Drawing Causal Inferences in Applied Lighting Research: Threats to Validity

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Definitions

• *Scientific research* is a systematic, controlled, empirical, and critical investigation of hypothetical propositions about the presumed relations among natural phenomena. *What happens to Y when X changes?*

• *Hypothesis:* a tentative proposition about the relation between two or more phenomena or variables. *X causes Y.*

• Inductive inference:
  – Causes covary with effects
  – Causes precede effects
  – Spurious causes can be eliminated

(Above credit to F. N. Kerlinger)
• **Construct**: a concept which is invented or adopted for a special scientific purpose, e.g., “brightness.”

• **Operational definition**: assigns meaning to a construct or a variable by specifying the operations necessary to measure it.

  *(Above credit to F. N. Kerlinger)*

• **Examples?**
Research Designs

• True experiments
  – Laboratory experiments
    • Maximal experimenter control over:
      – manipulated independent variables
      – elimination of unwanted variability
      – participant characteristics
    • Limited contextual richness
  – Field experiments

• Correlational investigations:
  – Observations
  – Surveys
Laboratory Experiments

• Two common research designs
  – Within-subjects - everyone experiences all experimental conditions
  – Between- subjects - participants randomly assigned to one experimental condition

*Demonstration: The Law of Large Numbers*
Research Design Decisions

• How will my investigation eliminate alternative explanations?
  • internal validity [Fotios too]
  • construct validity [Fotios too]
  • statistical conclusion validity [Uttley]

• To what people, settings, or times do I want to apply the results, and how far may I take this?
  • external validity
Internal Validity

- Test falsifiable hypotheses
  - Comparison group!
- Eliminate alternative hypotheses
- Eliminate sources of bias, including...
  - Participant expectations
  - Experimenter expectations
  - Participant selection (non-random group assignment)
  - Differential attrition
  - Testing (learning, fatigue, familiarity...)

Construct Validity of Causes

• Confounding
  – When more than one variable changes at a time

• Inadequate specification of conditions
  – See Day 1 presentations!

• Arbitrary choice of conditions
  – Refer back to the theory you want to test
  – Include levels that provide a meaningful comparison
  – Consider including extremes for which you have knowledge
Construct Validity of Outcomes

• Specify measurement operations
  – If a validated measurement of Y exists, use it!

• Multiple measures – avoid mono-method bias

• Assess validity & reliability of measurement tools
External Validity

• Generalizability

• Random selection from population

• Sample representativeness, preferably not just:
  – WEIRD: White, Educated, Industrialized, Rich, and Democratic. 99% of all published studies rely on participants recruited from populations that fit those criteria.

• Setting representativeness
Conclusions and Discussion

• Research design is a creative – and balancing – act
• There are few right and wrong answers – mostly trade-offs

• Discussion and thoughts...
Classic Resources


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