i213 User Interface Design and Development

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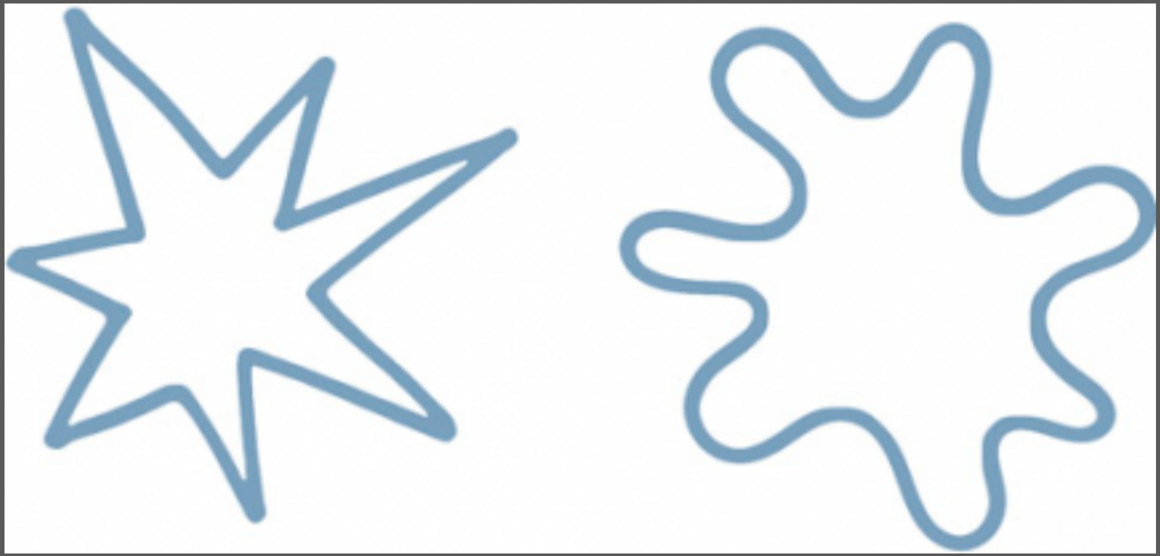
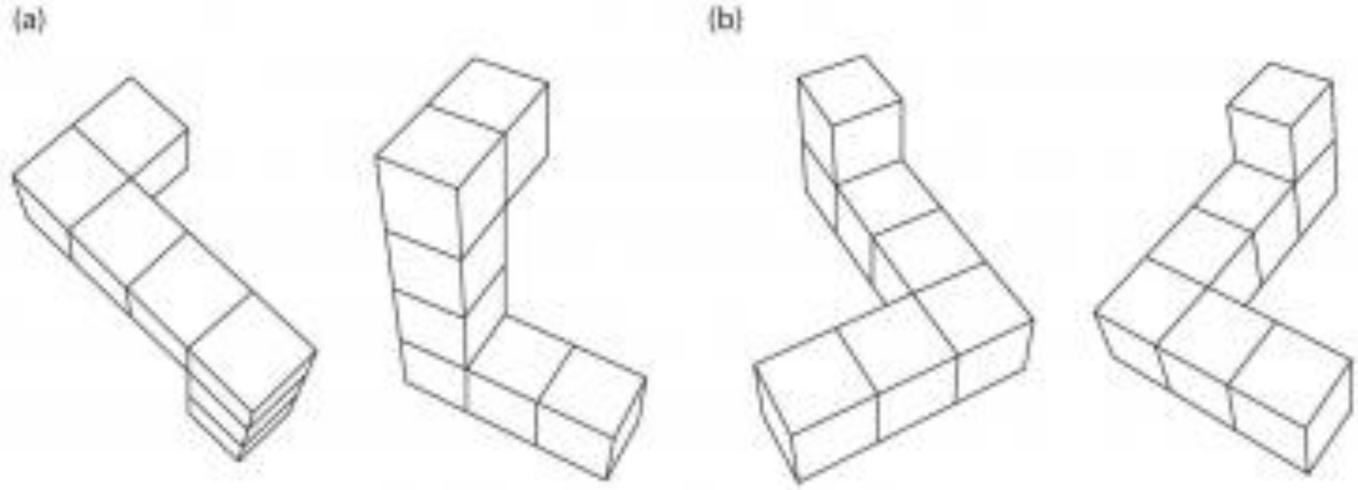
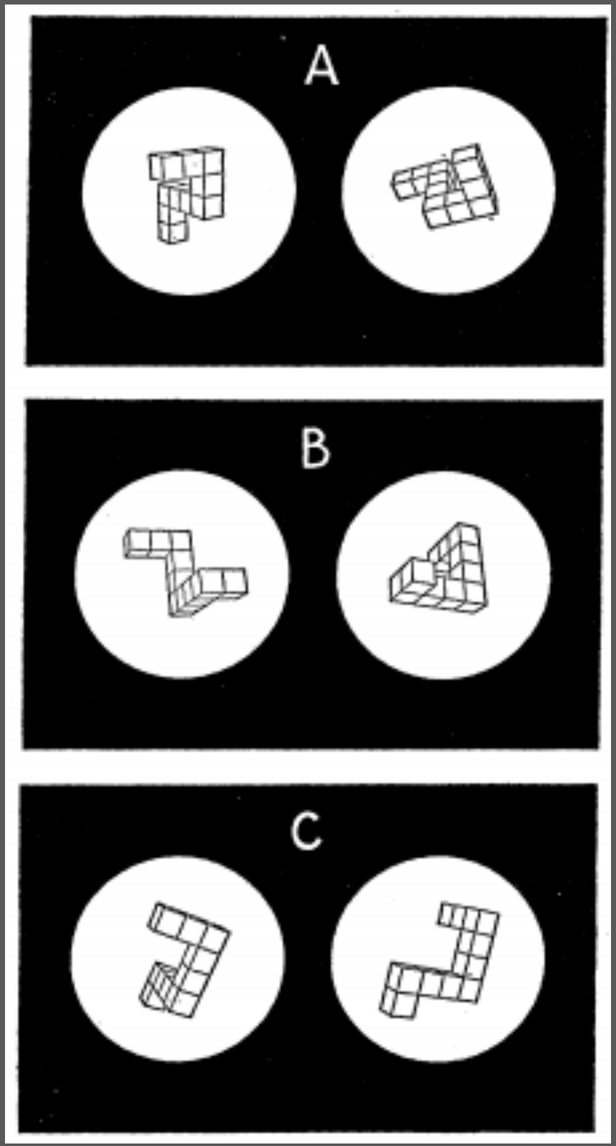


