Current Topics in Human–Computer Interaction

Research Approaches in HCI

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Summer Semester ’26

https://hci.rwth-aachen.de/cthci

RWTH AACHEN UNIVERSITY

Three Approaches to HCI Research

Test

Empirical science

Observe

Ethnography

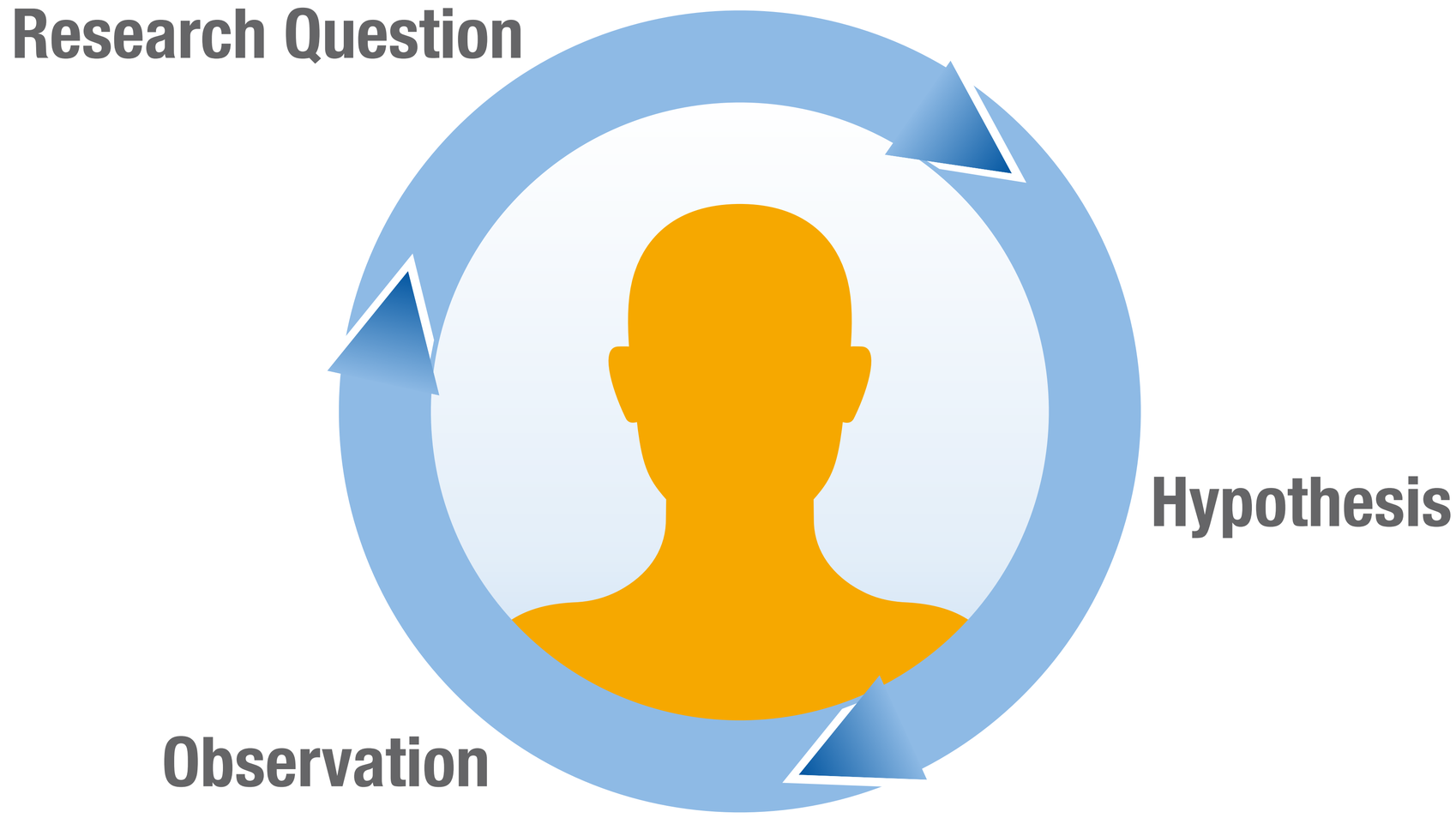
Make

Engineering & Design

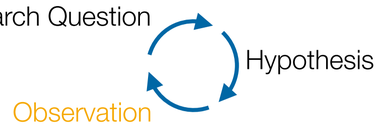
CHAPTER 4

Empirical Approach

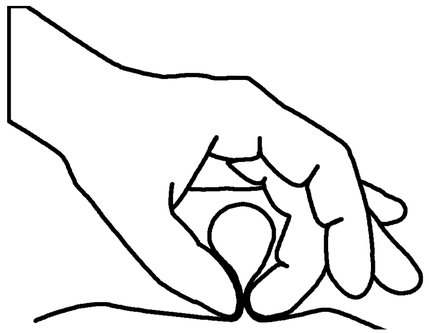
Empirical Approach



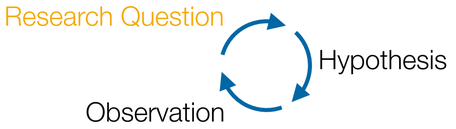
Initial Observation



- Begin with casual or informal observation
- Usually comes from personal experience that catches your attention or raises questions in your mind
- Example: “Cloth has an affordance of pinching. Could this be useful for interaction design?”

