Lecture 3

Studying Interaction Techniques and Research Methods

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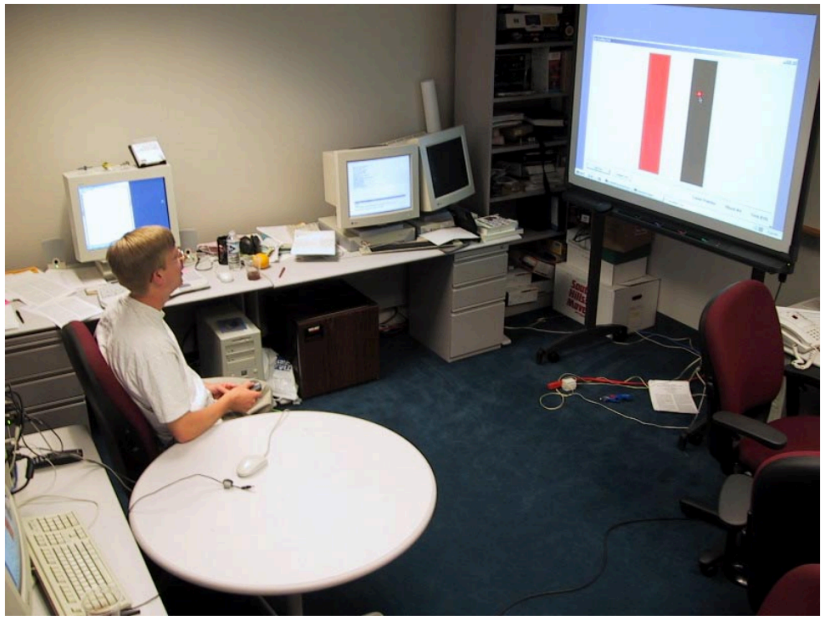
05-899A/05-499A

Spring, 2014



Homework 1

VS

VS

Don’t forget to enter in your devices!

http://www.cs.cmu.edu/~bam/uicourse/2014inter/homework1.html

Source: Photo Dictionary, Apple, wp.Inklein

What is Research?

Source: CMU

What is Research?

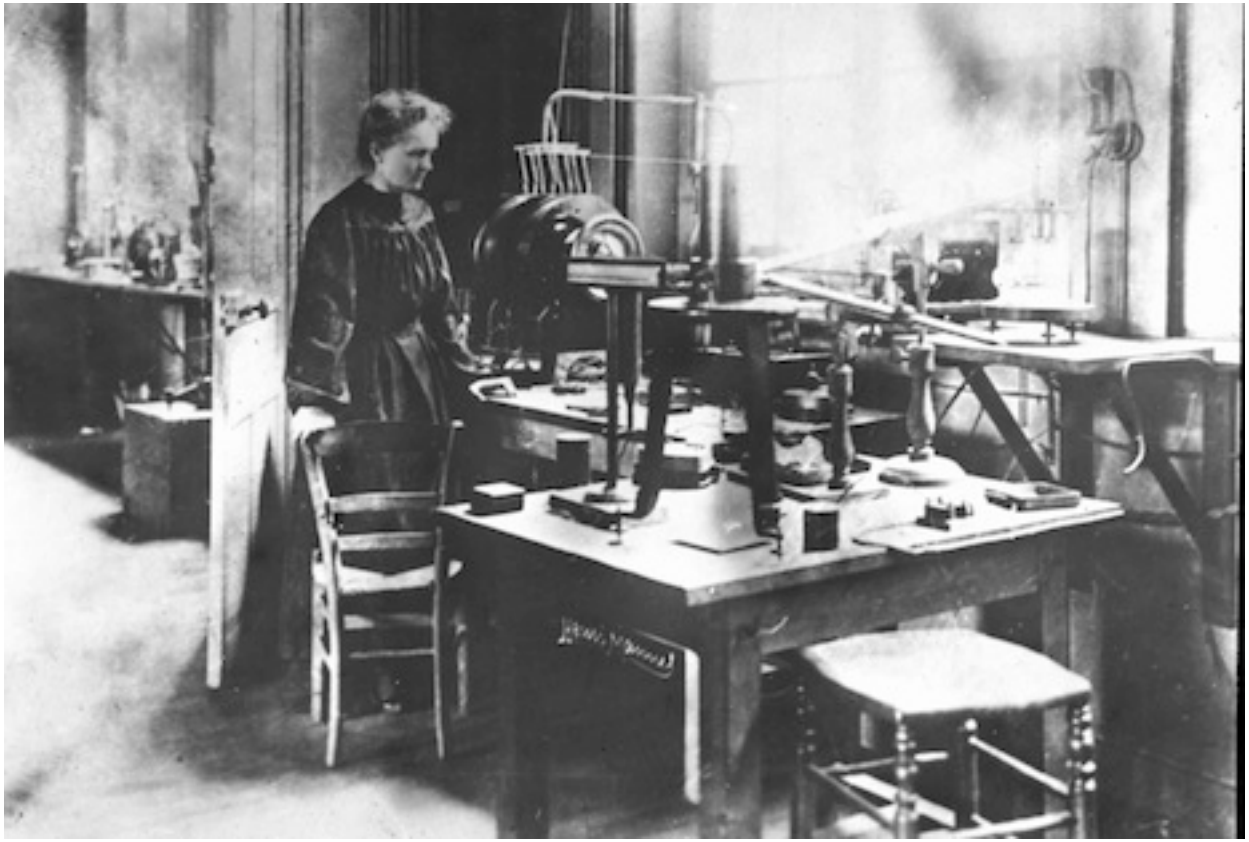
The **systematic investigation** into and **study** of **materials and sources** in order to **establish facts** and **reach new conclusions**

Source: Oxford English Dictionary

What is Research?

