Introduction to HCI

Human Abilities and Sketching

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Today

- Quiz [5 min]
- Discussion of readings [10 min]
- Lecture [50 min]
- Project discussions [10 min]

Discussion on requirement readings [10 min]

- A randomly assigned team will summarize and discuss readings:
  - What you learned?
  - What surprised you?
  - How can you use this knowledge in your project?

Learning goals

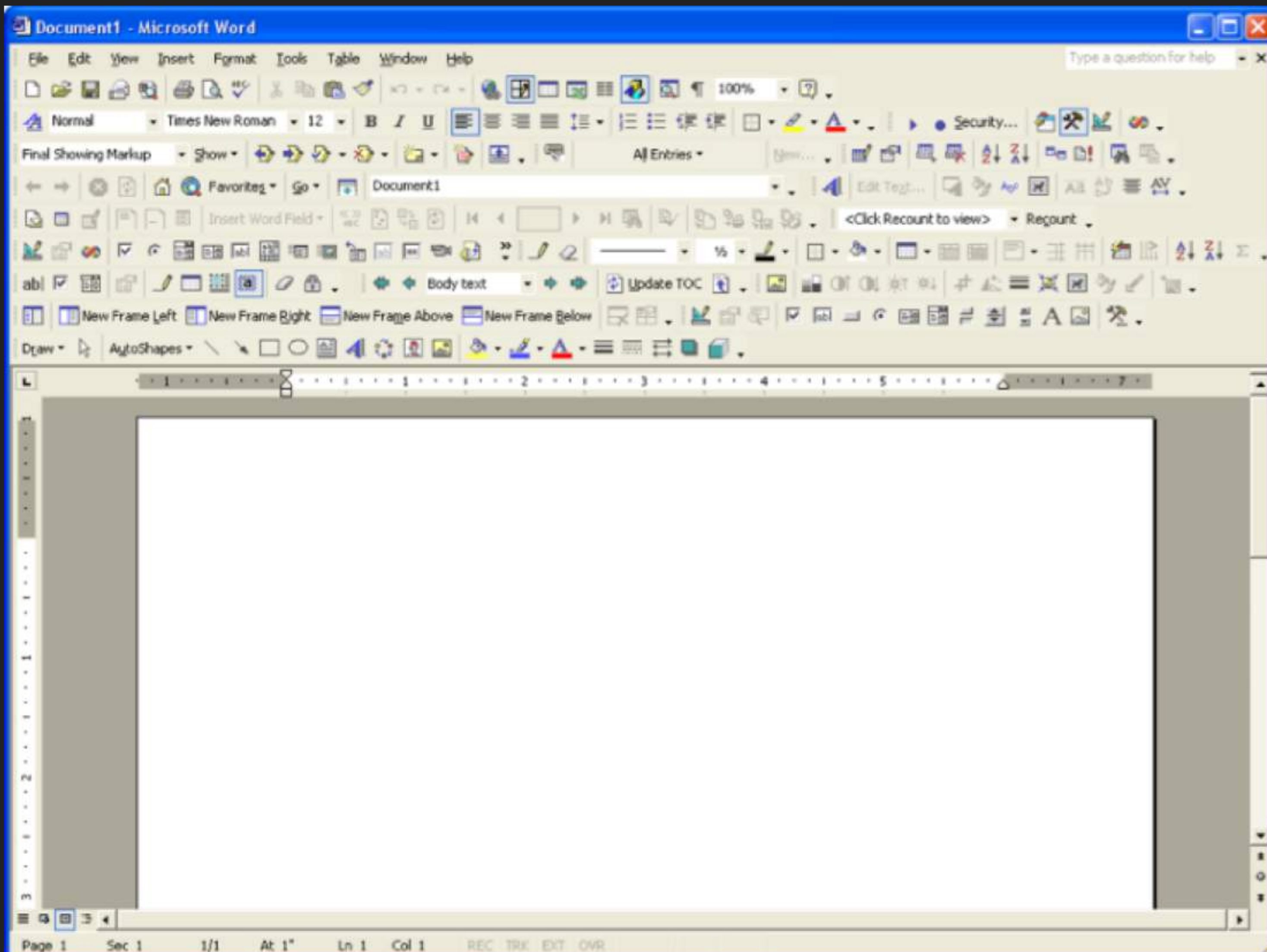
- Understand human abilities, perception and action subsystems.
- Understand models and theories of human performance and abilities.
  - Attention, divided attention, color, focus, motor, etc.
- Be able to identify and apply knowledge of human abilities in designing interfaces for humans.
- Understand vision systems, change blindness examples, and how related to interface design.
- Explain fitts' law, how to revisit an interface considering this principle, and how else fitts' law can be used.

Human-centered design

- Beyond understanding the tasks (task-centered design), the type of users (persona-based design) that we want to support, as well as an appropriate conceptual model

- We must understand human abilities in order to do detailed interface and interaction design

