Human Abilities: Vision & Cognition

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Stanford University

Autumn 2017

November 6, 2017

Hall of Fame or Shame?

https://accounts.google.com/SignUp?service=...

Apps | CS 147: HCI+D Autu | Gates Information N | Axess | NETGEAR Router WN | kimonify | Other Bookmarks

Google

Sign in

Create your Google Account

One account is all you need

A single username and password gets you into everything Google.

Take it all with you

Switch between devices, and pick up wherever you left off.

Name

First | Last

Choose your username

@gmail.com

Create a password

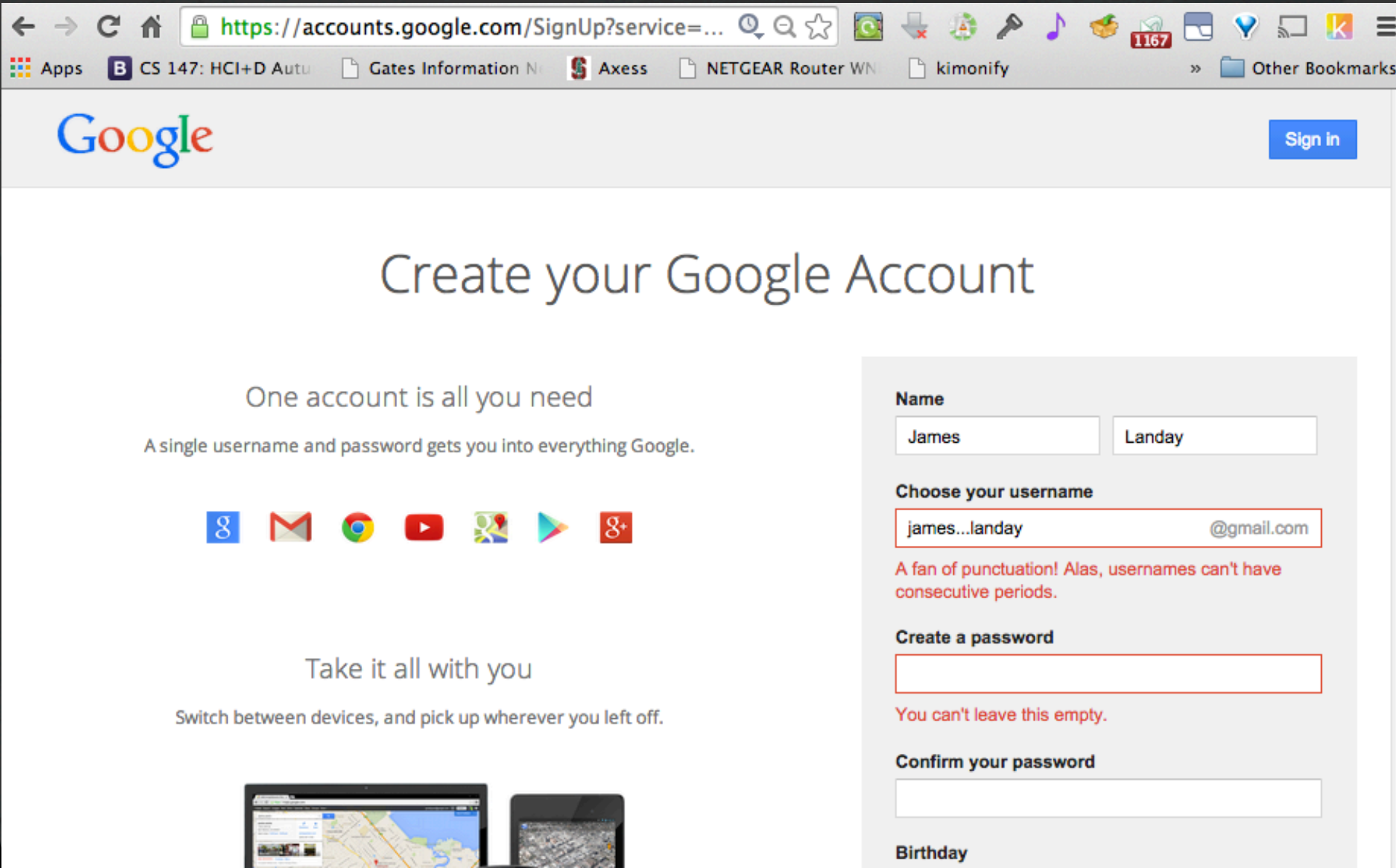
Confirm your password

Birthday

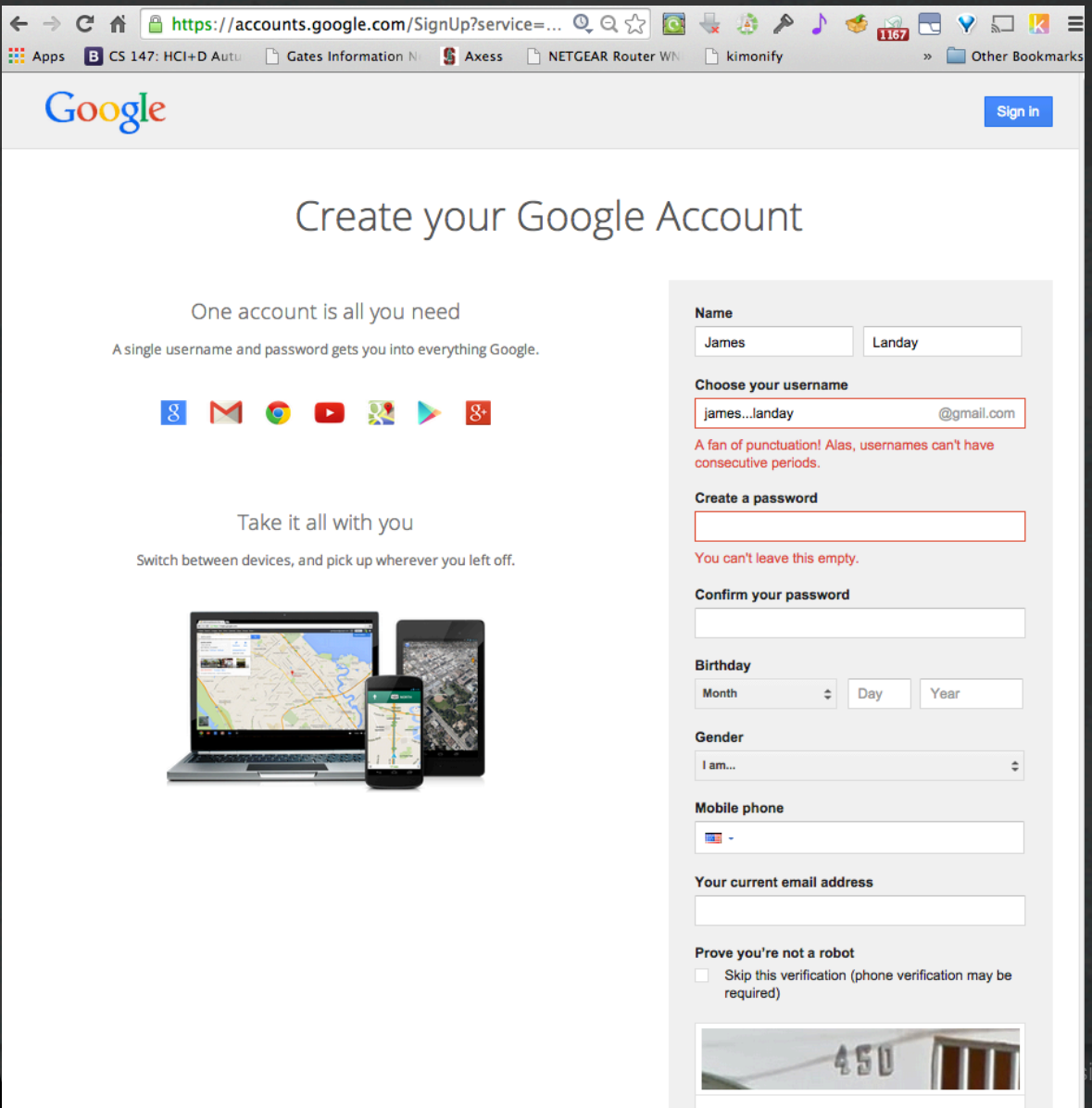
Month | Day | Year

Gender

Hall of Fame or Shame?



Hall of Fame!



Clearly highlights error (red text & box)

Tells me what I did wrong/how to fix it

In user's language (careful w/ humor)

Red may be issue, more later..

Hall of Fame or Shame?

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MY CART

SEARCH BY: Size, Narrow Shoes, Wide Shoes, Popular Searches

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ALPHABETICAL BRAND INDEX # • A • B • C • D • E • F • G • H • I • J • K • L • M • N • O • P • Q • R • S • T • U • V • W • X • Y • Z

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Oh no! We're very sorry, please fix the following issues...

- Please ensure you included a proper phone number.

PLEASE FILL OUT THE FOLLOWING FORM TO EMAIL US

You can also check our Frequently Asked Questions section for help in finding an immediate answer to our most commonly asked questions.

