Introduction to HCI
Fall 2021

Human Abilities

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Logistics

- Milestone 3 due tonight

- Final Demo
  - Presentation
  - Report
    - Description is out by tomorrow

Logistics

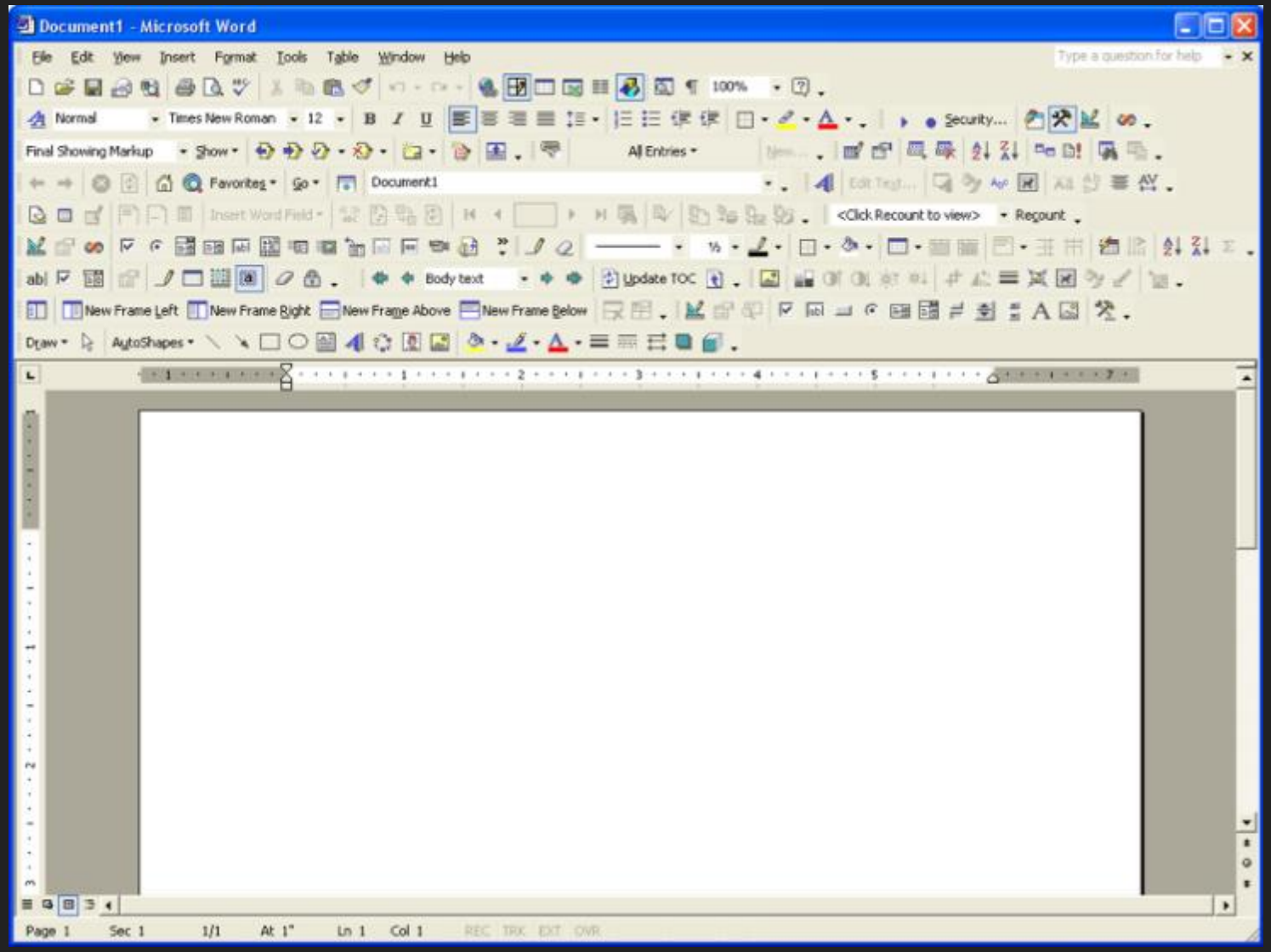
- Final demo presentation
  - **Attendance is mandatory**
  - Grading rubric
    - Problem and solution
    - Prototype
      - Features
      - Usability
      - Aesthetics
    - Evaluation
    - **Project Participation**

Learning goals

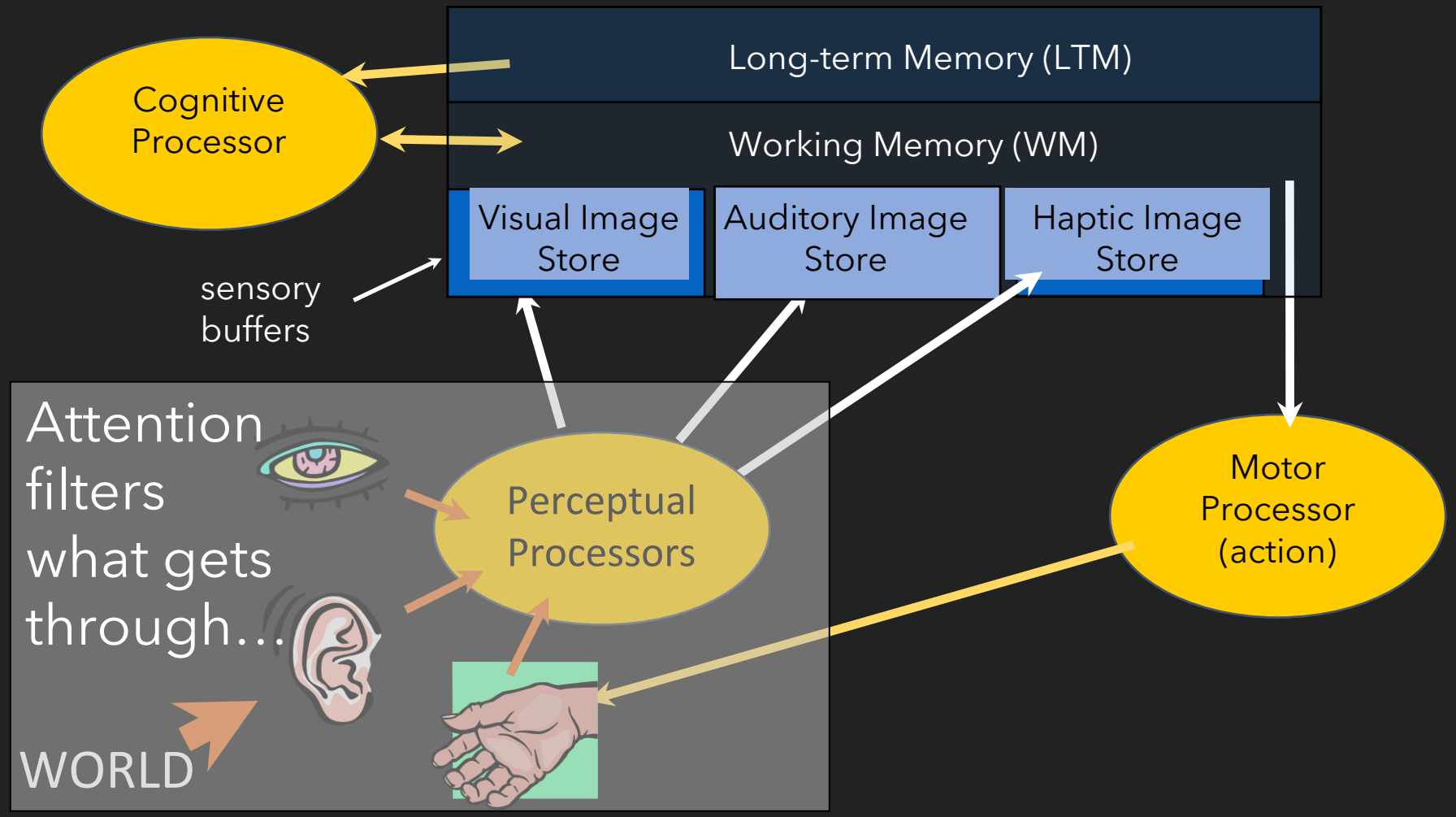
- Understand human abilities, perception and action subsystems.
- Understand models and theories of human performance and abilities.
    - Attention, divided attention, color, focus, motor, etc.
- Be able to identify and apply knowledge of human abilities in designing interfaces for humans.