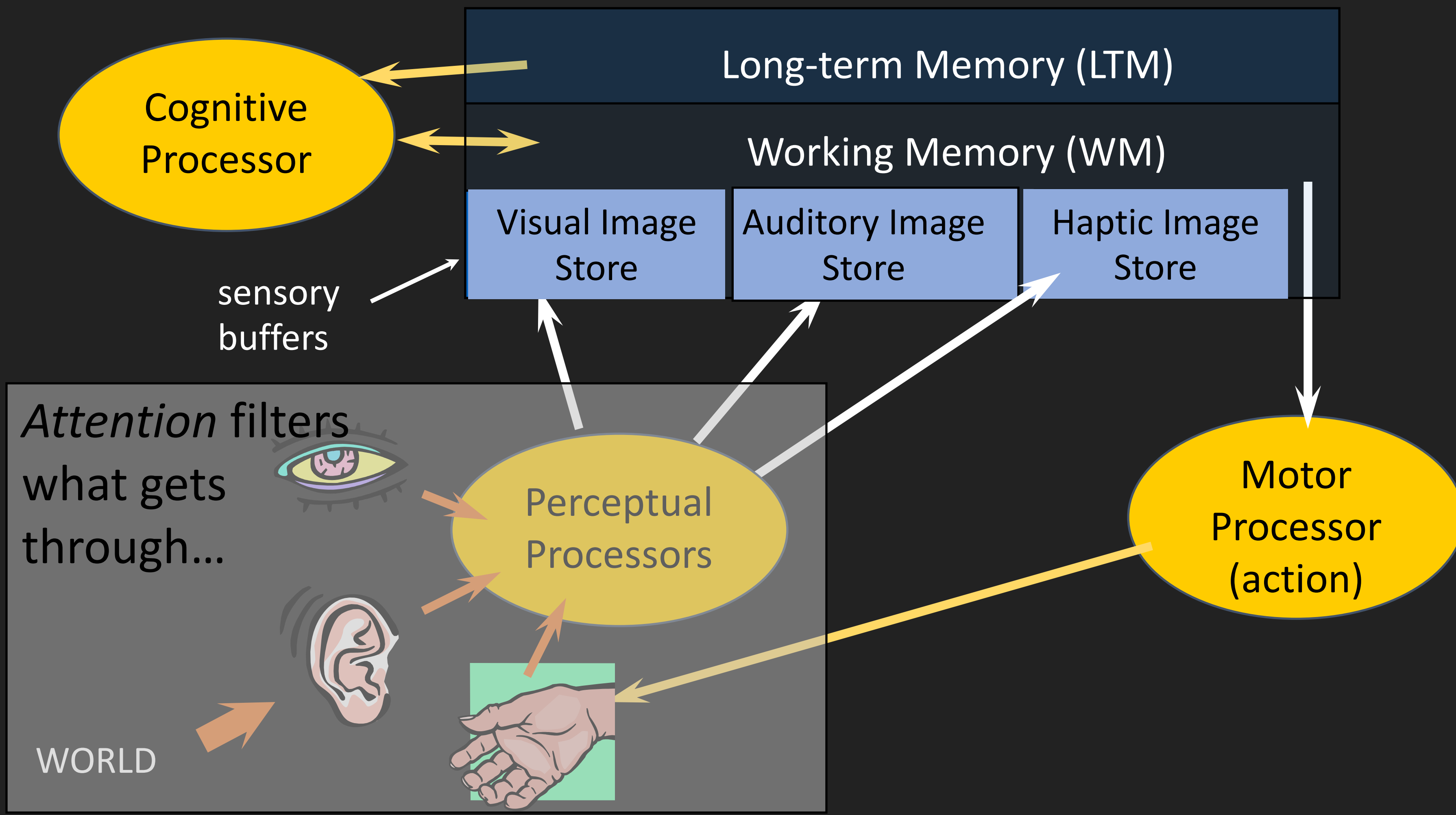
Is this a good interface?



How do we characterize human abilities?

- Where do we start?
- With a model of the human.

Model Human Processor (MHP) :
one model for perception → memory → cognition



- "The Psychology of Human-Computer Interaction", 1983 Card, Moran, & Newell

Perception & action subsystems

- Subsystems may operate in parallel (theory):

Input (perception):

- **Visual** subsystem for what we see (most studied)
- **Acoustic** subsystem for what we hear
- **Haptic** subsystem for what we feel

Output (action):

- **Vocal** (**articulatory**) subsystem for what we speak
- **Motor** subsystem for how we move
- **Brain waves!** Think to interact (brain-computer interfaces)

Smellmap: Amesterdam

Kate McLean, IEEE vis 2014, art program
https://visap.uic.edu/2014/art/Smellmap.pdf

Analogies to a computer system

- Can be a helpful way to think about it:
- Perception, audition, motor control = **system I/O**
  - Each has associated memory (“cache”)
  - Limits on input speed (“sample rate”) and throughput capacity
- Cognition = **CPU**
  - Includes multi-level main memory
  - Multithreading ? *we don’t really understand how this works in people*

Use analogy with caution:
some systems do NOT work this way.

Takeaways for this lecture

- When designing for humans, you need to factor in knowledge of their abilities.
- There are many models and theories of human performance / ability, we will touch on only a few today.
- This lecture brings together content from 4 different lectures in HCI. Each of those lectures only scratches the surface, so this one is even more abridged.

Attention

- Attention is a filter on perceptual input.

- It's one important mechanism for information moving between types of memory
  - (image store -> working memory -> long term member)

Perceptual limitations

The following is intended to illustrate just how bad our senses really are

Example:
change blindness

- In upcoming images,
  - Image will blink or flicker
  - Image changes with each blink

Raise your hand as soon as you identify change

Images from o'regan, rensink & clark 1999

Airplane

Diners

Airplane without blink:

Diners without blink:

Vision system: like a camera?

Seems like it:

Camera: keep steady, adjust focal lens length

Eye: focal point always moving, yet we perceive the world as being sharp and in focus

But how does it really work?