- Systematic investigation
- Discover new facts
- Affirm or disprove existing theories
- Extend knowledge about natural world, human existence, culture, technology, etc.
- (Generalizeable)

What is Research?



Source: Wikipedia (public domain)

What is Research?

Source: Jacob Nielsen, Nielsen Norman Group

What is a Research Question?

- Do students that work harder perform better in school?
- Are items in radial menus faster to access than right-click context menus?
- How do people hold a mouse, and which way is most common?

What is a Research Question?

- Comes from existing knowledge/research, but stretches to find out something new
- Can be answered with reasonable certainty after doing research
- Worth answering, has value

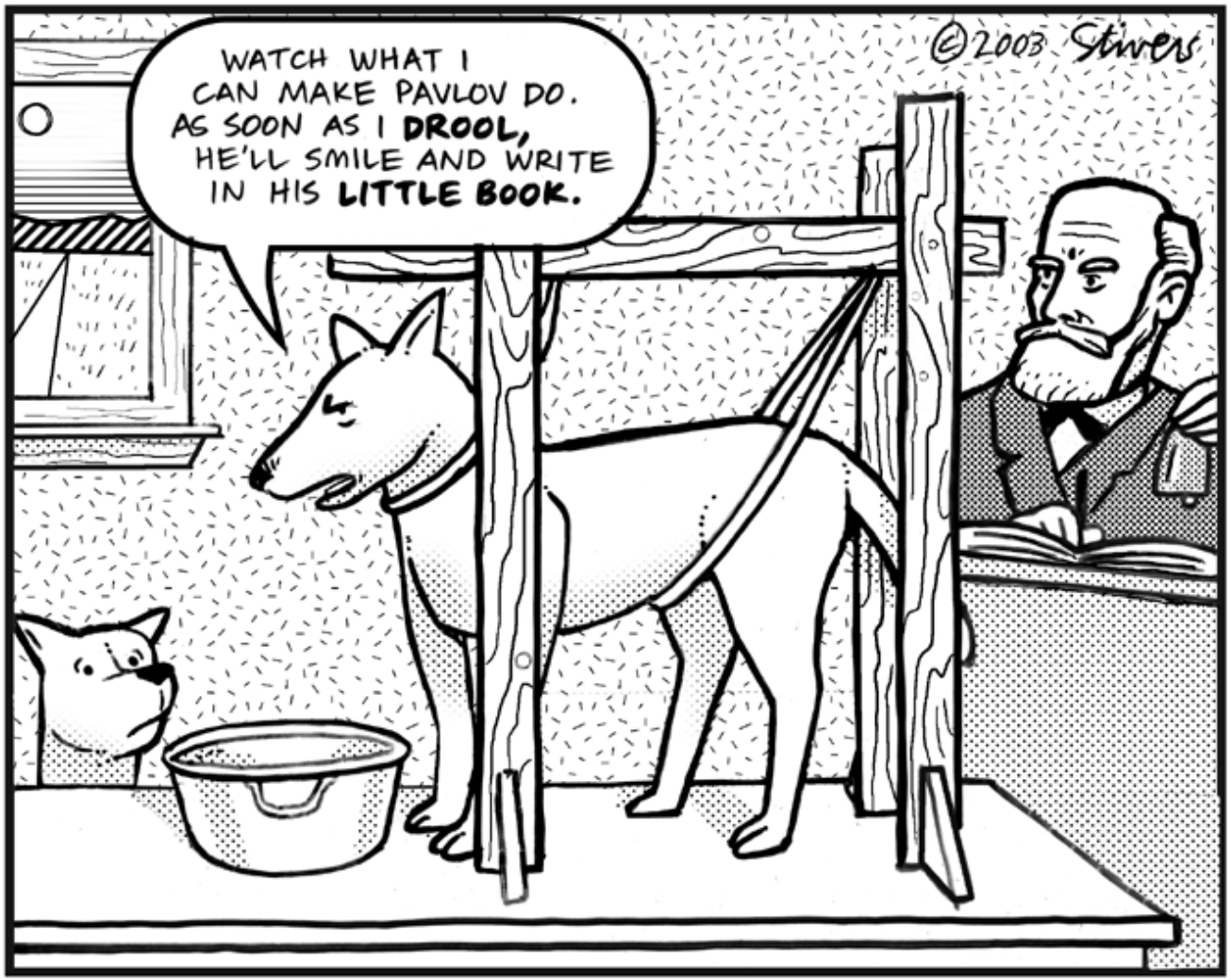
- *Thesis statements*

What is a Research Question?

- What about in our homework?

- RQ1:

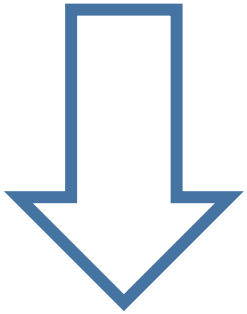
Hypotheses



Source: Mark Stivers

Hypotheses

- RQ: Students that **work harder** will **perform better** in school.



- H: Students that spend **more hours studying textbooks** will **receive higher grades**

Hypotheses

- **Students** that **spend more hours studying** textbooks will **receive higher grades**

- *Prediction* that's testable
- Comes from *past research*/knowledge
- Based on *observation*
- Specific *measures*
- Usually *affirmative* and not negative
- Often more than one

Hypotheses

- Examples from our homework?