- Explain fitts' law, how to revisit an interface considering this principle, and how else fitts' law can be used

Is this a good interface?



Model Human Processor (MHP) : 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: Amsterdam

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.

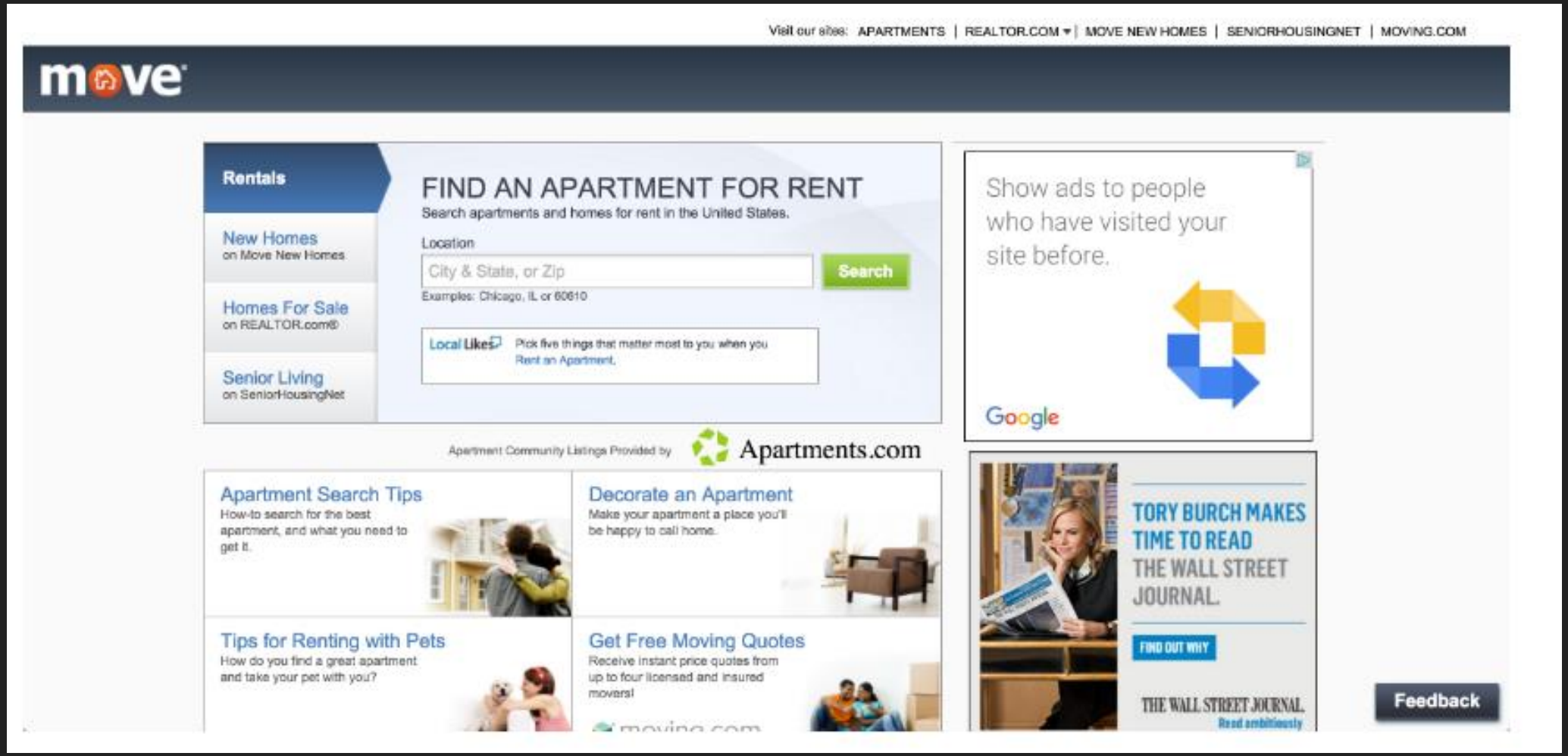
- There are many models and theories of human performance / ability, we will touch on only a few today.

Attention

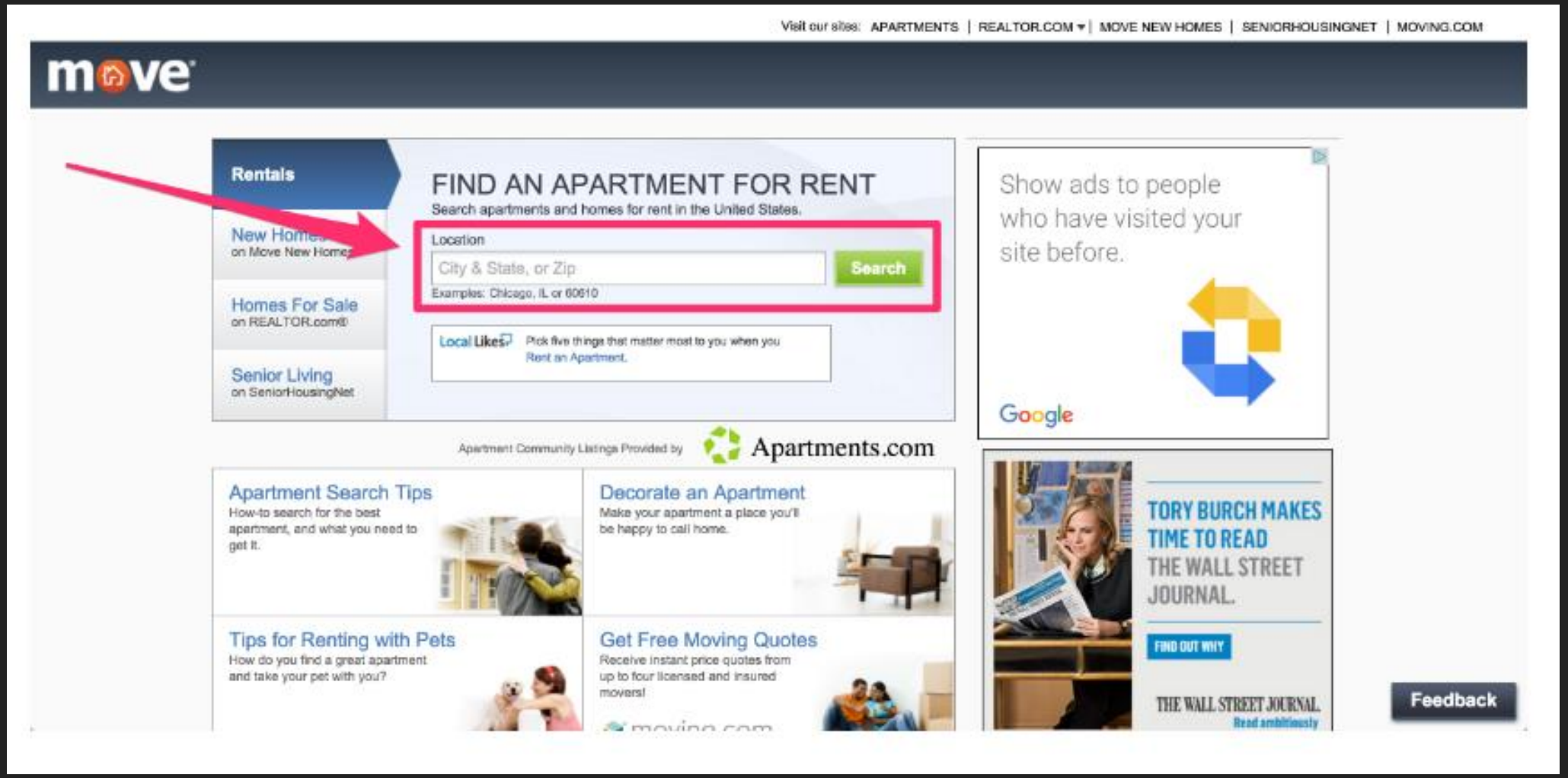
- Attention is a filter on perceptual input.

