03

Human Perception and Information Processing

Notice

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Bibliography

- **Many examples are extracted and adapted from**
  - **Interactive Data Visualization: Foundations, Techniques, and Applications,**

    Matthew O. Ward, Georges Grinstein, Daniel Keim, 2015
  - **Visualization Analysis & Design,**

    Tamara Munzner, 2015

Practical information

Teams: lets check the actual situation

- **Teams registration**

Group ID	ID-1	Name-1	ID-2	Name-2	ID-3	Name-3
G01	48389	Luís Miguel Frade Ferreira Monteiro	50487	Bárbara Inês Bento Gaspar Lopes	51104	Miguel Appleton Fernandes
G02	45088	André Huy do Vale	50837	Carlos Pedro Leal Boinas	45604	Alexandru Alin Caramida
G03	56926	Rafaela Carreira Eleutério Gregório da Cruz	56969	André Filipe Neves Bastos	57213	Carolina Pinto Pereira Muelle Goldstein
G04	57120	Manuel Luís Lopes Gonçalves	56892	André Filipe Alberto Pedrinho	56861	João Pedro Marques Camacho
G05	50321	Joana Sofia Rodrigues Barradas	50433	Diogo Alexandre Freire da Silva	49834	João Pedro Ferreira Fernandes
G06	41730	André António da Veiga	41735	Diogo Miguel Alves Montoia	48057	Ricardo Nazir
G07	59051	Annemarie Witschas	58978	Robert Brada	59023	Aron Gaden
G08	50450	Ana Maria da Silva Cristão	50210	Sofia Frederico de Sousa Braz	41866	Rodrigo de Almeida Graças
G09	56922	Miguel Veríssimo Matias Albino	56887	Mário Paraíso Moimenta	57166	Nuno Filipe Braz Eusebio
G10	48303	Ana Sofia Lopes Afonso	47872	Sara Jardim Fernandes		
G11	56856	Inês Santos Gomes	47427	Ângelo Miguel Vaz Duarte	45305	André Filipe Branco Rosado
G12	50170	Miguel Teodoro Moreira	47316	Renato Gonçalves Pinto	50712	André Antunes Rodrigues
G13	57255	Duarte Miguel da Silveira	56998	Maelis Anouchka Oliveira Lopes	58746	Wendi Nambili Francisco de Carvalho
G14	52405	André Jorge Martins Sousa	52706	David Miranda Ribeiro Moreira	59082	Gustavo de Souza Morozi
G15	57162	Afonso Manuel Cunha Marques	59041	Emanuel Kryszton	54771	Henrique Fernandes Pereira
G16	45067	André Marques de Carvalho Ferreira Victorin	48078	Duarte Pinto Luís Esteves	50488	Miguel de Sousa Lourenço
G17	54827	Luís Filipe Rosa Dias	57179	Pedro Manuel dos Santos Marques	44677	Keiven Patrick Borges Marques
G18						
G19						
G20						

Teams: lets check the actual situation

- **Not in any team !**

43368	Ricardo Manuel Rodrigues Amaral	MIEI
48157	João Carlos Raposo dos Reis	MIEI
57024	Pedro Carlos Estêvão Laranjeira	MAEBD
57918	Kamil Trojnar	MIEI

Shared folder on Google Drive

Shared folder on Google Drive

- **You have received access to a shared folder:**
  - **VID-19-20-GNN**
    - Where GNN is your group ID
    - If not please let me know

Shared folder on Google Drive

- **You have received access to a shared folder:**
  - **VID-19-20-GNN**
    - Where GNN is your group ID
    - If not please let me know
- **Proposed organization for your folder**
  - **Data and Workbooks**
  - **Papers and PDFs**
  - **Project Paper**
    - Name the files like VID-GNN-2020.MM.DD-Paper.pdf
  - **You may use overleaf to work on the paper**
  - **Goggle Docs to share drafts**

Never Forget !

What is the Goal of Data Visualization?

The (ultimate) goal of DV

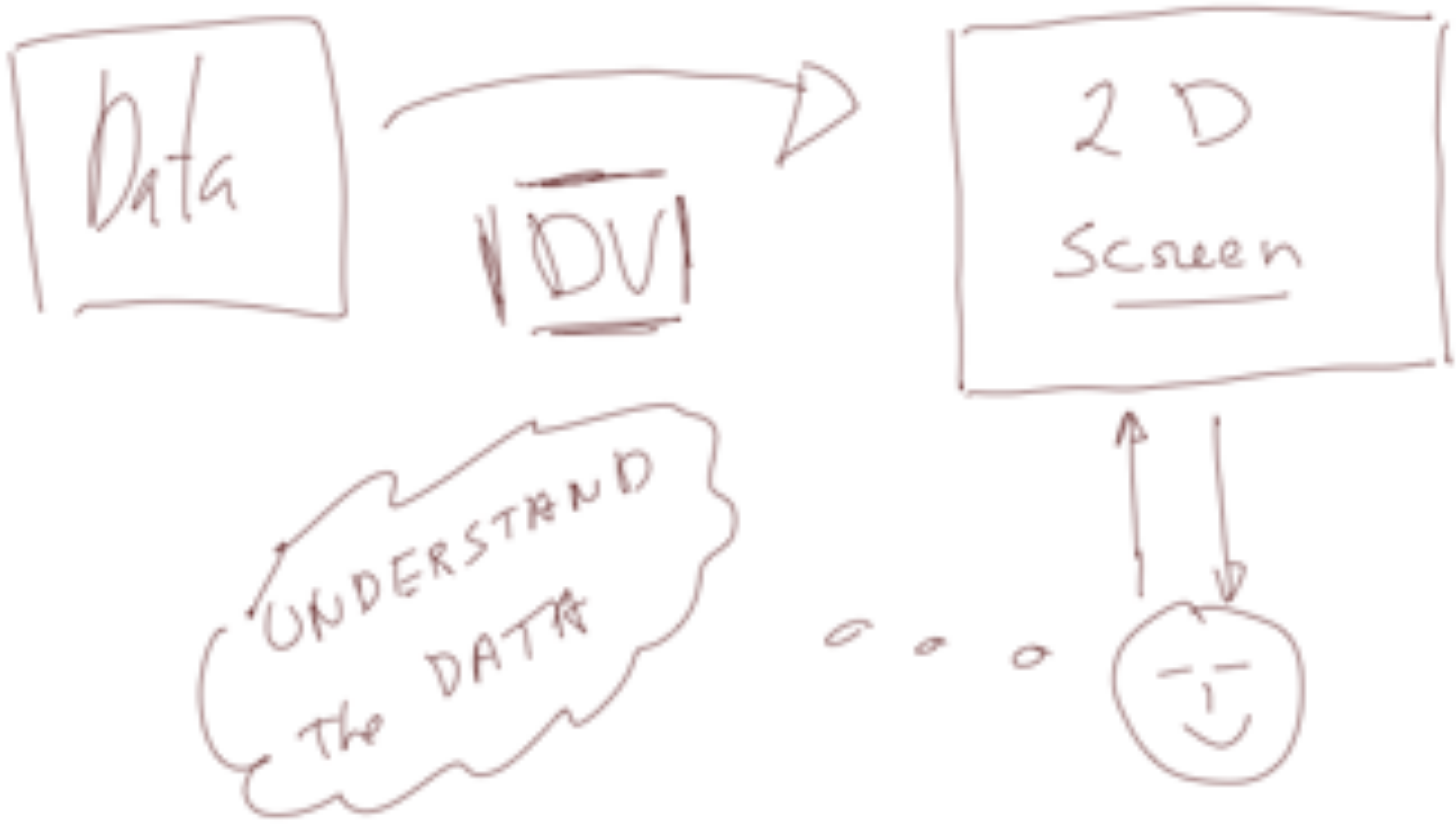
“Data visualization is not just about seeing data !

Is about UNDERSTANDING data,

and being able to make decisions based on the data”

by John C. Hart

What is the core idea of Interactive Data Visualization?



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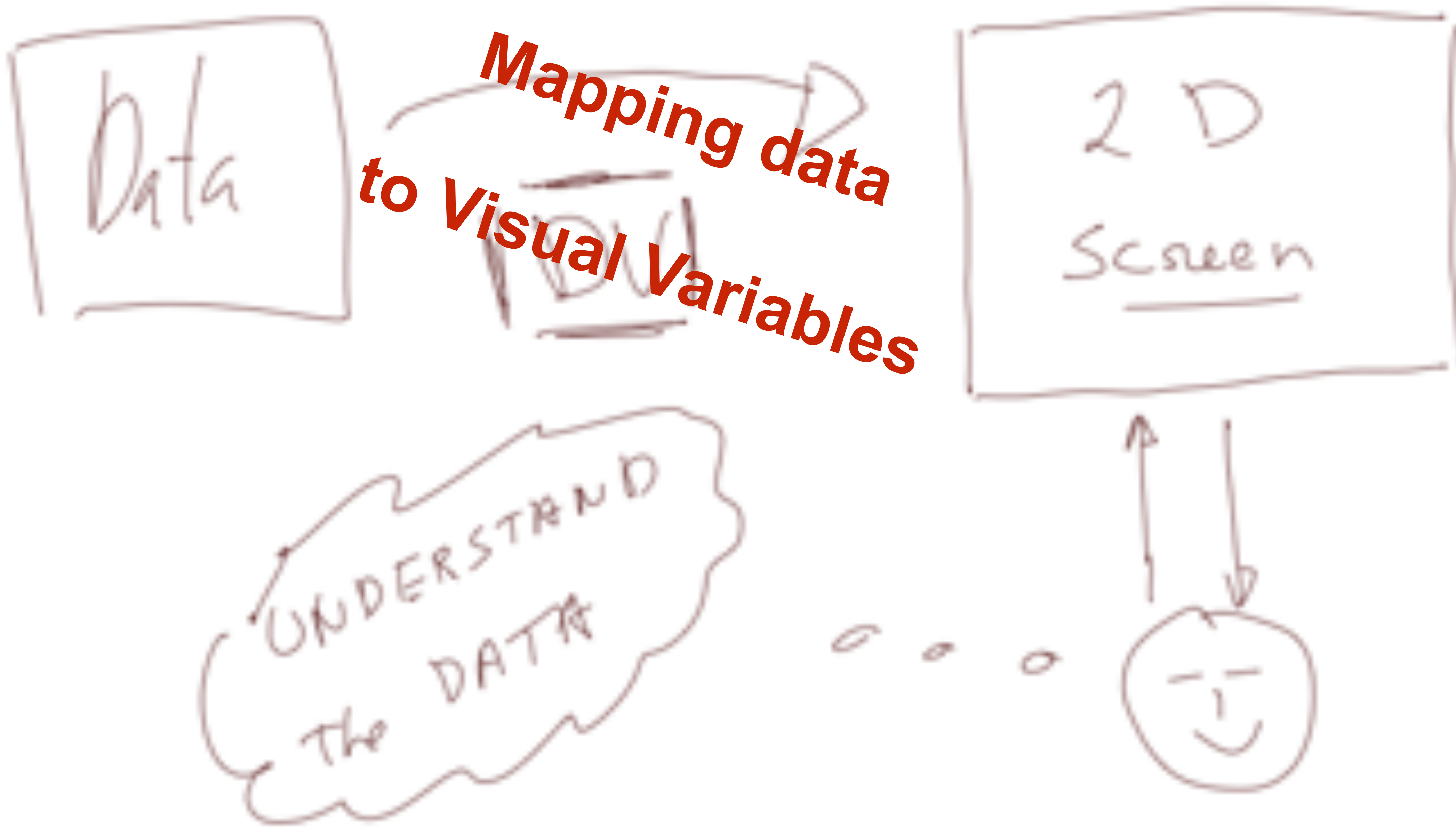

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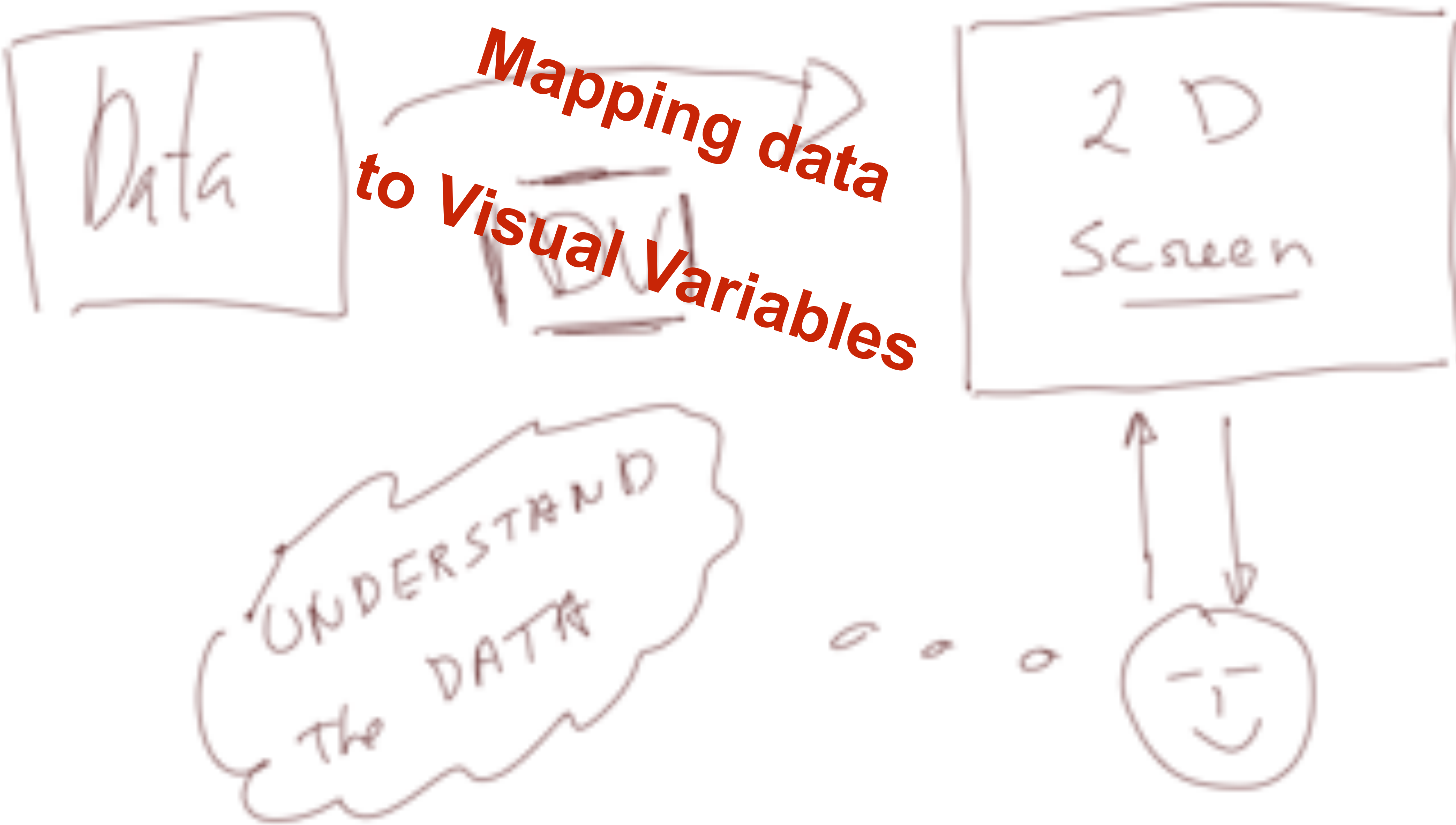
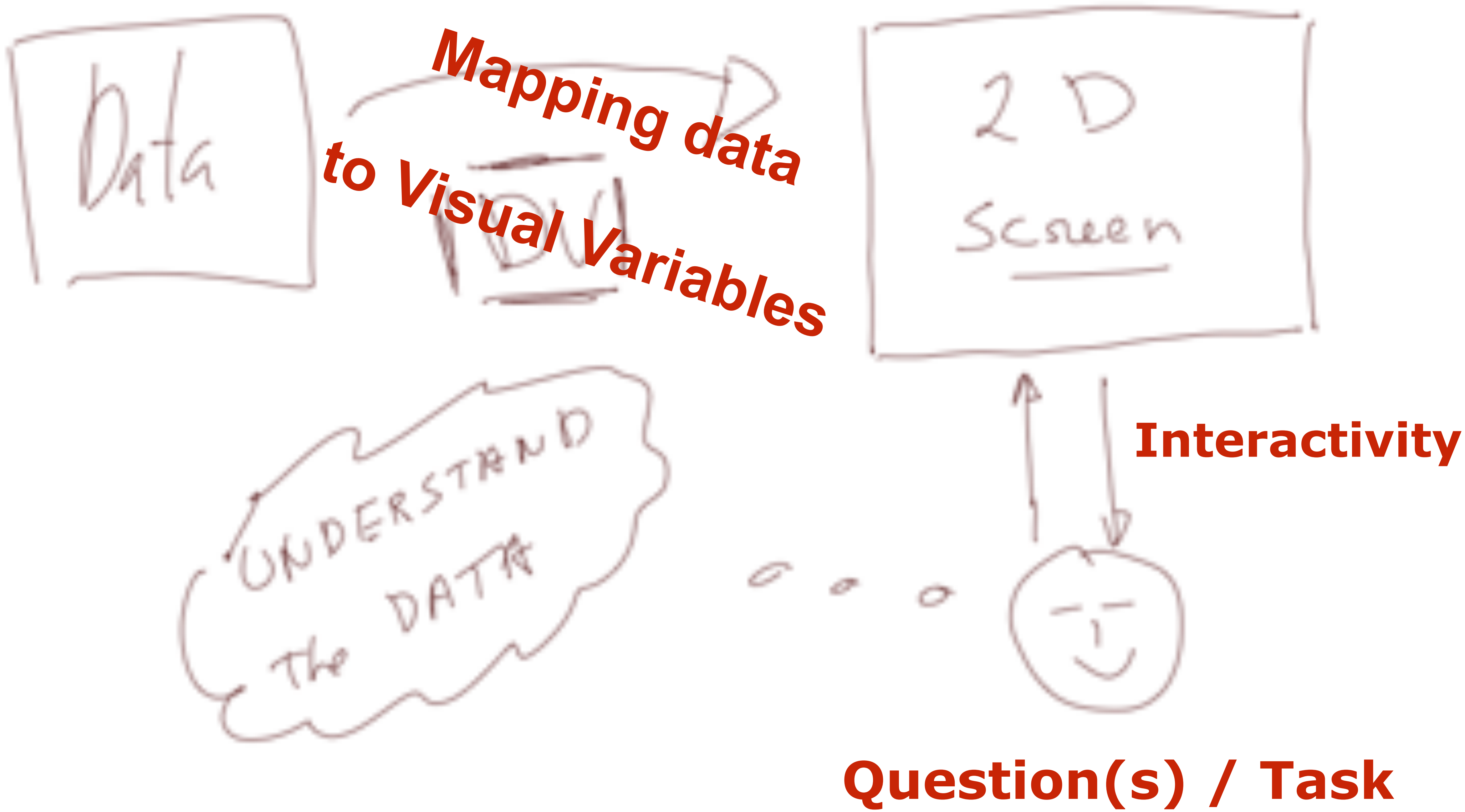


Question(s) / Task

What is the core idea of Interactive Data Visualization?



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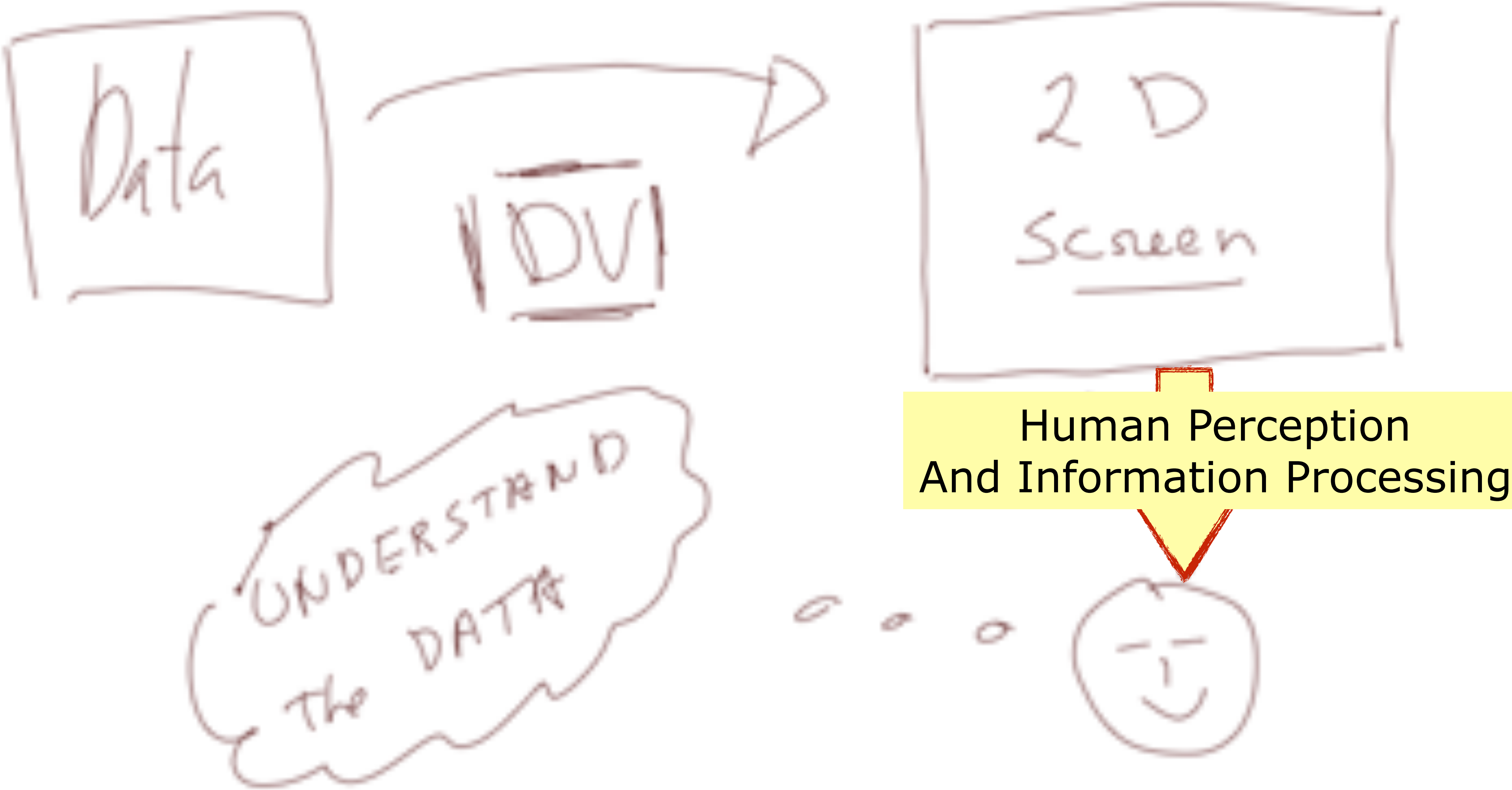