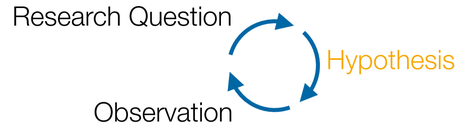


Research Question



- Identify variables and research question for your observation
- **Variables:** characteristics or conditions that change or have different values for different individuals
- **Research question:** a statement that describes or explains a relationship between or among variables
  - A proposal to be tested
- Example: “When pinching cloth, different **areas** of the body would differ in **preference** and **the way people pinch**”

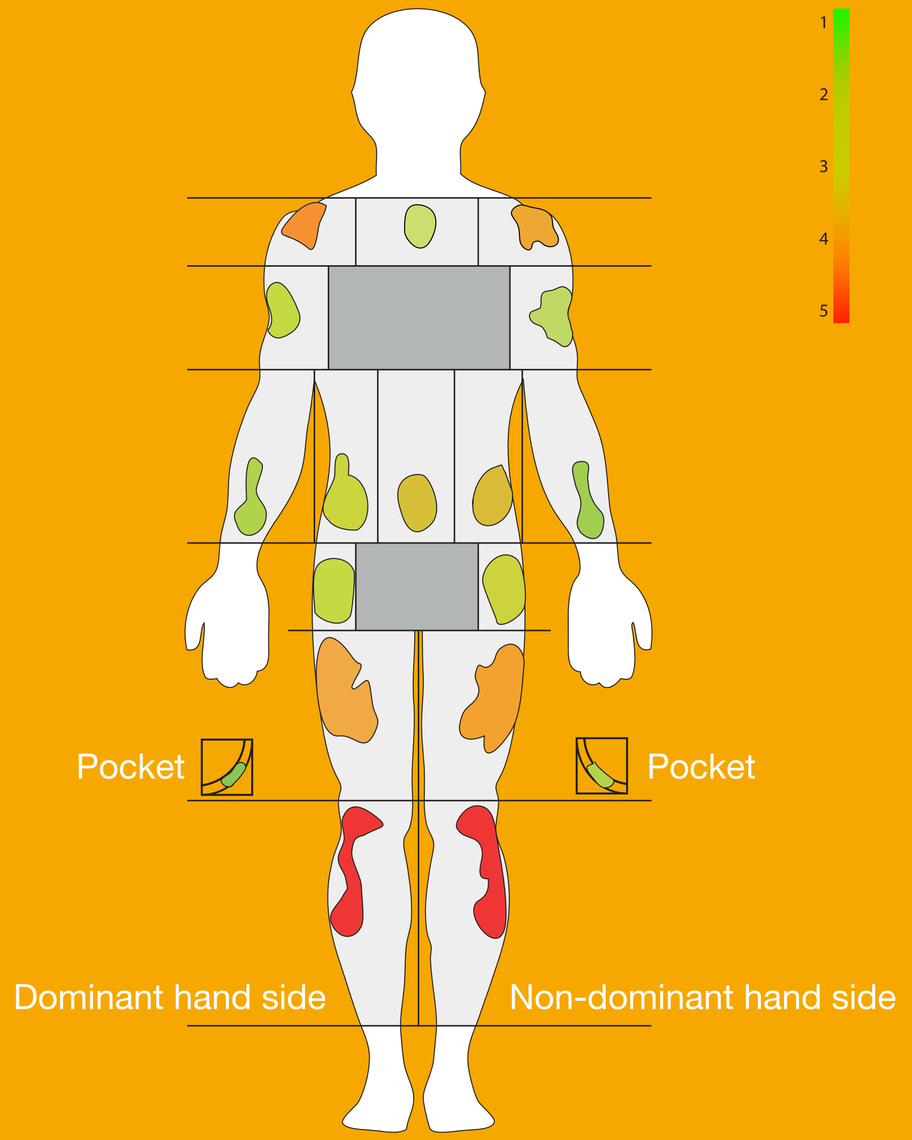
Hypothesis



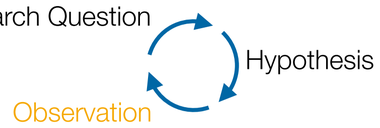
- **Concrete and testable** statements derived from the research question
- **Operational definition:** a specific set of operations for measuring external, observable behavior
- In-class exercise: try giving an operational definition for the variables highlighted below
  - “There would be a difference in **user’s preference** for pinching cloth among different **areas** on the body.”

Example: Pinstripe

- Karrer et al., CHI ’11
- Recall the prediction:
  - “There would be a difference in **user’s preference** for pinching cloth among different **areas** on the body.”
- Method (operationalization):
  - Identify 16 different body areas
  - Ask the participants to perform the pinching gesture in these areas
  - Collect convenience rating in 5-point Likert scale



Conducting the Study



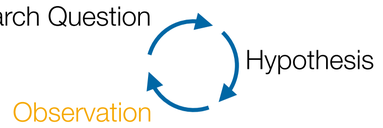
- Goal: Collect data to support, refute, or refine the original hypothesis

- Three strategies
  - **Descriptive research:** X happens
    - Focus on the current state of each **individual** variable
  - **Relational research**: X and Y happen together
    - Measure **two or more variables** that **exist naturally** from each participant
  - **Experimental research:** X causes Y
    - **Manipulate** one or more variables and observe their **effects** on other variables

EMPIRICAL

Descriptive Research

Descriptive Research

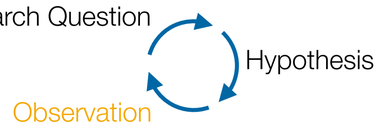


- Describe a naturally-occurring phenomenon
- Measure and report individual variables **without claiming relationships**
- Natural phenomena can occur when using a new technology as well
- Methods: observation, survey, case study

EMPIRICAL

Relational Research

Relational Research

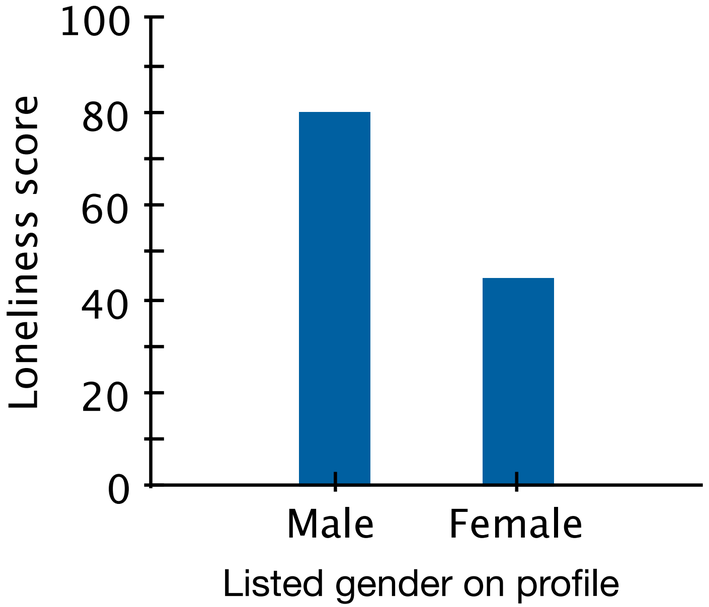


- Measure a set of variables for each participant
- Examine the data to identify **patterns** and relationships
  - Goal: Finding **correlations** (changes in one variable are consistently and predictably accompanied by changes in another variable)
- Measure the **strength** of the relationships

