Interacção Humana com o Computador

Departamento de Informática
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Human-Computer Interaction

Let’s Start our Study

Our Key Principle

When simple things need pictures, labels, or instructions, the design has failed.

Always, …

Remember!

Donald Norman, in The Design of Everyday Things, 1988

The Human - Information Proc. Unit

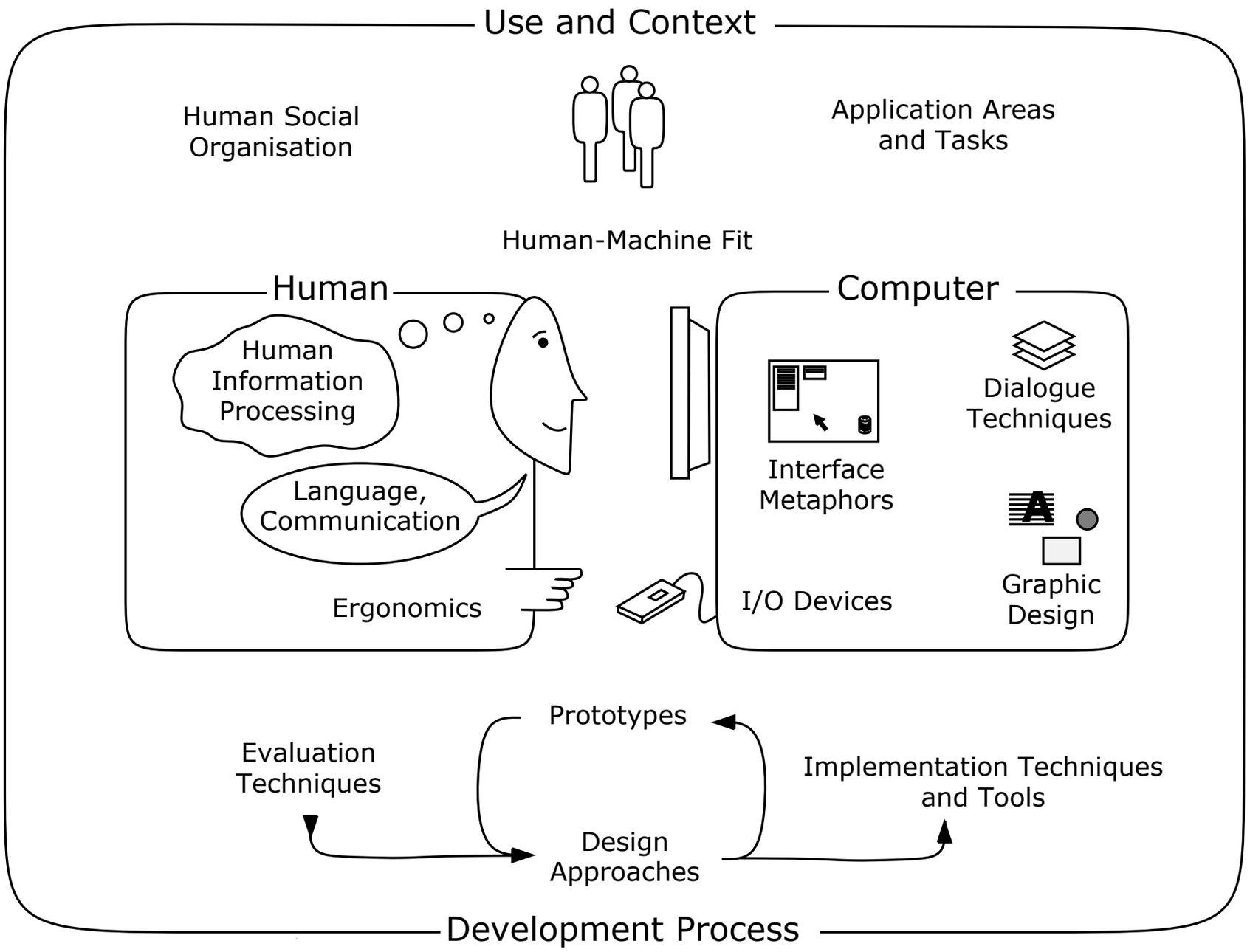
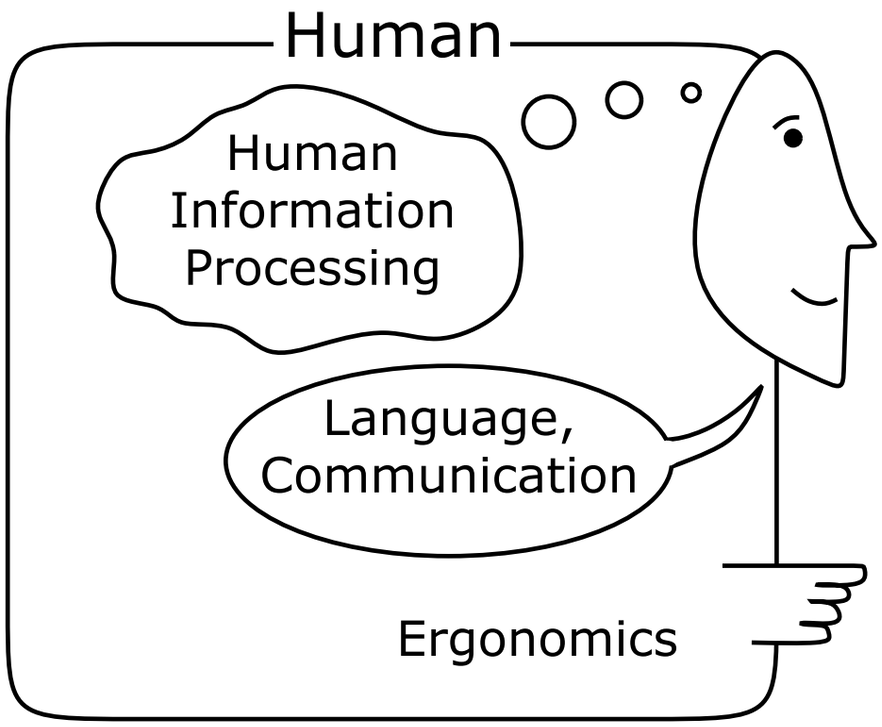


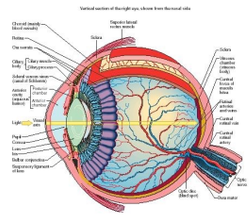
Figure 1.1: The nature of Human-Computer Interaction. Adapted from Figure 1 of the ACM SIGCHI Curricula for Human-Computer Interaction [Hewett et al., 2002]

The Human - Information Proc. Unit

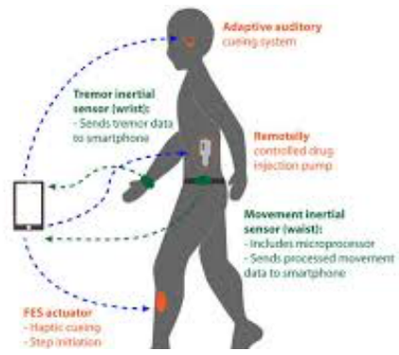


Cognitive Psychology

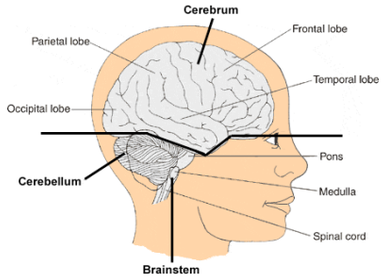
- Perceptive System



- Motor System



- Cognitive System



The human user = Information Processing Unit (IPU)

Morgan & Newell 1983

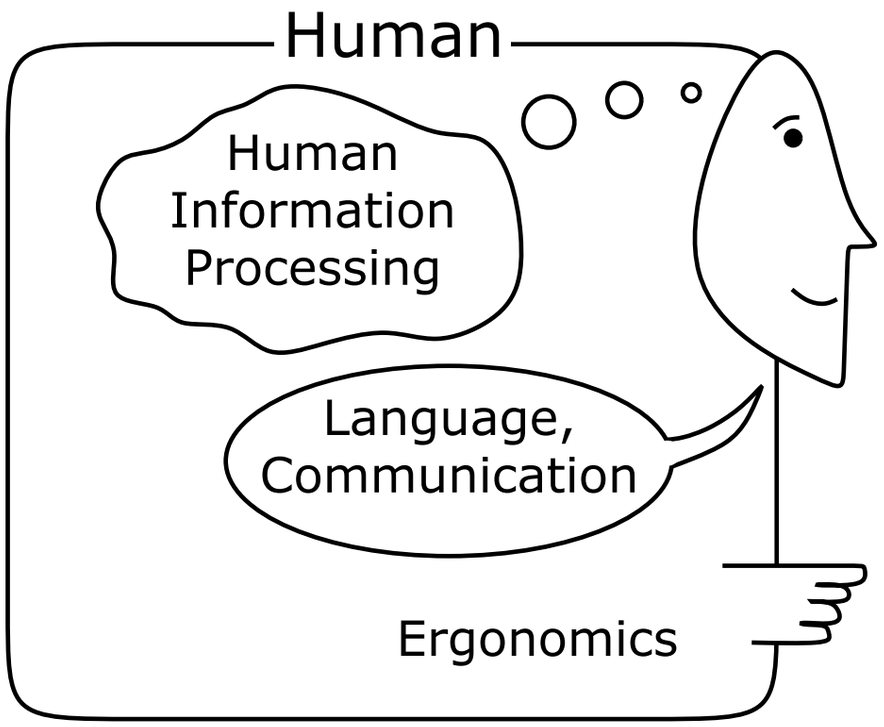
The Human - Information Proc. Unit

Human user viewed as an IPU

Morgan & Newell 1983

Humans process information in **stages** — receiving, interpreting, processing, and then acting upon it — much **like a computer** system. This analogy has been foundational in developing user interfaces and interaction designs that accommodate **human cognitive limits**, preferences, and error patterns. By viewing humans as IPUs, **designers**, and researchers are encouraged to consider the **limitations** and **capabilities** of human memory, attention, and decision-making processes when creating t**echnology that is meant to be intuitive**, efficient, and accessible.

The Human - Information Proc. Unit



The human user
=
Information Processing
Unit (IPU)

Morgan & Newell 1983

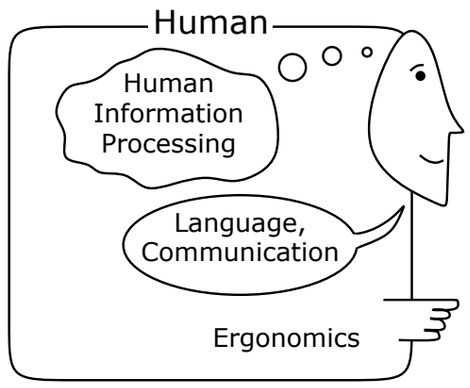
Cognitive Psychology

Create for human usage

↓

- Aware of capacities and limitations
- What is easy and difficult?
- What is pleasant?
- Main user Modus Operandi.

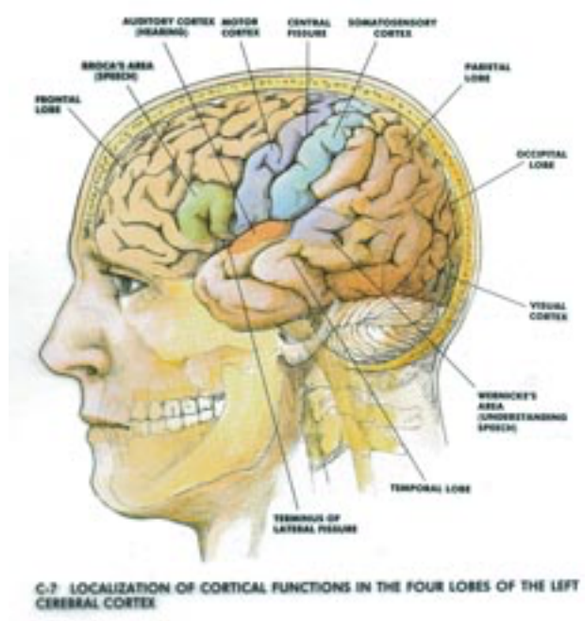
The Human - Information Proc. Unit



Cognitive Psychology

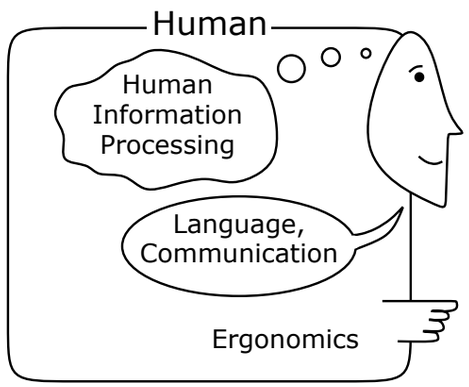
Human = IPU

- **Information input/output**
  - visual, hearing, haptic, movement
- **Information stored in memory**
  - sensorial, short and long term
- **Information processed and applied**
  - reasoning, problem solving, skills, error
- **The emotional dimension**
- **The uniqueness of each person**



C-7 LOCALIZATION OF CORTICAL FUNCTIONS IN THE FOUR LOBES OF THE LEFT CEREBRAL CORTEX

The Human



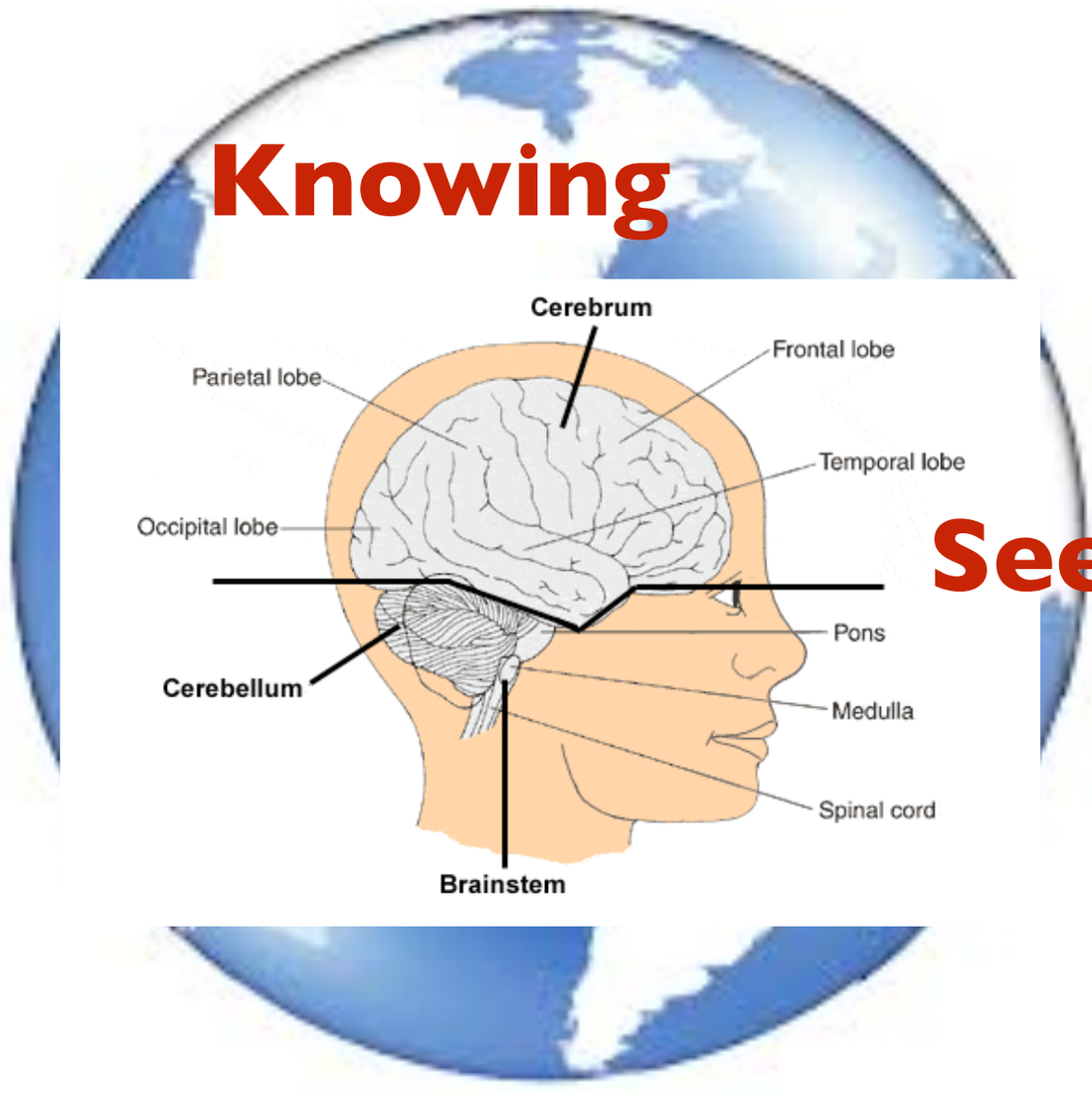
Cognitive Psychology

Humano = IPU

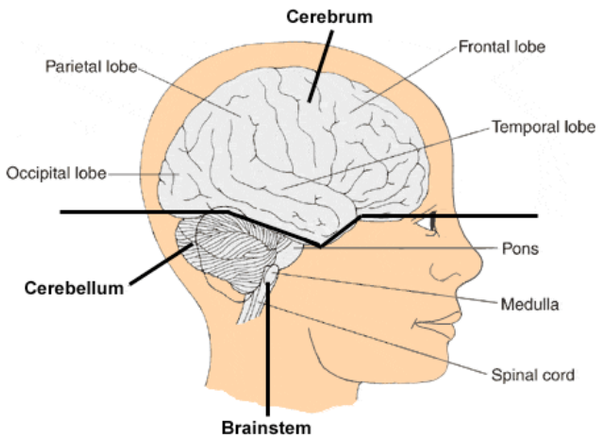
“We do not see what we see but what we are”

“Não vemos o que vemos, vemos o que somos”