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

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



https://www.usertesting.com/blog/limited-attention



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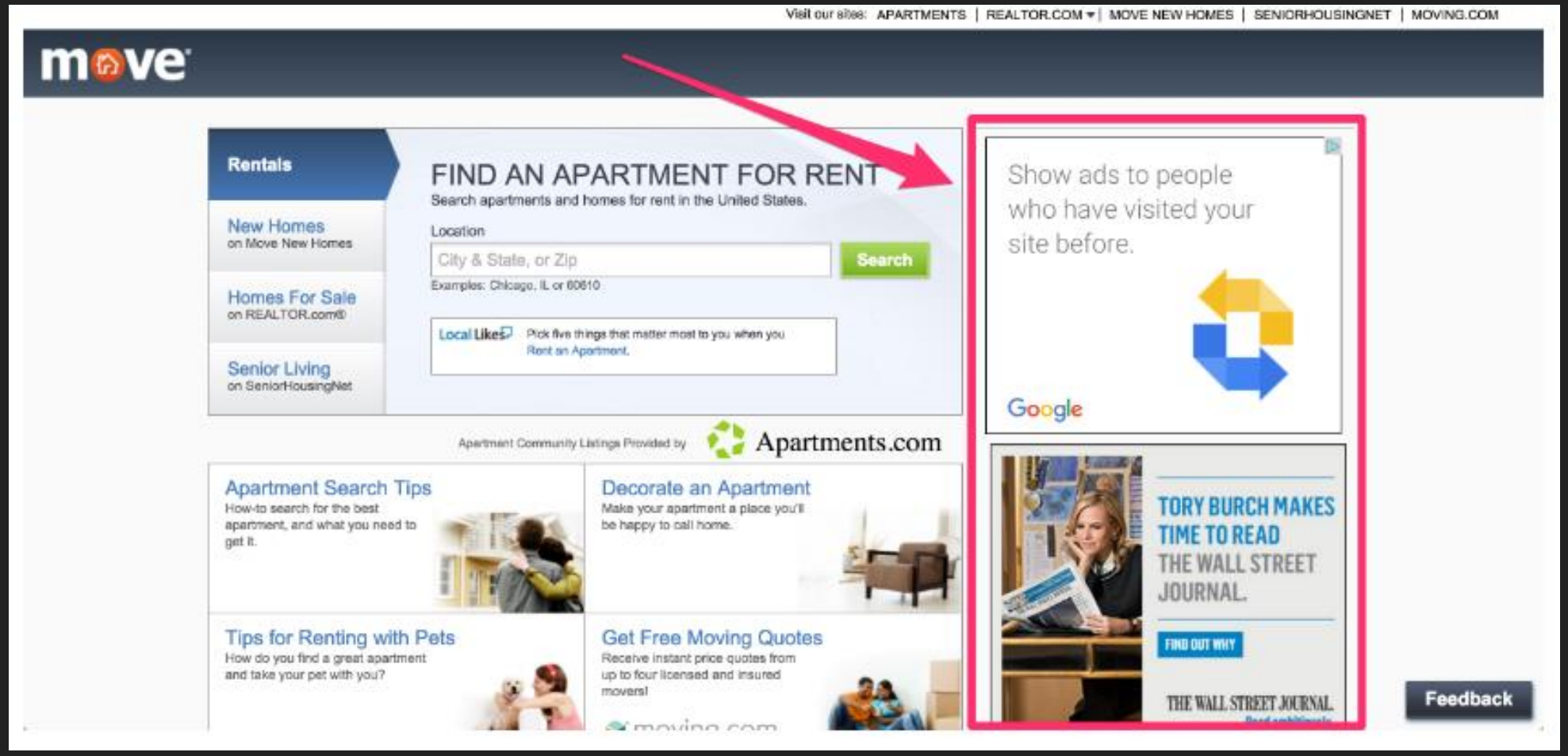


https://www.usertesting.com/blog/limited-attention

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!

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

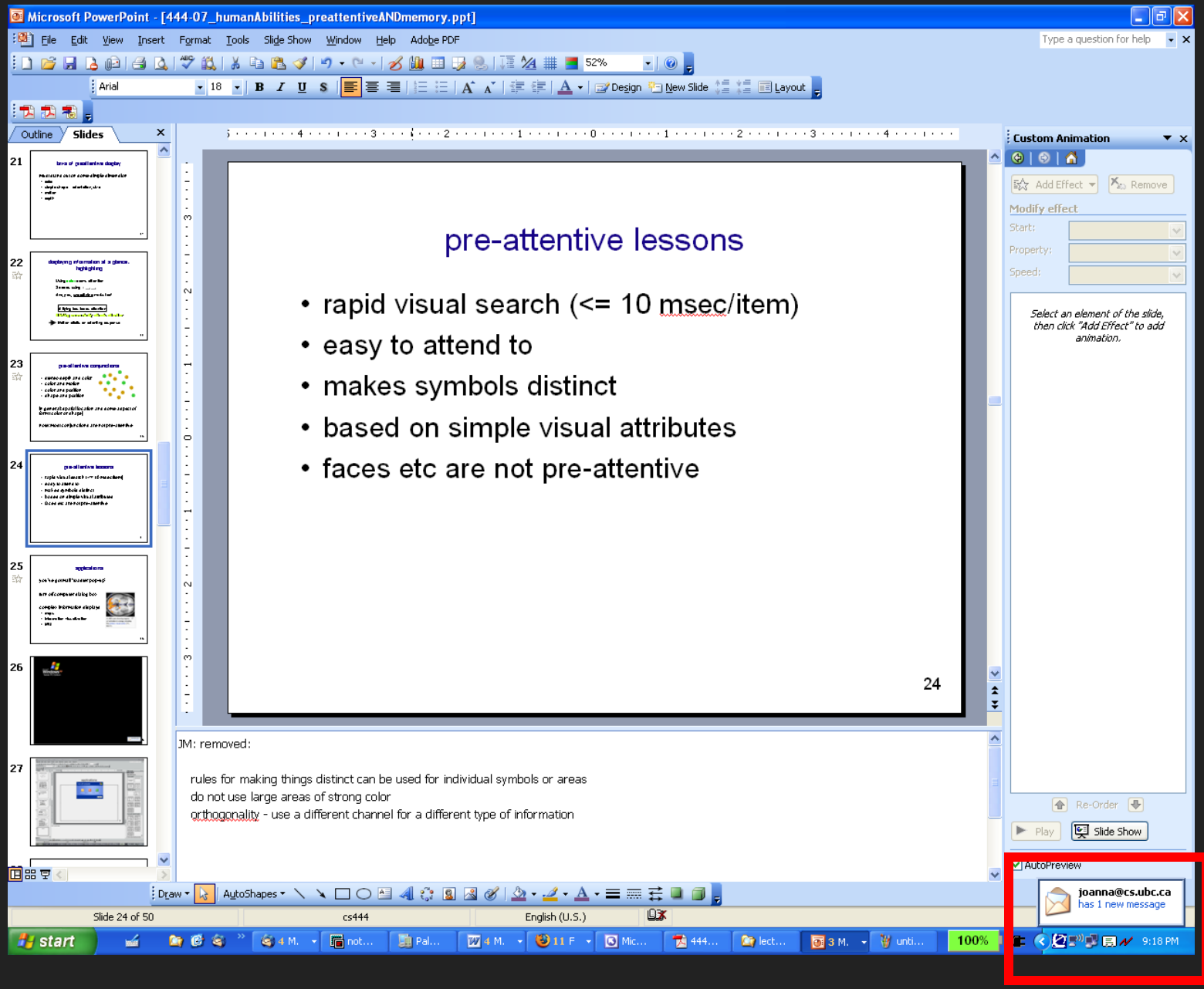
Diners

Airplane without blink:

Diners without blink:

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?