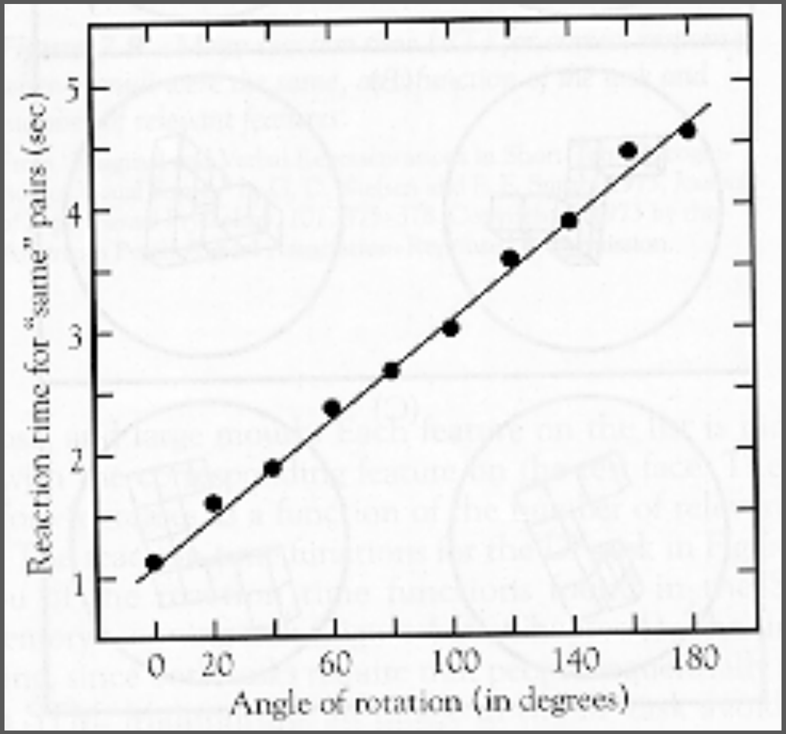


Can the two figures in each set be made identical by rotating them in space?

Shepard & Metzler 1971



Shepard & Metzler 1971



Shepard & Metzler 1971

Motivation: Provide a scientific foundation for design, like other engineering fields

Can we predict behavior without implementation?

Do some cognitive tasks have reliable, "Big-O"-style performance characteristics across individuals?

Adapted from Rob Miller

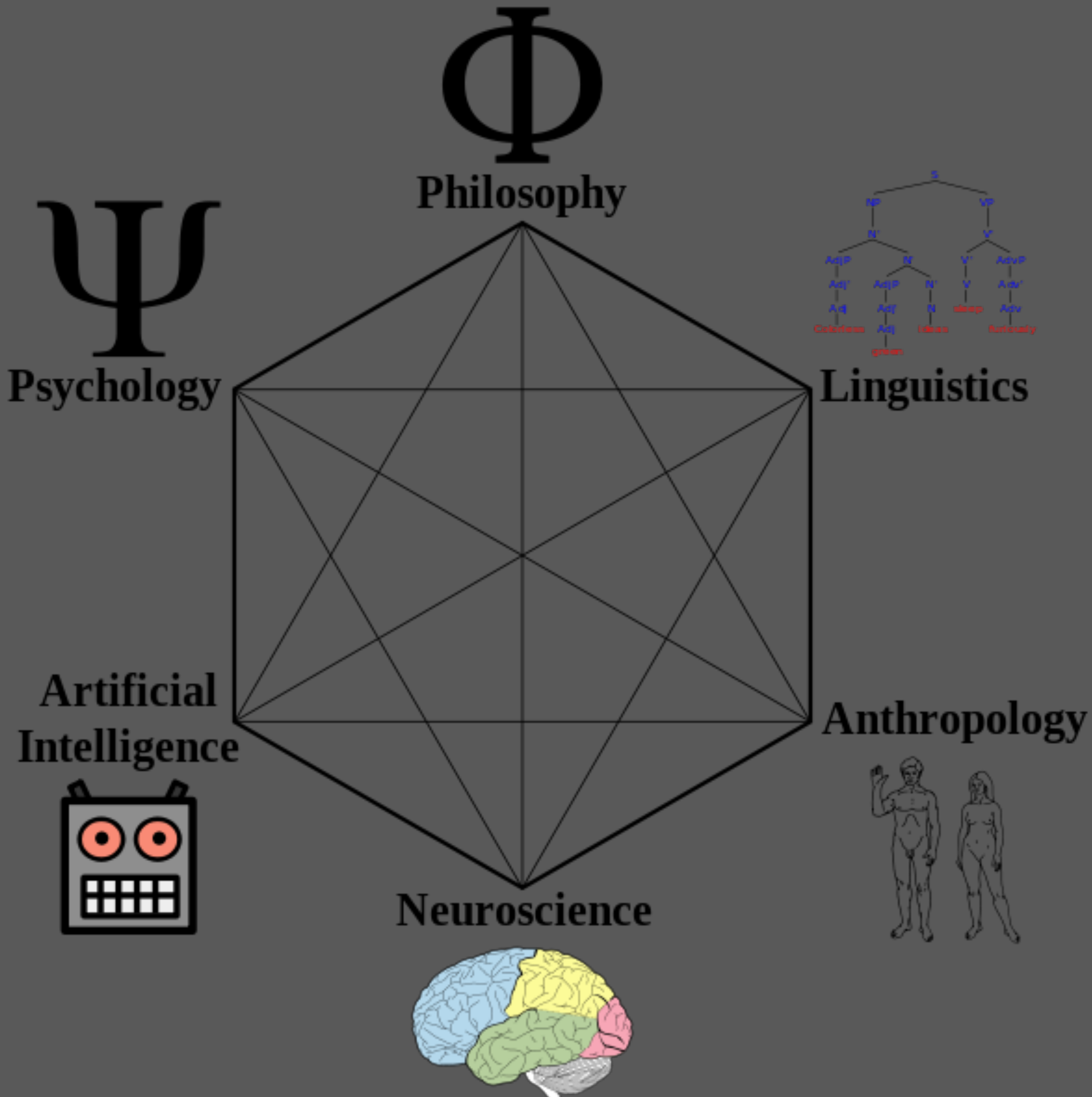
Goal: predict user performance based on a ***model*** of cognition

Like physics can inform structural engineering, can these models inform UI design?

