scores divided by number of scores

Median ('middle')
  • Middle score in distribution (equal amount above & below)

Mode ('most')
  • Most frequently occurring score
Measures of Variability

Information about the spread of scores in a distribution

- Range
  - Highest score in the distribution minus the lowest score
- Standard Deviation
  - Larger the standard deviation, the more spread out the scores are in a distribution (more variation)
## Table A.2

### Calculating the Standard Deviation

<table>
<thead>
<tr>
<th>Weight ( X )</th>
<th>Mean ( \bar{X} )</th>
<th>Weight – Mean ( X - \bar{X} )</th>
<th>(Weight – Mean) Squared ((X - \bar{X})^2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>155</td>
<td>124</td>
<td>31</td>
<td>961</td>
</tr>
<tr>
<td>149</td>
<td>124</td>
<td>25</td>
<td>625</td>
</tr>
<tr>
<td>142</td>
<td>124</td>
<td>18</td>
<td>324</td>
</tr>
<tr>
<td>138</td>
<td>124</td>
<td>14</td>
<td>196</td>
</tr>
<tr>
<td>134</td>
<td>124</td>
<td>10</td>
<td>100</td>
</tr>
<tr>
<td>131</td>
<td>124</td>
<td>7</td>
<td>49</td>
</tr>
<tr>
<td>127</td>
<td>124</td>
<td>3</td>
<td>9</td>
</tr>
<tr>
<td>125</td>
<td>124</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>120</td>
<td>124</td>
<td>-4</td>
<td>16</td>
</tr>
<tr>
<td>115</td>
<td>124</td>
<td>-9</td>
<td>81</td>
</tr>
<tr>
<td>112</td>
<td>124</td>
<td>-12</td>
<td>144</td>
</tr>
<tr>
<td>110</td>
<td>124</td>
<td>-14</td>
<td>196</td>
</tr>
<tr>
<td>105</td>
<td>124</td>
<td>-19</td>
<td>361</td>
</tr>
<tr>
<td>102</td>
<td>124</td>
<td>-22</td>
<td>484</td>
</tr>
<tr>
<td>95</td>
<td>124</td>
<td>-29</td>
<td>841</td>
</tr>
</tbody>
</table>

**Sum (\( \Sigma \)) = 1,860**  
**\( \Sigma = 0 \)**  
**\( \Sigma = 4,388 \)**

**Mean (\( \bar{X} \)) = 124**

\[
SD = \sqrt{\frac{\sum (X - \bar{X})^2}{N}} = \sqrt{\frac{4,388}{15}} = 17.10
\]
The Normal Curve ("bell curve")

Symmetrical distribution
- mean, median & mode all at the exact middle of distribution

Used with standard deviation to test for statistical significance
- link between descriptive & inferential statistics
- Most common cut point for statistical significance is 2+ standard deviations from the mean ($p < .05$)
- If normal curve approximates the general population (assumption), than less than 5% of population would be 2+ standard deviation from mean
**Correlation**

Assesses strength of relationship between 2 variables
- Ranges from -1 to 1 (0 = no association)
  - Positive correlation
    - Variables change in same direction
  - Negative correlation
    - Variables change in opposite direction
- Correlation does not equal causation
  - Either variable (or another unmeasured variable) could be causing the change
  - No way of knowing based on correlation alone
$r = 1$
Perfect (linear) correlation

$r = 0.5$
Intermediate correlation

$r = 0$
No correlation

$r = -1$
Perfect (linear) inverse correlation
Correlation

Assesses strength of relationship between 2 variables

- Ranges from -1 to 1 (0 = no association)
  - Positive correlation
    - Variables change in same direction
  - Negative correlation
    - Variables change in opposite direction
- Correlation does not equal causation
  - Either variable (or another unmeasured variable) could be causing the change
  - No way of knowing based on correlation alone
Research Methods

Critical Thinking & The Scientific Method
- Critical thinking...
  - Examines assumptions
  - Discerns hidden values
  - Evaluates evidence
  - Assesses conclusions

Scientific Attitude
- Curiosity
- Skepticism
- Humility

Research Strategies
- Differ along 3 main dimensions
  - Research Design
  - Descriptive
  - Correlational
  - Experimental
  - Setting
  - Field
  - Laboratory
  - Data Collection Method
  - Self-report
  - Observation
  - Longitudinal - incorporates time

Research Ethics
- A human subject's right to privacy must be protected
- The risk of discomfort or harm to human subjects must be minimal
- Deceiving subjects about the subject of a study is both common and controversial
- Routine measures to protect subjects include obtaining informed consent, letting subjects know they can opt out at any time, maintaining anonymity in results, and deceiving subjects about the subject of the study