

Lecture 7

Human Input-Output Channels – Part I

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In the Last Lecture

- Cognition
- Cognitive Models
- Human Information Processing Model
- Human Processor Model
- GOMS
- External Cognition
- Distributed Cognition

In Today's Lecture

- Vision
 - Human Eye
 - Visual Perception
 - Reading

Input-Output Channels

- Interaction with world
 - Occurs through information
- Interaction with computer
 - Input and output
- Human Input
 - Through Senses
- Human Output
 - Through Effectors

Input via Senses

- Vision
- Hearing
- Touch
- Taste
- Smell

Output via Effectors (Responders)

- Limbs
- Fingers
- Eyes
- Head
- Vocal system

Interaction with PC Using Input-Output Channels

- Using a GUI-based computer
- Information received by sight
- Beeps received by ear
- Feel keyboard and mouse with fingers

Vision

- Highly complex activity
- Physical and perceptual limitations
- 2 stages of visual perception:
 - Physical reception of the stimulus
 - Interpretation/processing of stimulus
- Processing allows construction of images from incomplete information

Human Eye

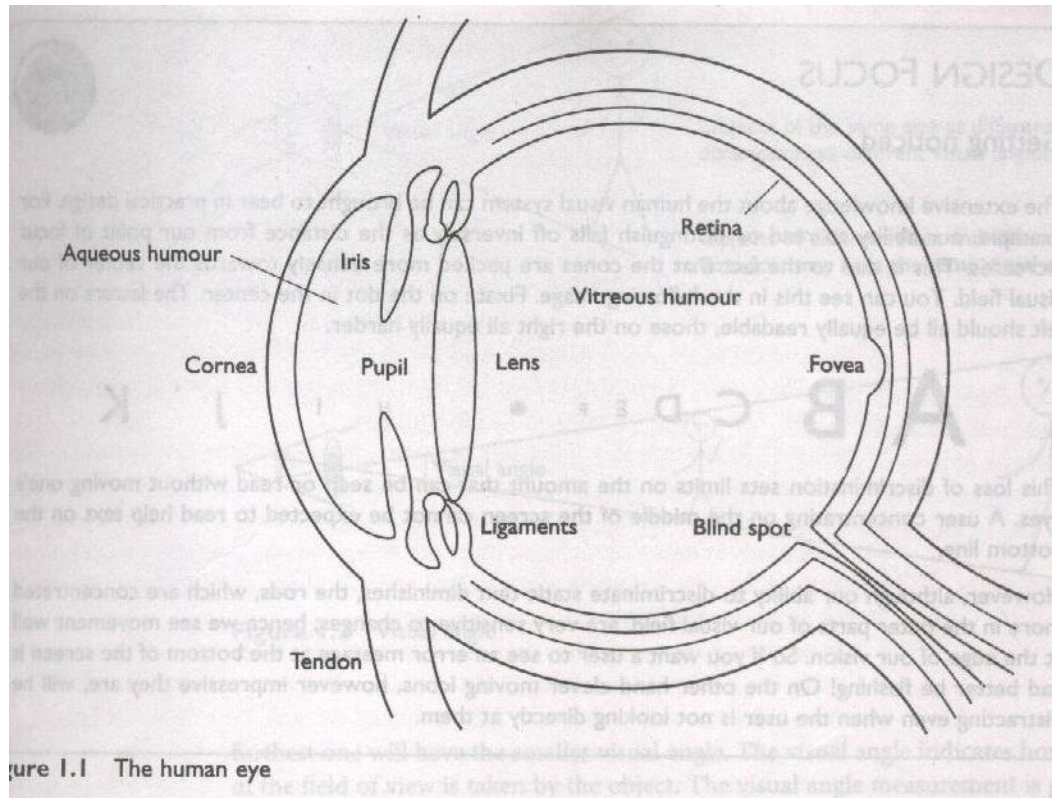
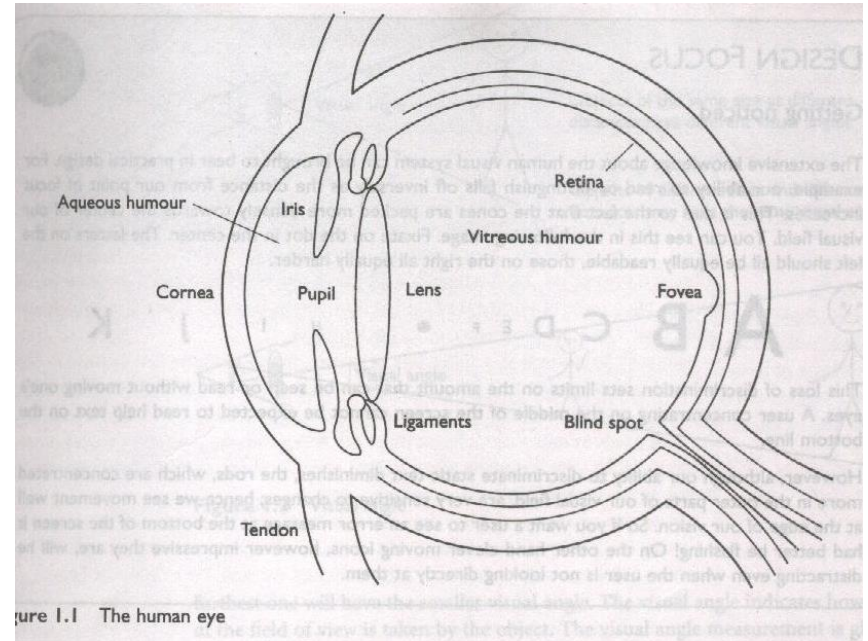


