Welcome to cs303

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Fridays 2:15p-5:00p
http://cs303.stanford.edu

Scott's favorite course in graduate school was the grad OS course, b/c it was co-taught by Brewer & Hellerstein. Each asked the other good questions and offered another perspective on the material.

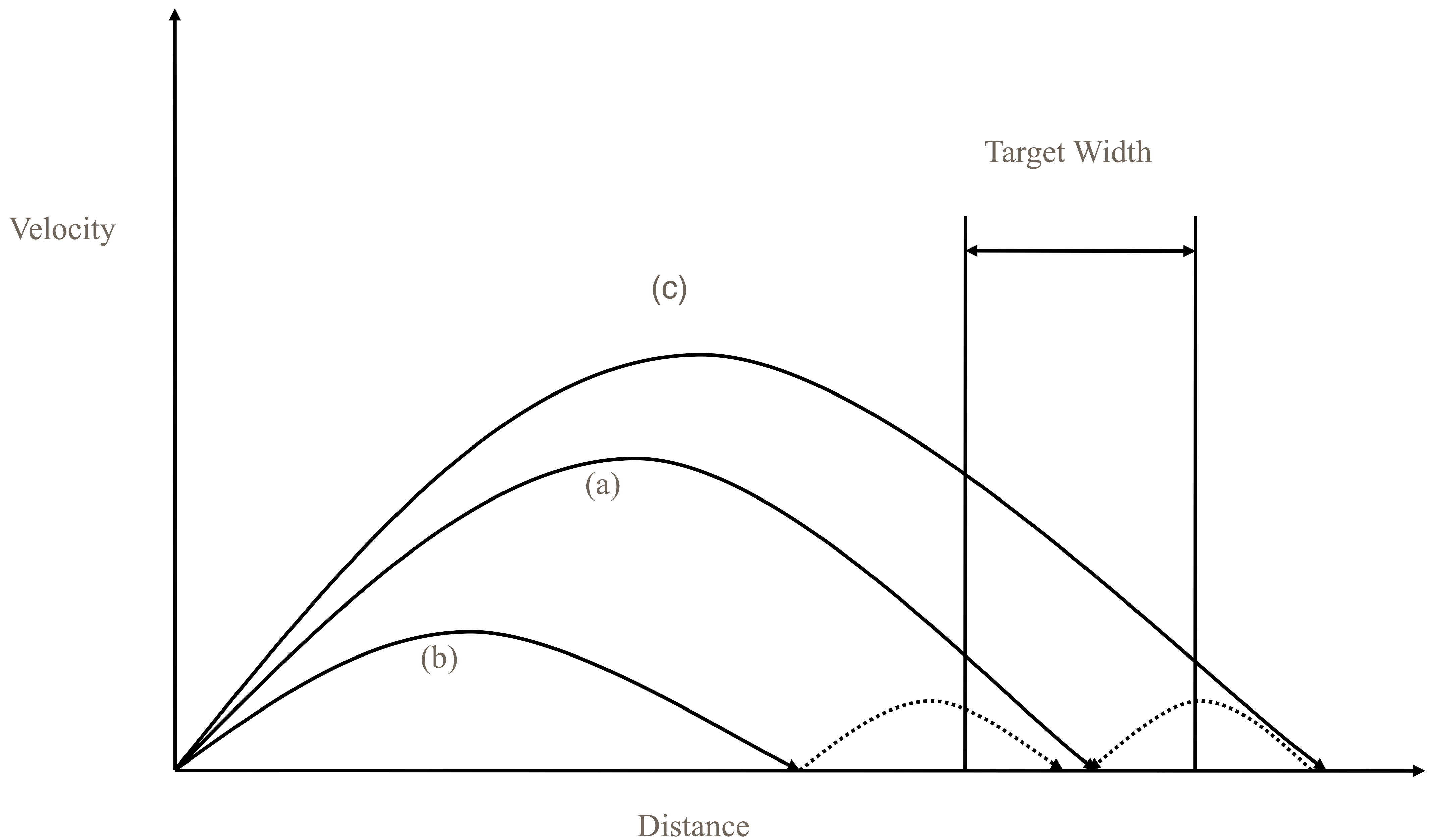
- Cases, with Homework
- Projects, with Notebook

POINTING DEVICES

Mouse. Engelbart and English

- Fitts' Law
  - Time T_{pos} to move the hand to target size S which is distance D away is given by:
    - $T_{pos} = a + b \log_2 (Distance/Size + 1)$
    - The log part is the "index of difficulty" of the target; it's units are bits
  - summary
    - time to move the hand depends only on the ***relative precision*** required

What does Fitts' law really model?