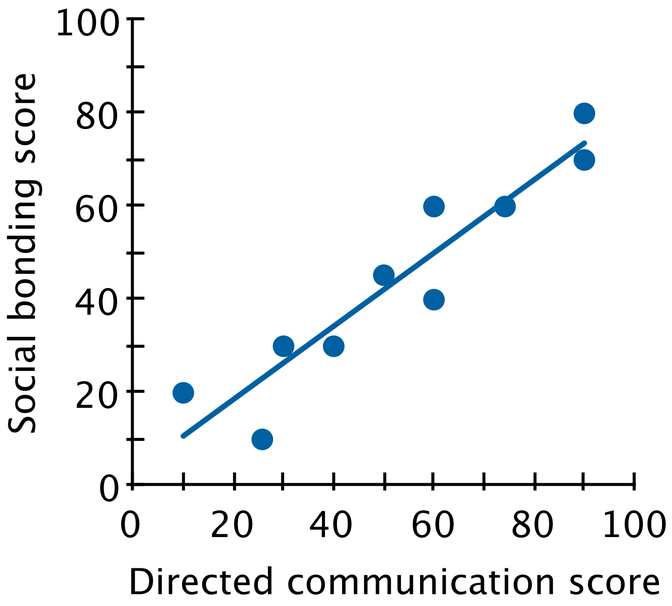
Example: Social Network Activity and Social Well-Being

- Burke (CMU), Marlow, and Lento (Facebook), Best paper CHI ’10 🏆
  - “An empirical analysis of the **relationship** between **direct** and **passive communication** on Facebook and social well-being, including loneliness, bridging, and bonding social capital.”
- Survey using Likert scales (N = **1193**)
- Analyzed the past two months of users’ Facebook activity data, e.g.,
  - Friend count
  - Directed communication: comments, likes
  - Passive consumption of broadcast items such as status updates

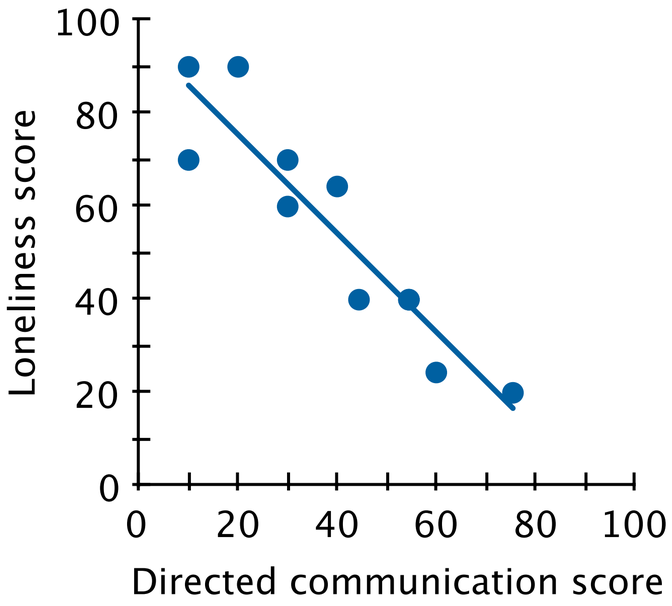
Patterns in the Relationship between Variables