NAME (FIRST AND LAST):	James Landay
PHONE NUMBER: (OPTIONAL)	+1 206 651 4382
EMAIL ADDRESS:	landay@gmail.com
CONFIRM EMAIL ADDRESS:	landay@gmail.com

(•) Contact me by email
( ) Contact me by phone

REGARDING: Returns

ORDER NUMBER: (OPTIONAL) 119342675

MESSAGE SUBJECT LINE: didn't get credited for 1 pair returned

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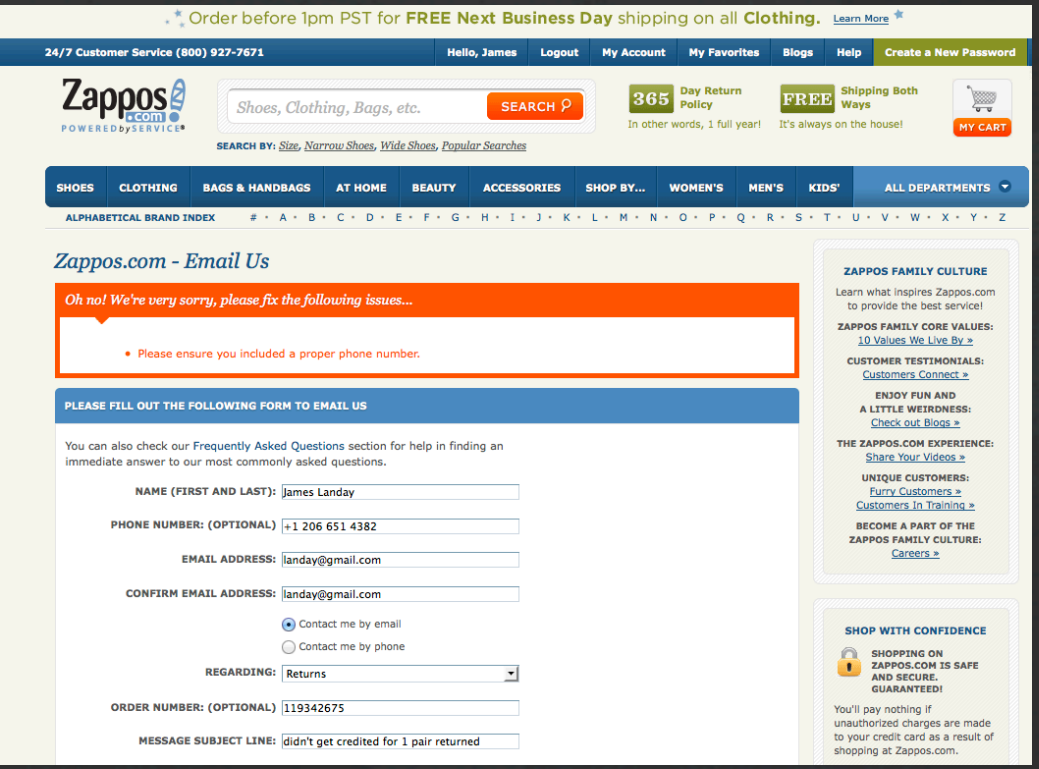
Hall of Shame!



- Error Messages
  - where is the error?
  - what's wrong with it?
  - parse & fix it yourself!

Human Abilities: Vision & Cognition

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Outline

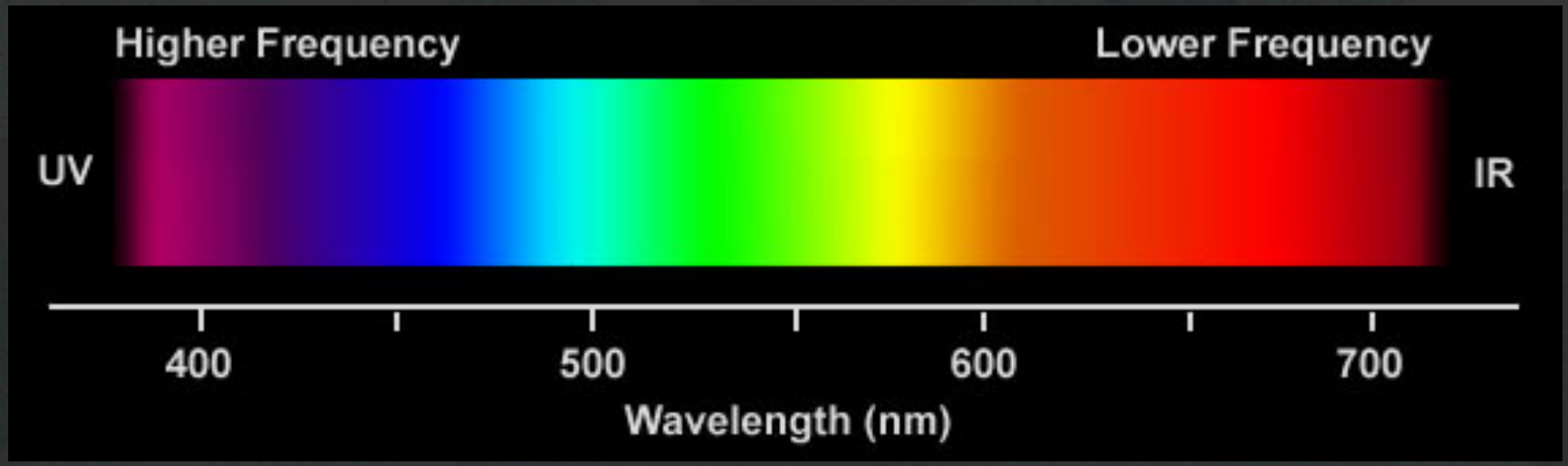
- Human visual system
- Guidelines for design
- Team Break
- Two in class experiments
- Models of human performance (MHP)
- Memory

Why Study Color?

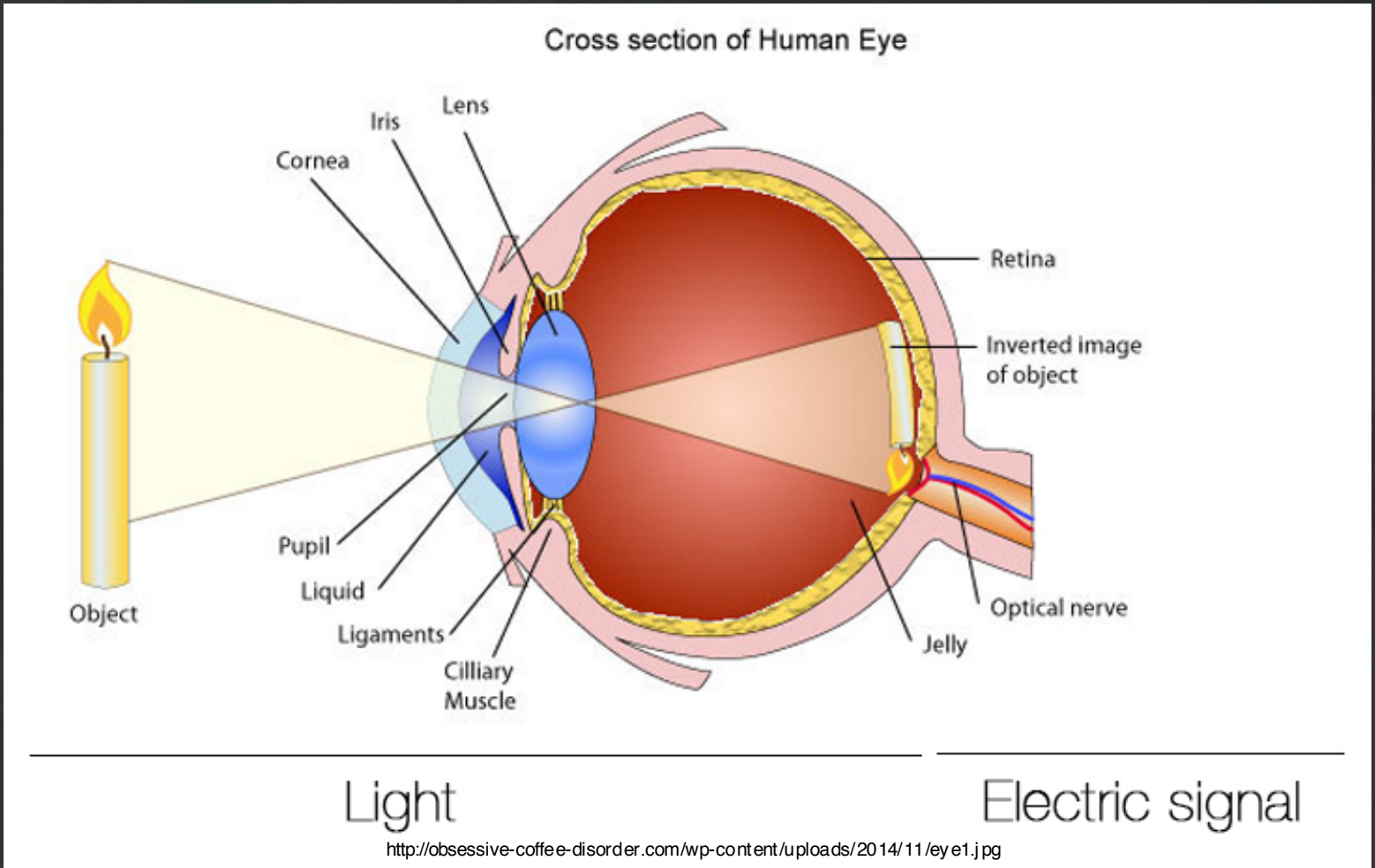
1) Color can be a powerful tool to ***improve*** user interfaces by communicating key information

2) Inappropriate use of color can severely *reduce* ***the performance*** of systems we build

