SYDE 543 (Fall 2016)
Cognitive Ergonomics

Senses and Perception I

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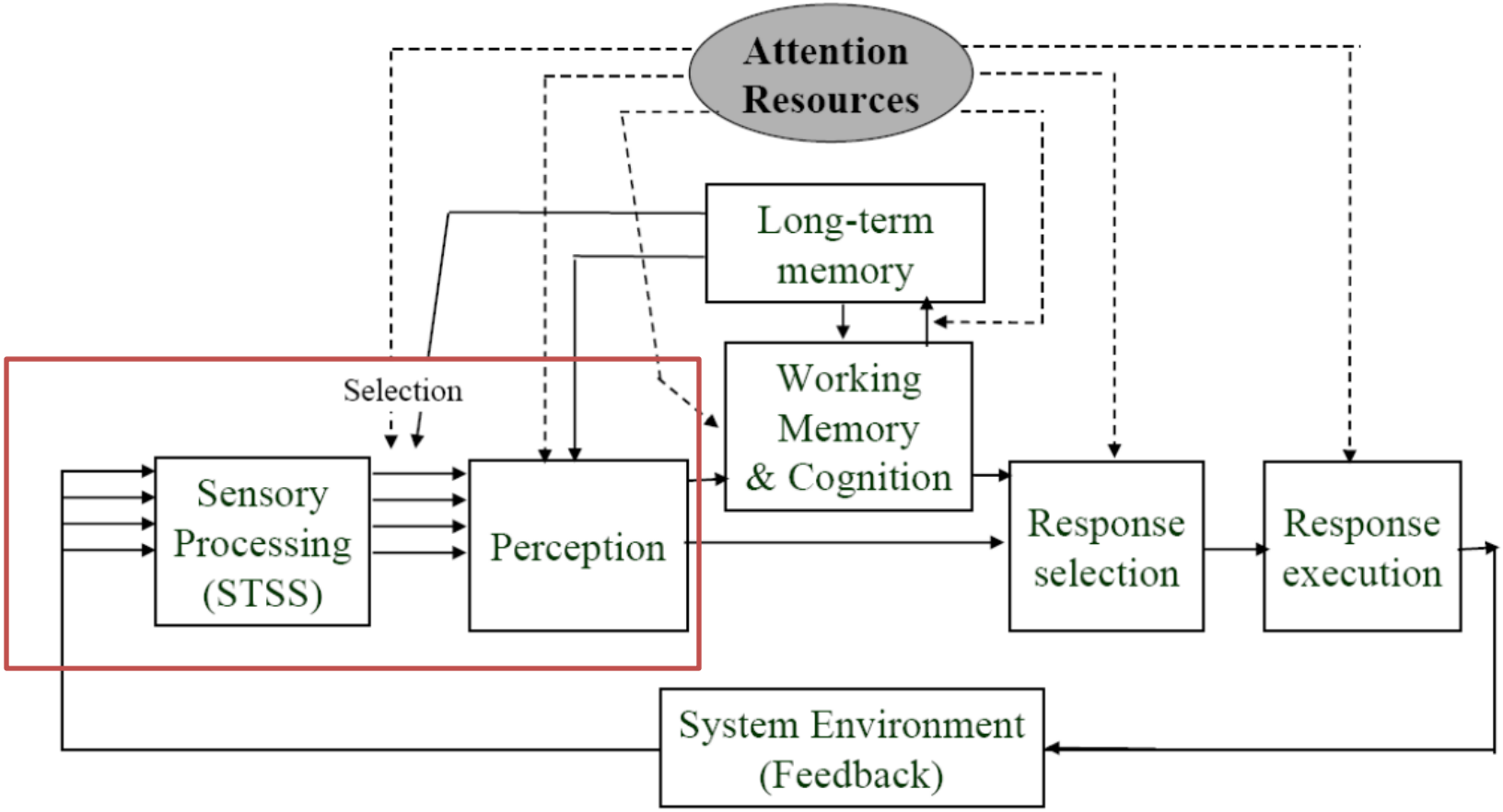
Overview of today's lecture

- Vision sense
- Visual depth perception
- Applications in design

Theme: Descriptive model of human information processing

- Senses and perception in the cognitive model



Sensation vs. Perception

- **Sensation** occurs when special **receptors** in the sense organs—the eyes, ears, nose, skin, and taste buds—are activated, allowing various forms of outside stimuli to become neural signals in the brain.
  - From physical energy or substance to neural signals
  - Automatic, no attention needed

- **Perception** is the method by which the brain takes all the sensations people experience at any given moment and allows them to be interpreted in some meaningful fashion.
  - From neural signals to meaningful mental representations
  - Affected by individual experience

important

Types of human senses

- Vision/sight
- Hearing/auditory
- Smell/olfaction
- Taste/gustation
- Touch/haptic
- Temperature/thermoception
- Pain
- Proprioception/kinesthetic
- Balance
- … …

http://www.manypathstohealing.com/2014/06/12/come-to-your-senses/

Vision

- Sense of light

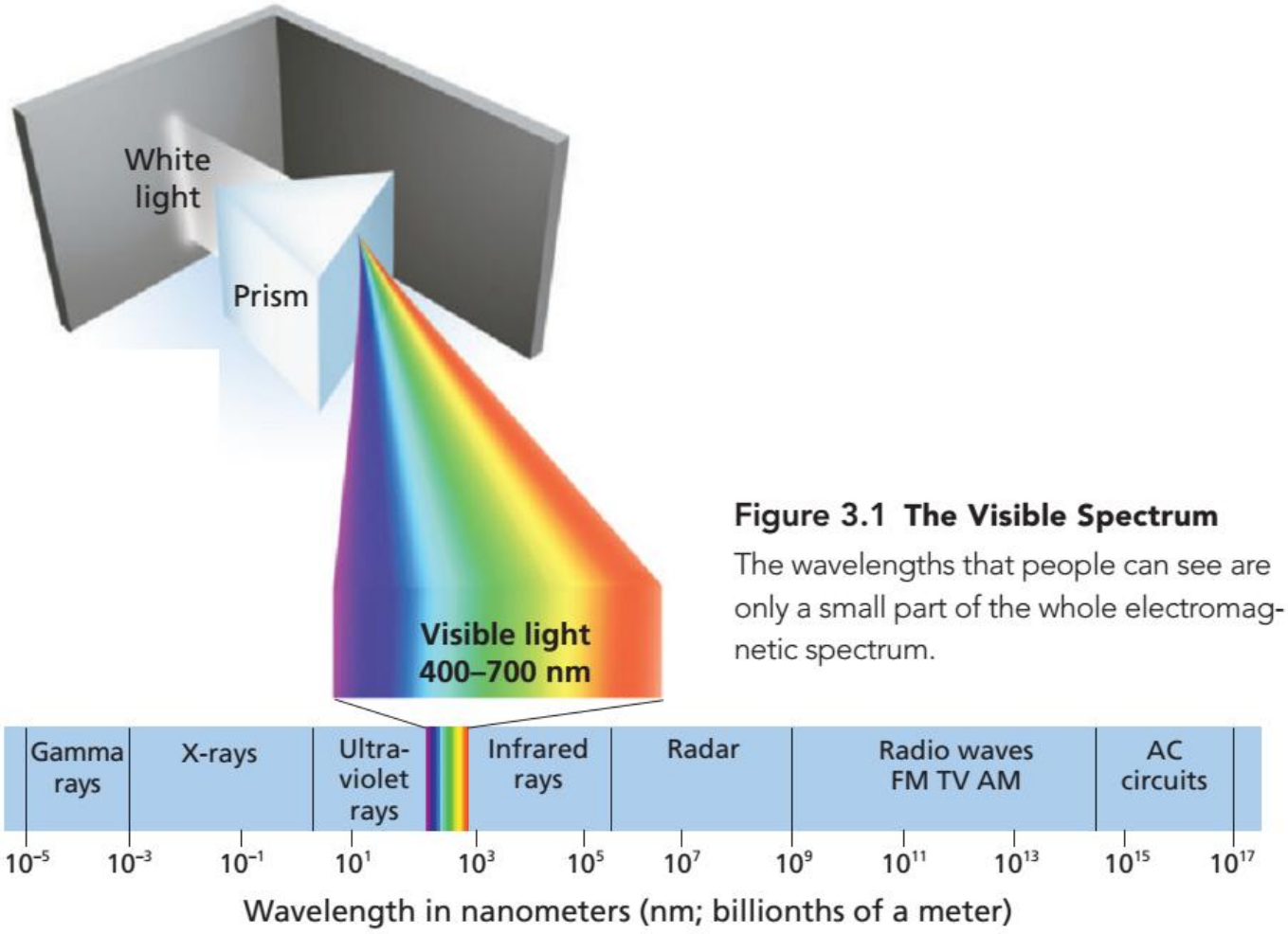


Figure 3.1 The Visible Spectrum

The wavelengths that people can see are only a small part of the whole electromagnetic spectrum.