Camera: film is exposed all at once by light from scene

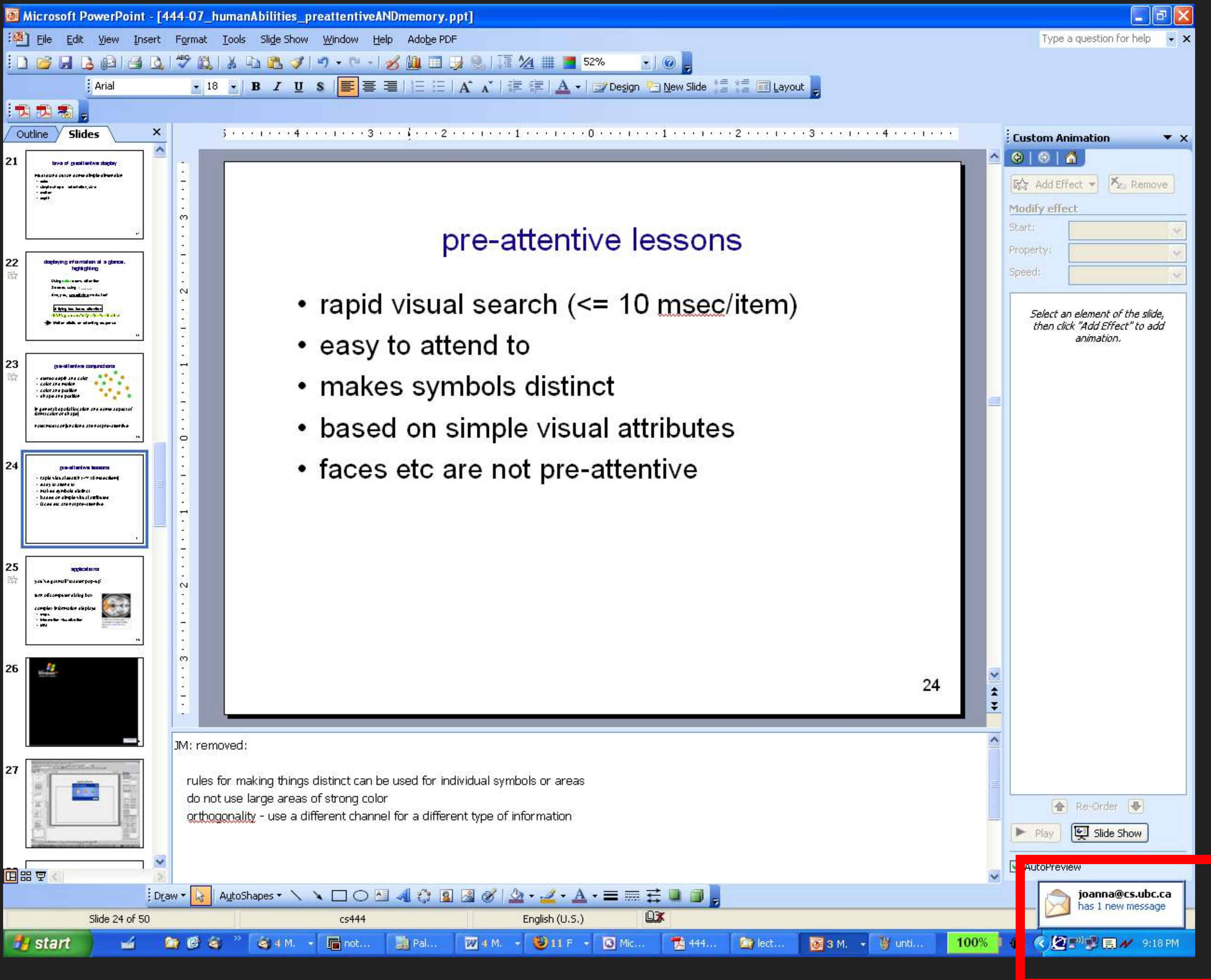
eye: electrical signals travel to brain, which *gradually* + *selectively updates* a mental image of a scene

→ camera is a poor metaphor for vision!

How does this relate to interface design?

- What are some everyday situations where ‘change blindness’ occur?
- For those situations, how might you help by changing the design?

Divided Attention


Microsoft PowerPoint - [444-07_humanAbilities_preattentiveANDmemory.ppt]
File Edit View Insert Format Tools Slide Show Window Help Adobe PDF
Type a question for help
52%
Arial 18
Design New Slide Layout
Outline Slides
Custom Animation
Add Effect Remove
Modify effect
Start:
Property:
Speed:
Select an element of the slide, then click "Add Effect" to add animation.
pre-attentive lessons
rapid visual search (<= 10 msec/item)
easy to attend to
makes symbols distinct
based on simple visual attributes
faces etc are not pre-attentive
24
JM: removed:
rules for making things distinct can be used for individual symbols or areas
do not use large areas of strong color
orthogonality - use a different channel for a different type of information
Re-Order
Play Slide Show
AutoPreview
joanna@cs.ubc.ca
has 1 new message
Draw AutoShapes
Slide 24 of 50
cs444
English (U.S.)
start
100%
9:18 PM

color

color can substantially *improve* user interfaces…

but inappropriate use can severely *reduce* usability

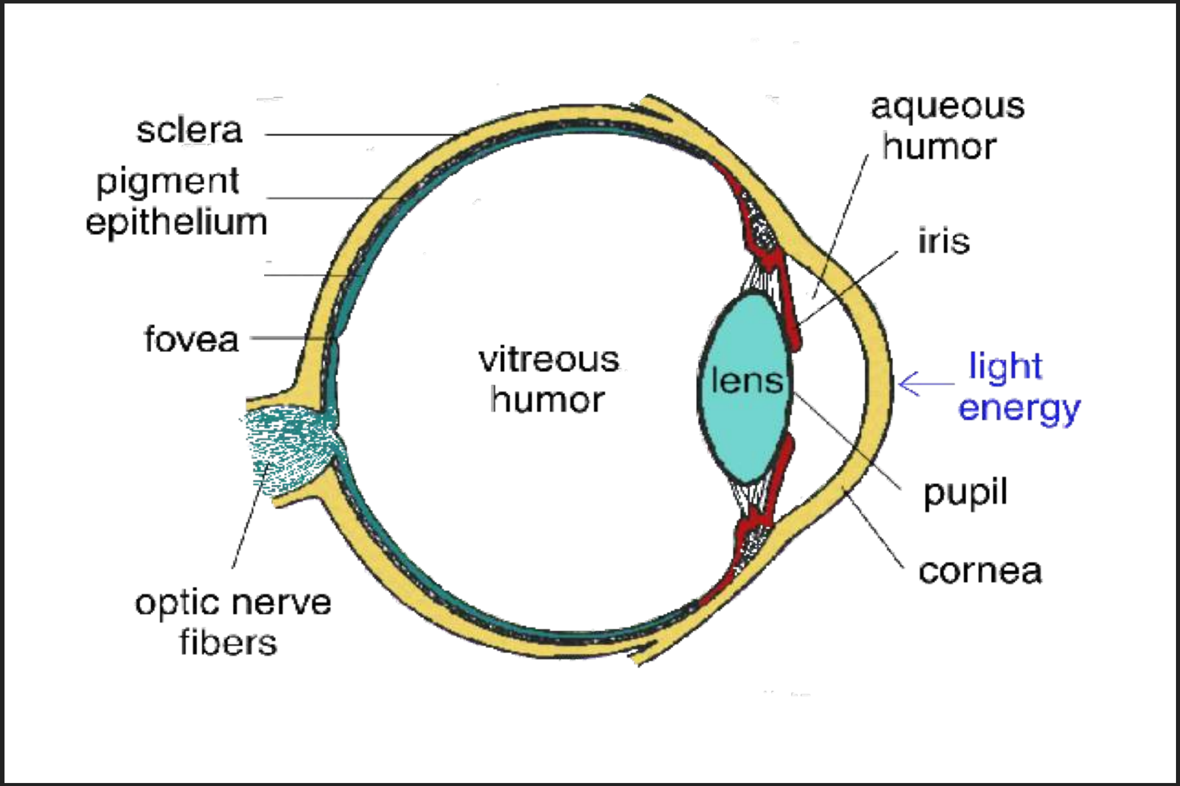
Johannes Itten, color theory

Itten theorized seven types of color contrast by:

(1) hue
(2) value
(3) temperature
(4) complements
(5) simultaneous contrast
(6) saturation
(7) extension

Itten leading his students in physical exercise

human visual system



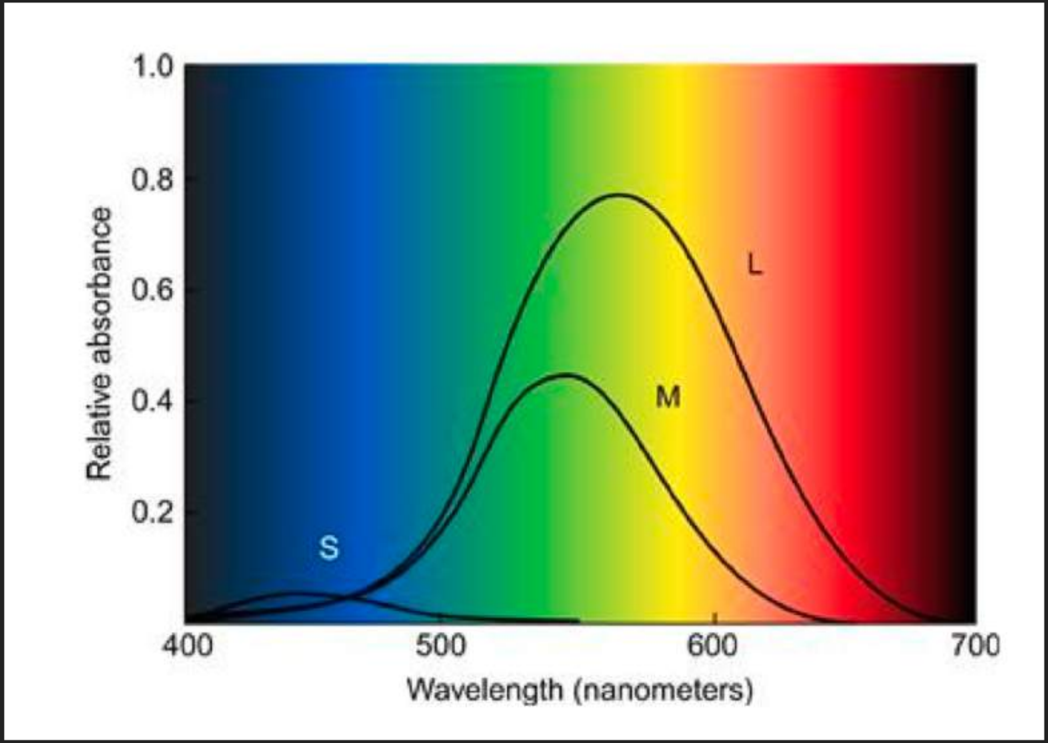
- light passes through lens
- focused on retina

Retina

- Center of retina (fovea) has most of the cones
  - Allows for high acuity of objects focused at center
- Edge of retina (periphery) is dominated by rods
  - Allows detecting motion in periphery

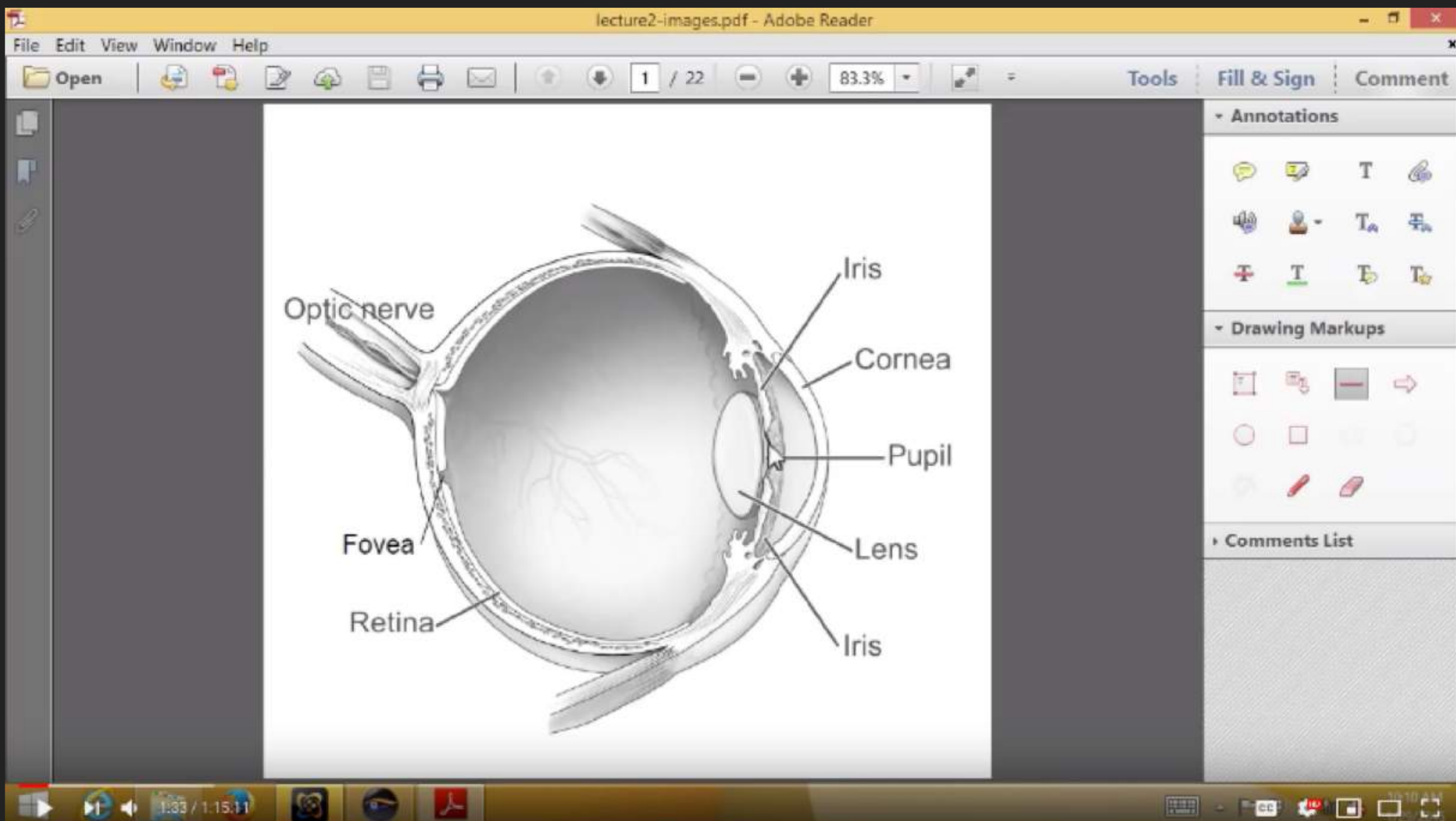
Trichromacy theory

- color vision is three dimensional, because there are three cone-receptor types in the retina
- Cone receptors: short, medium, long (really more yellow)



from *Ware (2013). Information Visualization, Perception for design*

Digital Image Processing Lecture



Rich Radke, Rensselaer Polytechnic Institute: https://www.youtube.com/watch?v=eK4ZAsKgCg4

