Controlled Studies

The Basics of Research Logic and Scientific Technique

What is Science?

- Systematic, logical progression
- Control
- Comparison
- Repeatible

Quantification?

Quantitative	Qualitative
• Explanation through numeric comparison • Objective, but this is deceptive • Predefined variables and scales • Data collection before analysis • Search for causal links • Deductive (broad study describes individual)	• Explanation by comments, words, images • Subjective, but this too is deceptive • Categories and variables defined while or AFTER data are collected analysis and data stages are intermixed • Detailed description, texture and case studies. • Inductive, a case describes the class

Empirical

- Information from observable experience or comparison
- Controlled Study: Simplified environment or cause. Or statistical control.

Variables

- **Construct**: A formal definition of a research quality, i.e. “satisfaction”, “quality”, “utility”
- **Variable**: A definition of a research quality suitable for observation or measurement., i.e. “discontinuance”, “life or durability”, “uses”
- **Measure or operational definition**: Specifies how to observe or gauge: i.e. “months used”, “average time to failure (MTBF)”, “different applications in 1 month”

Scientific Method

- Theory: Tentative, testable explanation
- Causation
- Hypothesis: Tentative statement of relationship among variables. Causation implied or tested.
- Control: Uses a comparison to check cause. Rules out competing causes
- Tested with real people or objects similar to everyday use.
- Is generalisable beyond test group. Sampling and inference.
- Argue for validation by strength of findings, replications
- In usability: how does one show usability: must define it operationally in context of use. *Hypothesis: Dvorak simplified keyboard increases input speed.*

a1 is better than a2 for causing b

(this is made up)

a1: finger swipe

a2: scroll wheel

faster than

improved
b: window scrolling

mouse size example

theory: mouse size affects children's performance on selection tasks

comparative controlled experiment

hypothesis:
children can select targets faster with a small mouse compared to a regular mouse

cause:
mouse size
e.g., regular mouse 15 x 10 x 7 cm **vs**. 10 x 7 x 4 cm mouse

effect:
tasks speed from beginning to select

population:
children aged 4 to 6

be careful with proofs

you can **never** prove a hypothesis
you can **never** prove a statement with observations
you can **only** find **support for** or **disprove**

be careful with proofs

statement: all swans are white
observe: 10,000,000 swans
result: all observed swans are white

does this constitute a proof that
all swans are white?

Proof: no ***Support***: yes

Null Hypothesis

Science opposes the real hypothesis with a NULL – that is a statement that the theory may NOT be supported.

What's the null for the Dvorak keyboard?

Variables

Something that can **vary, can be called a vector**
Has values that can be **measured** or **specified**

e.g.,

font size = 8, 10, 12 (varies and can be 8, 10, or 12)

color = red, green, blue, etc. (varies and can be one of…)

time = n seconds (varies and can be 0-600)

error rate = x% (varies and can be 0-100%)

subject type = novice or expert, male or female

Kinds of Variables

- Independent: Presumed Cause
  (a) manipulated, altered
  (b) assigned, given by environment, situation
- Dependent: Presumed Outcome, the EFFECT
- Control: Variables removed by test environment or mathematically
- Intervening: Unwanted influences on dependent variable that are NOT known or controlled out
  Can be called ***exogenous or confounding***

children's mouse example

controlled variables:
set age, handedness, experience to be constant

if there are performance differences, it is not a result of age, handedness, or experience; it must be from the independent variables

Validity

- Does the experiment measure what I think it does?
- Face Validity
- Construct Validity
- Internal or test logic validity
- External or does the study match real situations

internal validity

the certainty that the change in IV causes the change in DV

independent variable: mouse size
e.g., regular mouse 15 x 10 x 7 cm **vs**. 10 x 7 x 4 cm mouse

dependent variable: task speed

*is it the **mouse size** that is affecting **task speed**?*

Ensuring internal validity . . . .

Novelty: *how can we stop novelty effects?*

Experimentor: *Do we try to please the experimentor?*

Learning: *How can we stop learning effects?*

Fatigue effects? Comparison groups?

the Hawthorne effect

1920's, Western Electric Company's Hawthorne factory

Example: Hawthorne effec

- improve productivity by improving working conditions
- **study 1:** provide better lighting
  group A: better lighting, group B: no change
- both groups had improved morale and productivity (DVs)
- **study n:** change length of day, heating, etc

  morale and productivity kept increasing regardless of conditions

the Hawthorne effect

- the **change in behavior** relates to the experimenter's **paying attention** to the participant
- **the problem:** the workers knew what was being changed; it was noticeable
- **the solution:** limit what participants know about the factors they are being exposed to
  e.g., they can't know that lighting is different for their group

external validity

generalizability: does the relationship between IV and DV **generalize** to the target population or situation?

if we study mouse use in a lab setting, will it generalize to home usage?

will **all** kids behave as those in the study?

ensuring external validity

- carefully select participants
  e.g., random sample
- carefully setup laboratory environment
- e.g., same as home setup but still controlled between participants
- select representative tasks
- e.g., click on a mouse target from a certain distance -> frequent real world task