- H1:

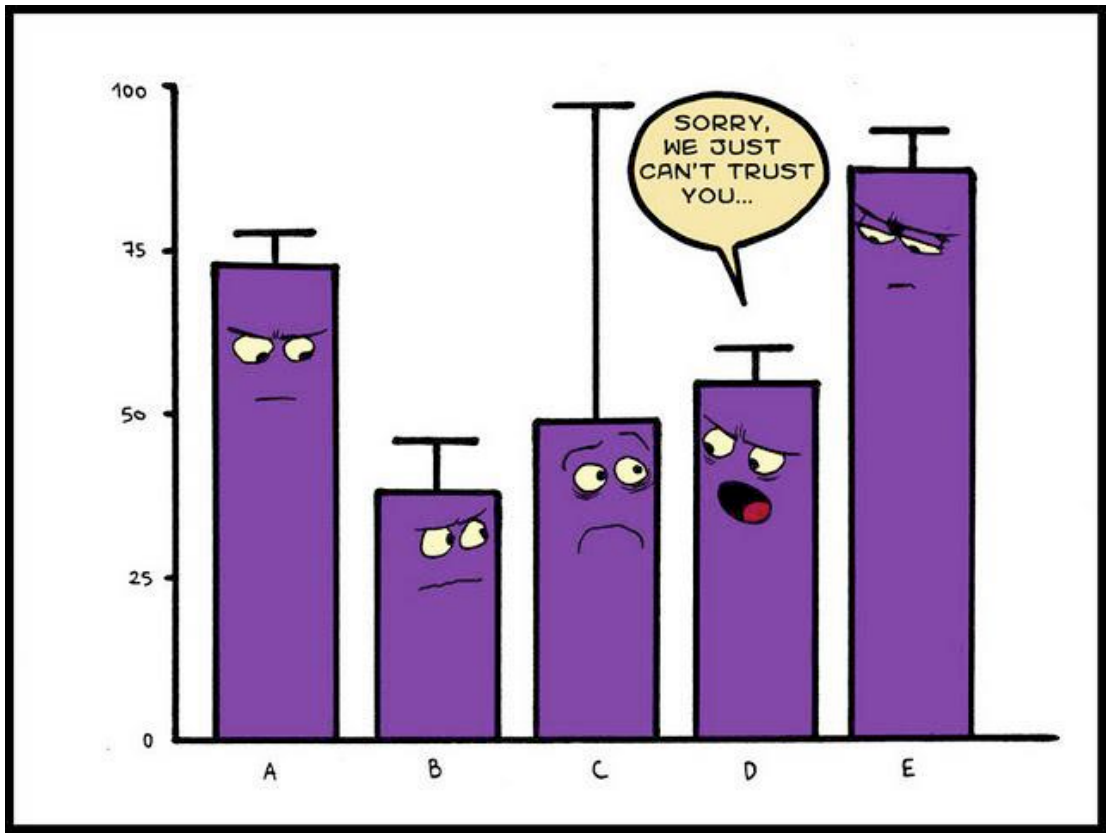
NULL Hypothesis

- “There is no relationship between hours spent studying textbooks and higher grades”
- ~~Spending time studying textbooks does not improve grades.~~

- Particular hypothesis could not be proven
- Does not mean that there isn’t a relationship, or the opposite is true
- Indicates a need for future study

Confounds

- Other factors that might influence the results



Source: velica.deviantart

Confounds

- Study was poorly designed
- Measuring the wrong thing
- Participants didn’t know what to do
- Some other thing caused a bigger effect than what you were trying to measure

Source: velica.deviantart

Confounds – Third Factors

- H: Students who spend more **hours studying textbooks** will get better **grades** in their courses

- Does hours studying books affect hours spent doing other kinds of studying?
- How much does this depend on an individual's normal study habits?
- Do some courses use textbooks more than others?

Confounds

- What about our homework?

- Why don’t we just use pixels to measure the size of the ribbons in the homework?

Proving a Negative

- Much, much harder

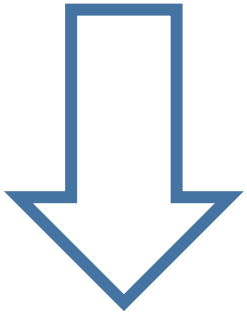
- Prove there is a pencil in this room
  - Just have to see a cylinder-shaped thing and prove that it's a pencil
- Prove there are no pencils in this room
  - Have to search every tiny corner of the room to make sure none are hiding

Variables

Source: XKCD

Variables

- RQ: Students that **work harder** will **perform better** in school.



- H: Students who spend more **hours studying textbooks** will get better **grades** in their courses

Variables

- H: Students who spend more **hours studying textbooks** will get better **grades** in their courses

- Specific and match with the research ?
- Not too dependent on our participants
  - What if we measured “% of notes highlighted”

Variables

- H: Students who spend more **hours studying textbooks** will get better **grades** in their courses

Independent Variable (IV)

"What you change" – input

Explanatory variable

Variables

Independent Variable (IV)

"What you change" – input

Explanatory variable

What about our homework?

Variables

- H: Students who spend more **hours studying textbooks** will get better **grades** in their courses

Dependent Variable (DV)

"Changes because of IVs" – output

Explained variable

Variables

Dependent Variable (DV)

"Changes because of IVs" – output

Explained variable

What about our homework?

Other Variables / Factors

- H: Students who spend more **hours studying textbooks** will get better **grades** in their courses (at CMU, in a particular course, with different majors, different study habits, etc.)