It was inspired by information theory

- It treats acquiring a target as specifying a number of bits
- i.e., in the Fitts' worldview, the human motor system is a noisy information channel
- Smaller target? More bits
- Further target? More bits

The Experiment

- Click on the blue circle
- Keep doing it till the system says done

Rotation

- If you're at an input device, use it until done
- If you're not, begin reading the paper.
- The readers are the queue.
- We'll rotate through.

Go!

Teaching staff can be readers.

Let’s Open R

- Open a laptop, and follow along.

A very brief introduction to R

- x <- c(1,2,4)
- x [1] 1 2 4
- x[3] [1] 4
- mean(x) [1] 2.333333
- sd(x) [1] 1.527525
- y <- mean(x)
- y
- q <- c(x,x,8)
- ?datasets
- mean(Nile) [1] 919.35
- sd(Nile) [1] 169.2275
- hist(Nile)
- q()

The web tutorials are great.

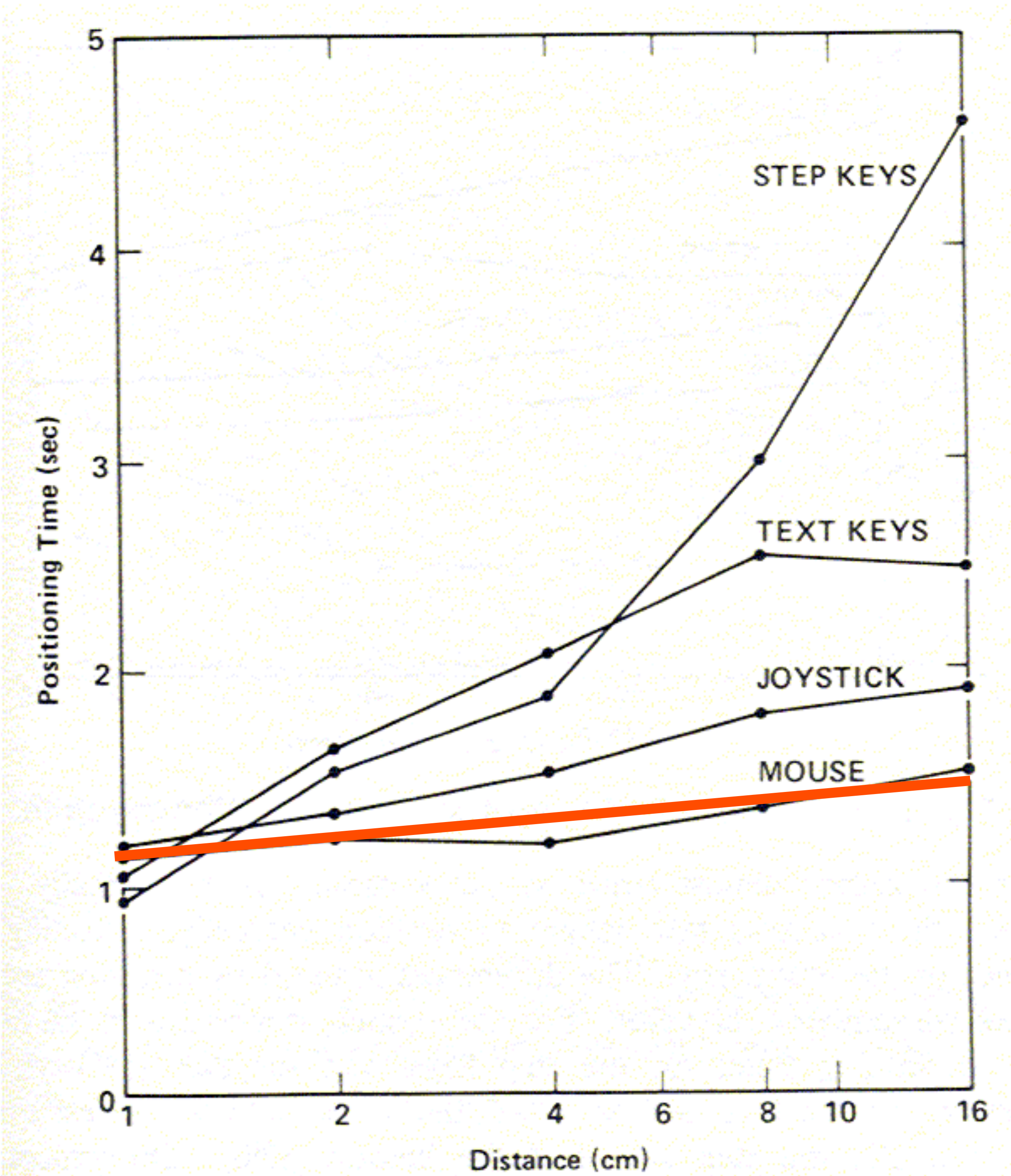
Let's Look at the Data

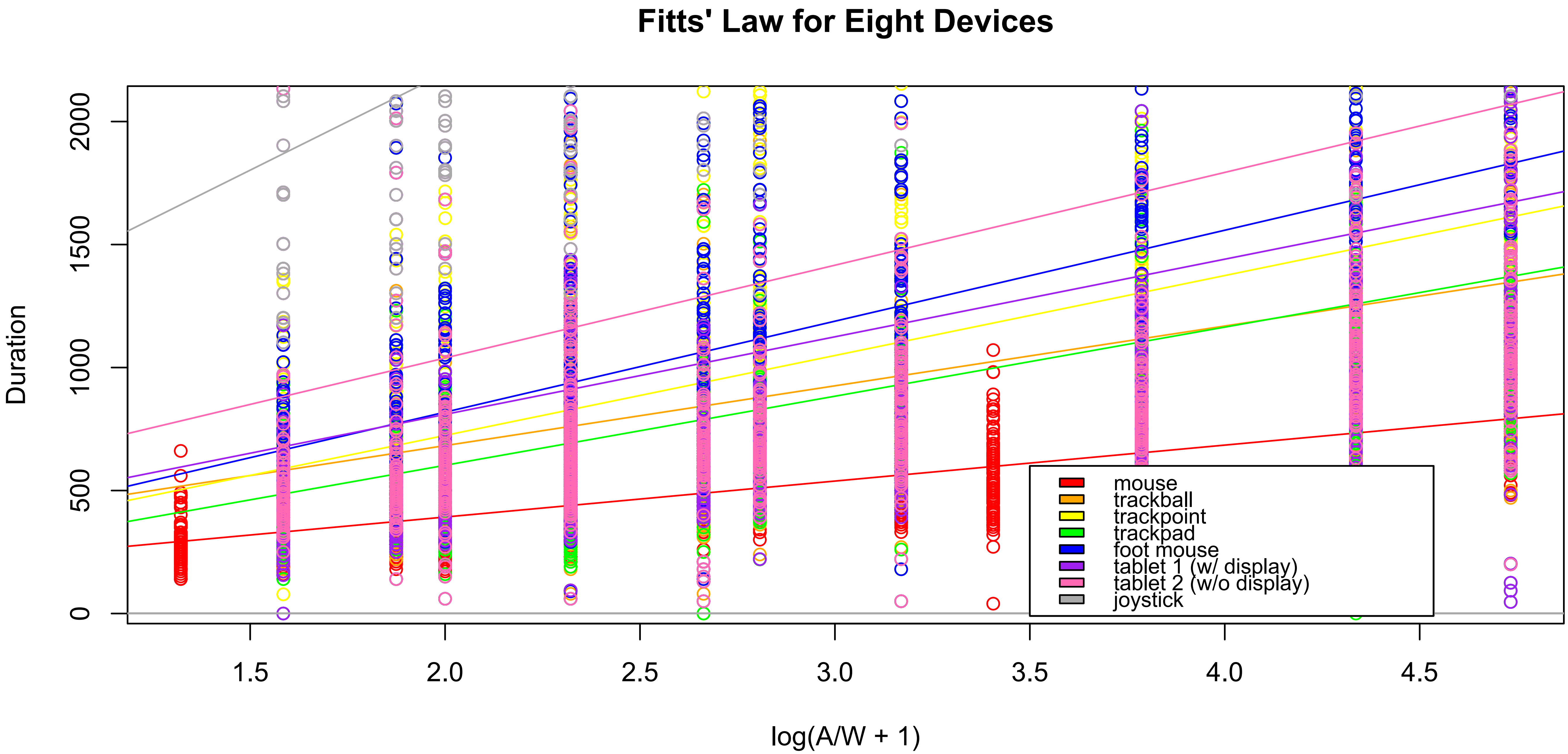
- testdata<-read.csv("~/Dropbox/cs303/Intro/s42_2D_nomet__49844285.txt", header=T, as.is=T)
- names(testdata)
- plot(testdata[,13],testdata[,57])
- plot(testdata[,"A"],testdata[,"Duration"])
- color <- rep("black",length(testdata[,"A"]))
- color[testdata[,"A"]==256] <- "green"
- color[testdata[,"A"]==384] <- "blue"
- plot(testdata[,"W"],testdata[,"Duration"],col=color)
- plot(testdata[,"W"]/testdata[,"A"],testdata[,"Duration"],col=color)
- attach(testdata)
- plot(Duration ~ log(A/W), col=color)
- plot(Duration ~ log(A/W), col=color, xlab= "distance/size",ylab="milliseconds")
- abline(lm(Duration~log(A/W)))

What else might we have measured?