No need for human subjects?!

Provided theoretical foundation of HCI in the 1970s and 1980s

“Model Human Processor”



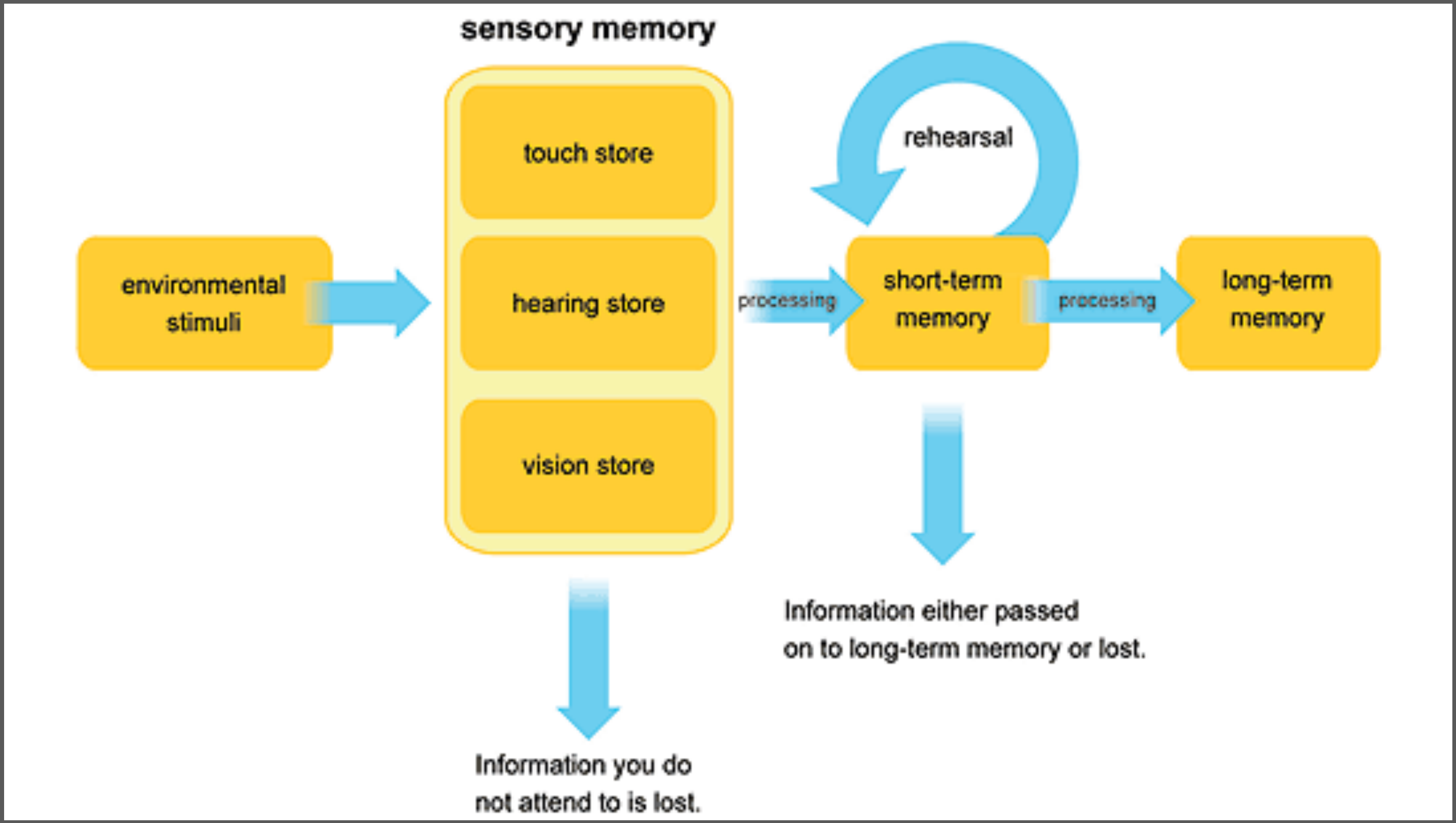
adapted from: Miller, George A (2003).

Outline of this lecture

- Memory
- Attention
- Cogsci in HCI

1. Memory

memory



Source: Card, Moran, Newell, The Psychology of Human-Computer Interaction

	SM →	STM →	LTM
duration:	**<0.3s**	**<15s**	**∞?**
capacity:	**3-4s “echoic”**	**7±2 “chunks”**	**?**

memory - chunking

	SM →	STM →	LTM
duration:	**<0.3s**	**<15s**	**∞?**
capacity:	**3-4s “echoic”**	**7±2 “chunks”**	**?**