Fernando Pessoa

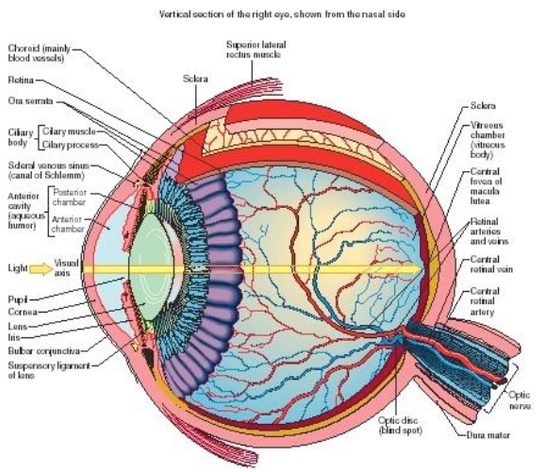


The Human - Vision



Input: through the senses

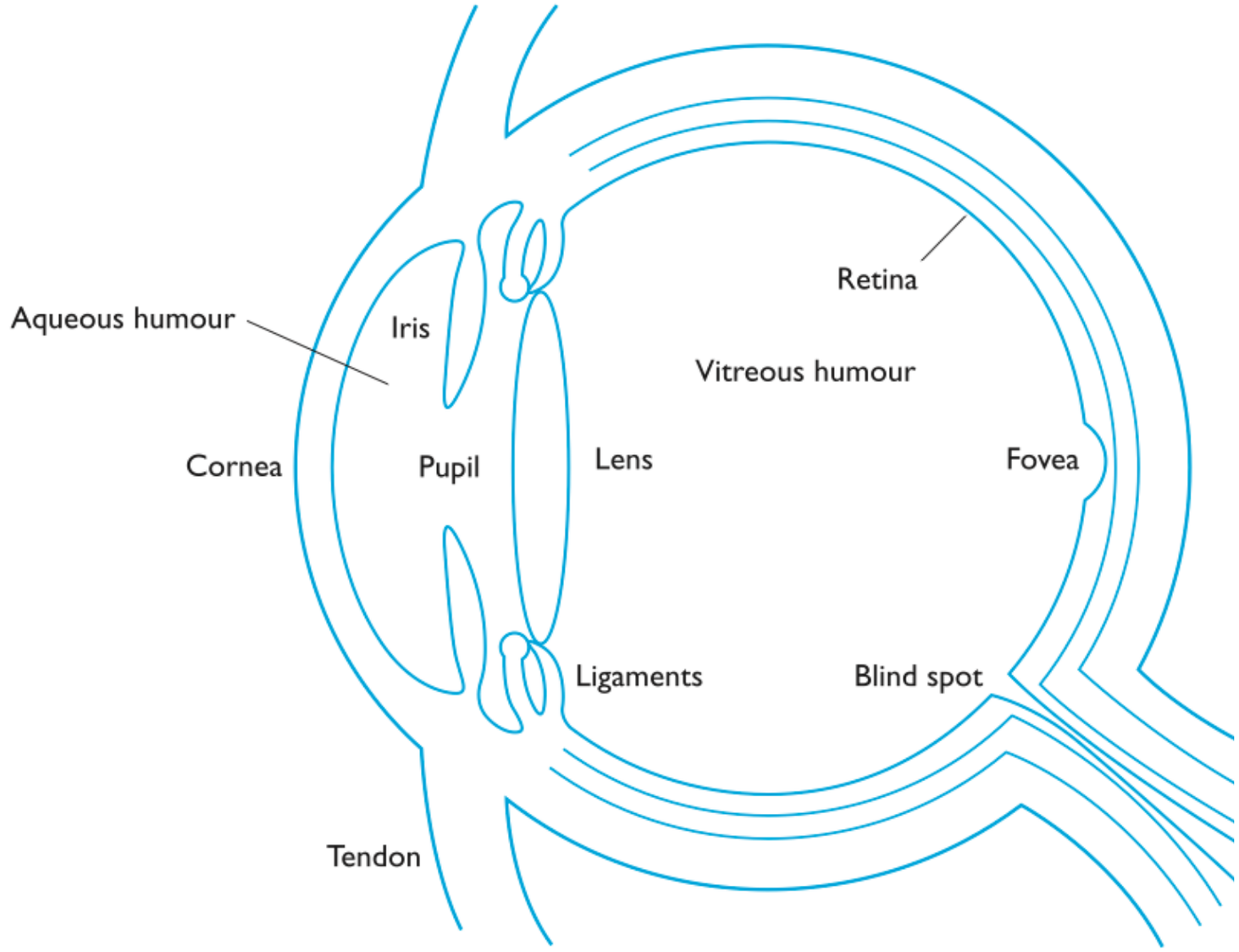
Vision



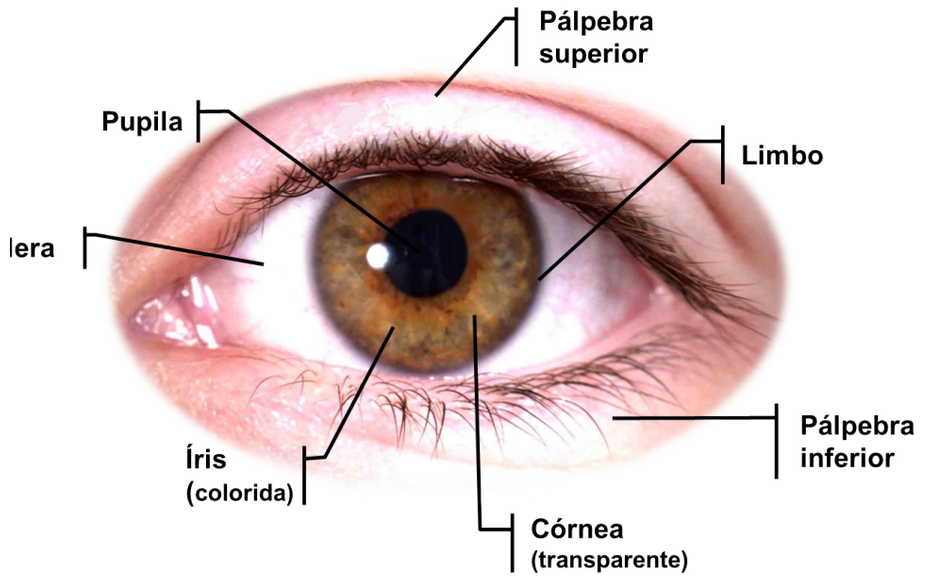
Involves two steps:

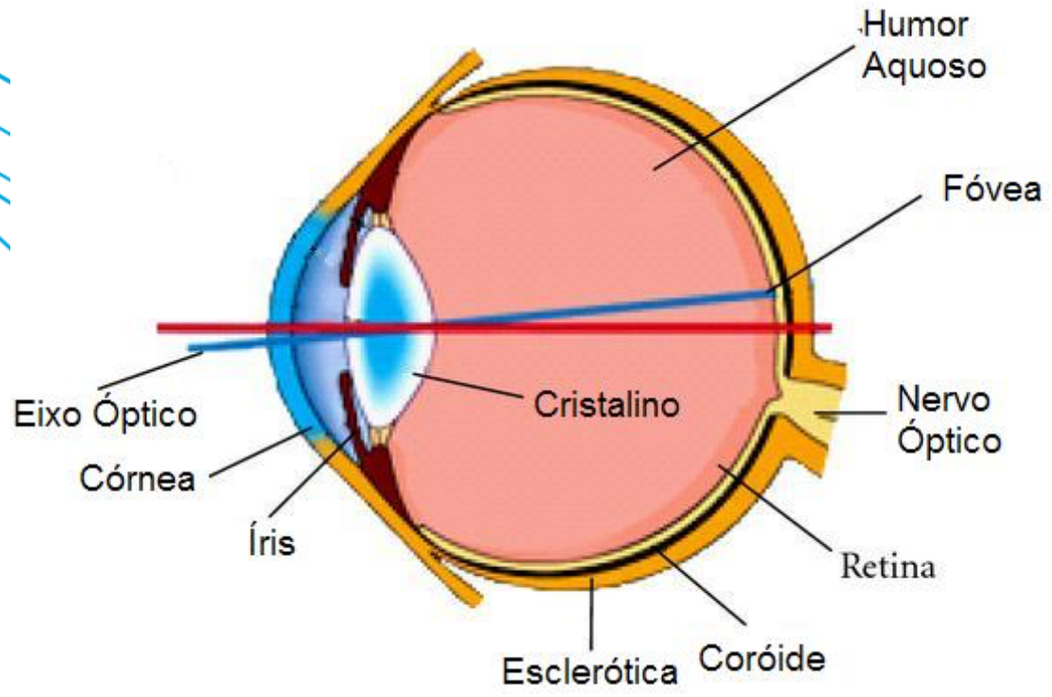
- Physical reception of a Stimulus
- Interpretation and Processing

The Human - Vision



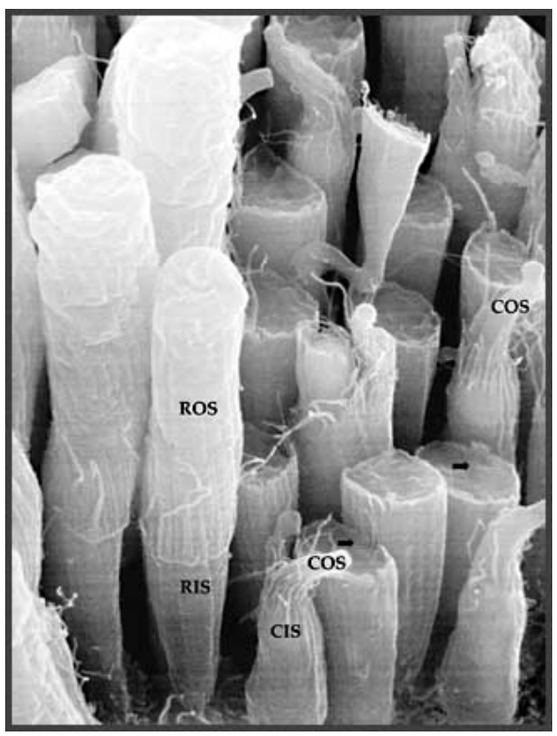
I.1 The human eye





The Human - Vision

Eye - The Reception of a Stimulus



- Light **received** and transformed into electrical signals.
- Light **emitted** and **reflected** by objects
- The **retina** focus images upside down
- The retina contains two kind of photoreceptors:
  - **Rods (**bastonetes**) -** luminosity sensitivity
  - **Cones -** chromatic vision
- The **Ganglion** cells detects patterns (**X** in foeva) and movement (Y peripheral).

The Human - Vision

Eye - The Reception of a Stimulus

Rods (Bastonetes**) ~ 120 million** 94.3%

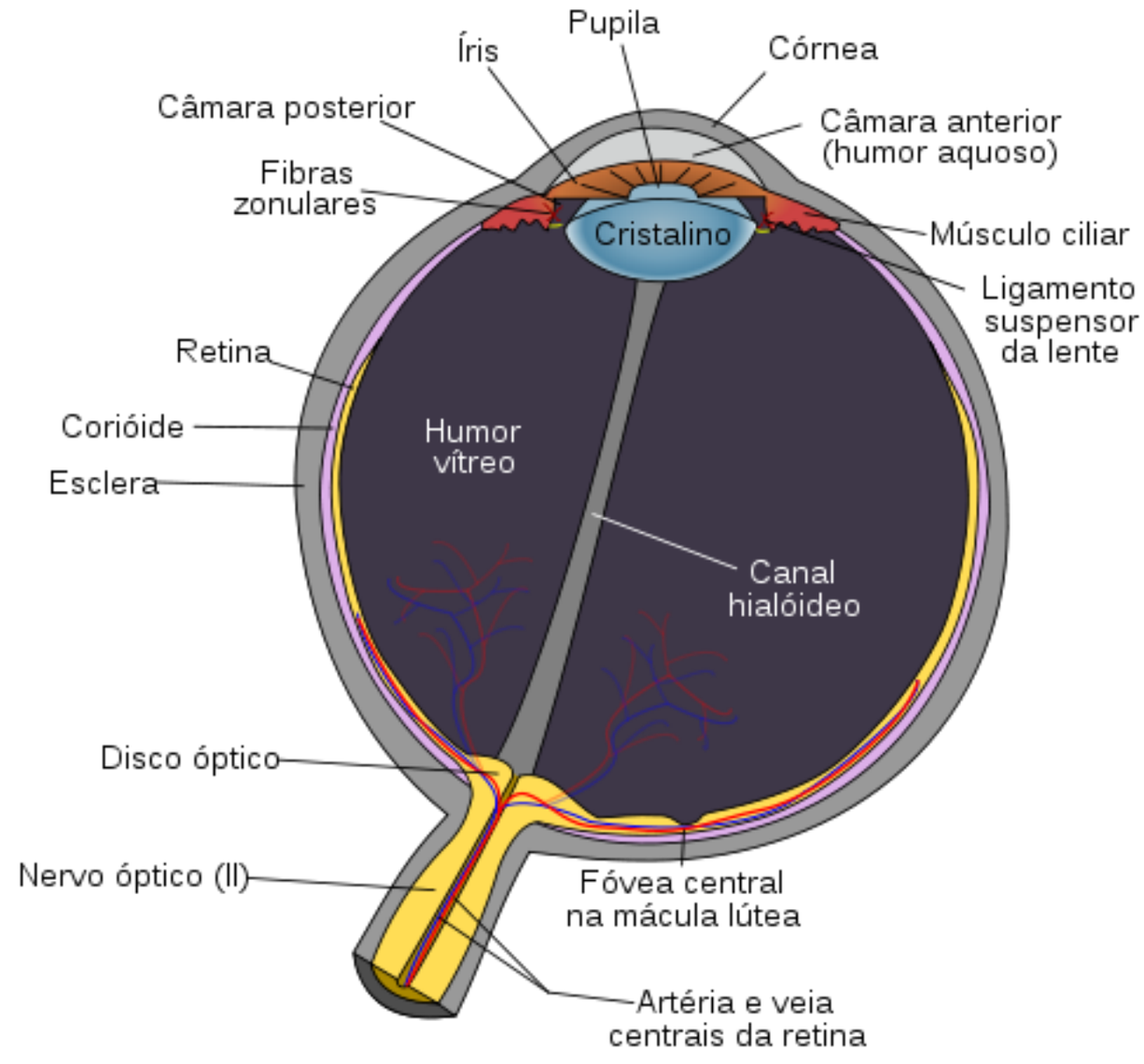
- In the retina extremities
- Peripheral vision

Cones ~ 6 million 4.7%

- There are three kind
- Concentrated in the fovea”

Ganglions ~ 1.2 million

- X-cells ~> Patterns
- Y-cells ~> Movement

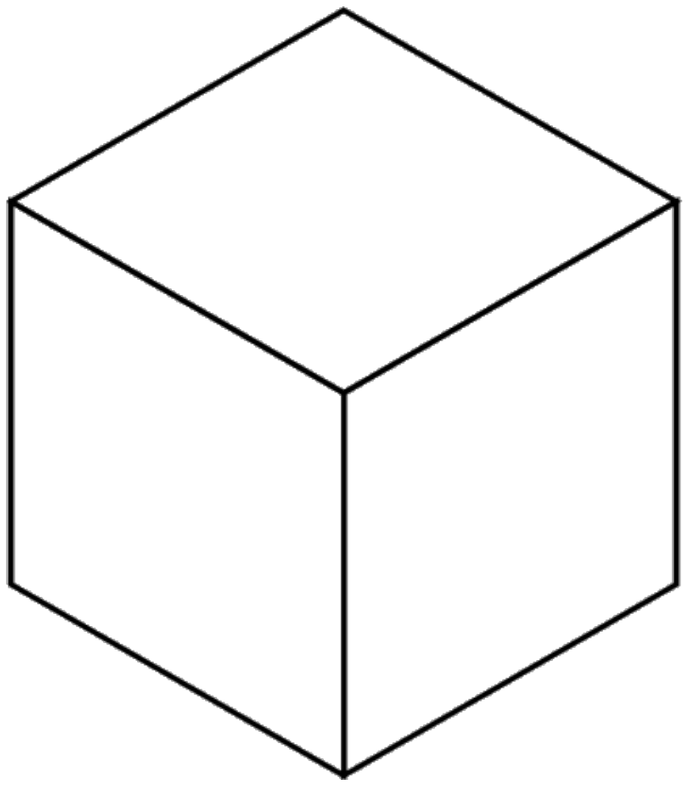


Vision and Signal Processing

The Human - Vision

Signal Interpretation

How do we perceive what we see?



- **Size**
- **Depth**
- **Brightness**
- **Color**

The Human - Vision

Signal Interpretation

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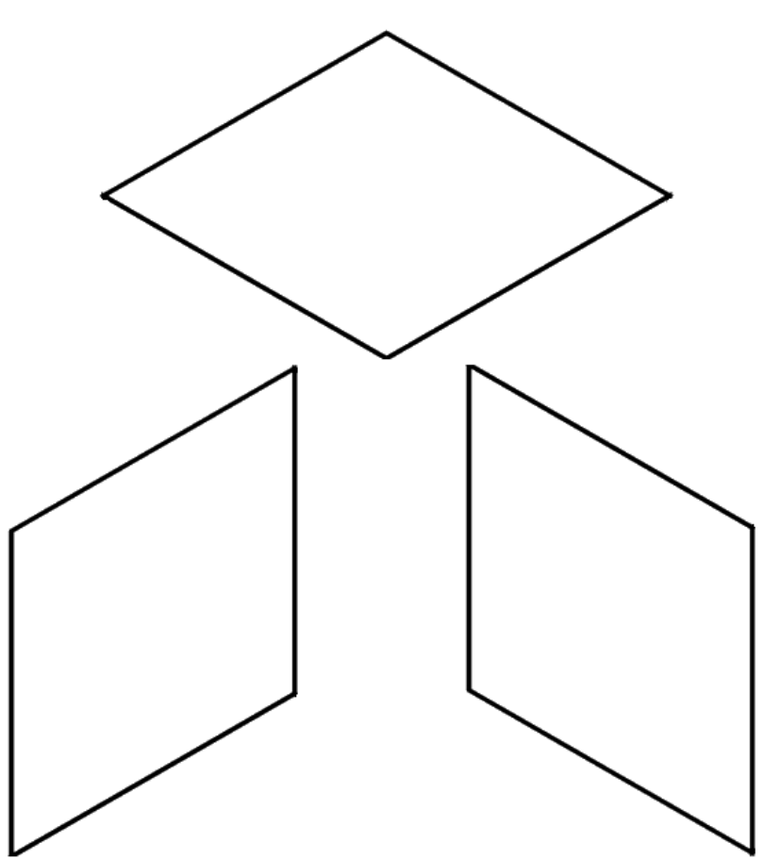

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The Human - Vision

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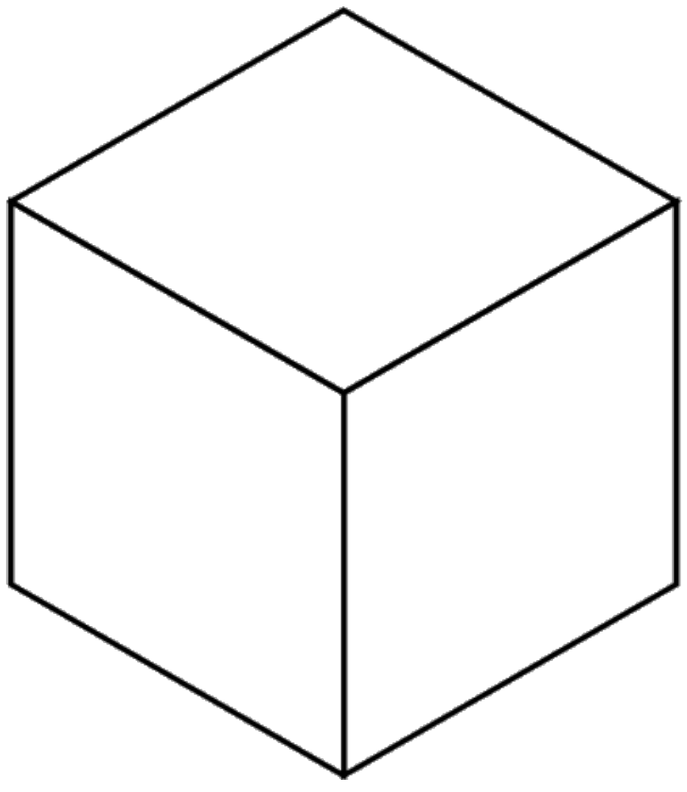

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The Human - Vision

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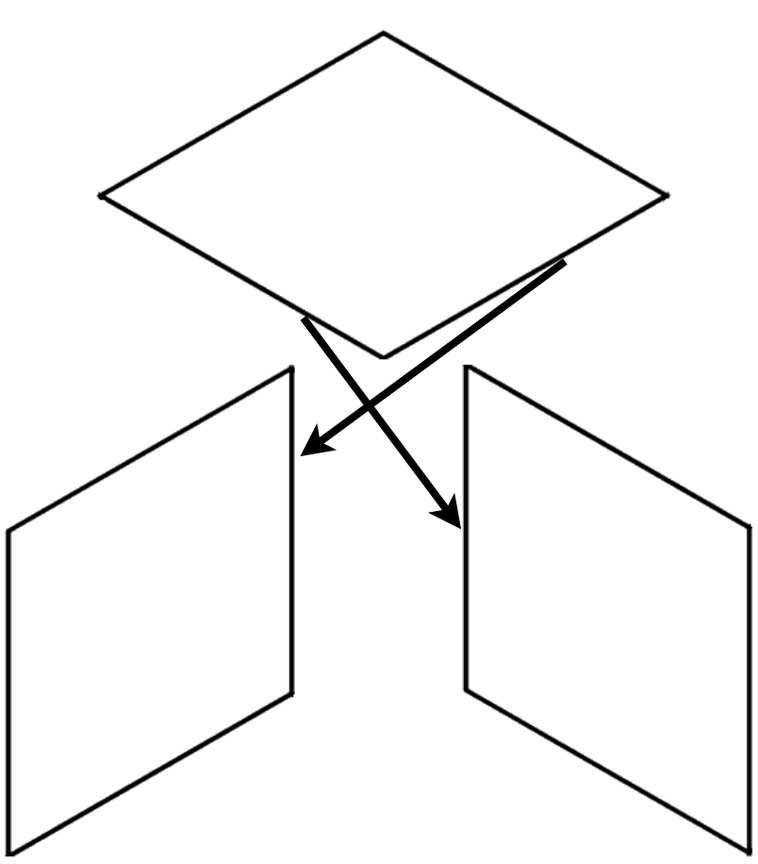