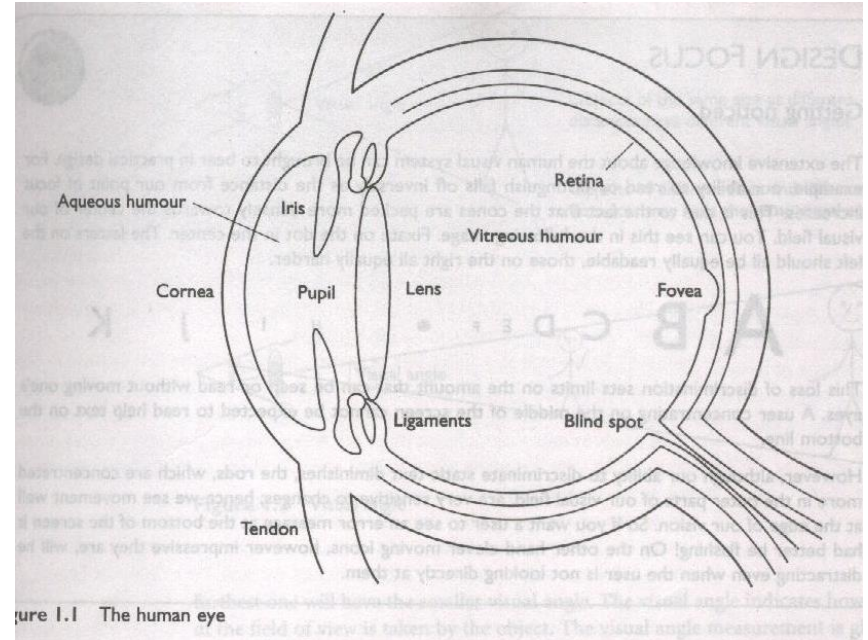
Image Formation

- Cornea and lens
 - Focuses light into a sharp image on retina
 - An upside down image is formed on the retina.