General relationship



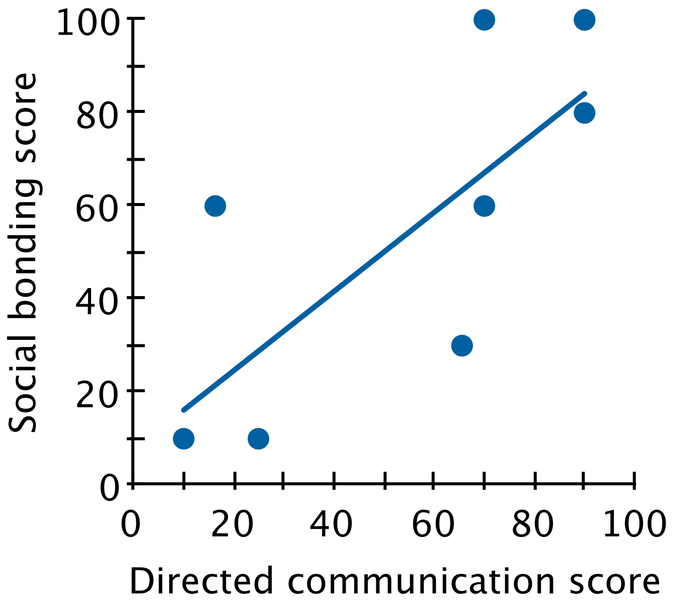
Positive relationship

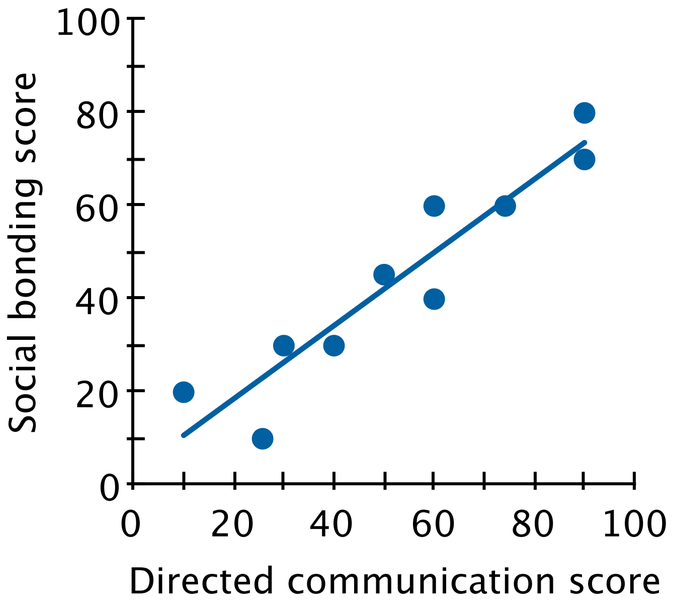


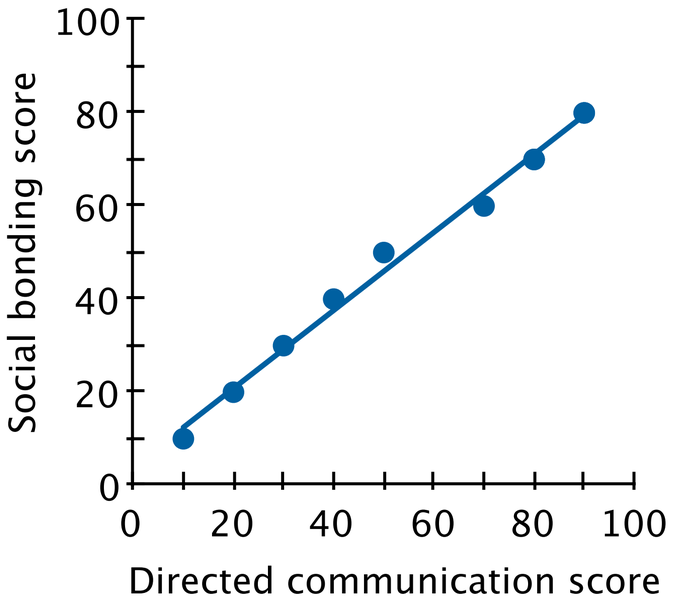
Negative relationship

Simulated data for instructional purposes, based on results from [Burke et al., CHI '10]

Strength of the Relationship between Variables





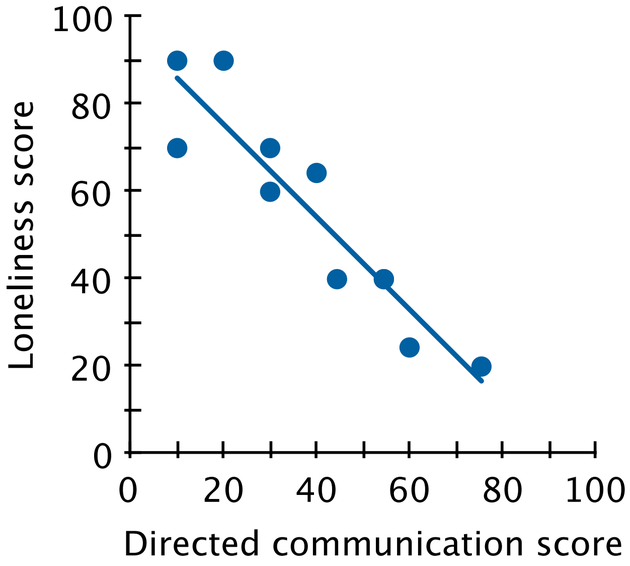


Weak ⟵ Relationship ⟶ Strong

Simulated data for instructional purposes

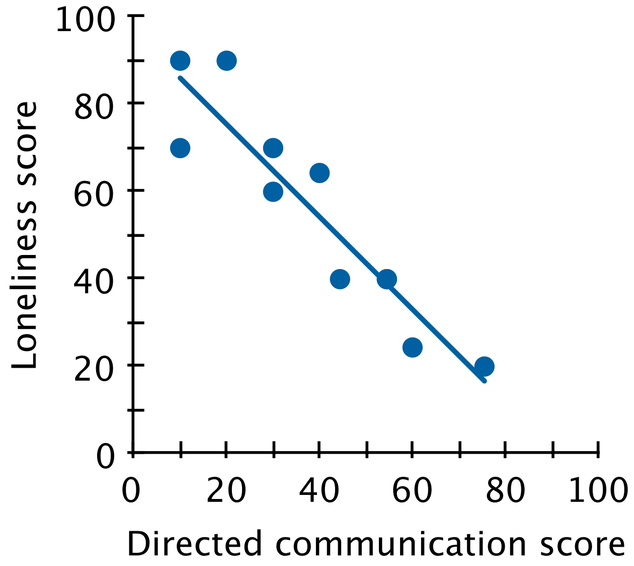
Limitations of Relational Research

- **Correlation does not imply causation**
- E.g., here we do not know:
  - Loneliness ⇒ less direct communication?
  - Less direct communication ⇒ loneliness?
  - Third variable ⇒ direct communication and loneliness?
- **Third variable problem:** unidentified variable controls the correlated variables



Limitations of Relational Research

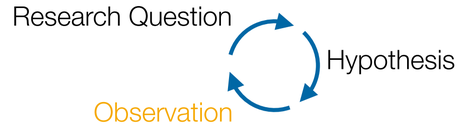
- **Shallow** data from large number of people instead of **deep** data
  - Can be improved by follow-up interviews, follow-up surveys
- Participant sampling method limits the conclusion
  - Method: advertisement on Facebook
  - Participants: only English-speaking users (but compensated by many countries of origin)