Visible Spectrum



Human Visual System



http://obsessive-coffee-disorder.com/wp-content/uploads/2014/11/eye1.jpg

- Light passes through lens
- Focused on retina

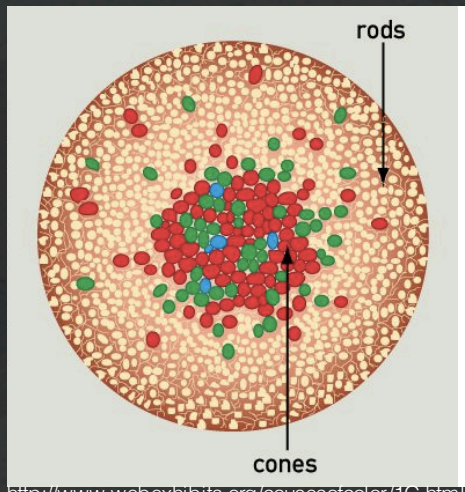
Retina

- Retina covered with two types of light-sensitive receptors called?
  - rods
    - primarily for night vision & perceiving movement
    - sensitive to broad spectrum of light
    - can't discriminate between colors
    - sense intensity or shades of gray
  - cones
    - used to sense color

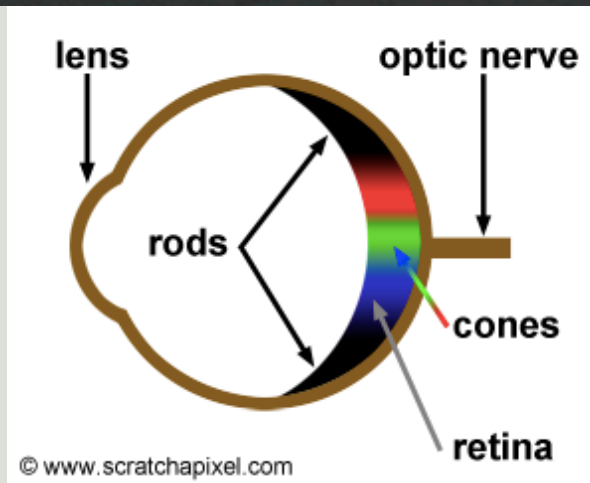
Retina

Center of retina has most of the cones

- allows for high acuity of objects focused at center



http://www.webexhibits.org/causesofcolor/1G.html



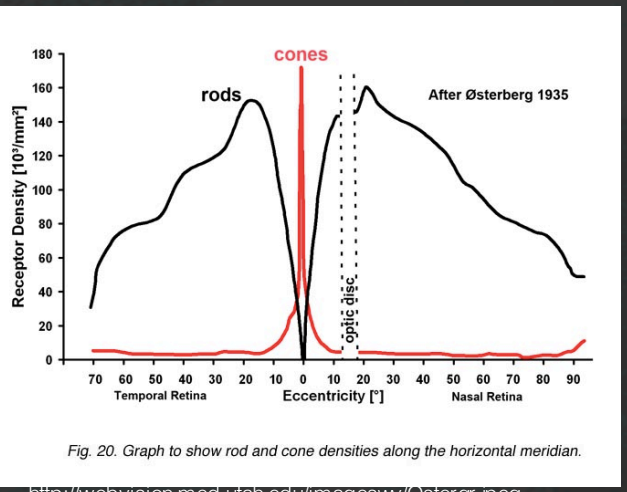


Fig. 20. Graph to show rod and cone densities along the horizontal meridian.

http://webvision.med.utah.edu/imagesw/Ostergr.jpeg

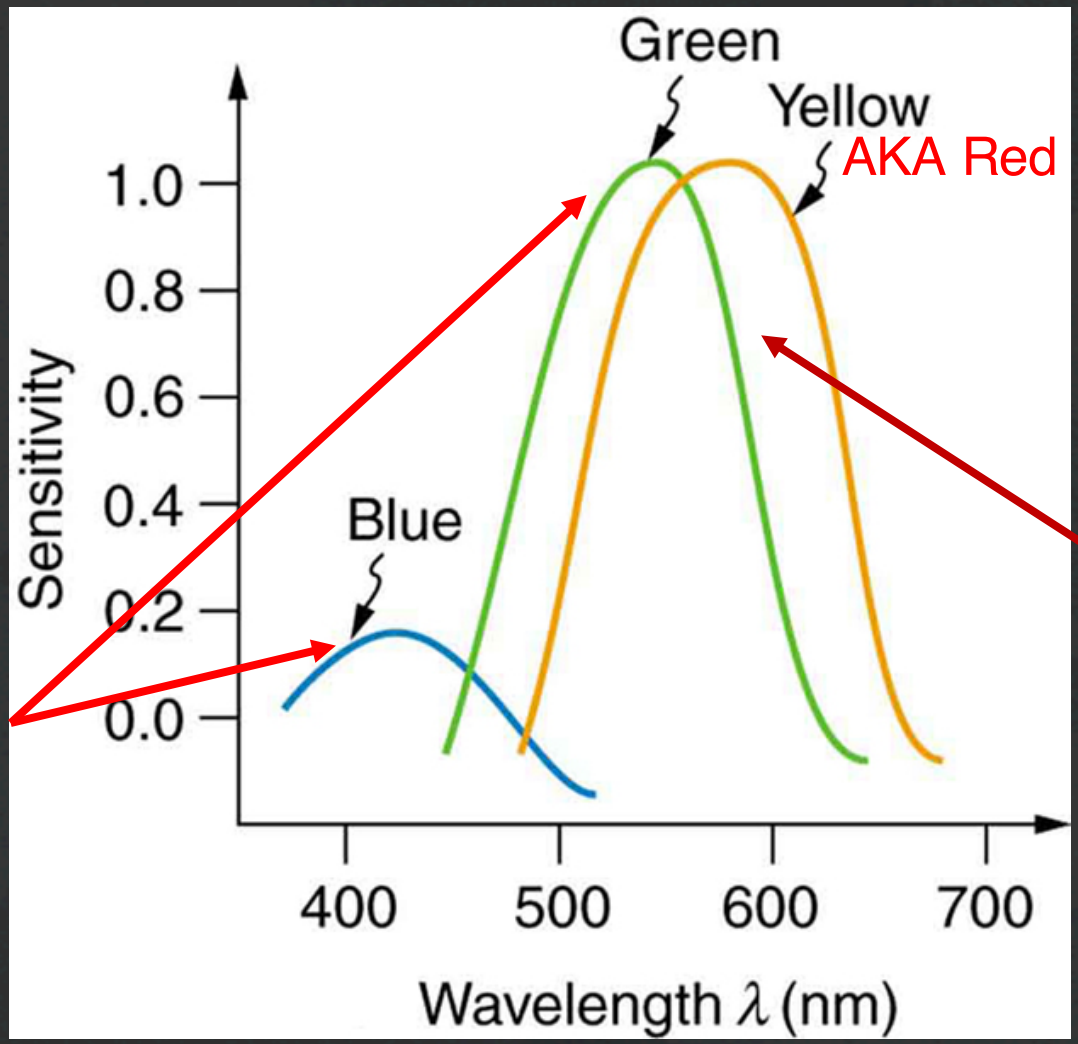
Edge of retina is dominated by rods

- allows detecting motion of threats in periphery

Color Perception via Cones

- "Photopigments" used to sense color
- 3 types: blue, green, "red" (really yellow)
  - each sensitive to different band of spectrum
  - ratio of neural activity of the 3  color
    - other colors are perceived by combining stimulation