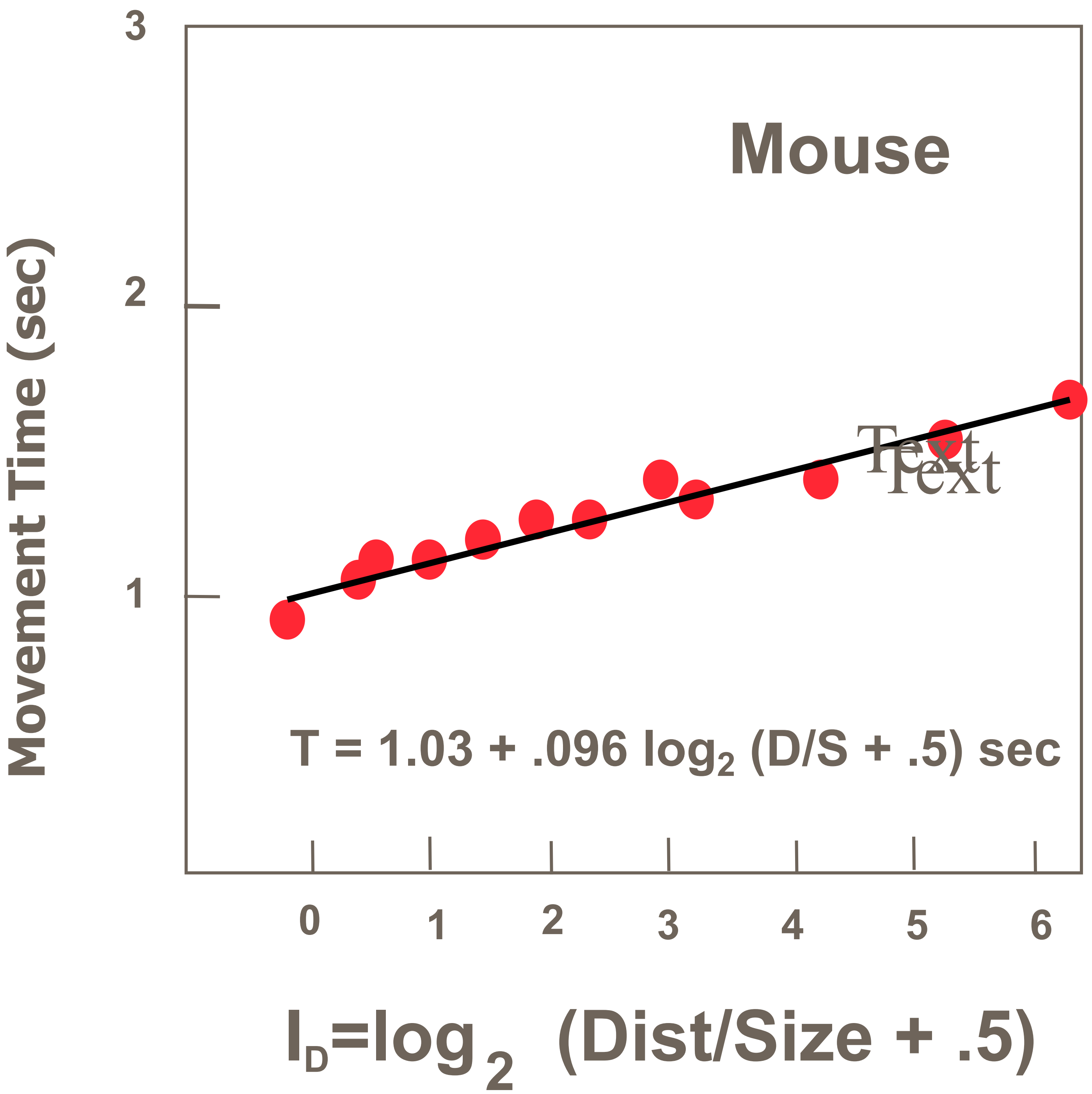
- Time on Task -- How long does it take people to complete basic tasks? (For example, find something to buy, create a new account, and order the item.)
- Accuracy -- How many mistakes did people make? (And were they fatal or recoverable with the right information?)
- Recall -- How much does the person remember afterwards or after periods of non-use?
- Emotional Response -- How does the person feel about the tasks completed? (Confident? Stressed? Would the user recommend this system to a friend?)