EMPIRICAL

Experimental Research

Experimental Research



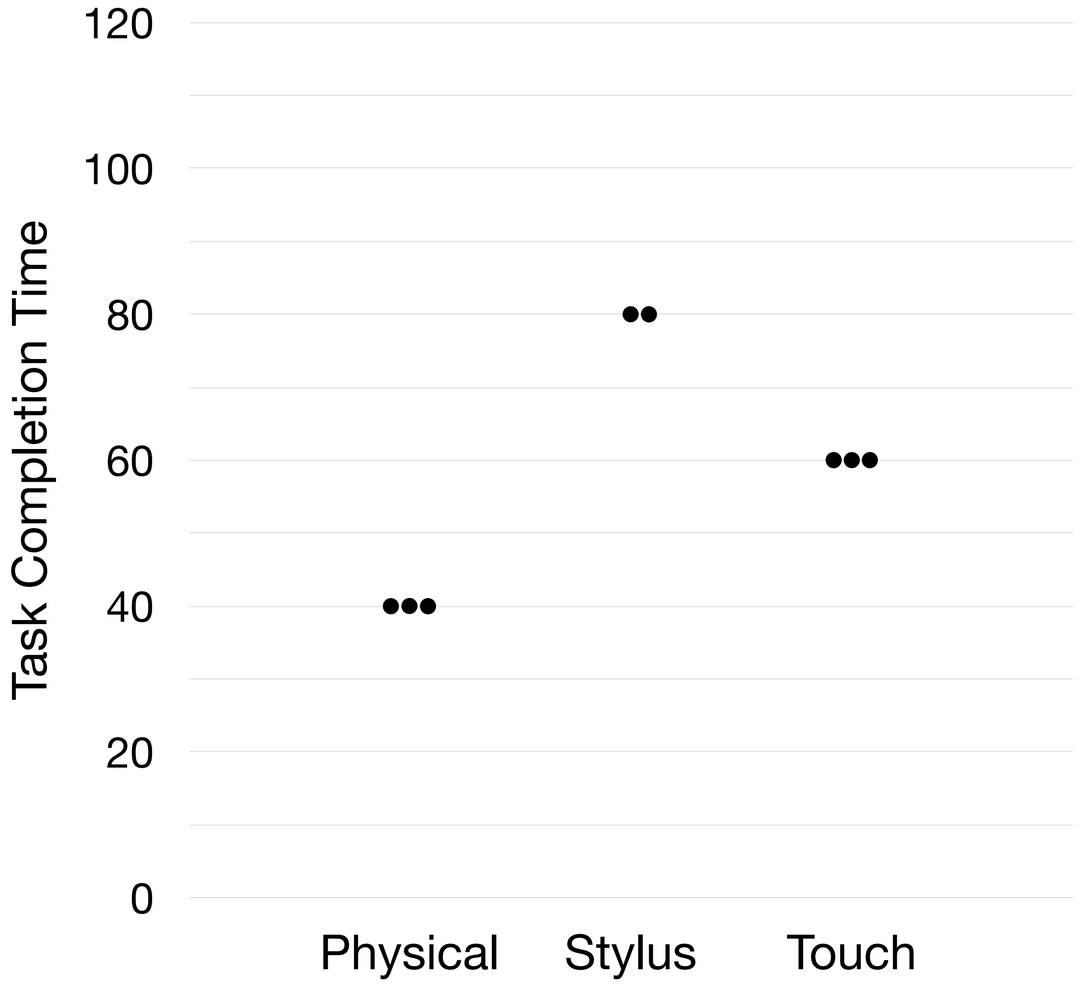
- Purpose: To infer cause-and-effect relationship
- Controlling **independent variable**
- Observe the change in the **dependent variables**
- In-class exercise: recall the following experimental designs from DIS1
  - Between-groups vs. within-groups
  - Benefits and drawbacks
- More details in next lecture

Exercise: Mobile Phone Text Input Example

- Research question: On a mobile phone, is typing faster using *physical keys* compared to using a touchscreen and your *fingers* or a *stylus*?
- IV: keyboard types: {physical, stylus, touch}
- DV: time in seconds for typing a specified sentence.
  - Begin: when the user presses the first key
  - End: when the user presses Enter
- Design: between-groups
  - Each keyboard is tested by 20 participants
  - Each participant types the sentence only once (one trial)