M W R C A A O L I B M F B I B

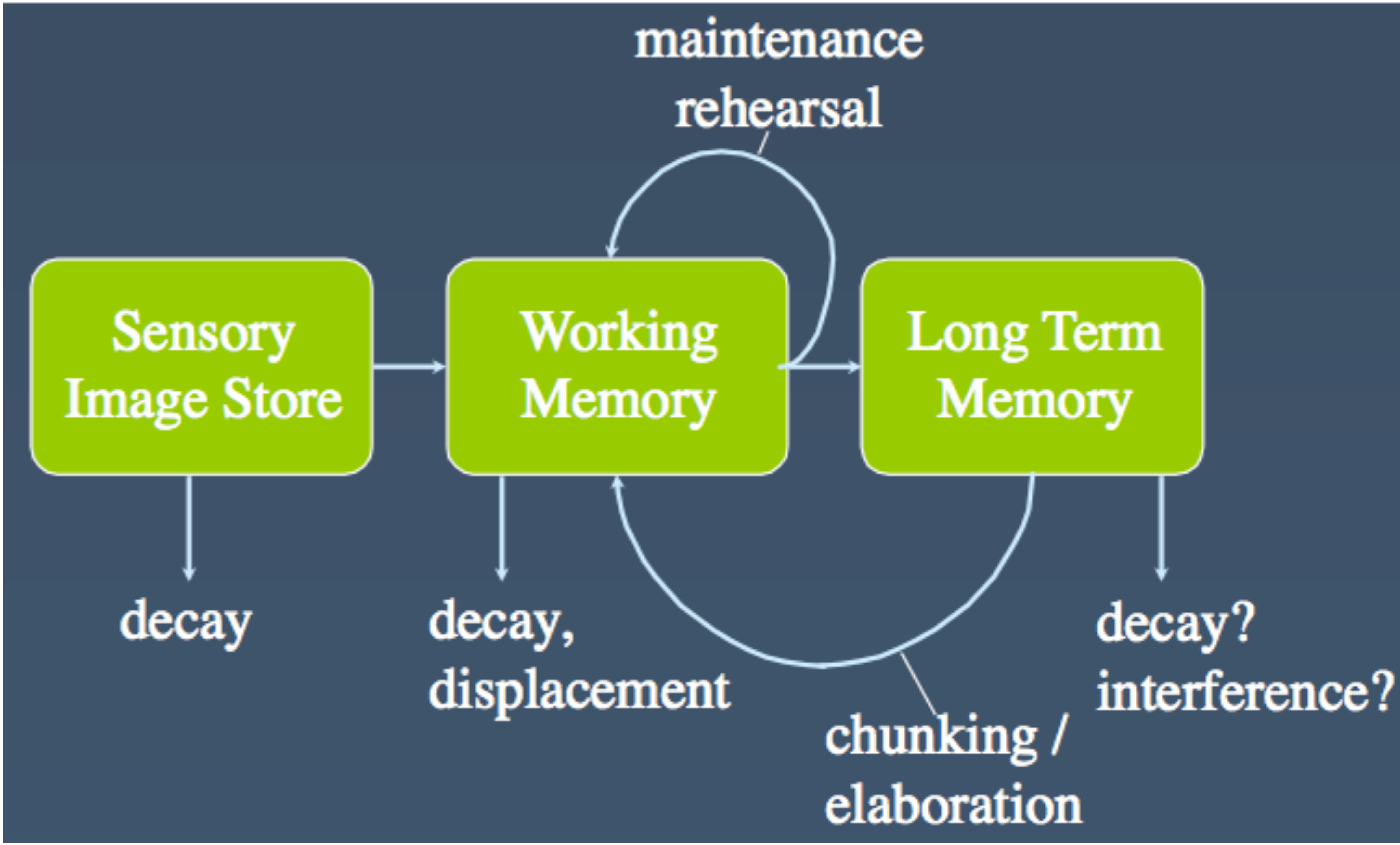
MWR CAA OLI BMF BIB

BMW RCA AOL IBM FBI

Keywords:

- organized as "**chunks**" of information
- **decay rate** is function of number of chunks in store
- modulo any **semantic meaning** the chunks might have…

https://www.youtube.com/watch?v=S2Vvn7xzik8



Adapted from Landay, Sinha, Klemmer

Recall and **recognition** work by different mechanisms.

Adapted from Robert Miller

Recall and **recognition** work by different mechanisms.

QUICK- which of the following did NOT appear on the last slide?

IBM AOL NSA BMW RCA

Adapted from Robert Miller

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memory

	SM →	*STM* →	*LTM*
duration:	**<0.3s**	**<15s**	∞ ?
capacity:	**3-4s "echoic"**	**7±2 "chunks"**	**?**

SM - perceptual fusion

Two stimuli within the same perceptual processing cycle (T_p ~ 100ms) appear fused

Consequences

- $1/T_p$ frames/sec is enough to **perceive a moving picture**
- Computer response **< 100ms feels instantaneous**
- **Causality** is strongly influenced by T_p

Adapted from Robert Miller

memory

	SM →	STM →	LTM
duration:	**<0.3s**	**<15s**	∞ ?
capacity:	**3-4s “echoic”**	**7±2 “chunks”**	**?**

Long term memory (LM)

Least well-understood facet of memory

Significant **spatial** component

Accessed associatively from working & sensory memory

- decay ~ infinite ?
- size ~ infinite ?
- **fast-read, slow-write**

Complicated tasks disrupt maintenance and encoding - harder to transfer from WM to LTM

Adapted from Robert Miller

2. Attention

TEST OF YOUR ATTENTION:

http://www.youtube.com/watch?v=vJG698U2Mvo

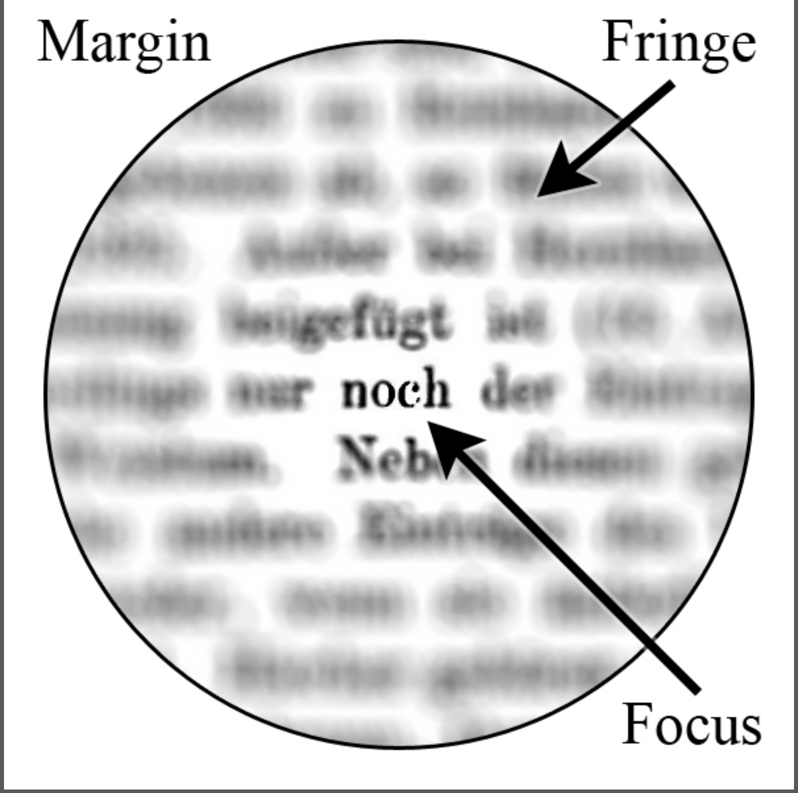
Attention:

“The allocation of **limited cognitive resources**” (Anderson, 2004)

One of the hottest topics in cognitive science

- **Mind wandering**
- **Multitasking** (or “rapid attention shifting”)
- Default mode network (**DMN**)

Spotlight model (James,1972) —>Zoom-lens model (Eriksen, 1986)

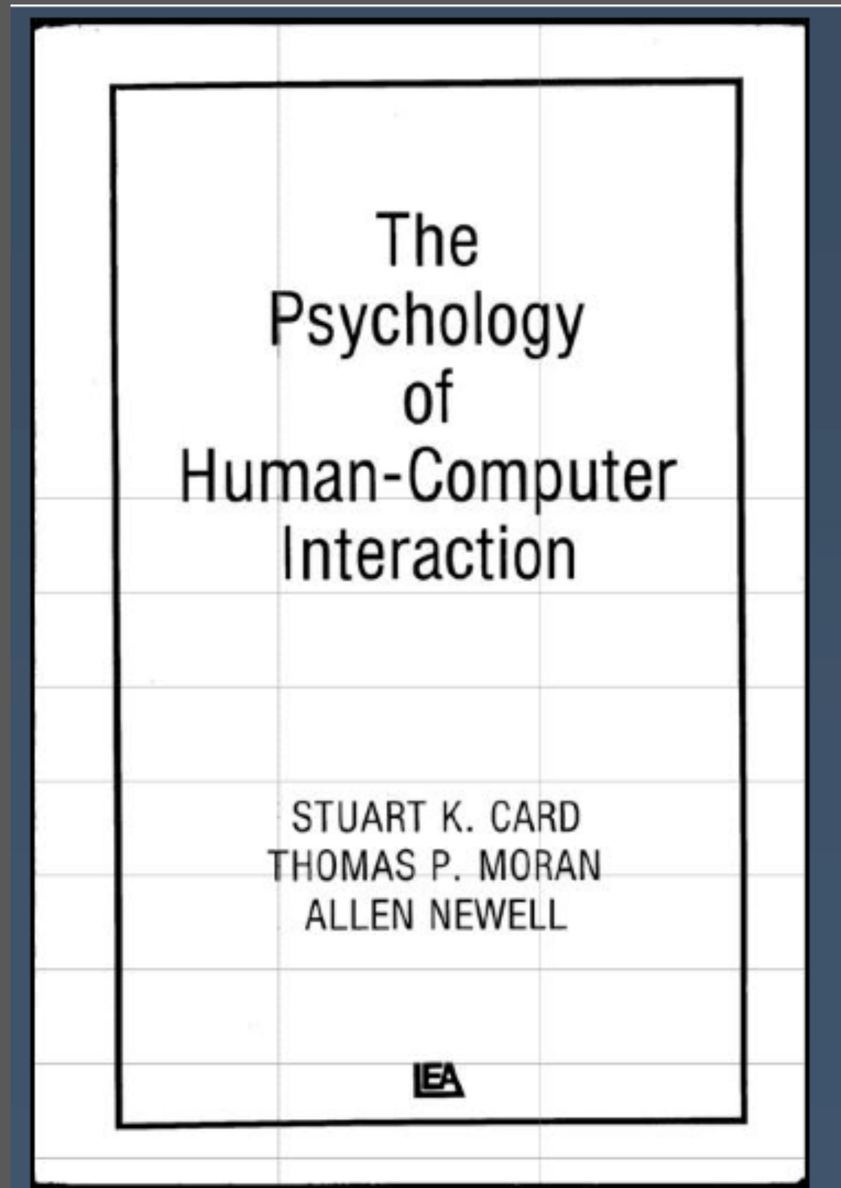


What captures visual attention?

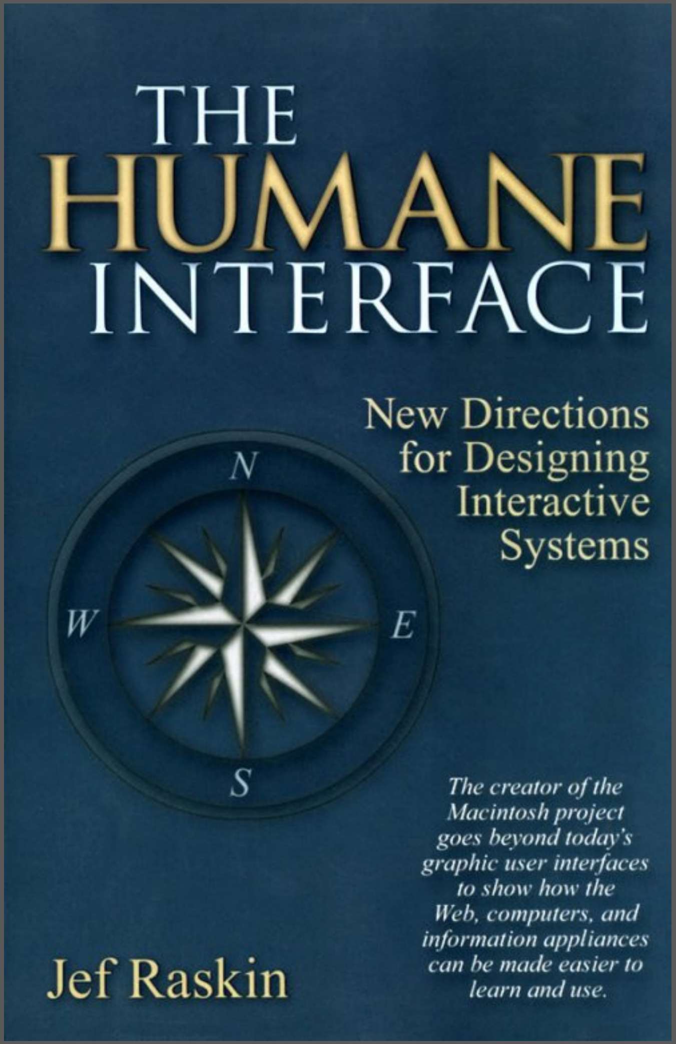
- Abrupt appearance of a new object? Not always. (see, e.g., Jonides & Yantis, 1988)