Microsoft PowerPoint - [444-07_humanAbilities_preattentiveANDmemory.ppt]
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Outline Slides
Custom Animation
Add Effect Remove
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Select an element of the slide, then click "Add Effect" to add animation.
Re-Order
Play Slide Show
AutoPreview
joanna@cs.ubc.ca
has 1 new message
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
Draw AutoShapes
Slide 24 of 50
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English (U.S.)
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Color

- Color can substantially improve user interfaces
- But inappropriate use can severely reduce usability

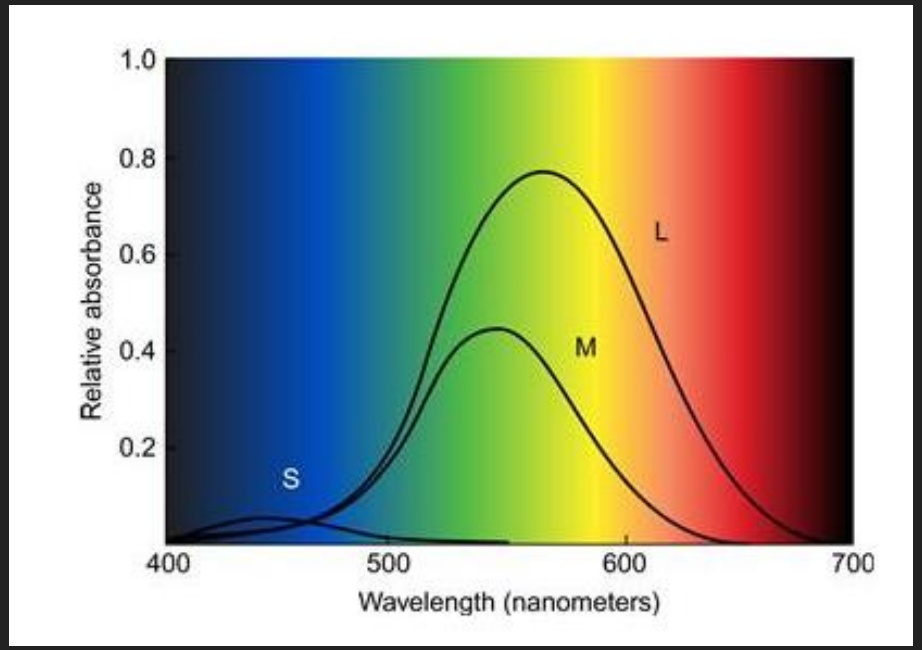
Johannes Itten, color theory

Itten theorized seven types of color contrast by:

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

Trichromacy theory

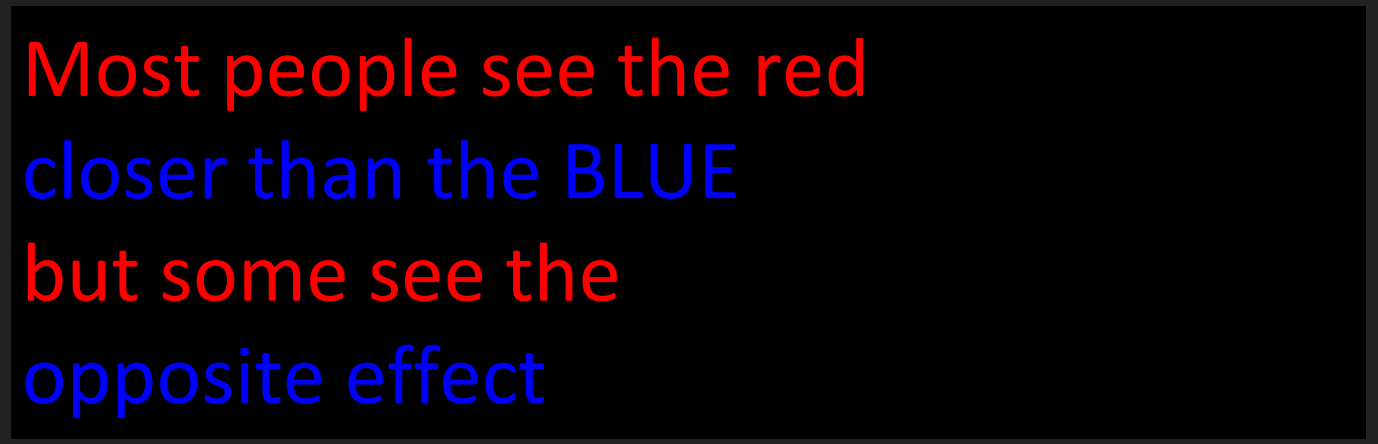
- Color vision is three dimensional, because there are three cone-receptor types in our eyes
- Cone receptors: short, medium, long (really more yellow)



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

Focus

- Wavelengths of light focus at different distances behind eye's lens
- Need for constant refocusing (causes fatigue)