- Differences in participants
- Experimental environment
- Other factors

Other Variables / Factors

- What about in our homework?
  - People
  - Environment
  - Other

Findings

- Correlation
  - Relationship between variables
  - As X goes up, so does Y
- Causation
  - Cause and effect relationship in variables
  - Because X went up, Y went up

Findings - Correlation

- Correlation
  - As X goes up, so does Y
- Problem - Third factors
  - Maybe people who spent more time studying also got more tired. They went to bed early more often, so they earned better grades
  - Really, really hard to eliminate sometimes

Findings - Causation

- Causation
  - Because X went up, Y went up

- Problem – Sometimes hard to accomplish
  - Need to experimentally isolate the IV and control it so you can show the cause and effect
  - Not always ethical or possible
    - Do we force some students to look at their books more than other students?

Running Experiments

Source: Public Domain

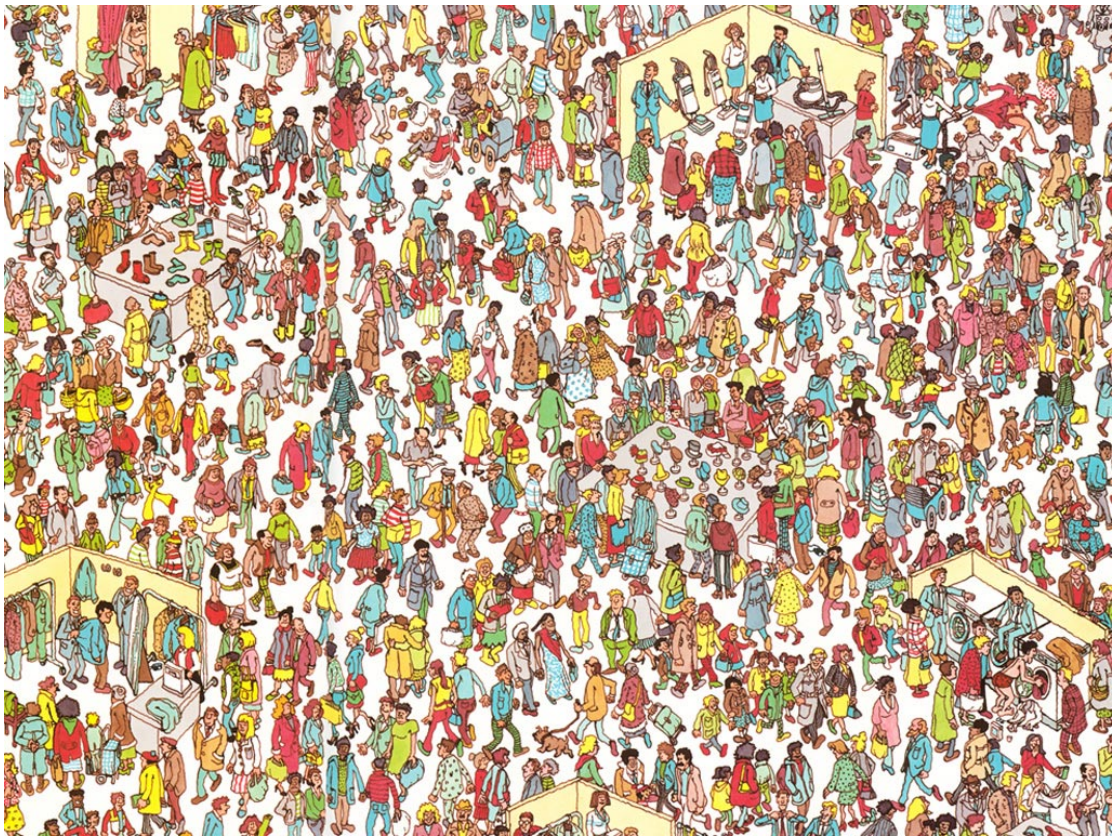
Running Experiments

- How we handle the IVs
- How we measure the DV
- How we control for other factors/variables

- How we analyze the results

Finding Participants

- Find the ‘right’ people for the experiment



Source: Martin Handford

Finding Participants

- Recruit friends and family
  - Homophily
- Participant pools
  - CBDR pool at CMU, MTurk, many others
- Ads & Paid Participants
  - IRB and Funding
  - Getting the ‘right’ people

Conditions

- Combine ‘levels’ of controlled variables
  - Say we have two IVs: target size & device

	Wide Ribbon	**Narrow Ribbon**
Touchpad	Condition 1	Condition 2
Mouse	Condition 2	Condition 4

Matching Participants to Conditions

- Within-subjects
  - All participants do all levels of the IV

Participant 1	Touch, Wide Ribbon	Touch, Narrow Ribbon	Mouse, Wide Ribbon	Mouse, Narrow Ribbon
Participant 2	Mouse, Narrow Ribbon	Mouse, Wide Ribbon	Touch, Narrow Ribbon	Touch, Wide Ribbon

Matching Participants to Conditions

- Within-subjects
  - All participants do all levels of the IV

- What are the downsides?

Matching Participants to Conditions

- Between-subjects
  - Groups of participants do different levels of IV

Participant 1	Touch, Wide Ribbon	Touch, Narrow Ribbon
Participant 2	Mouse, Narrow Ribbon	Mouse, Wide Ribbon