Ciccarelli and White, Ch. 3

Vision

DON'T NEED TO REMEMBER THIS STUFF

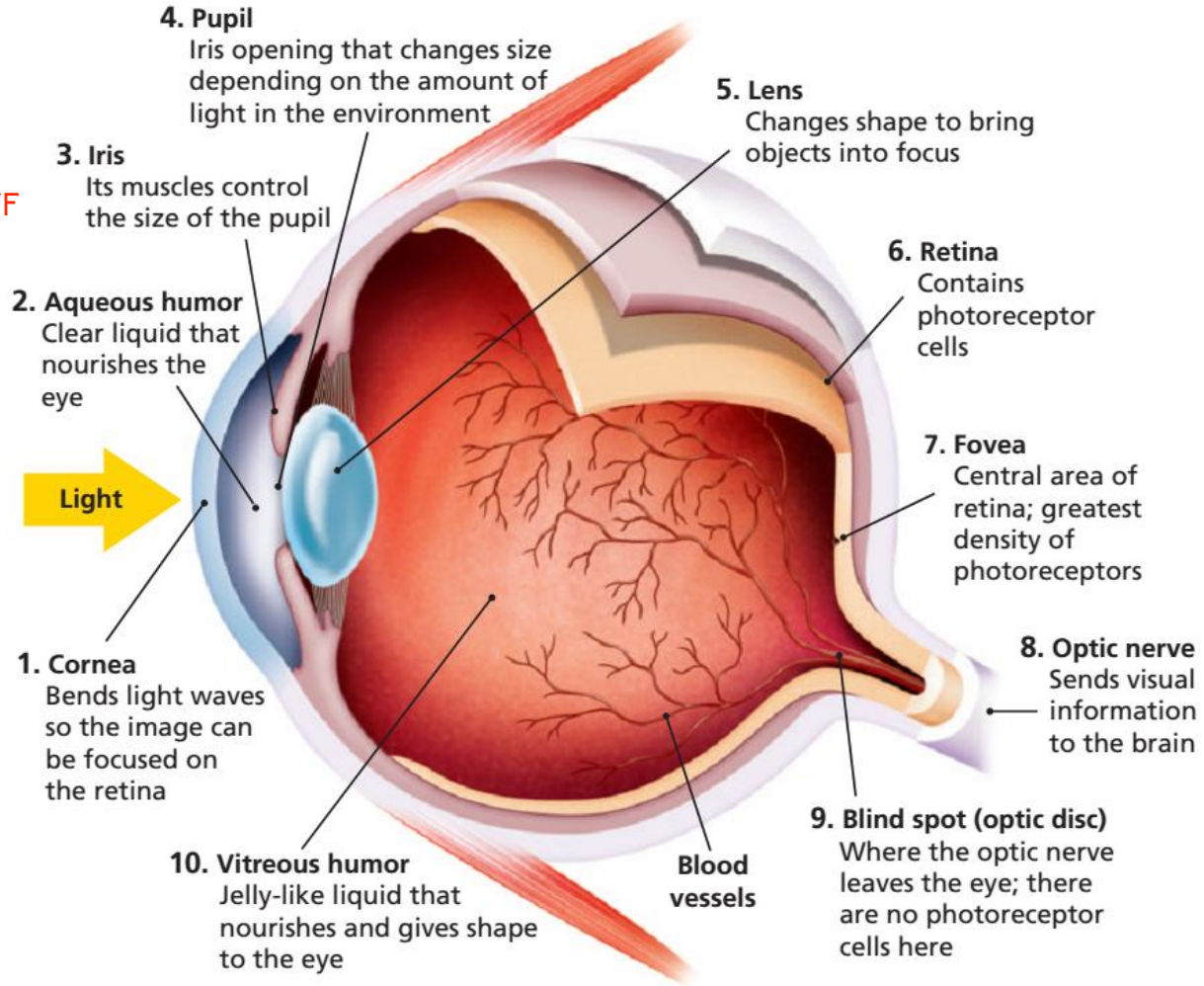


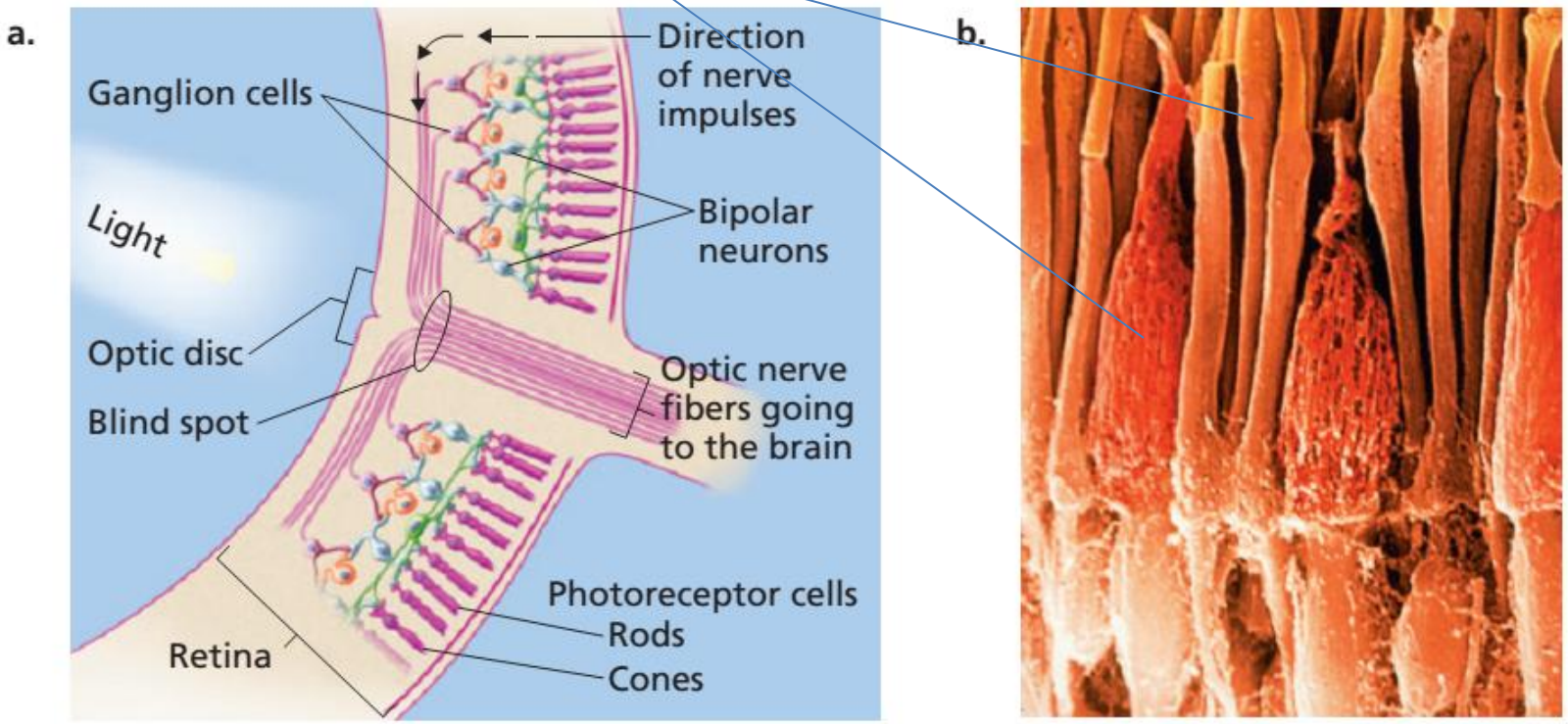
Figure 3.2 Structure of the Eye

Light enters the eye through the cornea and pupil. The iris controls the size of the pupil. From the pupil, light passes through the lens to the retina, where it is transformed into nerve impulses. The nerve impulses travel to the brain along the optic nerve.