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

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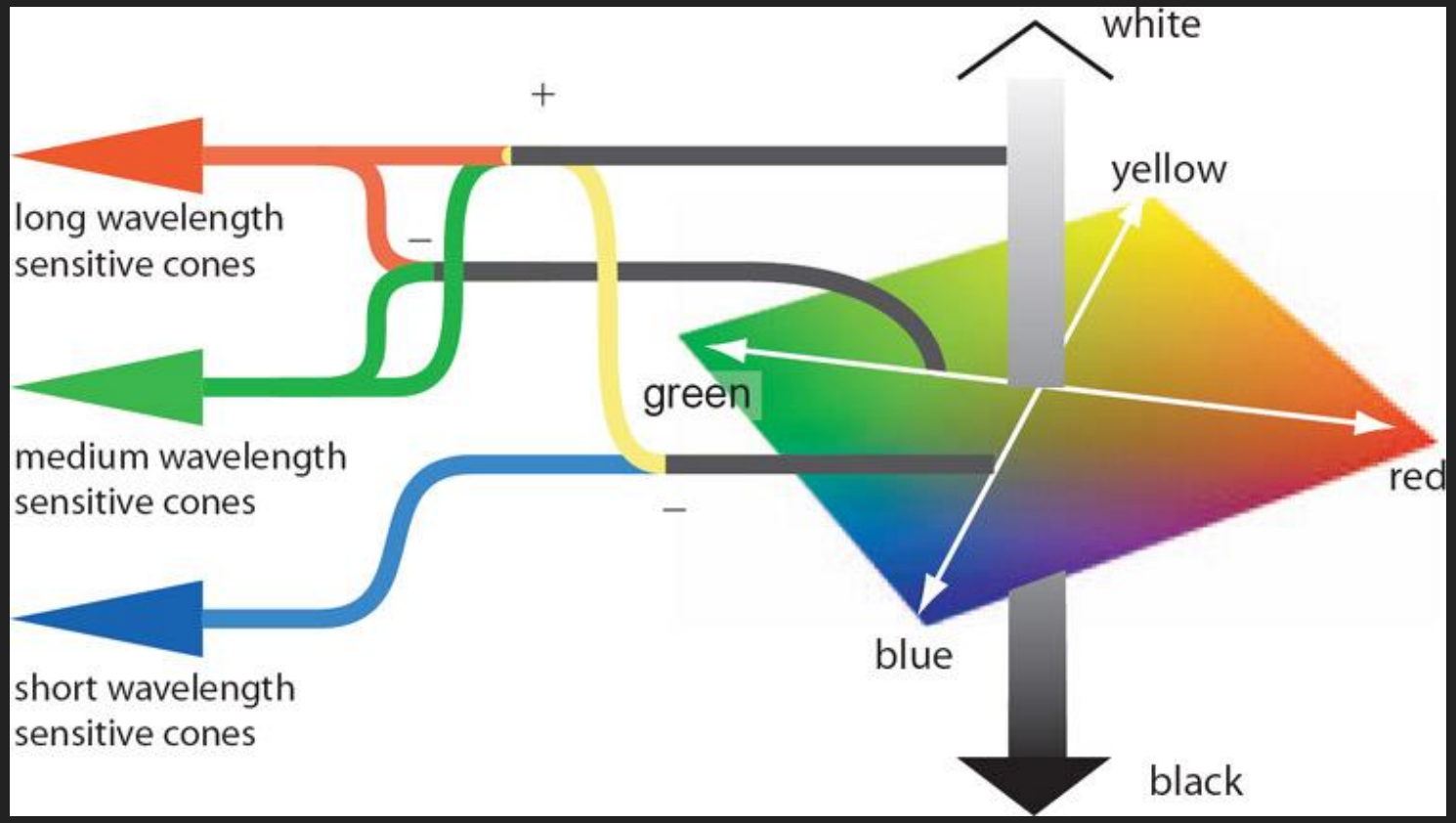
Blue text on a dark background to be avoided. We have few short-wavelength sensitive cones in the retina and they are not very sensitive.
Older users need brighter colors.

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 colors.
Need a lot of luminance contrast

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

Color channels: opponent process theory

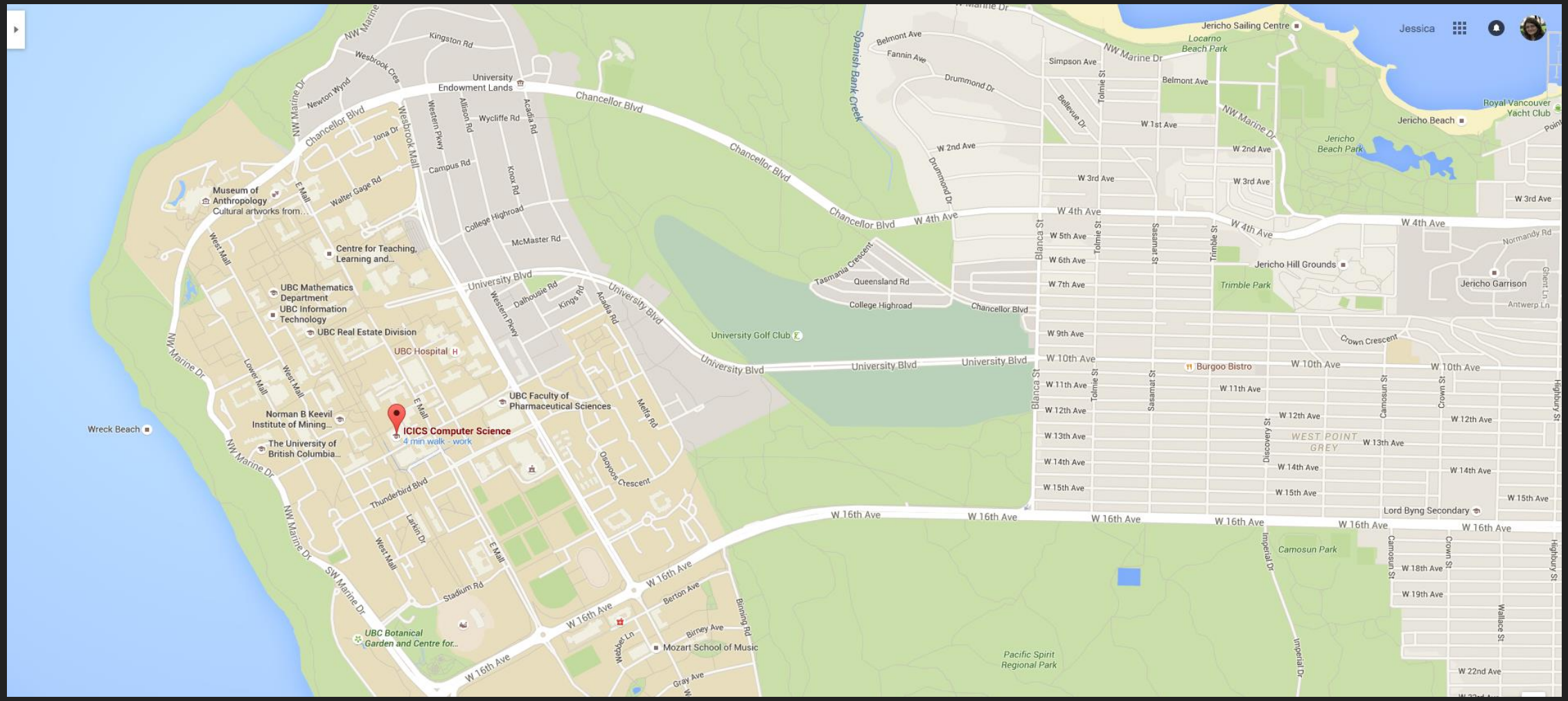


Input from cones processed into three distinct channels immediately after receptors

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 are 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