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The Human - Vision

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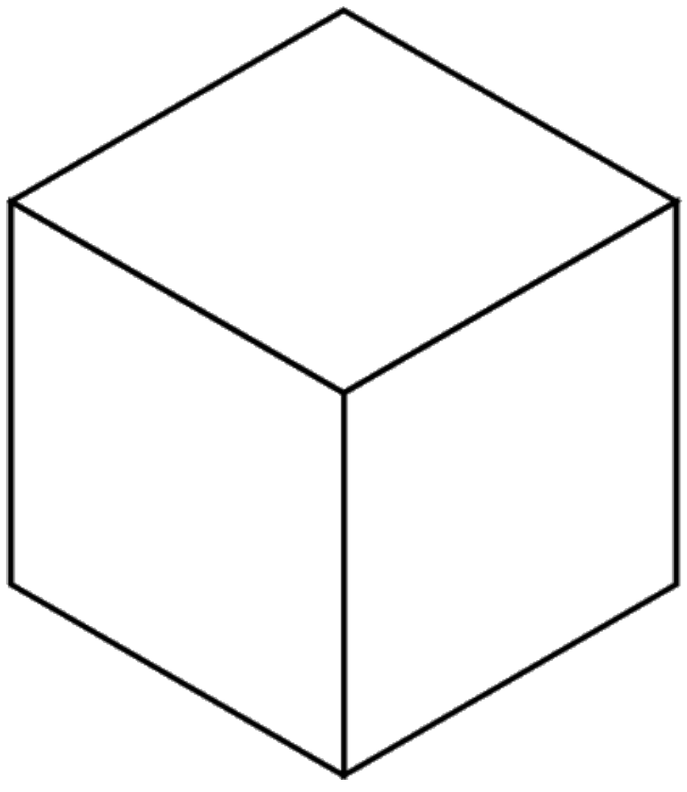

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The Human - Vision

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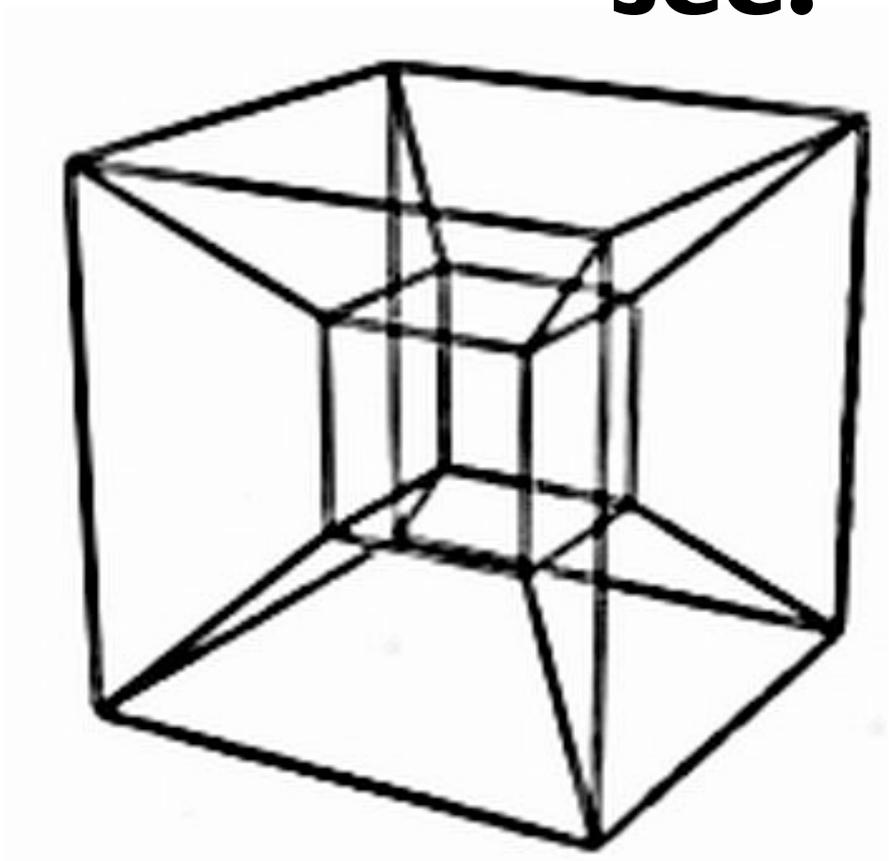

- **Size**
- **Depth**
- **Brightness**
- **Color**

A projection oh the 4D cube

The Human - Vision

Signal Interpretation

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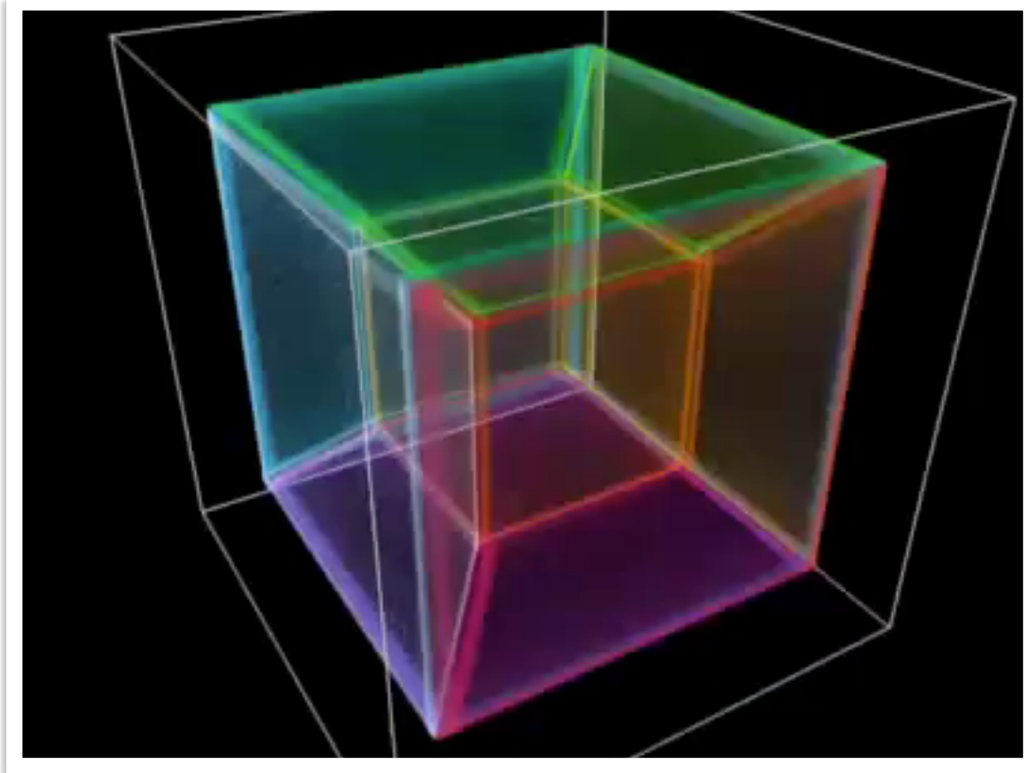


- **Size**
- **Depth**
- **Brightness**
- **Color**

A projection oh the 4D cube

The Human - Vision

Signal Interpretation

Correct assessment requires observer's world knowledge.

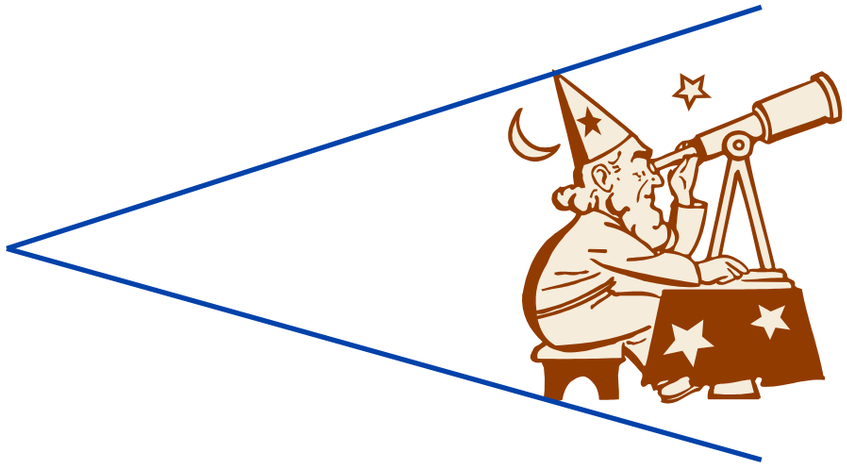
Size

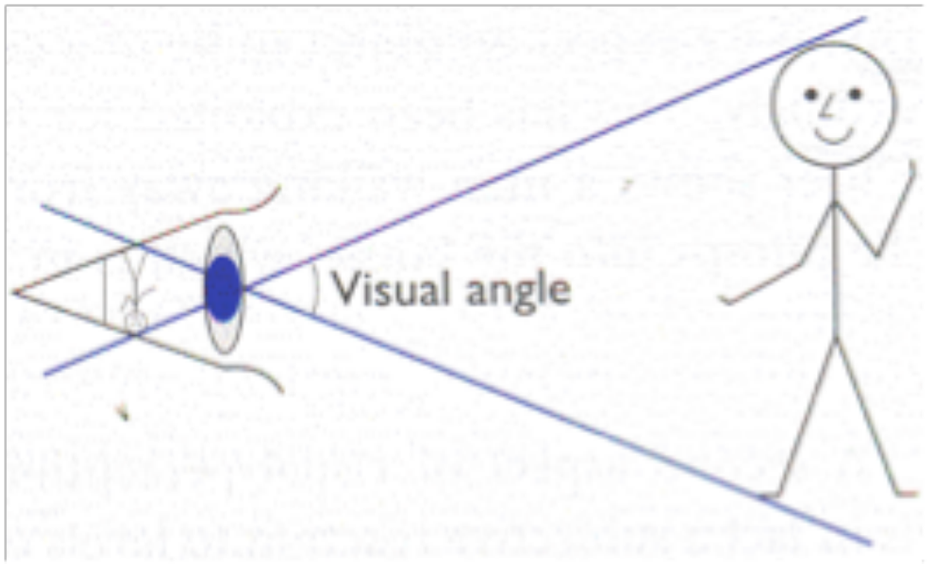
- Measuring the visual angle: degrees, minutes, and arcseconds:
  - **Same-size** objects at different distances have different visual angles;
  - **Different-size** objects positioned at the right distances will have the same visual angle in the eye of the observer.

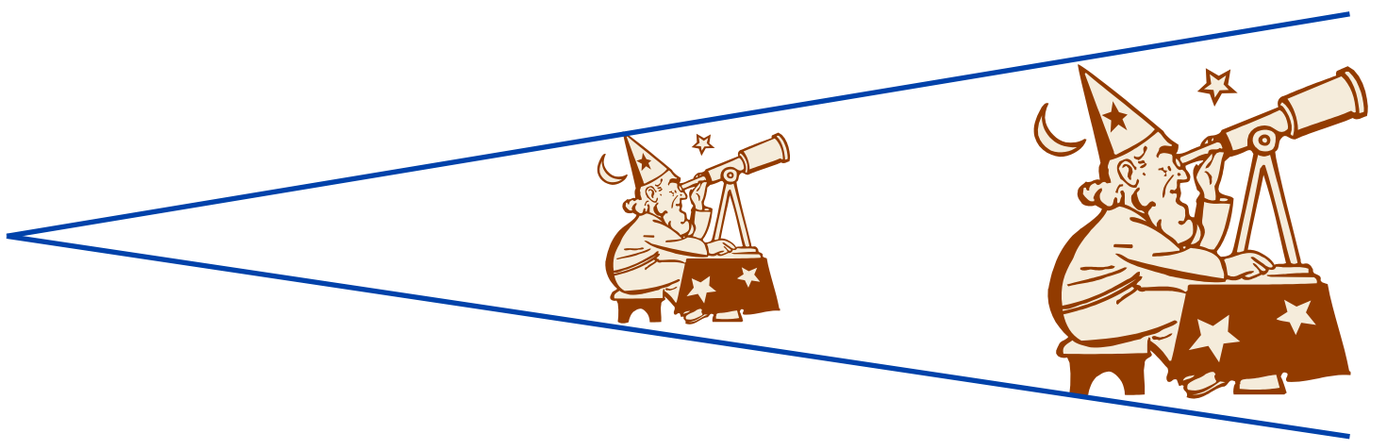
The Human — Vision

Signal Interpretation

Size ~ Visual Angle ~ Distance







The Human — Vision

Signal Interpretation

Visual Acuity

- The ability of a person to perceive the thinest details

Example:

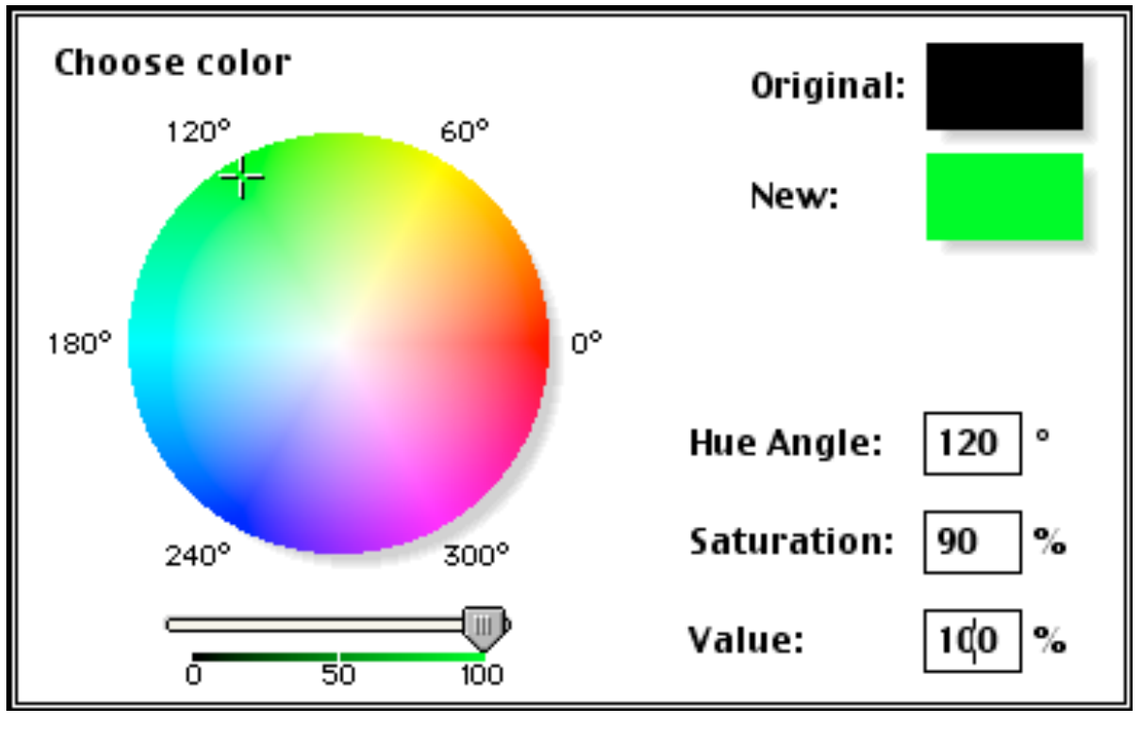
— perceive lines with 0.5 arc seconds in width

— perceive line spaced 30 arc seconds

Vision - Signal Interpretation

Color Hue

Hues can refer to the set of "pure" colours within a color space.

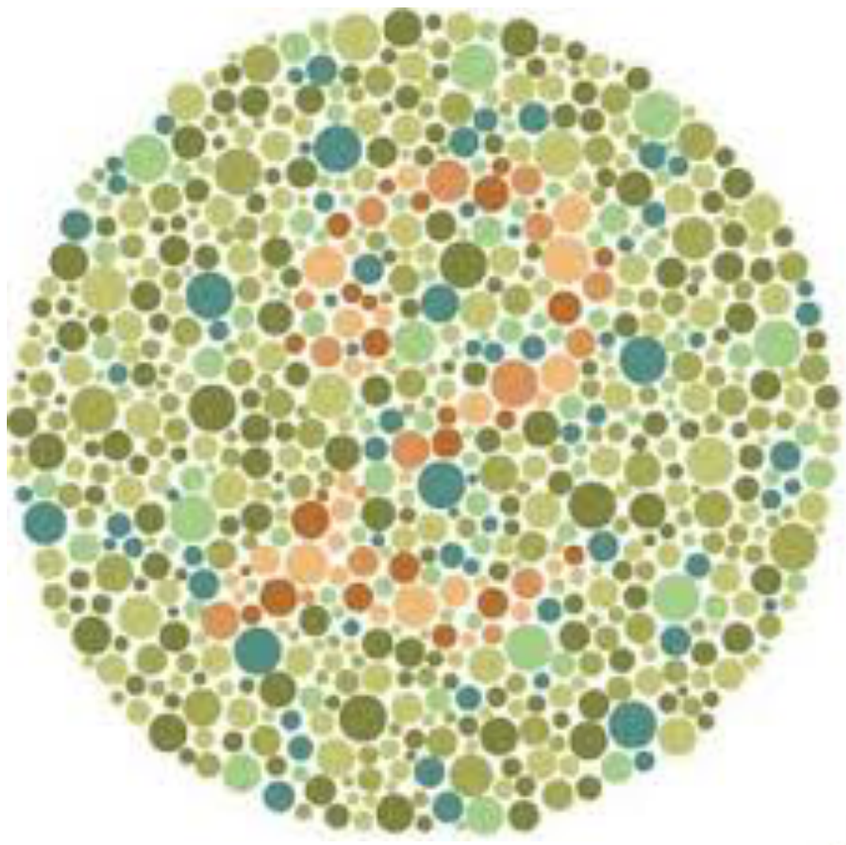


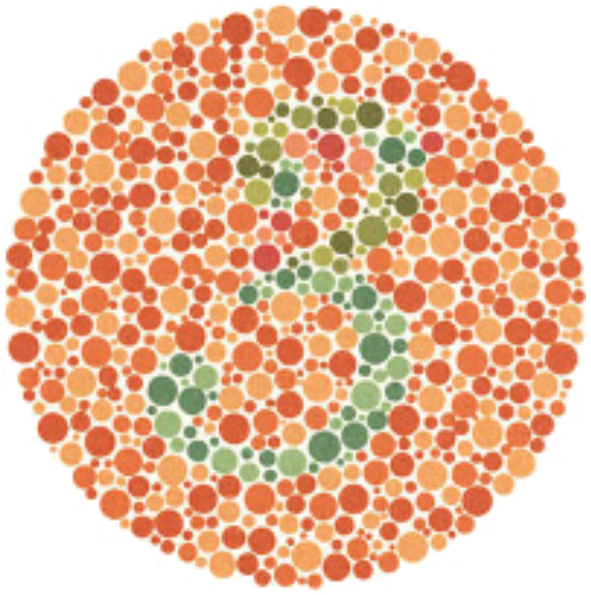
The Human — Vision

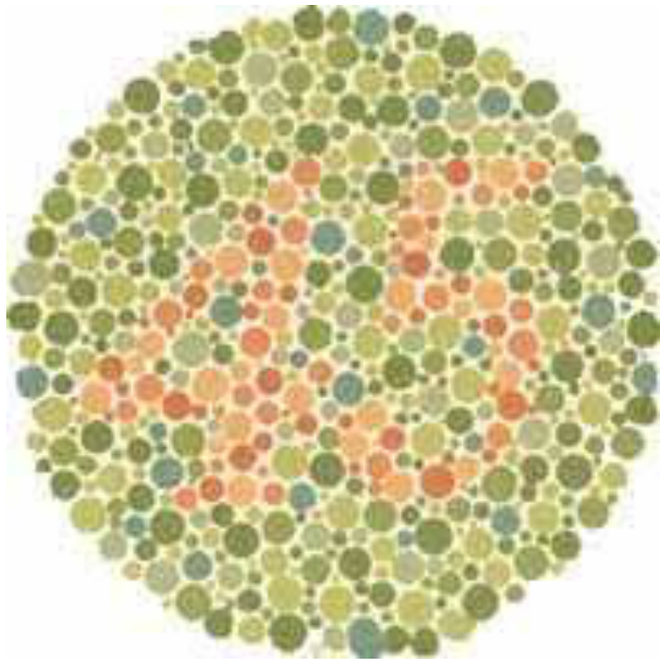
Chromatic vision

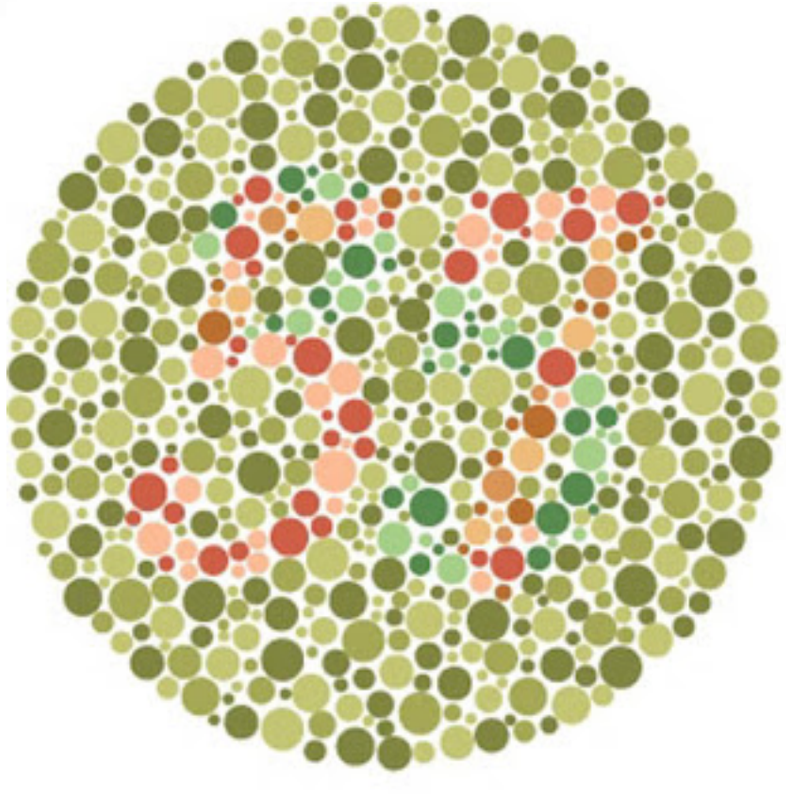
- The three components:
  - **Hue** — the spectral wavelength (average person: 150)
  - **Intensity** — the color brightness
  - **Saturation** — the amount of whiteness in the color
- Perceive approximately 7 million colors
- Green ~ maximal acuity.
- Blue ~ minimal acuity (3% to 4% blue cones).
- 8% men and 1% women have some kind of color perception deficiency — **colorblind**
  - Green <> Red ?