- **Luminance change**! (Franconeri, 2003)

3. UX design?


The Psychology of Human-Computer Interaction
STUART K. CARD
THOMAS P. MORAN
ALLEN NEWELL
LEA

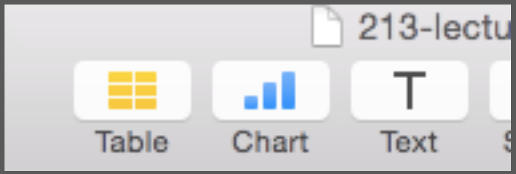
1981

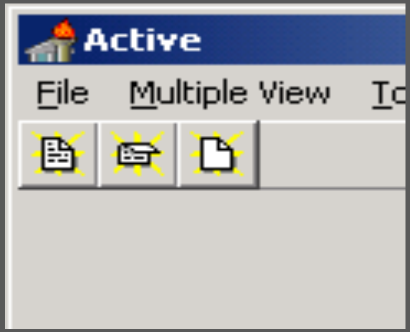

THE
HUMANE
INTERFACE
New Directions for Designing Interactive Systems
N
W
E
S
The creator of the Macintosh project goes beyond today's graphic user interfaces to show how the Web, computers, and information appliances can be made easier to learn and use.
Jef Raskin

2000

1. Fitt’s Law (buttons)
2. Steering law (menus)
3. “Fun” exercise

Which is more efficient?