Ciccarelli and White, Ch. 3

Vision

- Two kinds of photoreceptor cells on the retina
  - **Cone cells** REMEMBER THIS STUFF
  - **Rod cells**



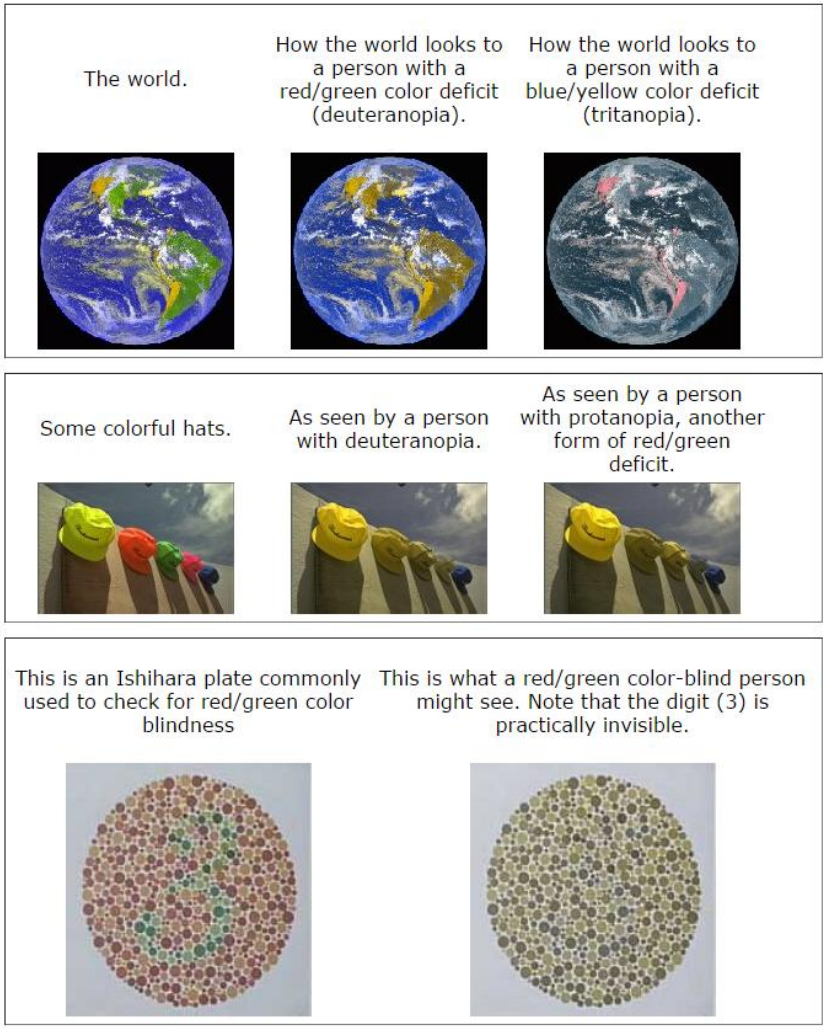
Vision

- 3 types of cone cells, tell colors
  - Red (long-wavelength), Green (middle-wavelength), Blue (short-wavelength)
- Rod cells, work better in low light, better at detecting motion

In trichromatic theory, the three types of cones combine to form different colors much as these three colored lights combine.

Implications for design

- Color blindness, one or more types of cone cells not working



http://www.vischeck.com/

Implications for design

- How to design better traffic lights?
- Considering red/green color blind people
- Draw your design
- Discuss with your neighbour students

Use multiple shapes
- Hand = red
- Triangle = yellow
- Circle = green

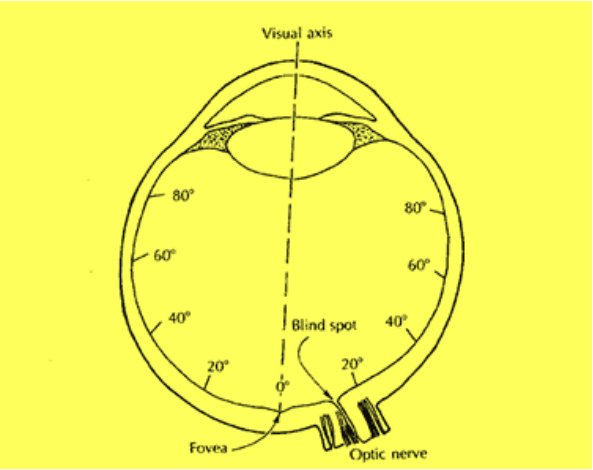
Can maybe do different things for different modes. Lights flashing etc

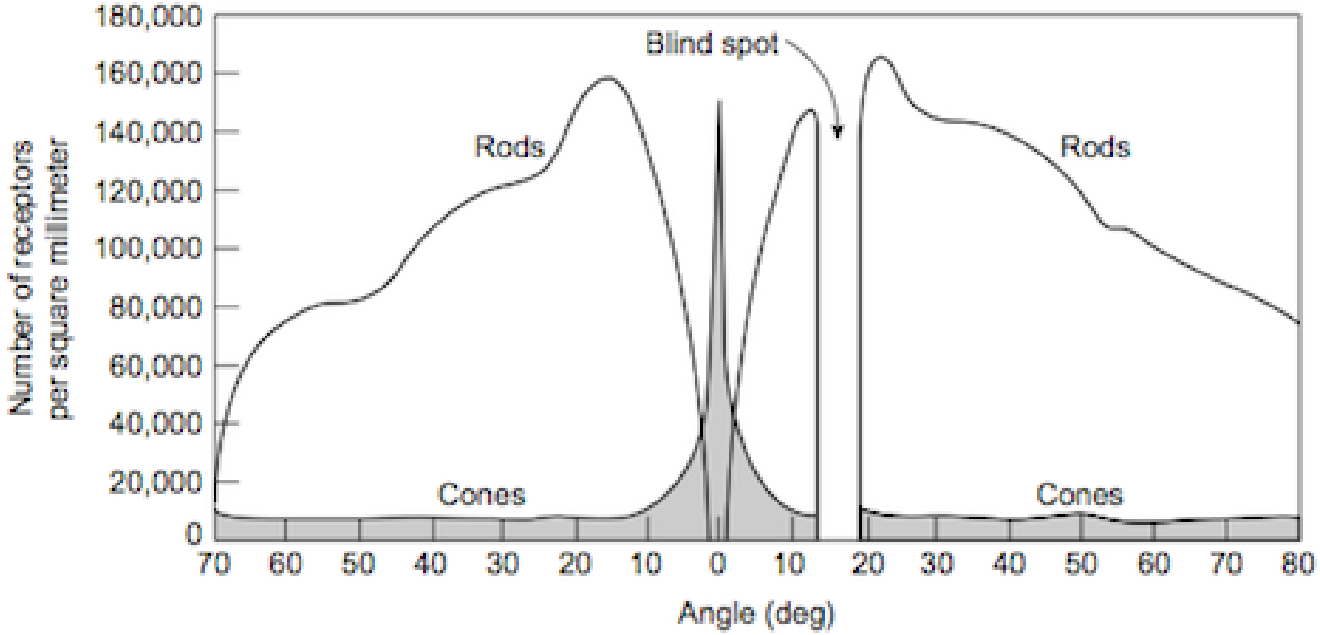
Different colours - Issue is that people will have to unlearn and relearn conotations