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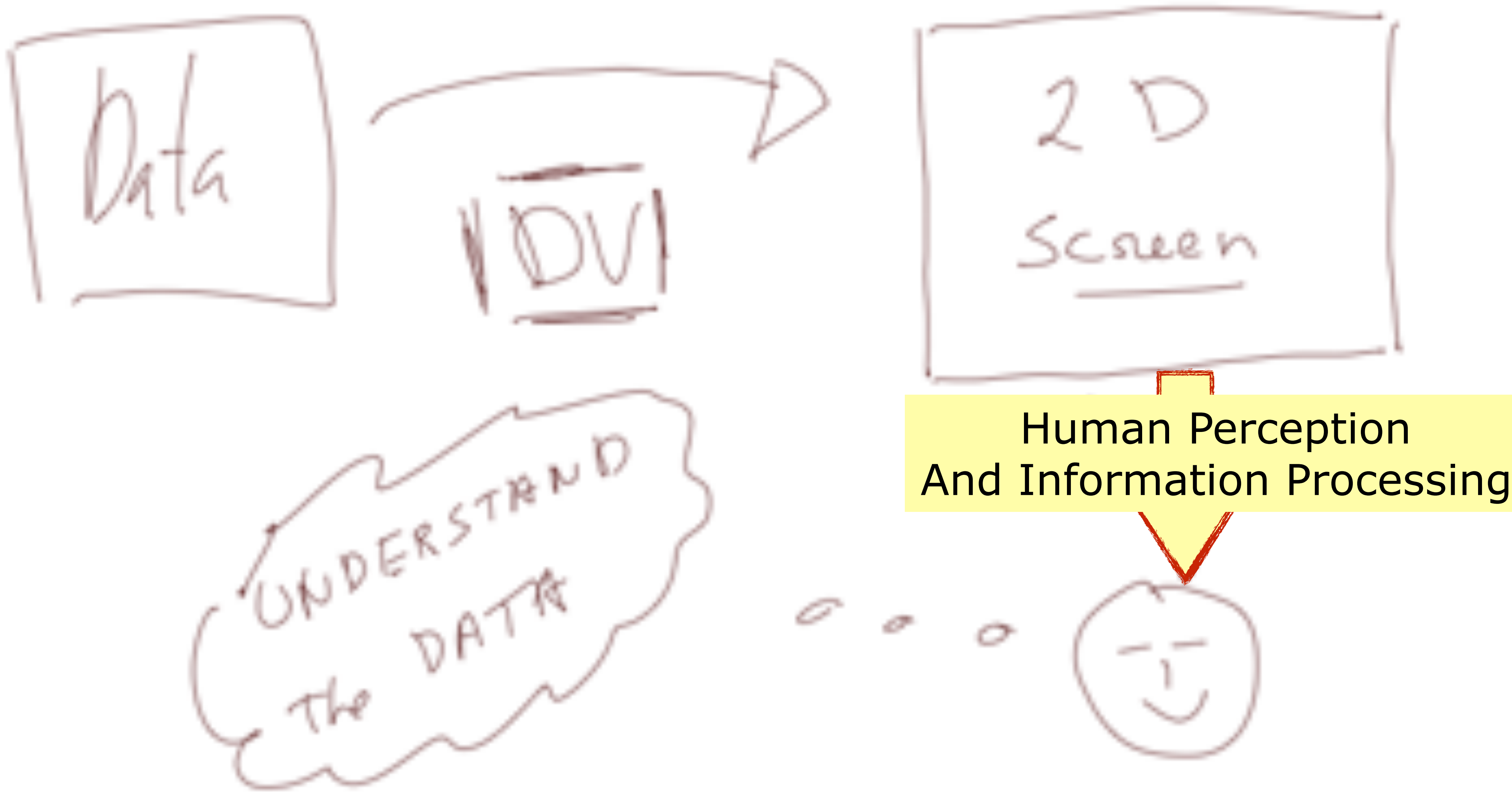

Question(s) / Task

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- **What Is Perception?**
- **Physiology**

Introduction to Data Visualization

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Interaction Concepts and Techniques

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- **What Is Perception?**
- **Physiology**
- **Perceptual Processing**

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- **What Is Perception?**
- **Physiology**
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- **Perception in Visualization**

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- **What Is Perception?**
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- **Perception in Visualization**
- **Metrics**

Introduction to Data Visualization

What Is Visualization?
Relationship between Visualization and Other Fields.
The Visualization Process.
Data Foundations.
Human Perception and Information Processing.
Semiology of Graphical Symbols.
The Visual Variables.

Visualization Techniques

Visualization Techniques for Spatial Data
Visualization Techniques for Geospatial Data
Visualization Techniques for Time-Oriented Data
Visualization Techniques for Multivariate Data
Visualization Techniques for Trees, Graphs, and Networks
Text and Document Visualization

Interaction Concepts and Techniques

Interaction Operators, Operands and Spaces (screen, object, data, attributes)
Visualization Structure Space (Components of the Data Visualization)
Animating Transformations
Interaction Control
Designing Effective Visualizations
Comparing and Evaluating Visualization Techniques

Visualization Systems

Systems Based on Data Type
Systems Based on Analysis Type
Text Analysis and Visualization
Modern Integrated Visualization Systems
Toolkits

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- What Is Perception?
- Physiology
- Perceptual Processing
- Perception in Visualization
- Metrics
- Cognition

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What Is Perception?

What is perception?

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- **Most define perception as the process of:**
  - **recognizing (being aware of);**
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- **Perception is the process by which we interpret the world around us, forming a mental representation of the environment.**

- **The brain makes assumptions about the world to overcome the inherent ambiguity in all sensory data, and in response to the task at hand.**

The brain makes assumptions !

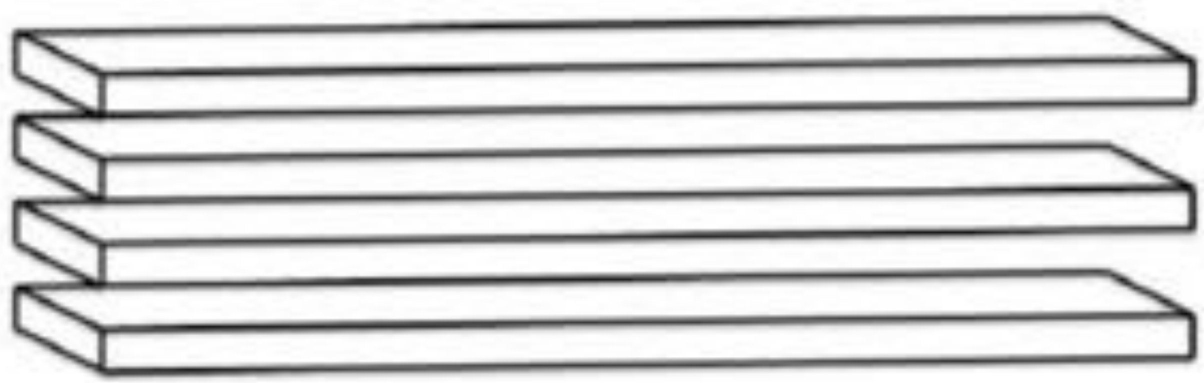
Figure 3.1 (Matthew Ward, et. all)

The brain makes assumptions !

Two seated figures, making sense at a higher, more abstract level, but still disturbing. On closer inspection, these seats are not realizable. (Image courtesy N. Yoshigahara.)

Figure 3.1 (Matthew Ward, et. all)

The brain makes assumptions !



Four ≠ three. As in Figure 3.1, this object would have a problem being built (there are four boards on the left and three on the right).

Figure 3.2 (Matthew Ward, et. all)

The brain makes assumptions !

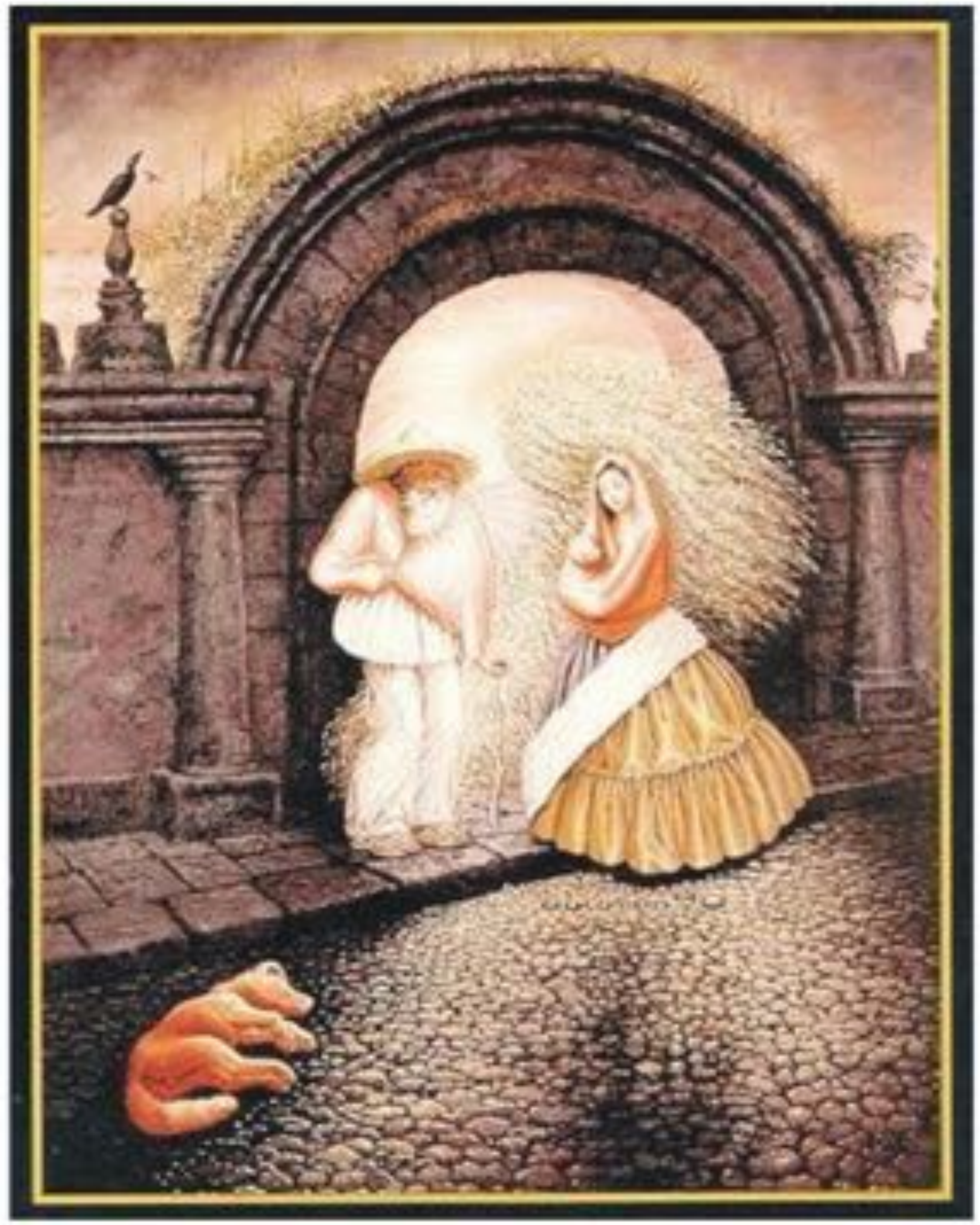


Figure 3.3 (Matthew Ward, et. all)

A more complex illusion: there are two people drawn as part of the face.

The brain makes assumptions !

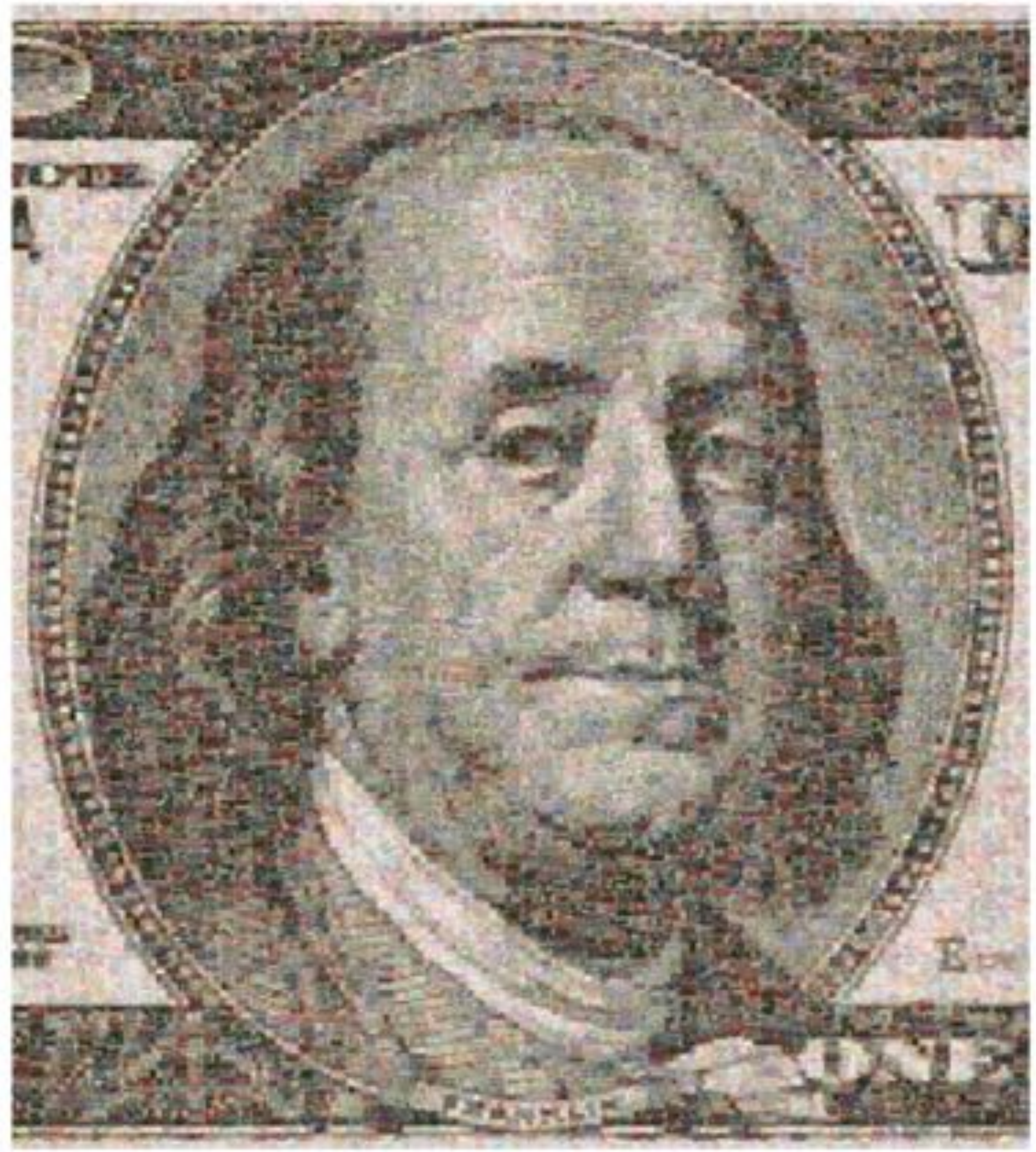


Figure 3.4
(Matthew Ward, et. all)

Photomosaic of Benjamin Franklin using images of international paper money or bank notes. (Photomosaic® by Robert Silvers, http://www.photomosaic.com.)

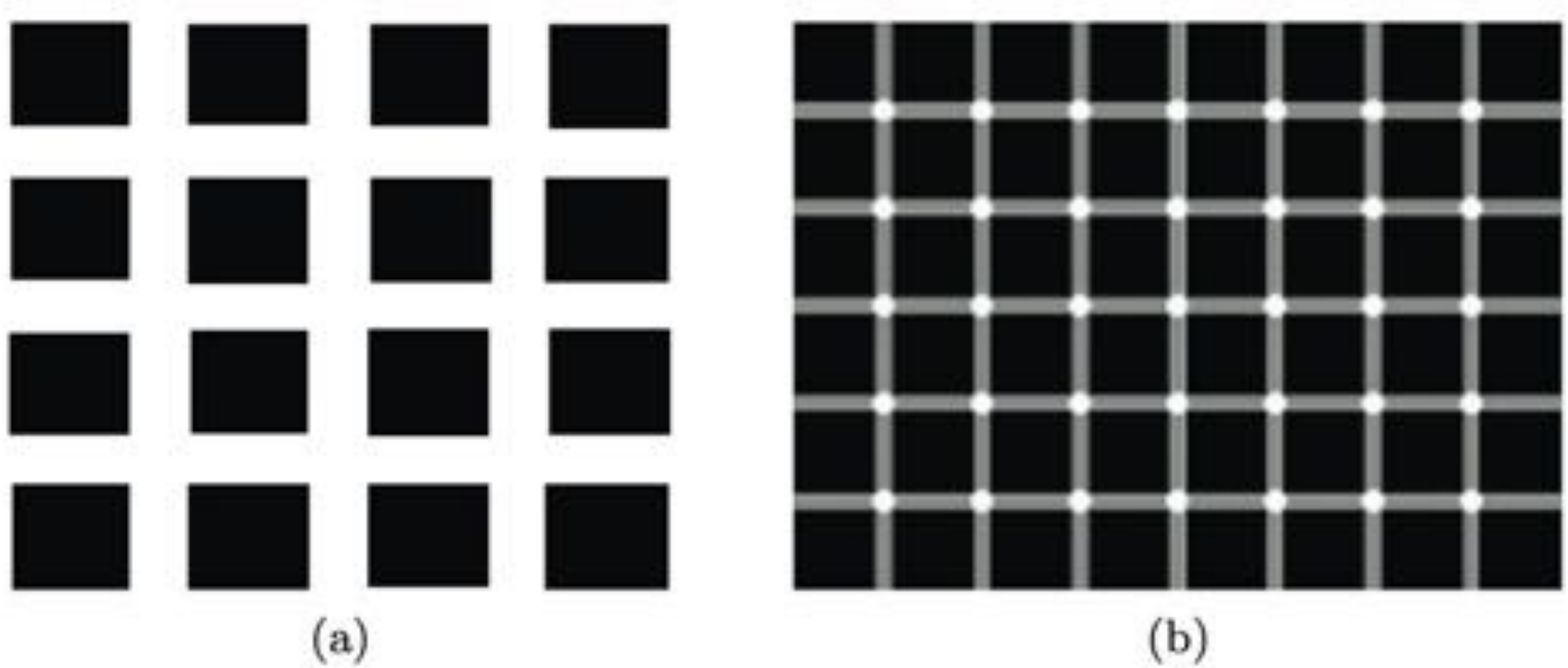
The brain makes assumptions !

Figure 3.5
(Matthew Ward, et. all)

Close-up view of the eye in Figure 3.4. (Photomosaic® by Robert Silvers, http://www.photomosaic.com.)

The brain makes assumptions !

- **Our vision system is, foremost, not static, and secondly, often not under our full control.**



The Hermann grid illusion: (a) illusionary black squares appear over the complete image as you gaze at it; (b) similar to (a) but even more dynamic and engaging.

Figure 3.6 (Matthew Ward, et. all)

The brain makes assumptions !

- **When we visualize data, we need to make sure that no such interferences are present that would impede the understanding of what we are trying to convey in the visualizations.**

The study of perception

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The study of perception

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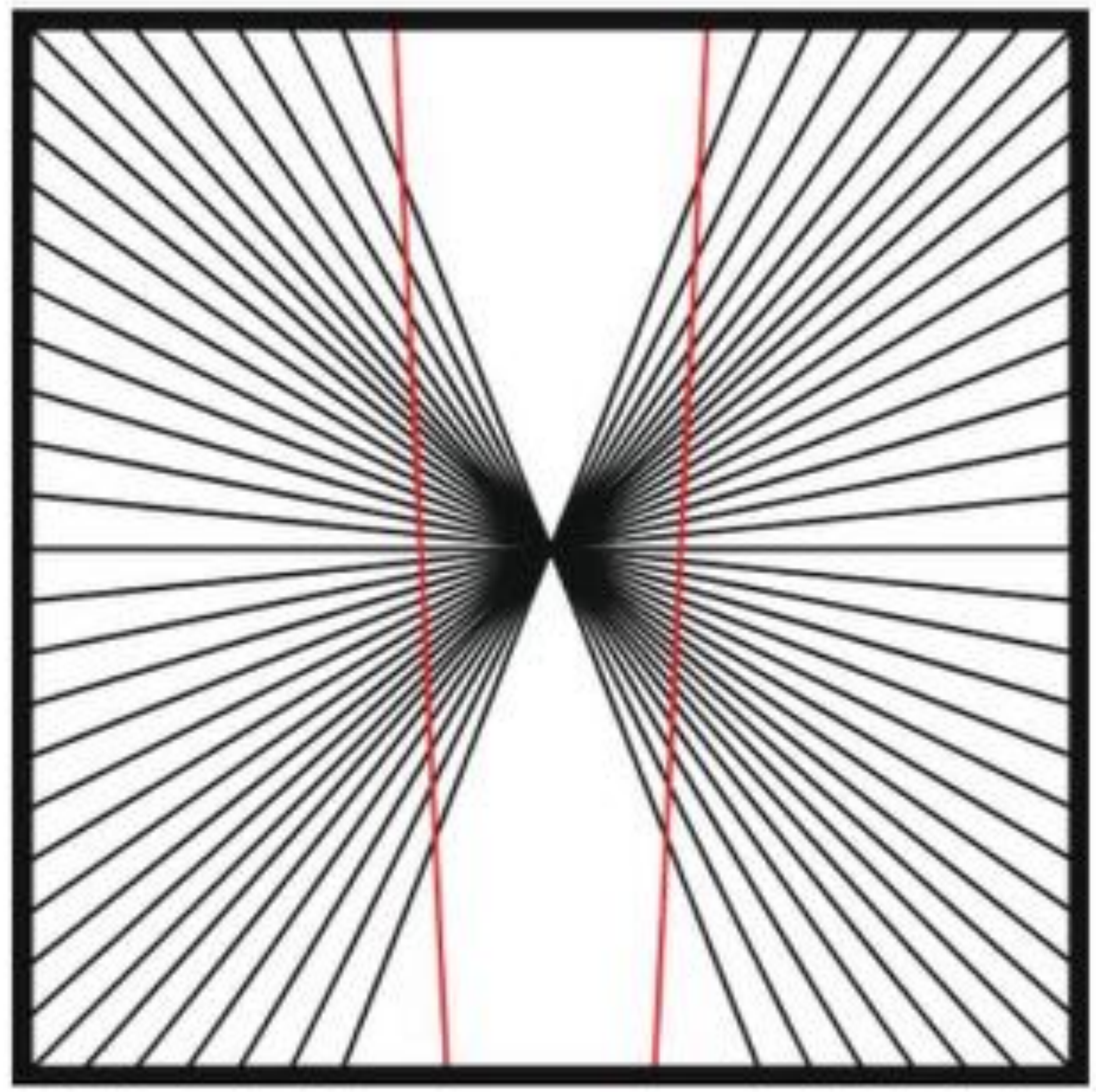

Figure 3.7
(Matthew Ward, et. all)

