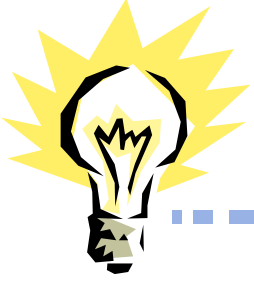# Human Abilities 1

Understanding the user

Human Capabilities

➢ In this class we often talk about finding out what people want and need, and improving their lives.

➢ But, we also need to consider humans as biological systems with specific abilities and aptitudes.

➢ Designs should interlock well with human abilities.

➢ Knowing the user <u>informs the design</u>

1. Senses
2. Information processing systems
3. Motor abilities
4. Motivations
5. Social Attachments

Overview of User Abilities

I. Senses
   A. Vision
   B. Hearing
   C. Touch
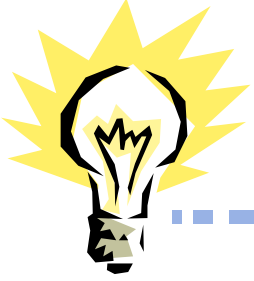   D. Smell?

II. Information processing
   A. Perceptual
   B. Cognitive
      1. Memory
         a. Short term
         b. Medium term
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         a. Selective attention
         b. Learning
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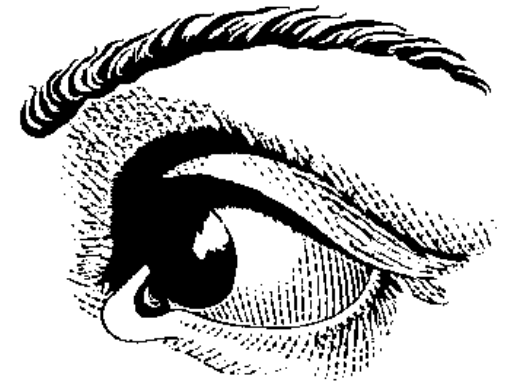   d. Language
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I. Senses

➢ Sight, hearing, touch important for current HCI

  ❖ smell, taste ???

➢ Abilities and limitations affect design

➢ Learn all you can about senses and impact on HCI

  ❖ Sensory pathway & perceptual processing

➢ Knowledge of human senses helps inform and constrain designs
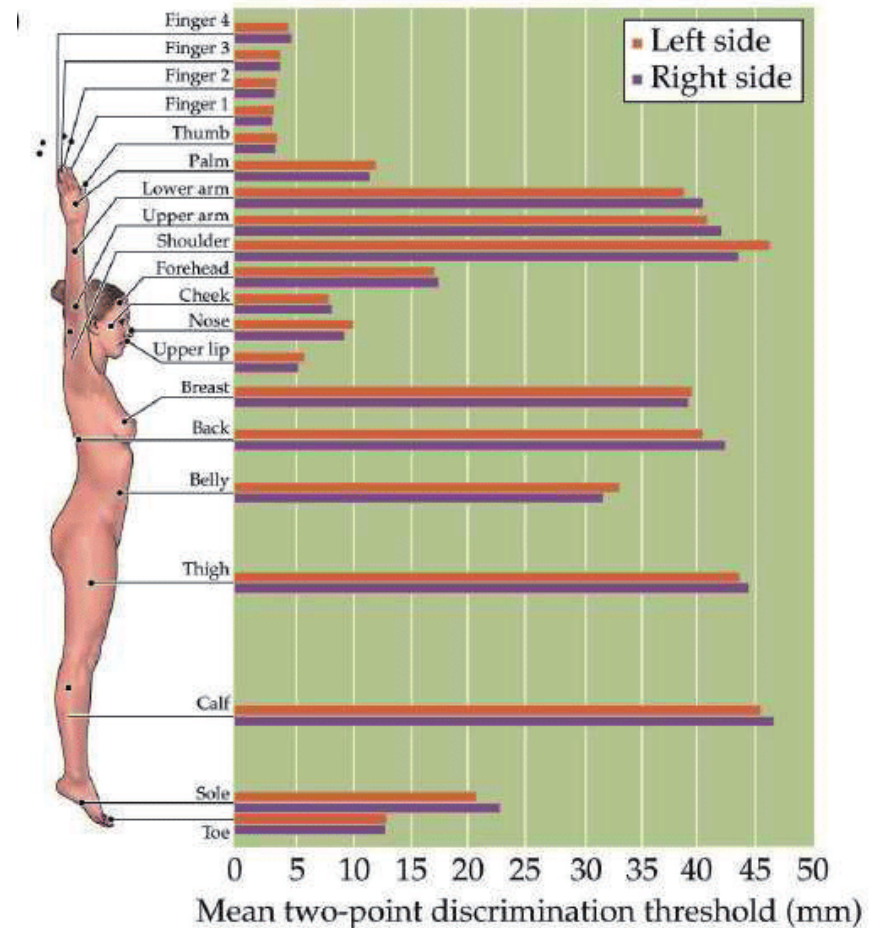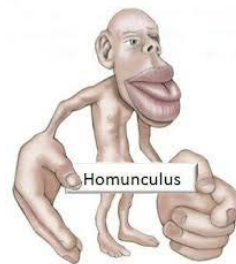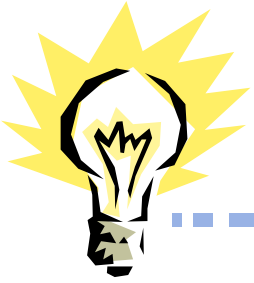
Example: Backpack Display