Matching Participants to Conditions

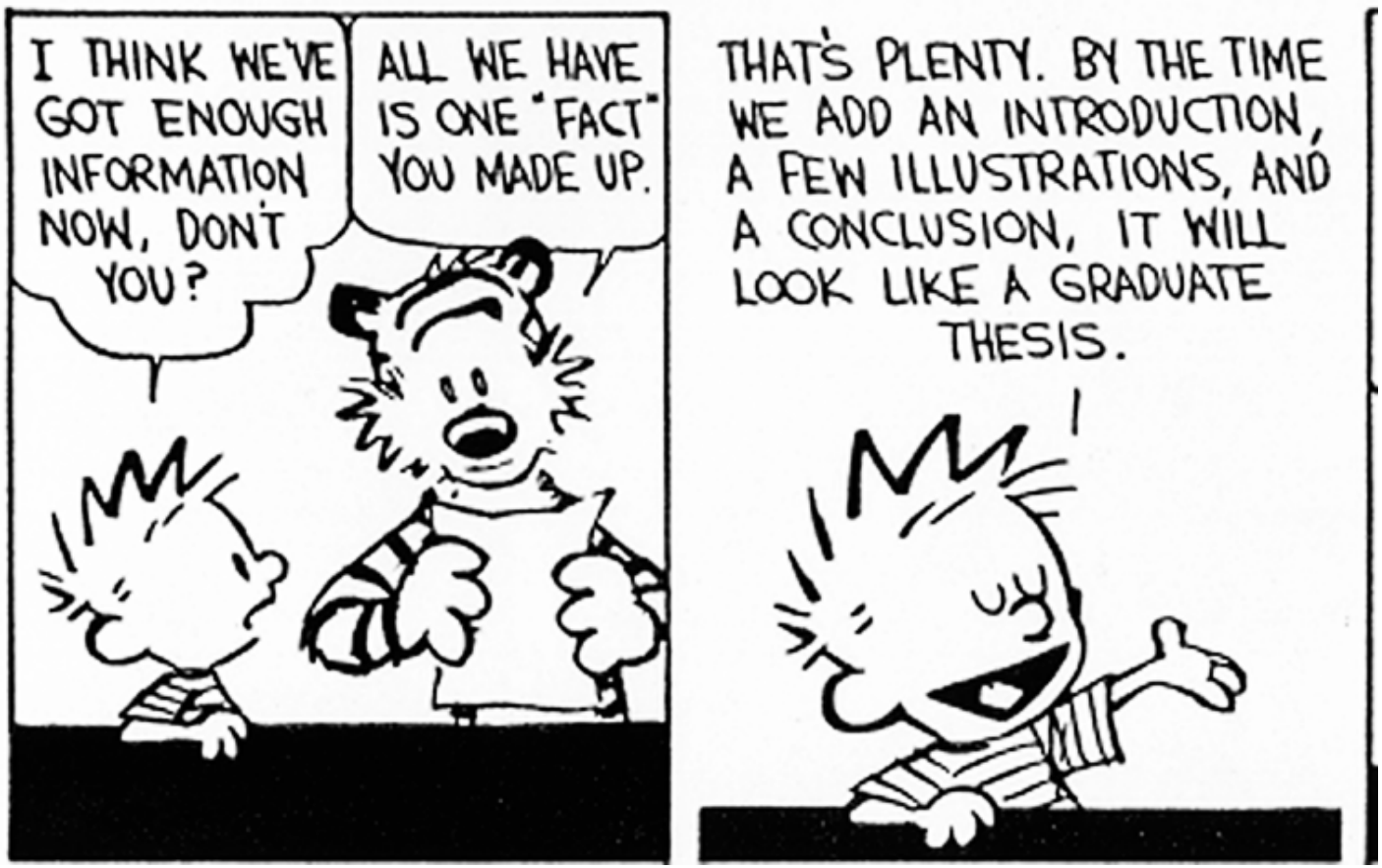
- Between-subjects
  - Groups of participants do different levels of IV

- What are the downsides?

Matching Participants to Conditions

- What about in our homework?

Running an Experiment



Source: Calvin and Hobbes

Running an Experiment

- Follow a strict procedure
  - Avoid confounds that may happen because you do something different between participants
- Revise instructions, then revise again
  - "Quickly AND accurately" in Fitts' Tester
- Think about other factors as you design
  - Control for as many confounds as you can

Analyzing your Data

- Depends on the particular research question you're asking

- There is no toolbox for statistics
  - Though JMP, R, SPSS, Excel, and others do help quite a bit