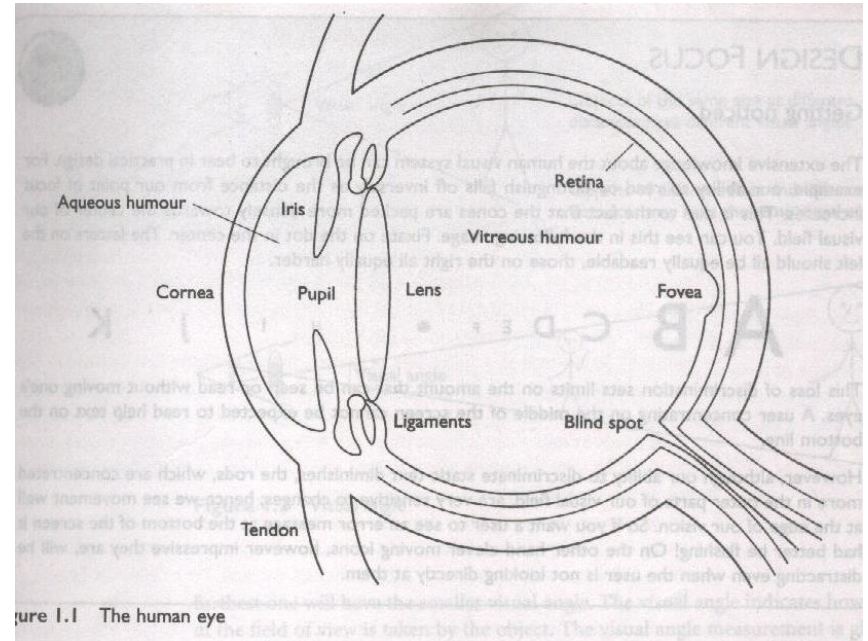
Photoreceptors

- Rods
- Cones



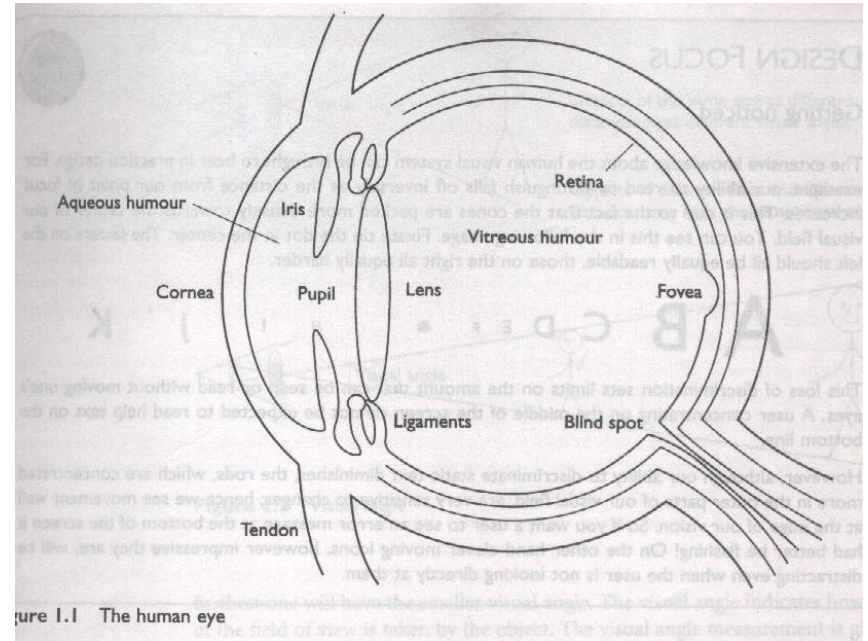
Rods

- Situated towards the edges of retina
 - Dominate peripheral vision
- Sensitive to light
 - Allow us to see under low level of illumination
- Unable to resolve fine detail and are subject to light saturation
 - Cause of temporary blindness when moving from dark areas to very bright ones
- 120 million rods per eye