Color Sensitivity

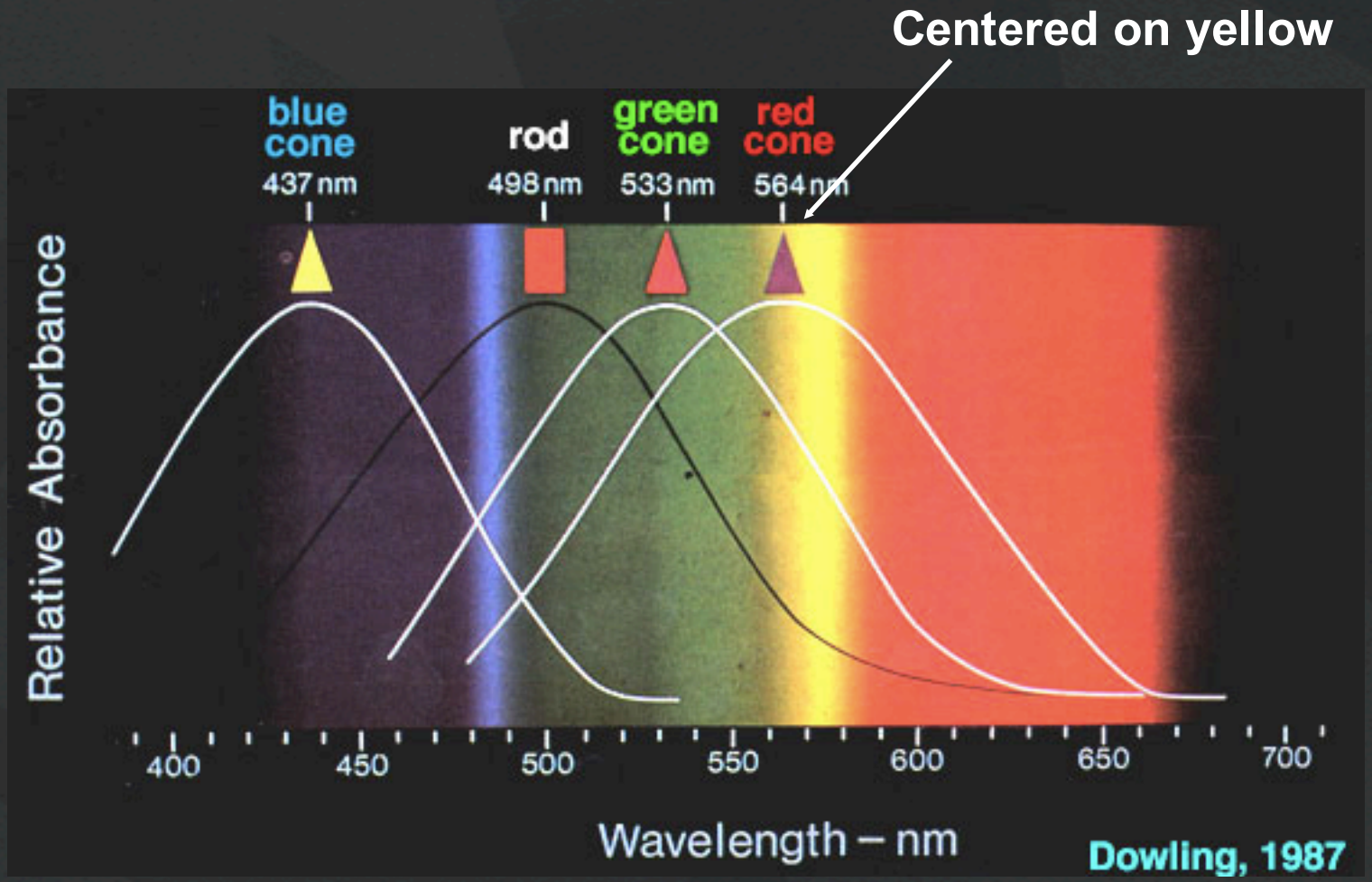


not as sensitive to blue

lots of overlap

http://archive.cnx.org/contents/d42c807d-a9fa-4e3d-83d0-0f7c745b51a0@4/color-and-color-vision#import-auto-id1844887

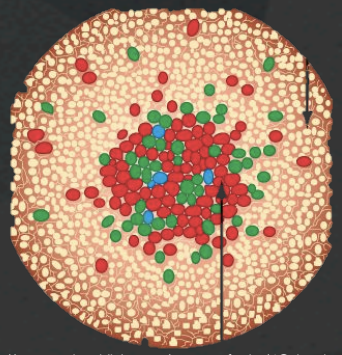
Color Sensitivity



http://retina.umh.es/webvision/imageswv/spectra.jpeg

Distribution of Photopigments

- Not distributed evenly – mainly reds (64%) & very few blues (4%)
  - insensitivity to short wavelengths (blue)

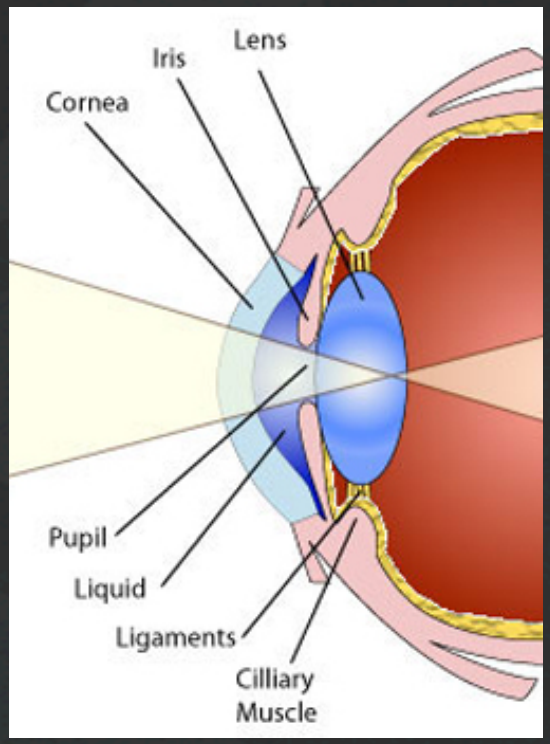


http://www.webexhibits.org/causesofcolor/1G.html

- Few blue cones in retina center (high acuity)
  - "disappearance" of small blue objects you fixate on
- As we age lens yellows & absorbs shorter wavelengths
  - sensitivity to blue is even more reduced
- Implication
  - **don't rely on blue for text or small objects!**

Focus

- Different wavelengths of light focused at different distances behind eye's lens
  - need for constant refocusing 🎭 ?
    - causes fatigue
  - be careful about color combinations



Focus

- Different wavelengths of light focused at different distances behind eye's lens
  - need for constant refocusing 🎭 ?
    - causes fatigue
  - be careful about color combinations
- Pure (saturated) colors require more focusing than less pure (desaturated)
  - don't use saturated colors in UIs unless you really need something to stand out

http://www.pallasweb.com/color.html

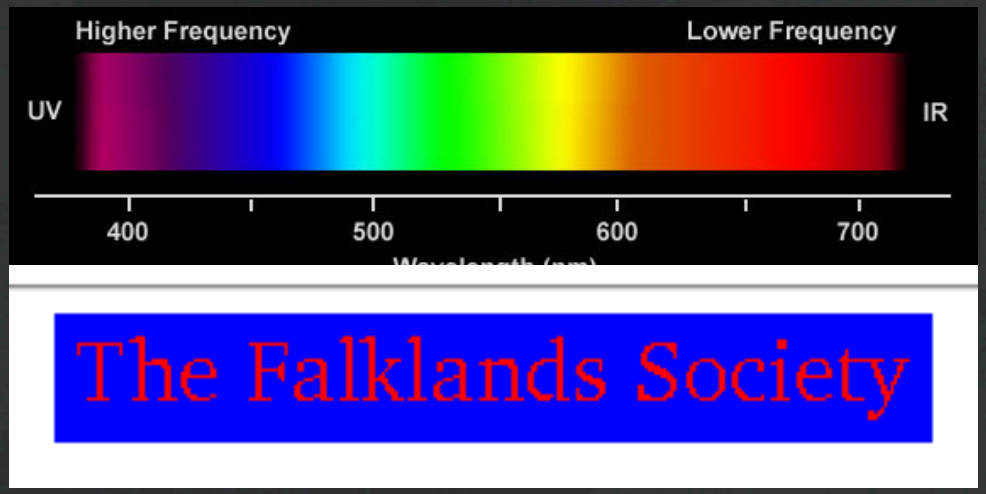
Color Deficiency
(Also known as "color blindness")

- Trouble discriminating colors
  - besets about 9% of population
- Two main types
  - ***different photopigment response*** most common
    - reduces capability to discern small color diffs
  - ***red-green deficiency*** is best known
    - lack of either green or red photopigment  can't discriminate colors dependent on R & G

Color Guidelines

Avoid simultaneous display of highly saturated, spectrally extreme colors

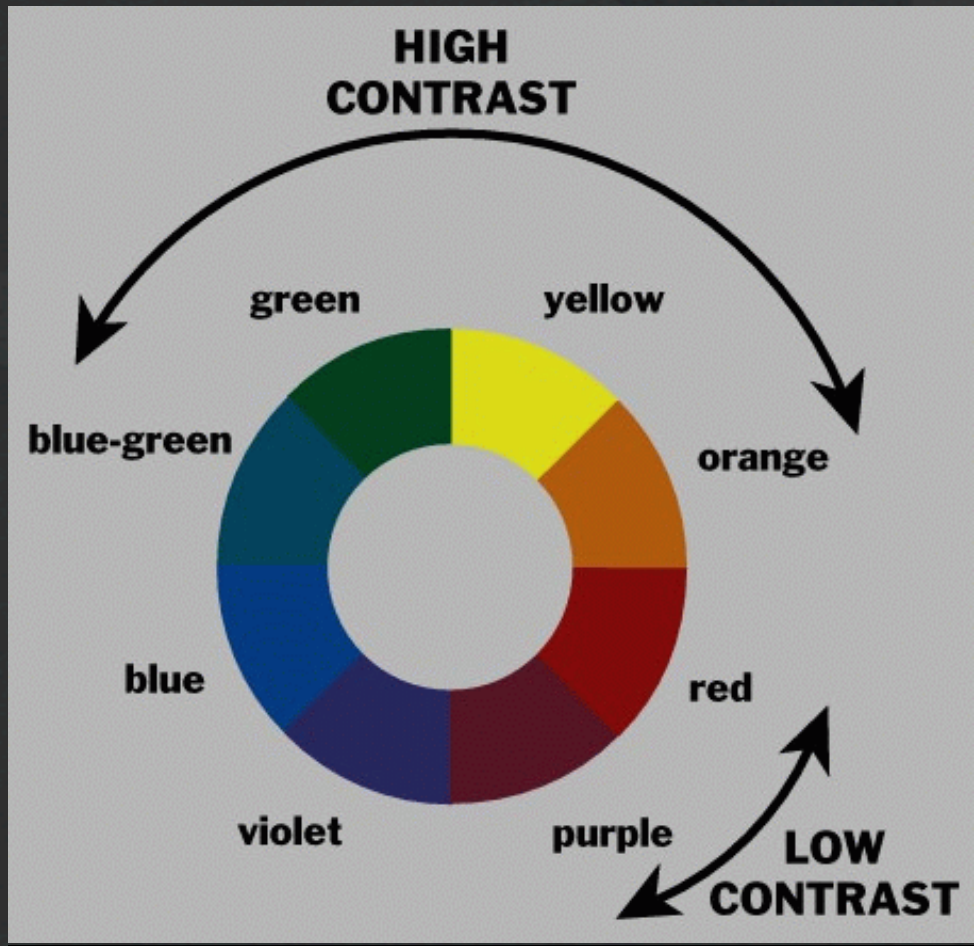
- e.g., no cyans/blues at the same time as reds, why?
  - refocusing!



