

User Interface Design, Prototyping, and Evaluation

Human Abilities: Vision & Cognition

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 University of Washington
 CSE 440
 Winter 2012

Hall of Fame or Shame?

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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 sorry, please fix the following items...

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):

PHONE NUMBER (OPTIONAL):

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CUSTOMER EMAIL ADDRESS:

CONTACT ME BY EMAIL: Contact me by email Contact me by phone

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Hall of Shame!

- Error Messages
 - Where is error?
 - What's wrong with it?
 - Parse it & fix it yourself!

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Add/Update Shipping Information

We found an error while verifying your shipping address. We've marked the problem in red for you.

Update the address book of

Required information is marked in GREEN CAPS.

For questions about shipping.

NICKNAME:

First name is "nickname" for the person you're shipping to. You may change or delete this information at any time.

FIRST NAME: MIDDLE INITIAL

LAST NAME:

ADDRESS:

 (Optional for only)

CITY:

STATE/PROVINCE:

ZIP/POSTAL CODE:

COUNTRY:

SHIPPING METHOD: In the U.S.: Standard UPS International: Canada Canada Post

Hall of Shame!

- Design based on a top retailer's site
- In study, user could not get by this screen, why?
- Color deficiency
 - can't distinguish between red & green
- How to fix?
 - redundant cues

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Outline

- Review
- Human visual system
- Guidelines for design
- Models of human performance (MHP)
- Memory

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Why Study Color?

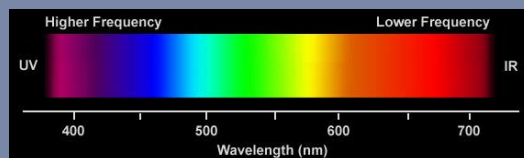
- 1) Color can be a powerful tool to *improve* user interfaces by communicating key information
- 2) Inappropriate use of color can severely *reduce the performance* of systems we build

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Visible Spectrum

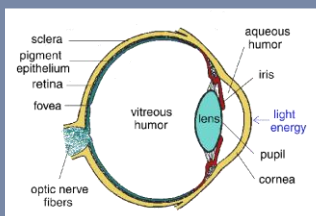


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Human Visual System



- Light passes through lens
- Focussed on retina

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Retina

- Retina covered with light-sensitive receptors,
 - 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

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Retina

- Center of retina has most of the →
 - allows for high acuity of objects focused at center
- Edge of retina is dominated by →
 - allows detecting motion of threats in periphery

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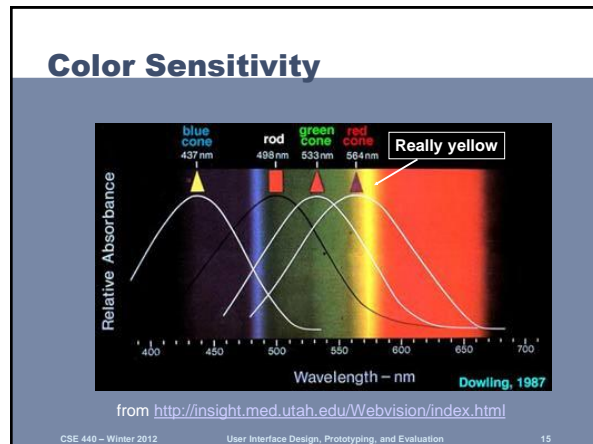
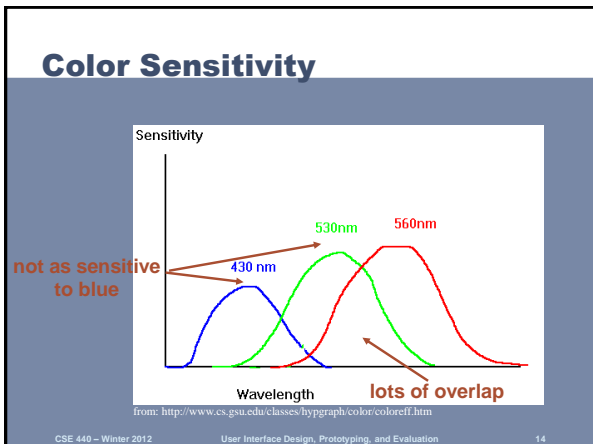
Color Perception via Cones