The Human — Vision/Colorblindness



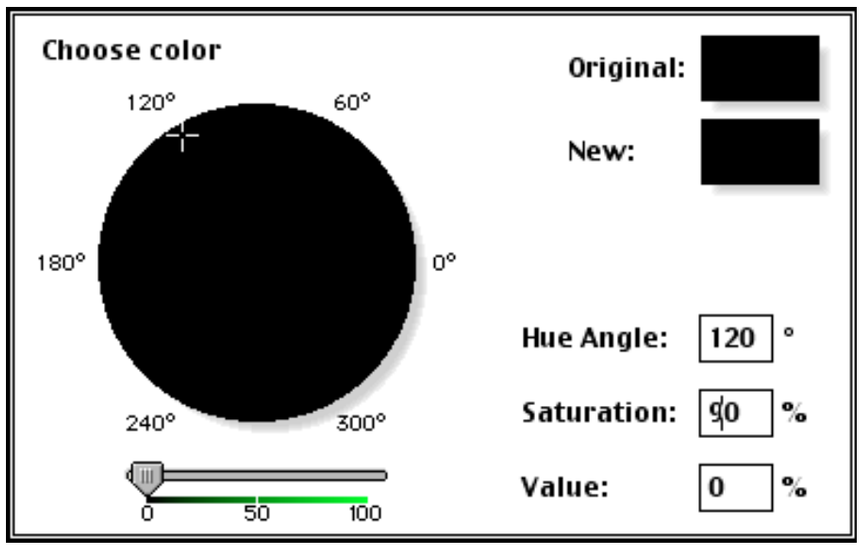


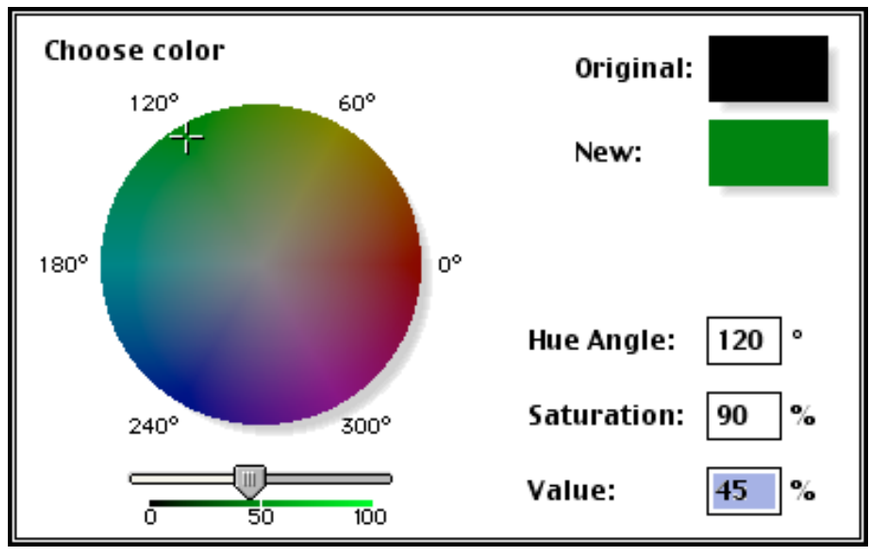


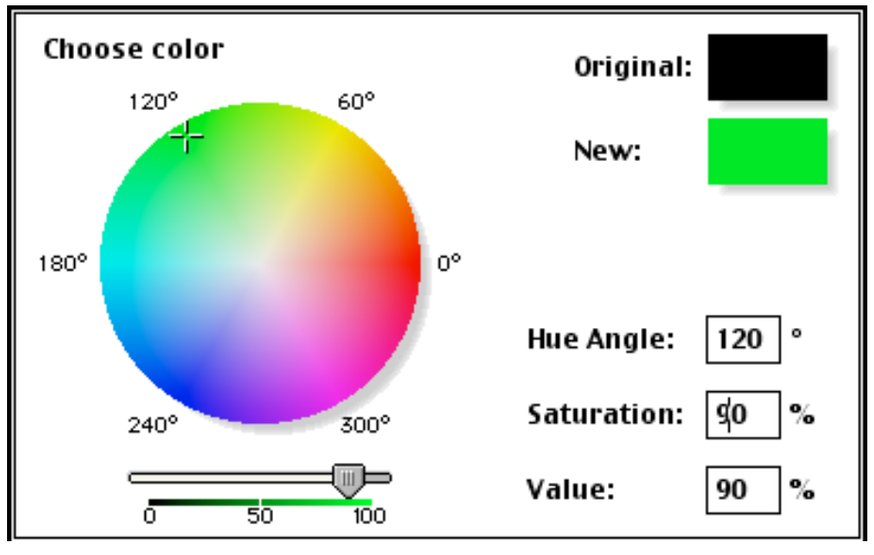


Vision - Signal Interpretation

Color Intensity







The Human — Vision

Brightness

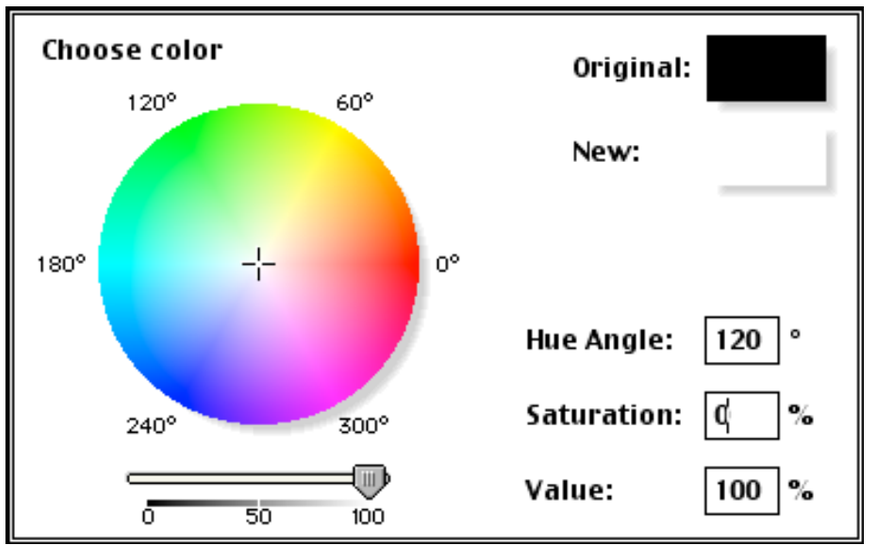
- Measures the light intensity
- Related with luminance, measured through a photometer
- *Contrast:* the ratio between two brightness levels
- The pupil compensates for brightness variation
- Visual acuity increases with luminance

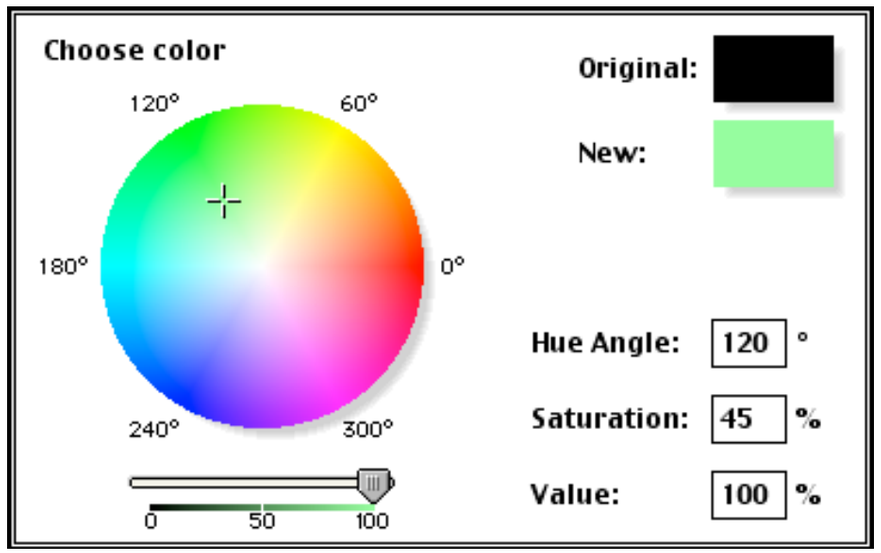
The Human — Vision

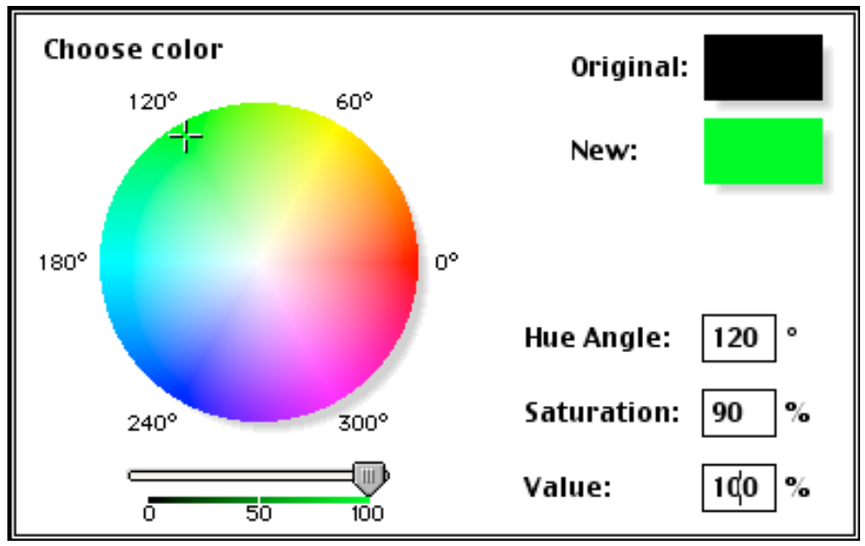
Chromatic vision

- The three components:
  - **Hue** — the spectral wavelength (average person: 150)
  - **Intensity** — the color brightness
  - **Saturation** — the amount of whiteness in the color
- Perceive approximately 7 million colors
- Green ~ maximal acuity.
- Blue ~ minimal acuity (3% to 4% blue cones).
- 8% men and 1% women have some kind of color perception deficiency — **colorblind**
  - Distinguish green from red (very common)!

Color Saturation







Human Visual Interpretation

The retina captures an image, and this **raw sensory input** is converted into **neural signals**, which are then transmitted to the brain for further analysis. The brain's occipital lobe plays a critical role in interpreting these signals, which involves **deciphering** shapes, colors, depth, and movement. Subsequent processing **integrates** this visual information with prior knowledge, memories, and context stored in other **brain parts** to **construct** a coherent understanding of what is being seen. This stage is where **perception truly happens**—objects are recognized, spatial relationships are understood, and meaning is assigned to visual cues.

Vision - Signal Interpretation

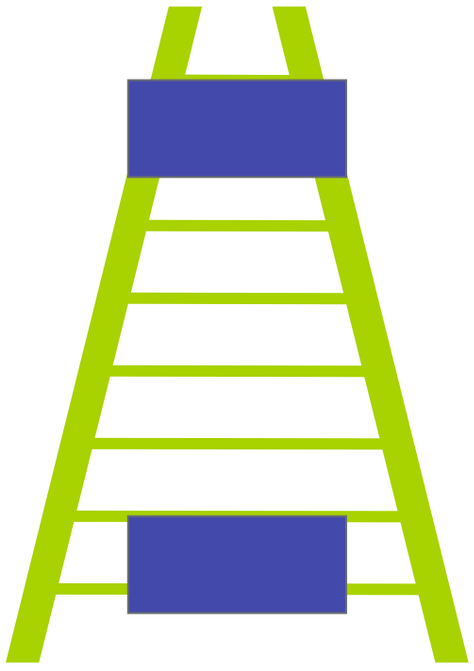
Visual Processing

- Action of the brain on the **significance** of the visual signal input.
- What we see is an interpretation guided by our **expectations**
  - Example: the notion of constant size.
- Our brain can infer complete images when there are “holes”.
- Your mind can be deceived!

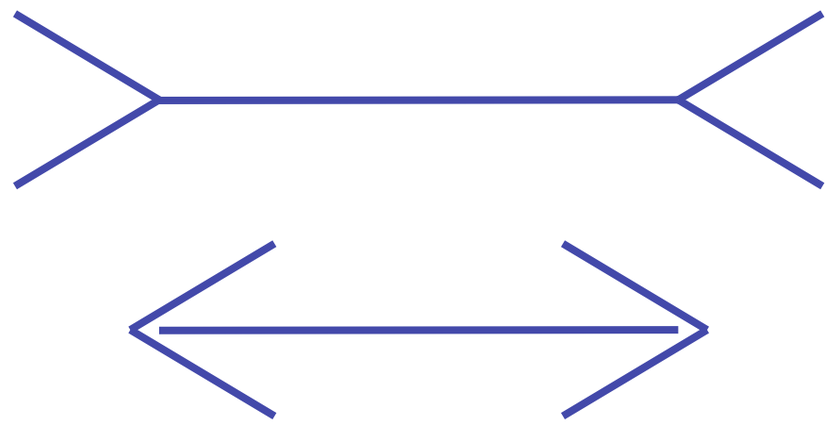
The Human - Vision

Optical Illusions

The law of size preservation



The Ponzo illusion

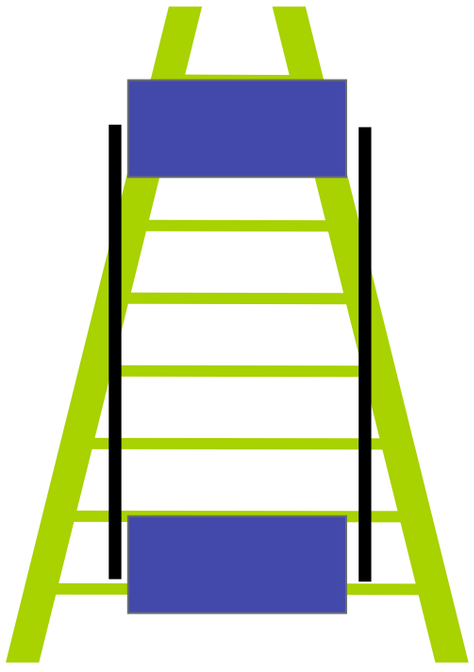


The Muller Lyer illusion

The Human - Vision

Optical Illusions

The law of size preservation



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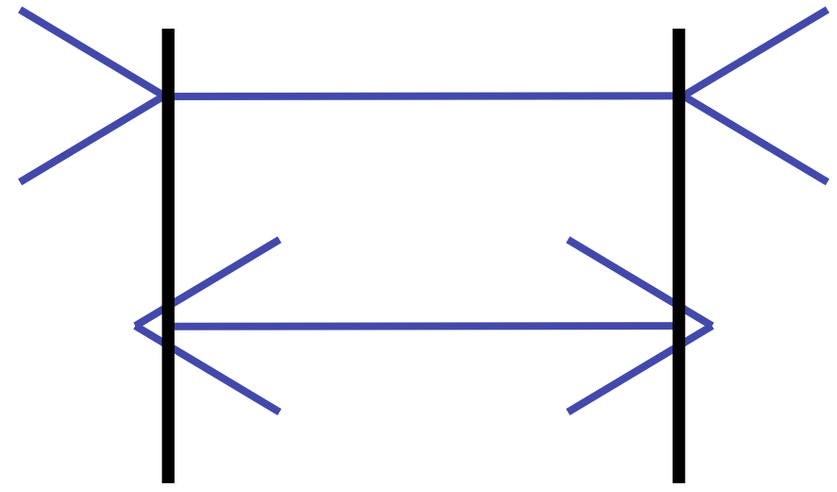
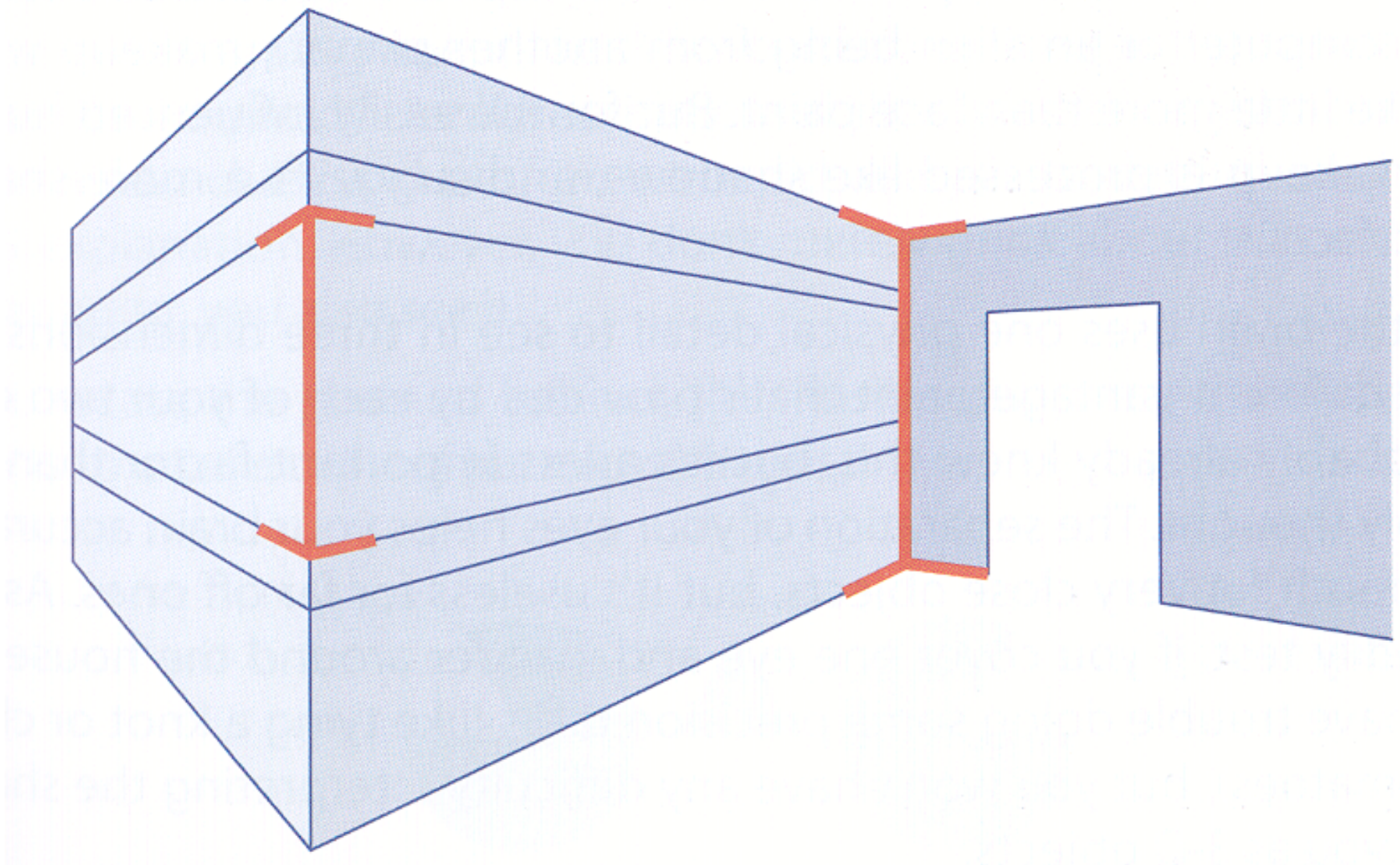