Implications for design

Distribution of cones and rods

- Fovea area
  - Center of the retina, only cones
- Periphery area
  - Both cones and rods



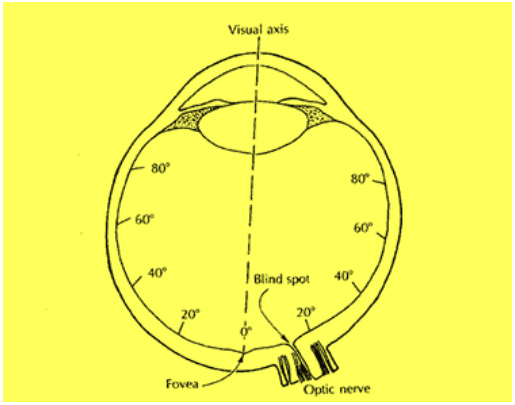


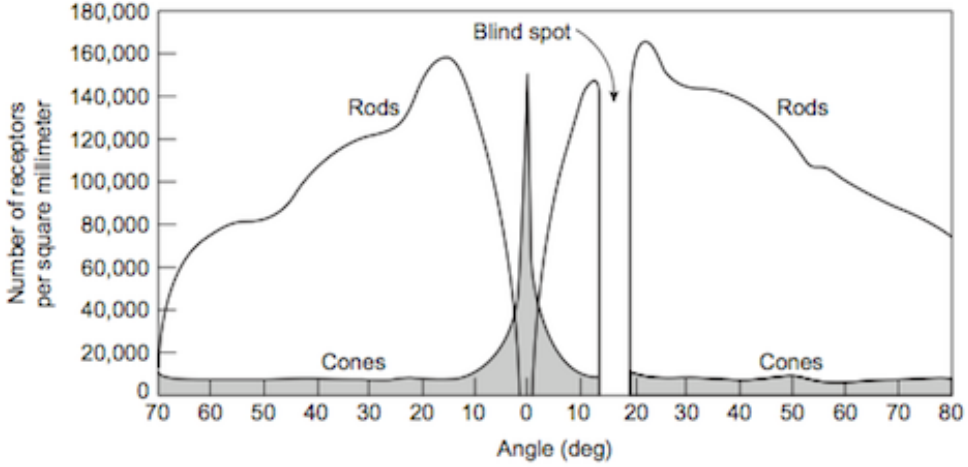
Left eye

(Lindsay, Peter H., and Donald A. Norman. *Human Information Processing*. New York: Academic Press, 1972.)

Blind spot

- You can test this spot.
- Draw two dots on a piece of paper, four fingers apart.
- Use only the left eye, looking at the dot on the right.
- Move the paper closer and further, until the dot on the left is gone.





How to avoid missing information on the blind spot?

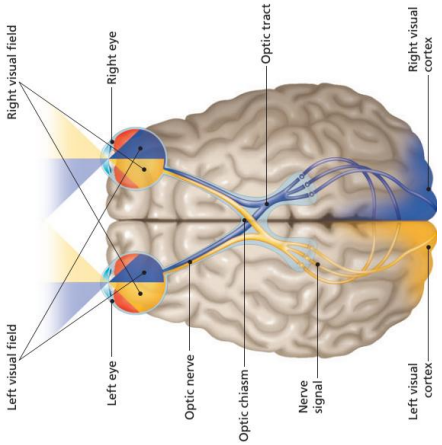
- Use both eyes
- Moving the eye if using only one eye

Image adjusted for retinal acuity

Why the peripheral area has lower visual acuity (lower spatial resolution)?

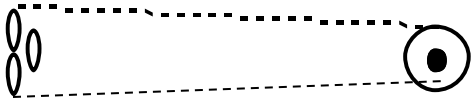
Lecture notes from Parasuraman

Retina-Brain (thalamus) Cells mapping



cones

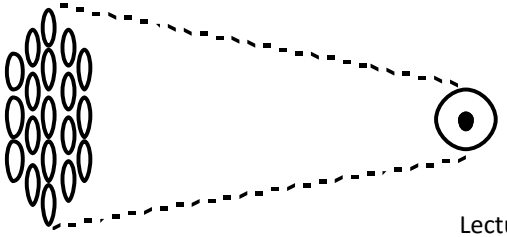
small receptive field
(higher resolution)



Parvo cell

rods

large receptive field
(lower resolution)



Magno cell

Lecture notes from Parasuraman

Eye movement

- **Pursuit**: smooth tracking of moving targets
- **Saccade**: short and quick movements involving stops
  - Initiation and dwell time (> 200 ms)
  - Actual movement time (30-50 ms)

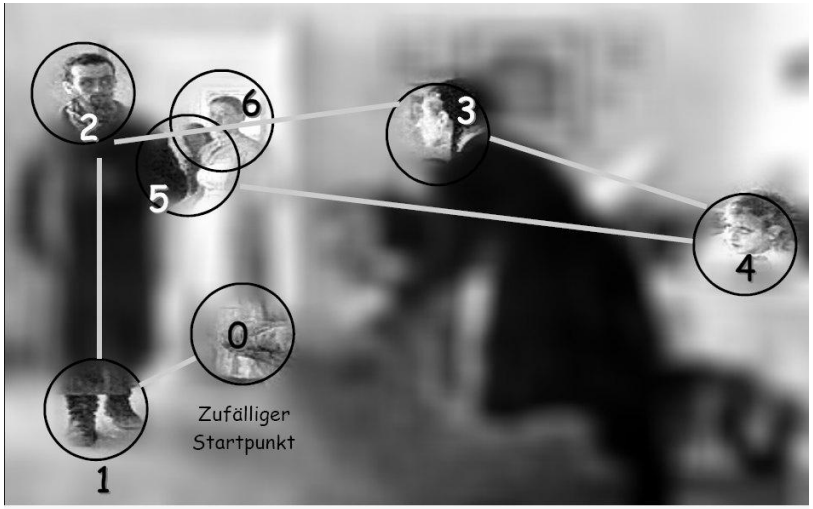
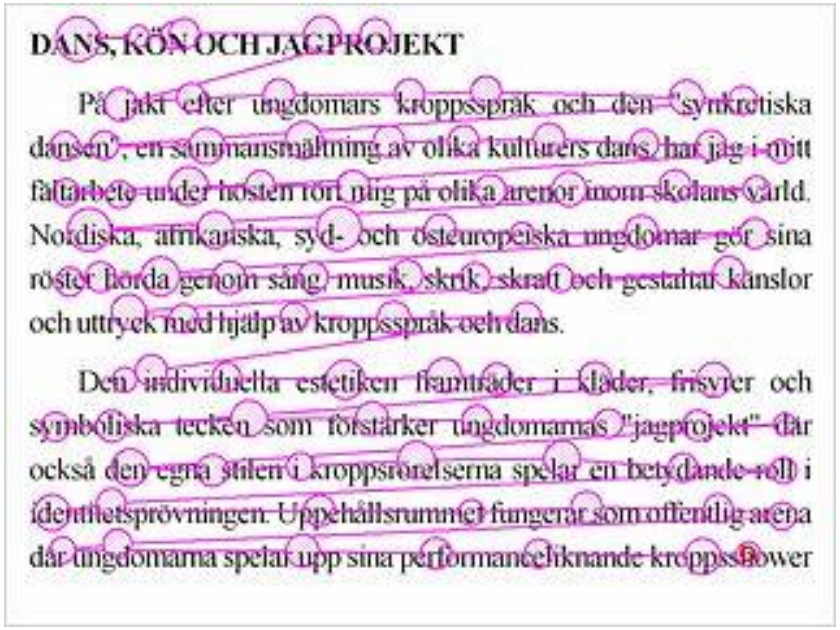


Bild 11: Foveale Ergänzung durch die ersten 6 Fixationen (nach Daten von *Yarbus,1967*)

"Vision 2 secondes" by Hans-Werner Hunziker - Im Auge des Lesers, Transmedia Verlag, Stäubli AG, Zürich 2006.