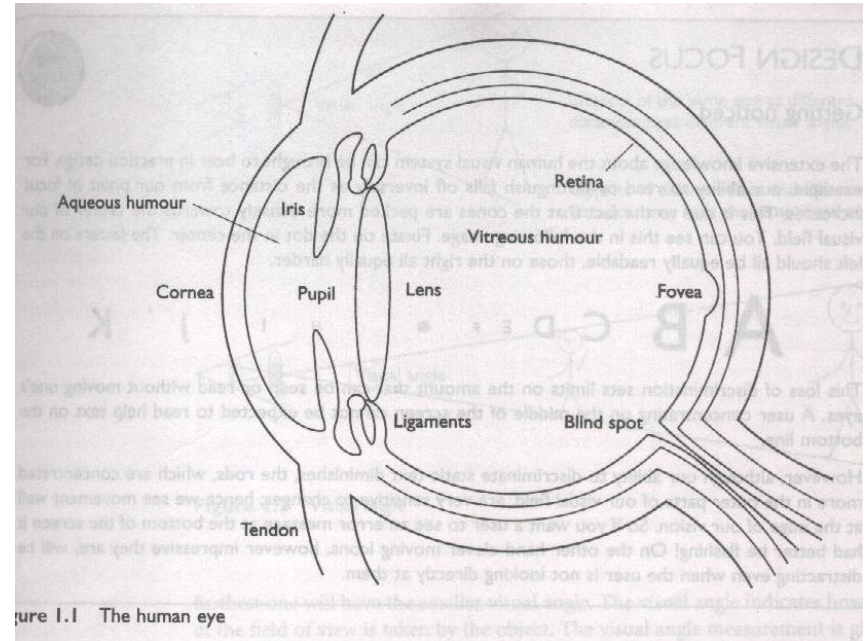
Cones

- Less sensitive to light
 - Can tolerate more light than Rods
- Basic function is color vision
- Situated in Fovea
 - Small area on retina where image is fixated
- Three types
 - Each sensitive to a different wavelength



Blind Spot

- Area where optic nerve enters
- No rods or cones in this area
- Visual system compensates for lack of rods and cones



Nerve Cells

- A.k.a. Ganglion Cells
- Specialized Nerve Cells
- Types
 - X-cells
 - concentrated in fovea
 - detection of patterns
 - Y-cells
 - widely distributed in retina
 - early detection of movement
 - can not detect change in patterns