The Muller Lyer illusion

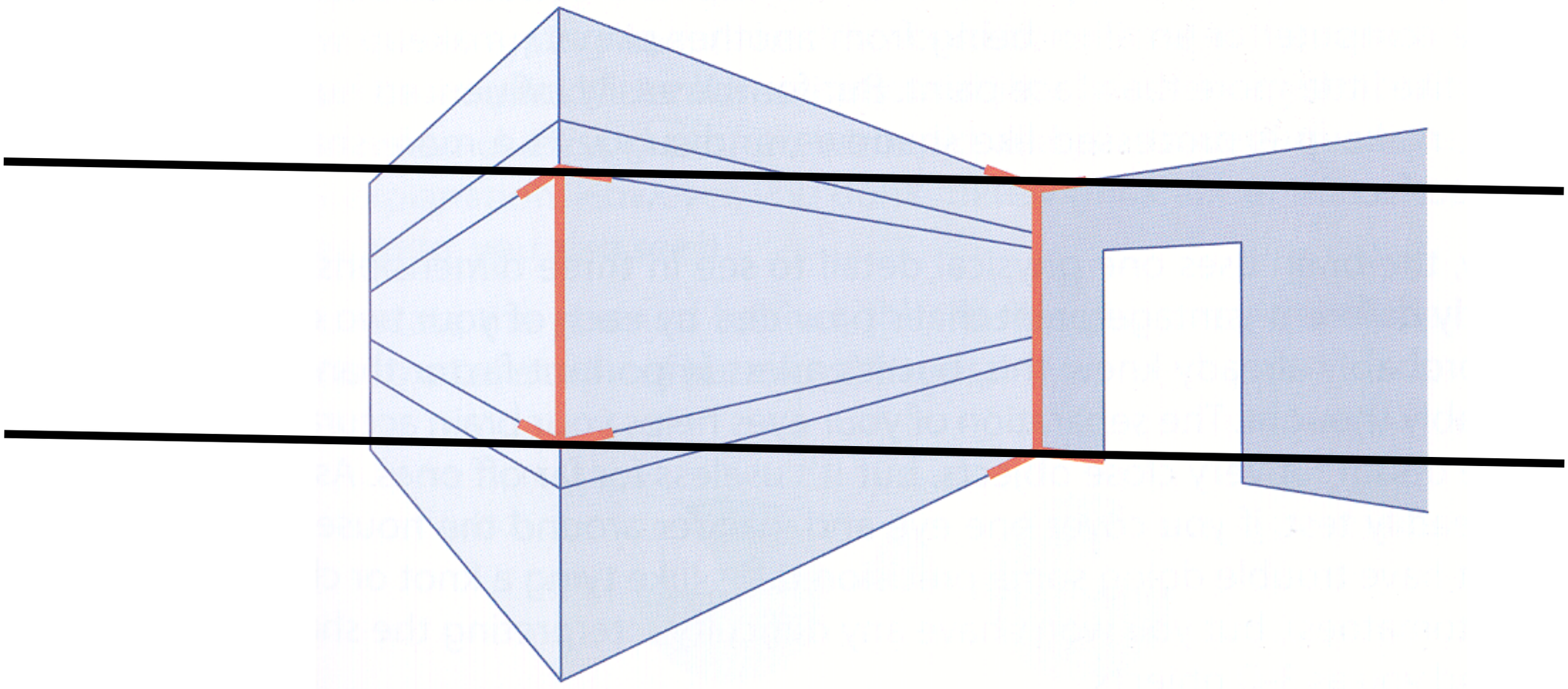
Optical Illusions



Confusions of 3D in 2D !

The Human - Vision

Optical Illusions



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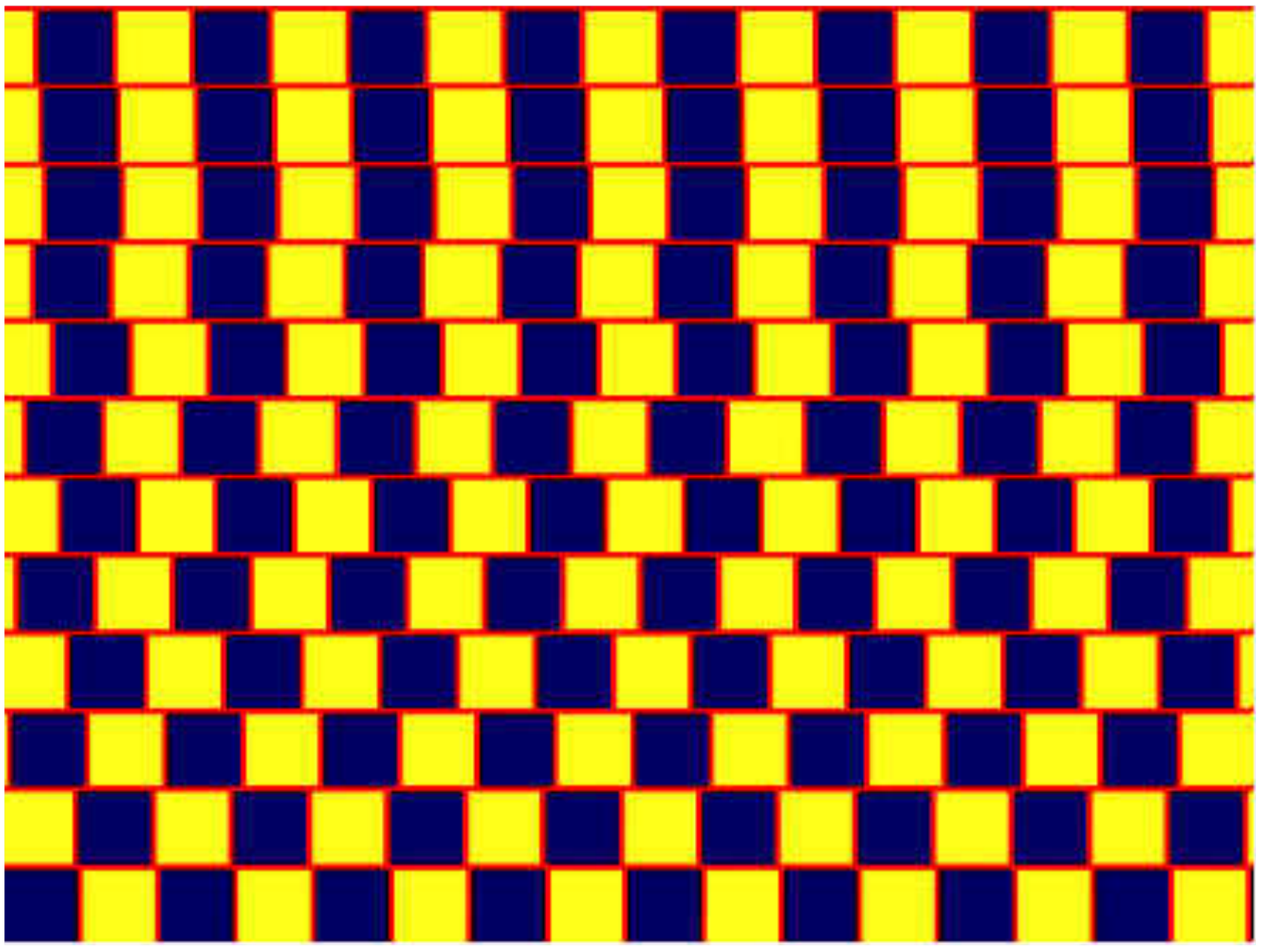
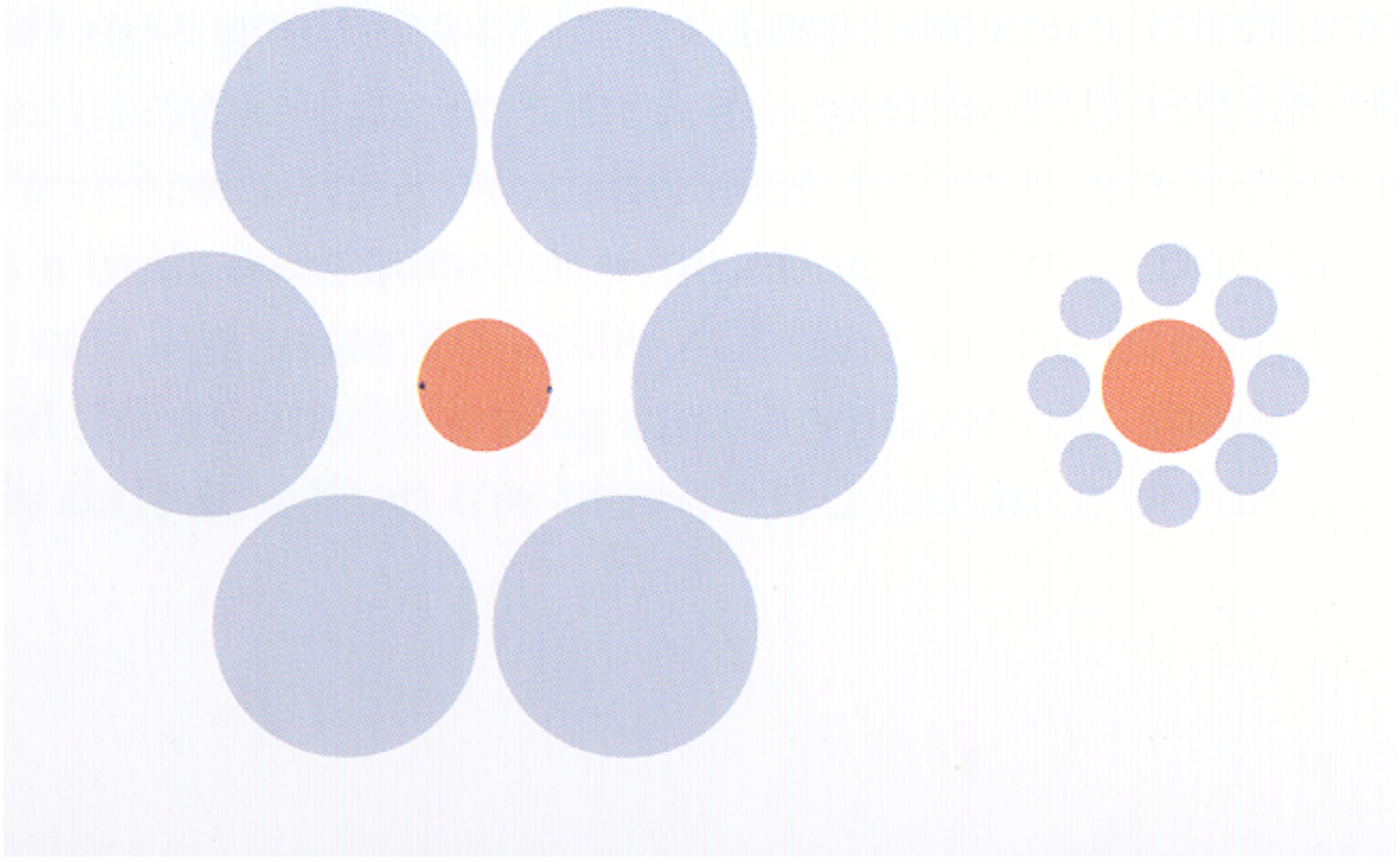
Optical Illusions



Diluted Parallelism

The Human - Vision

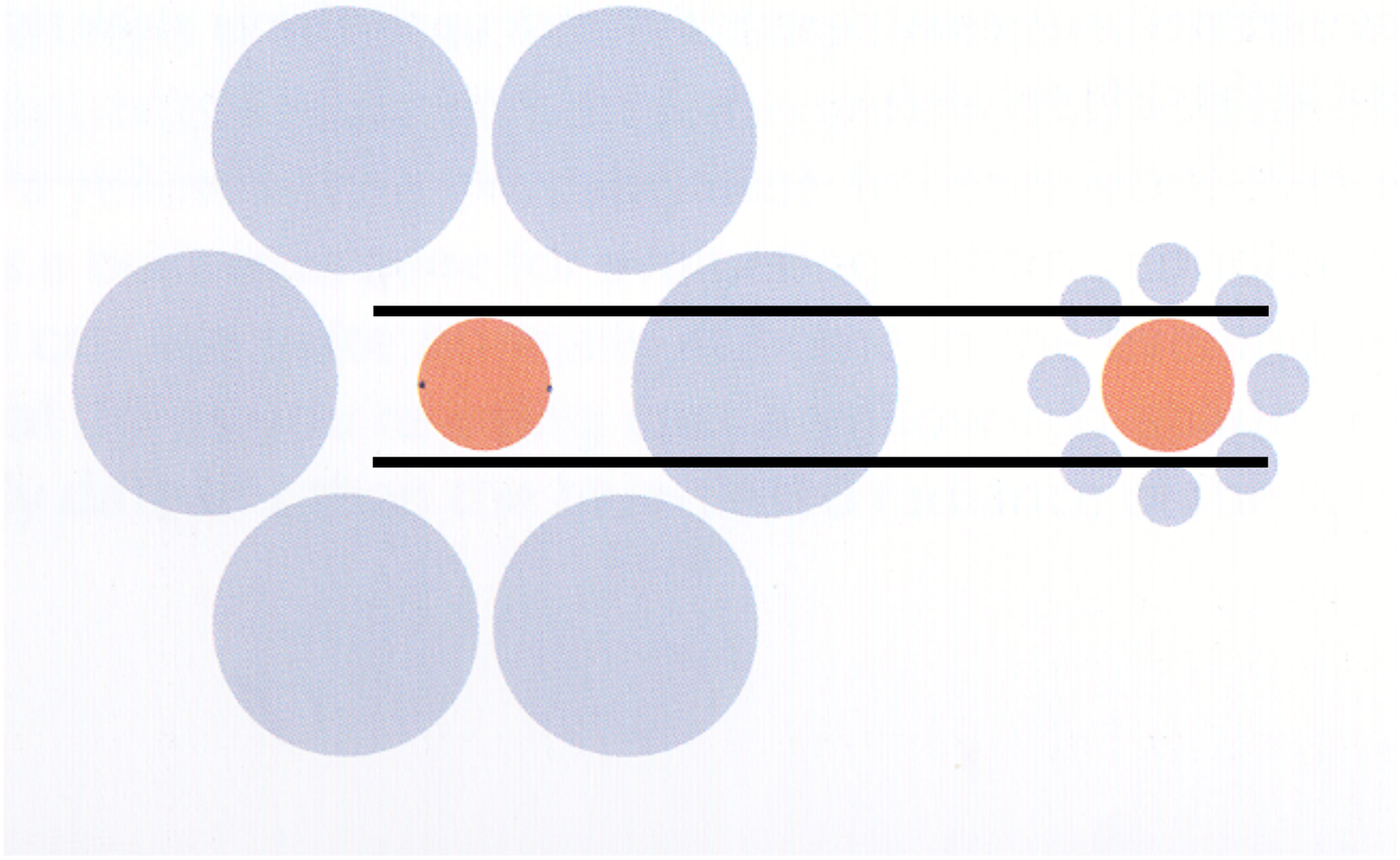
Optical Illusions



Relativity

The Human - Vision

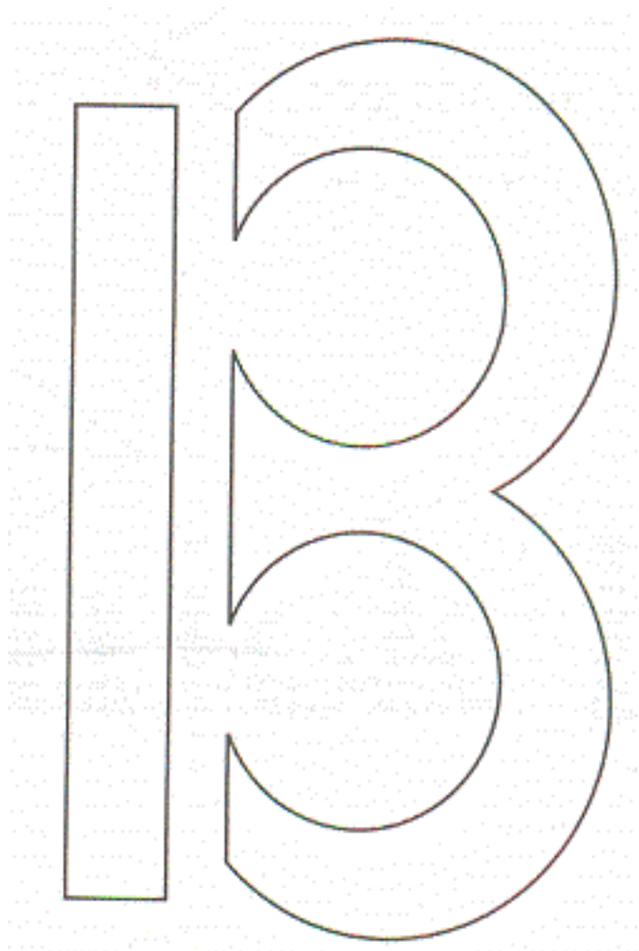
Optical Illusions



Relativity

The Human - Vision

The power of a context



What do you see here?

The Human - Vision

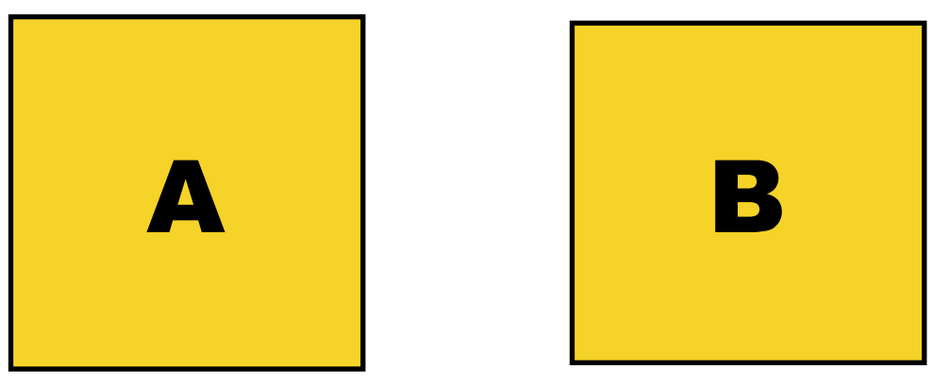
The power of a context

And now?