DANS, KÖN OCH JAGPROJEKT

På jakt efter ungdomars kroppsspråk och den "synkretiska dansen", en sammansmältning av olika kulturers dans, har jag i mitt fältarbete under hösten rört mig på olika arenor inom skolans värld. Nordiska, afrikanska, syd- och östeuropeiska ungdomar gör sina röster hörda genom sång, musik, skrik, skratt och gestaltar känslor och uttryck med hjälp av kroppsspråk och dans.

Den individuella estetiken framträder i kläder, frisyrer och symboliska tecken som förstärker ungdomarnas "jagprojekt" där också den egna stilen i kroppsrörelserna spelar en betydande roll i identitetsprövningen. Uppehållsrummet fungerar som offentlig arena där ungdomarna spelar upp sina performanceliknande kroppsflower

"Reading Fixations Saccades" by Original uploader was Lucs-kho at en.wikipedia - Transferred from en.wikipedia.

Eye movement

- Eye tracking provides an important performance measurement

http://www.eyegaze.com/are-you-ready-for-eye-tracking-to-be-part-of-daily-life-part-2/

"Eye movements of drivers". Via Wikipedia - http://en.wikipedia.org/wiki/File:Eye_movements_of_drivers.jpg#mediaviewer/File:Eye_movements_of_drivers.jpg

Peripheral vision is good at dark night

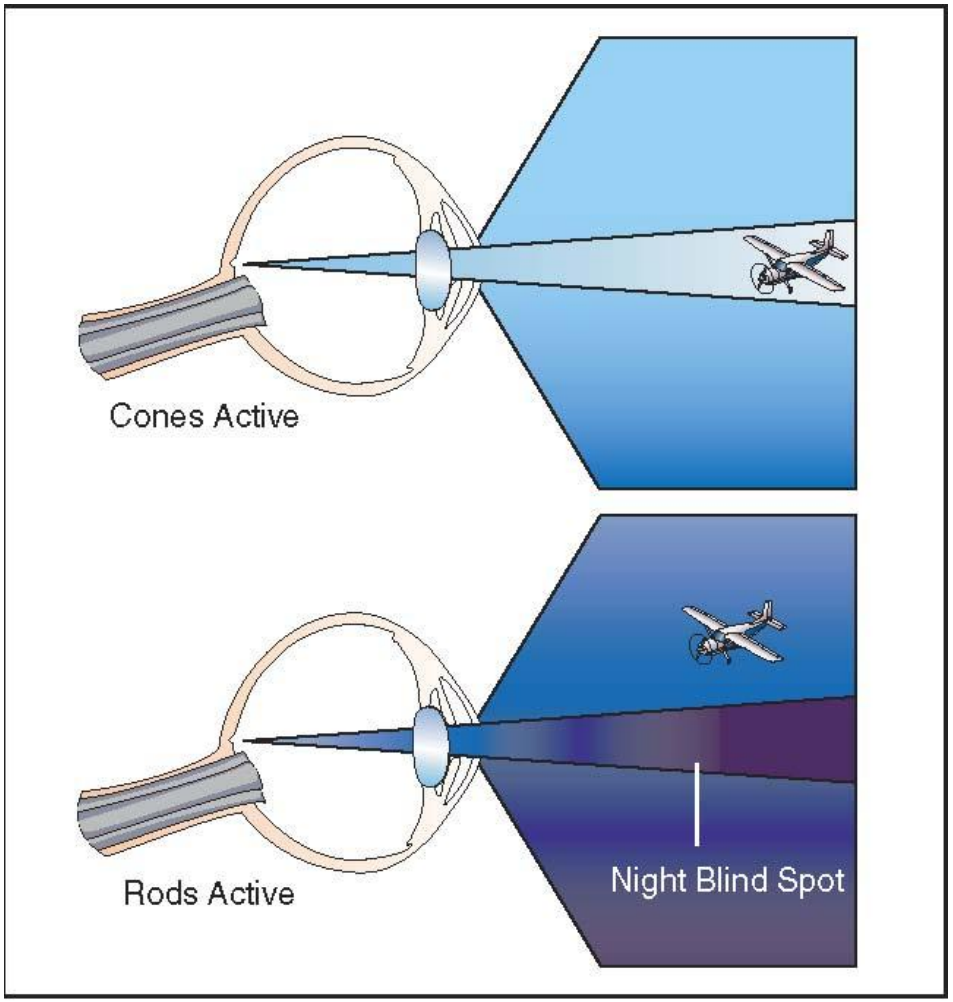


Figure 15-8. Night blind spot.

Implications for design

- If you are looking for faint/dim targets at night (e.g., stars, planes), how should you look?

Implications for design

- Regarding vehicle control console design, what should be considered to avoid distracting drivers especially at night?

Low Brightness, Prevent any motion,

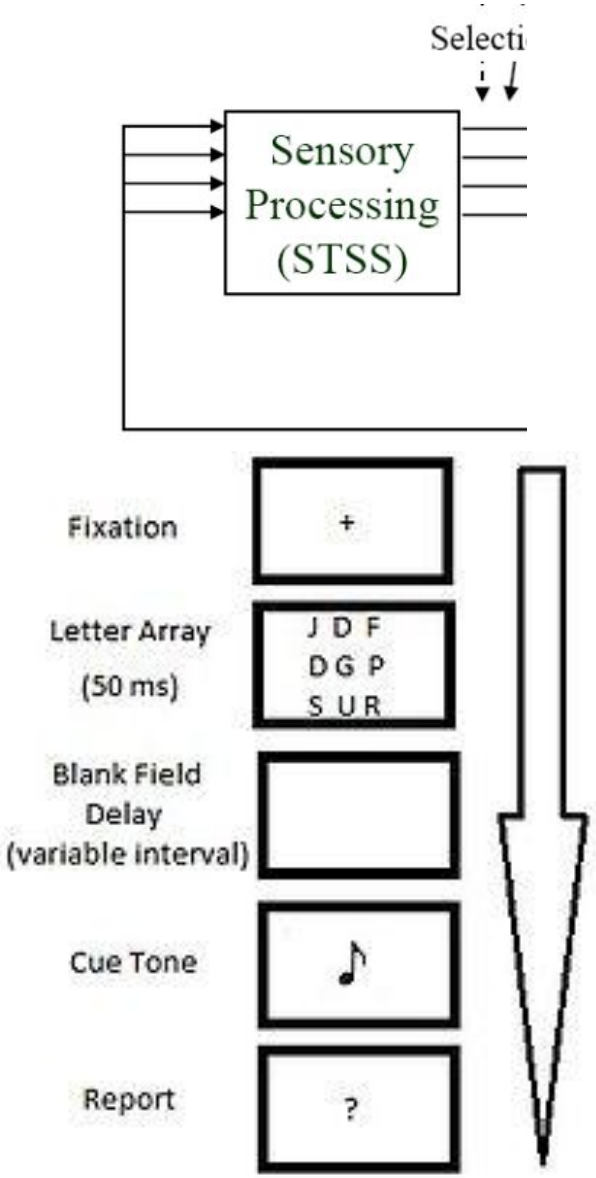
Comparison between rods and cones

Photocells	Cones	Rods
Color	Three types: red, green, and blue	Cannot tell colors (gray scale)
Low Light	Poor in low light	Sensitive
Motion	Less sensitive	Sensitive
Spatial Detail **(fovea vs. peripheral)**	Fine detail (high resolution)	Coarse (low resolution)

important!!!!!!

