Human Abilities: Vision & Cognition

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Autumn 2022
November 2, 2022
Hall of Fame or Shame?

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: [text input]
Last: [text input]

Choose your username
[unique username with '@gmail.com']

Create a password

Confirm your password

Birthday
Month: [text input]
Day: [text input]
Year: [text input]

Gender

Hall of Fame or Shame?

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
James

Choose your username
james...landay@gmail.com

A fan of punctuation! Also, usernames can’t have consecutive periods.

Create a password

You can’t leave this empty.

Confirm your password

Birthday
Hall of Fame! (but still some issues...)

Clearly highlights error (red text & box)

Tells me what I did wrong/how to fix it

In user’s language
(but, be careful w/ humor)

Red may be an issue when used alone, more later...
Hall of Fame!

Google

Create your Google Account

First name
James

Last name
Landay

Username
james...landay @gmail.com

1. Sorry, your username cannot contain consecutive periods (.)
Use my current email address instead

Password

Confirm

Sign in instead
Next

Clearly highlights error (red text & box)

Tells me what I did wrong/how to fix it

In user’s language
(but, be careful w/ humor)

Red may be an issue when used alone, more later...

New version fixes these 2 problems
- adds caution icon & removes the humor

dt+UX: Design Thinking for User Experience Design, Prototyping & Evaluation
Hall of Shame!

Like
- error message prominent with different color & shape

Wish
- where is the error?
- what’s wrong with it?
- parse & fix it yourself!
Hall of Shame!

Update (today)
- no longer have that form
  (uses phone, SMS, live chat)

Contact Information

Our Customer Loyalty Team is available 24/7 on all support channels for anything you need!

1. CALL the Zappos Customer Loyalty Team:
   1-800-937-7671

2. TEXT the Zappos Customer Loyalty Team:
   Text CHAT to 1-833-937-7671 to chat with the Zappos Customer Loyalty Team by text.
   By texting CHAT, you consent to receive text messages (including automated and marketing messages) from or on behalf of Zappos at your mobile number provided. Consent is not a condition of any purchase. Text STOP to end your chat. Message & data rates may apply.

3. CONNECT WITH LIVE HELP:
   Ask your question right now with a member of the Zappos Customer Loyalty Team.
   Go ahead - start a conversation now!

   Frequently Asked Questions: Answers to our most commonly asked questions: Frequently Asked Questions
   Haga click aquí para preguntas frecuentes en español

   ADDITIONAL INQUIRIES:
   Brand Inquiries:
   Feature your brand on the website! Please direct all brand inquiries via email to: merchinitiatives@zappos.com.

   Press Inquiries:
   Please direct all media inquiries via email to: pr@zappos.com
Human Abilities: Vision & Cognition

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Outline

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

There is an order to the colors… ROY G. BIV

But remember, do not use that ordering to order data! (recall Tufte’s example of how unusable a map is using this ordering for elevation)
Human Visual System

- Light passes through lens
- Focused on retina

![Diagram of the human eye showing light passing through the lens and focused on the retina](http://obsessive-coffee-disorder.com/wp-content/uploads/2014/11/eye1.jpg)
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 to intensity or shades of gray
  – cones
    • used to sense color

http://www.webexhibits.org/causesofcolor1G.html
Retina

- Center of retina has most of the cones →
  - allows for high acuity of objects focused at center

- 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

AKA Red

http://archive.cnx.org/contents/d42c807d-a9fa-4e3d-83d0-0f7c745b51ad@4/color-and-color-vision#import-auto-id1844887
Color Sensitivity

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

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

- 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!

[Source: http://www.webexhibits.org/causesofcolor/1G.html]
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

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  - 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

https://physics.info/color/
Focus

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  - need for constant refocusing → ?
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  - be careful about color combinations
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Color Deficiency
(Also known as “color blindness”)

• Trouble discriminating colors
  – besets about 4.5% of population (~8% men, ~.5% women)

• 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 solely dependent on Red & Green