How we see colors

Colm Kelleher: https://www.youtube.com/watch?v=l8_fZPHasdo

Focus

- Wavelengths of light focus at different distances behind eye's lens

→ Need for constant refocusing (causes fatigue)

Most people see the red
closer than the BLUE
but some see the
opposite effect

reproduced from *Ware (2013). Information Visualization, Perception for design*

But Trichromacy theory Insufficient…

Blue text on a dark background to be avoided. We have few short-wavelength sensitive cones in the retina and they are not very sensitive.
Older users need brighter colors.

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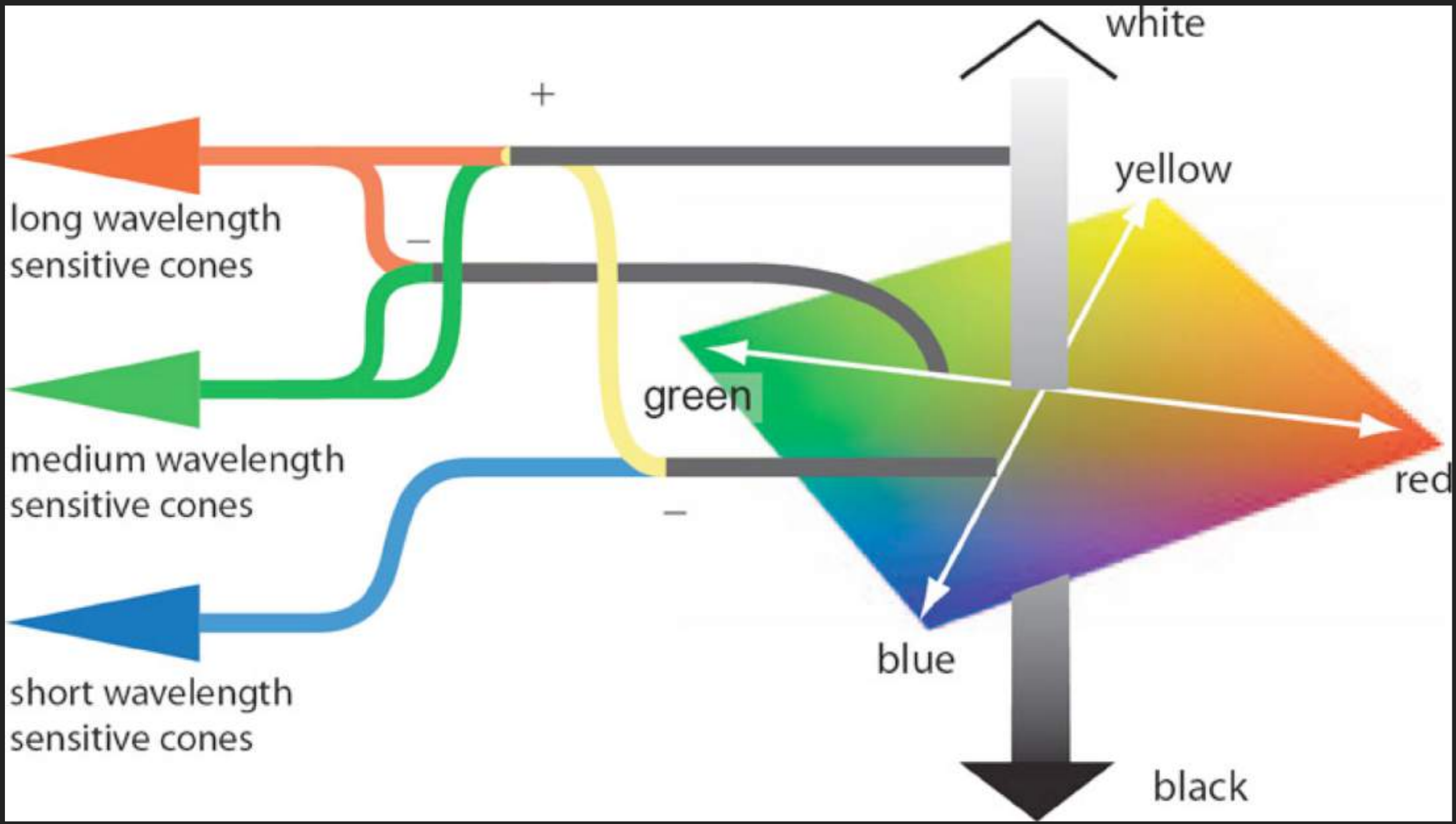
Older users need brighter colors.

Showing small yellow text on a white background is a bad idea.
Pure yellow excites both our M and L cones, making yellow the brightest of colours.
Need a lot of luminance contrast

reproduced from *Ware (2013). Information Visualization, Perception for design*

Color channels: opponent process theory



Input from cones processed into three distinct channels immediately after receptors

From *Ware (2008). Visual Thinking for Design. p68*

luminance “channel”

- Carries ~2/3 more details than either of the chromatic channels
- Therefore chromatic channels alone not suitable for fine details, small fonts, etc.