➢ Scenario:

  ❖ Your company's engineers have designed a new kind of small, lightweight, low-power tactor. They would like to put these into a backpack to create a haptic backpack display

  ❖ They come to you, the expert, and want to know if a user could use a grid of 16x16 tactors to interpret symbols

  ❖ What do you do?
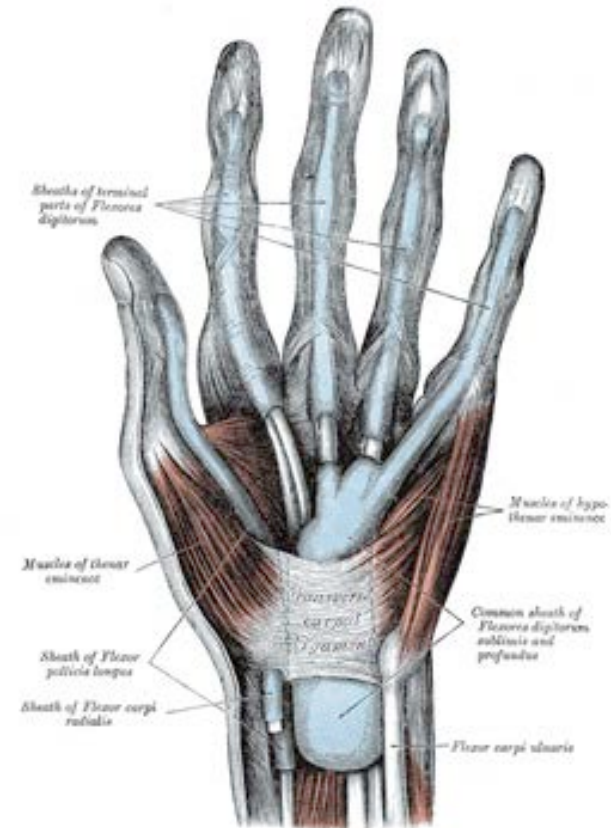
Two-point threshold

- ➢ Different parts of the body have different tactile acuity
- ➢ For the back, its about 40mm
- ➢ Implications for design?

Homunculus

Mean two-point discrimination threshold (mm)

- Left side
- Right side

Finger 4, Finger 3, Finger 2, Finger 1, Thumb, Palm, Lower arm, Upper arm, Shoulder, Forehead, Cheek, Nose, Upper lip, Breast, Back, Belly, Thigh, Calf, Sole, Toe

➢ Three main sensations handled by different types of receptors:

  ❖ Pressure (normal)

  ❖ Intense pressure (heat/pain)

  ❖ Temperature (hot/cold)

  ❖ Each of these has different

  sensitivity thresholds

➢ Where important?
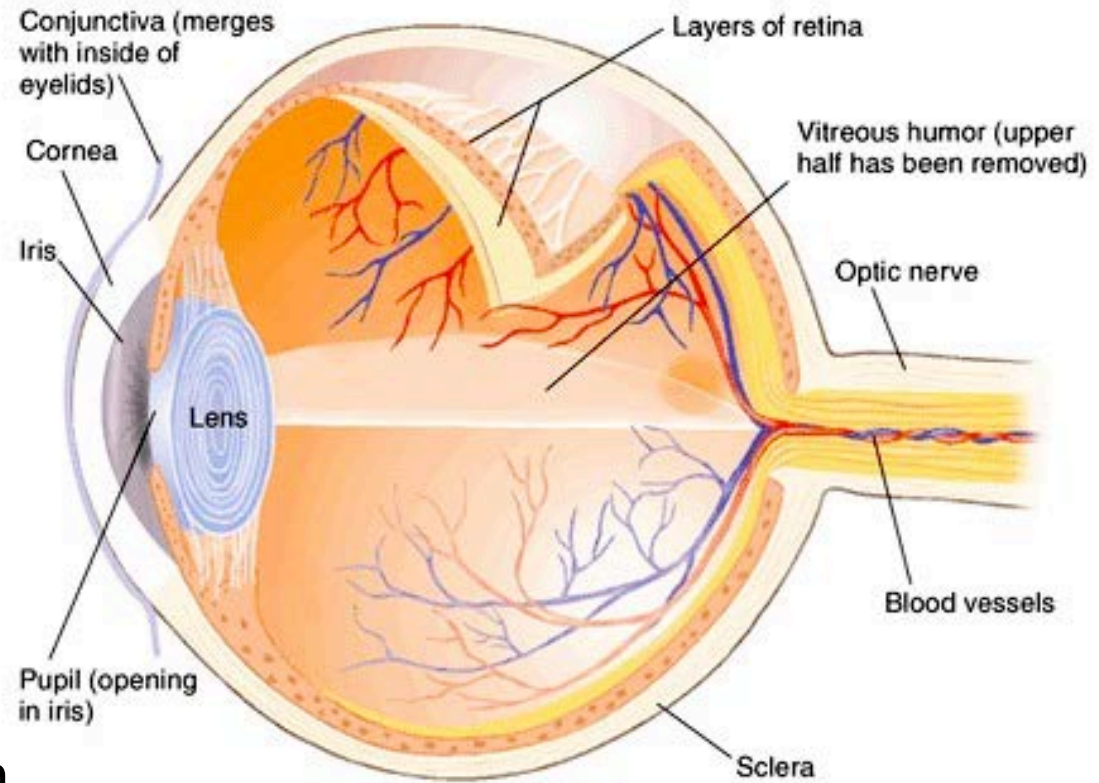
  ❖ Input devices, VR, surgery, drivers...