- desaturated combinations are better 🎭 pastels

Use the Hue Circle

- Pick non-adjacent colors
  - opponent colors go well together
    - (red & green) or (yellow & blue)



Color Guidelines (cont.)

- Avoid pure blue for text, lines & small shapes
  - also avoid adjacent colors that differ only in blue
  - blue makes a great background color

Color Guidelines (cont.)

- Size of detectable changes in color varies
  - hard to detect changes in reds, purples, & greens
  - easier to detect changes in yellows & blue-greens
  - older users need higher brightness levels
- Hard to focus on edges created by only color
  - use both brightness & color differences
- Avoid single-color distinctions
  - mixtures of colors should differ in 2 or 3 colors
  - helps color-deficient observers

TEAM BREAK

Administrivia

- Quiz 2 grades
  - Average: 3.25 / 4
  - Median: 3 / 4
  - Std. Dev.: .5
  - Range 2-4

- Have your Heuristic Evaluation ready to go when you arrive in studio Thur/Fri

To show this poll

1

Install the app from
pollev.com/app

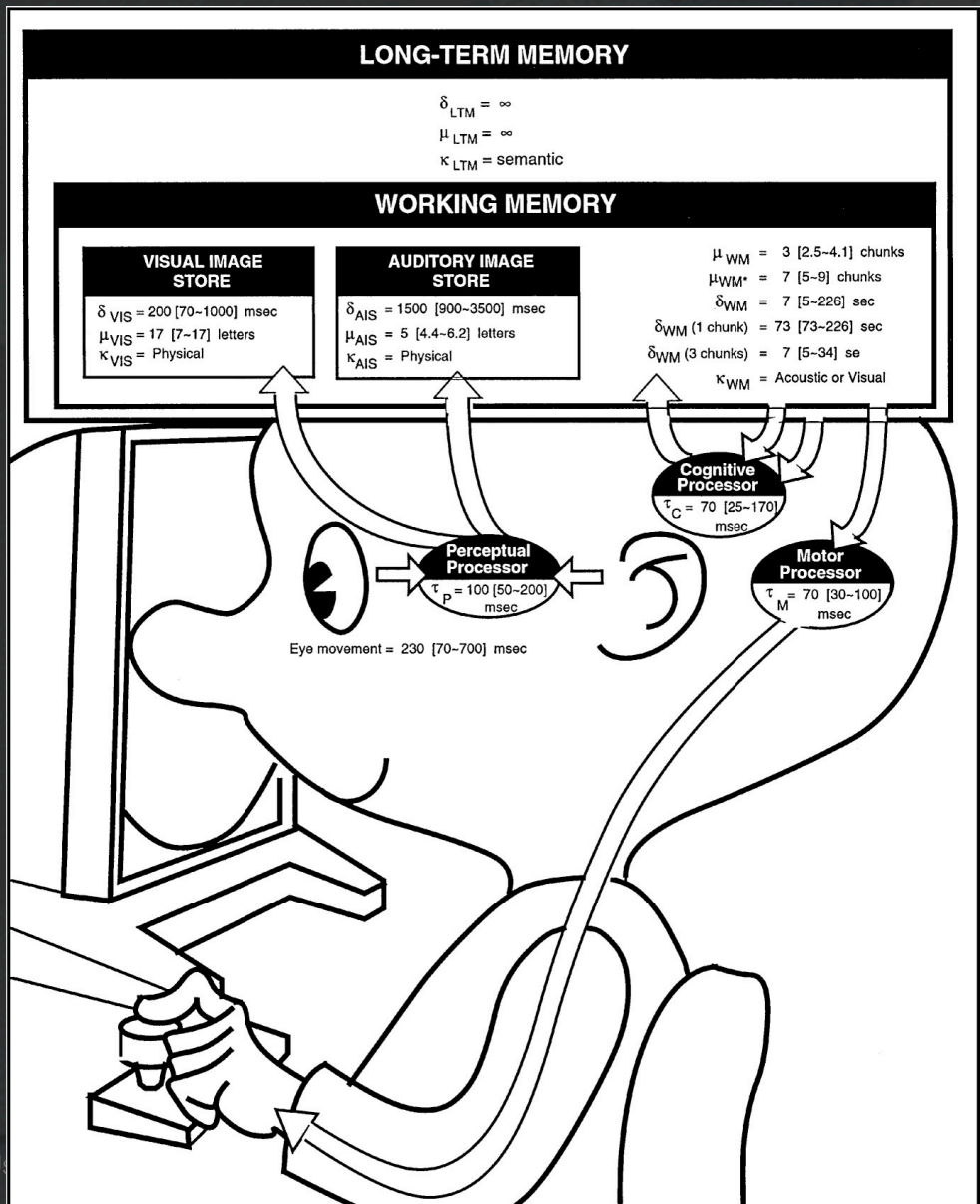
2

Start the presention

Still not working? Get help at pollev.com/app/help
or
Open poll in your web browser

The Model Human Processor

- Developed by Card, Moran & Newell (’83)
  - based on empirical data



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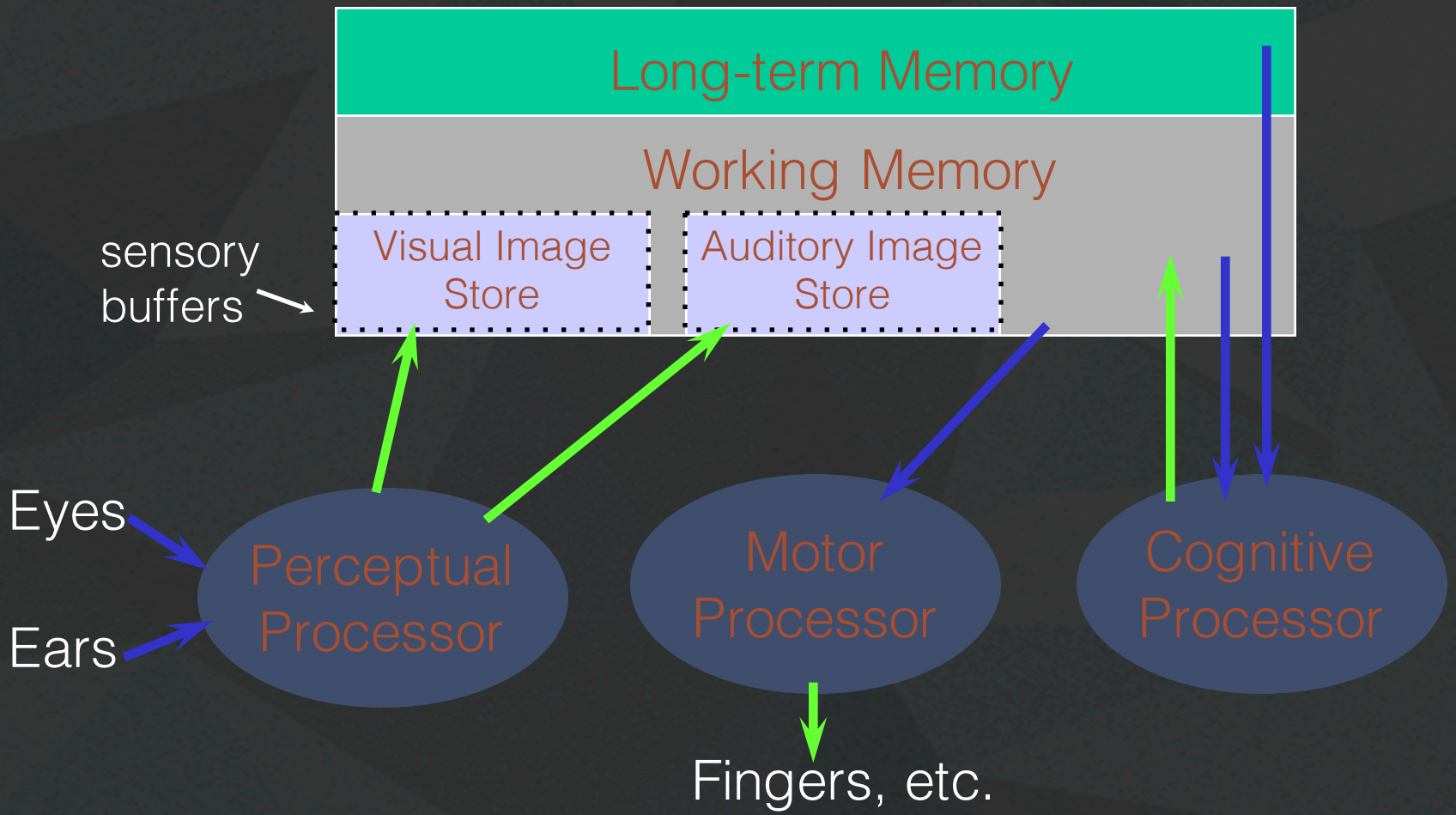
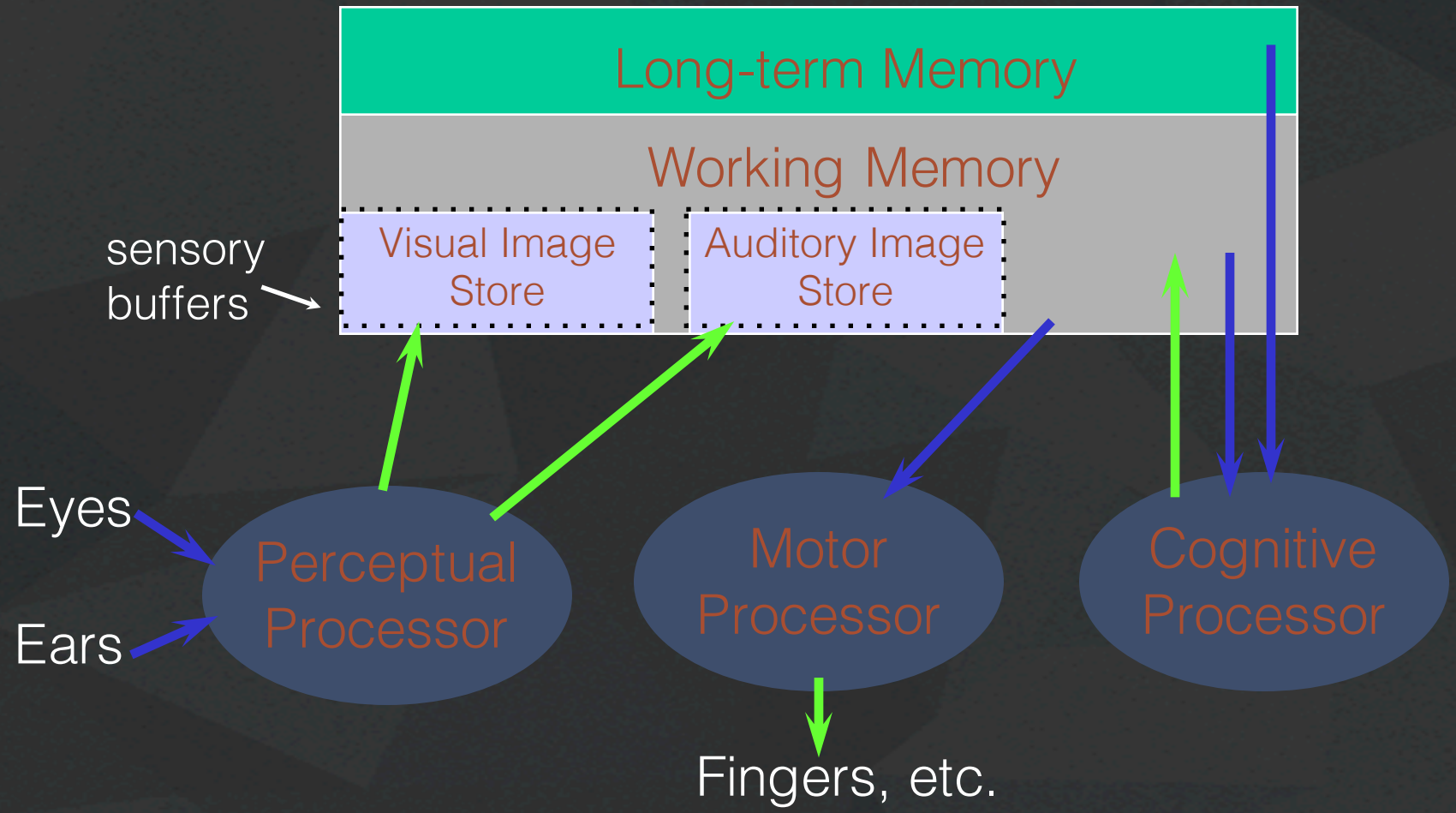