Implications:

- Luminance contrast critical for fine details
- Harder to focus on edges created by color alone
    - Best to use both luminance & color differences

Color guidelines

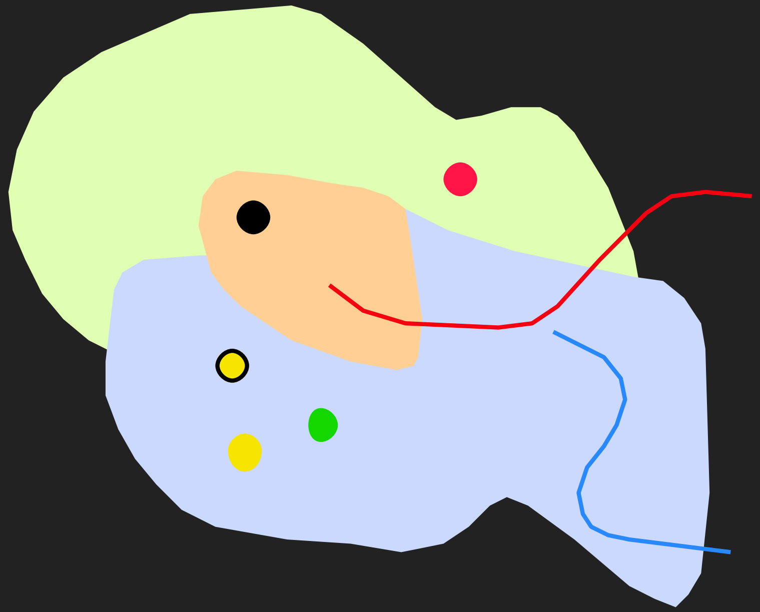
- Generally want to avoid single-color distinctions and encodings (color blindness)
  - E.G.  Better than 

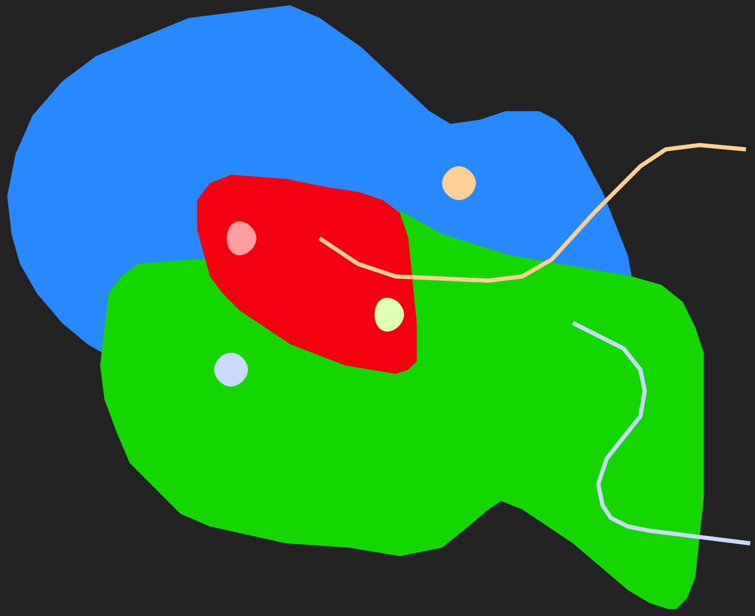
Color Guideline

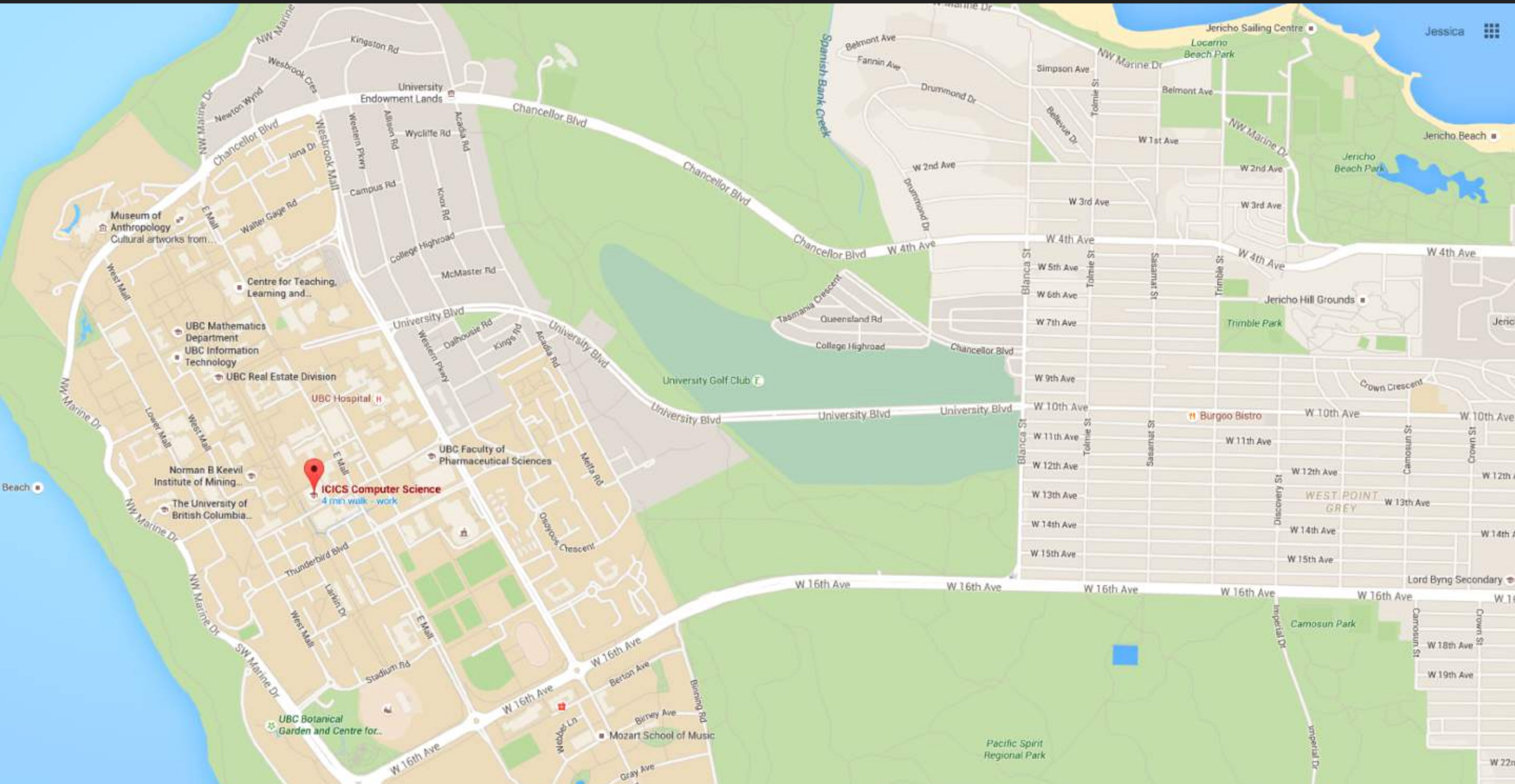
- Don’t rely on color (changes) in the periphery to “grab attention”

color guidelines

- large areas: low saturation
- small areas: high saturation (strong contrast with background)