- “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

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- ### Distribution of Photopigments
- Not distributed evenly – mainly reds (64%) & very few blues (4%) →?
 - insensitivity to short wavelengths (blue)
 - No 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!
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- ### Color Sensitivity & Image Detection
- Most sensitive to the center of the spectrum
 - blues & reds must be brighter than greens & yellows
 - Brightness determined mainly by R+G
 - we use brightness & color differences
 - Shapes detected by finding edges
 - hard to deal w/ blue edges & shapes
-
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- ### 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 (stop sign)
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- ### Color Deficiency (AKA “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
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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

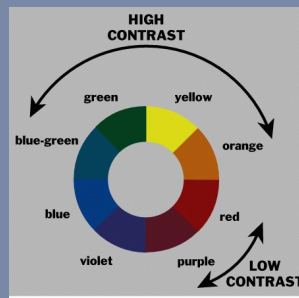
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Using the Hue Circle

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



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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 red & green in the periphery (no RG cones)
- Avoid pure blue for text, lines, & small shapes
 - also avoid adjacent colors that differ only in blue
- Avoid single-color distinctions
 - mixtures of colors should differ in 2 or 3 colors
 - helps color-deficient observers

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Why Model Human Performance?

- To test understanding
- To predict influence of new technology

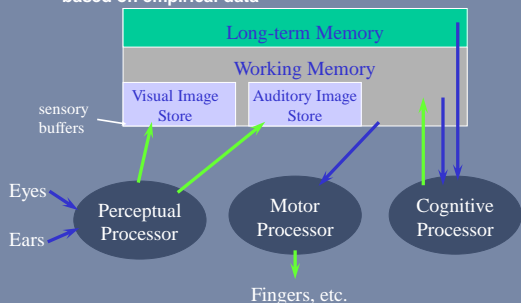
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The Model Human Processor

- 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
 - driving, reading signs, & hearing at once
- Parameters
 - processors have cycle time (T) ~ 100-200 ms
 - memories have capacity, decay time, & type

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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

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Memory

- Working memory (short term)
 - small capacity (7 ± 2 “chunks”)
 - 6174591765 vs. (617) 459-1765
 - DECIBMGMC vs. DEC 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

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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

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EXPERIMENT

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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

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Fitts' Law Example

Pop-up Linear Menu



Pop-up Pie Menu



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

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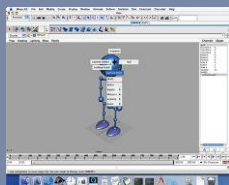
Pie Menus in Use Today



The Sims



Rainbow 6

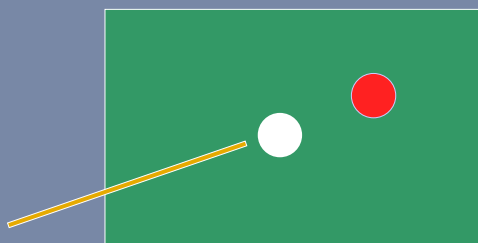


Maya

Perception

- Stimuli that occur within one PP cycle fuse into a single concept
 - frame rate needed for movies to look real?
 - time for 1 frame $< T_p$ (100 msec) \rightarrow 10 frame/sec.
- Perceptual causality
 - two distinct stimuli can fuse if the first event appears to *cause* the other
 - events must occur in the same cycle

Perceptual Causality



- How soon must red ball move after cue ball collides with it?
 - must move in $< T_p$ (100 msec)

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

- Yellow
- White
- Black
- Blue
- Red
- Green

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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

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Stage Theory

- Working memory is small & temporary
- Maintenance rehearsal – rote repetition
 - not enough to learn information well
- Chunking / elaboration moves to LTM
 - remember by organizing & relating to already learned items

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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.

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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
 - e.g., perceive distinct events in same cycle as one
- 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: 100 ms

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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.
- Articles
 - “Using Color Effectively (or Peacocks Can’t Fly)” by Lawrence J. Najjar, IBM TR52.0018, January, 1990, <http://mime1.marc.gatech.edu/mime/papers/color TR.html>

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Next Time

- Midterm exam
- Closed book & closed notes

UI Hall of Fame or Shame?

- Dialog box
 - ask if you want to delete



UI Hall of Shame!

- Dialog box
 - ask if you want to delete
- Problems?
 - use of color problematic
 - Yes (green), No (red)
 - R-G color deficiency
 - cultural mismatch
 - Western
 - green good
 - red bad
 - Eastern & others differ