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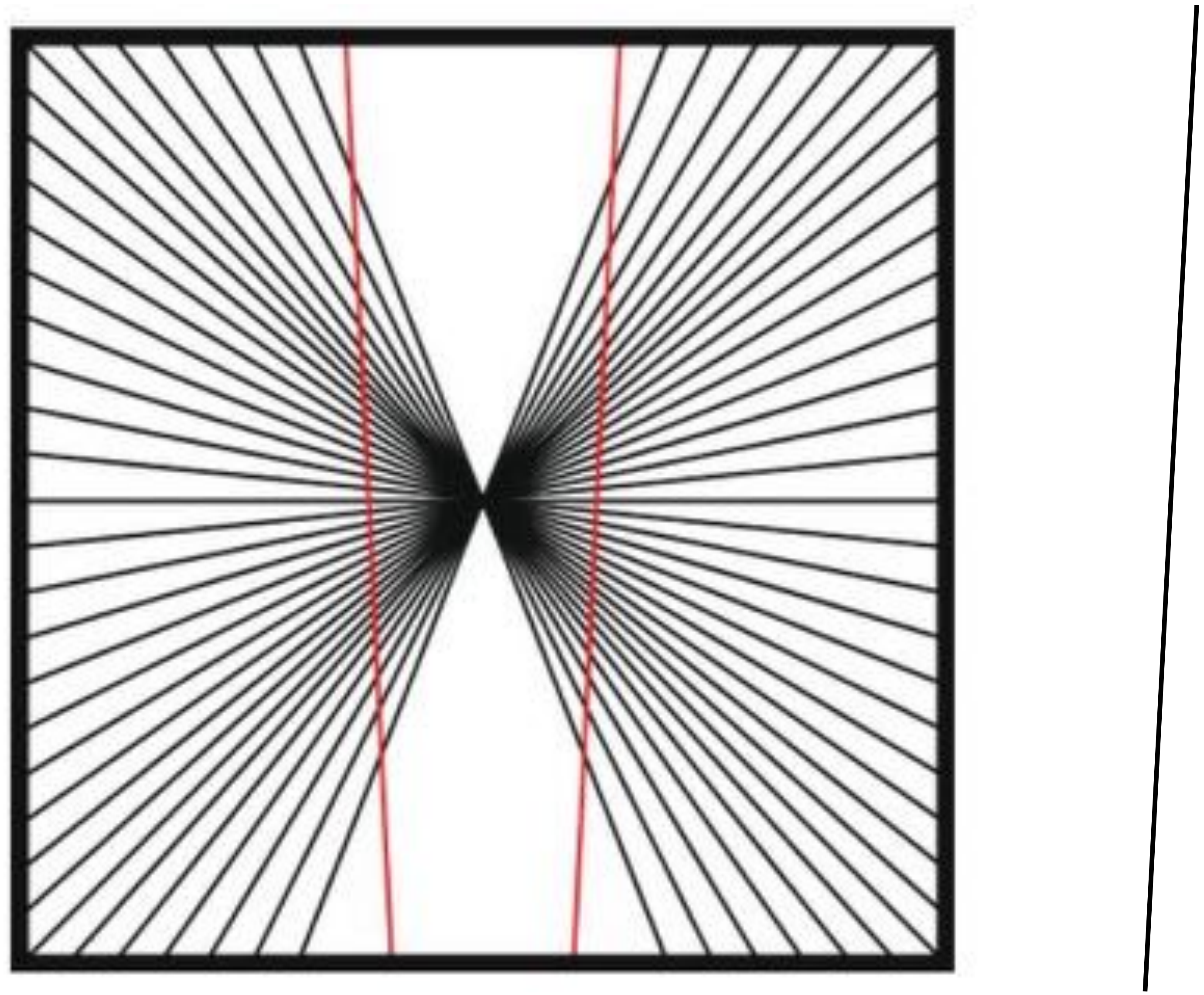

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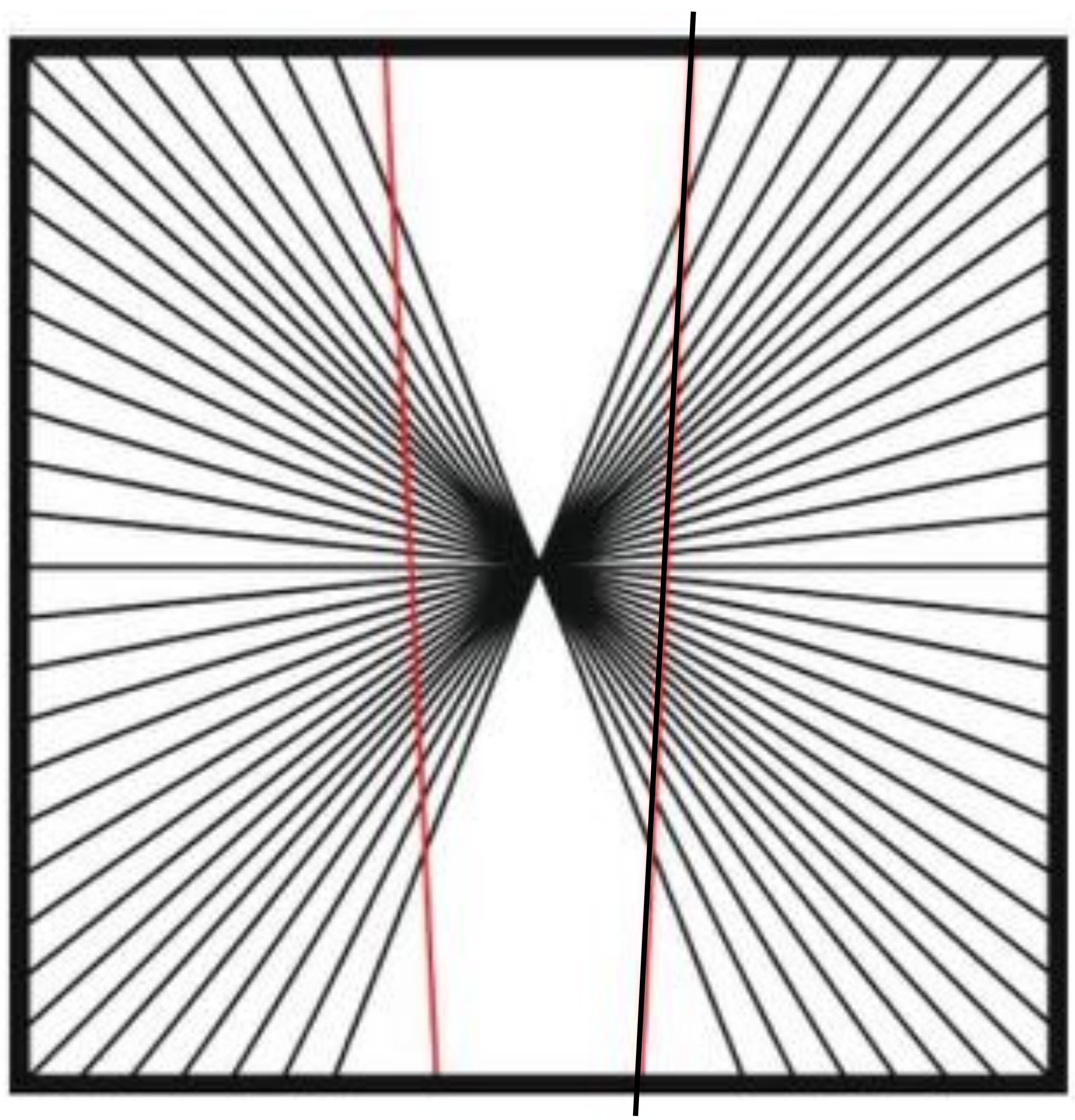
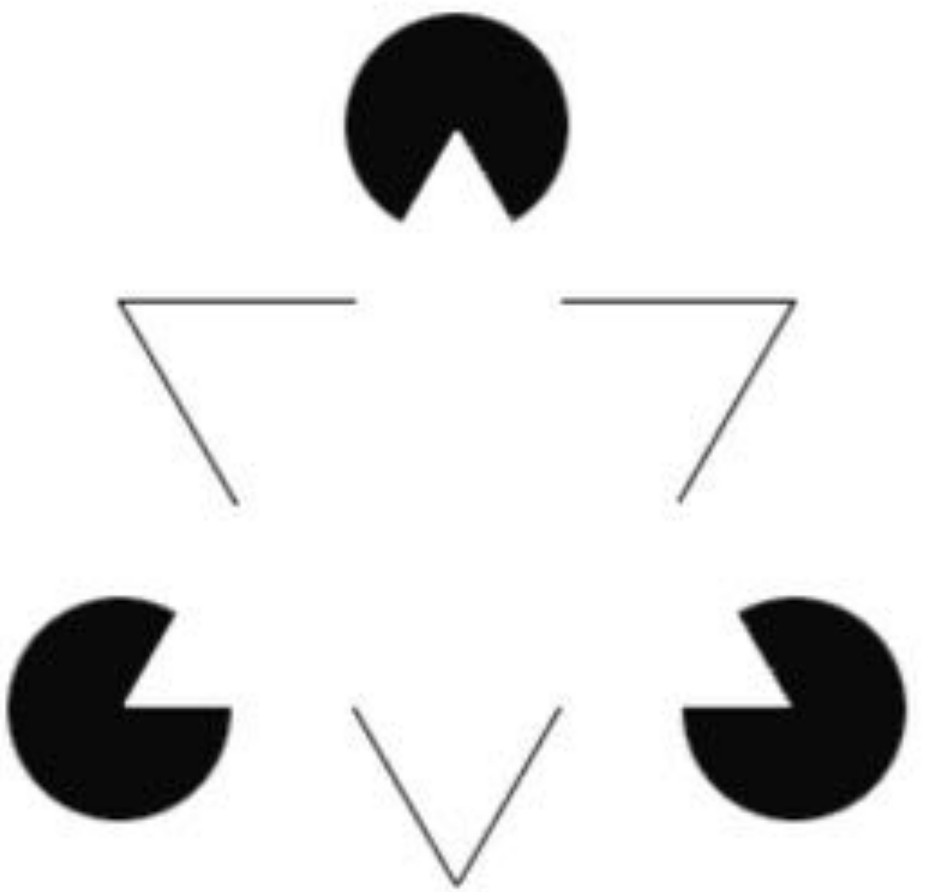


Figure 3.7
(Matthew Ward, et. all)

The study of perception

- **The study of perception is to identify the whole process of perception, from sensation to knowledge. What is causing the triangle to stand out?**



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The study of perception

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  - **Measurements can help in the development of a model, and in turn, a model should help predict future outcomes, which can then be measured to validate the model.**

The study of perception

- Two main approaches to the study of perception: One deals with measures, and the other with models. Both are linked.
  - Measurements can help in the development of a model, and in turn, a model should help predict future outcomes, which can then be measured to validate the model.
  - We can measure low-level sensory perception (which line is longer) or higher level perception (can you recognize the bird in this scene?).

Summary

Q&A

What you should know

- **What is perception.**
  - Process the sensorial information of the world around us, forming a mental representation of the environment

What you should know

- **What is perception.**
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  - Why it seems reasonable and necessary. Examples.

What you should know

- **What is perception.**
  - Process the sensorial information of the world around us, forming a mental representation of the environment
- **The notion that the brain makes a lot of assumption in the process.**
  - Why it seems reasonable and necessary. Examples.
- **The role of measurements and theories in the study of perception.**

Q&A

Physiology

Physiology

- **Visible Spectrum**
- **Anatomy of the Visual System**
- **Visual Processing**
- **Eye Movement**

Visible Spectrum

- **The range is very much dependent on the individual.**

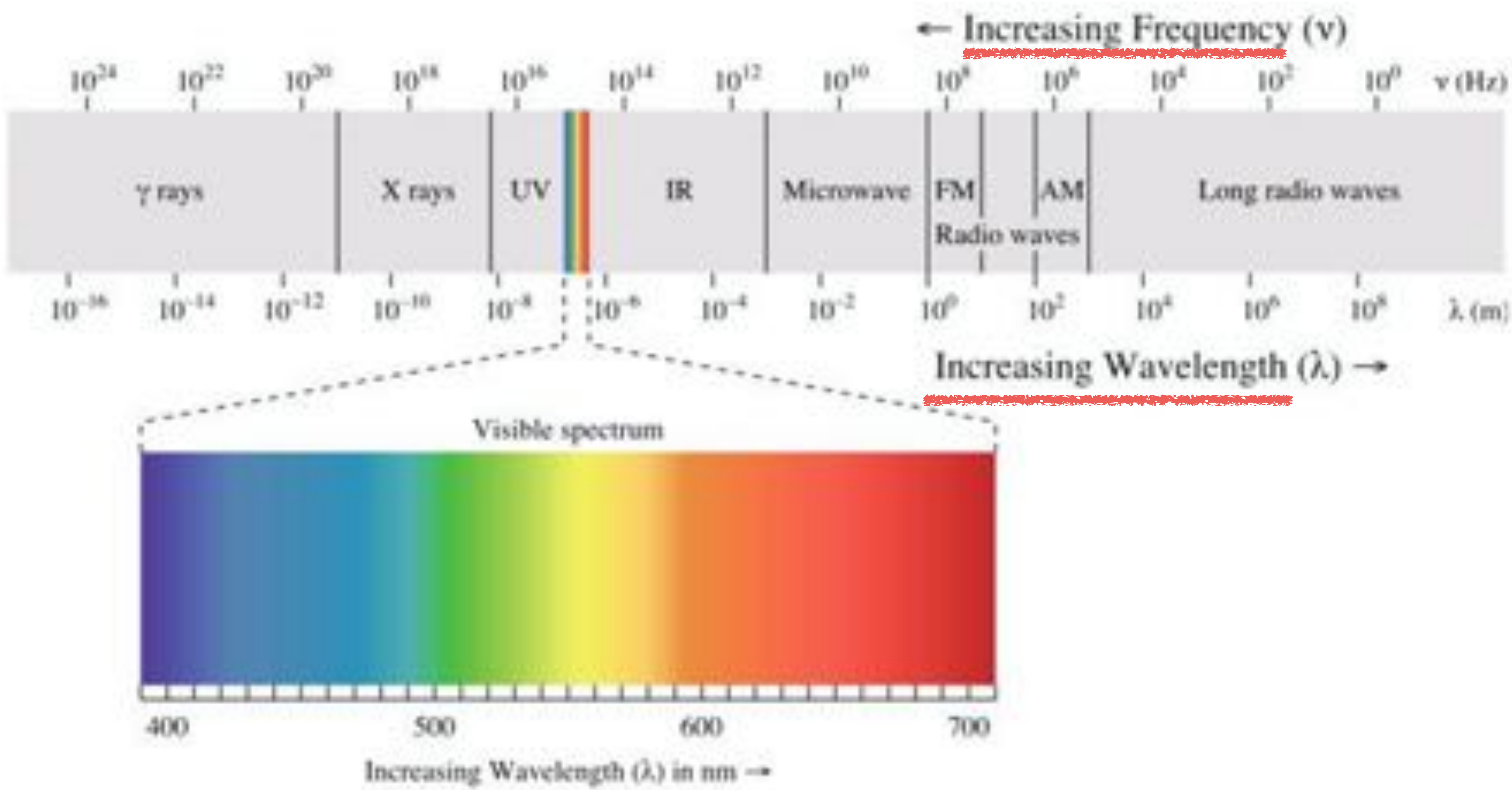

Figure 3.8 - (Matthew Ward, et. all)

Visible Spectrum

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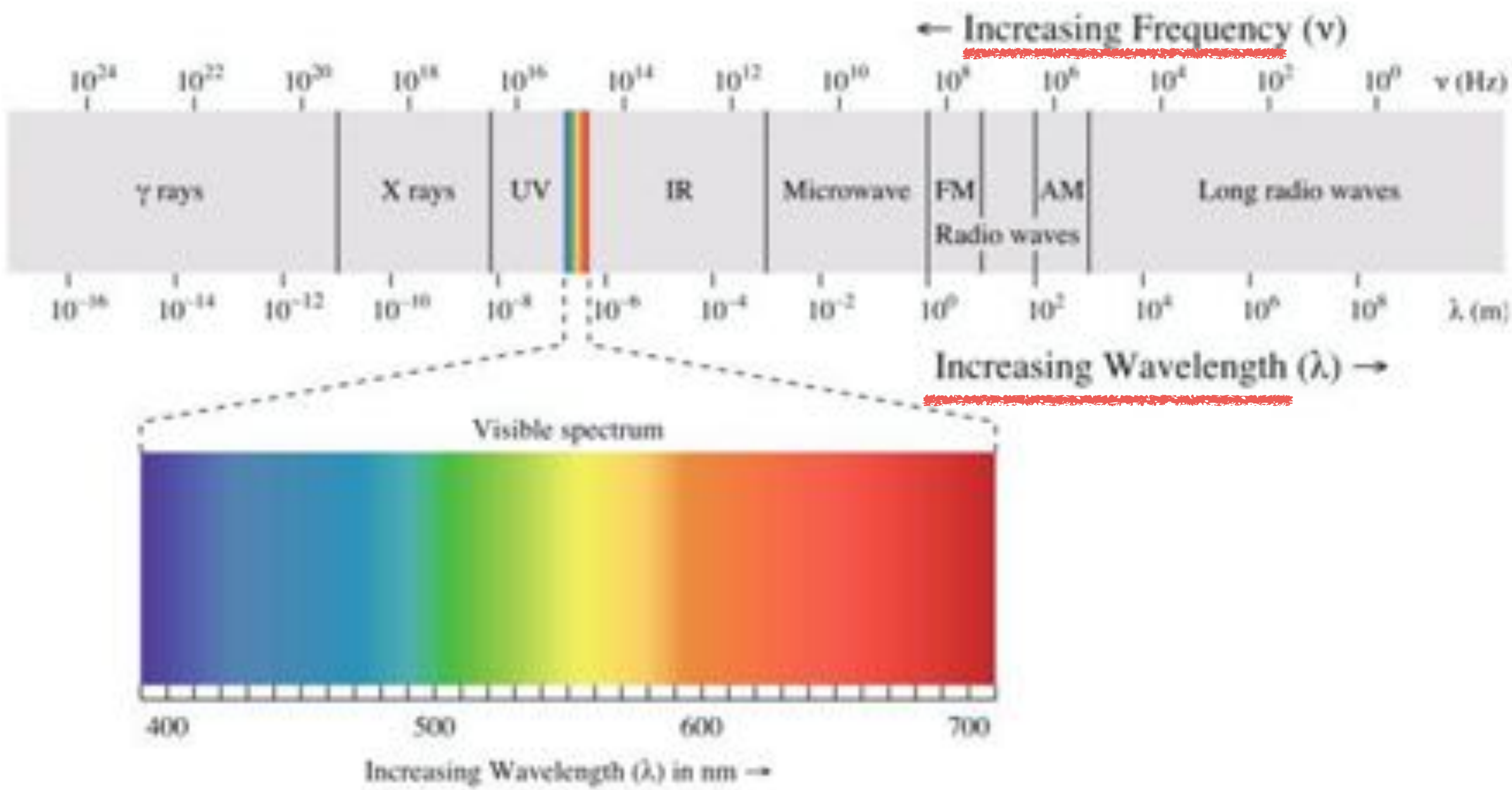
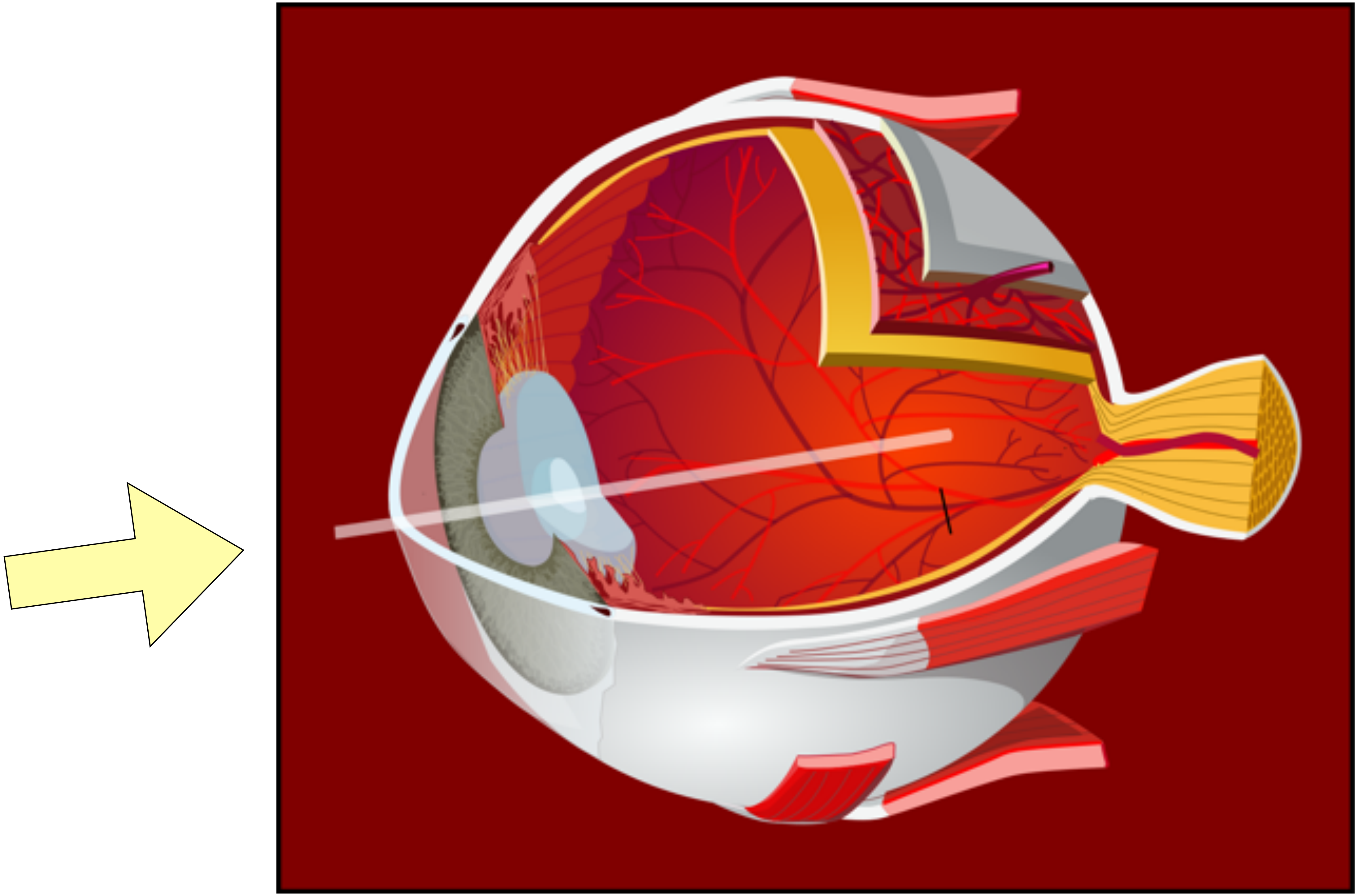