Vision

➢ Visual System

  ❖ Eye

  ❖ Retina

  ❖ Neural pathway

    ~ 80% of brain's operation

Conjunctiva (merges with inside of eyelids)

Cornea

Iris

Lens

Pupil (opening in iris)

Layers of retina

Vitreous humor (upper half has been removed)
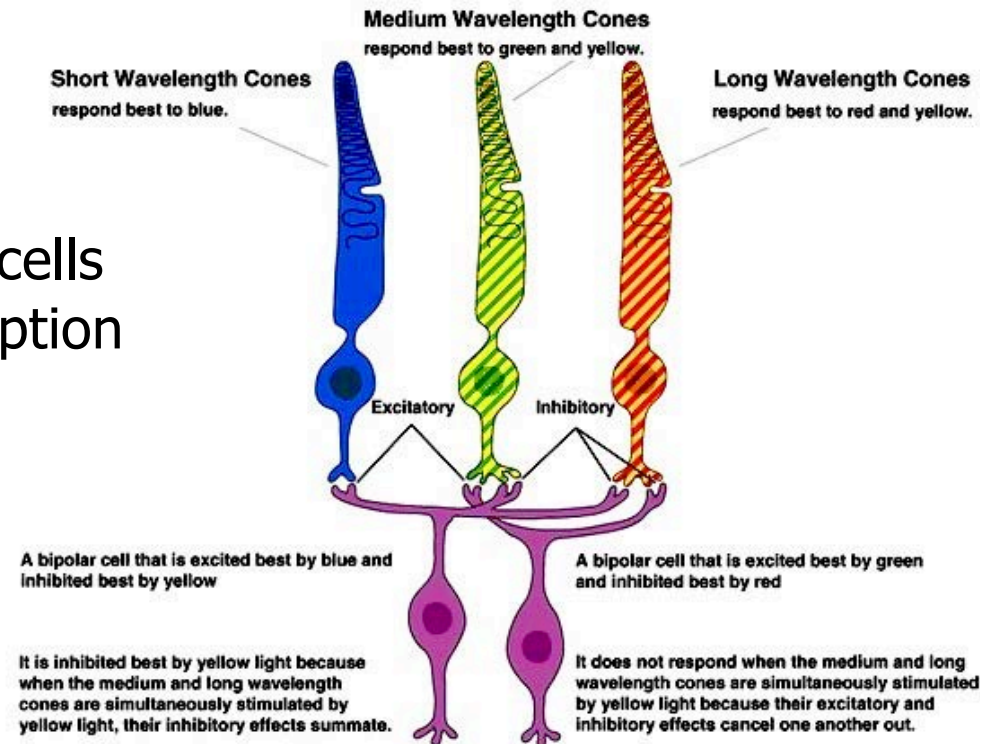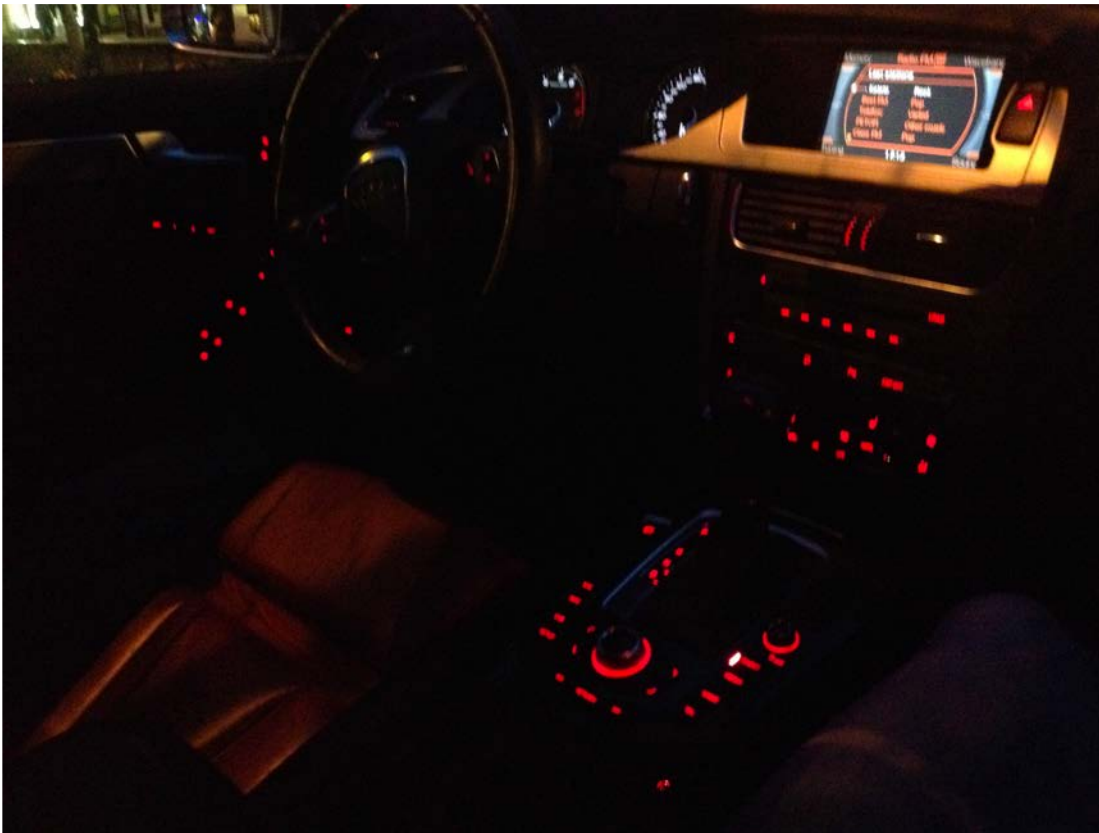
Optic nerve

Blood vessels

Sclera

Color Vision

➤ Color & the retina
  - 380 (blue) ~ 770nm (red)
  - Problems with cones or ganglion cells causes problems with color perception
  - (not really "color blindness")
  - 8% males, 0.5% females

➤ Implications (??)
  - avoid saturated colors
  - color coding should be redundant when possible
  - Avoid blue for small fonts
  - Consider light/dark adaptation

Medium Wavelength Cones
respond best to green and yellow.