Visual Perception

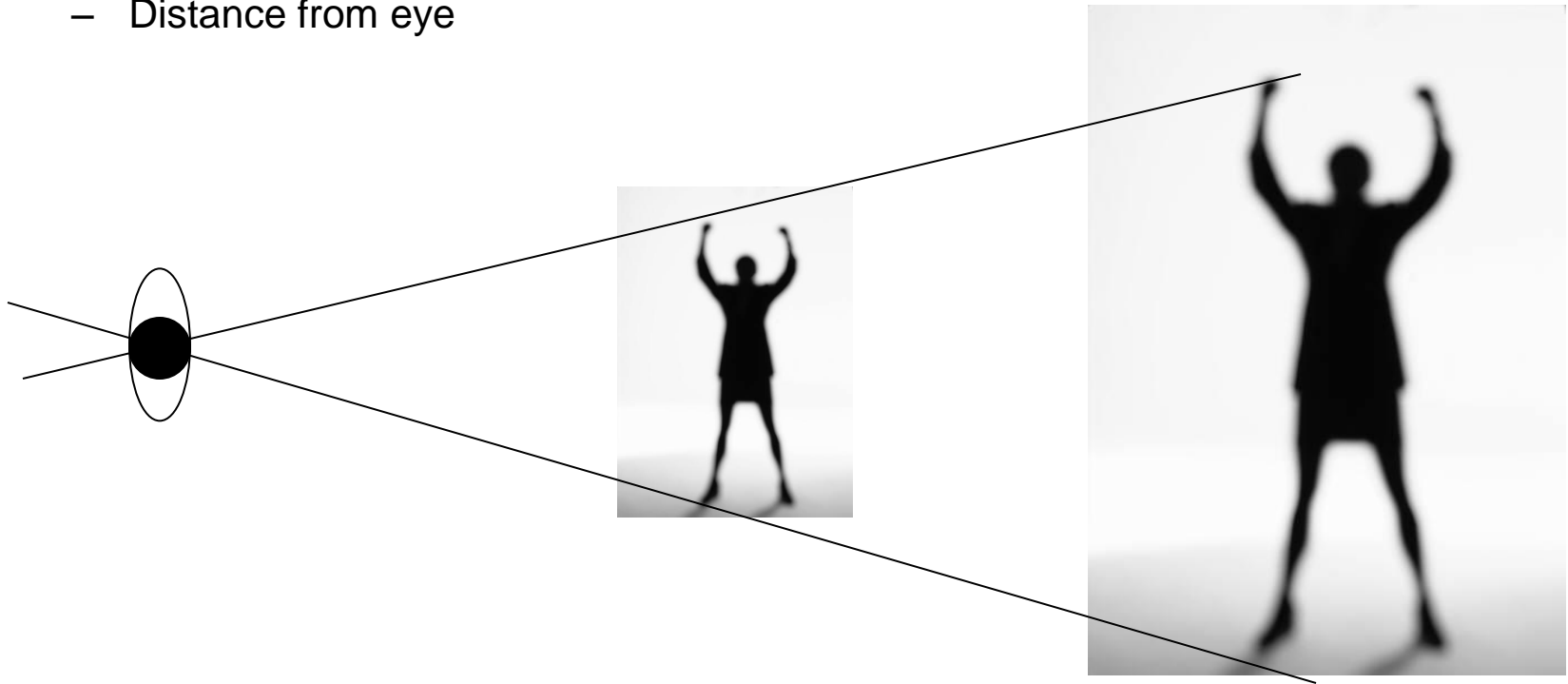
- Size
- Depth
- Brightness
- Color

Notions of Size and Distance

- You are standing on a hill
- Rocks, sheep and small tree on summit
- Farmhouse on hillside
- Person walking on track
- Small market town in valley

Perceiving Size and Depth

- Size specified by visual angle
- Affected by both
 - Size of object
 - Distance from eye



Perceiving Size and Depth

- Visual angle
 - Indicates how much of the field of view is taken by the object
 - Measured in degree or minutes of arc

Visual Angle and Perception

- Visual Acuity
 - Visual Acuity is the ability of a person to perceive fine detail
 - Objects with visual angles smaller than 0.5 seconds of an arc are not visible.
 - Spaces between lines visible at 30s-1min of arc visible
- Law of size constancy
 - Perception of the object size remains constant even if its visual angle changes
 - Perception depends on factors other than visual angle

Factors Affecting Visual Perception

- Perception of depth
 - Cues to determine relative positions of objects
 - Objects overlapping
- Size and height of object
 - Provides cue for distance
- Familiarity
 - Certain size helps to judge the distance accordingly

Example

• **A B C D E F . H I J K**

Perceiving Brightness

- Brightness
 - subjective reaction to levels of light
 - affected by luminance of object
- Luminance
 - Depends on
 - Amount of light falling on object
 - Reflective properties of object
 - Measured by photometer
- Contrast
 - Function of the luminance of an object and the luminance of its background

Perceiving Brightness

- Measured by just noticeable difference caused by luminance
- Rods (periphery) predominate in dim lighting
 - Enables better periphery vision
- Cones (center) not dominate in dim lighting
 - Cannot fixate on images
- Visual acuity increases with luminance
 - Case for using high luminance displays
 - Flicker also increases with luminance (>50Hz)
 - Larger the display, the more it will appear to flicker

Perceiving Color

- 3 components
 - Hue
 - Determined by the spectral wavelength
 - Blue (short)
 - Green (medium)
 - Red (long)
 - 150 hues determined by eye
 - Intensity
 - Brightness of color
 - Saturation
 - Amount of whiteness in the color
- 7 million colors can be perceived