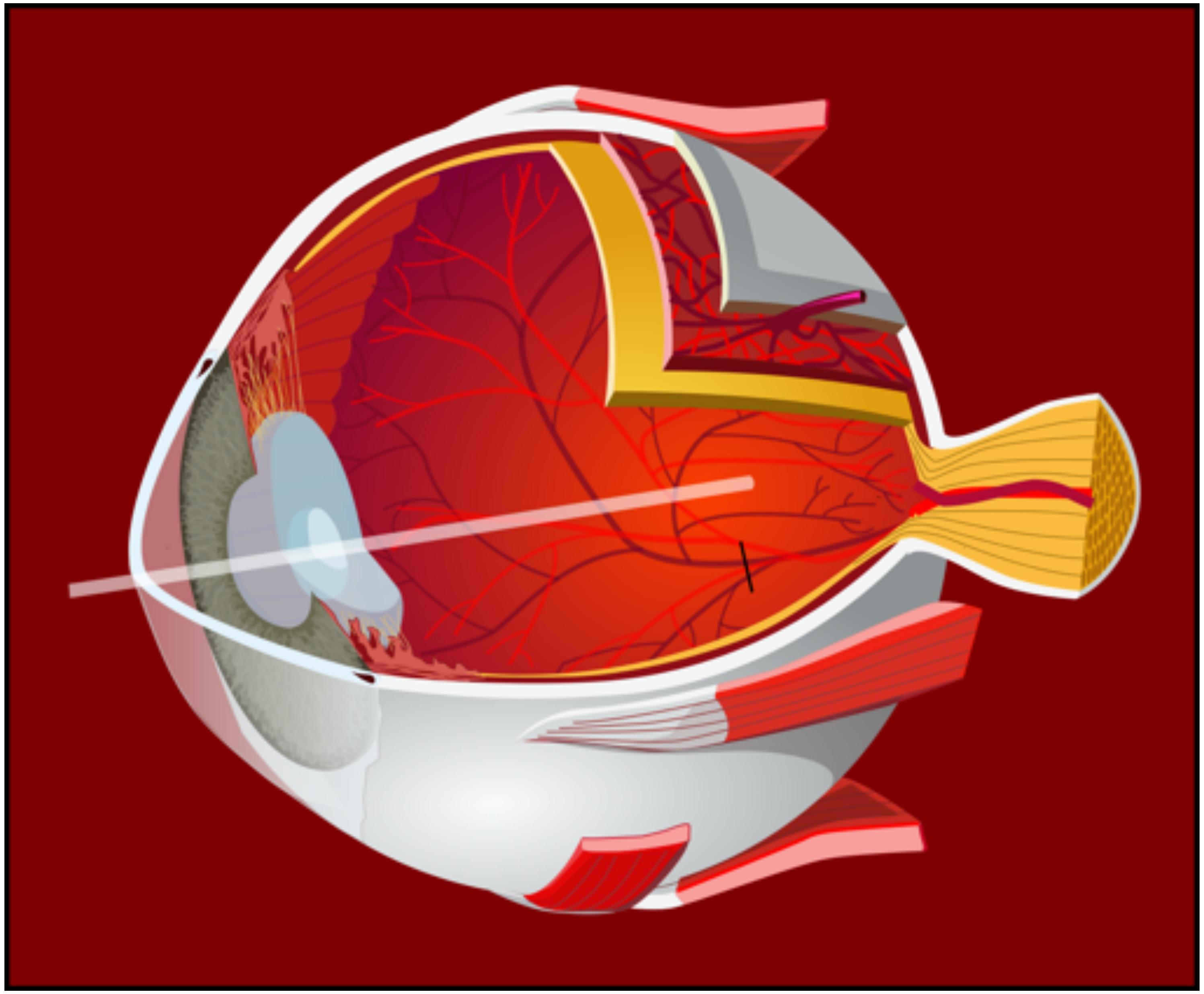
- **Color blindness and total blindness in humans are the result of an individual not responding to certain wavelengths.**

Figure 3.8 - (Matthew Ward, et. all)

Anatomy of the Visual System



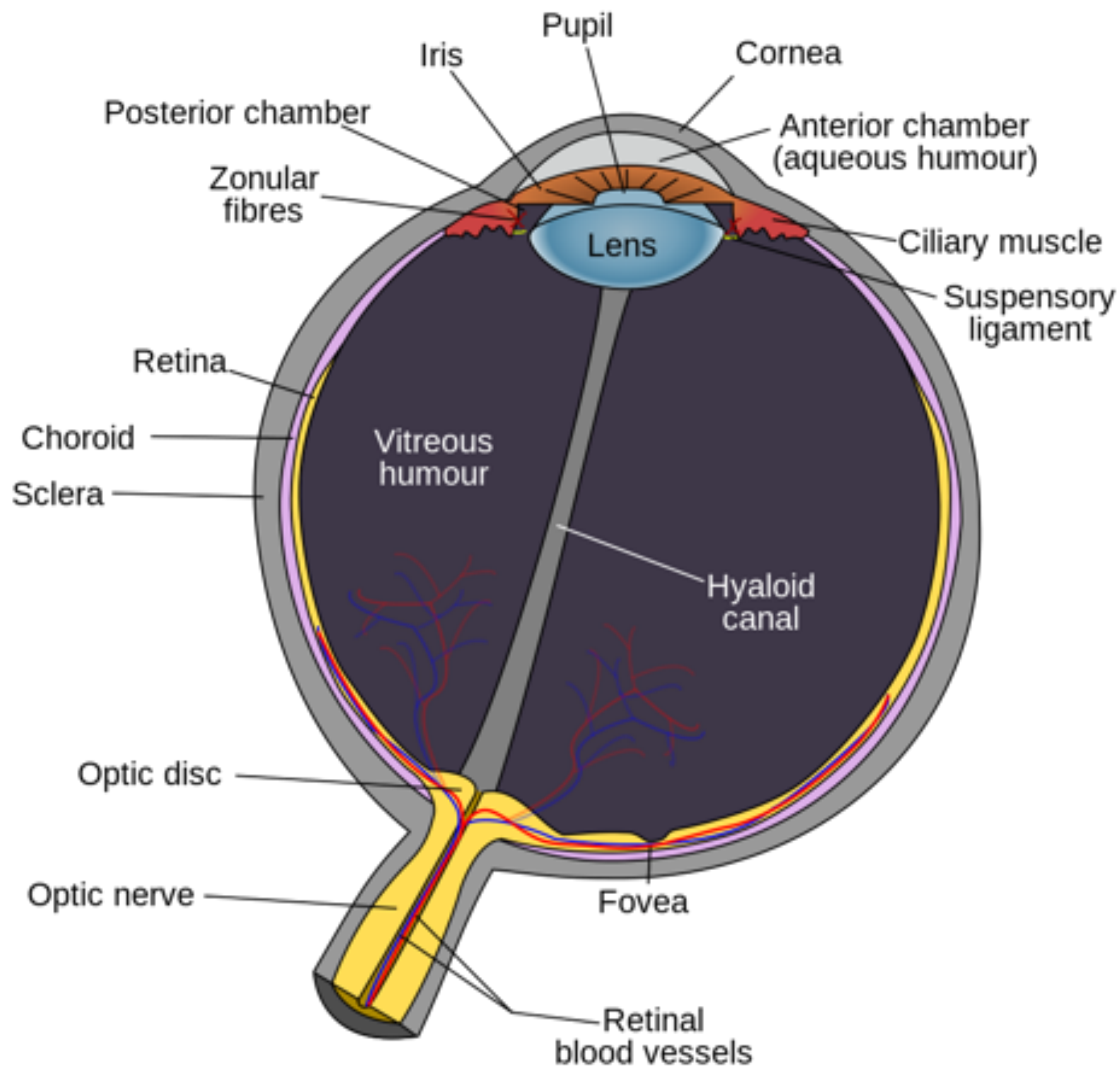
Anatomy of the Visual System



Connected to the head and brain by **six motion control muscles** and **one optic nerve**.

Six muscles are generally considered as motion controllers, providing the **ability to look at objects** in the scene. Tend to maintain the **eye-level with the horizon** when the head is not perfectly vertical and in **stabilization of images**.

Anatomy of the Visual System



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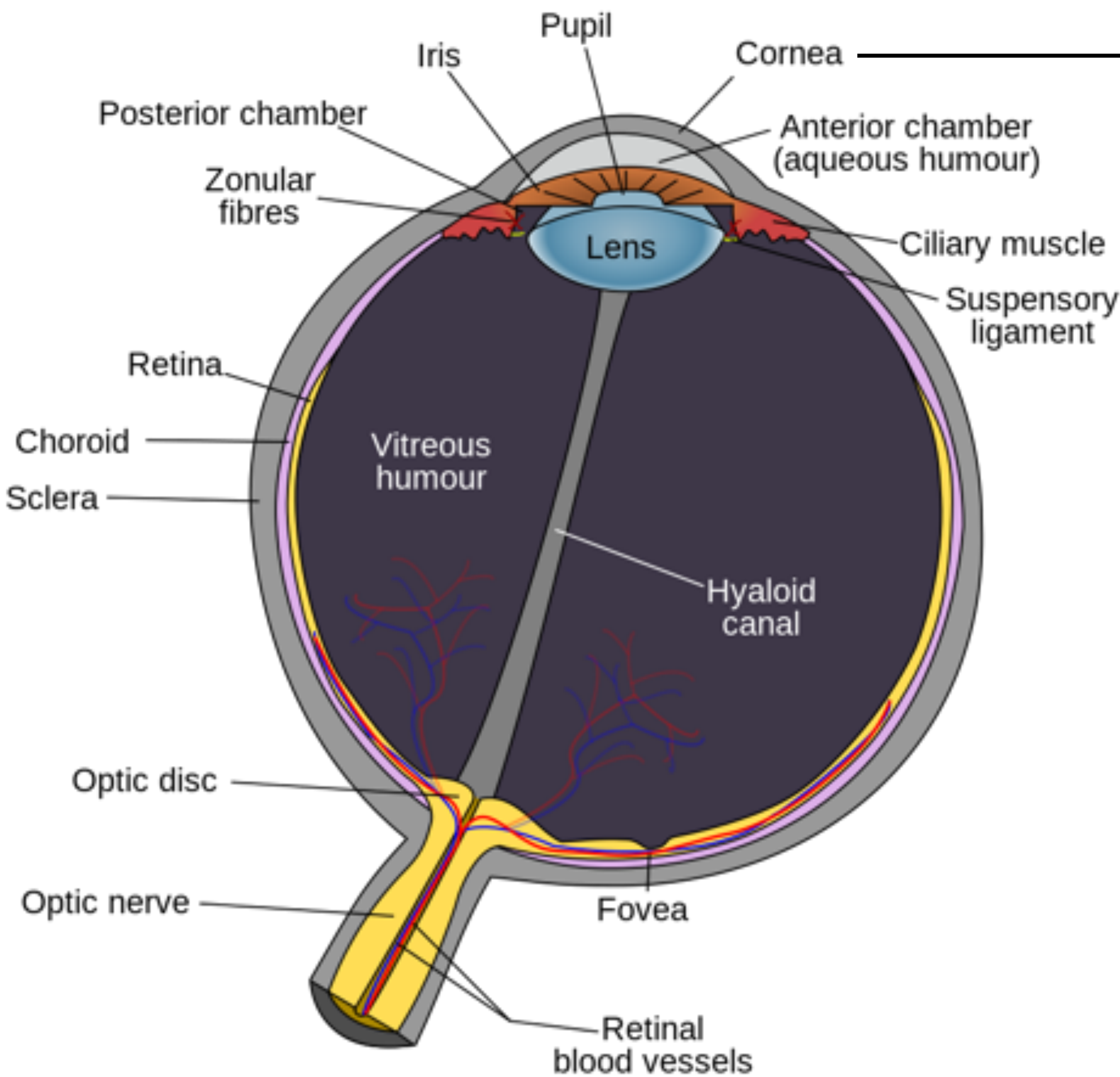
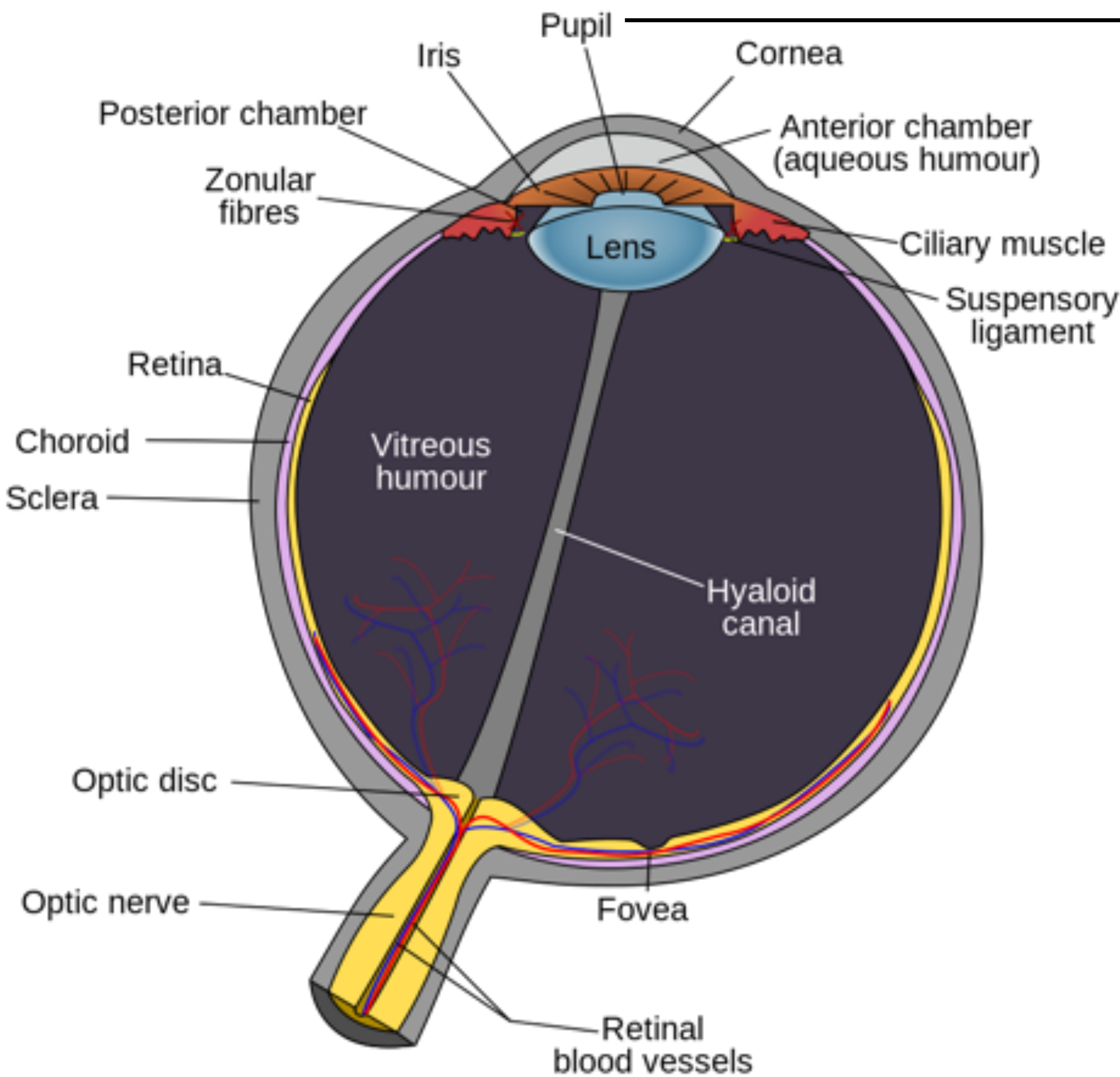


the **exterior cover** of the front of the eye:

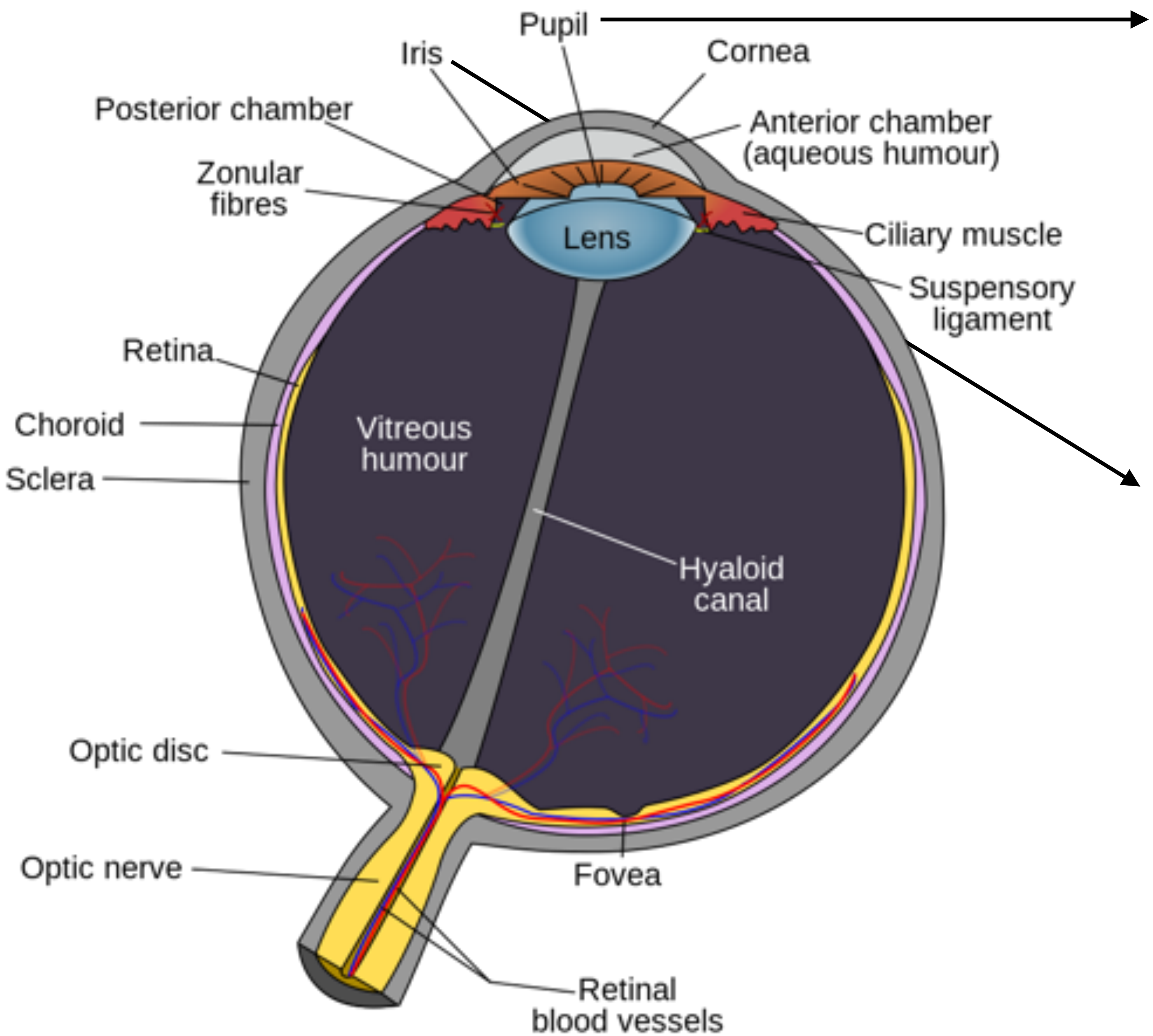
- acting as a **protective mechanism** against physical damage to the internal structure
- it also serves as **one lens focusing the light from the surrounding scene** onto the main lens

Anatomy of the Visual System



a **circular hole in the iris**, similar in function to an aperture stop on a photographic camera

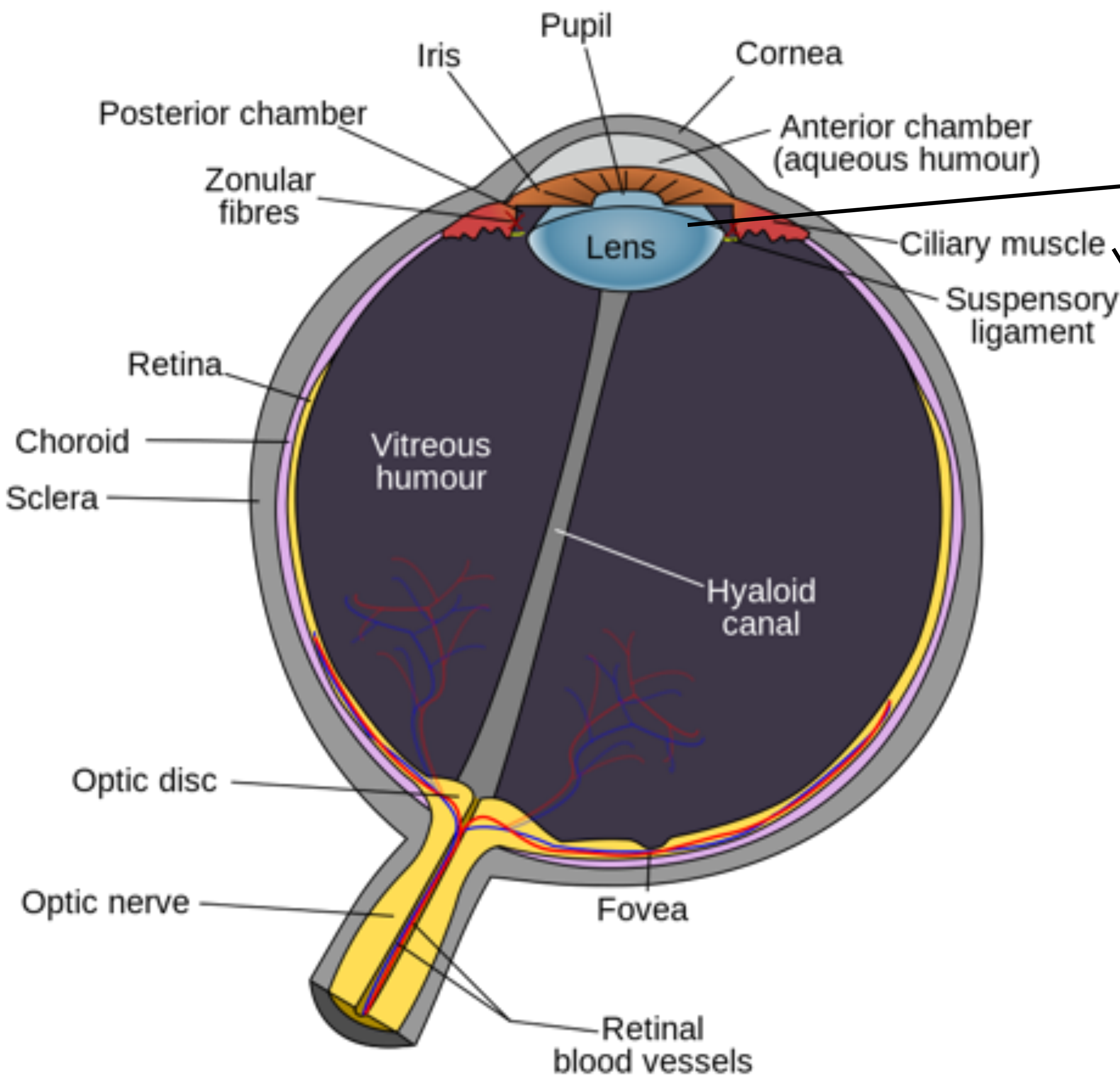
Anatomy of the Visual System



a **circular hole in the iris**, similar in function to an aperture stop on a photographic camera