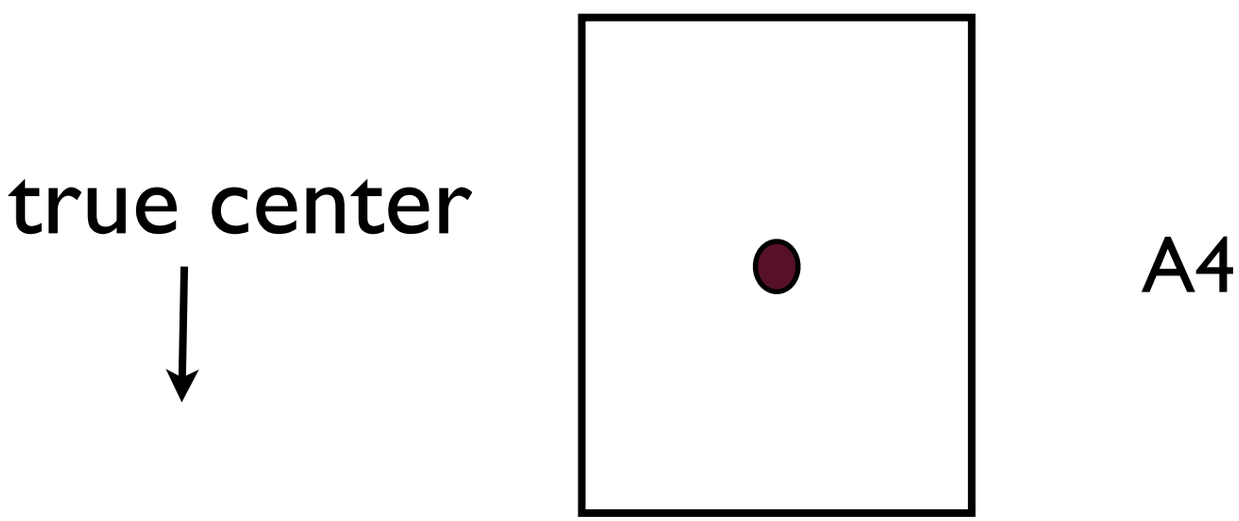
The Human - Vision

Graphic Design

- We tend to increase horizontal lines and shorten the vertical ones

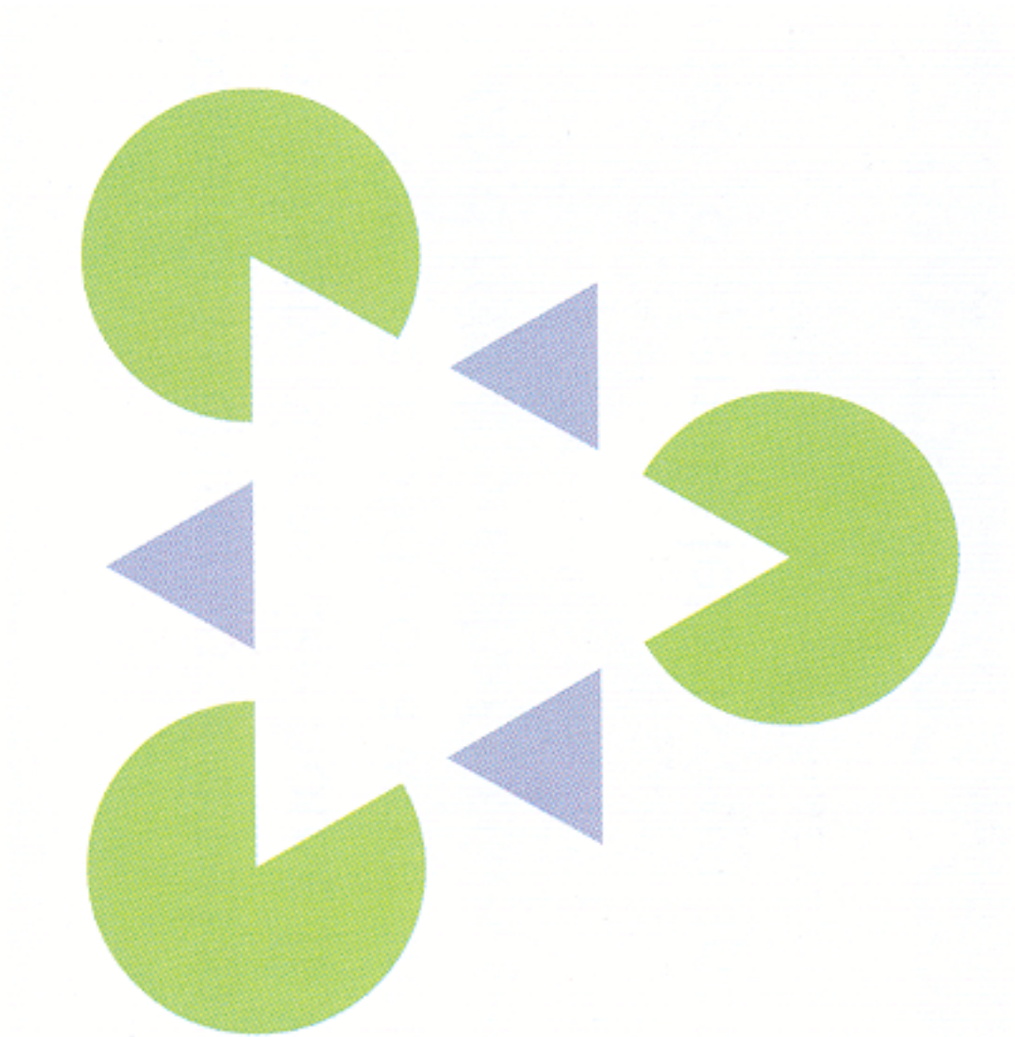


- The perceived "optical center" is position slightly above the true center



The Human - Vision

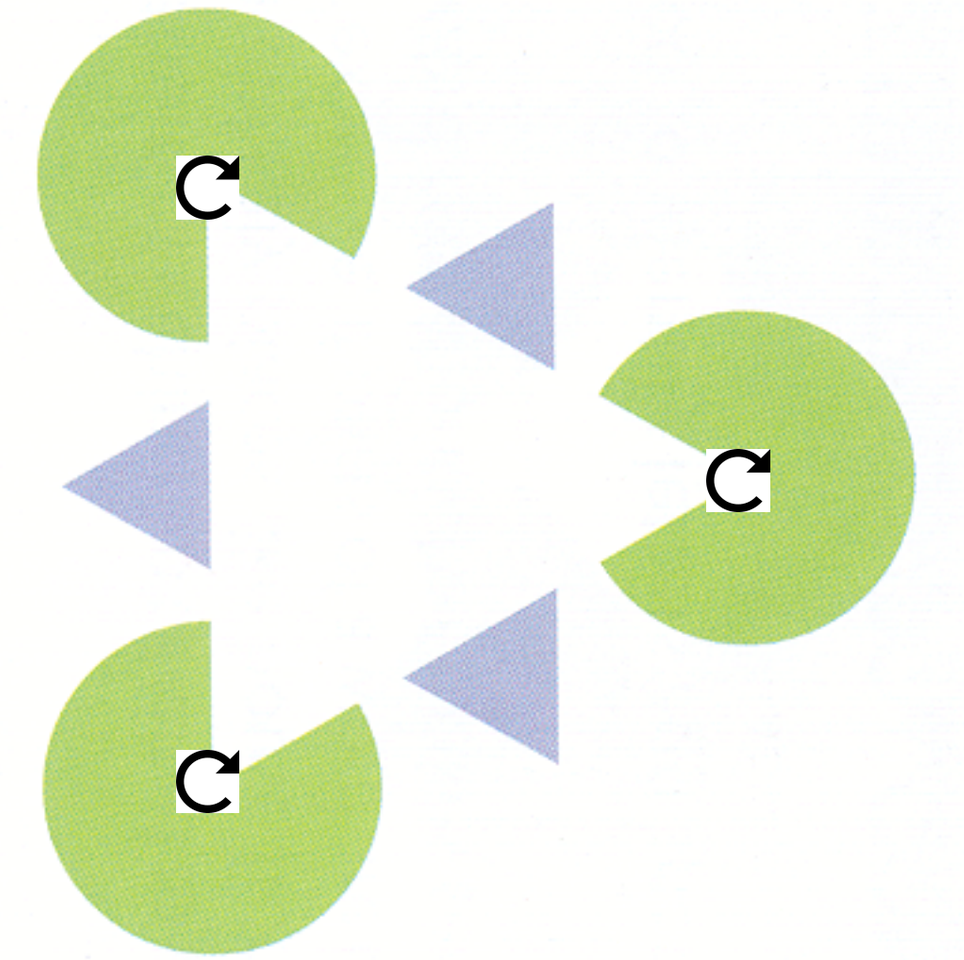
Optical Illusions



Filling the gap — a human perspective

The Human - Vision

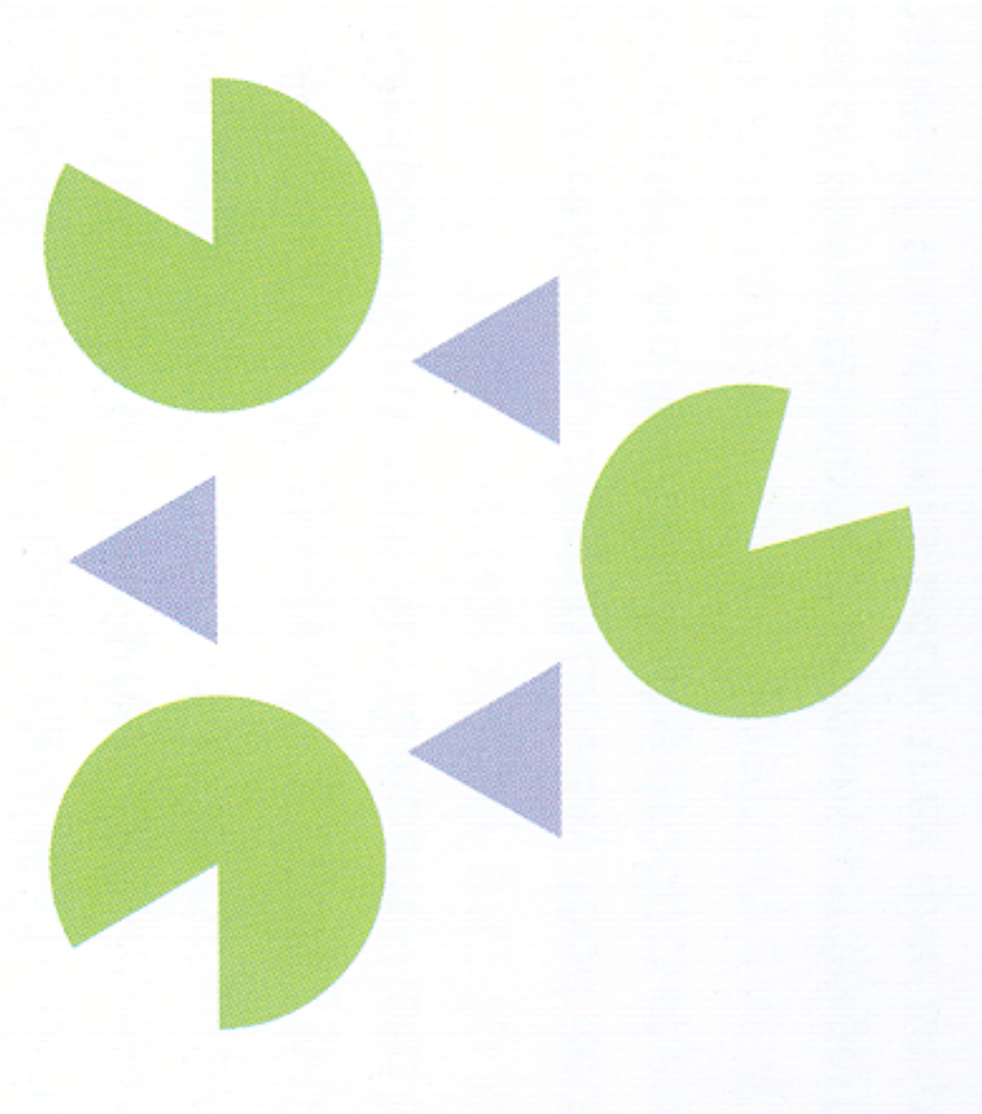
Optical Illusions



Filling the gap — a human perspective

The Human - Vision

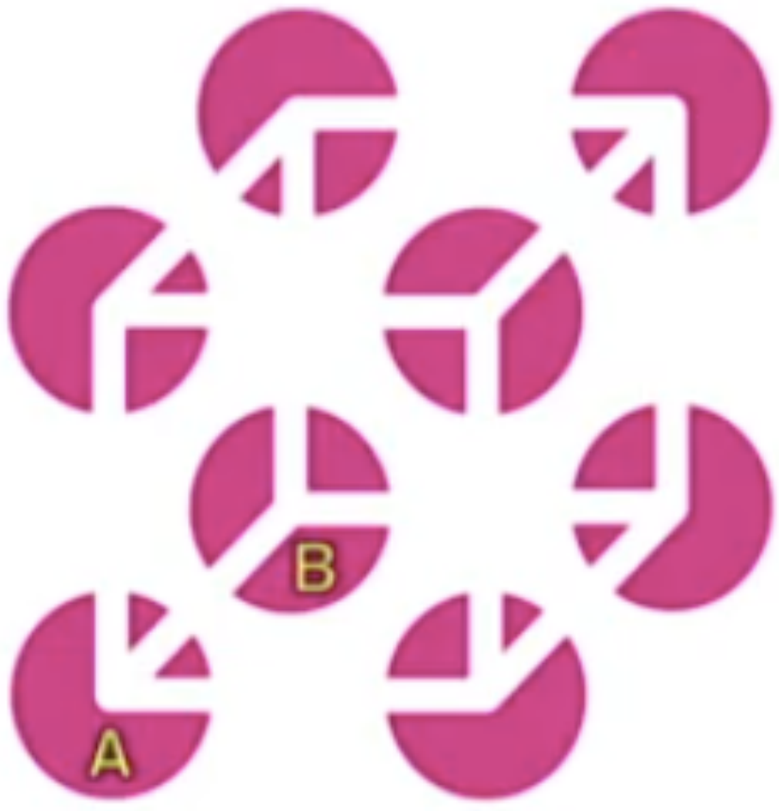
Optical Illusions



Filling the gap — a human perspective

The Human - Vision

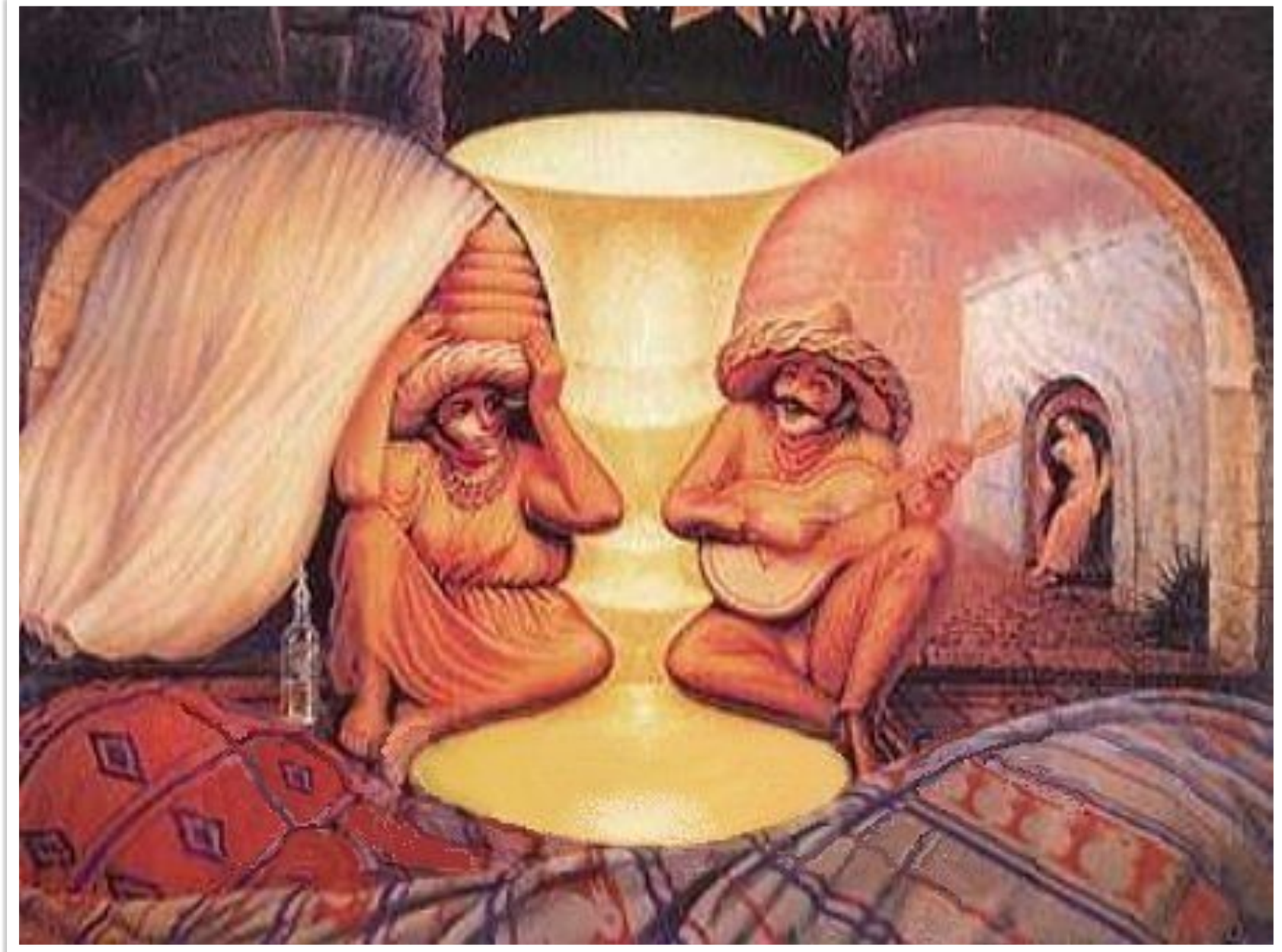
Optical Illusions



Filling the gap — a human perspective

The Human - Vision

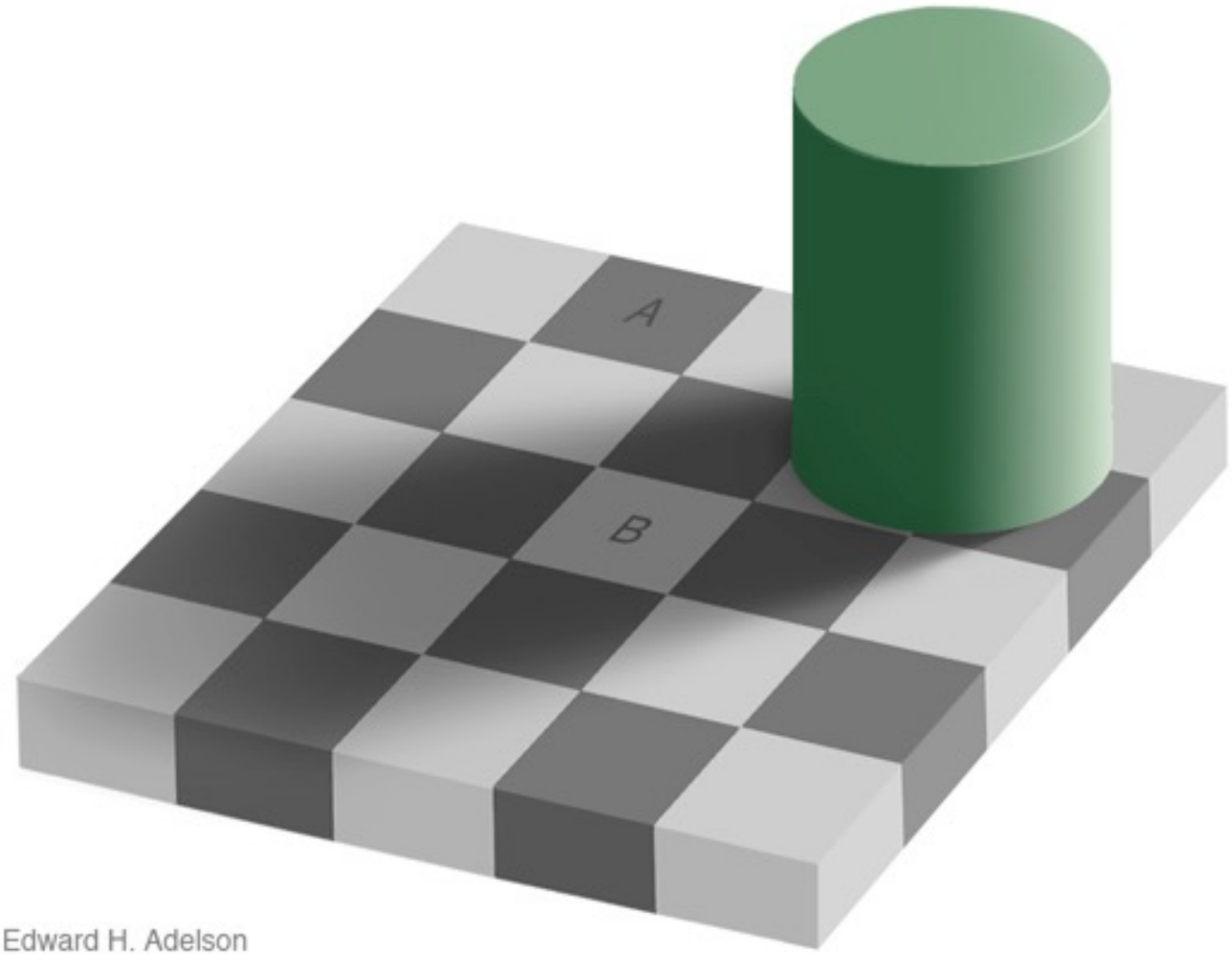
Optical Illusions



A relative true

The Human - Vision

Optical Illusions



Edward H. Adelson

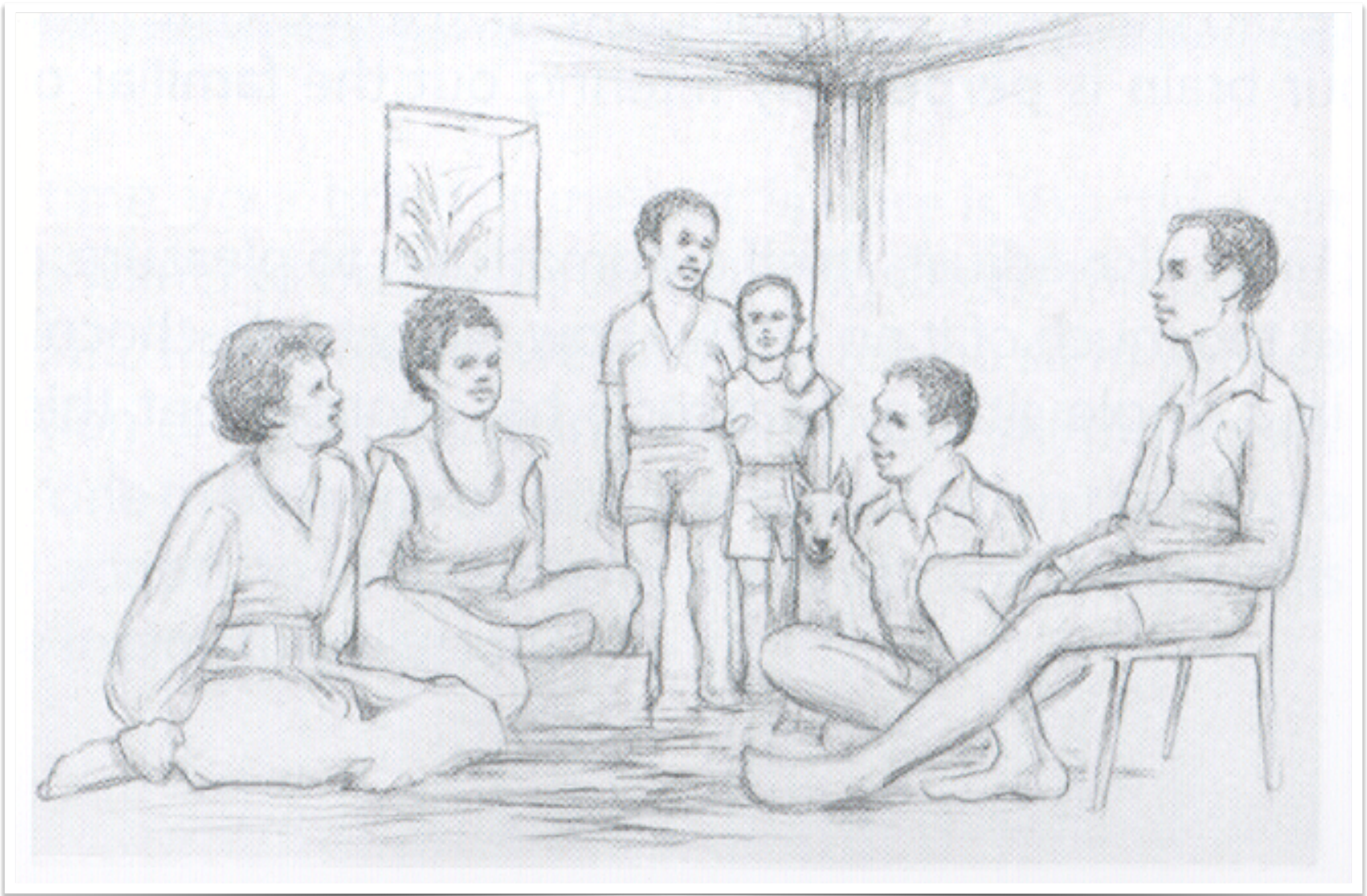
Gray hues

The Human - Vision

Strange colors

The Human - Vision

Optical Illusions



A cultural perspective

Human Visual Interpretation

The cultural background provides a context-rich framework that influences our expectations, values, and the meanings we ascribe to what we see. For instance, **color perception** is culturally relative — white may symbolize purity in some cultures, yet in others, it represents mourning. When designing products and applications, it is crucial to **recognize that cultural diversity** can lead to a multiplicity of user interpretations and needs. Acknowledging and addressing these differences is key to **creating inclusive designs** sensitive to the broad spectrum of human experience, ensuring that products are **functional and culturally congruent** with their intended user base.