Short Wavelength Cones
respond best to blue.

Long Wavelength Cones
respond best to red and yellow.

Excitatory   Inhibitory

A bipolar cell that is excited best by blue and inhibited best by yellow

A bipolar cell that is excited best by green and inhibited best by red

It is inhibited best by yellow light because when the medium and long wavelength cones are simultaneously stimulated by yellow light, their inhibitory effects summate.

It does not respond when the medium and long wavelength cones are simultaneously stimulated by yellow light because their excitatory and inhibitory effects cancel one another out.

Visual Abilities

➢ ## Sensitivity

❖ luminance: $10^{-6} \sim 10^7$ mL (see notes)

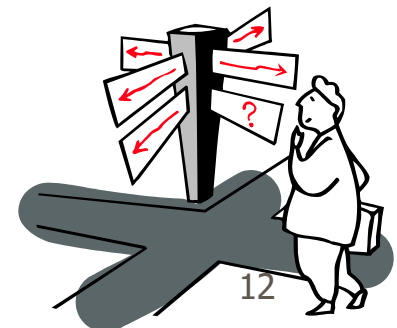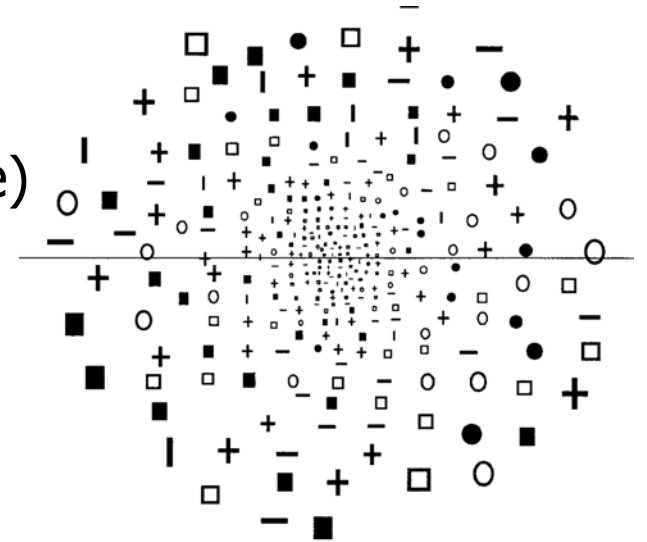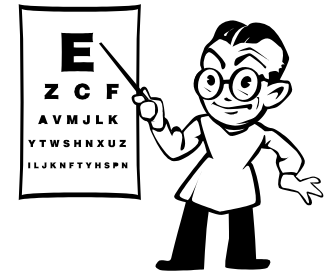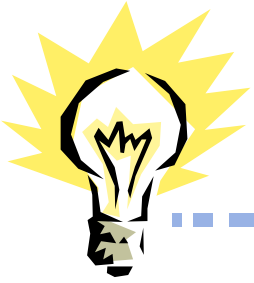➢ ## Acuity

❖ detection, alignment, recognition (visual angle)
❖ retinal position: fovea has best acuity

➢ ## Movement
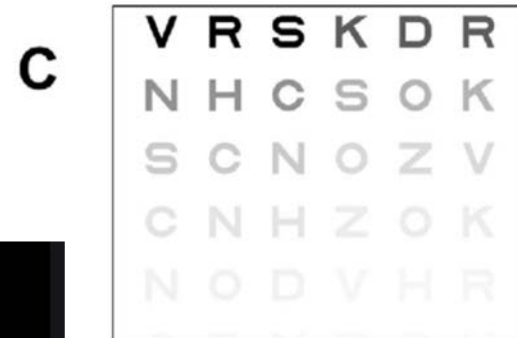
❖ tracking, reading, vibrations
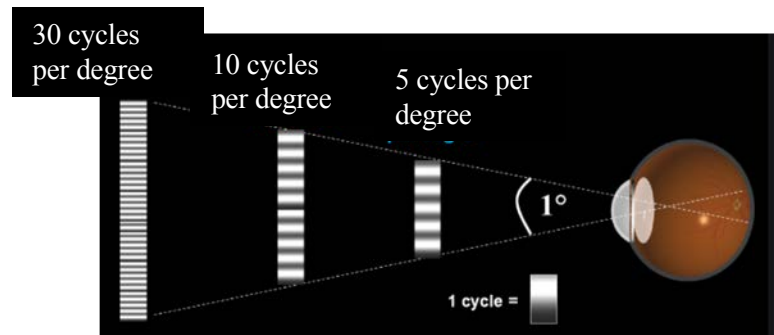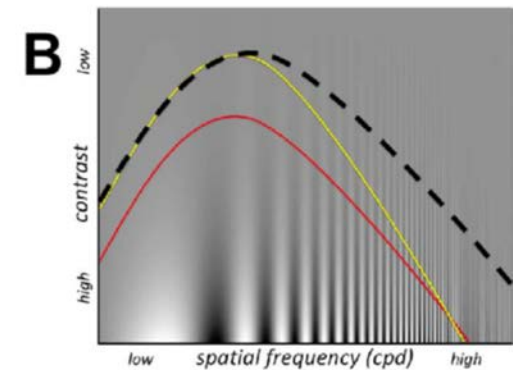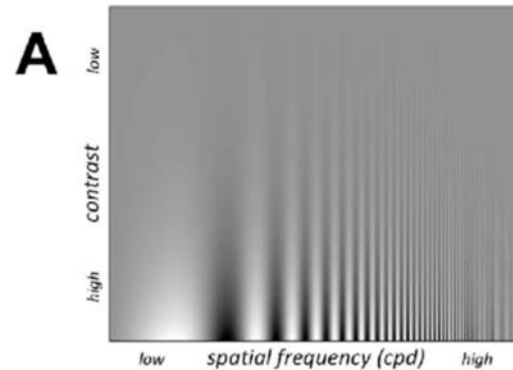
➢ ## Note: Vision decreases with age