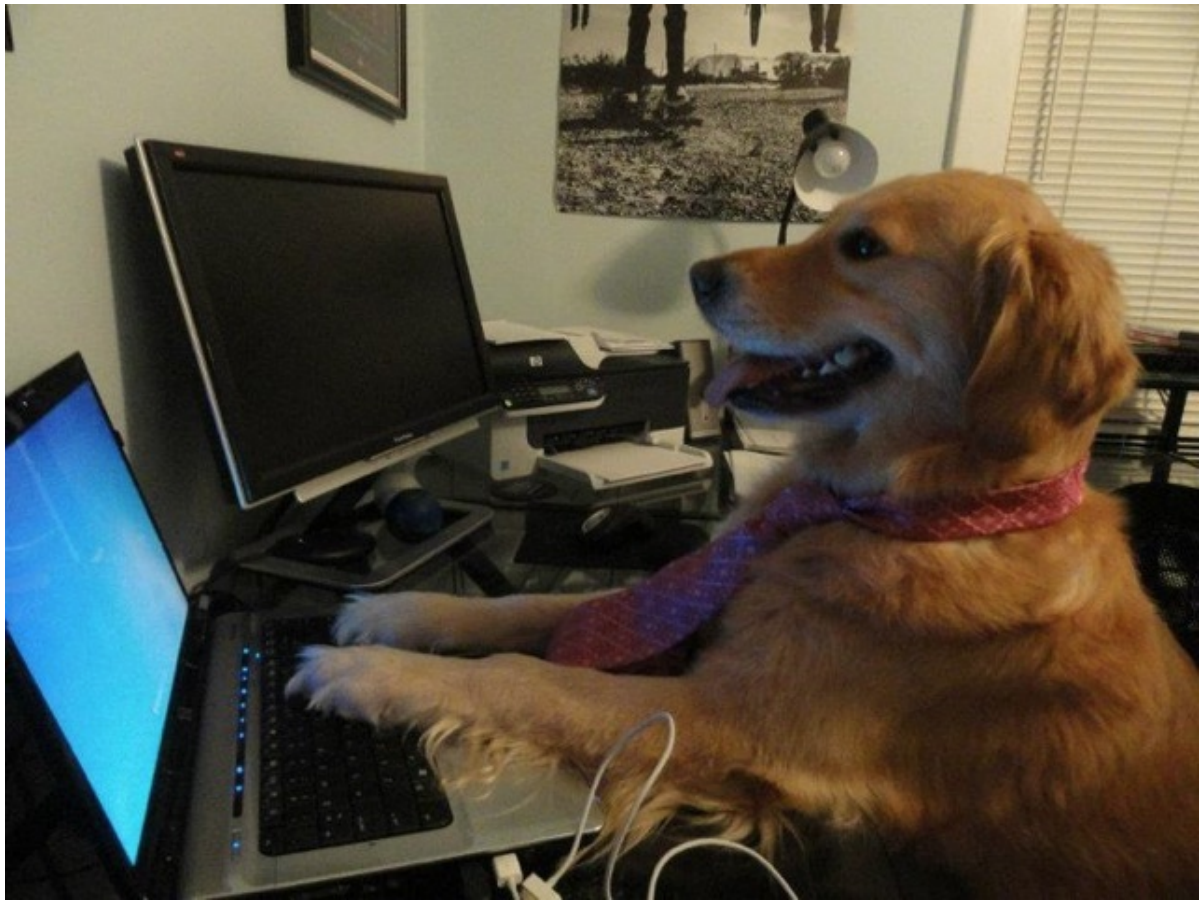
- Always make sanity checks

Analyzing your Data

- What about the homework?

- Descriptive statistics
- Relate to Fitts' Law and readings

FITTS' LAW



Human Factors

How do we design systems that match human capabilities and limitations to improve performance?

(see HCII class)

1954, Paul Fitts

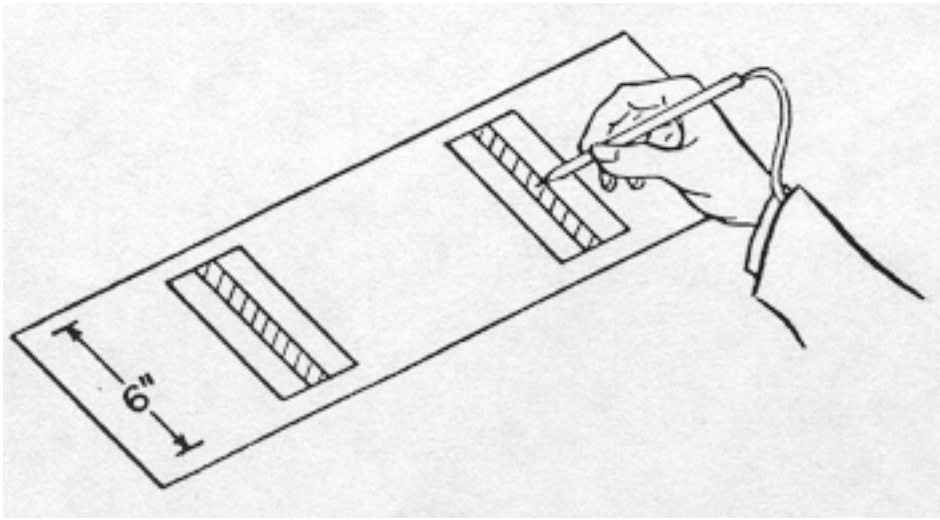
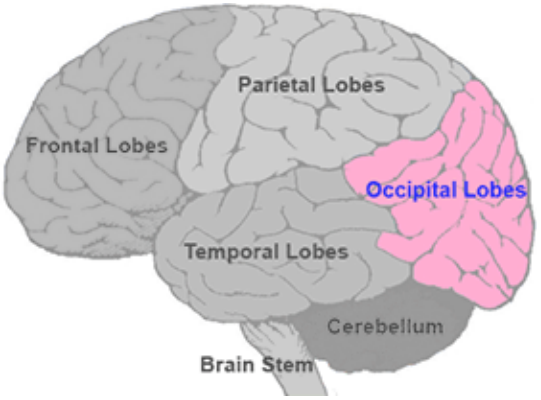


Figure out how quickly people could move a pointing device to a target and select it



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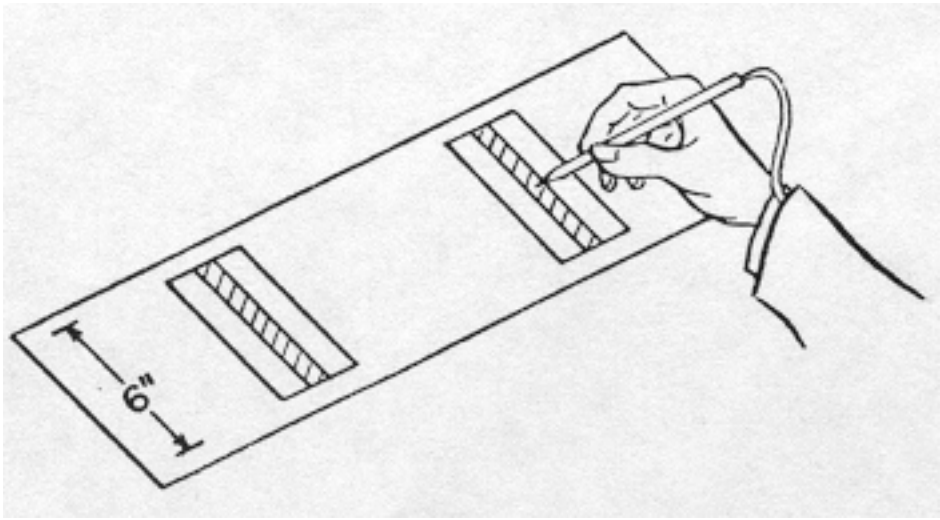