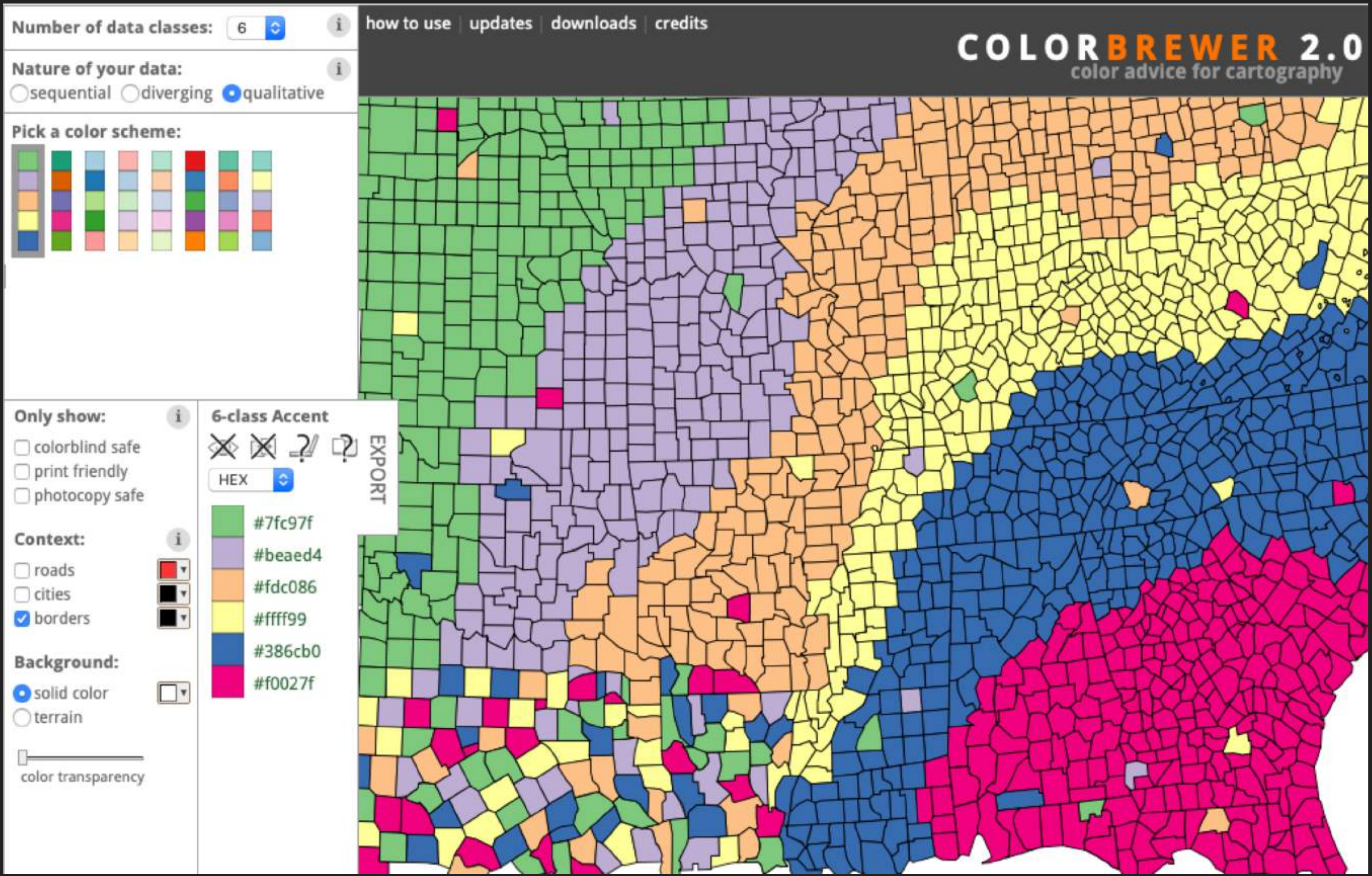






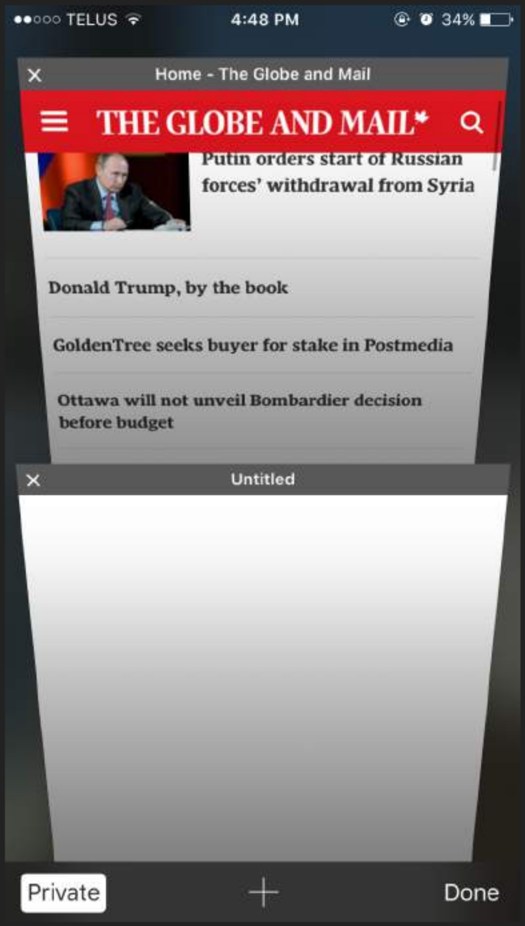
- Red objects are processed pre-attentively (10 ms or less per item) – they “pop out” – we attend to them first.
- Attention and color are related!