Source: http://www.asktog.com/columns/022DesignedToGiveFitts.html

Adapted from Hearst, Irani

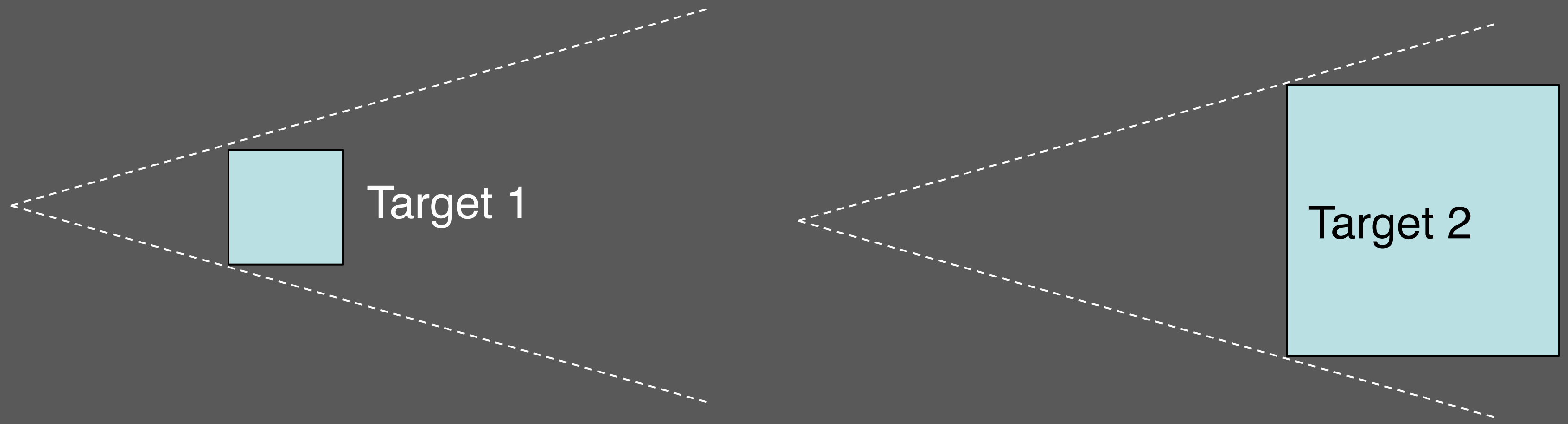
Fitts in practice

Adapted from Landay, Sinha, Klemmer

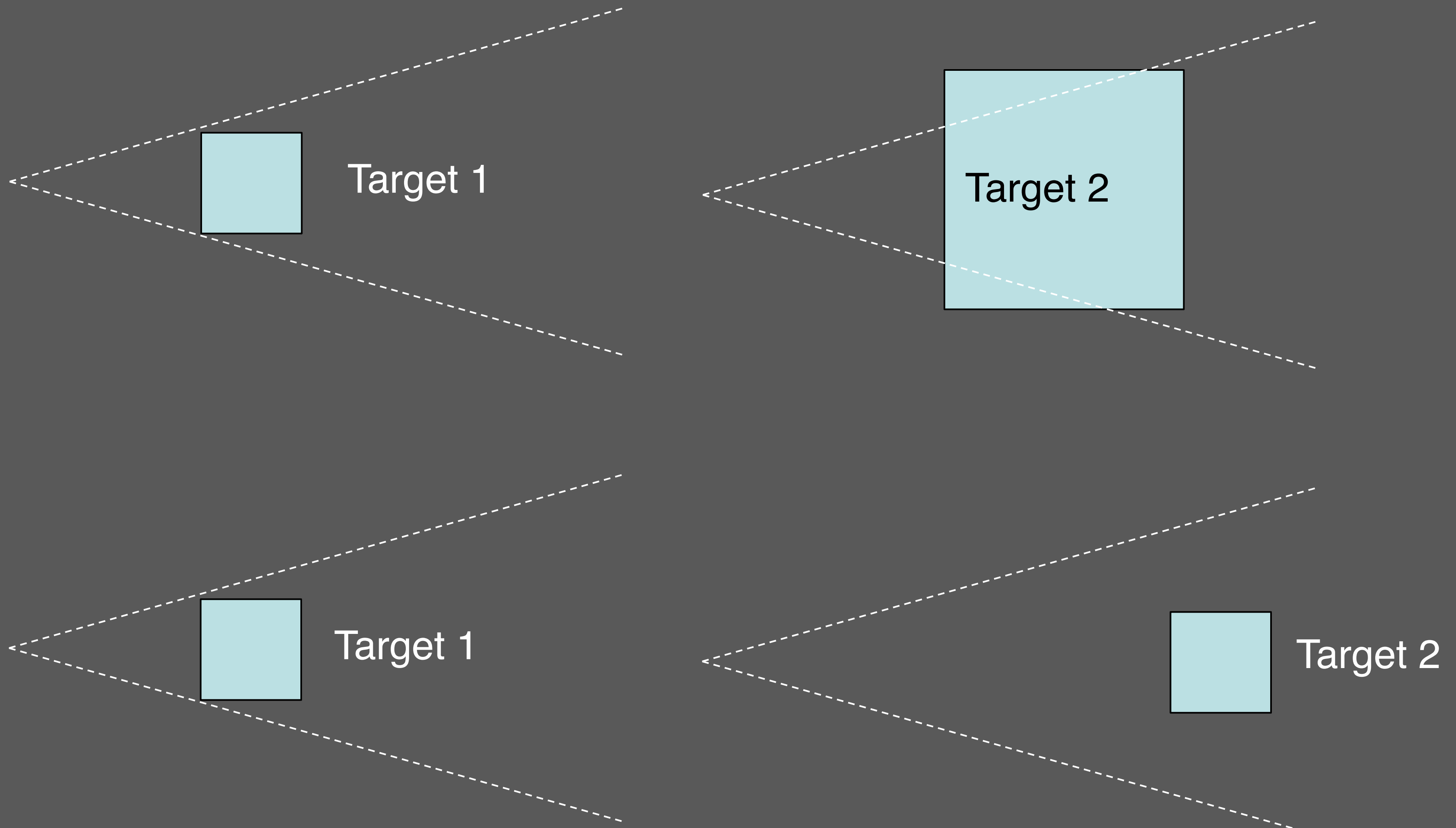
time = distance / size

Time-to-target is not limited by motor activity of moving your arm / hand, but rather by the cognitive activity of keeping on track

In below example, time will be the same because the ratio d/s is the same



Fitts' law examples



Adapted from Hearst, Irani

Fitts' Law Equation

$$T_{msec} = a + b\ \mathbf{log_2}\ (d/s + 1)$$

a, b = empirically-derived constants

d = distance, s = width of target

ID (Index of Difficulty) = $\log_2 (d/s + 1)$

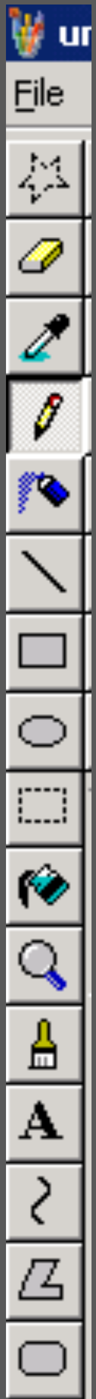
Adapted from Robert Miller

Fitts in practice

You have a toolbar with 16 icons, each with dimensions of 16x16

Without moving the array from the left edge of the screen, or changing the size of the icons, how can you make this more efficient?

Adapted from Hearst, Irani



Make sure that each button can be activated up to the last pixel on the left hand edge

Why? Because you cannot move your mouse off of the screen, the effective width s is infinite