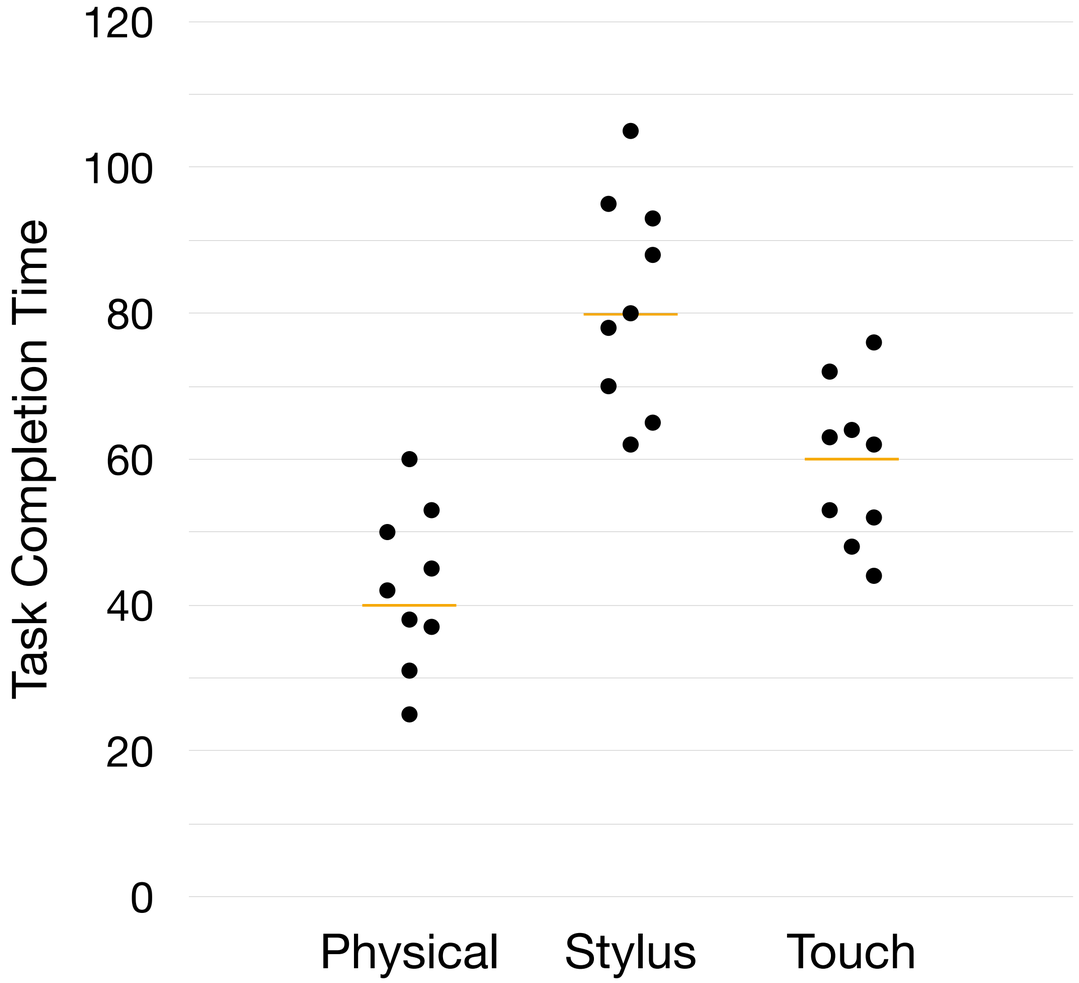
Limitations of Experimental Research

- Ideal world: variance caused by IV only ("IV has an effect on DV")



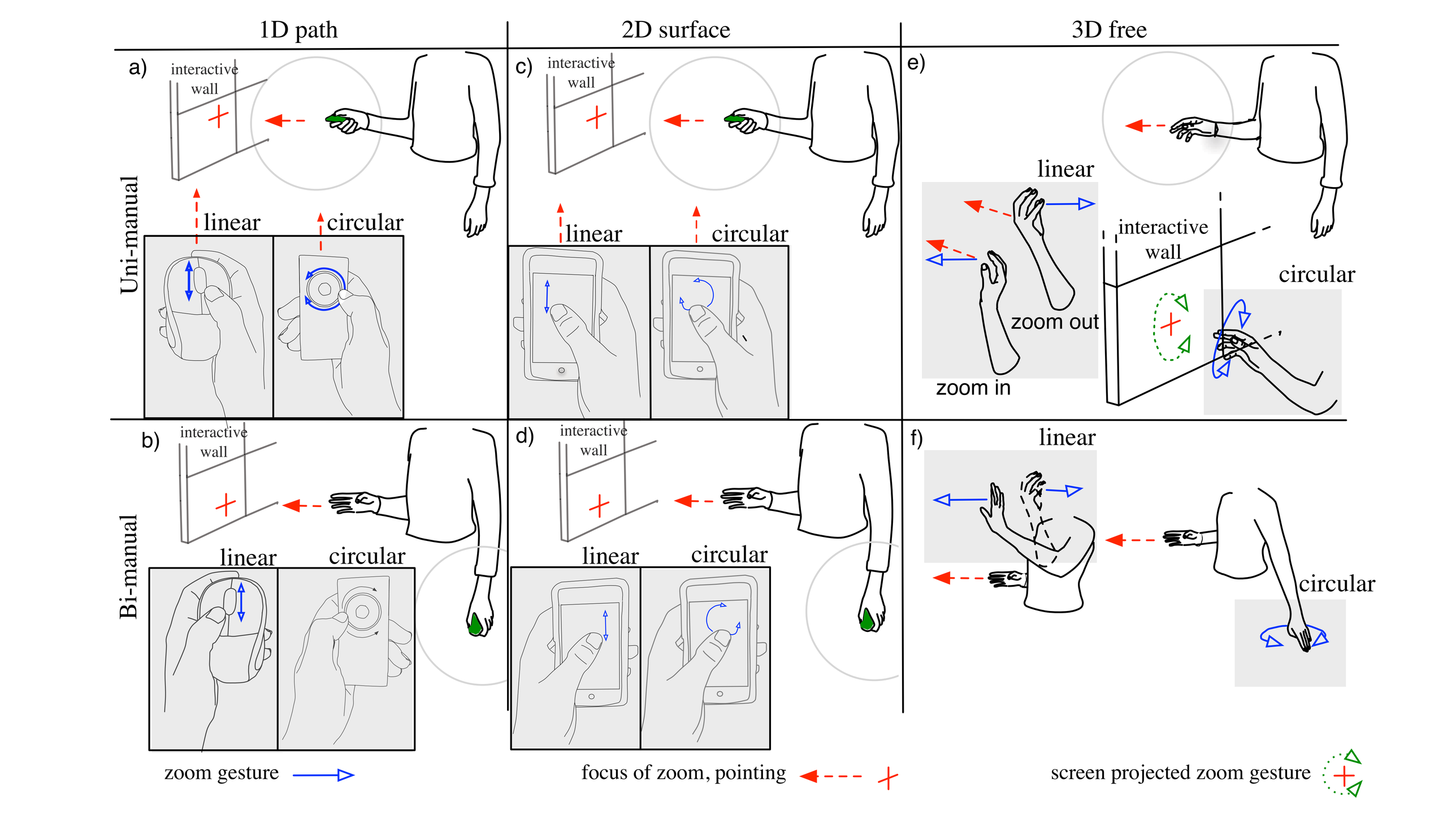
Limitations of Experimental Research

- Ideal world: variance caused by IV only ("IV has an effect on DV")
- Real world:
  Data from experiments is noisy (here: differences between people or trials)
- => Variance caused by IV **and/or** by those uncontrolled factors ("confounding variables")?
- Statistics help resolve this