Visual Abilities

➢ Spatial Frequency

❖ Humans can clearly perceive a certain *frequency* of details, per degree of visual angle
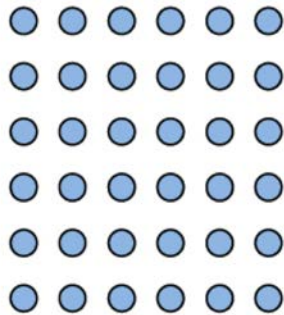
Example

➢ How big should the onscreen buttons on a smart watch be?
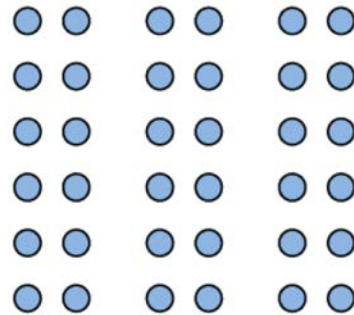
  ❖ You could do a user study, or…

Visual Abilities

➤ Serial visual search takes a long time

➤ Humans utilize expectations, grouping and pop-out effects to speed up comprehension and detection
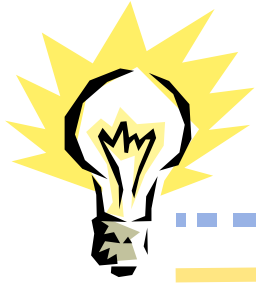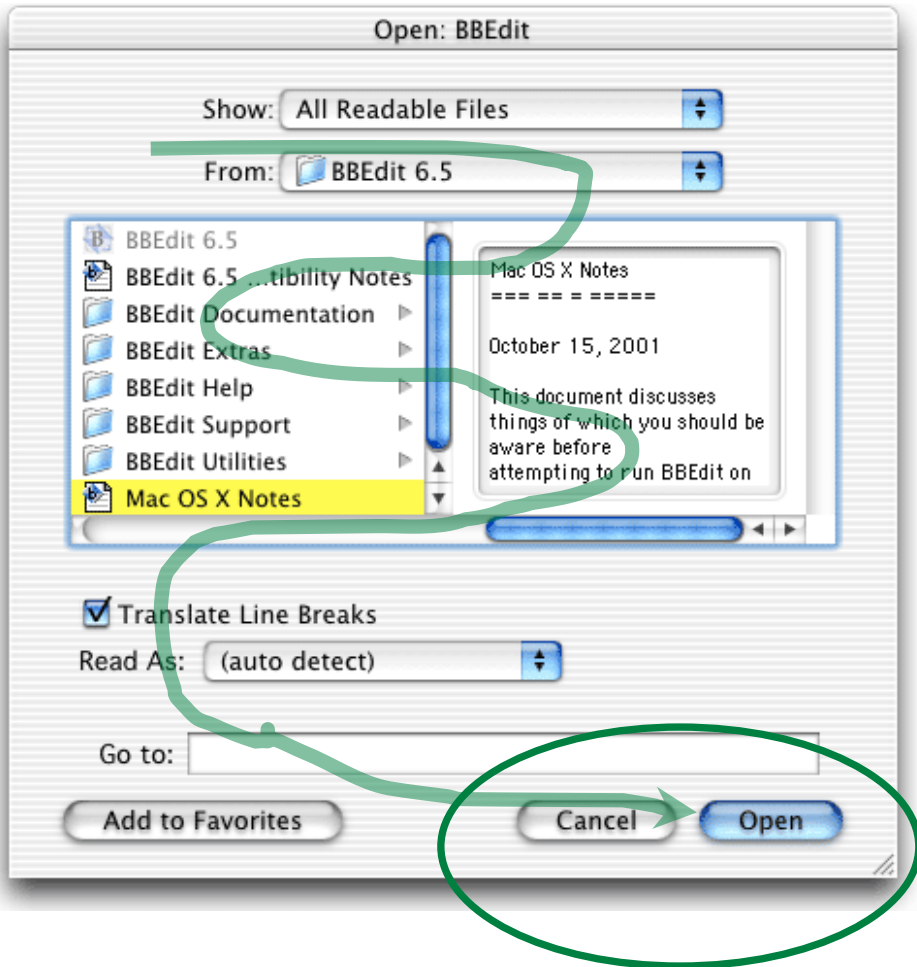

(a)　　　　(b)

Perception Matters in Usability

➢ **Read-flow principle:**

- ❖ Action items (buttons, links) should support the flow of the user in the same way as reading occurs.