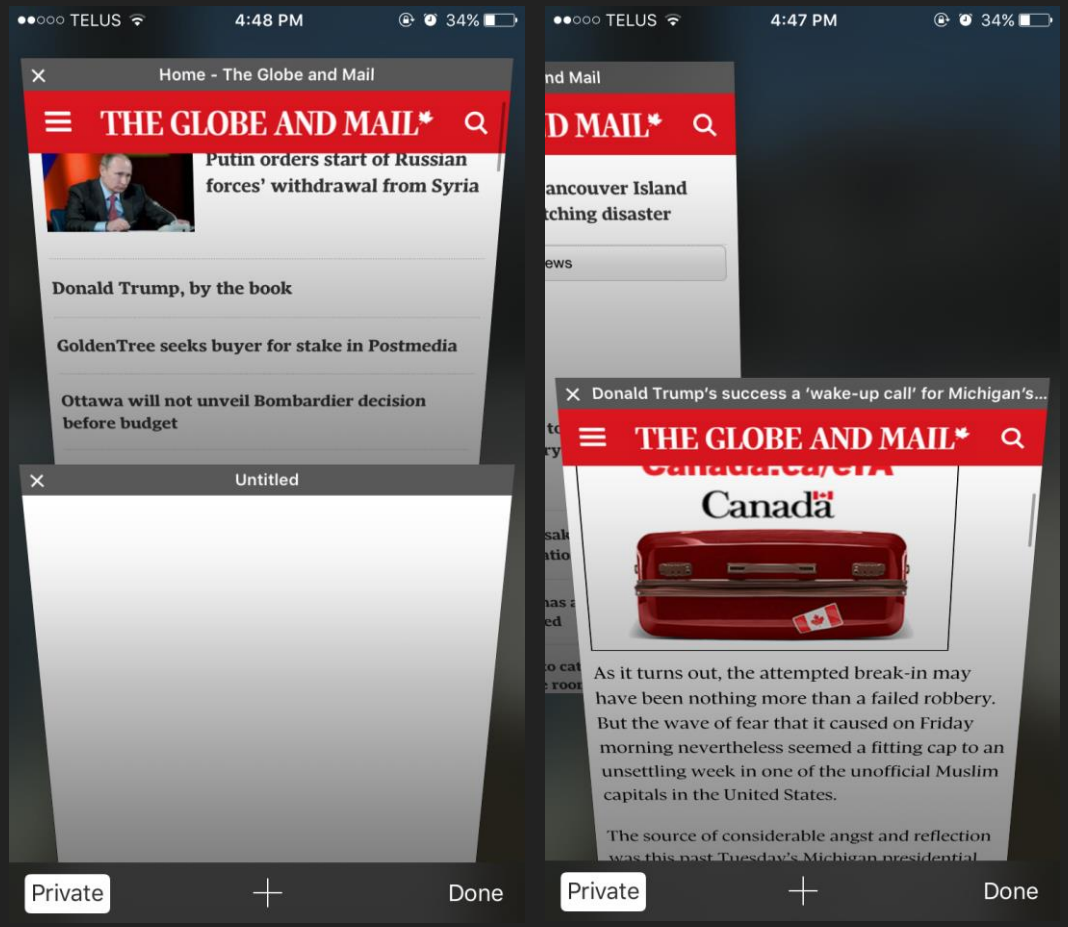


- Red objects are processed pre-attentively (10 ms or less per item) – they "pop out" – we attend to them first.
- Attention and color are related!

Motor

- The movement or actions performed by users

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

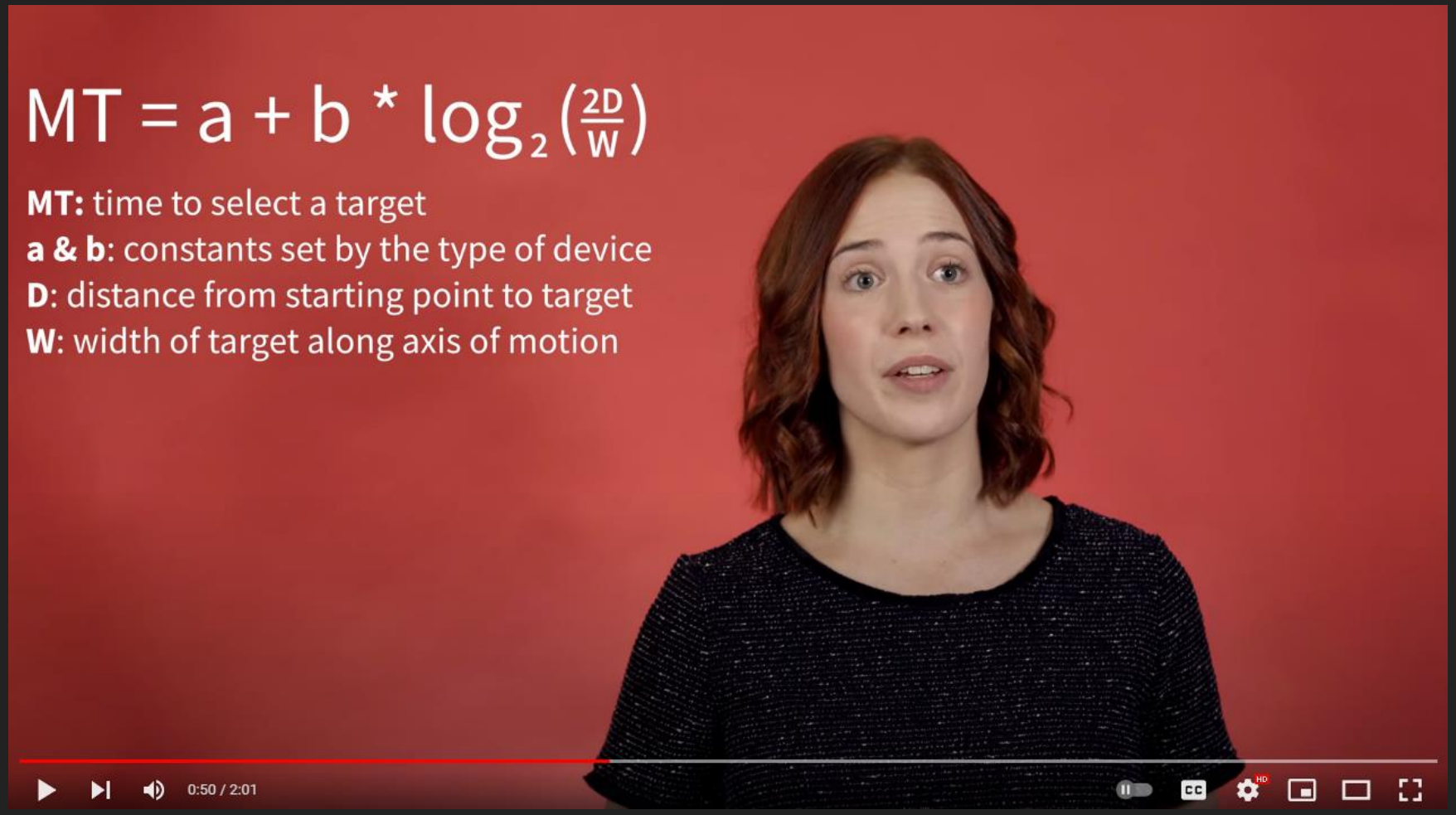


Fitts' Law: Paul Fitts, 1954

$$MT = a + b * \log_2\left(\frac{2D}{W}\right)$$

MT: time to select a target
a & b: constants set by the type of device
D: distance from starting point to target
W: width of target along axis of motion