Short-Term Sensory Storage (STSS)

- For vision, it is also called **iconic memory**.
  - very brief (<1000 ms)
  - high capacity
  - Support temporal integration of visual info (movies, saccadic eye movement)



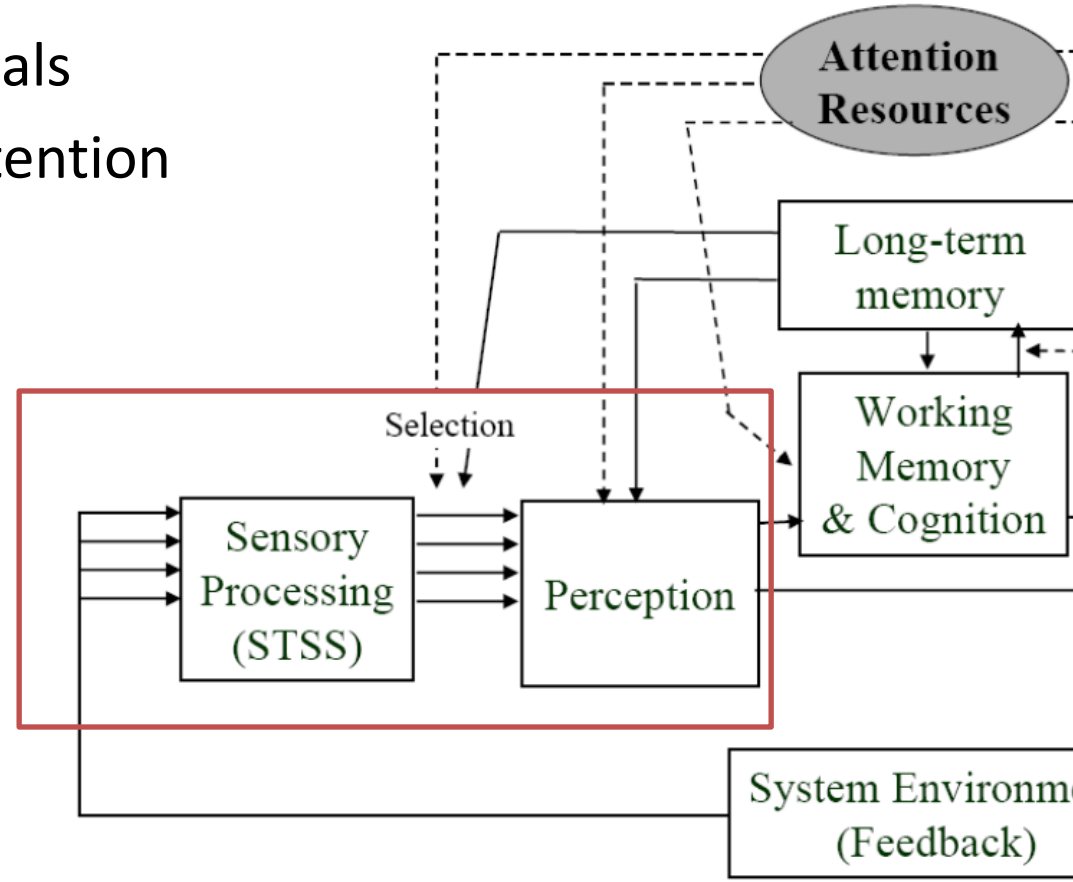
- Sperling, partial report experiment (1960)
- Examine visual STSS capacity
- Whole report (forget before reporting)
- Partial report (shows high capacity)

Application in design

- Iconic memory supports the perception of seeing continuous motion in motion pictures (movie/film/gif), which are essentially discrete frames (e.g., 24p, 30p, and 60p per second).

Sensation vs. Perception

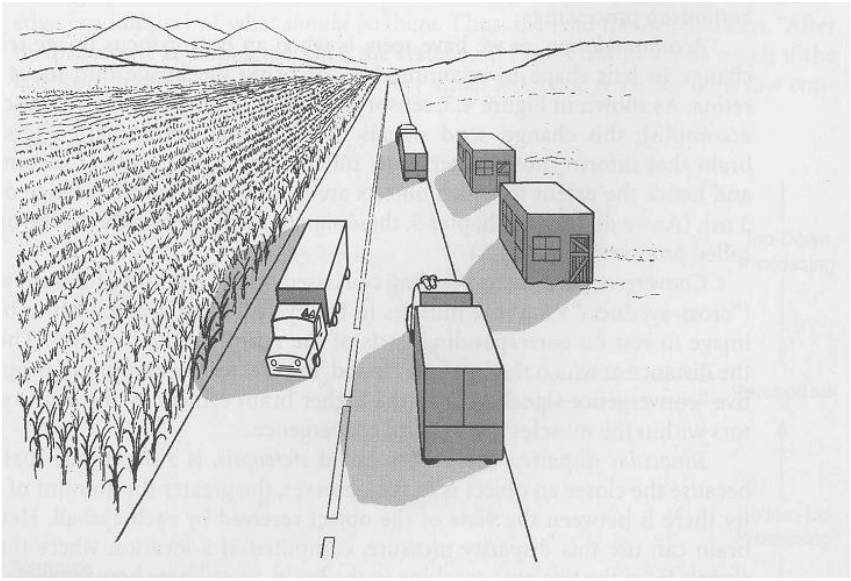
- **Sensation**
  - From physical energy or substance to neural signals
  - Automatic, almost no attention needed
- **Perception**
  - From neural signals to meaningful mental representations
  - Affected by individual experience



Visual depth perception

Monocular cues, object centered, pictorial

- Linear perspective
- Relative size
- Overlap
- Aerial (atmospheric) perspective
- Texture gradient



important

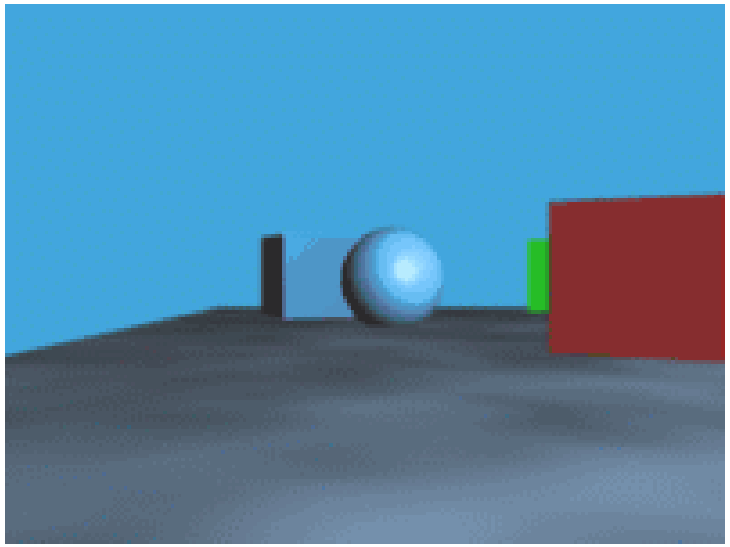
Depth perception, application (Art)