- ❖ The last action should be the most-likely action to avoid backtracking.

- ❖ Left=back, stop, quit, cancel, previous
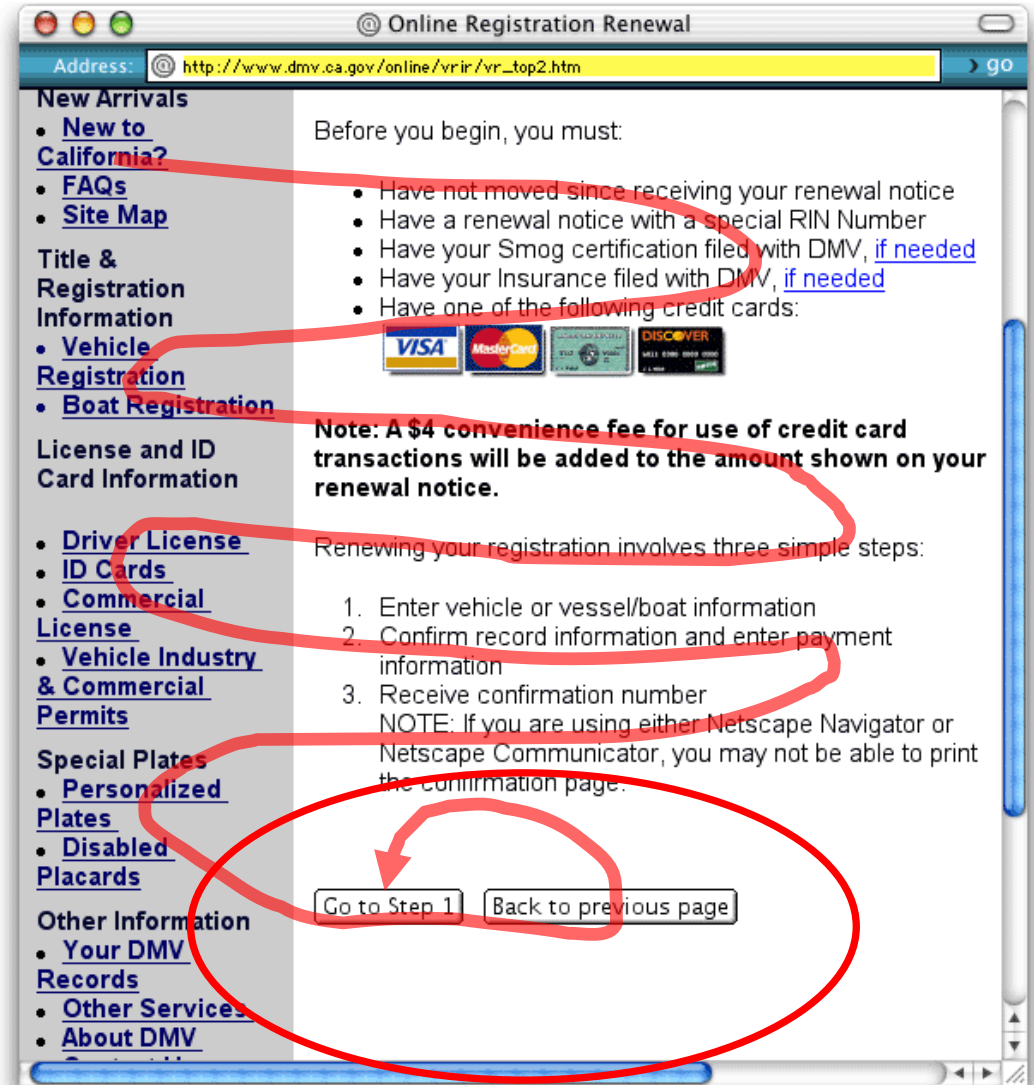- ❖ Right=next, continue, submit

<< Previous Slide   Next Slide >>

Read flow…

FLOWS

DOES NOT FLOW

Hearing

➢ Capabilities (best-case scenario)

❖ pitch - frequency (20 - 20,000 Hz)

❖ loudness - amplitude (30 - 100dB)

❖ location (5° source & stream separation)

     • Not good at front/back and top/bottom discrimination

❖ timbre - type of sound (lots of instruments)

❖ number of simultaneous streams – 2-3, depending on stream distinctness

❖ Better at detecting change than absolute properties
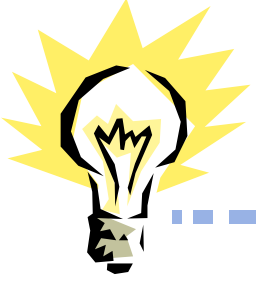
Example

➢ A company that makes monitoring displays for the stock market wants to incorporate auditory displays.

➢ How many stocks could be simultaneously monitored via auditory display?
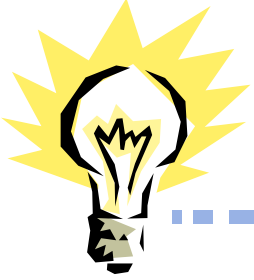
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   D. Smell?