Cognitive Processes + Physical Processes

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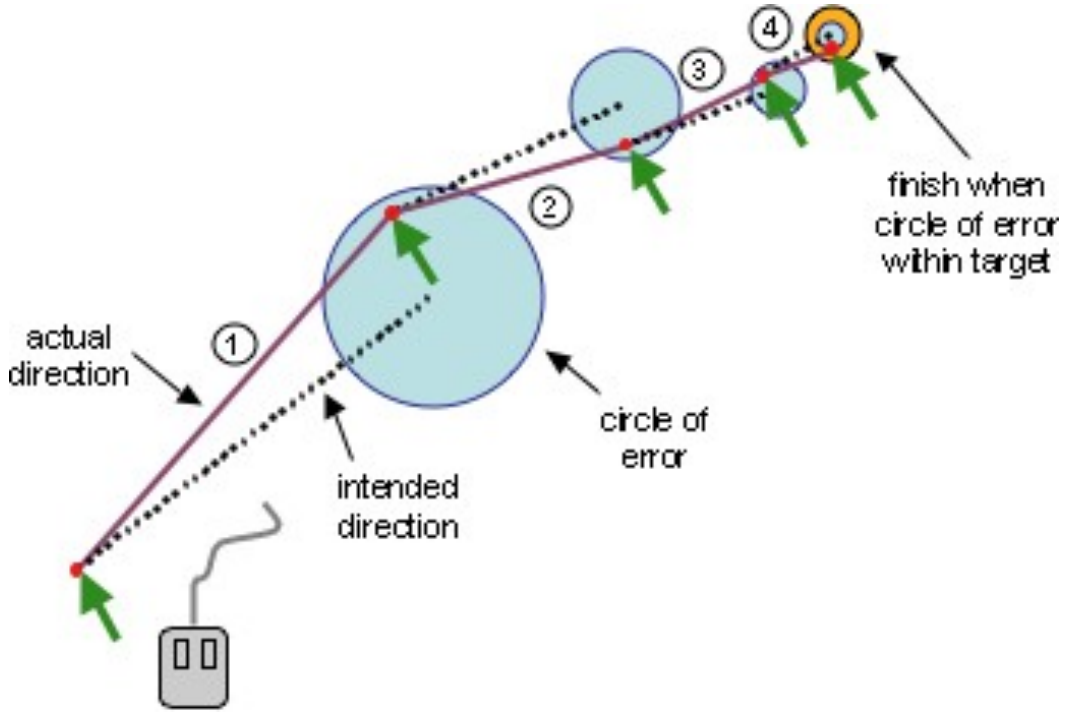
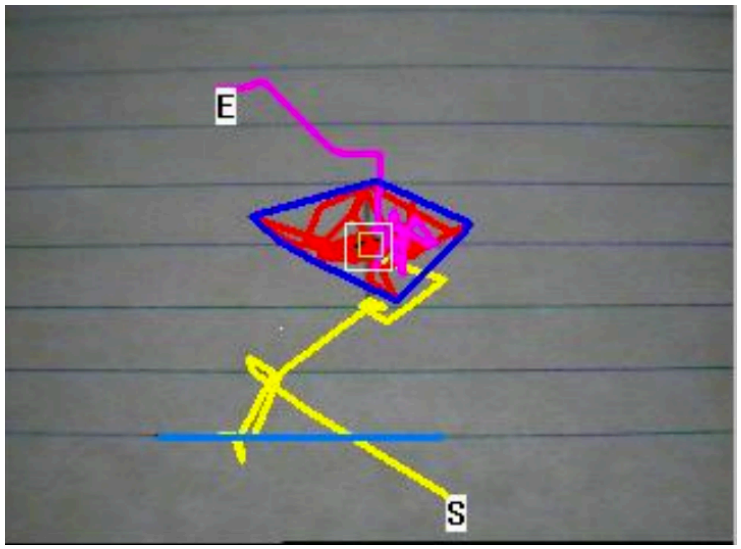
Pointing Performance





Laser Pointer Example

Source: hcibook.com

$$\mathbf{T = \mathit{a} + \mathit{b}\ \log_2(D/W + 1)}$$

T = time to complete a movement

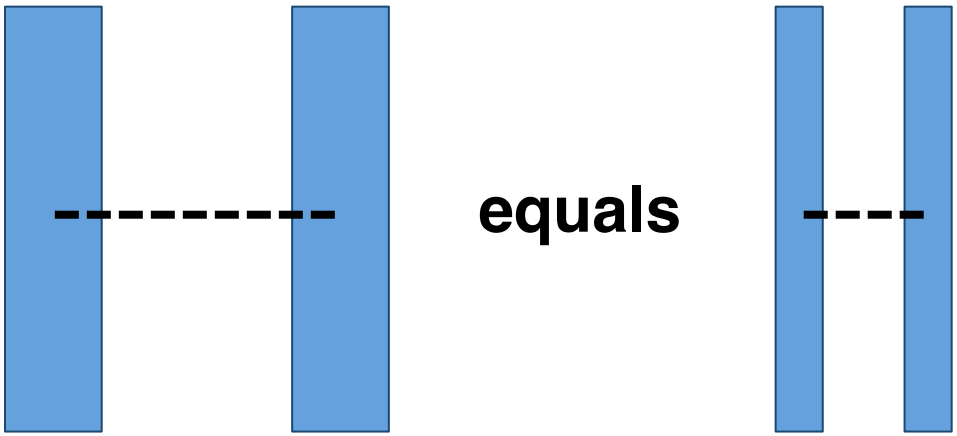
a = fixed cost to start/stop moving & click