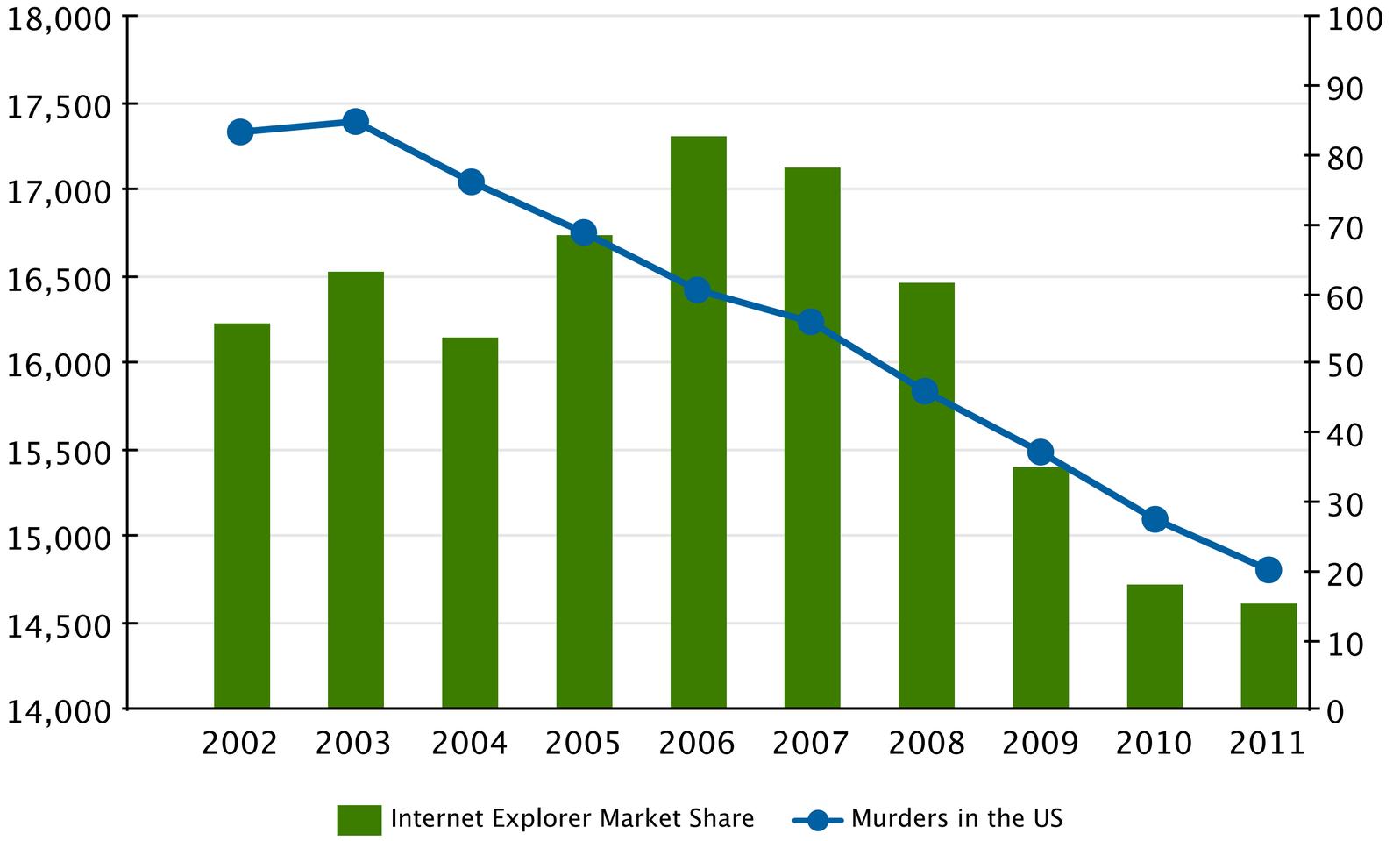
Example: Mid-air Pan-and-Zoom on Wall-sized Displays

- Nancel et al. (Paris), Best paper CHI ’11🏆
- Contributions & Benefits:
  - “Design and evaluation of multiscale navigation techniques for very large displays based on **three key factors:** number of hands involved, type of movement, type of feedback.”


1D path
2D surface
3D free
Uni-manual
Bi-manual
a)
b)
c)
d)
e)
f)
interactive wall
linear
circular
zoom out
zoom in
zoom gesture
focus of zoom, pointing
screen projected zoom gesture

Correlation Does Not Imply Causation

Adapted from a tweet of @altonncf with data from FBI and W3Schools



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CHAPTER 5

Ethnography

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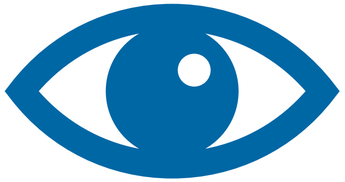