Perceiving Color

- Color perception best in fovea, worst at periphery
- 3-4% cones in fovea sensitive to blue light
 - Blue acuity lower
- Color blindness
 - Cannot differentiate between green and red
 - 8% males
 - 1% females

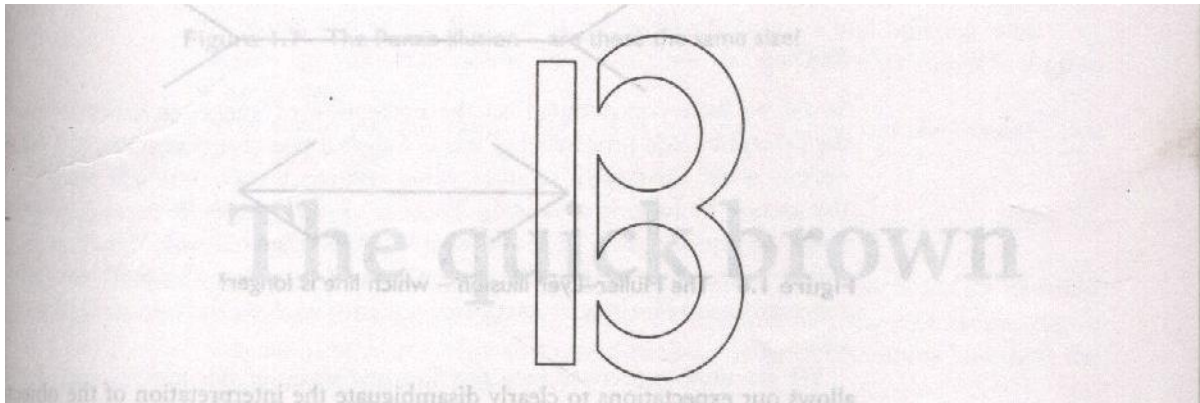
Human Visual Perception

- The visual system compensates for:
 - movement
 - changes in luminance.
- Context is used to resolve ambiguity

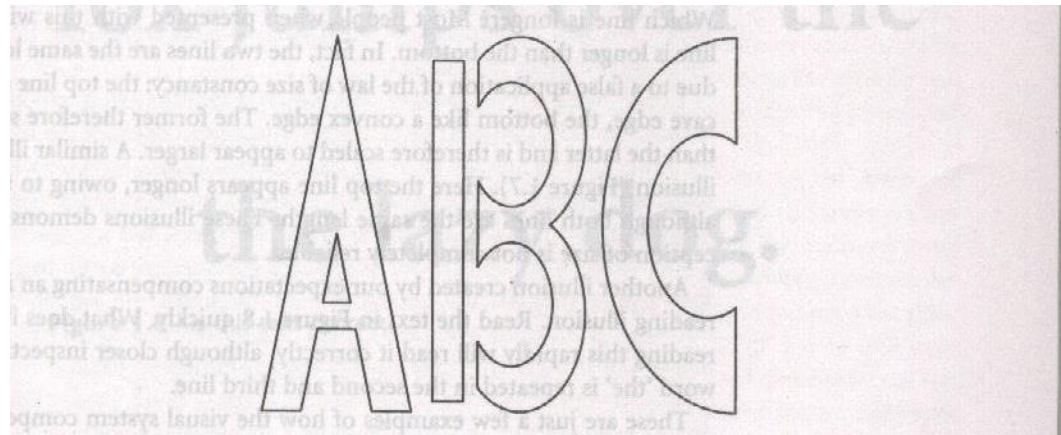
Capabilities and Limitations of Visual Processing

- Visual processing allows transformation and interpretation of a complete image
- Visual processing compensates image movement
 - Image moves on retina, but we see it stable
- Color and brightness perceived constant (hue, intensity, saturation)