Adapted from Hearst, Irani

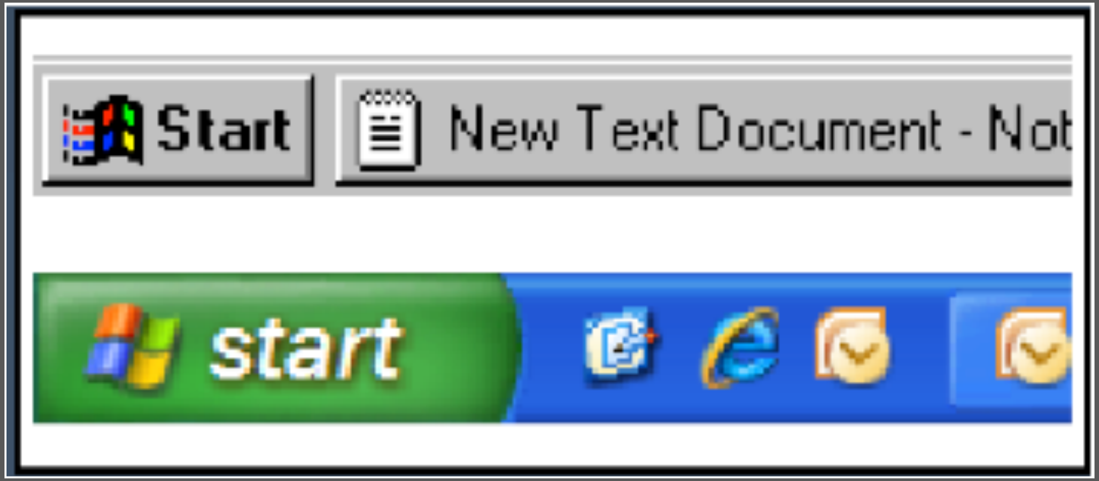
Determining a,b constants

Conduct experiments varying d,s; but keeping everything else the same

Measure execution time, error rate, accuracy

Perform linear regression

Fitts in practice



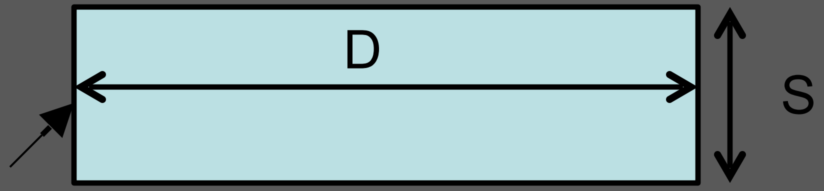
Adapted from Landay, Sinha, Klemmer

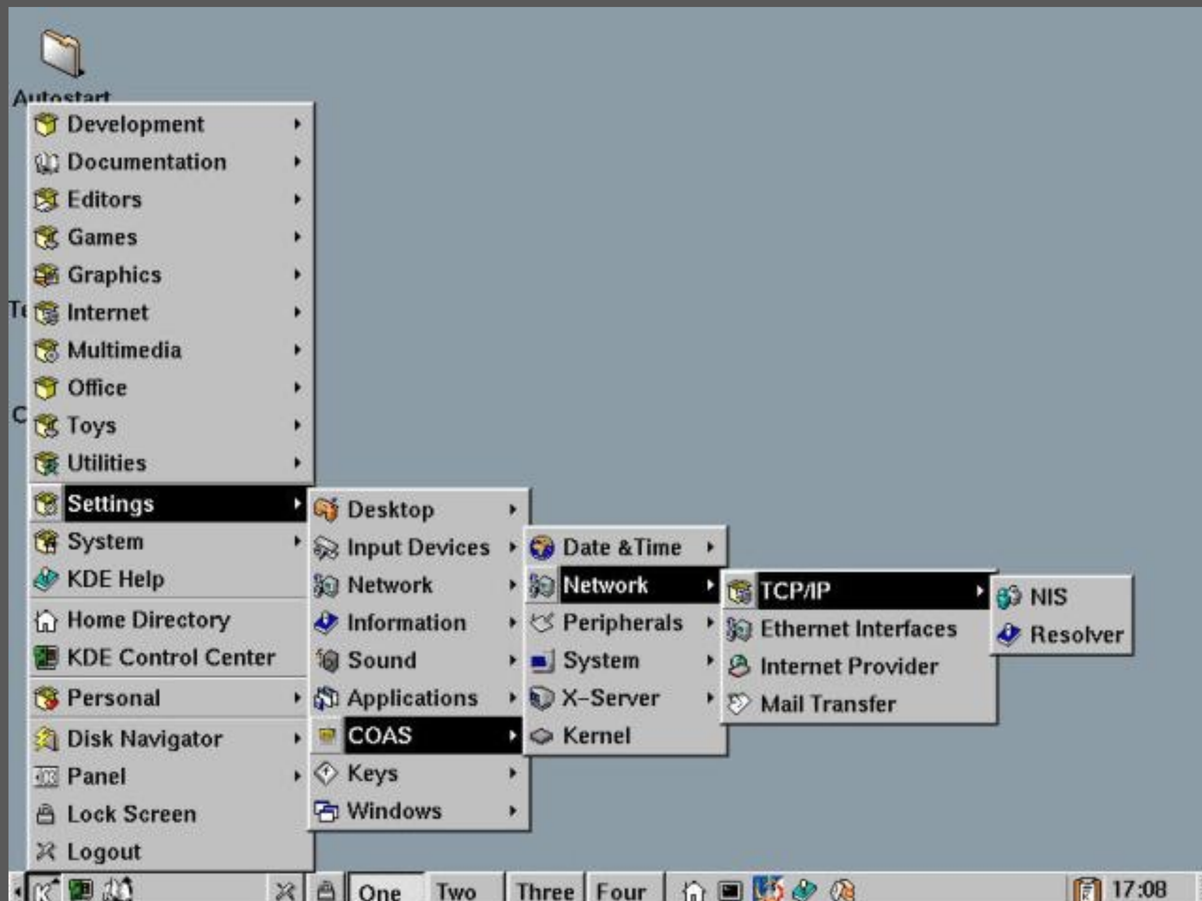
2. Steering law

Applies Fitts principles to *two dimensions* (Accot, Zhai 1997)

Must keep the pointer within the boundaries ***throughout***, not only at the target

Fitts' Law used for pointing, Steering Law used for drawing





Source: http://linuxbook.orbdesigns.com/ch09/btlb_c09.html

Steering Law Equation

$$T_{msec} = a + b\ (d/s)$$

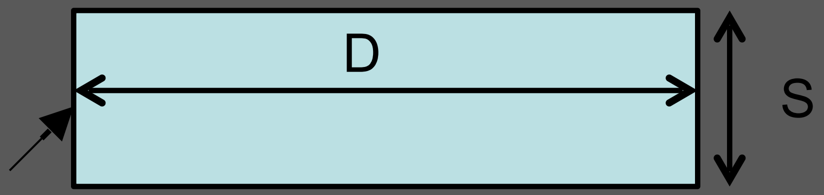
a, b = empirically-derived constants

d = distance, s = width of tunnel

ID (Index of Difficulty) = (d/s)

Index of Difficulty now *linear*, not logarithmic

(i.e. steering is more difficult then pointing)



Adapted from Robert Miller

Historical note:

Cogsci was popular in HCI before "UX" was even a term.

But, these older findings are interesting, IMO

They explain why we have the language we have - menus, buttons, why they tend to be positioned and configured the way they are

Exercise:

Take a popular website, and make some cursory analyses w/r/t Fitts law or Steering law.

Cool books

The Human Interface. Jeff Raskin.

Consciousness: A User's Guide. Adam Zeman.

Quantum Computing Since Democritus. Scott Aaronson.

Gödel, Escher, Bach. Douglas Hofstadter.

For next time

Work on interactive prototypes

Balsamiq / Justinmind poll?