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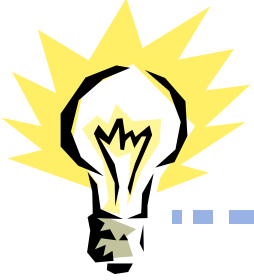   C. Touch
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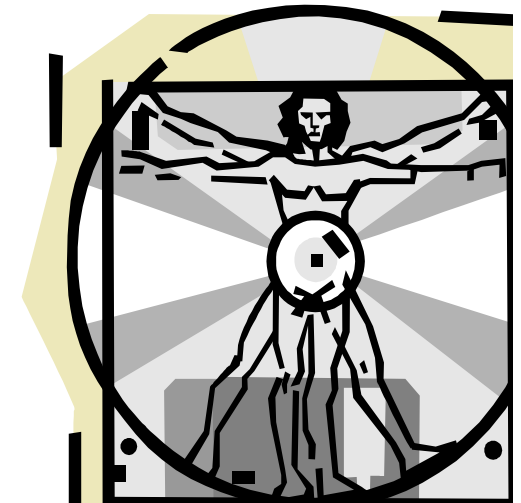
III. Motor system

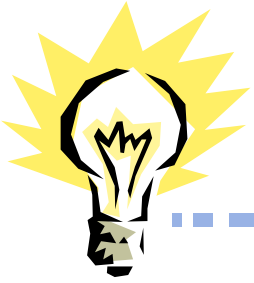IV. Motivations

V. Social Attachments

III. Motor System

➤ Capabilities to consider

  ❖ Range of movement, reach, speed/accuracy tradeoff, strength, dexterity

➤ Human movement is neurologically "noisy" and imprecise.

Principles

- ❖ Designs should generally not require require precise movements

- ❖ Feedback is important, because movement errors are common

- ❖ Fast & accurate pointing movements require extended visual input

- ❖ Surface or air gestures are an alternative to precise pointing, but can be difficult to recall and execute

Reach envelopes/ anthropometry

- Each limb has a certain range (depending on the person's height) that can be comfortably reached.

IPHONE TO IPHONE 4S
IPHONE 5 TO 5S
IPHONE 6
IPHONE 6 PLUS

OW · STRETCH · NATURAL
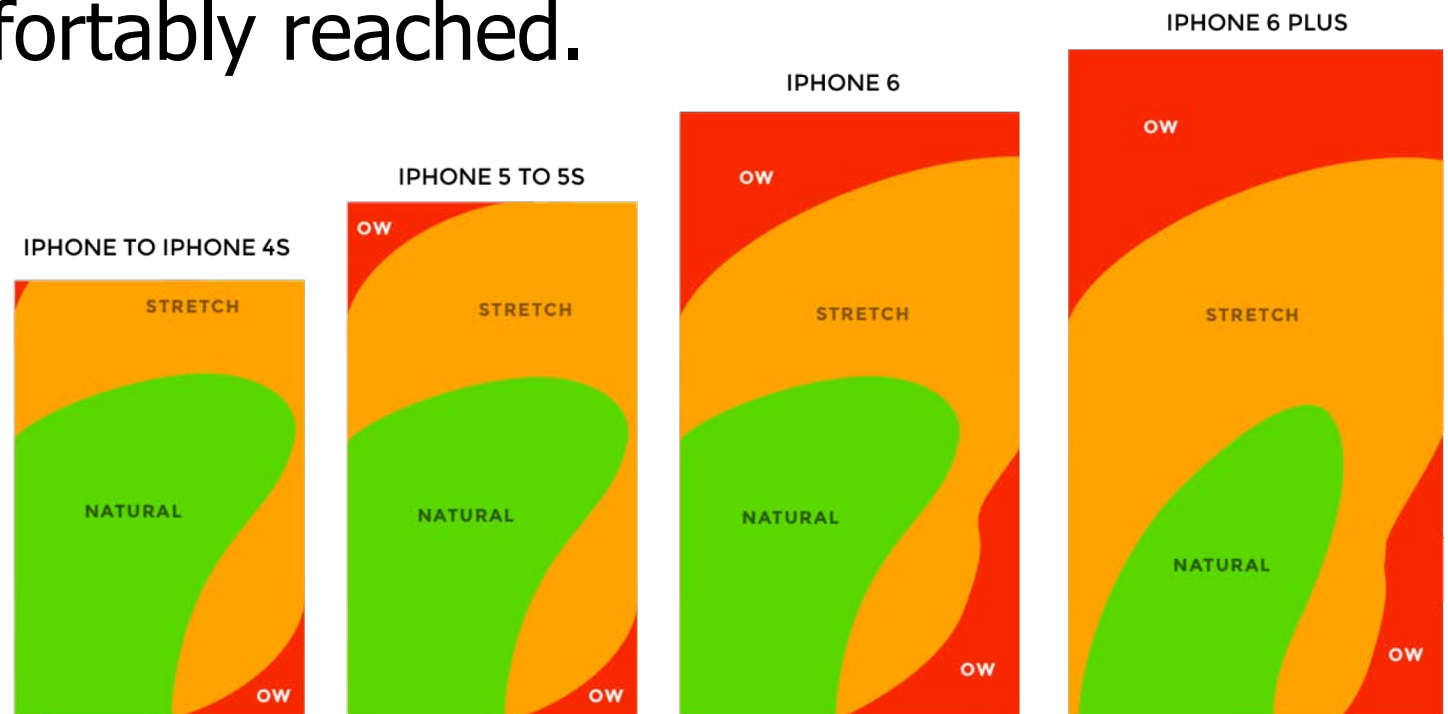
Example

➢ Your employer wants to create a gesture language that can be made with a single thumb, to control large tablets.

➢ How long would a swipe gesture need to be? What direction is "left" and which is "right"?