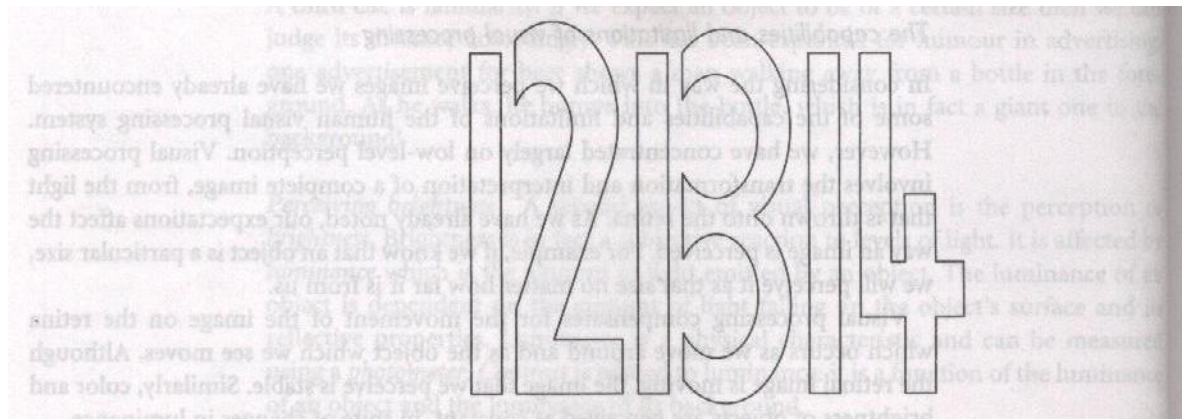
Context Illusions



Context Illusions



Context Illusions

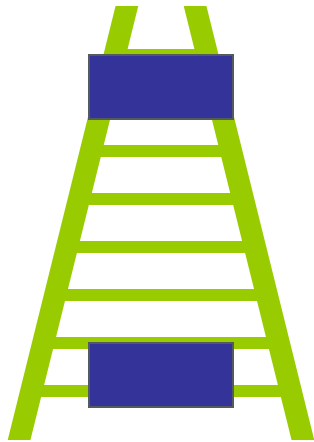


Context Illusions

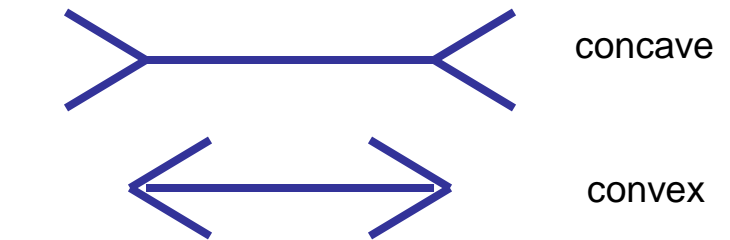
THE CAT

Over Compensation Illusions

- Optical illusions sometimes occur due to over compensation
 - Our perception of size is not reliable