MHP Basics

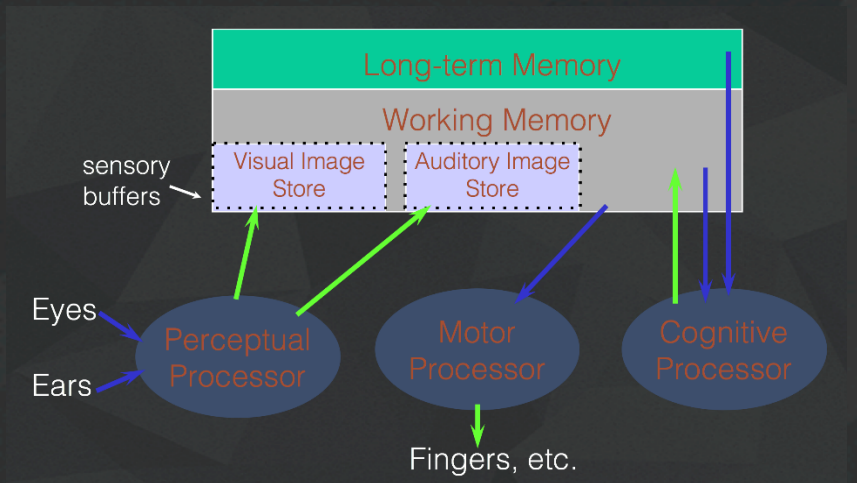
- Sometimes serial, sometimes parallel
  - serial in action & parallel in recognition
    - pressing key in response to light (serial)
    - driving, reading signs & hearing at once (parallel)
- Parameters
  - processors have cycle time (T) **~ 100 ms**
  - memories have capacity, decay time & type

What is missing from MHP?



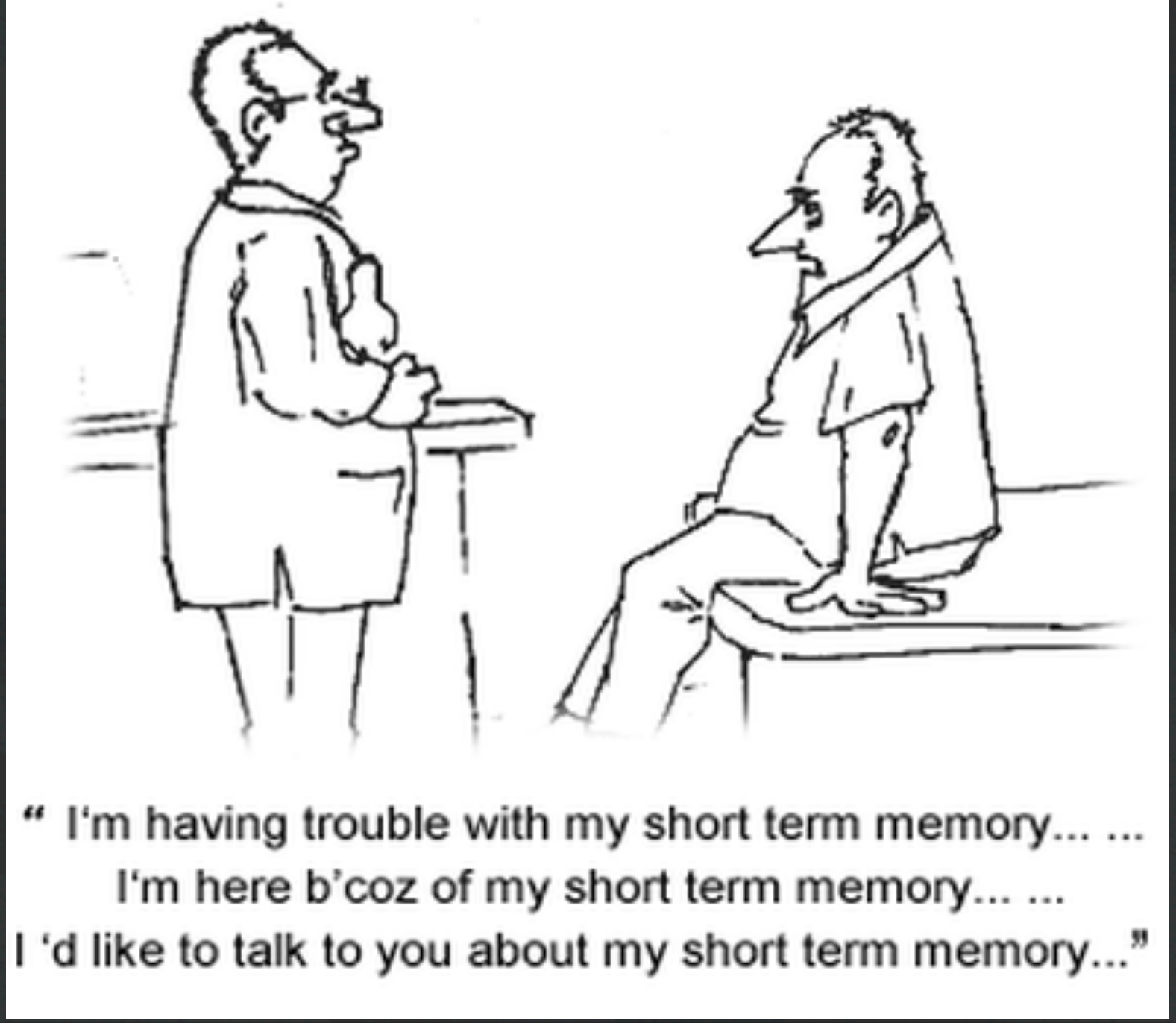
What is missing from MHP?

- Haptic memory
  - for touch



- Moving from sensory memory to WM
  - attention filters stimuli & passes to WM

- Moving from WM to LTM
  - elaboration


" I'm having trouble with my short term memory... ...
I'm here b'coz of my short term memory... ...
I 'd like to talk to you about my short term memory..."