EXPERIMENT: MICE ARE FASTEST




Fitts' Law for Eight Devices
Duration
0
500
1000
1500
2000
1.5
2.0
2.5
3.0
3.5
4.0
4.5
log(A/W + 1)
mouse
trackball
trackpoint
trackpad
foot mouse
tablet 1 (w/ display)
tablet 2 (w/o display)
joystick

WHY?



Why these results?

Time to position mouse proportional to Fitts' Index of Difficulty I_D.

Proportionality constant = 10 bits/sec, same as hand.

Therefore speed limit is in the eye-hand system, not the mouse.

Therefore, mouse is a near optimal device.

50 years of data

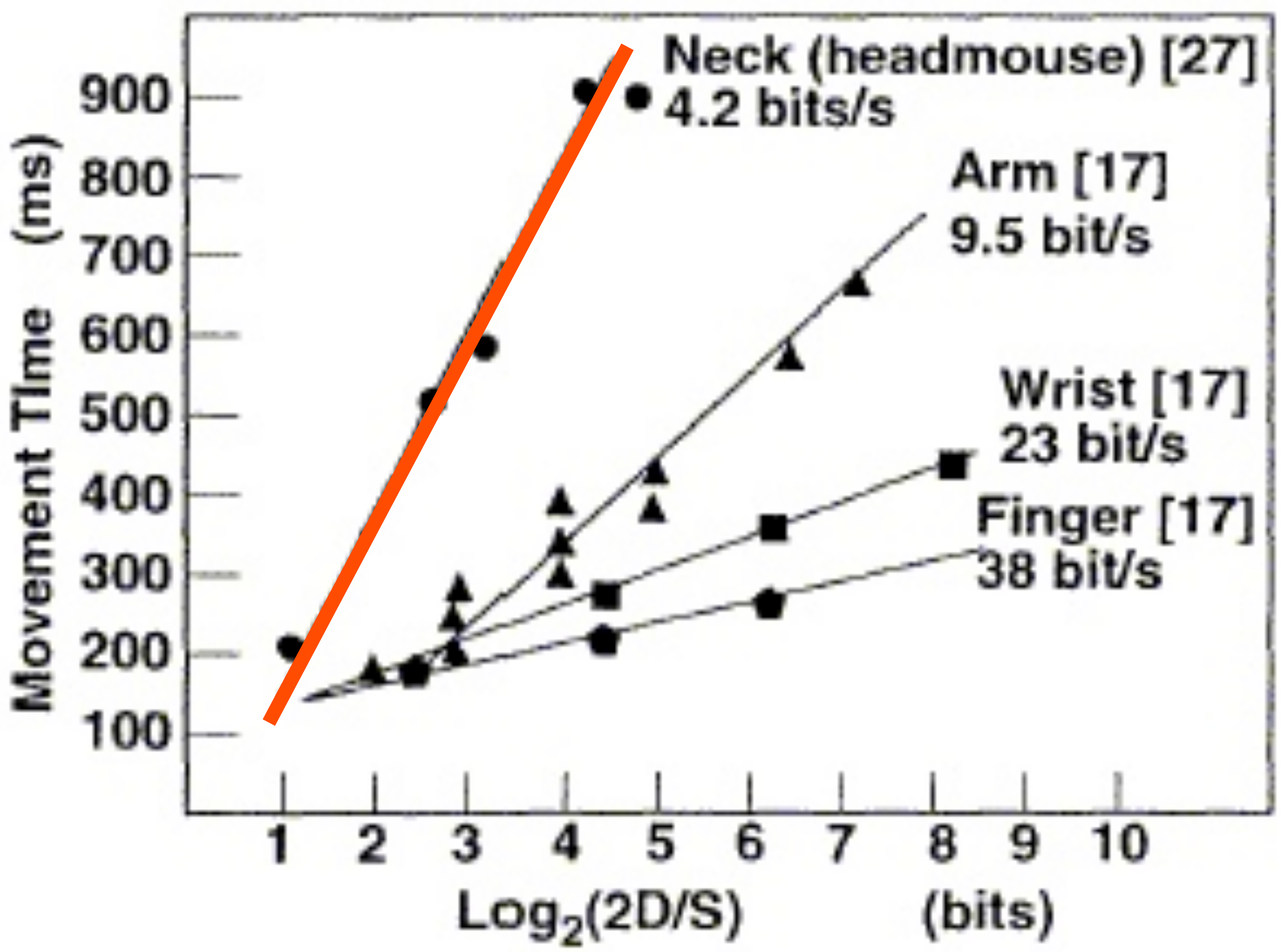
Device	Study	IP (bits/s)
Hand	Fitts (1954)	10.6
Mouse	Card, English, & Burr (1978)	10.4
Joystick	Card, English, & Burr (1978)	5.0
Trackball	Epps (1986)	2.9
Touchpad	Epps (1986)	1.6
Eyetracker	Ware & Mikaelian (1987)	13.7