• Key is to avoid single color distinctions

Difficult pairs for severe red deficient person to discern
https://www.colorblindness.com/red-green-color-blindness/
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 \(\rightarrow\) 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
- Avoid adjacent colors that differ only in blue
- Blue makes a great background color
| Oct 31 - Nov 4 | Accessible Design Workshop (Recording)  
Sat., Nov. 5 | Designing the Future: Early and Future Visions of HCI  
*As We May Think* by Vannevar Bush  
*Tools For Thought* (Ch 9), Engelbart Demo  
*Listen and Read: Of Mice and Men: Invisible, Episode 149* (21 minutes) | Human Abilities  
*Learning From Design Critiques* by Fowler and Haskins  
*Listen: Wait Wait... Tell Me!, 99% Invisible, Episode 349* (36 minutes) | Half-way Review with Outside Experts |
| Nov 7 - 11 | A7 Heuristic Evaluation (individual)  
A8 Hi-fi Prototype (group)  
Midway due by studio week 9 (Dec 1-2)  
Video demo due by Wed week 10 (Dec 7)  
Complete due by studio week 10 (Dec 8-9)  
A11 Final Report (group)  
Writeup due Sunday Dec 11 | Heuristic Evaluation (with in-class exercise)  
*How to Conduct a Heuristic Evaluation* by Jakob Nielsen | Conceptual Models and Interface Metaphors  
*The Psychology of Everyday Things* (Ch 1) from *The Design of Everyday Things* by Donald Norman | A9 Heuristic Evaluation  
Due Friday, Nov. 11 @ 11:59pm |
| Nov 14 - 18 | None | Usability Testing/Midterm Review  
Optional: Inclusive Design  
Optional: "Disability Studies as a Source of Critical Inquiry for the Field of Assistive Technology" | Midterm | Project Group Work |
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<td>1) &quot;Making the Most of Web Design Patterns&quot; (Ch 2)</td>
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| Dec 5-9 | Guest Lecture | Smart Interfaces for Human-Centered AI | 30-Second Pitch and Demo Practice |
| Project Expo from 6-9 PM |
Dishcovery’s Bird’s Eye View of the Prototype
StoreaTime’s Low-Fi Prototype Construction

Tested scrolling and swiping interactions
Administrivia

• Grading
  – buckets are weighed in the rubric so two minuses are not equal
  – note: each team member’s contribution will be assessed at the end of class & grades adjusted appropriately

• Final workshop – Accessibility – coming soon
  – we will be giving a few bonus points for projects that do a good job of addressing accessibility

• Watch the previous two (Figma Basics & Design Systems) if you have not already (links on the calendar)
TEAM BREAK
The Model Human Processor

Developed by Card, Moran & Newell (’83)

- based on empirical data

- Model can help us test understanding & make predictions

- Underlies other usability techniques
  - GOMS, KLM, tools, etc.
The Model Human Processor

- Perceptual Processor
- Motor Processor
- Cognitive Processor
- Long-term Memory
  - Visual Image Store
  - Auditory Image Store
- Working Memory
- Sensory buffers
- Eyes
- Ears
- Fingers, etc.
MHP Basics

• Parameters
  - processors have cycle time ($T$) $\sim 100$ ms
  - memories have capacity, decay time & type
What is missing from MHP?

- Long-term Memory
- Working Memory
  - Visual Image Store
  - Auditory Image Store
- Cognitive Processor
- Motor Processor
- Perceptual Processor
- Fingers, etc.
- Sensory buffers

- Eyes
- Ears
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
    - NBCIBMGMGC 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

Long-term Memory

Working Memory

Visual Image Store

Auditory Image Store

Perceptual Processor

Motor Processor

Cognitive Processor

Eyes

Ears

sensory buffers

Fingers, etc.
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
Volunteer for Experiment

http://simonwallner.at/ext/fitts/
Experiment

• Task:
  Quickly tap each target 50 times accurately

• Conditions:
  - Two $\frac{1}{2}$” diameter targets 6” apart
  - Two $\frac{1}{2}$” diameter targets 24” apart
  - Two 2” diameter targets 24” apart
  - 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 (pre-covid)

• Task:
  Quickly tap each target 50 times accurately
If we plot the data...

Index of Difficulty: \( ID = \log \left( \frac{D}{W} \right) + 1 \)
\( D \) = distance to target, \( W \) = width of target (or size)
Run This Experiment On Your Own

http://simonwallner.at/ext/fitts/
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:
  
  \[
  T_{pos} = a + b \log_2 \left( \frac{D}{S} + 1 \right)
  \]

- summary
  - time to move the hand depends only on the relative precision required
Fitts’ Law Example

Which will be faster on average?
- pie menu (bigger targets & less distance)
Pie Menus in Use Today

The Sims

Rainbow 6

Firefox

Maya
Apple Watch Is a Negative Fitts’ Law Example
Apple Watch Is a Negative Fitts’ Law Example
Volunteer for Experiment

https://faculty.washington.edu/chudler/java/ready.html
Volunteer for Experiment

Stroop Effect
• interference in your working memory
Memory Interference in Action: *Cultural*

The current date and time is Tuesday, October 27, 2015 at 3:20:21 PM.
Memory Interference in Action: Cultural

The current date and time is Tuesday, October 27, 2015 at 3:20:21 PM.
Memory Interference in Action: Labels/Terms
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
  – easier because of cues to retrieval
    • cue is related to item or situation learned in
    • e.g., 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: sensory, 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 & memory access time
Further Reading
Vision and Cognition

• Books


• Applying Fitts’ Law to Mobile Interface Design by Justin Smith
Next Time

• Lecture
  – Heuristic Evaluation

• Read
  – How to Conduct a Heuristic Evaluation by Jakob Nielsen

• Studio
  – Midterm review
  – Medium-fi prototype feedback from TAs & visitors