The **iris** is a colored annulus containing **radial muscles for changing the size of the pupil opening**

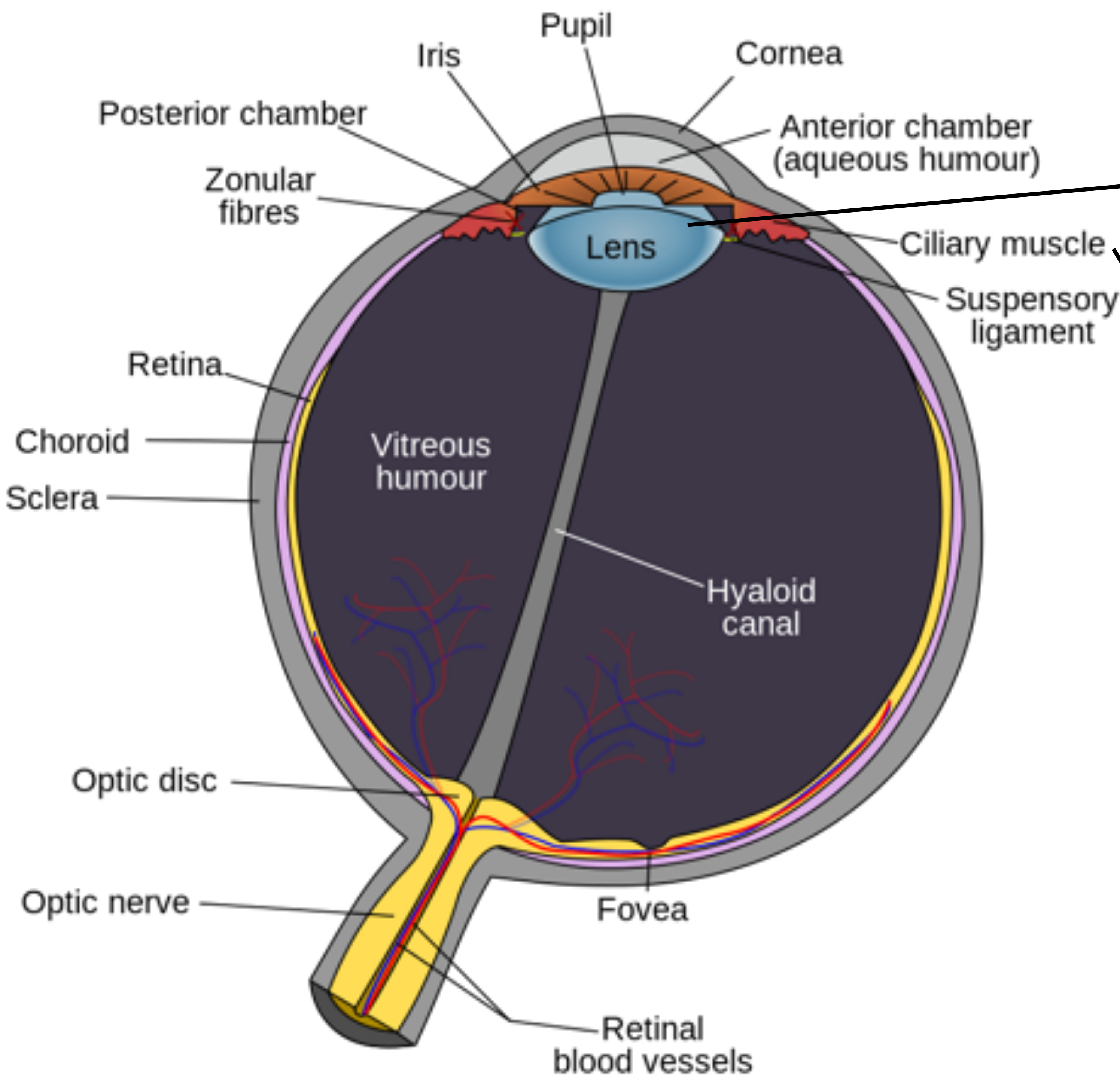
Anatomy of the Visual System



The third major component is the **lens**, whose **crystalline** structure is similar to onion skin.

Surrounded by the **ciliary body, a set of muscles**, the lens can be stretched and compressed, changing the thickness and curvature of the lens and consequently **adjusting the focal length of the optical system**.

Anatomy of the Visual System

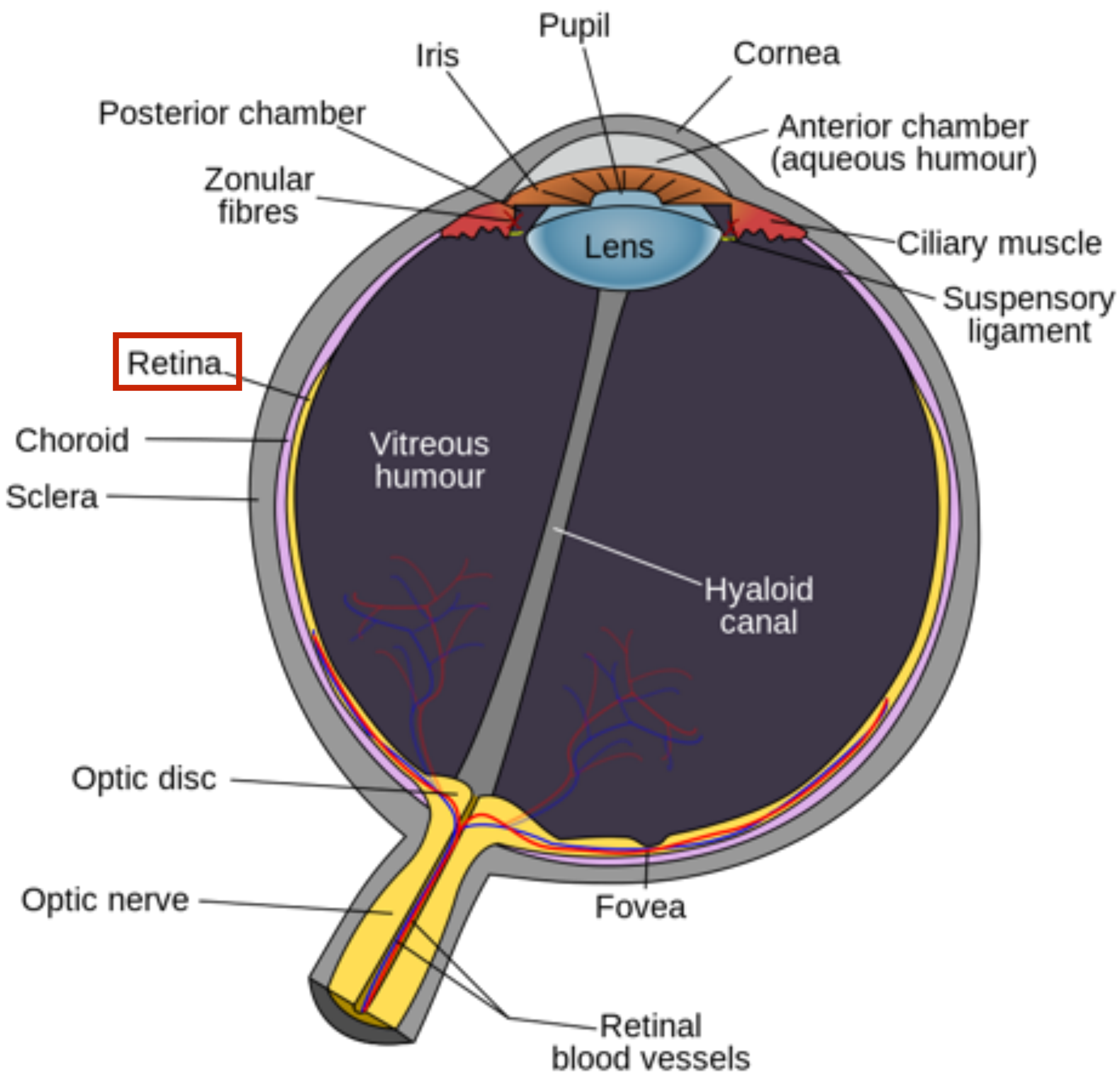


The third major component is the **lens**, whose **crystalline** structure is similar to onion skin.

Surrounded by the **ciliary body, a set of muscles**, the lens can be stretched and compressed, changing the thickness and curvature of the lens and consequently **adjusting the focal length of the optical system**.

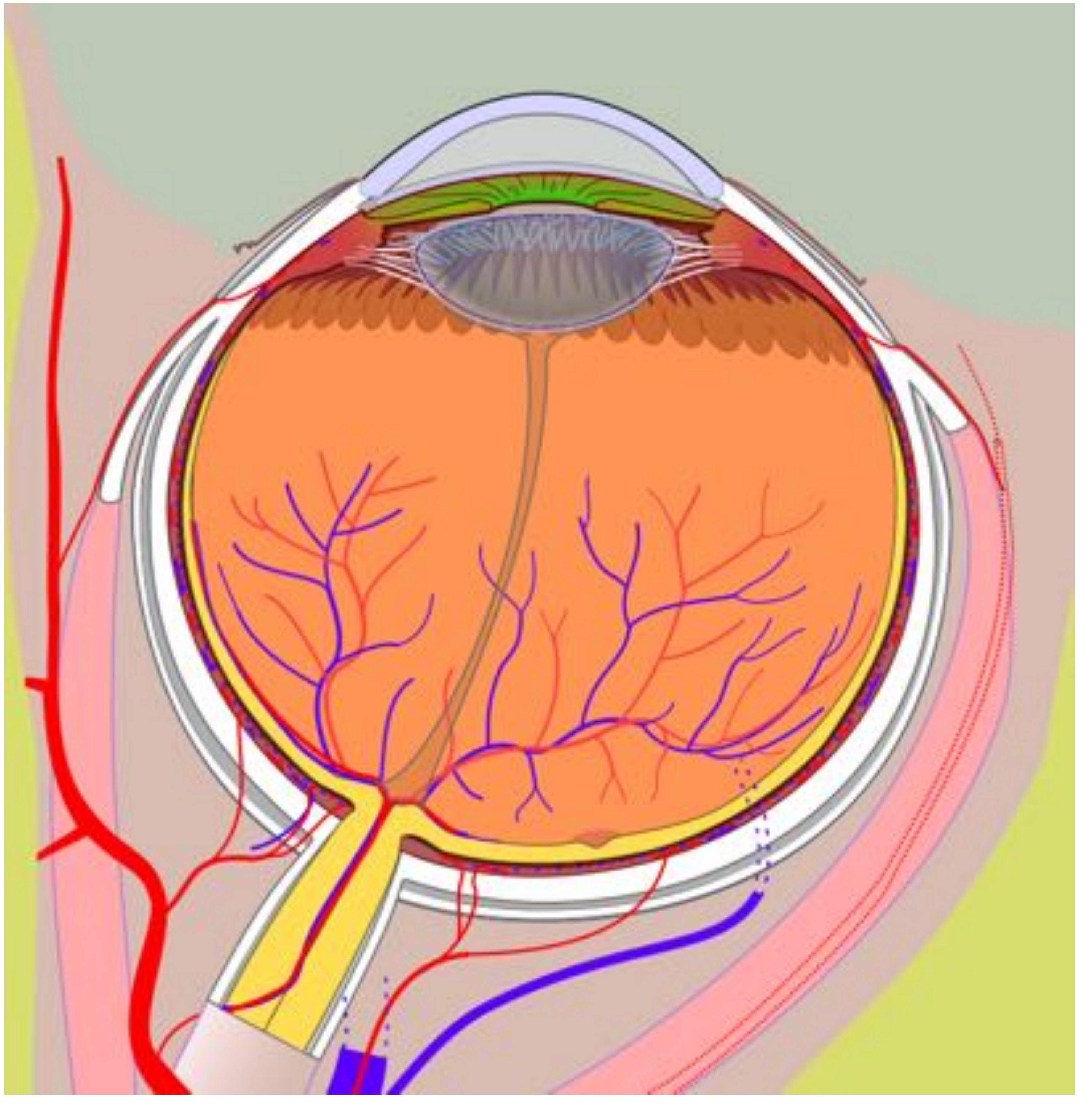
The **elasticity of the lens** determines the range of shape changes possible, which **is lost as one ages**, leaving the lens in a slightly stretched state

Anatomy of the Visual System



Once the light has passed through this lens system, the final light rays are projected onto the **photoreceptive layer**, called the **retina**.

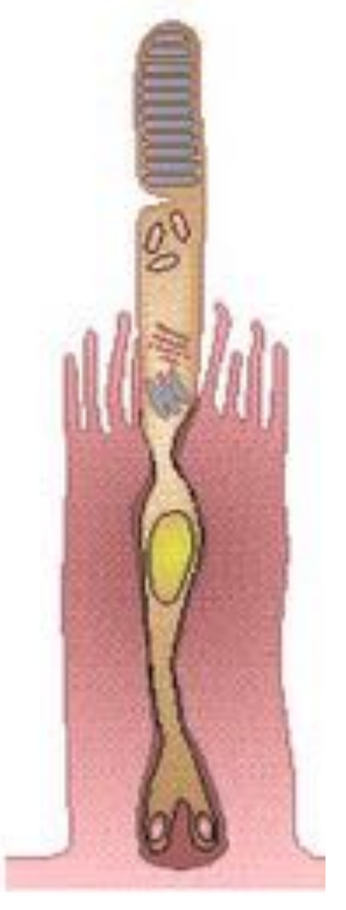
Anatomy of the Visual System: Retina



Anatomy of the Visual System: Retina

- **Two types of photosensitive cells: rods and cones**
  - **Rods are primarily responsible for intensity perception. They are associated with scotopic vision, night vision, operating in clusters for increased sensitivity in very low light conditions.**

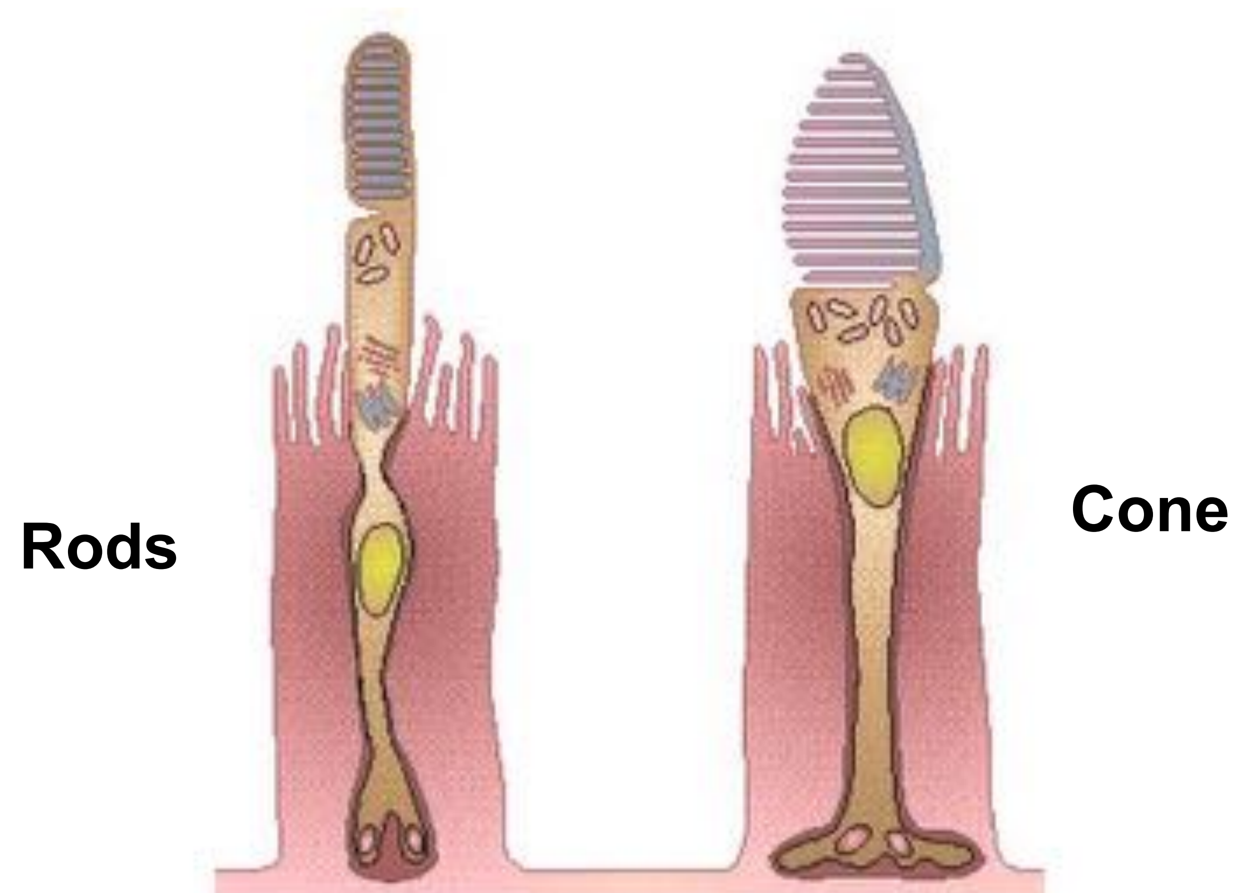
Rods



Human rod (left) and cone (right).

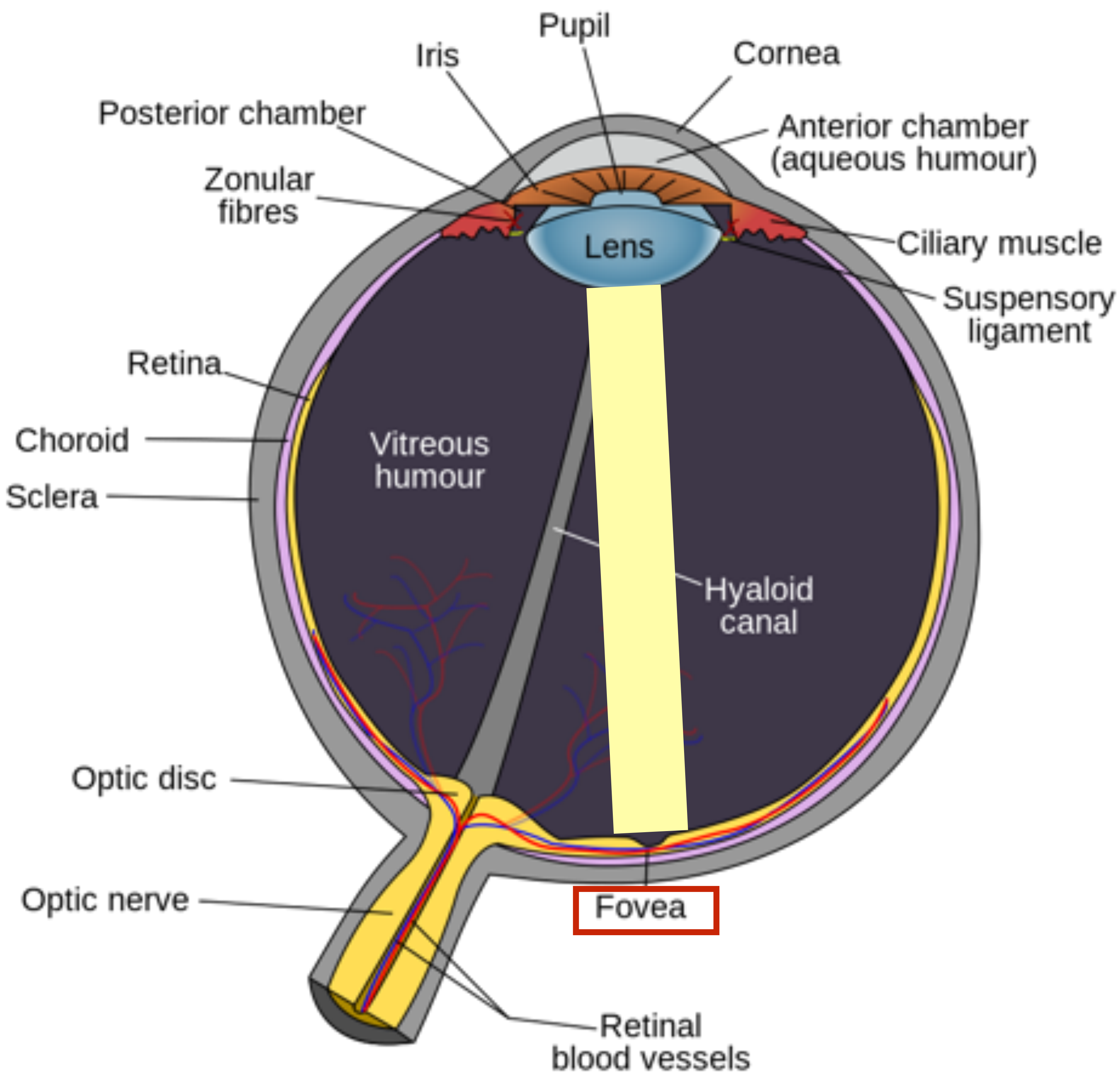
Anatomy of the Visual System: Retina

- Two types of photosensitive cells: rods and cones
  - Rods are primarily responsible for intensity perception. They are associated with scotopic vision, night vision, operating in clusters for increased sensitivity in very low light conditions.
  - Cones for color perception
- Rods are typically ten times more sensitive to light than cones



Human rod (left) and cone (right). (Image © Colour4Free.)