Reference:
MacKenzie, I. Fitts' Law as a research and design tool in human computer interaction. Human Computer Interaction, 1992, Vol. 7, pp. 91-139

EXAMPLE: ALTERNATIVE DEVICES

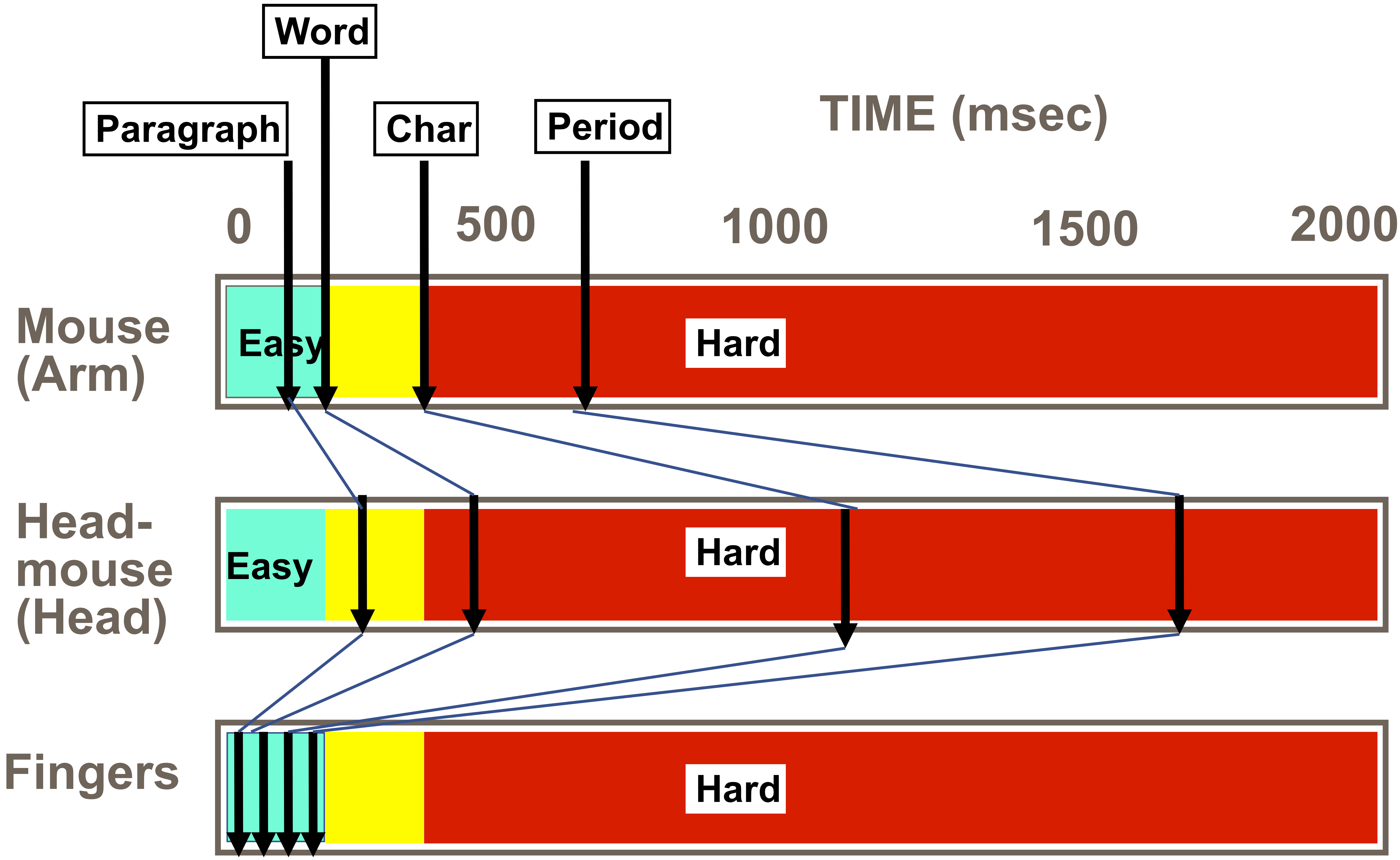
Headmouse: No chance to win

ATTACHING POINTING DEVICE



Use transducer on high bandwidth muscles

EXAMPLE: STRUCTURING THE TASK SPACE BY PROJECTING THE MODEL



Try to hit a target without looking

- You can open your eyes after each step
- Then, try it for both a mac-style and windows-style menu bar