Project (D1)

➢ Part 1 - Understanding the problem

- ❖ Discovery process
- ❖ In UCD terms, determine **Context**, **Domain**, **Users**, **Needs/Wants, Tasks, Anxieties**, and their <u>Design Implications</u>

- ❖ ***Who is it, what do they need to do, and where?***

- ❖ Interpretive evaluation of current interface, if it exists
- ❖ Establish objectives, requirements for (re)design

Reminder: UCD 9 Steps

1. **Define the Context**
2. **Describe the User**
3. **Needs & Task Analysis**

PROJECT PART D1

4. Function Allocation & Information Architecture
5. System Layout / Basic Design
6. Mockups & Prototypes
7. Usability Testing
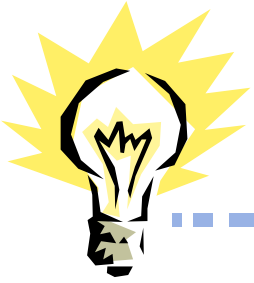8. *Iterative* Test & Redesign
9. Updates & Maintenance
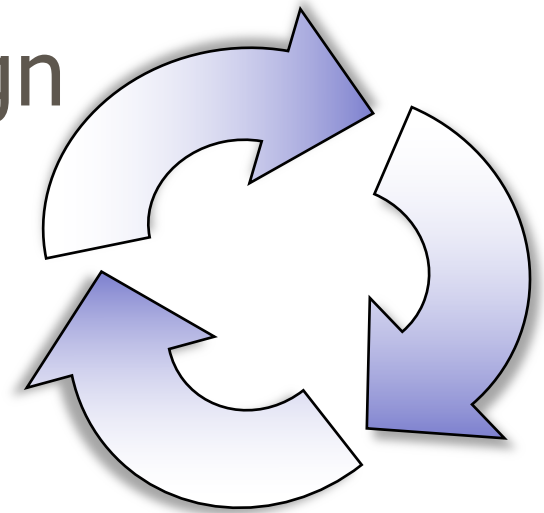
1. Define the Context

➢ Context: the "type" of uses, applications
  ❖ Life critical systems, applications
  ❖ Industrial, commercial, military, scientific, consumer
  ❖ Office, home, entertainment
  ❖ Exploratory, creative, cooperative

➢ Market

➢ Customer (not the same as the User)

...Design Impacts?...

2. Describe the User (!!)

➢ **Physical attributes**
(age, gender, size, reach, visual angles, etc…)

➢ **Physical work places**
(table height, sound levels, lighting, soft~~~~~~~~~~tion…)

➢ **Perceptual abilities**
(hearing, vision, heat sensitivity~~~~~~~~

➢ **Cognitive abilities**
(memory span, readin~~~~~~~~sical training, math…)

➢ **Personality a~~~~~~~~traits**
(likes, dislike~~~~~~~~es, patience…)

➢ **Cultur~~~~~~~~ternational diversity**
(lang~~~~~~~~og box flow, symbols…)

➢ **Specia~~populations, (dis)abilities**

Design Implications?!

UCD and User Groups

Define your users in terms of **context**, **attributes,** and **wants/needs.**

However, within the group that you define, support a wide range of variation in terms of user attributes.

Example: **Wheelchair users** who want to **use room-scale VR educational tools in school.**
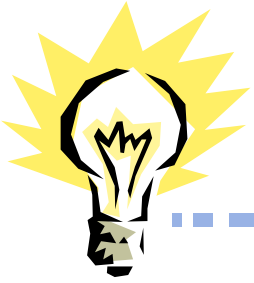
Here, physical mobility is crucial to defining the group.

But, there is not a good reason to exclude colorblind users. Within the group as defined, we need to design for varied abilities.
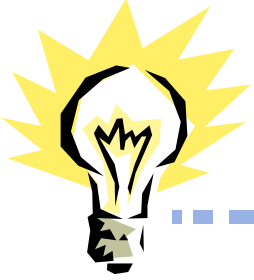
Scope for this Class

- A common guideline is to support the 5th to the 95th percentile in terms of abilities

- Also consider the resource cost of supporting differing abilities within your group
  - Easy to support red-green colorblind persons
  - Generally, easy to make web or app content readable by screen-readers
  - Currently difficult to make XR systems accessible to persons with blindness

- Within this class, talk to your TAs about what is feasible in this regard.

3. Task & Needs Analysis

➢ Talk to and observe **users** doing what they do; find out what they want/need to do

➢ Needs/wants, surveys, focus groups

➢ *Explore the* **PROBLEM SPACE**

➢ List each and every TASK

★ ABSTRACT these into standard tasks

➢ Avoid committing to a particular direction until you have data on the users

❖ Let the data guide you. Who knows what the users will want and need?
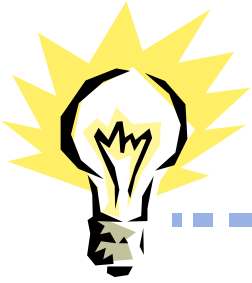
➢ Let's discuss your planned problem spaces and users for D1

❖ Remember, generally, the more specifically you can define your users, the better the project will go

❖ But, it depends on:

- Access to population of users
- Need to practice universal design, to the extent that is feasible given resources
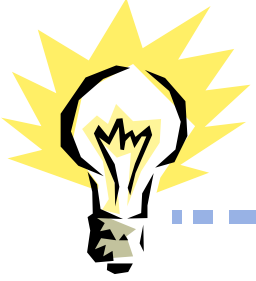
Upcoming

➢ More on human abilities (cognition, social aspects)