Anatomy of the Visual System: Retina



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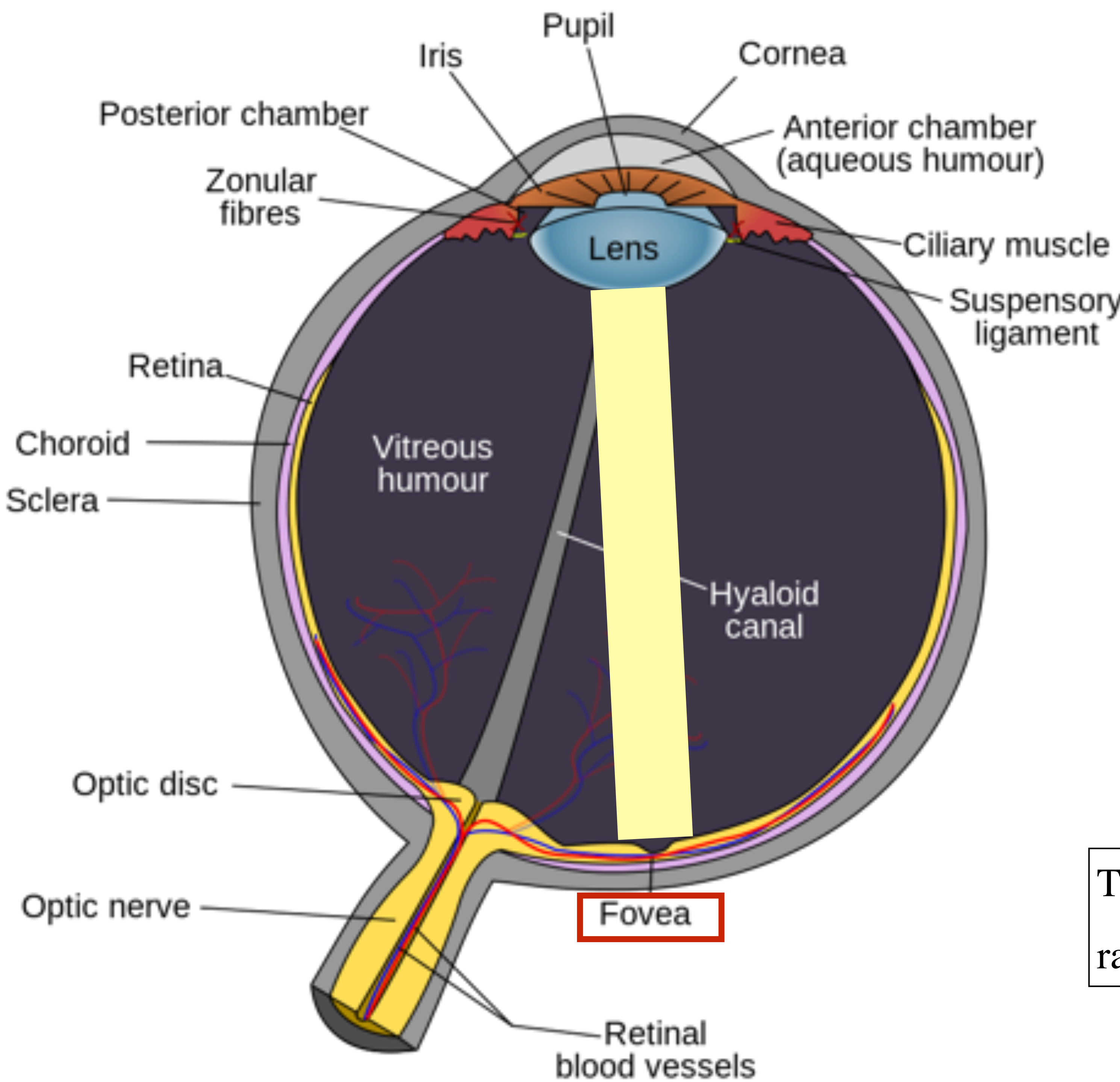
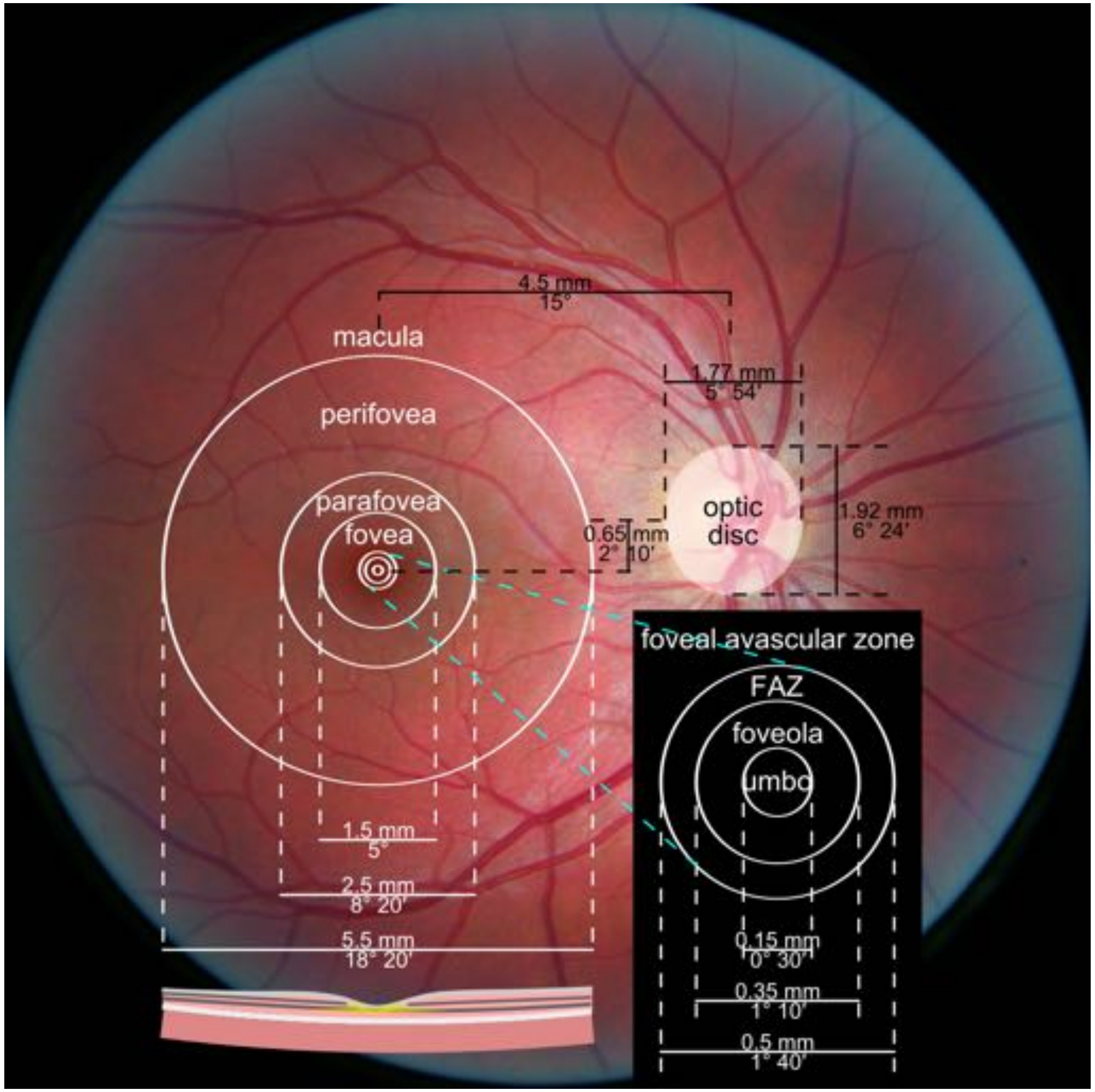


The structure of the retina is roughly radially symmetric around the **fovea**.

Anatomy of the Visual System: Retina



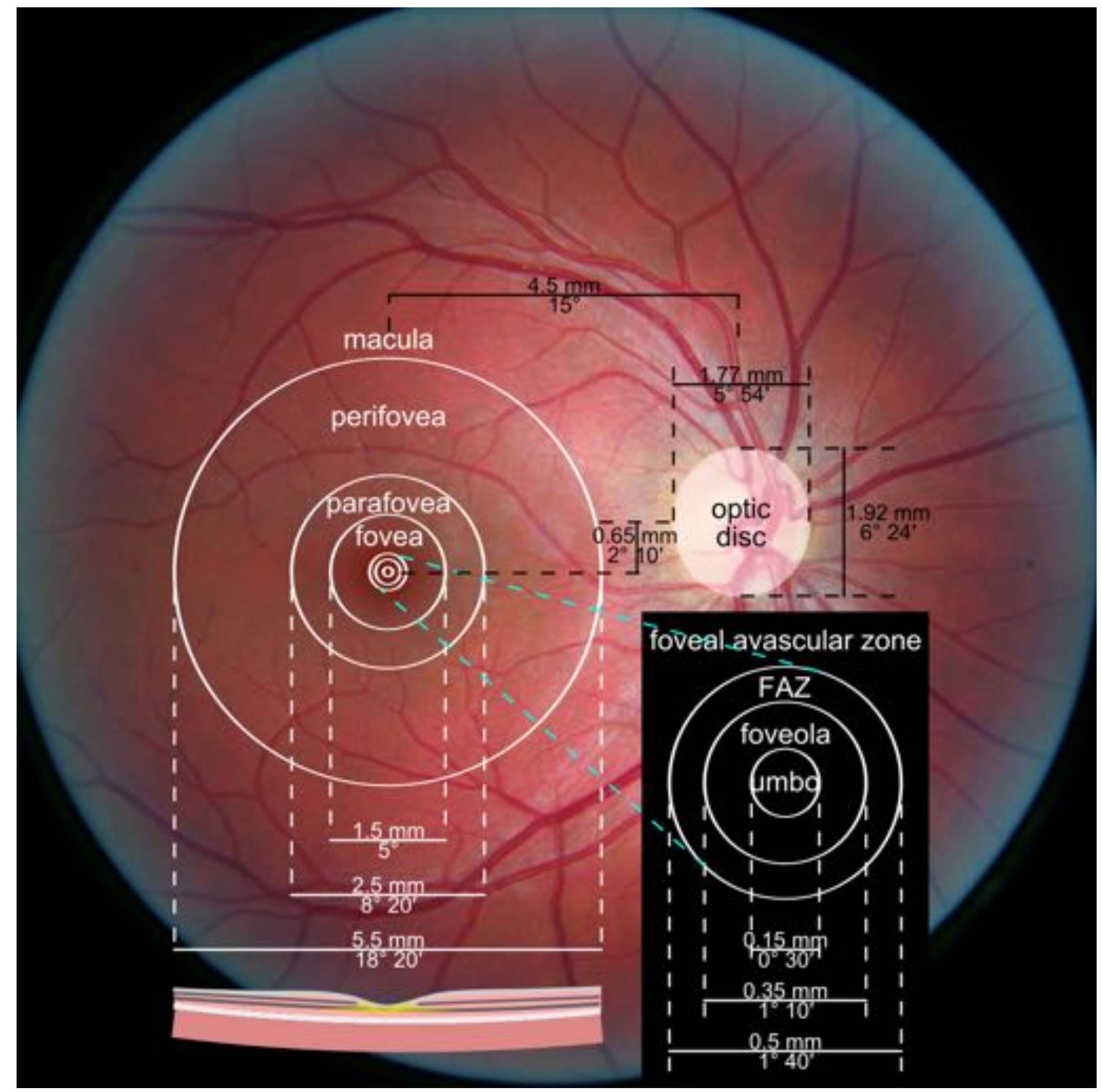
The structure of the retina is roughly radially symmetric around the **fovea**.

The fovea **contains only cones**, and linearly, there are about **147,000 cones per millimeter**.

The fovea is the **region of sharpest vision**.

Anatomy of the Visual System: Retina

- **There is an overall distribution of all cells across the retina, with the highest concentration occurring at the center of our visual field in the fovea and reducing in coverage toward the edges.**



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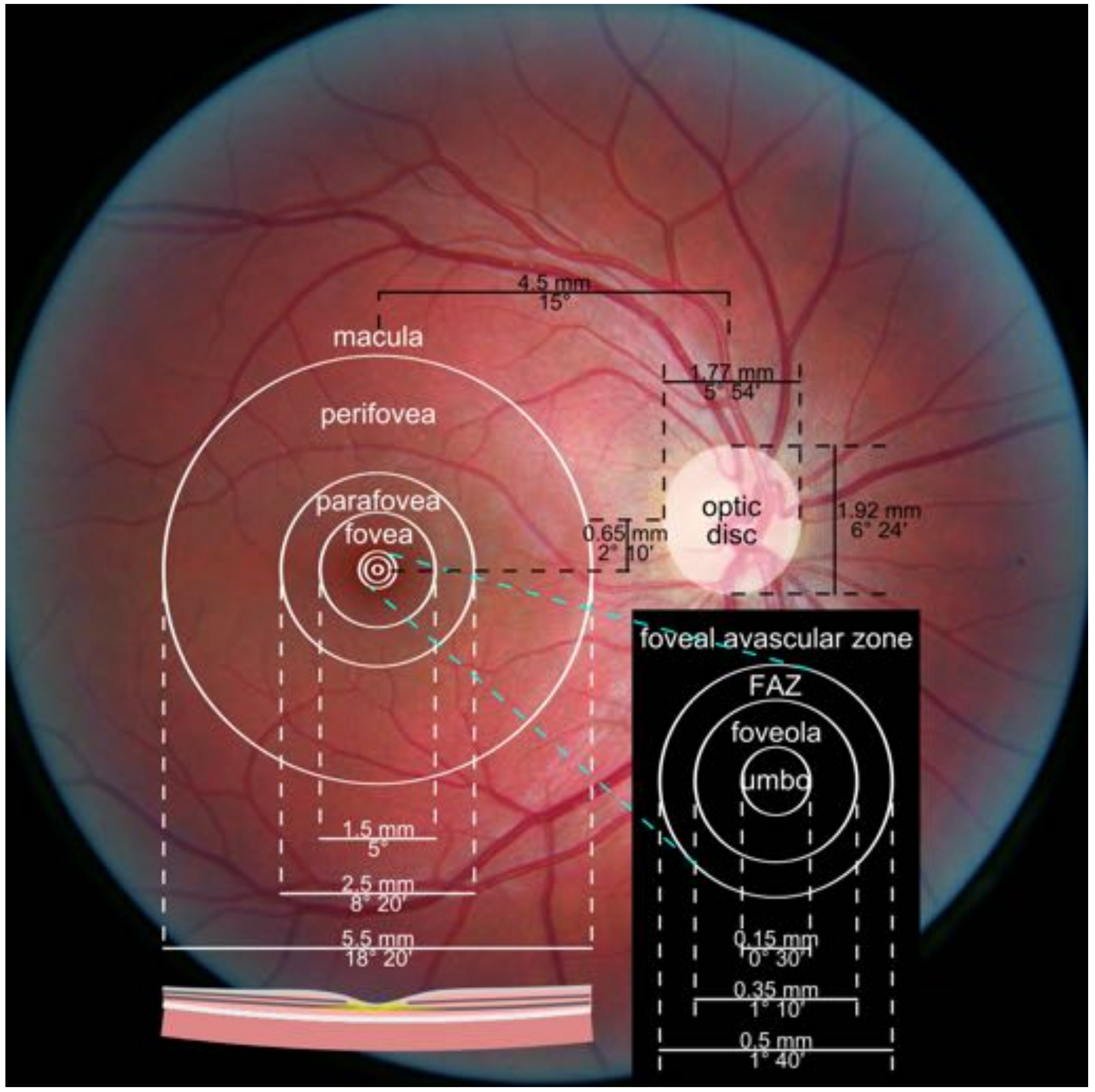

- **The fovea consists of only cone receptors, and no rods, for highly detailed and exact vision.**

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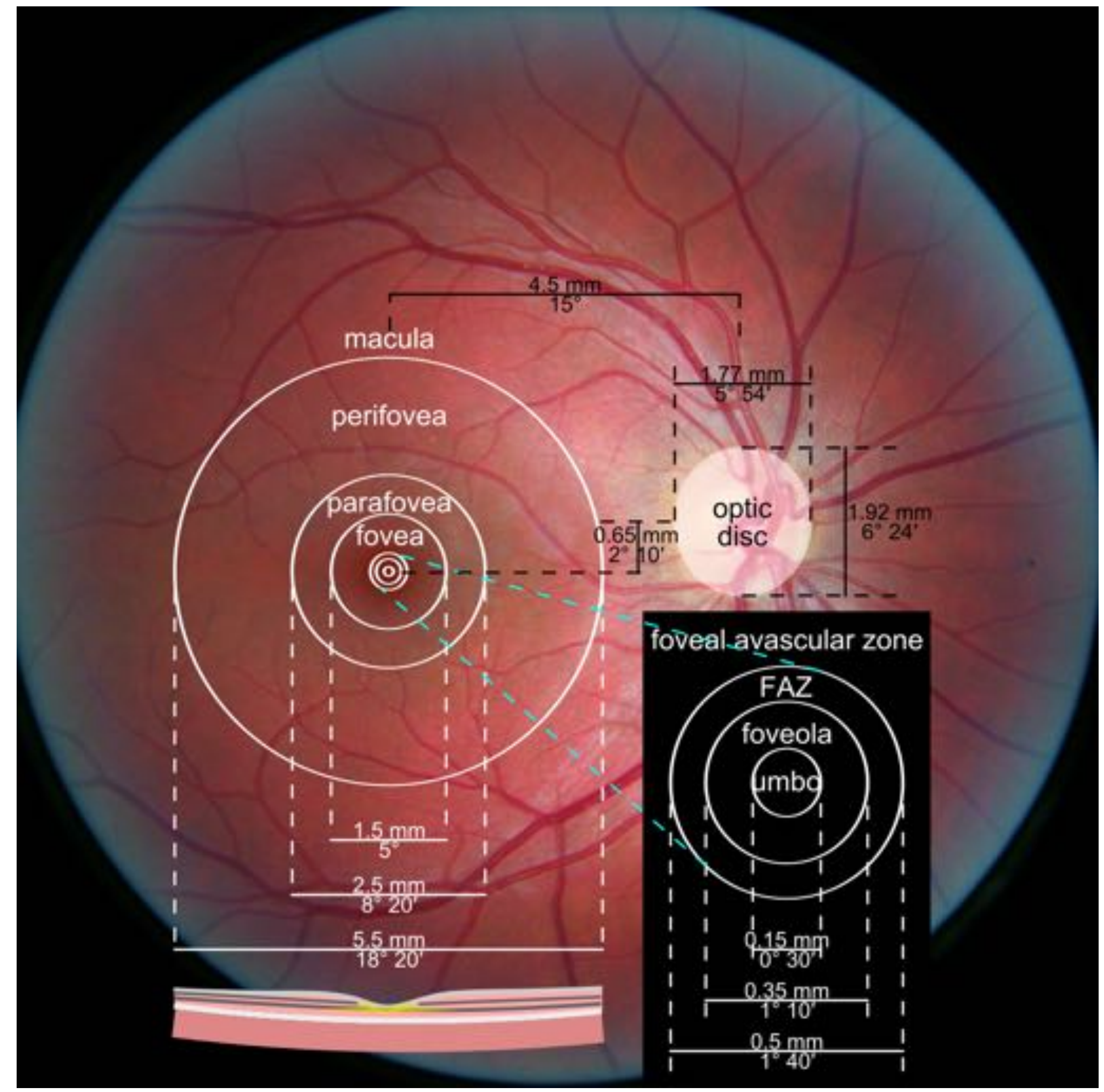
- **The parafovea with an outer ring of 2.5-mm diameter, with significantly more rods than cones.**



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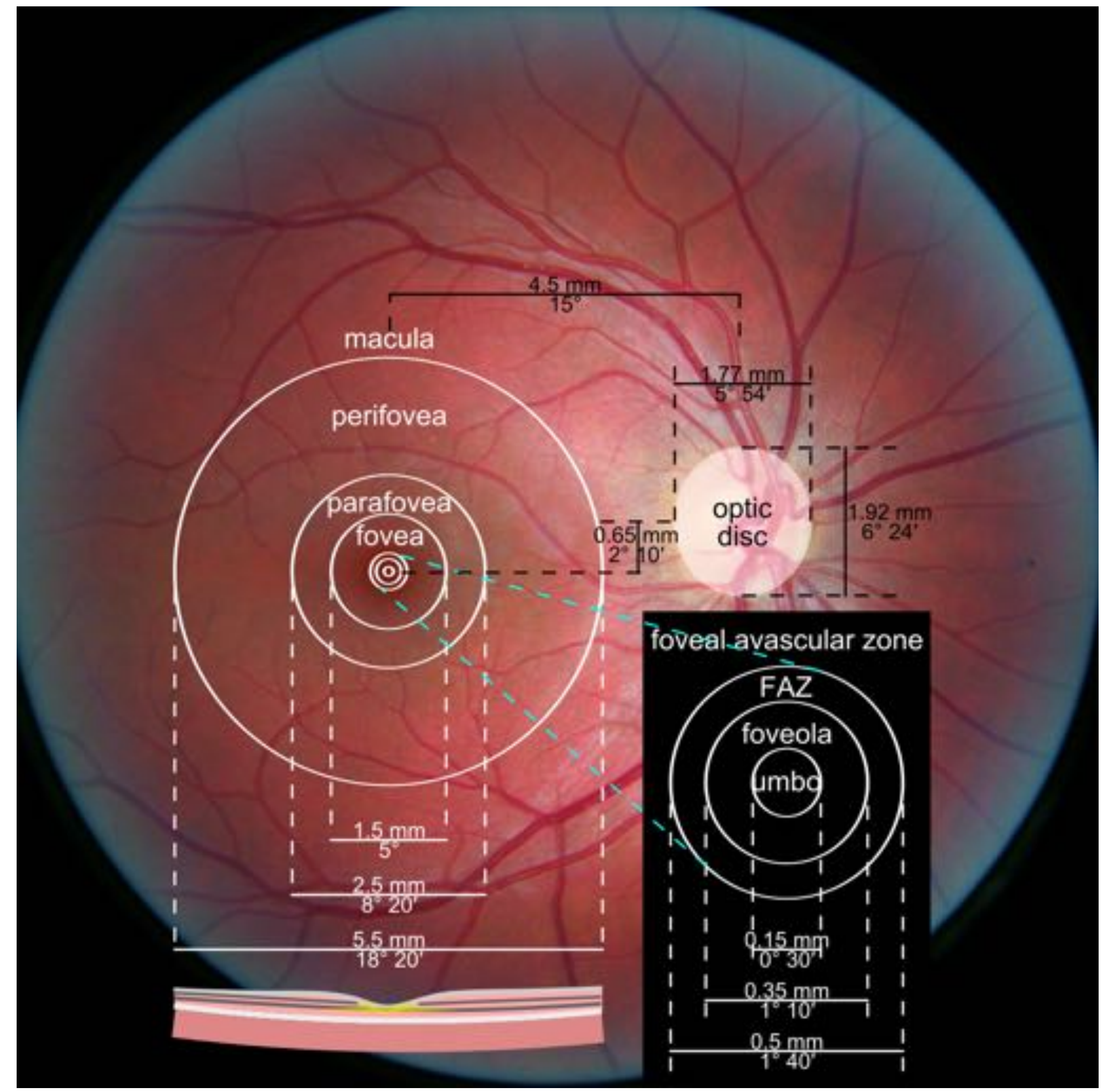
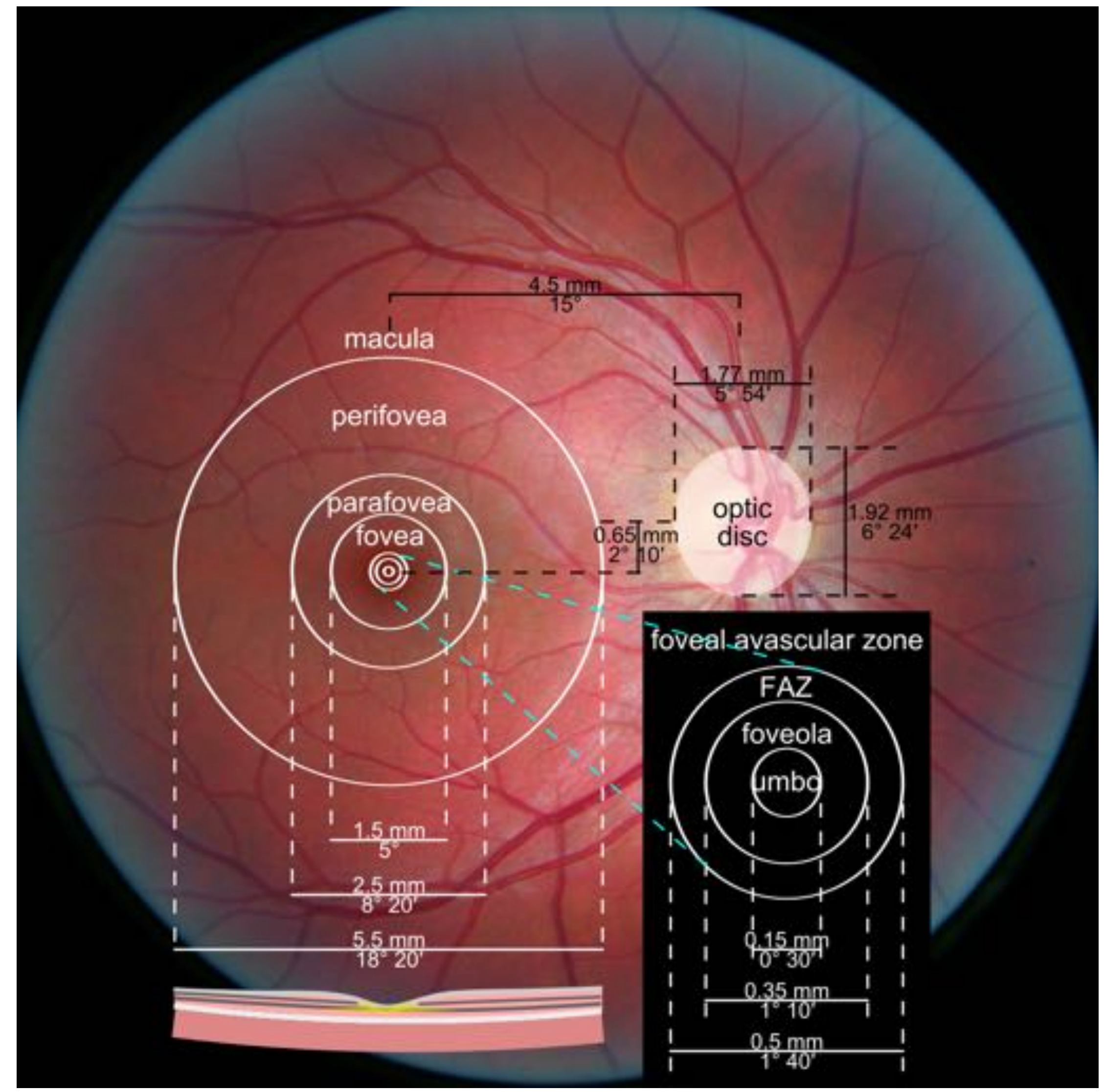
- **The parafovea with an outer ring of 2.5-mm diameter, with significantly more rods than cones.**
- **The perifovea with an outer ring of 5.5- mm diameter**