The Human - Vision

Optical Illusions

Read the following:

The quick brown fox
jumps over the
the lazy dog

Is it correct?

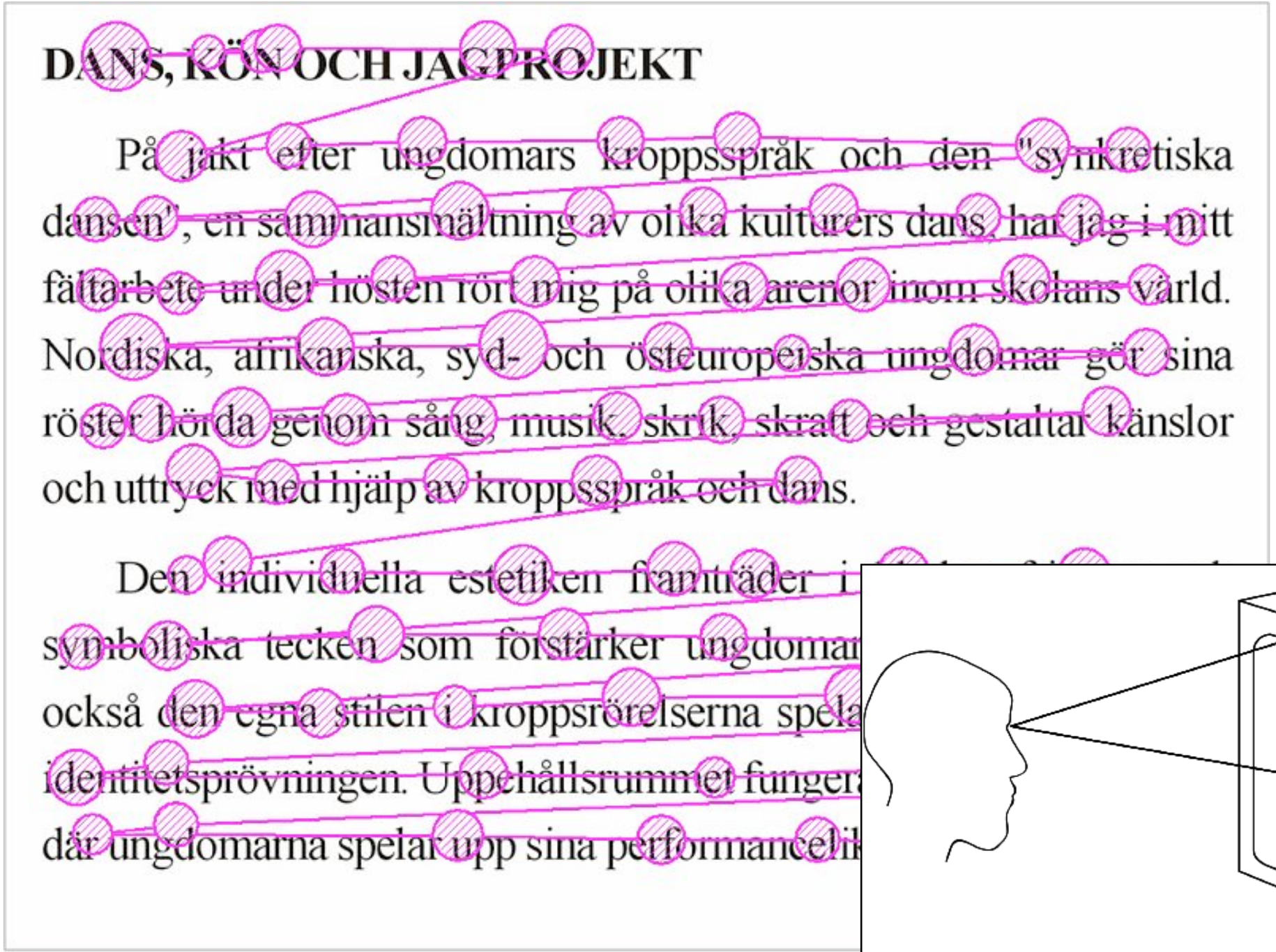
The Human - Vision

Text Reading

- Human eye makes rapid movements (**saccades**) and pauses (**fixations**) - 94% time breaks
- Information is collected during the "fixations" and there are 3 to 5 per line of text
- There are also ***regressions*** in the eye movement
  - Complex text => more regressions
- Reading speed in adults: 250 words / minute.
- Reading from a computer is slower than from a book
- Dark letters on light background is easier to read - more luminance => greater acuity
- Font sizes: 9 = 12 if proportional spacing on lines

The Human - Vision

Saccades and Fixations



DANS, KÖN OCH JAG PROJEKT

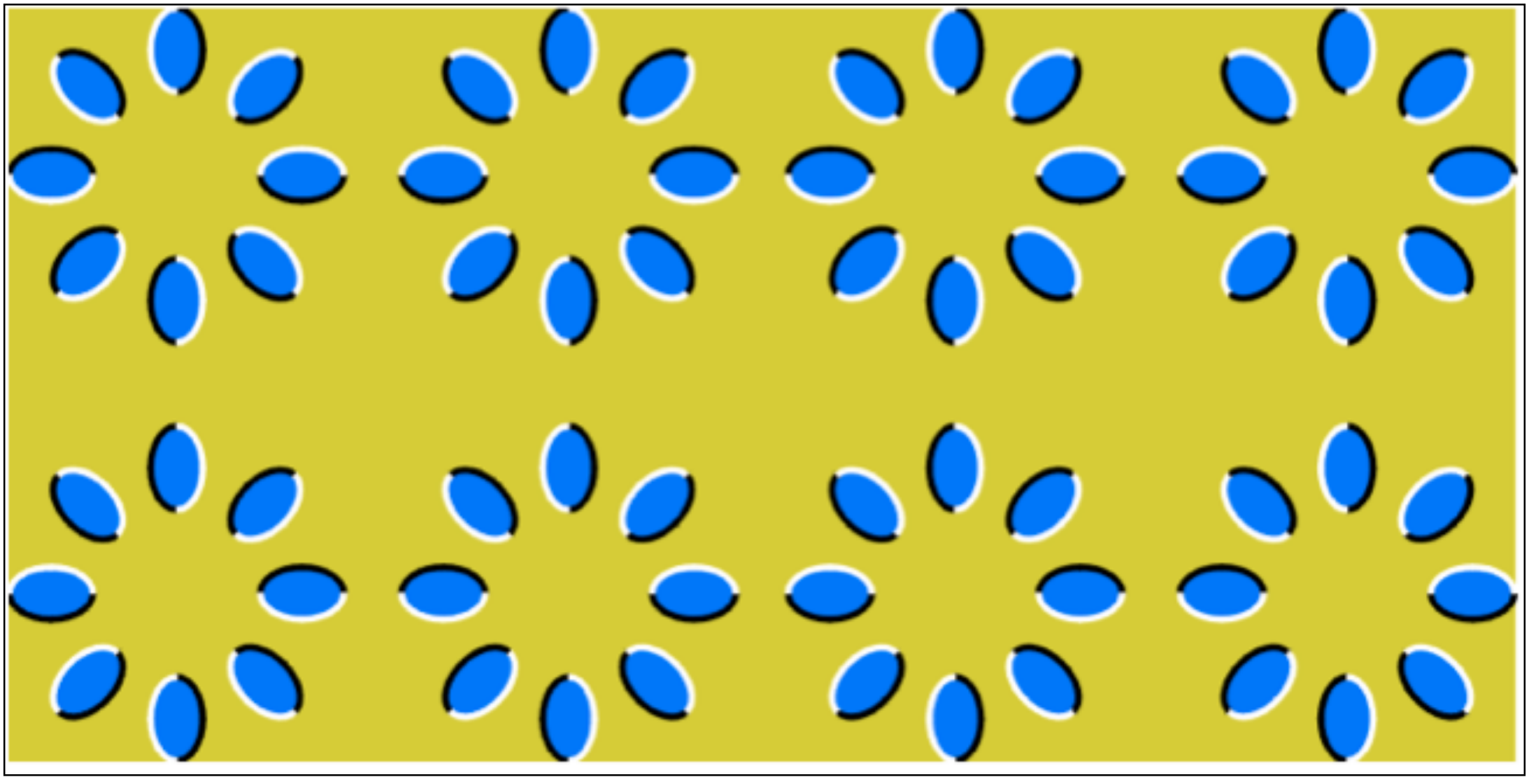
På jakt efter ungdomars kroppsspråk och den "synkretiska dansen", en sammansmältning av olika kulturers dans, har jag i mitt fältarbete under hösten fört mig på olika arenor inom skolans värld. Nordiska, afrikanska, syd- och östeuropeiska ungdomar gör sina röster hörda genom sång, musik, skrik, skratt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

Den individuella estetiken framträder i
symboliska tecken som förstärker ungdoma
också den egna stilen i kroppsrörelserna spela
identitetsprövningen. Uppehållsrummet fungera
där ungdomarna spelar upp sina performancelik

eye-gaze

The Human - Vision

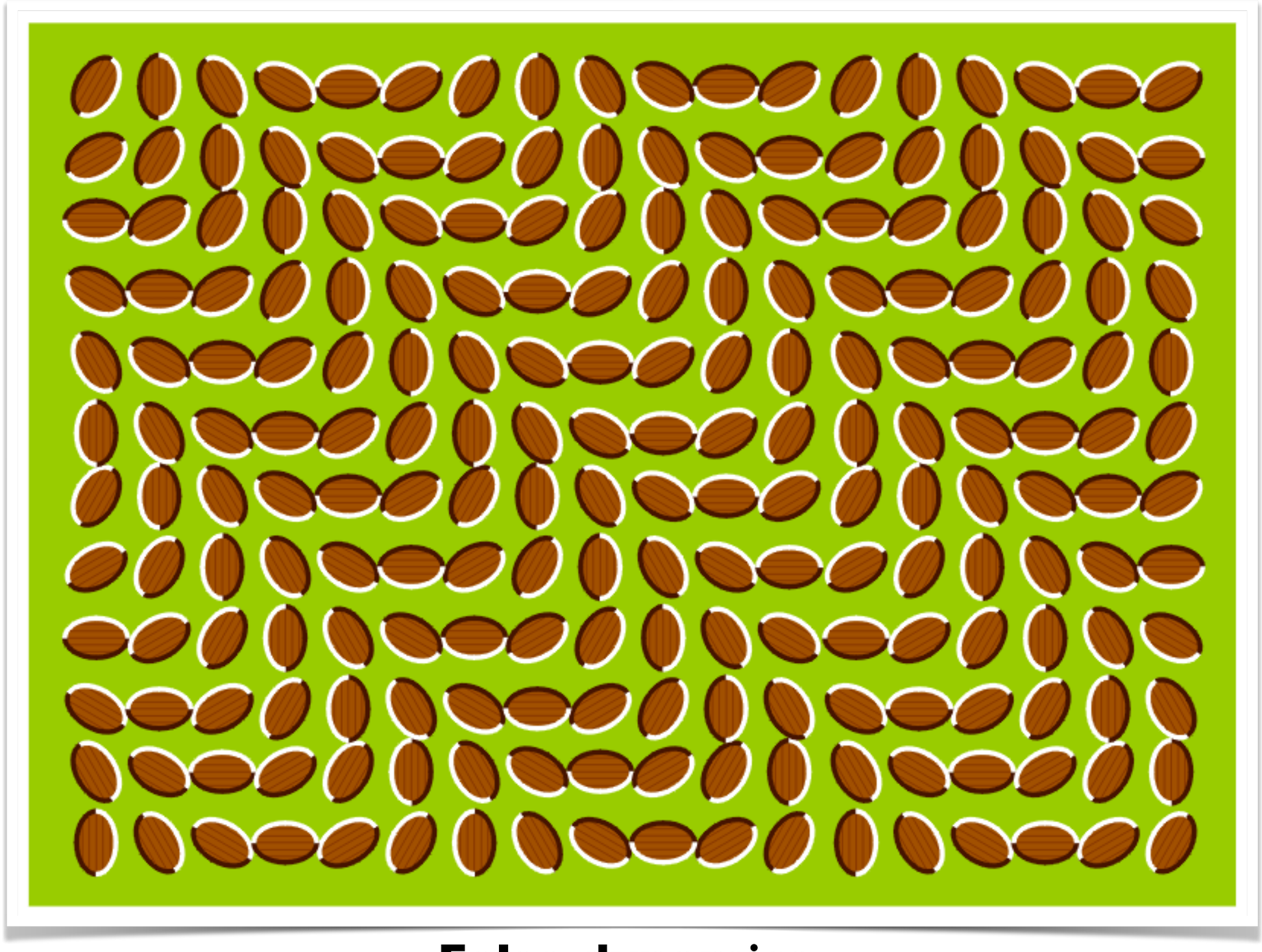
Saccades and Fixations



False dynamics

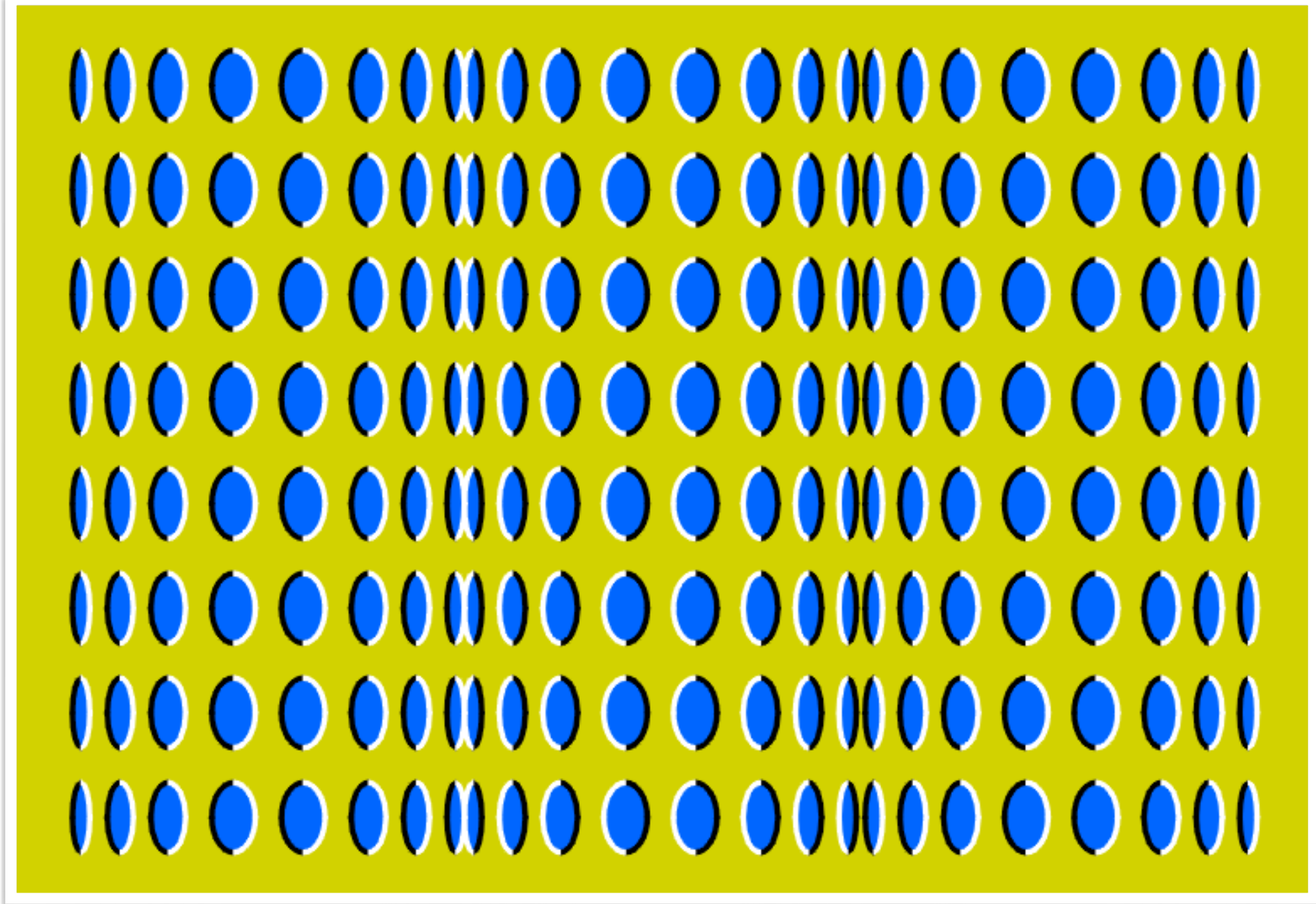
The Human - Vision

Saccades and Fixations



False dynamics

Saccades and Fixations



False dynamics

The Human - Vision

Text Reading

How do humans really read?