http://mindandmachines.wordpress.com/2012/11/26/perceptualoptical-illusions/

Visual depth perception

Monocular cues, object centered

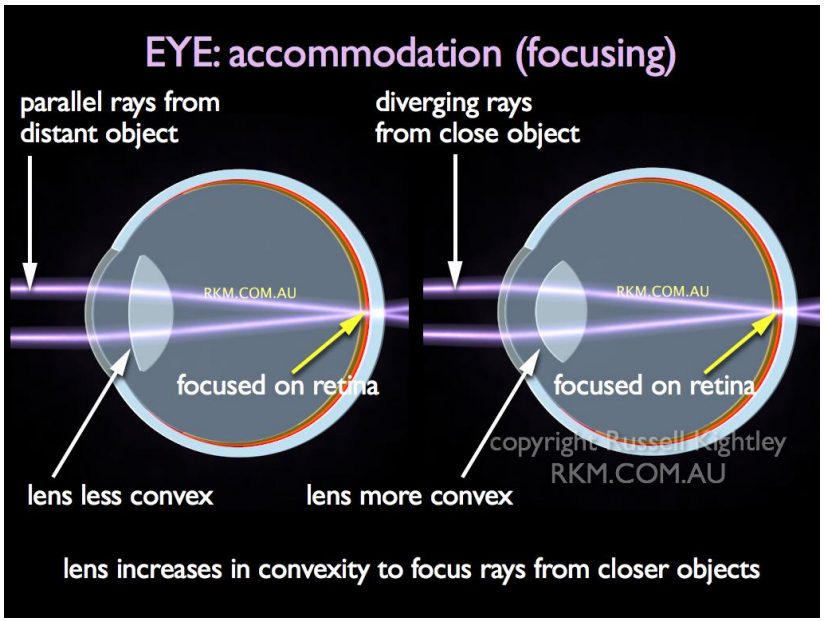
- Motion parallax (relative motion)



http://en.wikipedia.org/wiki/Parallax

Monocular cues, observer centered

- Accommodation

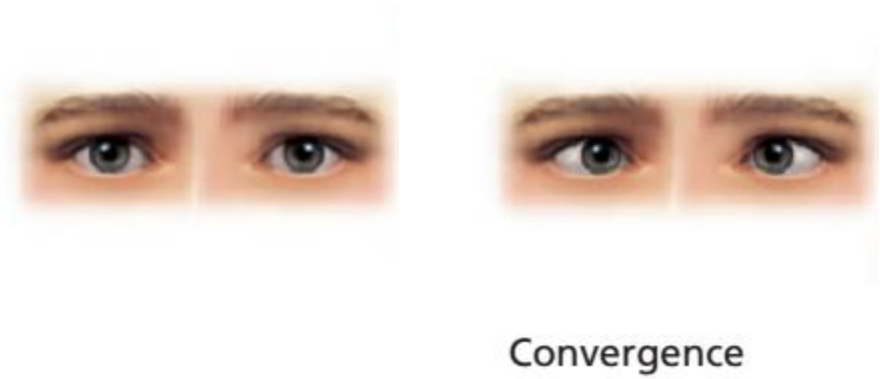


Motion parallax application

- Motion parallax. As the viewpoint moves side to side, the objects in the distance appear to move slower than the objects close to the camera.
- Real world application, Fish tank virtual reality
- http://www.youtube.com/watch?v=7CCJD-Ao-JQ

Visual depth perception (Binocular cues)

- Binocular disparity
  - Two eyes see two different images.
  - 3D movies using polarized glasses
- Convergence
  - The rotation of the two eyes in their sockets to focus on a single object.



Convergence

important

Which work with one eye? (Monocular cues)
Which require both eyes? (Binocular cues)
Which can be used in 3D VR display?

- Linear perspective Mono
- Relative size Mono
- Overlap Mono
- Aerial (atmospheric) perspective Mono
- Texture gradient Mono
- Motion parallax (relative motion) Mono
- Accommodation Mono
- Binocular disparity Binocular
- Convergence Binocular

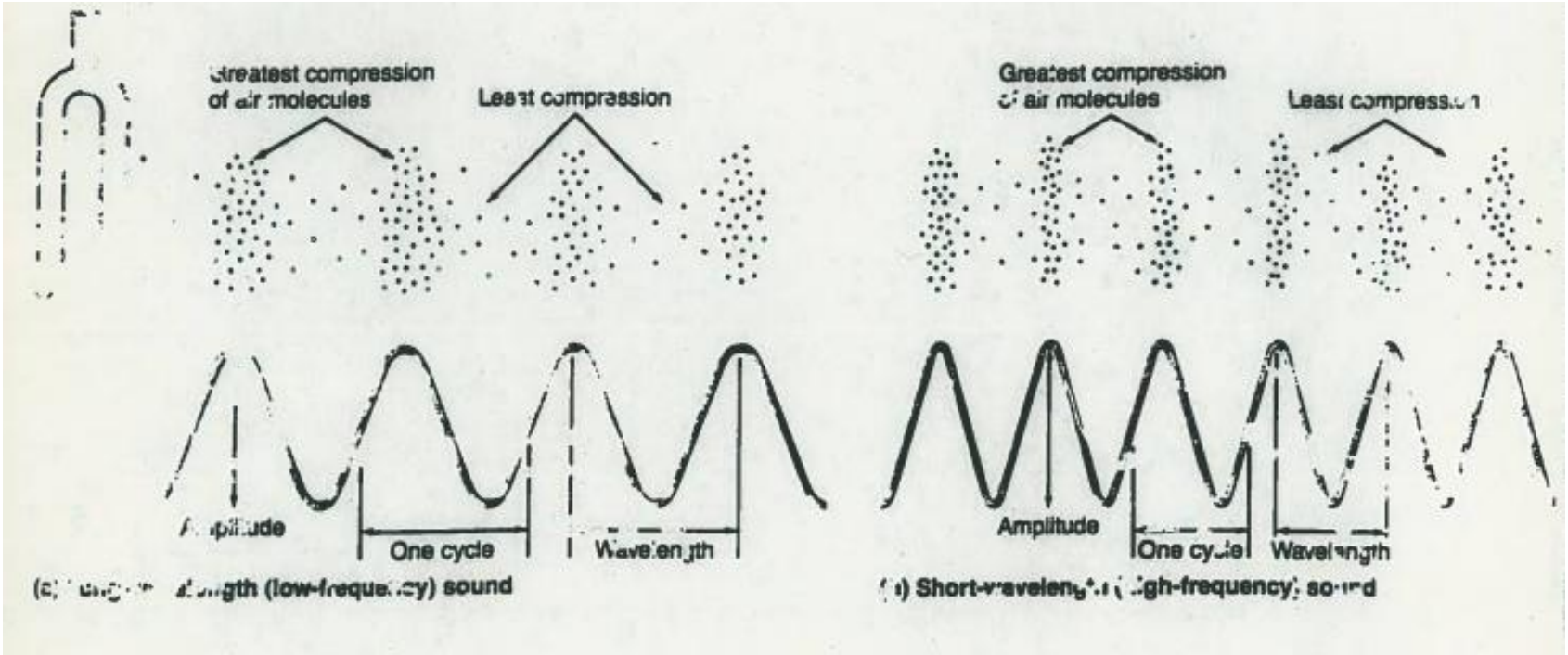
3D VR display can use use everything EXCEPT convergence and accomodation