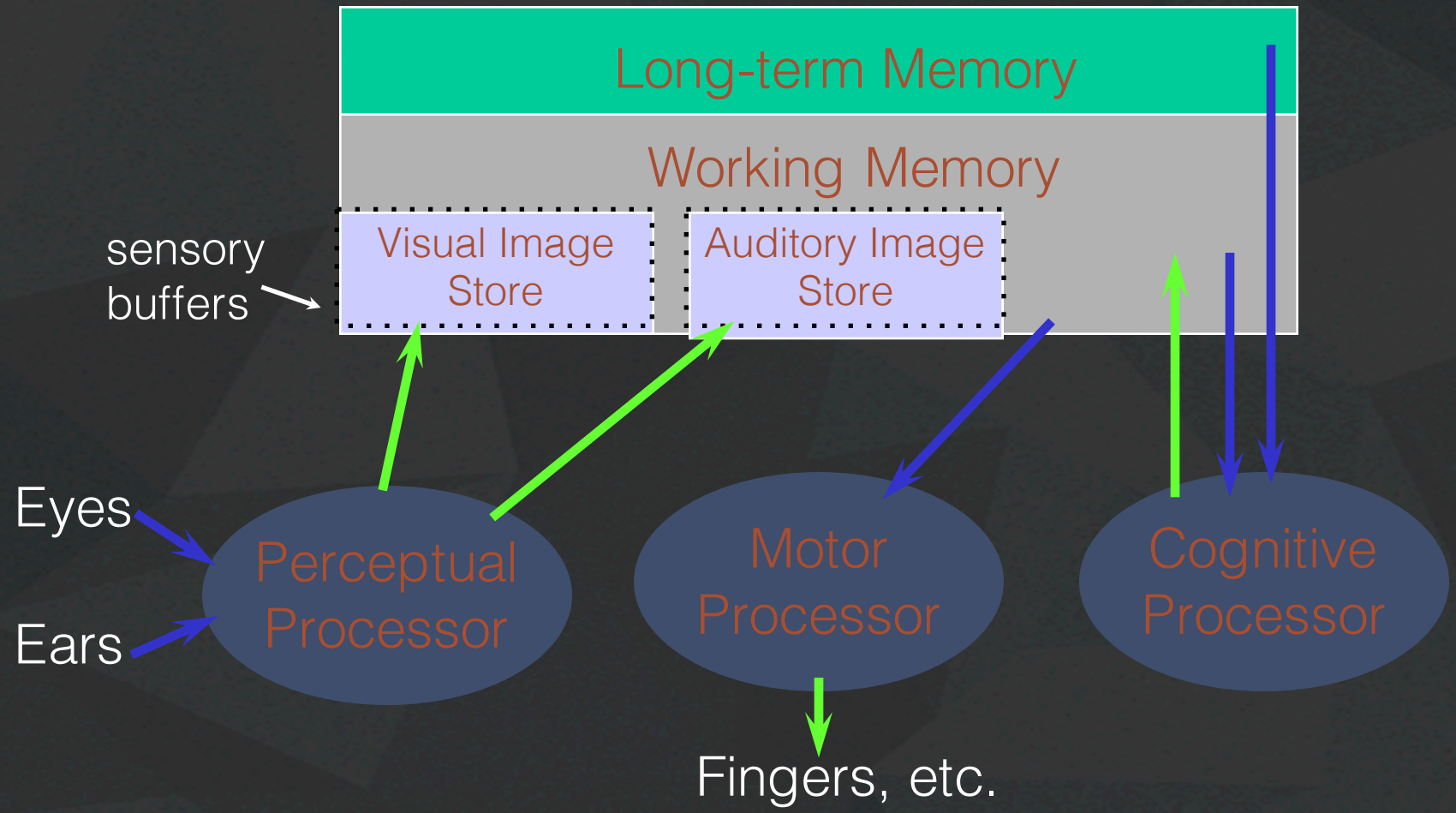
Memory

- Working memory (short term)
  - small capacity (7 ± 2 “chunks”)
    - 6174591765 vs. (617) 459-1765
    - NBCIBMGMC vs. NBC IBM GMC
  - rapid access (**~ 70ms**) & decay **(~200 ms**)
    - pass to LTM after a few seconds of continued storage
- Long-term memory
  - huge (if not “unlimited”)
  - slower access time (**~100 ms**) w/ little decay

MHP Principles of Operation

- Recognize-Act Cycle of the CP
  - on each cycle contents in WM initiate actions associatively linked to them in LTM
  - actions modify the contents of WM

MHP Principles of Operation



MHP Principles of Operation

- Recognize-Act Cycle of the CP
  - on each cycle contents in WM initiate actions associatively linked to them in LTM
  - actions modify the contents of WM
- Discrimination Principle
  - retrieval is determined by candidates that exist in memory relative to retrieval cues
  - interference by strongly activated chunks

Experiment

- Task:

  Quickly tap each target 50 times accurately

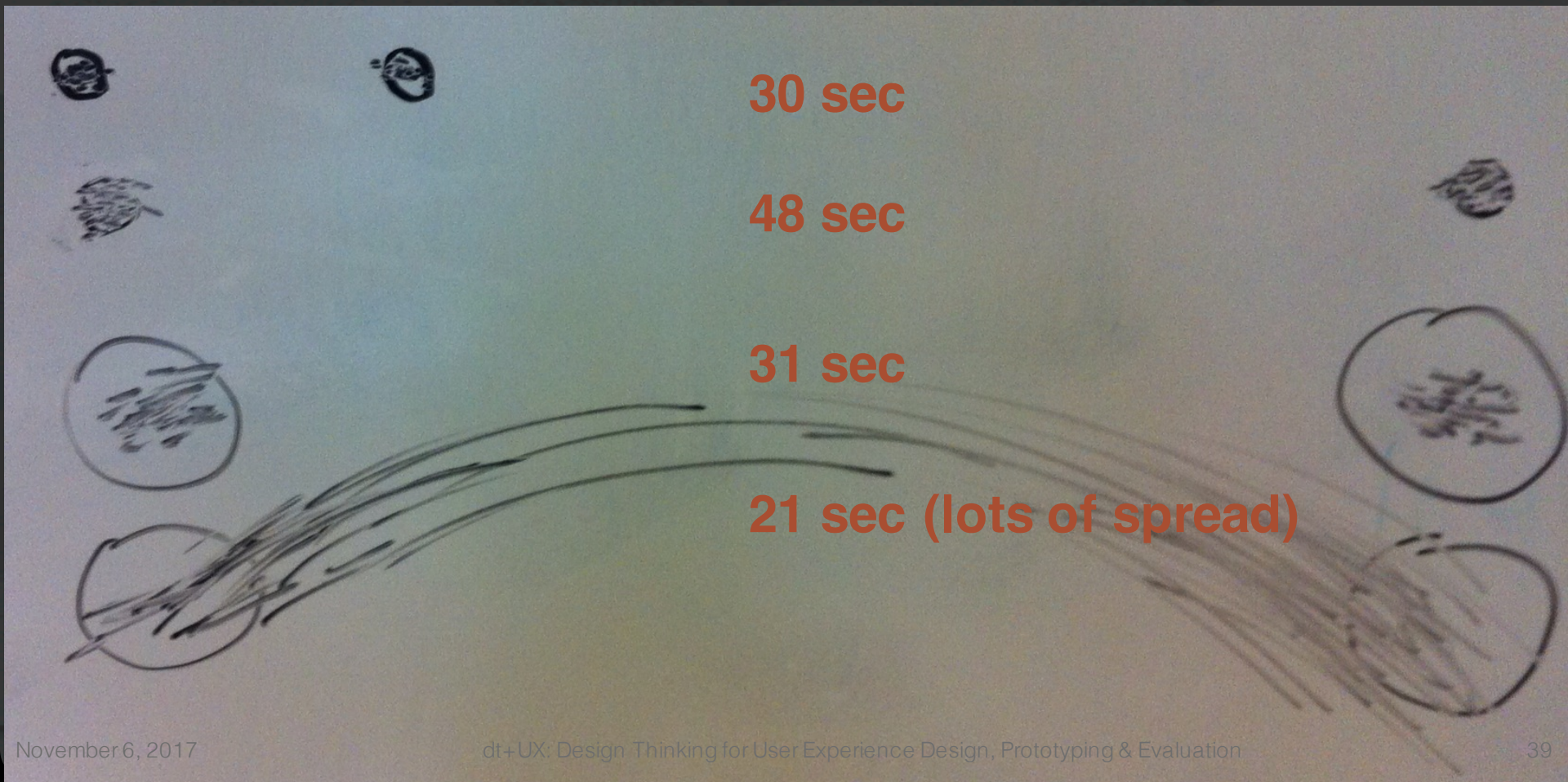
- Conditions:
  1. Two ½” diameter targets 6” apart
  2. Two ½” diameter targets 24” apart
  3. Two 2” diameter targets 24” apart
  4. Two 2” diameter targets 24” apart (no accuracy required)

- Turn to neighbor: discuss what will happen

Experimental Results

- Task:

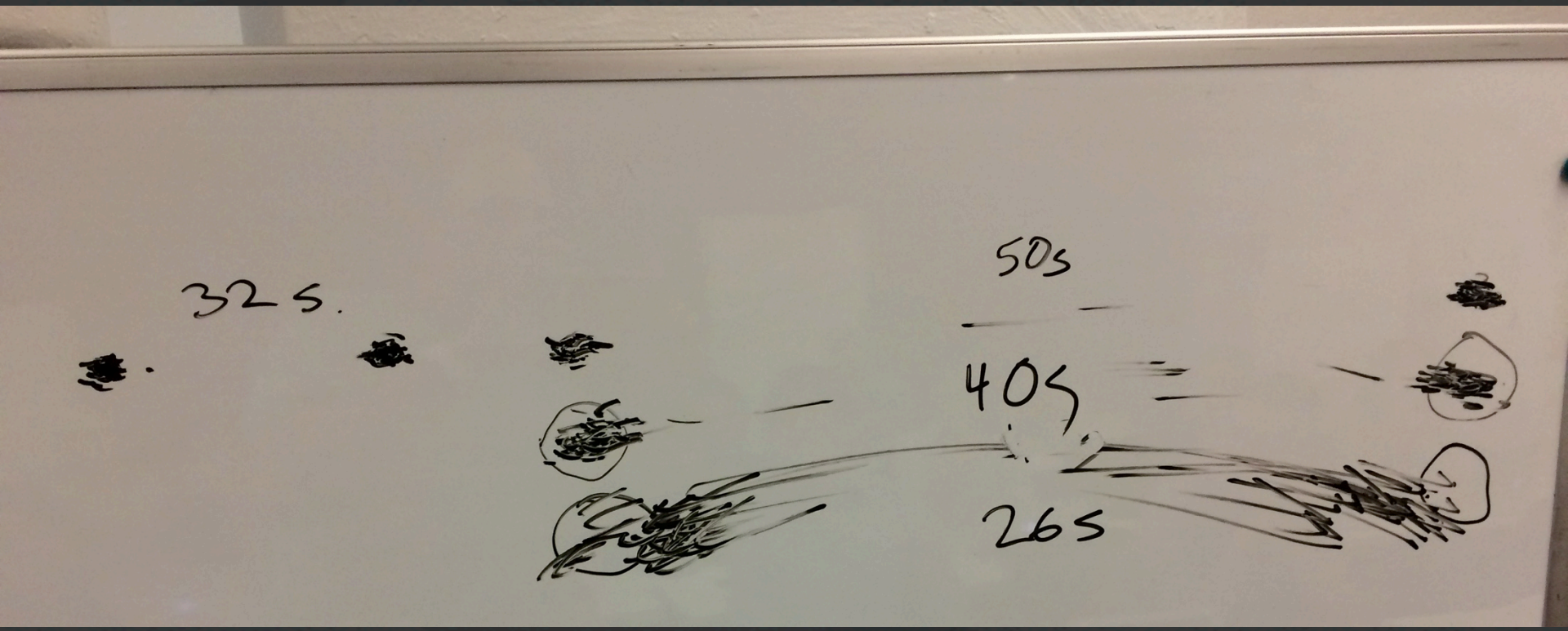
  Quickly tap each target 50 times accurately



Experimental Results

- Task:

  Quickly tap each target 50 times accurately



Principles of Operation (cont.)

- Fitts' Law
  - moving hand is a series of microcorrections
    - correction takes $T_p + T_c + T_m = 240$ msec
  - time T_{pos} to move the hand to target size S which is distance D away is given by:
    - **$T_{pos} = a + b \log_2 (D/S + 1)$**
  - summary
    - time to move the hand depends only on the ***relative precision*** required

Fitts' Law Example

Pop-up Linear Menu

Today
Sunday
Monday
Tuesday
Wednesday
Thursday
Friday
Saturday

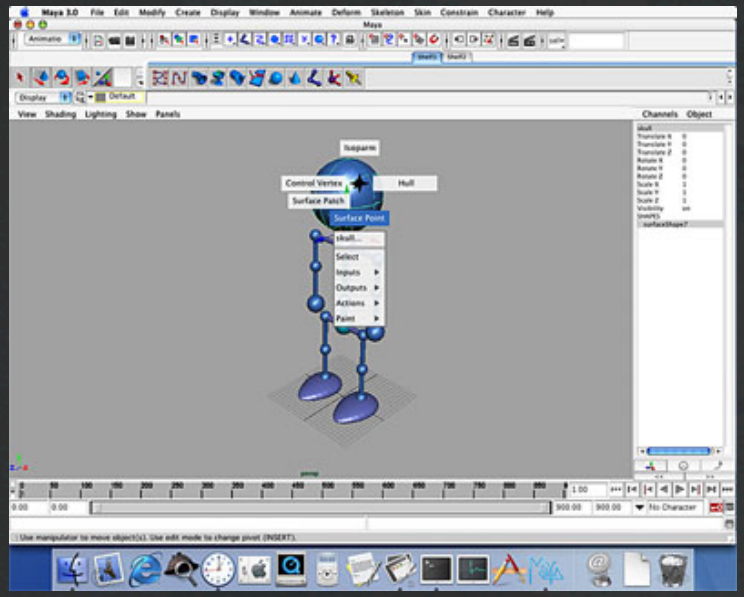
Pop-up Pie Menu

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

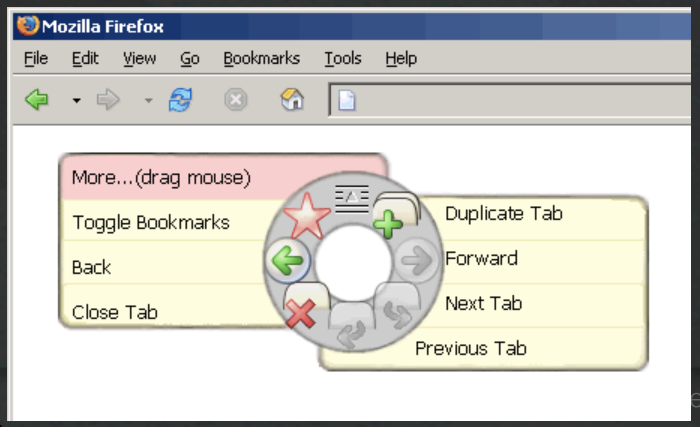
Pie Menus in Use Today

The Sims

Rainbow 6



Maya



Apple Watch

Simple Experiment

- Volunteer
- Start saying ***colors*** you see in list of words
  - when slide comes up
  - as fast as you can
- Say “done” when finished
- Everyone else time it…

Paper

Home

Back

Schedule

Page

Change

Simple Experiment

- Do it again
- Say “done” when finished

Bandana

Forward

Home

Test

Basket

Paper

Simple Experiment

- Do it again
- Say “done” when finished

Yellow

White

Black

Blue

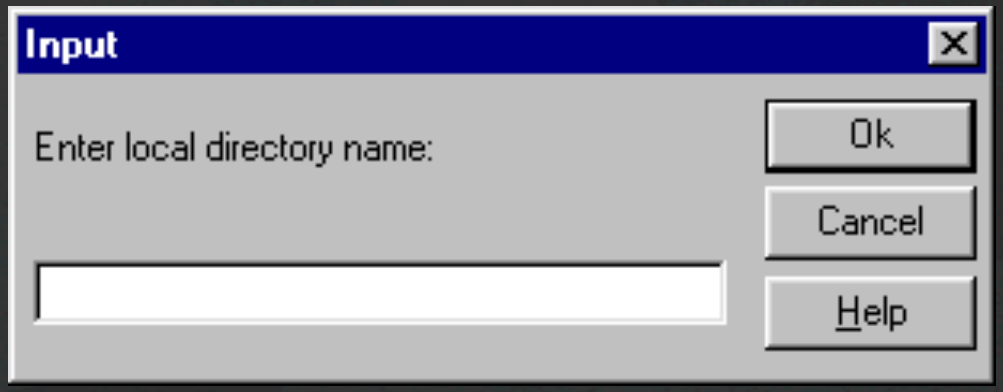
Red

Green

Memory

- Interference
  - two strong cues in working memory
  - link to different chunks in long term memory
- Why learn about memory?
  - know what's behind many HCI techniques
  - helps you understand what users will "get"
  - aging population of users

Design UIs for Recognition over Recall



- Recall
  - info reproduced from memory
  - e.g., command name & semantics
- Recognition
  - presentation of info provides knowledge that info has been seen before
  - e.g., command in menu reminds you of semantics
  - easier because of cues to retrieval
    - cue is anything related to item or situation where learned
    - e.g., giving hints, icons, labels, menu names, etc.

Human Abilities Summary

- Color can be helpful, but pay attention to
  - how colors combine
  - limitations of human perception
  - people with color deficiency
- Model Human Processor
  - perceptual, motor, cognitive processors + memory
  - model allows us to make predictions
- Memory
  - three types: sensor, WM & LTM
  - interference can make hard to access LTM
  - cues in WM can make it easier to access LTM
- Key time to remember from MHP: **~100 ms** cycle time and memory access time

Further Reading
Vision and Cognition

- Books
  - *The Psychology Of Human-Computer Interaction*, by Card, Moran, & Newell, Erlbaum, 1983
  - *Human-Computer Interaction*, by Dix, Finlay, Abowd, and Beale, 1998.
  - *Perception*, Irvin Rock, 1995.

- Pages 66-99 of "Cognitive Aspects in Interaction Design", from *Interaction Design*, 3rd Edition by Rogers, Sharp, & Preece

- Applying Fitts' Law to Mobile Interface Design by Justin Smith

Next Time

- Conceptual Models & Interface Metaphors
  - Read "The Psychology of Everyday Things" (Ch. 1), from *The Design of Everyday Things* by Donald Norman

- Studio
  - Ad-hoc group heuristic evaluation
  - Must be present to get credit on assignment