Fitts' Law Example

Pop-up Linear Menu

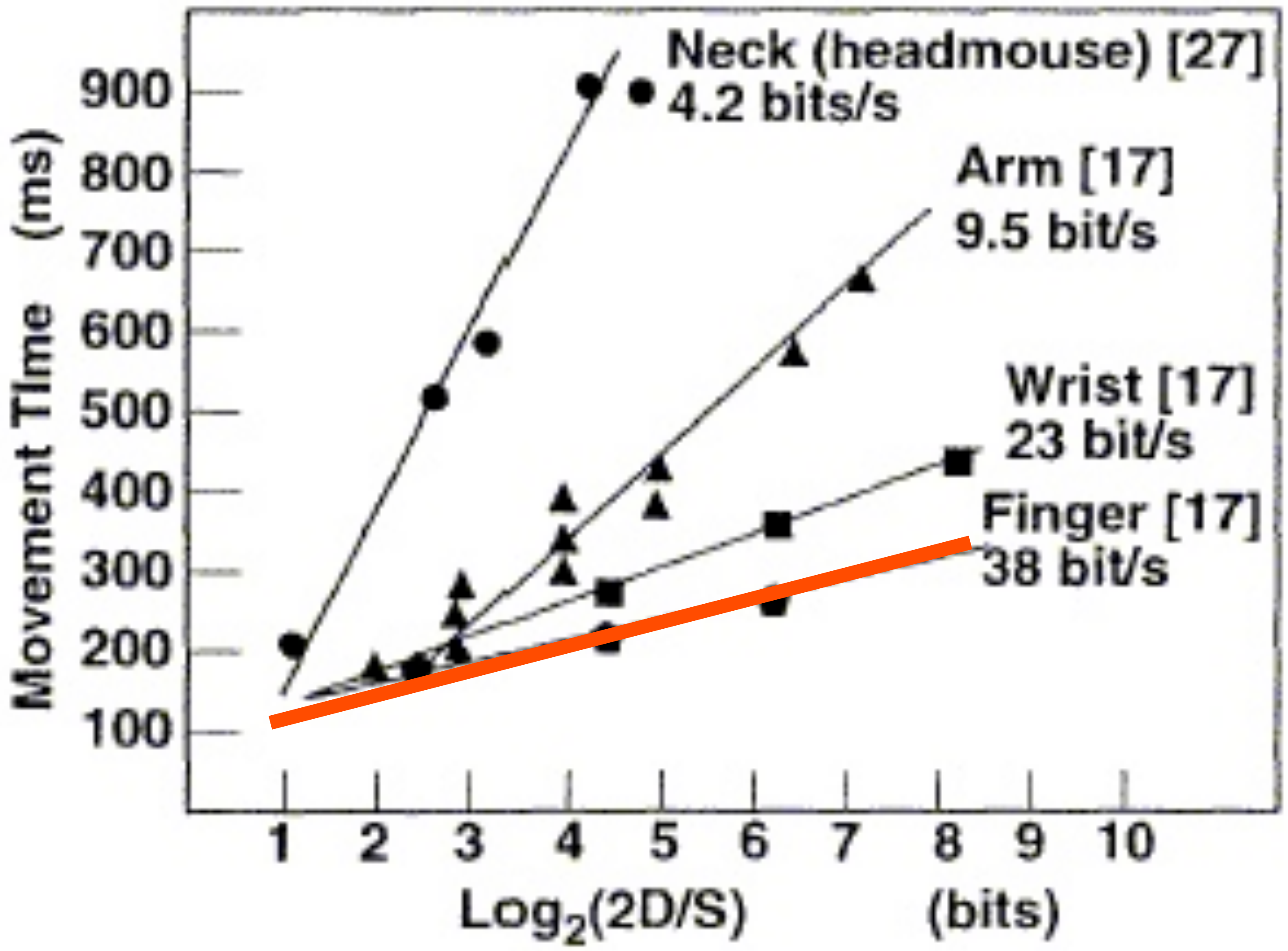
Today
Sunday
Monday
Tuesday
Wednesday
Thursday
Friday
Saturday

Pop-up Pie Menu

- Which will be faster on average?
  - pie menu (bigger targets & less distance)

Source: Landay, James. "Human Abilities". CS160 UC Berkeley.