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



https://www.youtube.com/watch?v=M-9FbUJk6tI

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

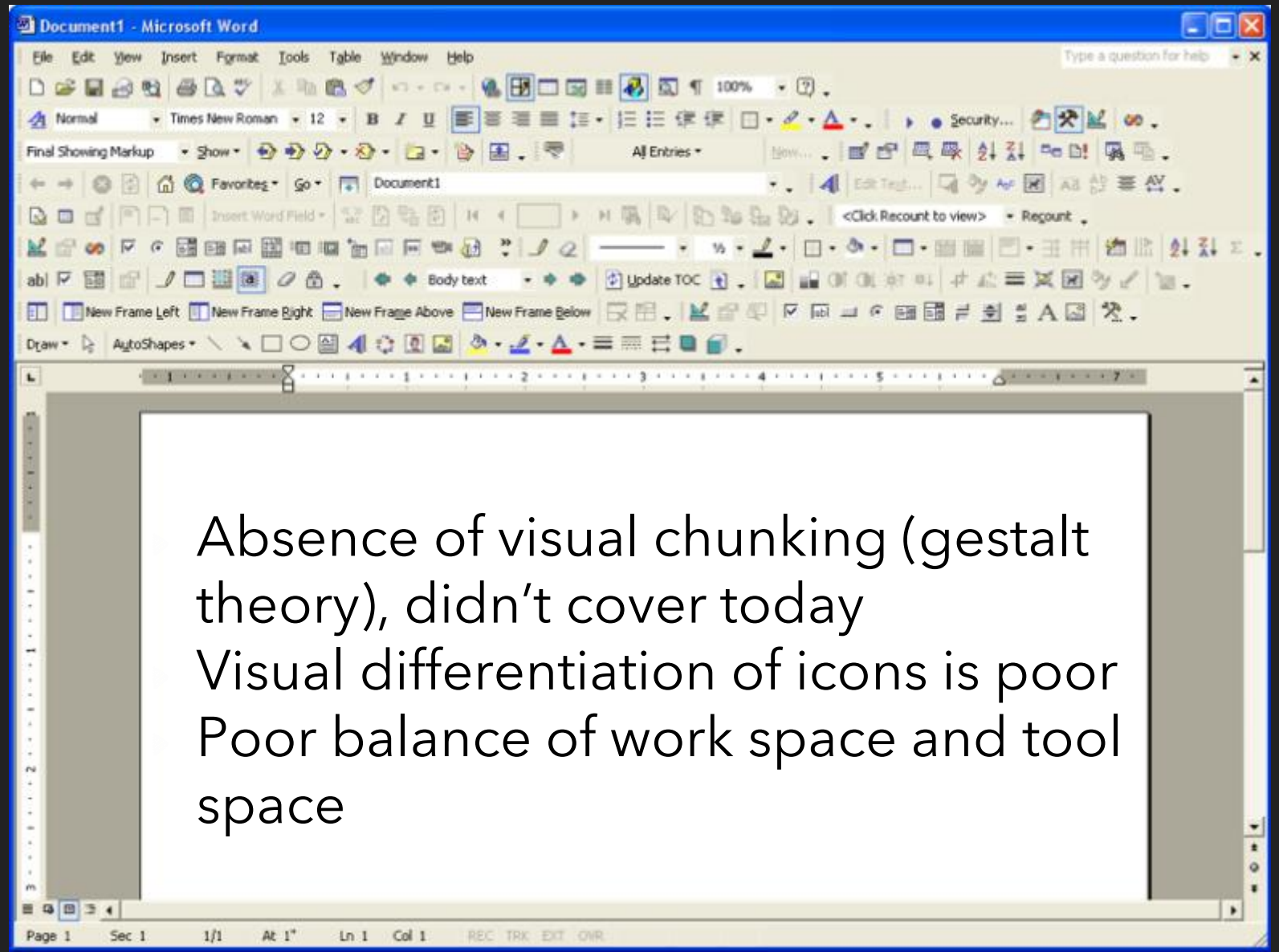
Tactile findability: “touch” keyboards

physical keys

“soft” keys have other benefits

tactus “bubble” keyboard:
best of both?

Back to this interface…



Key takeaways

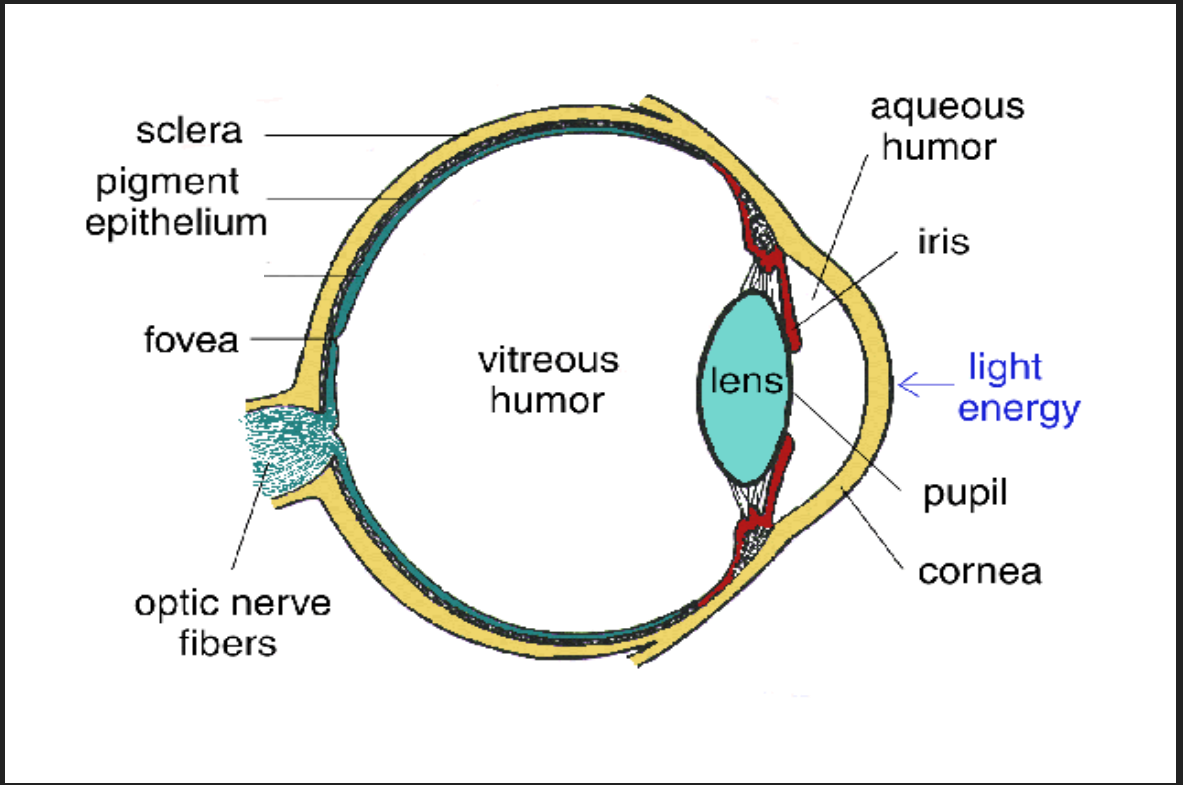
- When doing your research, ask yourself what aspect of human ability impact your design?
- If you are designing a
  - usable security system that involves passwords -> human memory
  - biomedical tele-surgery device -> haptics and motor
  - e-book reader for elderly people -> vision, motor, cognition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