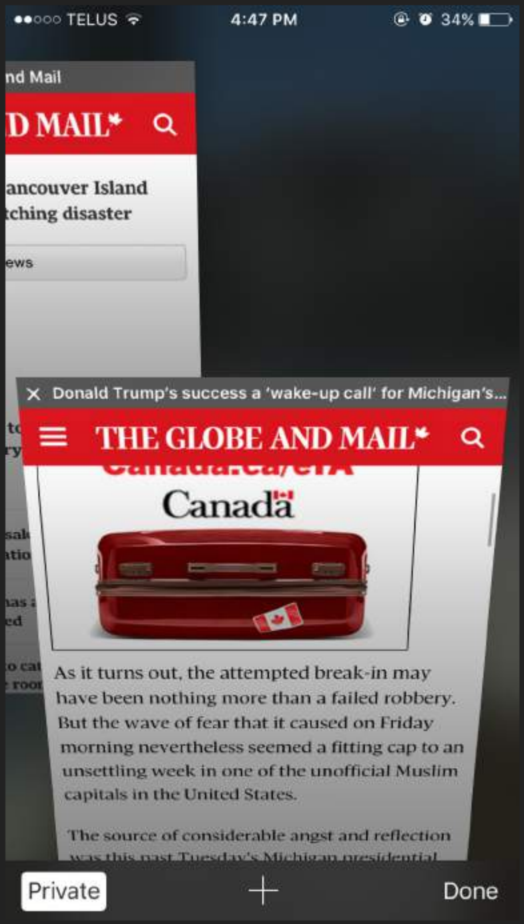
ColorBrewer



Motor

Predict performance / Justify design





- Compare the ‘swipe left to close’ interaction over ‘select the x to close’ interaction. Which do you think is better?

Fitts' Law

Paul Fitts, 1954

$$\underbrace{MT}_{\text{Movement Time}} = a + b\underbrace{\log_2\left(\frac{D}{W}+1\right)}_{\text{Index of Difficulty } (ID\ [bits])}$$

Movement Time — Index of Difficulty (*ID [bits]*)

Index of Performance (*IP*) = *ID/MT* (bits/s)

A simple mathematical model of human **pointing performance**

Fitts' Law

Paul Fitts, 1954

task difficulty for selecting a target (such as a menu item or icon)

is proportional to the *distance* (D) to the target and

inversely proportional to the *width* (W) of the target

How ELSE can we use Fitts' Law?

So what can we do with this information?

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

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

Other aspects of motor…

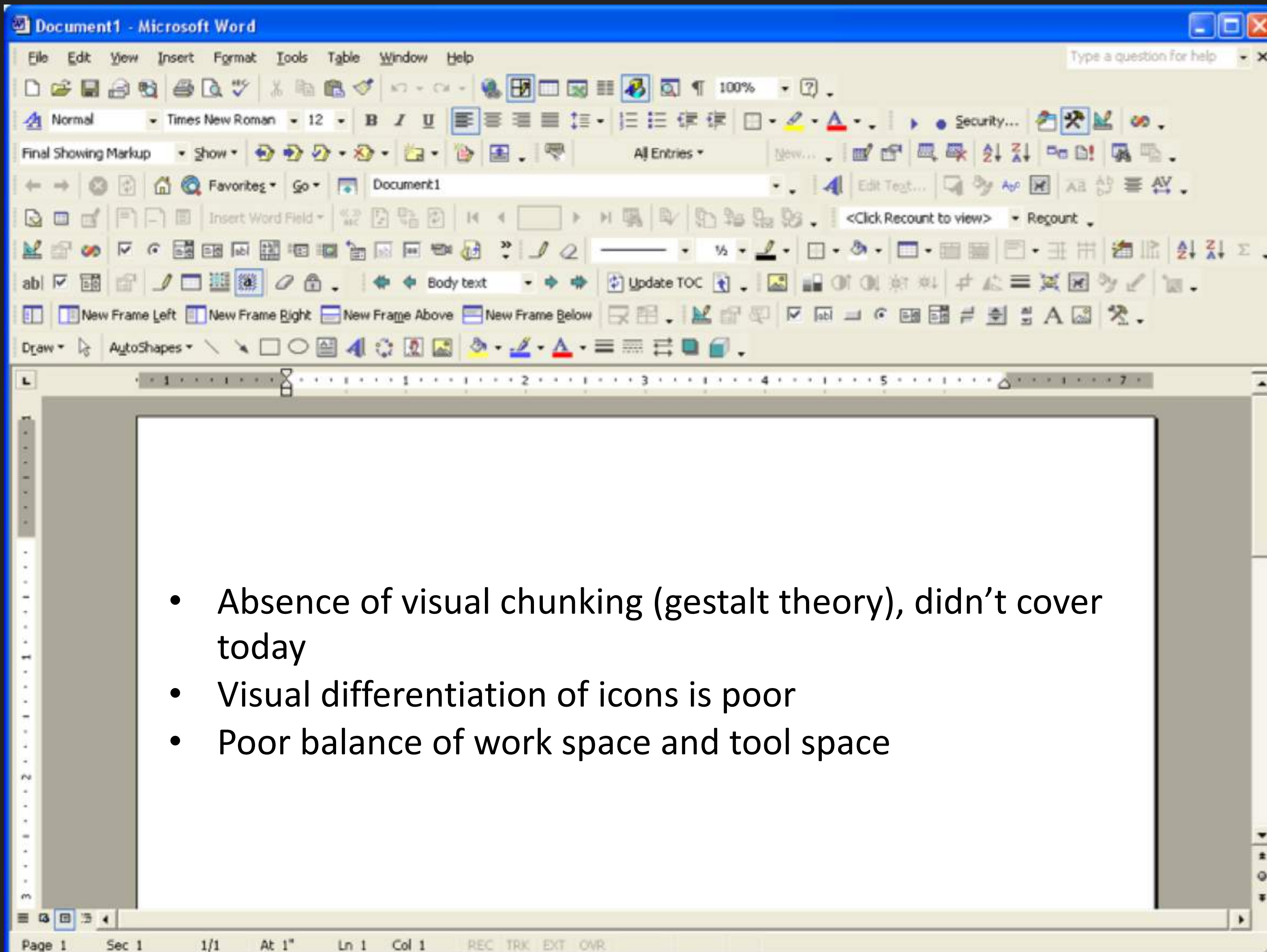
Tactile findability: “touch” keyboards

physical keys

“soft” keys have other benefits

tactus “bubble” keyboard: best of both?

Back to this interface…



- Absence of visual chunking (gestalt theory), didn’t cover today
- Visual differentiation of icons is poor
- Poor balance of work space and tool space

Key takeaways

- When doing your research, ask yourself what aspect of human ability impact your design?
- If you are designing a…
- usable security system that involves passwords -> human memory
- biomedical tele-surgery device -> haptics and motor
- e-book reader for elderly people -> vision, motor, cognition changes across the lifespan

On deck…

- Next class is canceled due to Monday schedule

- Second project milestone: Ideate
    - due on Oct 15th

Johannes Itten, artwork