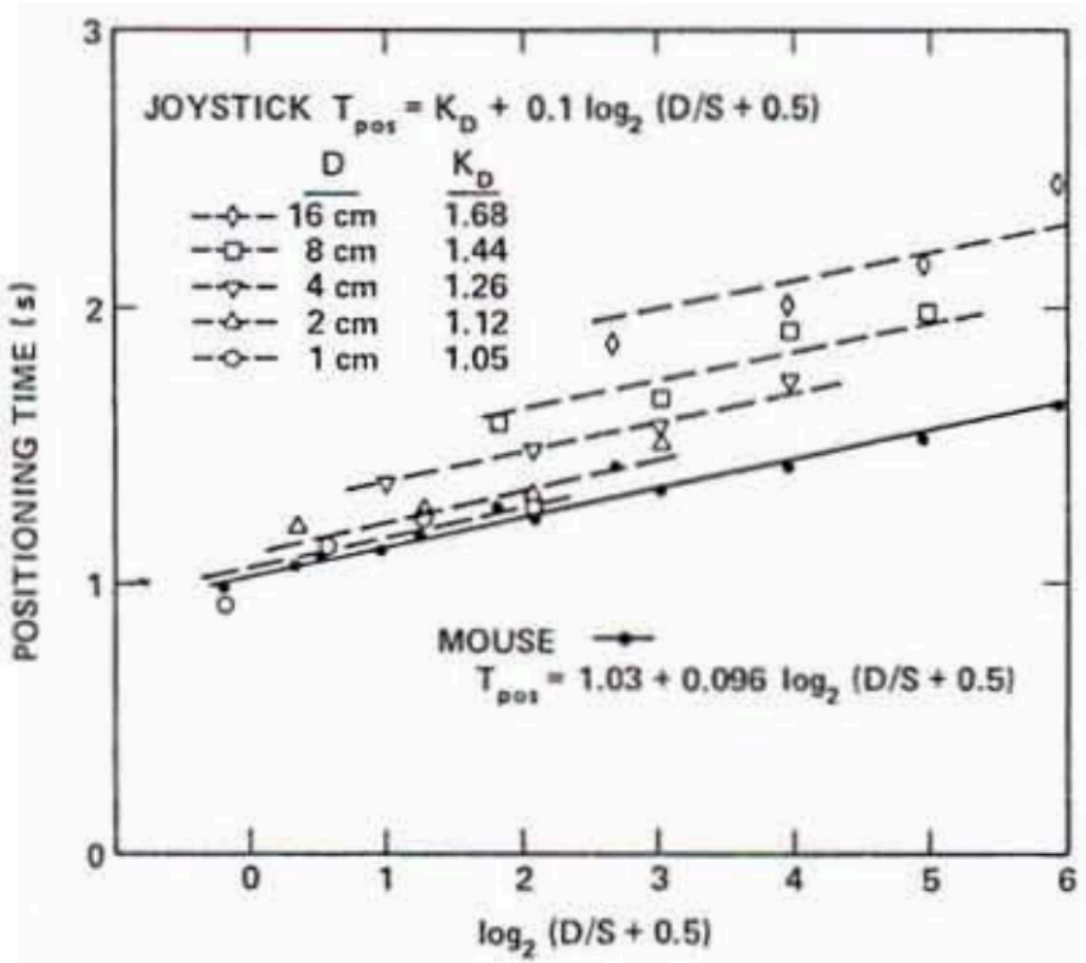
b = inherent speed of device

$\log_2(D/W + 1)$ = “index of difficulty” or ID bits

$$\mathbf{ID} = \log_2(\mathbf{D/W} + \mathbf{1})$$

“double the distance, double the width”





Fitts's Law predicts that plotting positioning time as a function of $\log_2 (D/S+0{\cdot}5)$ should give a straight line. As the solid line in Figure 6 shows, this prediction is confirmed. Furthermore, the slope of the line K should be in the neighborhood of 0·1 sec/bit. Again the prediction is confirmed. The equation for the line in Figure 6 as determined by regression analysis is

$$T_{\text{pos}} = 1{\cdot}03 + 0{\cdot}096 \log_2 (D/S + 0{\cdot}5)\,\text{s} \tag{4}$$

Homework 1 Analysis

- You can actually do this with your data!
  - The Fitts' Tester app roughly follows Card et al.
- Compute IDs from Amplitude and Width
- Chart them and see if they are linear
- Use Excel "Fit Trendline" to get coefficients for a and b and compare to other papers

Homework 1 Analysis

- Keep in mind that the papers you read collected MUCH more data
- It's okay to get a null hypothesis as long as you explain why that's reasonable
- Check out the error rates too
- The laser pointer paper is good example of how to structure a report

Homework 1

- Questions about it?

Bill Curtis, Stu Card, and Allen Newell

Source: SIGCHI Archives

Activity

- RQ: *Device X* allows people to point faster than *Device Y*.
- Form small groups and come up with a new hypothesis to test this RQ.
  - What are the IVs and DVs? How will you measure them?
  - What other factors will you control, and what might confound your results?
  - Who are your participants?
  - How will you conduct the experiment?