Anatomy of the Visual System: Retina

- **There is an overall distribution of all cells across the retina, with the highest concentration occurring at the center of our visual field in the fovea and reducing in coverage toward the edges.**
  - **The fovea consists of only cone receptors, and no rods, for highly detailed and exact vision.**
  - **The parafovea with an outer ring of 2.5-mm diameter, with significantly more rods than cones.**
  - **The perifovea with an outer ring of 5.5- mm diameter**
  - **The peripheral retina, covering approximately 97.25% of the total retinal surface and consisting largely of rods.**



Anatomy of the Visual System: Retina - Rods

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- **As these cells are thought to be achromatic, we tend to see objects at night in shades of gray.**
- **Rods do operate, within the visible spectrum between approximately 400 and 700 nm.**
- **It has been noted that during daylight levels of illumination, rods become hyper-polarized, or completely saturated, and thus do not contribute to vision.**

Anatomy of the Visual System: Retina - Cones

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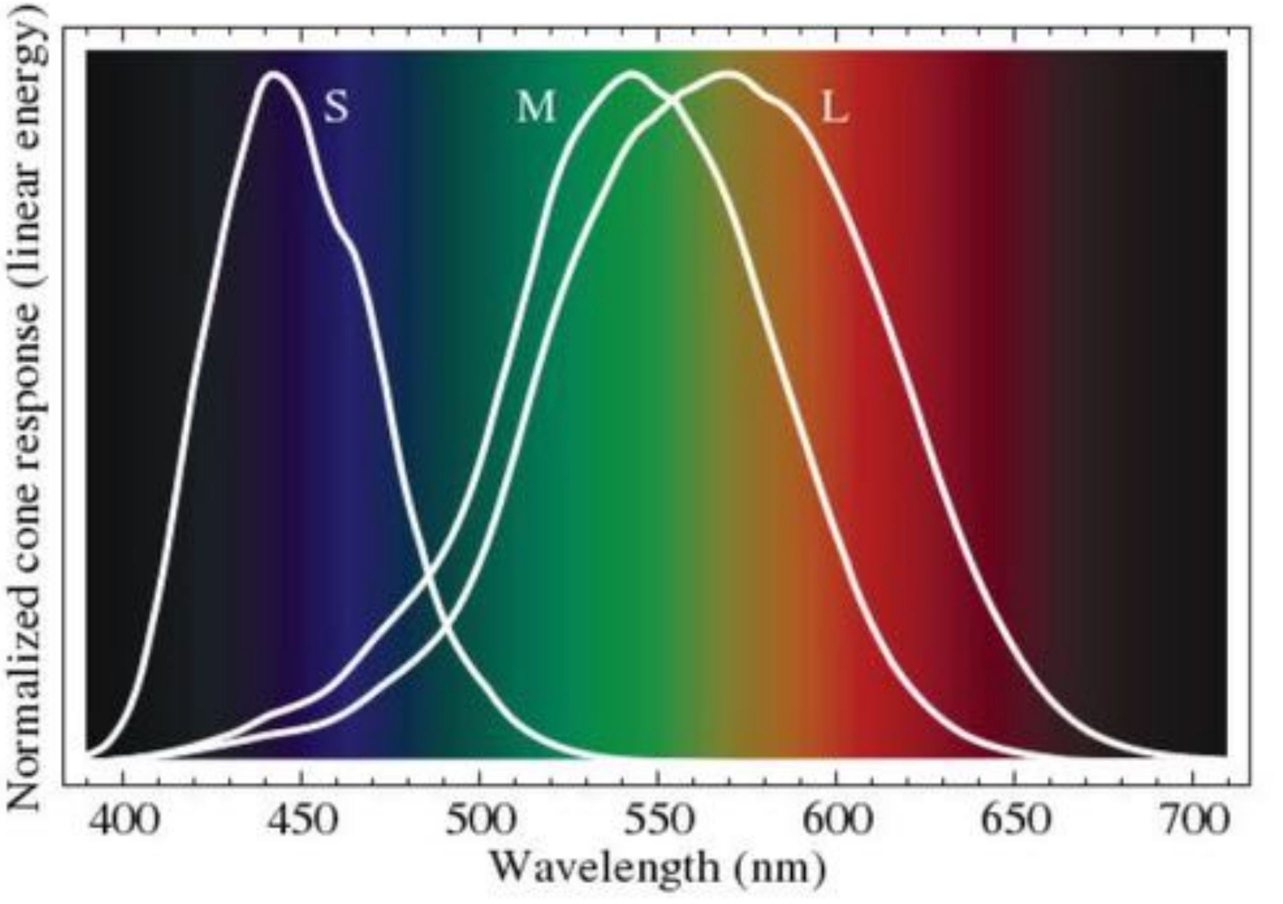
- **There are three types of cones in the human eye: S (short), M (medium), and L (long) wavelengths.**
- **The three types have been associated with color combinations using R (red), G (green), and B (blue).**



Anatomy of the Visual System: Retina - Cones

- **Three types of cones: S (short), M (medium), and L (long) wavelengths.**
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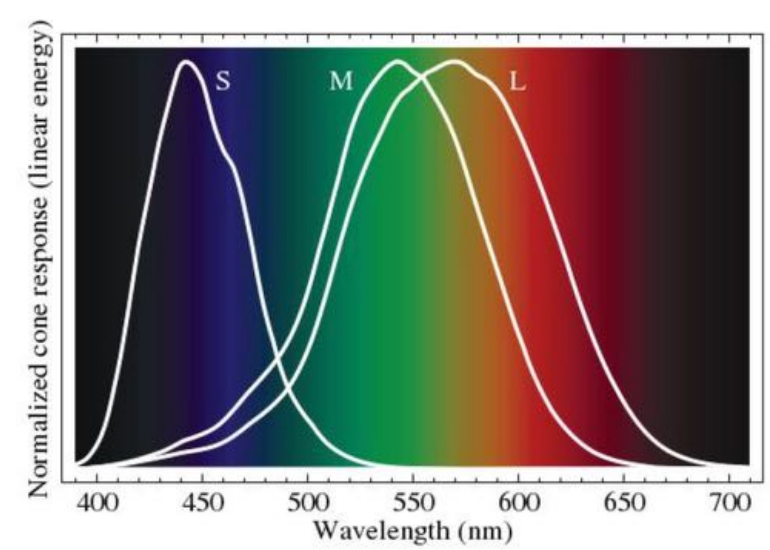

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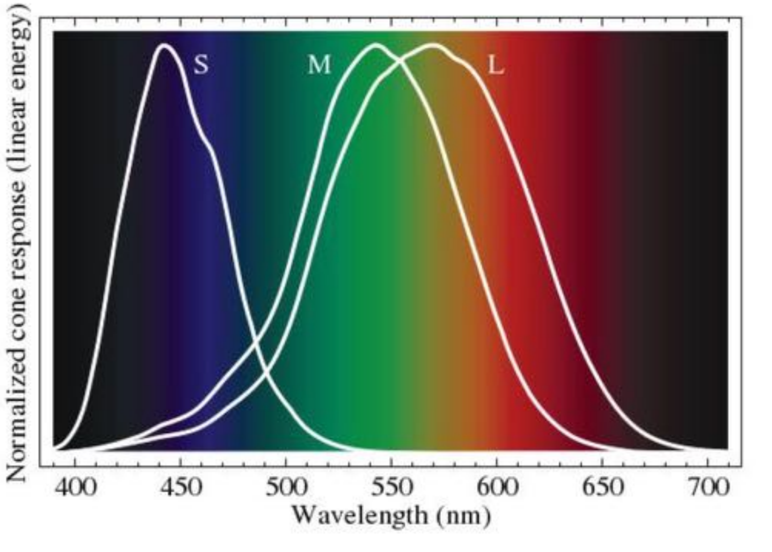

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Anatomy of the Visual System: Retina - Cones

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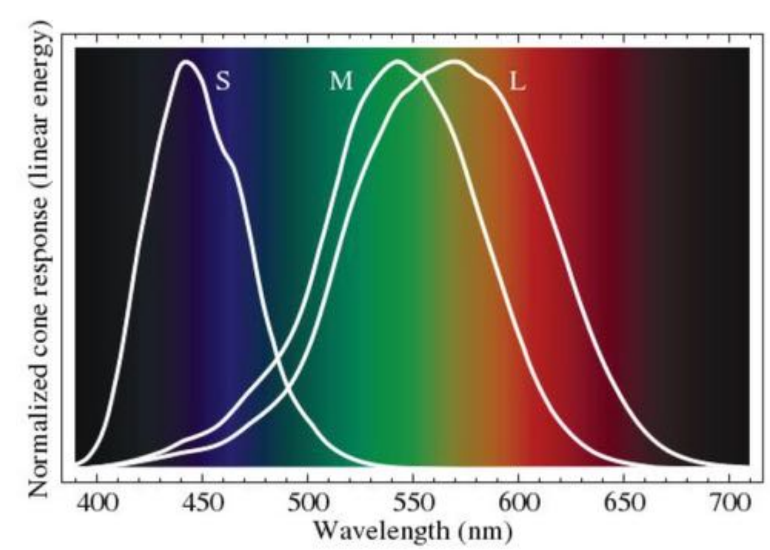
  - There are considerably fewer S cones, compared to the number of M and L cones
  - Humans can visually perceive all the colors within the standard visible spectrum
- Cones are not sensitive over a large fixed wavelength range but rather over a small moving-window-based range.

  Cones tend to adapt to the average wavelength where there is sensitivity above and below their peaks, and a shift in their response curve occurs when the average background wavelength changes.



Anatomy of the Visual System: blind spot

Figure 3.12 - (Matthew Ward, et. all)

Anatomy of the Visual System: blind spot

- **Where the optic nerve meets the retina, a blind spot occurs, due to the lack of photoreceptive cells**

Blind spot discovery by identifying disappearance of target.

Figure 3.12 - (Matthew Ward, et. all)

Visual system

- **Because the human eye contains a limited number of rods and cones (about 120 million rods and 6 million cones), it can only manage a certain amount of visual information over a given time frame.**

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- The optic nerve only contains about one million fibers; thus the eye must perform a significant amount of visual processing before transmitting information to the brain.
- Additionally, the information transferred from these two types of cells is not equivalent. The eye contains separate systems for encoding spatial properties (e.g., size, location, and orientation), and object properties (e.g., color, shape, and texture).

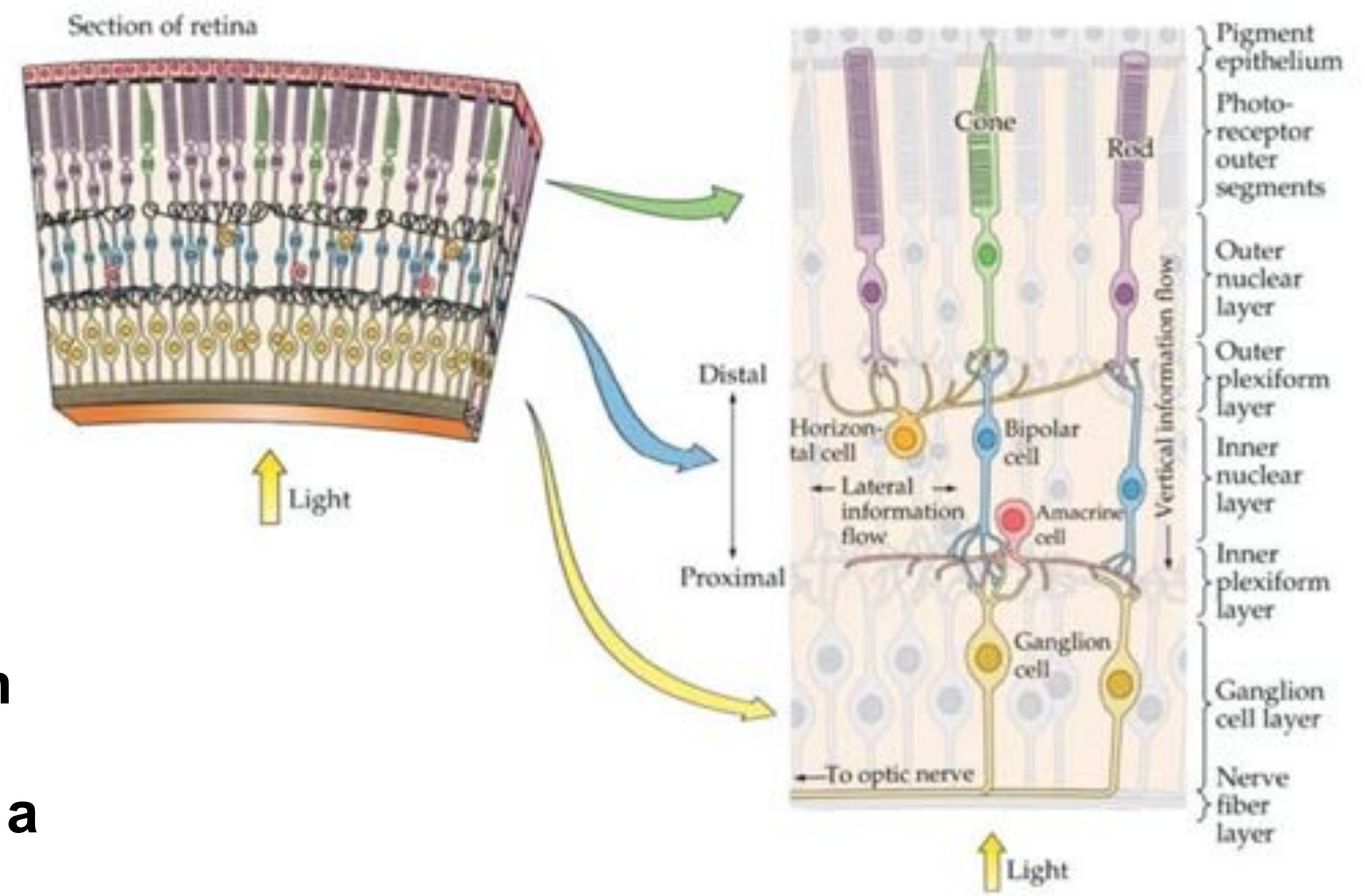
Figure 3.8 - (Matthew Ward, et. all)

Visual Processing

- The **Retina** is complex layer of many neurons and photoreceptive cells

- The retina is already performing some kinds of image compression, and possibly segmentation.

- This reduction of retinal stimulation is required, as there are only about a million optic nerve fibers relaying image information to the brain.



A representation of a retinal cross-section. (Image © The Brain from Top to Bottom.)

Visual Processing

- **Each Brain hemisphere receives visual information from both eyes, possibly to help with the perception of depth.**

- **As there is so much visual processing performed at both the eyes and within the brain, these linked organs form an integral visual system.**

Eye Movement

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- **Smooth pursuit movements: the eyes move smoothly instead of in jumps.**
  - **The angles from the normal to the face are equal (left and right as well as up and down).**
  - **For example, to make a pursuit movement, look at your forefinger at arms' length and then move your arm left and right while fixating on your fingertip.**

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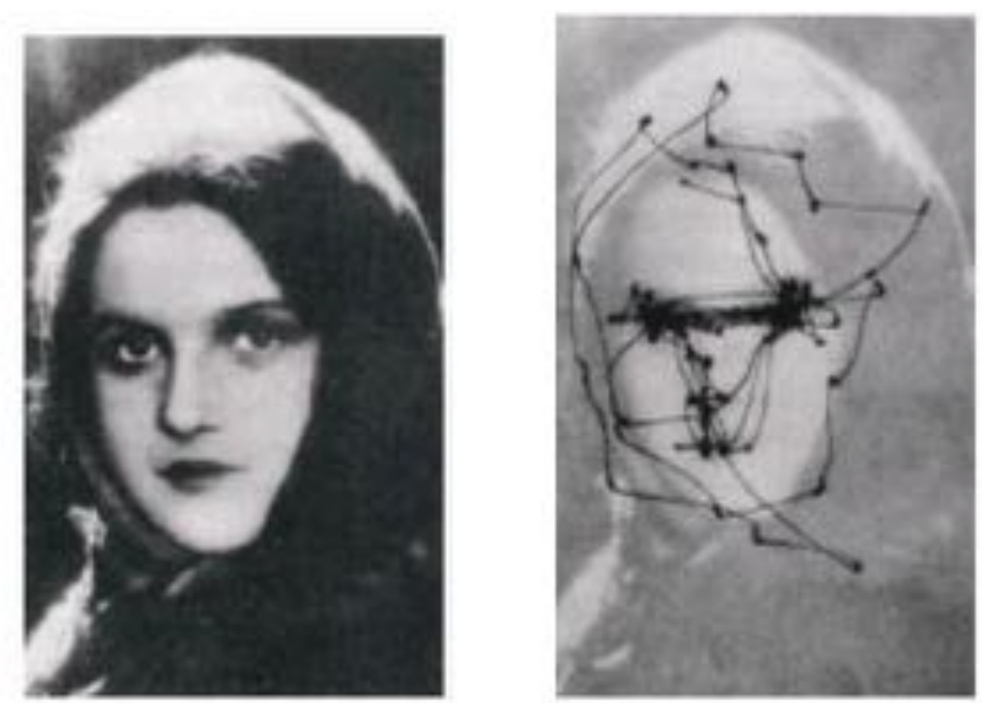
- **Vergence eye movements**: moving a finger closer to the face and staring at it will force the eyes inward, resulting in vergence movement. Defocusing to merge depths in illusions is another example.

Eye Movement

- **Saccadic eye movements: these result from multiple targets of interest (not necessarily conscious).**



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(a) The face used to study eye tracking. (b) The results of the tracking gaze.