漢 汉

字 字

- Chinese ideogramas
- There are about 42 000
- Only 3000 most used

The Human - Vision

Text Reading

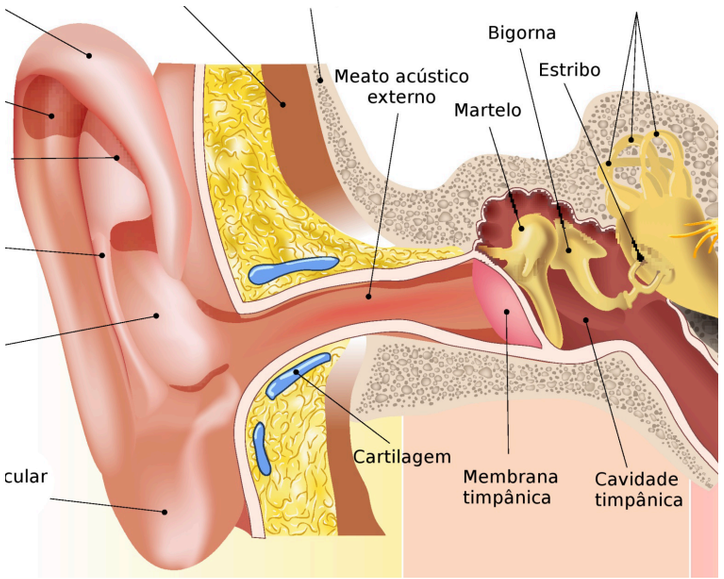
3M D14 D3 V3R40, 3574V4 N4 PR414, 0853RV4ND0 DU45 CR14NC45 8R1NC4ND0 N4 4R314. 3L45 7R484LH4V4M MU170 C0N57RU1ND0 UM C4573L0 D3 4R314, C0M 70RR35, P4554R3L45 3 P4554G3NS 1N73RN45. QU4ND0 3575V4M QU453 4C484ND0, V310 UM4 0ND4 3 D357RU1U 7UD0, R3DU21ND0 0 C4573L0 4 UM M0N73 D3 4R314 3 35PUM4.

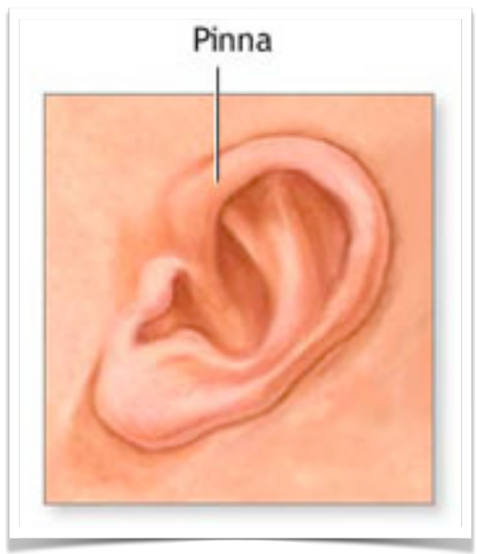
4CH31 QU3, D3P015 D3 74N70 35F0RC0 3 CU1D4D0, 45 CR14NC45 C41R14M N0 CH0R0, C0RR3R4M P3L4 PR414, FUG1ND0 D4 4GU4, R1ND0 D3 M405 D4D45 3 C0M3C4R4M 4 C0N57RU1R 0U7R0 C4573L0. C0MPR33ND1 QU3 H4V14 4PR3ND1D0 UM4 GR4ND3 L1C40; G4574M05 MU170 73MP0 D4 N0554 V1D4 C0N57RU1ND0 4LGUM4 C0154 3 M415 C3D0 0U M415 74RD3, UM4 0ND4 P0D3R4 V1R 3 D357RU1R 7UD0 0 QU3 L3V4M05 74N70 73MP0 P4R4 C0N57RU1R. M45 QU4ND0 1550 4C0N73C3R 50M3N73 4QU3L3 QU3 73M 45 M405 D3 4LGU3M P4R4 53GUR4R, 53R4 C4P42 D3 50RR1R! S0 0 QU3 P3RM4N3C3 3 4 4M124D3, 0 4M0R 3 C4R1NH0.

0 R3570 3 F3170 D3 4R314

The Human - Hearing

Human Hearing





Usually viewed as secondary, but …

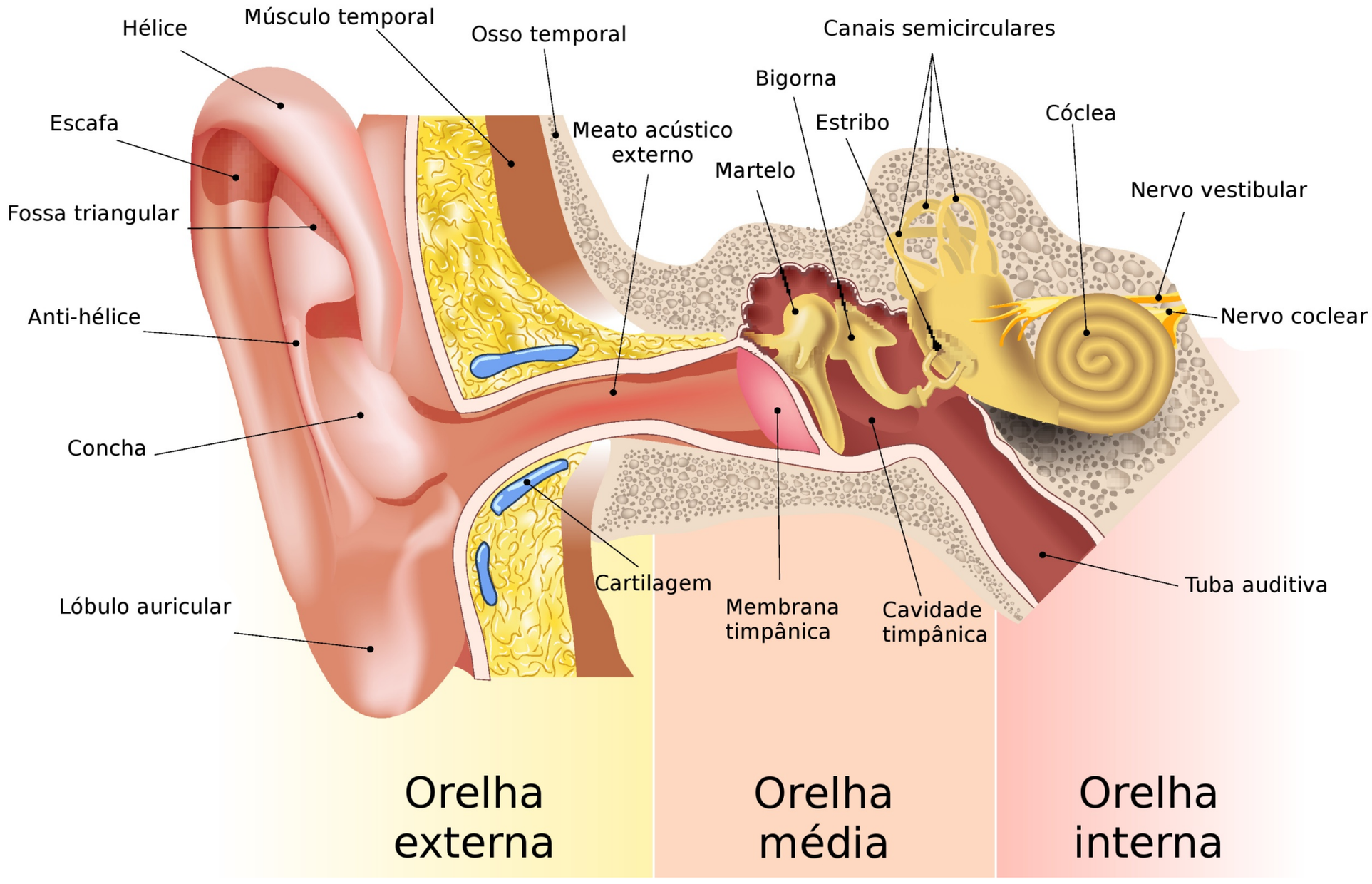
There is **much more** information entering than what is naively considered.

The pinna acts as a **funnel** that channels the sound into the ear.

We were able to **estimate distances**, due to delays in reception between the two ears.

The Human - Hearing

Anatomia da Orelha

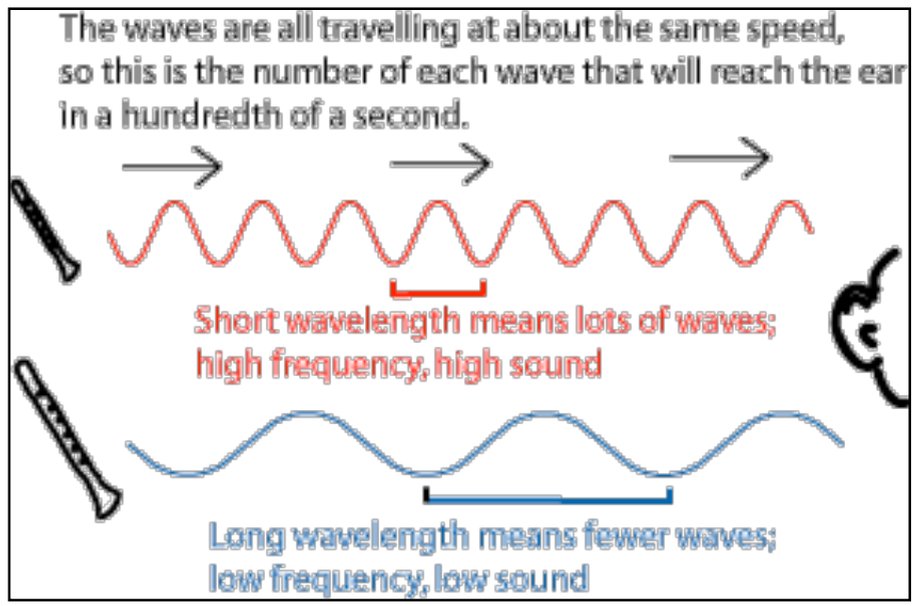


The Human - Hearing

- Provides rich environment information:

  distances, directions, etc.

- **Physical Apparatus**
  - **Outer ear** – protects inner ear and amplifies sound
  - **Middle ear** – transmits sound waves as vibrations to inner ear
  - **Inner ear** – chemical transmitters are released and cause impulses in auditory nerve
- **Sound**
  - **Pitch** – frequência (Hz)
  - **Loudness** – amplitude (dB)
  - **Timbre** – tipo de som



The Human - Hearing

Processing Sound

- Human hearing range between 20Hz and 15kHz
  - Dogs can hear ultrasounds;
  - Elephants communicate through infra-sounds;
- At low frequencies, we can detect differences of 1.5 Hz;
- At higher frequencies, we lose sensitivity;
- The hearing range varies with age;
- The brain efficiently filter sounds, e.g., "the cocktail party";
- There are also auditory illusions as well.

The Human - Hearing

There are also auditory illusions

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Edit links

Auditory illusion

From Wikipedia, the free encyclopedia

An **auditory illusion** is an illusion of hearing, the aural equivalent of an optical illusion: the listener hears either sounds which are not present in the stimulus, or "impossible" sounds.[1] In short, auditory illusions highlight areas where the human ear and brain, as organic, makeshift tools, differ from perfect audio receptors (for better or for worse).

Examples of auditory illusions:

- hearing a missing fundamental frequency, given other parts of the harmonic series
- Various psychoacoustic tricks of lossy audio compression
- Binaural beats
- Deutsch's scale illusion
- Glissando illusion
- Illusory continuity of tones
- McGurk effect
- Octave illusion/Deutsch's High-Low Illusion
- the Shepard-Risset tone or scale, and the Deutsch tritone paradox
- the constant spectrum melody
- File:Risset accelerando beat1 MCLD.ogg: Forever accelerating beat.

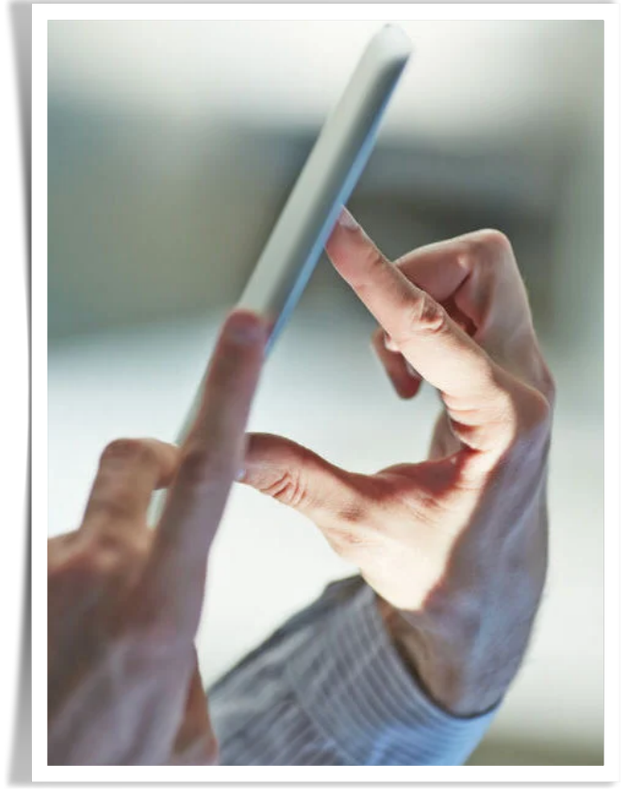
See also [edit source]

- Musical acoustics
- Psychoacoustics
- Jean-Claude Risset
- Auditory system
- Barber pole – auditory illusions compared to visual illusions
- Doppler effect – not an illusion, but real physical phenomenon
- Holophonics

The Human - Touch

Touch

- Also known as “haptic perception”.
- Normally used as an unconscious feedback:

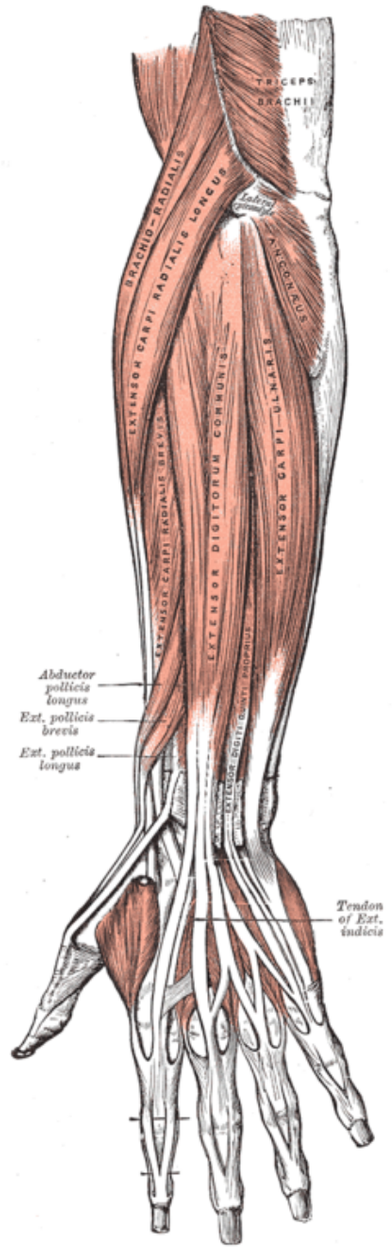


- The keypresses, when we write;
- Sensing the mouse location (kinaesthetic/cinestético/cinestesia);
- In electronic equipment: vibrations.

The Human - Touch

Touch

- **Stimuli through skin receptors:**
  - **Mecano-receptors** (pressure);
  - **Termo receptors** (heat);
  - **Nocio-receptores** (pain or intense pressure).
- **Heterogeneous sensitivity:**
  - The sensitivity of the fingertip is about **10 times** the sensitivity of the forearm.

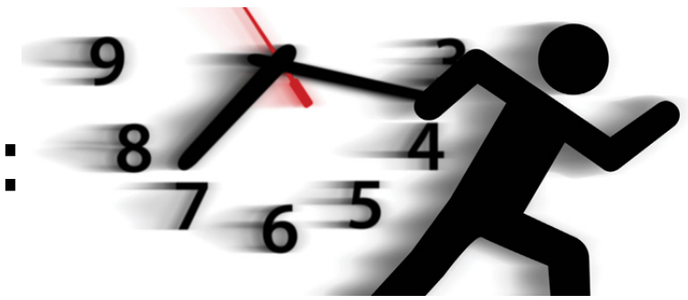


The Human - Movement

Movement

- The **motion** is made up of two essential features:
    - Speed
    - Precision
- **Speed** (reaction time) depends on two things (e.g., accident):
    - **Processing** Time
    - **Action** Time

The Human - Movement



- **Time taken to respond to stimulus**:
  reaction time + **motion time**

- The **reaction time** - how quickly an organism can respond to a particular stimulus.

- Dependent on the stimulus type:
  - **Visual** ~ 200 ms
  - **Auditory** ~ 150 ms
  - **Pain** ~ 700 ms

  combined stimulus => better RT

- The **Motion time** dependent on age, fitness, etc.

- Increasing reaction time decreases accuracy in the unskilled operator but not in the skilled one.

The Human - Movement

Fit's Law (1954)

Describes the time taken to hit a screen target:

$$\mathbf{Mt = a + b \log_2(D/S + 1)}$$

where: **a** and **b** are empirically determined constants,

Mt is the movement time

D is the distance to target,

S is the size of the target

⇒ **Rule**: targets as large as possible and distances as small as possible

The Human - Movement

The Hick's law (1952)

Models the time required to select one option among several possibilities:

$$T = b \log_2(n + 1)$$

where:

n is the number of possibilities,

T is the time taken to choose an option,

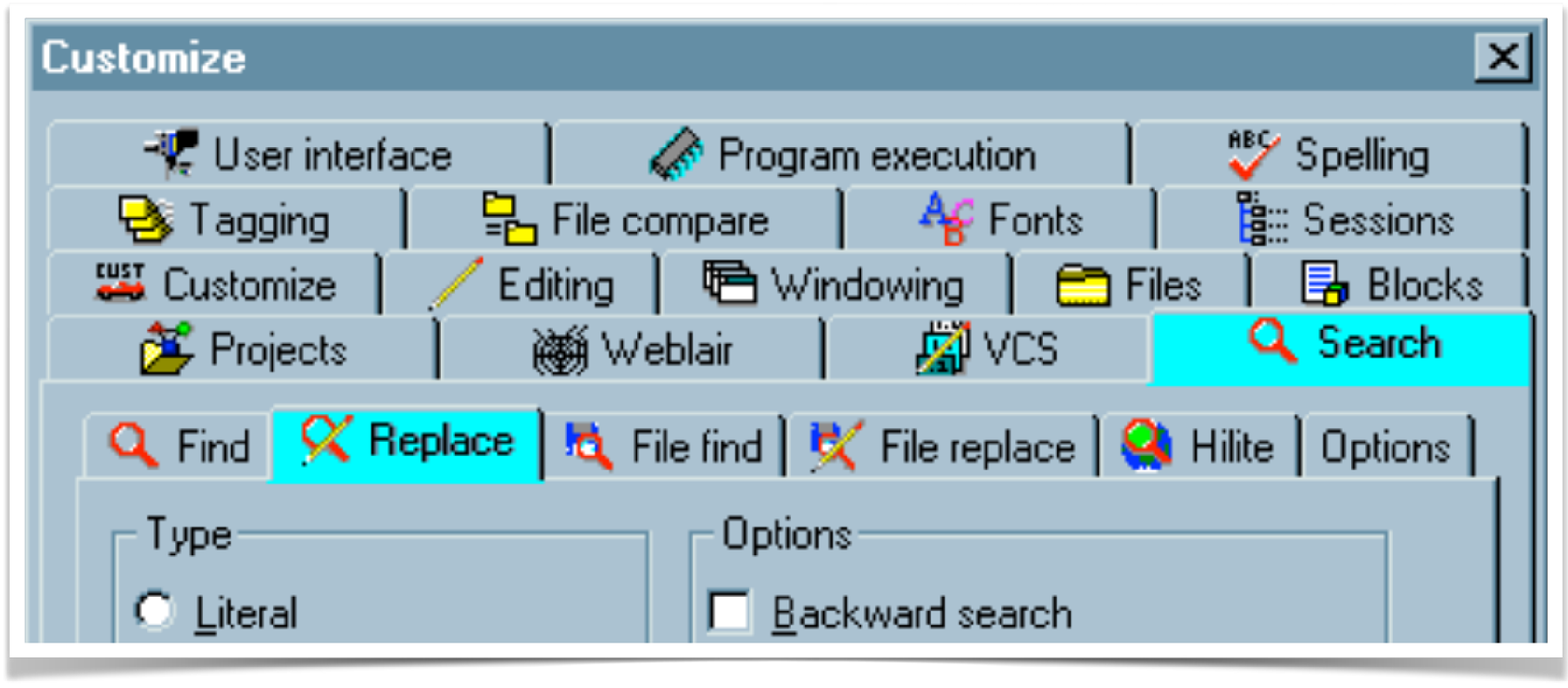
b is an empirical constant

⇒ **Principle**: always present the minimal number of choices in a given view. Less is much more!

The Human - Movement

The Hick's law (1952)

$$T = b \log_2(n + 1)$$



⇒ **Principle**: always present the minimal number of choices in a given view. Less is much more!