EXAMPLE: BEATING THE MOUSE



Use transducer on high bandwidth muscles


CORSAIR
Ergonomic Keyboard For Pirates
Avast
!
Shift
R
Enter

Why the repeated measures?

- Model the motor system reaction time...
- ...by factoring out the perception time

The importance of random assignment

- For example, say you wanted to find out whether people are faster at input in the morning or afternoon. You allowed people to come in whenever they wanted. What if people who have a preference for participating in the morning -- morning people -- are faster than people who have a preference for participating in the afternoon. You'll find that morning was faster. But the causal reason was the population difference, not the experimental manipulation. This confound is why a lot of economics is so hard -- it's computing correlations, but there's no manipulation. (That leads off to a longer story and more nuanced discussion, but that's not today's topic.) Random assignment is tool #1 in establishing causation.

Counterbalanced Assignment

- Say you worry that running speed will affect input speed (that fast runners are physically fast people, and they'll do better)
- You can assign participants so that running speed is balanced across conditions
- Do so with care: form matched pairs using a pre-test (work this out on the board)

A danger: regression

- Let’s find heady coins
- First, let’s flip all the coins (our pre-test)
- If they land heads more than half, we’ll call them heady
- Now let’s feed them a snack
- After a snack, do heady coins beat taily coins?
- Similarly, some of our runners will have had a relatively good run, and others a relatively bad one. They’ll exhibit regression to the mean if re-tested.
- If the pre-test is used to counterbalance, and assignment is random, then the error goes away

Counterbalanced Ordering

- If one task is always first, learning is a confound.

Between vs. within subjects

- Within subjects
  - All participants try all conditions
    - + Can isolate effect of individual differences
    - + Requires fewer participants
    - - Ordering and fatigue effects
- Between subjects
  - Each participant tries one condition
    - + No ordering effects, less fatigue.
    - - Cannot isolate effects due to individual differences.
    - - Need more participants

Choosing Participants

- Representative of target users
  - job-specific vocab / knowledge
  - tasks
- Approximate if needed
  - system intended for doctors
    - get medical students
  - system intended for engineers
    - get engineering students
- Use incentives to get participants

A real potential pitfall


Friday, August 17, 2007 11:03 AM PT Posted by Harry McCracken

A Not-Very-Useful iPhone Keyboard Study

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Research firm User Centric has released a study that tries to gauge how effective the iPhone's unusual on-screen keyboard is. The goal is certainly a noble one, but I can't say that the survey's approach results in data that makes much sense.

User Centric brought in twenty owners of other phones--half who had ones with QWERTY keyboards, and half who had ordinary numeric phone keypads. None were familiar with the iPhone. The research involved having the test subjects enter six sample text messages with the phones they already had, and six with an iPhone.

Logical end result: These iPhone newbies took twice as long to enter text with an iPhone as they did with their own phones, and made lots more typos.

Issues

- user sample
- statistical significance
- “newbie” effect / learning effects

Source: PC World

If you read a bit more carefully into the study, you'll notice that the study is about initial adoption of the iPhone keyboard compared to users' current phones. Also, it isn't a survey, it was a study with one on one interviews where users typed and were timed.
The multitap (Non-QWERTY) users did the same or better with the iPhone than their current method, which suggests that multitappers may have an easier time adopting the iPhone's keyboard than QWERTY users. Which to me is interesting.
The study does not at any time attempt to say that QWERTY users will be twice as slow on the iPhone for as long as they use the iPhone, but it does say they may have more difficulty than multitap users initially. Which to me is interesting.
It would be interesting to see ia study some expert iPhone texters and have them switch to a QWERTY phone to see if there is a similar difference in typing efficiency.

The Hawthorne Effect

In the 1930's some studies were held at the Western Electric production facility outside Chicago in a place called Hawthorne. The intent of the study was simple enough: invite a handful of employees to participate in various working condition tests to determine which conditions were most conducive to increased production. Those conditions that "tested" best were then to be rolled out to the general production floor. One of things they tested was brighter lights. Production went up. Then they tested dimmer lights. Production went up. In fact, no matter what they tested, production went up!

"By singling out a small group of employees to participate in an exclusive trial, participants felt valued, special and important. The special attention they received gratified their ego and created a positive emotional bond with what they were trialing. The practical upshot was that the research trials effectively transformed the research participants into advocates for whatever it was they were trialing."