Additional Information

Perceptual limitations

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

Human visual system

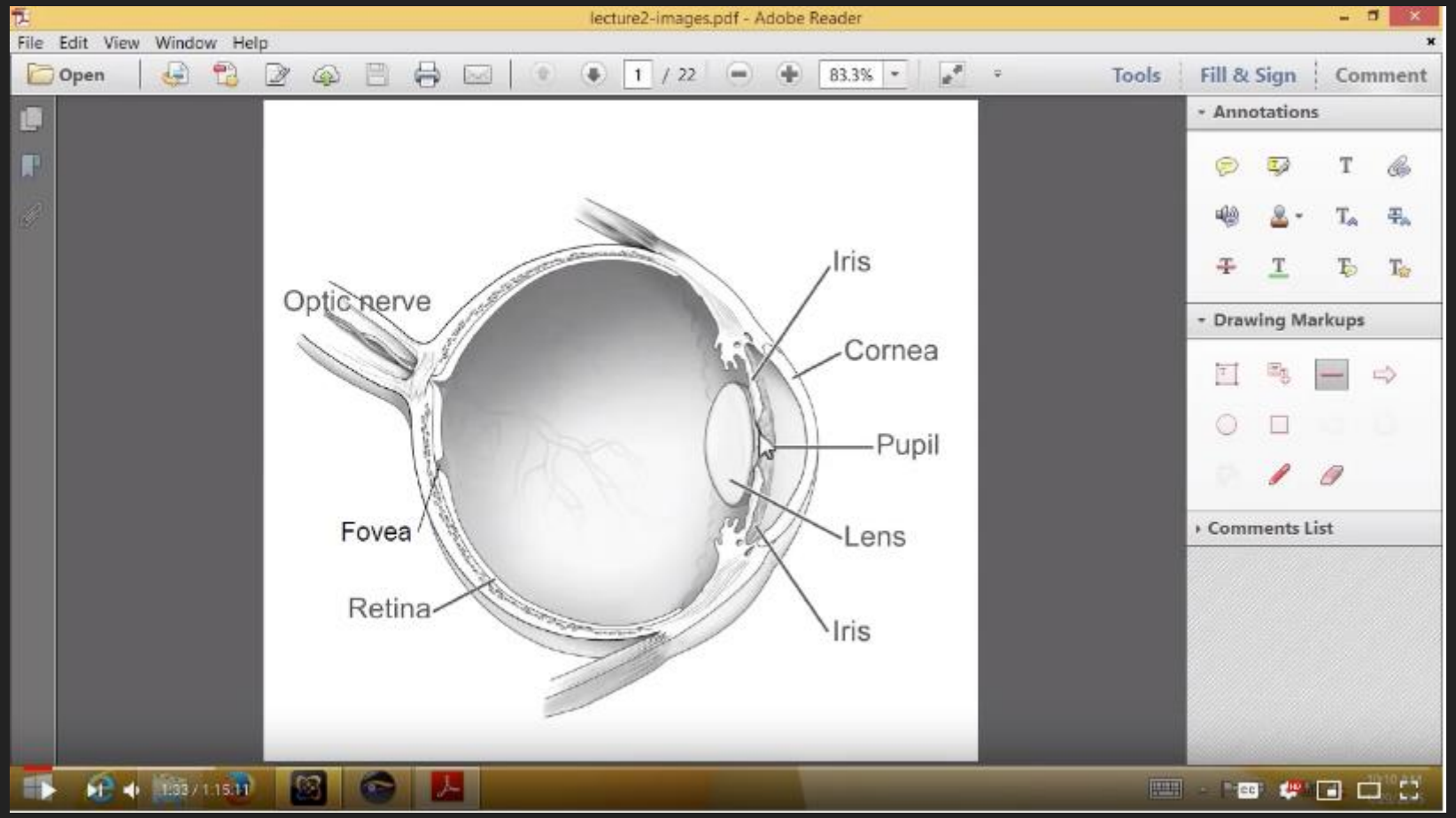


- Light passes through lens
- Focused on retina

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

Digital Image Processing Lecture



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

How we see colors

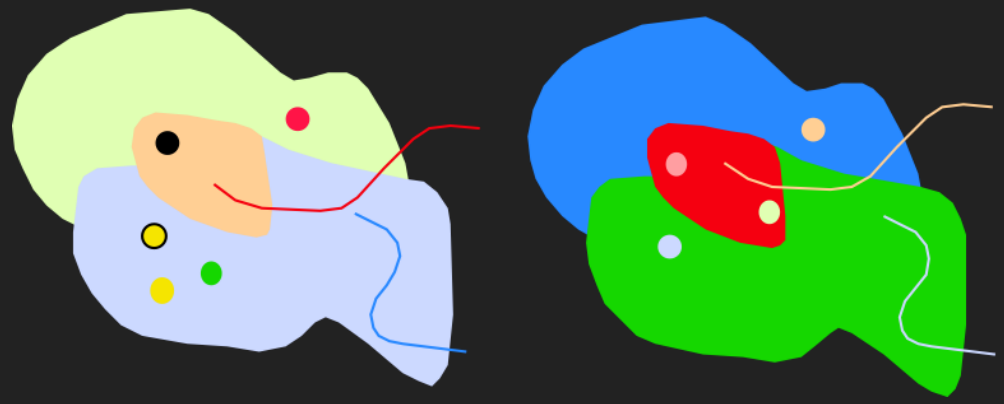
Colm Kelleher: https://www.youtube.com/watch?v=l8_fZPHasdo

Color guidelines

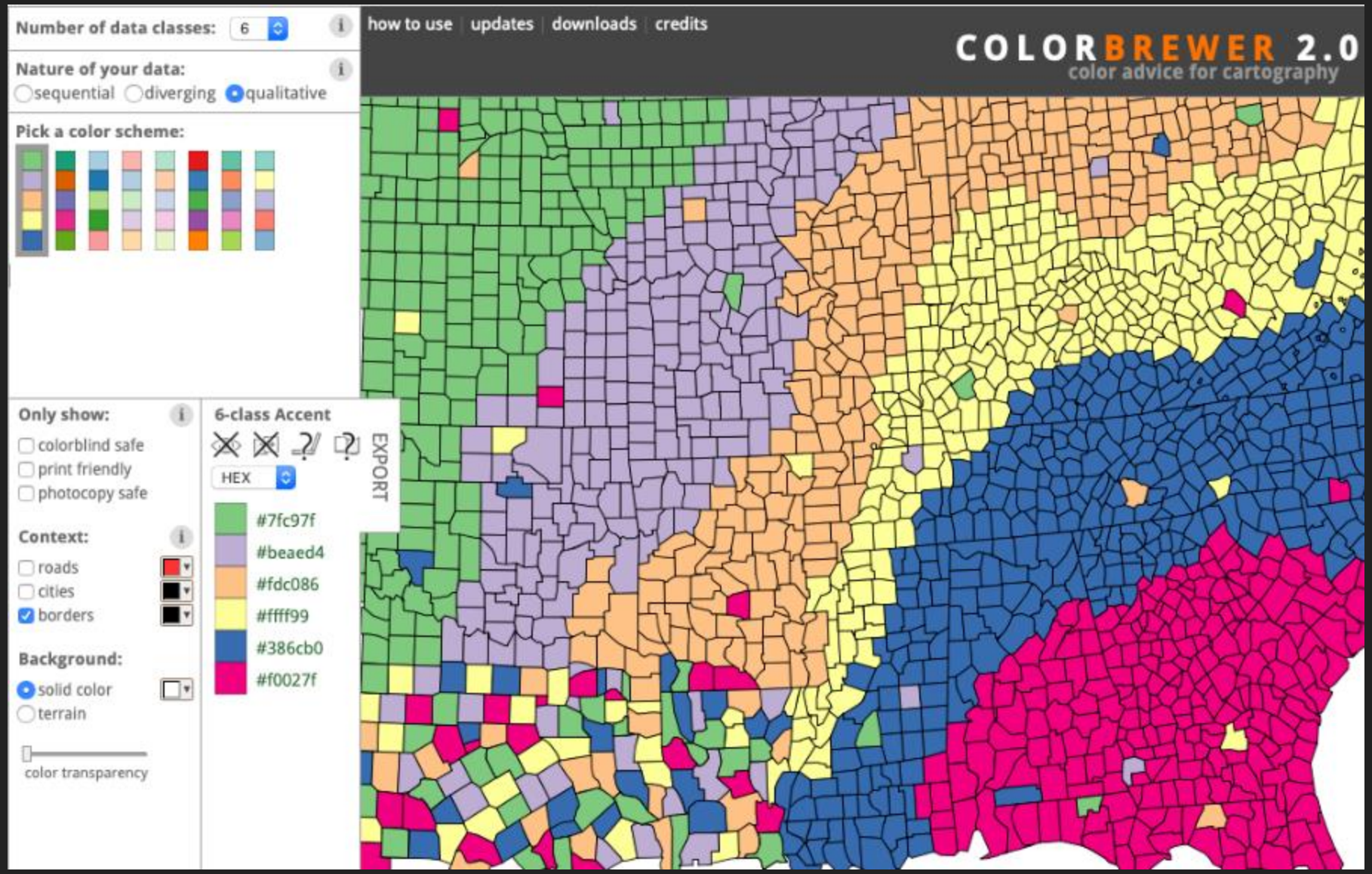
- Generally want to avoid single-color distinctions and encodings (color blindness)
- E.G.   Better than  

Color guidelines

- Large areas: low saturation
- Small areas: high saturation (strong contrast with background)



ColorBrewer



Johannes Itten, artwork