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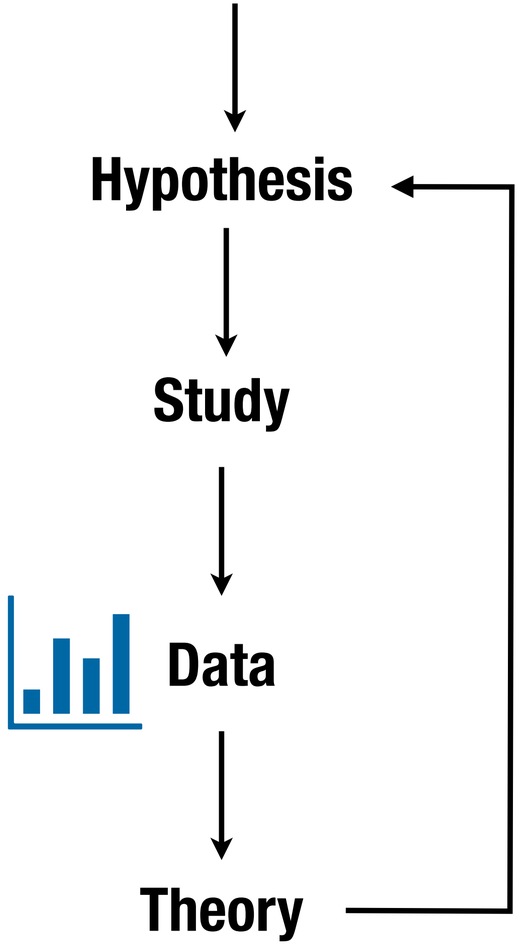
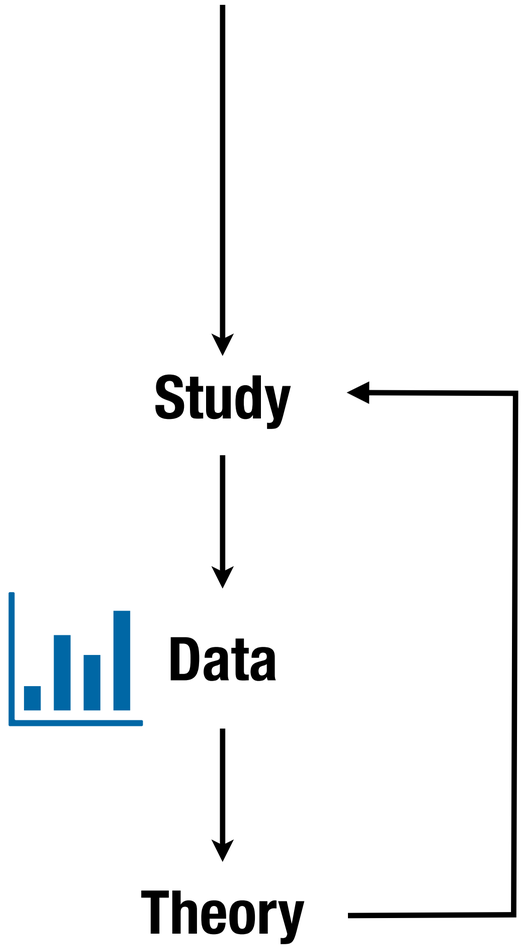


Experimental research

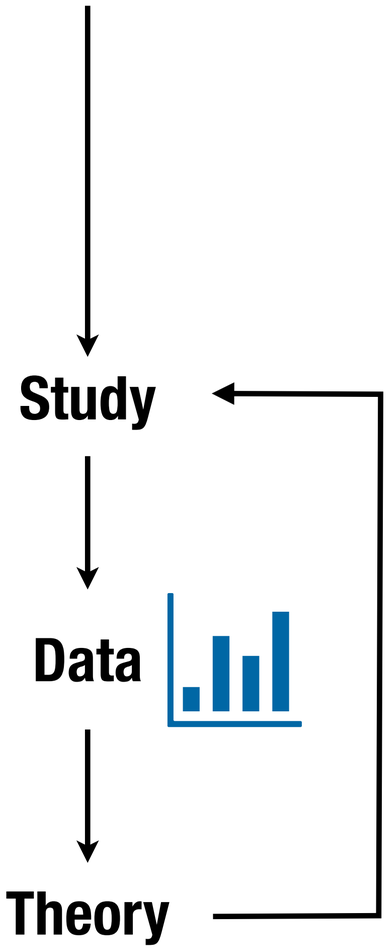
Ethnography



Ethnographic research

Ethnography

- Collect data with different methods, e.g.:
  - Observation
  - Interview
- Code data and find patterns in it
- Create theories that explain the data
- Try to attack the theories by gathering more data
  - Leads to stronger theories



Ethnographic research

Data Collection

- Methods: Observation, interview, participation, logging
  - Format: Field notes, video, audio, log files
- **Triangulation**: use multiple data sources to support an interpretation that increases the confidence of your conclusion
  - From different participants
  - From different types of data, e.g., observations, interviews, logs

Example 1: The Normal Natural Troubles of Driving with GPS

- Brown (Sweden) and Laurier (Edinburgh), Best paper CHI ’12 🏆
- Goal: To understand users’ interaction with GPS navigation system in non-controlled setting
- 14 drivers, 2 video cameras, field notes
  - 9 hours of video ⇒ 75 clips ⇒ 37 detailed transcriptions
  - Analyzed the data to find common patterns/themes and construct theories that explain them

Figure 1:
Following GPS instructions

While the driver 'follows' what the GPS recommends the driver still needs skill to read what the GPS says and even to ignore GPS instructions.

Source

Example 1: The Normal Natural Troubles of Driving with GPS

- Contribution & benefits:
  - “Presents a **video analysis study** of driving using GPS navigation systems in **natural settings**. The paper argues for [understanding] driving with [a] GPS as an active process and not as ‘docile driving’.”
- Conclusion
  - GPSs are used in ways that the designers had not foreseen: Drivers must match instructions and the map to the actual situation
  - Designer should take “driver intelligence” into account
    - E.g., less persistent instructions when user decided to deviate from them

Example 2: Video Blogging System in Dental Hygiene Clinical Instruction

- Becvar and Hollan (UCSD), ACM GROUP ’07
- Field site: Dental hygiene training program in San Diego, CA, USA
- Goals
  - Gain understanding of teaching and learning practices, media and representations
  - Implement & evaluate a design prototype based on those findings
- Method
  1. Ethnographic study of current practice
  2. Implementing and deploying prototype, then second ethnographic study

Example 2: Video Blogging System in Dental Hygiene Clinical Instruction

- Method for the first part (ethnographic study, 2004, **one year in the field**)
  - Observation
  - Video recording
  - Contextual interview
- 18 students, 4 instructors participated
- Sample finding: strategies used by clinical instructors
  - Molding: laying their hands over students' hands as they work with instruments
  - Directing: verbally talking a student through a new procedure ("Do this")
  - Demonstration: using hand gestures to show correct/incorrect ways to handle instruments

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What's next?

- Official project start next week
- Form groups of 3 in Moodle until next week, **May 19, 18:00**
- You will not be able to participate in the project and pass the course if you do not join a group in time

KW 20	KW 21	KW 22	KW 23	KW 24	KW 25	KW 26	KW 27	KW 28	KW 29	KW 30
M1: Research Topic	**M2:** Research Plan		**M3**: Conducting Research		**M4**: Data analysis			**M5**: Prepare Presentation		