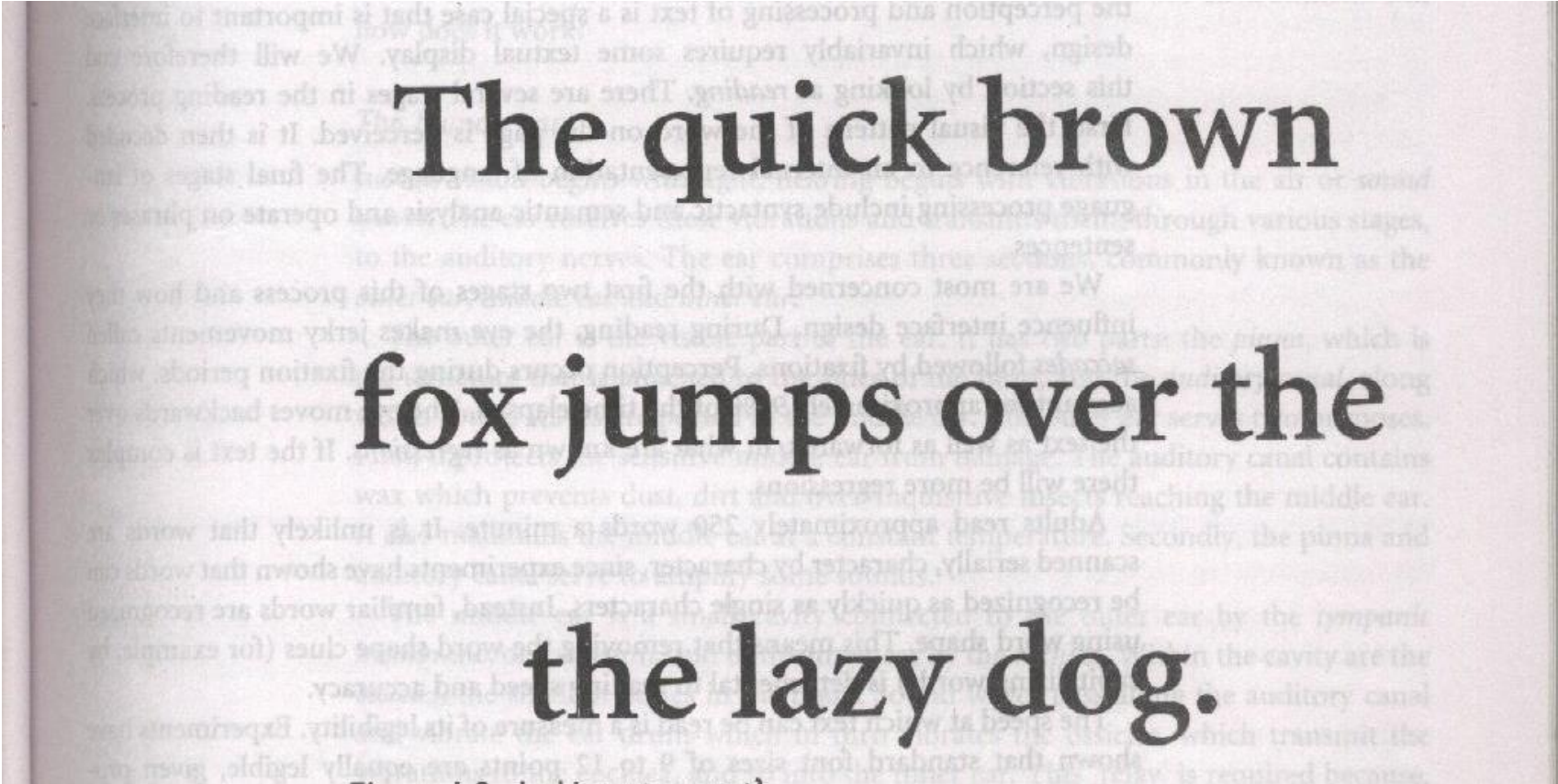


the Ponzo illusion



the Muller Lyer illusion

Proof-Reading Illusion



**The quick brown
fox jumps over the
the lazy dog.**

Proof-Reading Illusion

The quick brown

fox jumps over the

the lazy dog.

Lines & Optical Center Illusion

- We do not perceive geometric objects exactly as they are drawn
- Lines
 - Horizontal: Magnified
 - Vertical: Reduced
 - Solution: To display square, increase height
- Perceive actual center of page as a little lower
 - Solution: place objects higher

Reading

- Stages
 1. visual pattern perceived
 2. decoded using internal representation of language
 3. interpreted using knowledge of syntax, semantics, pragmatics
- Reading involves saccades and fixations (perception here: 94%)
- Perception occurs during fixations
- Regressions: eye move backwards and forwards
- Word shape is important to recognition
- Negative contrast improves reading from computer screen
- Average Reading Speed: 250 words per minute
 - Word shape important
- Reading speed is a measure of legibility
- Legibility can be increased using negative contrast

Next Lecture

- Memory Structures