This is since the distance between your eye and the screen is static

Answers

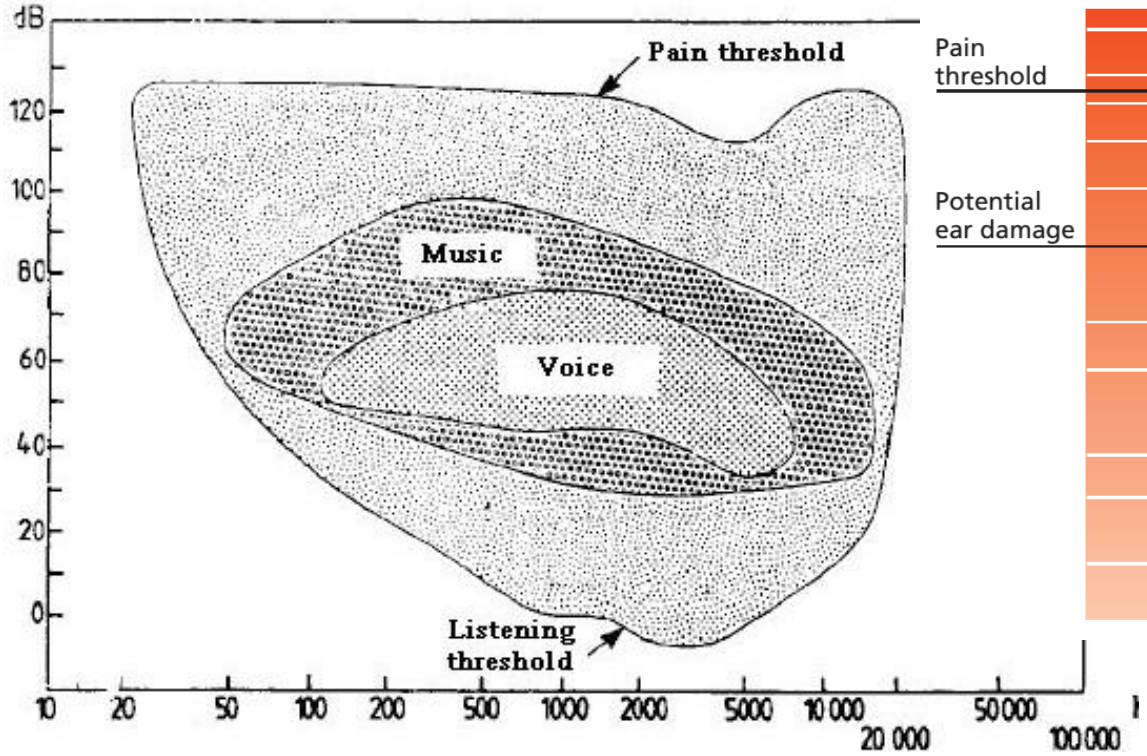
Auditory

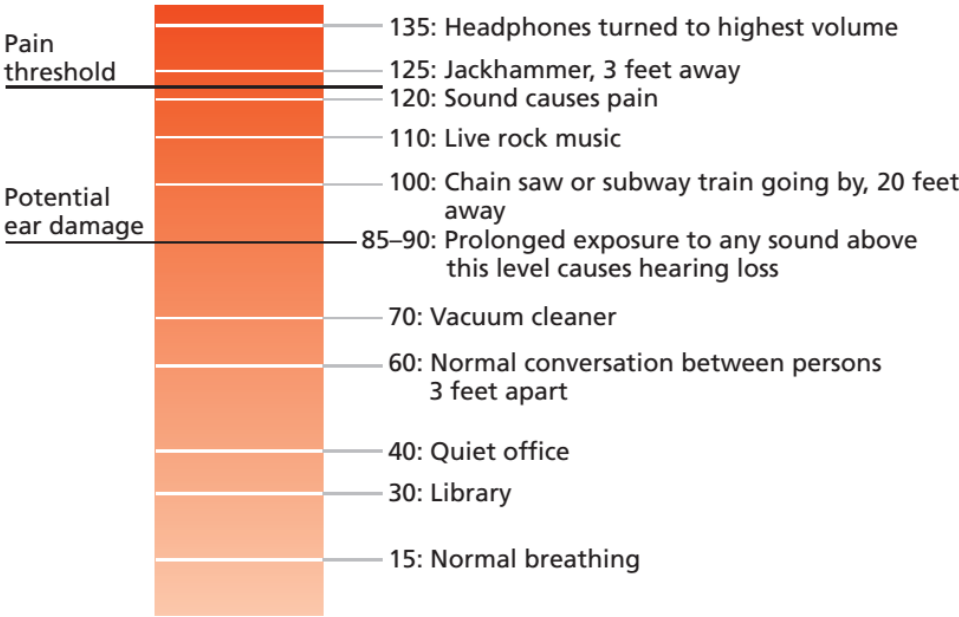
- Sense of sound
- Intensity (dB, decibel)
- Frequency (Hz)



Auditory

- Human audible range
- Intensity: about 0-130 dB
- Frequency: about 20 – 20k Hz





http://en.wikibooks.org/wiki/Acoustics/Fundamentals_of_Psychoacoustics#mediaviewer/File:Audible.JPG

Ciccarelli and White, Ch. 3

Auditory

- From physical energy to psychological feeling

1. frequency → pitch
2. intensity (amplitude) → loudness

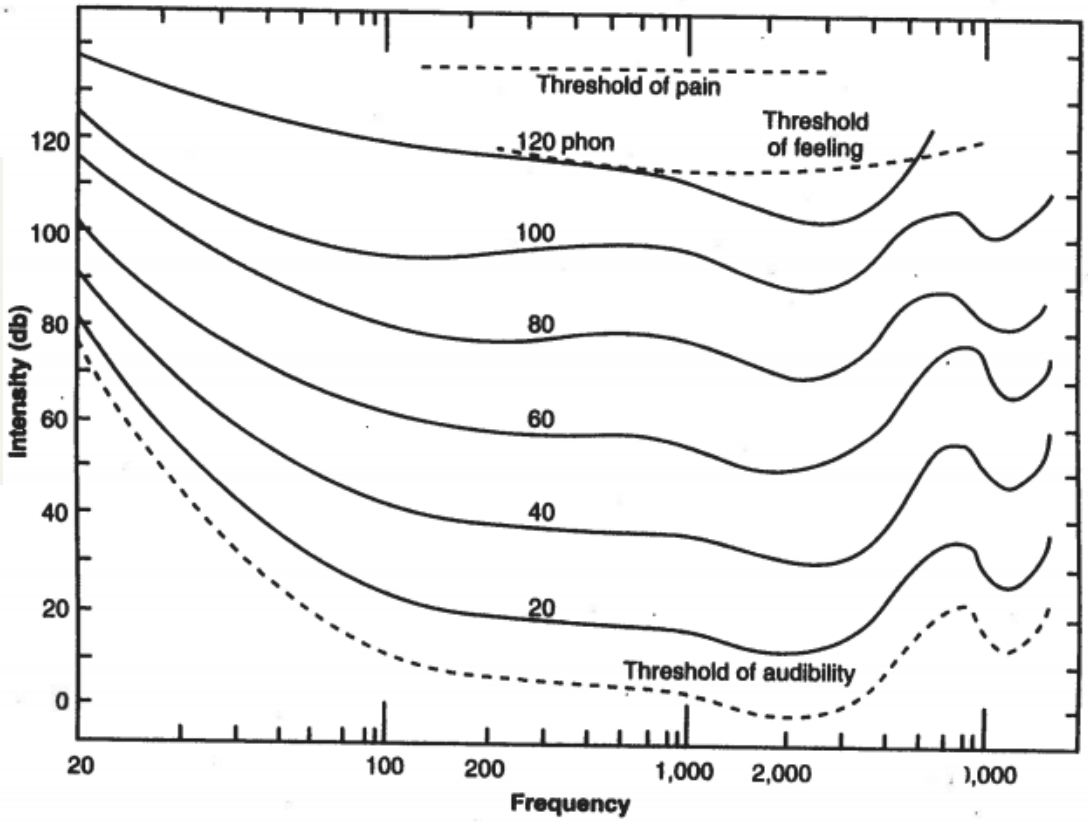


FIGURE 5.4
Equal loudness contours showing the intensity of different variables as a function of frequency. All points lying on a single curve are perceived as equally loud. (*Source:* Van Cott, H.P., and Kinkade, R.G., eds., 1972. *Human Engineering Guide to System Design.* Fig. 4-6. Washington, DC: U.S. Government Printing Office.)

Implications for design?

- Warning signals
- Hearing protection
- Noise reduction