Figure 3.15 - (Matthew Ward, et. all)

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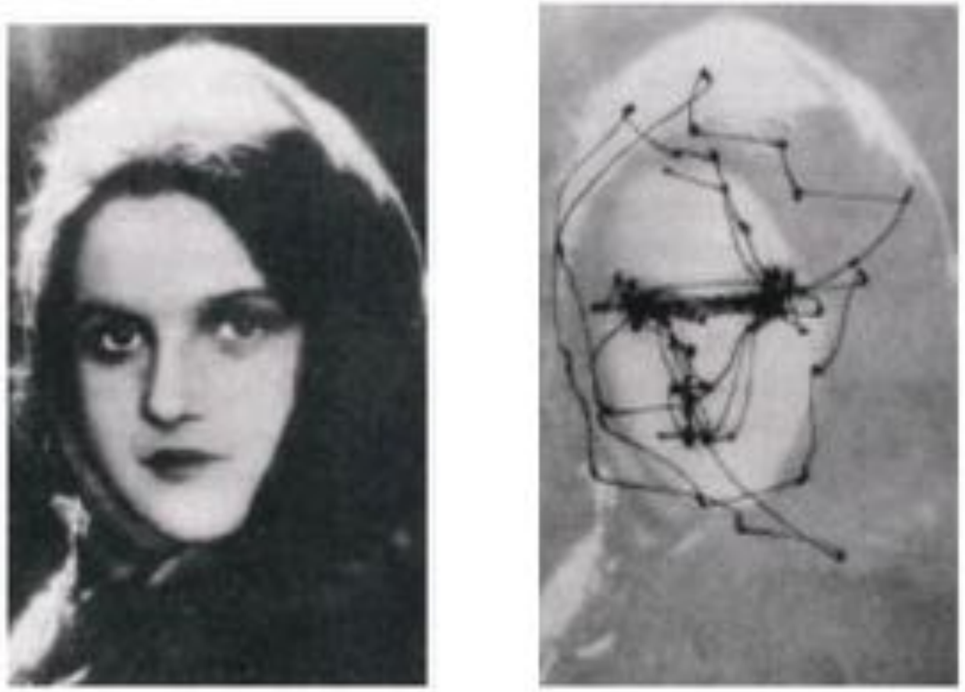

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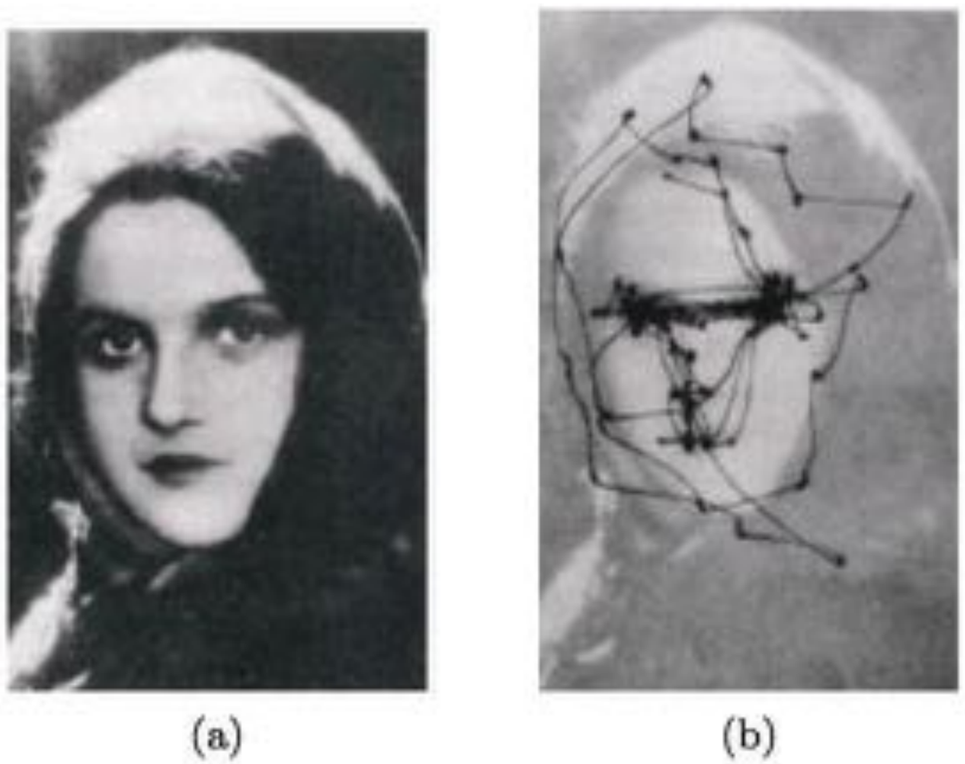

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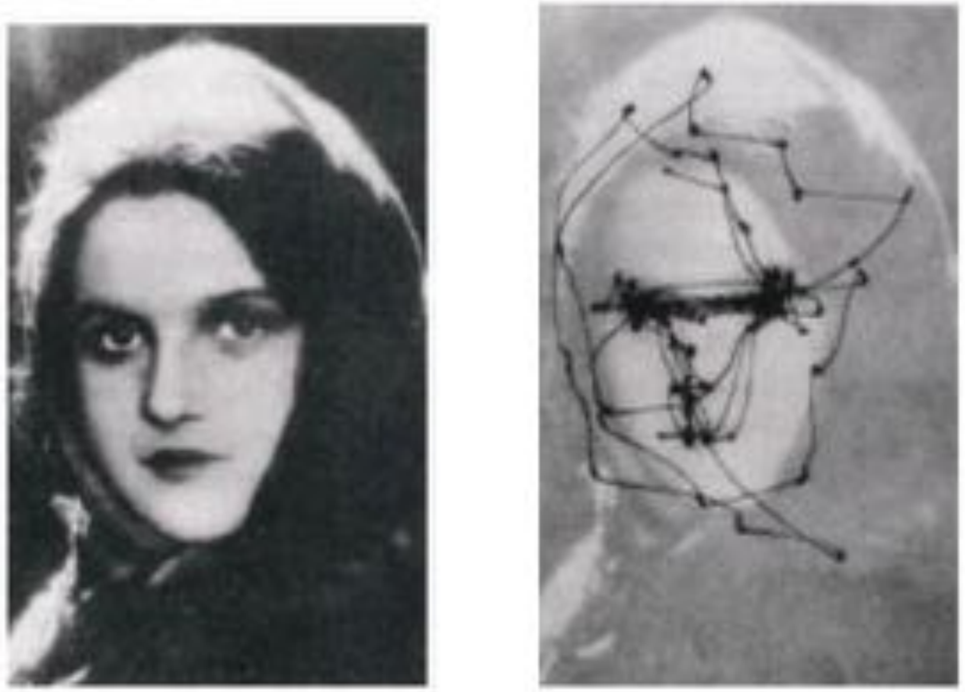

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Eye Movement

- **Saccadic masking** or suppression occurs during two states between saccadic views.
  - The gap produced is ignored (some say blocked).
  - A continuous flow of information is interpreted, one that makes sense.
  - The higher-level visual system filters out the blurred images acquired by the low-level one, and only the two saccadic stop views are seen.

Summary

Q&A

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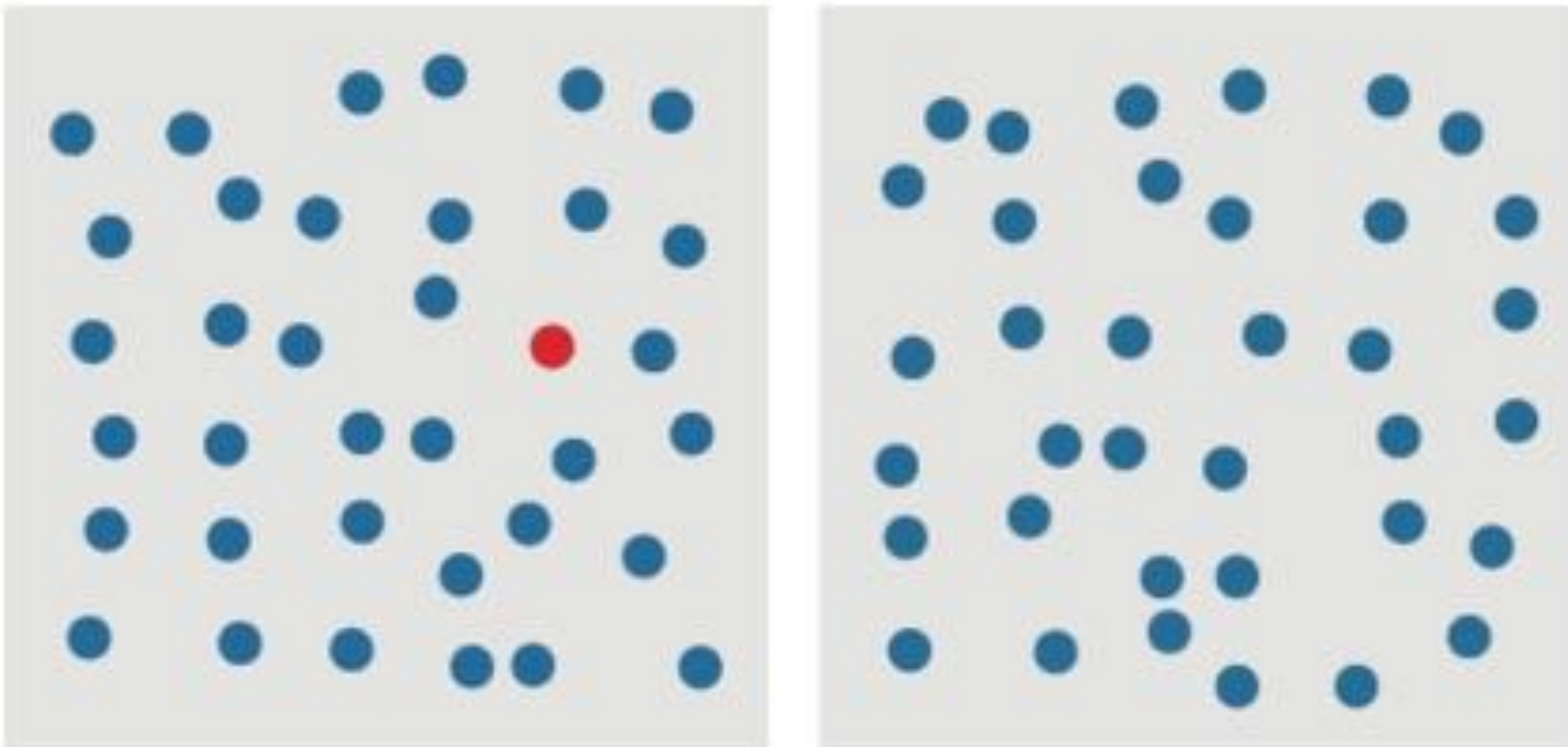
Q&A

Perceptual Processing

Perceptual Processing

- **Preattentive Processing**
- **Theories of Preattentive Processing**
- **Feature Hierarchy**
- **Change Blindness**

“Preattentive” properties



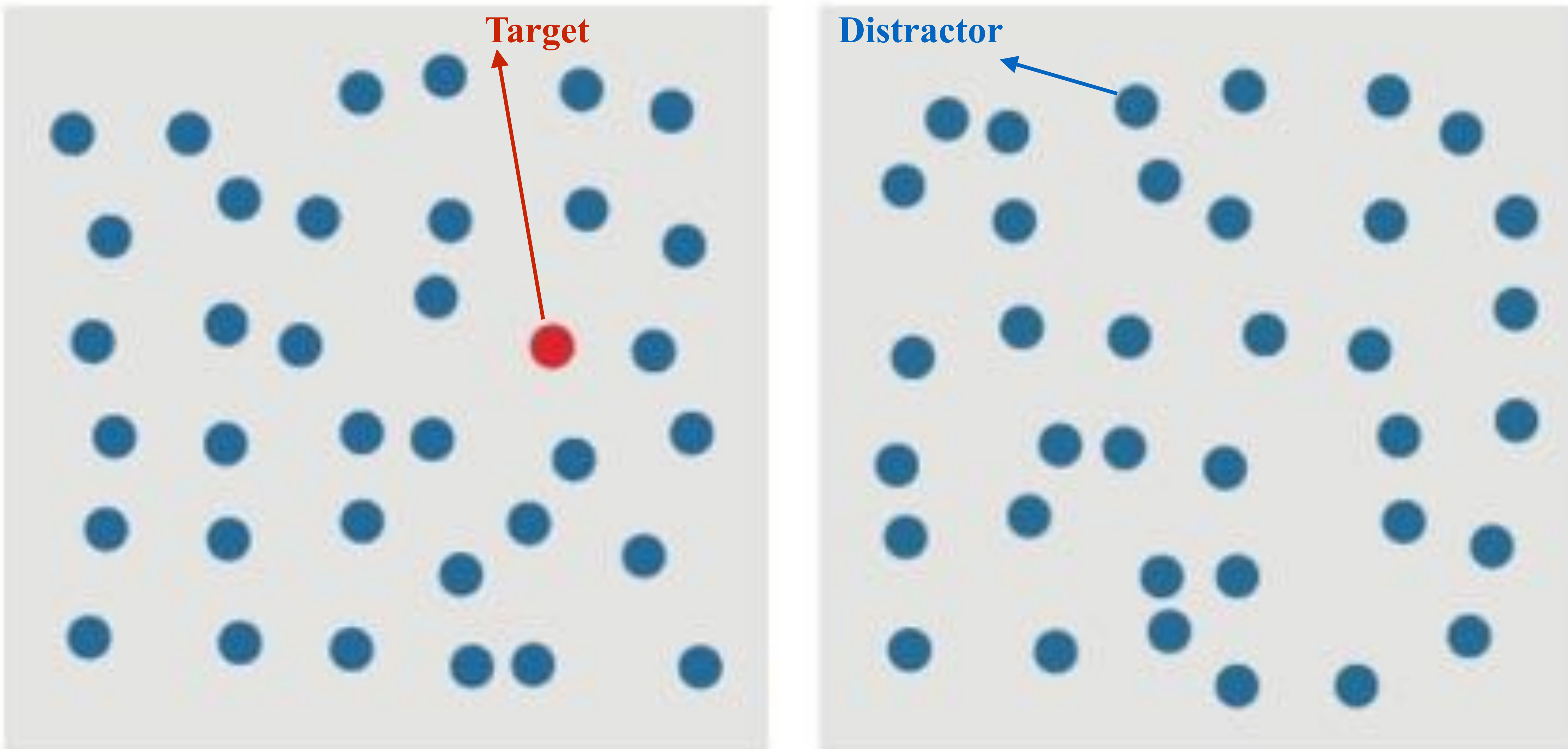
(a) Target is present in a sea of blue circle distractors.

(b) Target is absent.

An example of searching for a target red circle based on a difference in hue.

Figure 3.18 - (Matthew Ward, et. all)

“Preattentive” properties



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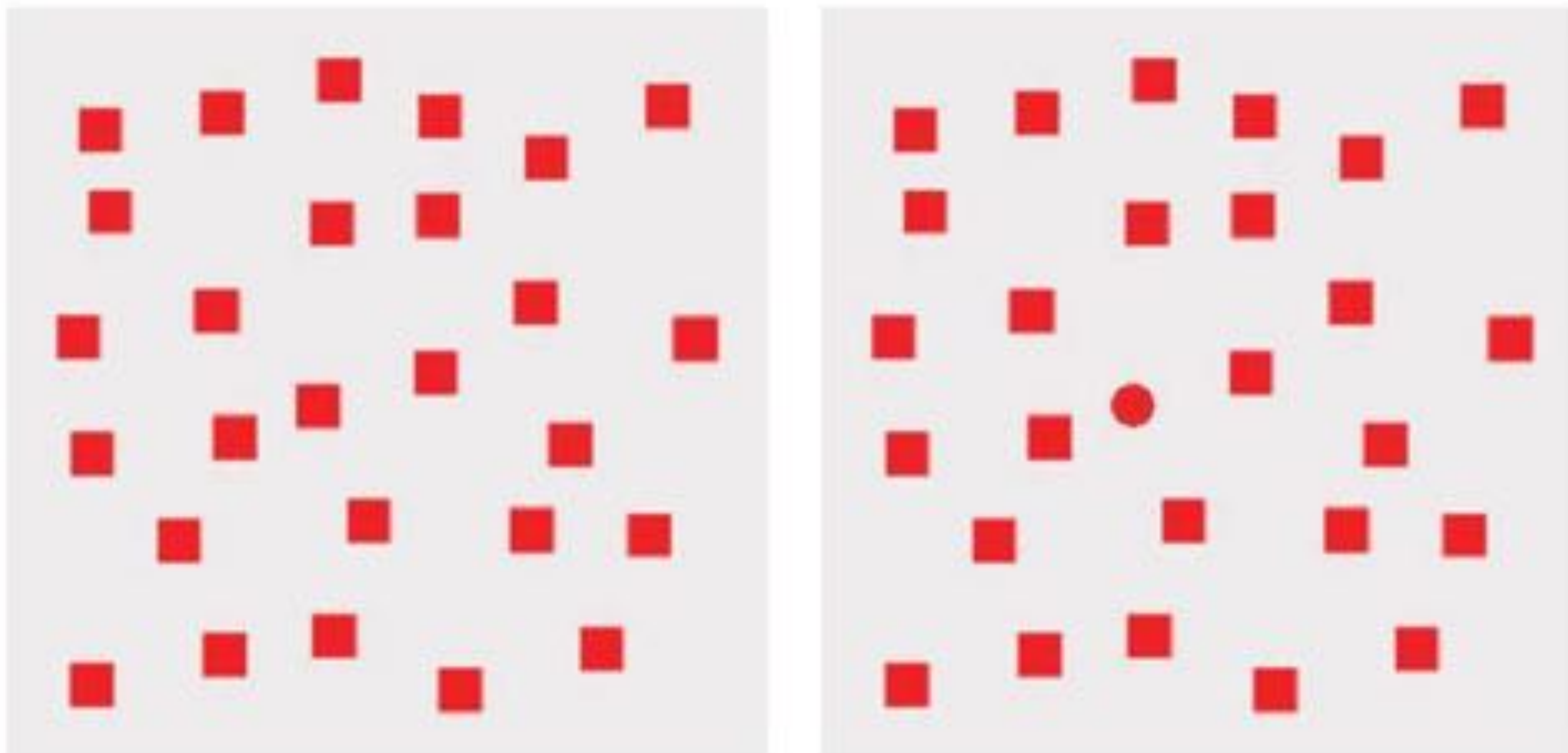

(a) Target is absent in a sea of red square distractors.

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An example of searching for a target red circle based on a difference in curvature.

Figure 3.19 - (Matthew Ward, et. all)

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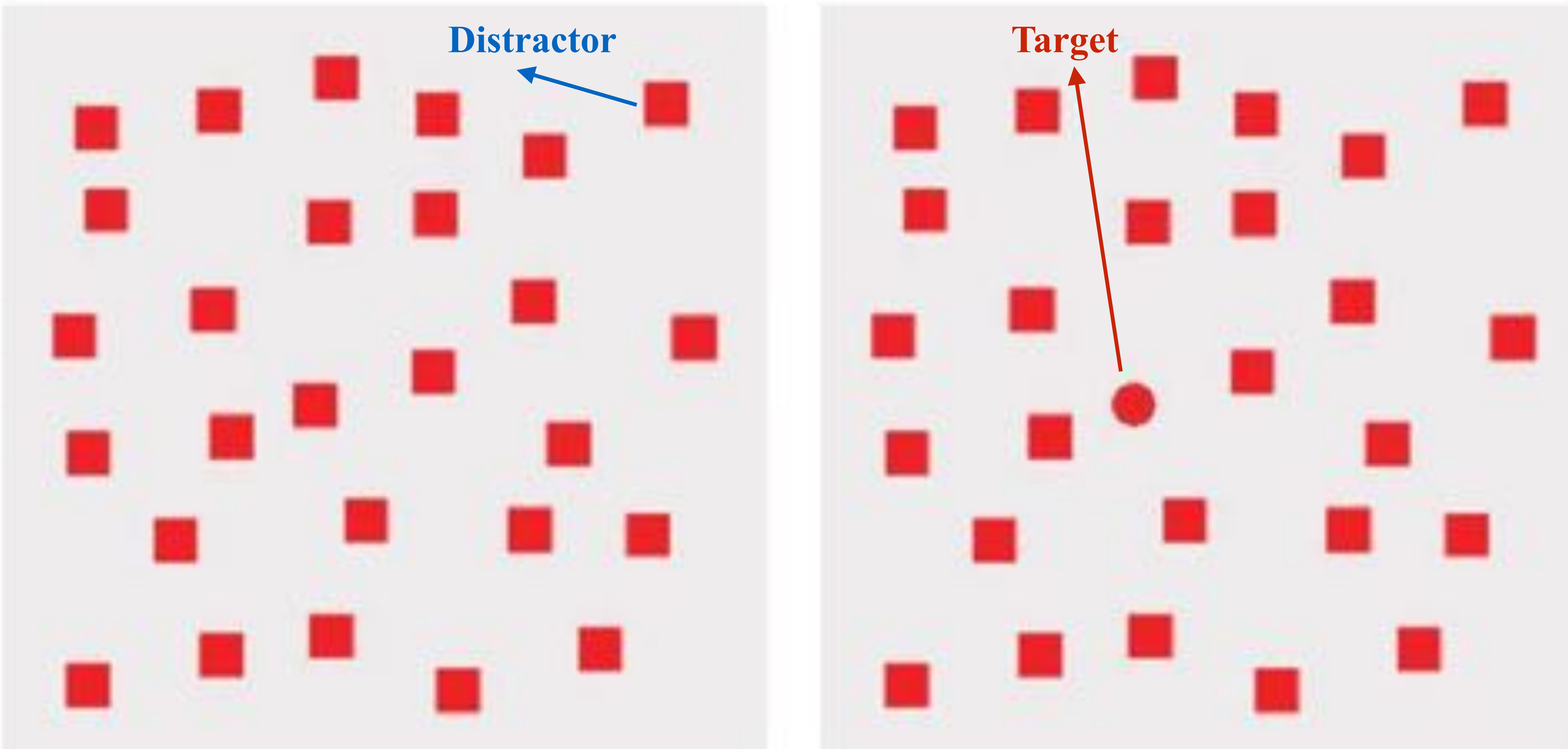

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  - **This suggests that certain information in the display is processed in parallel by the low-level visual system.**

“Preattentive” properties

An example of a conjunction search for a target red circle.

Figure 3.20 - (Matthew Ward, et. all)

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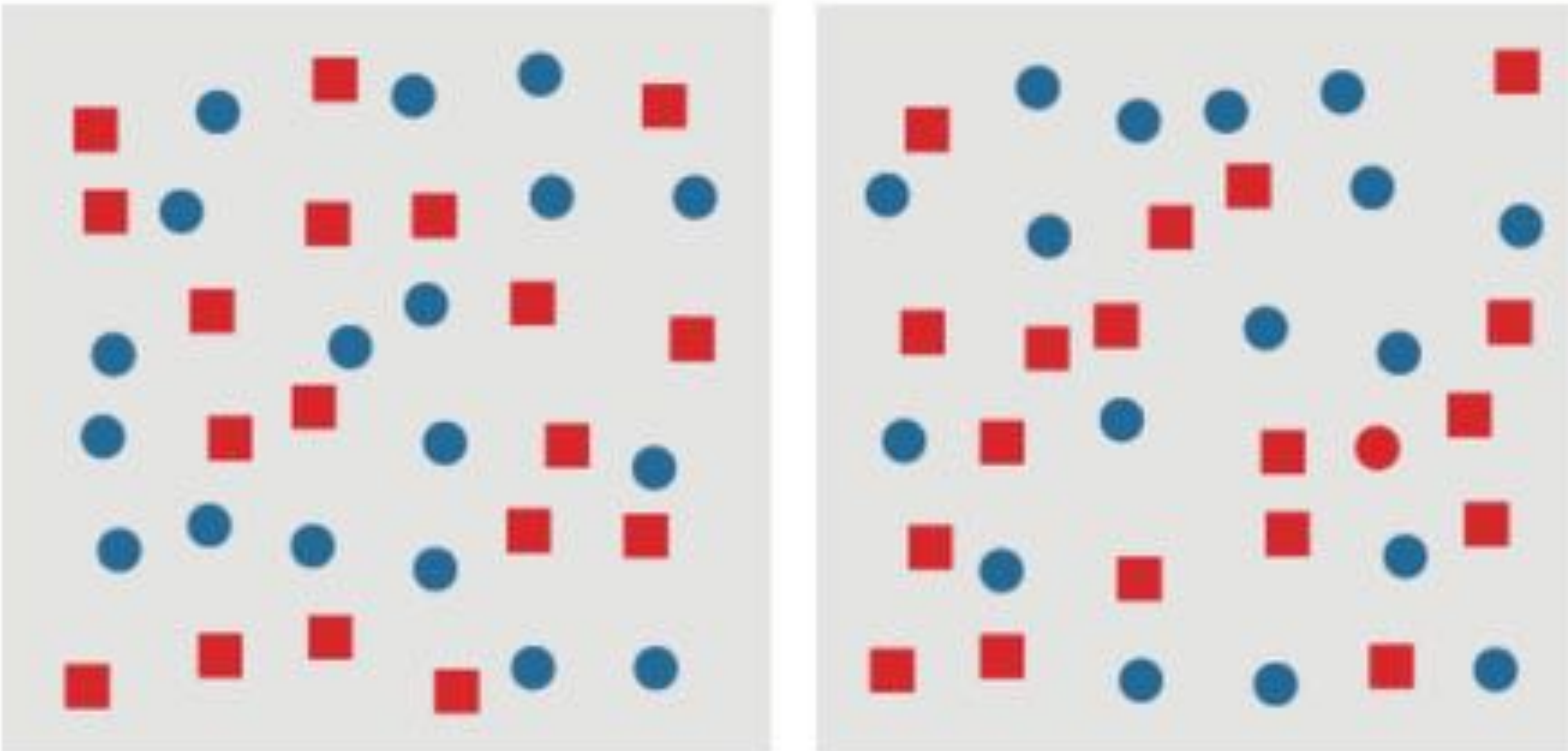

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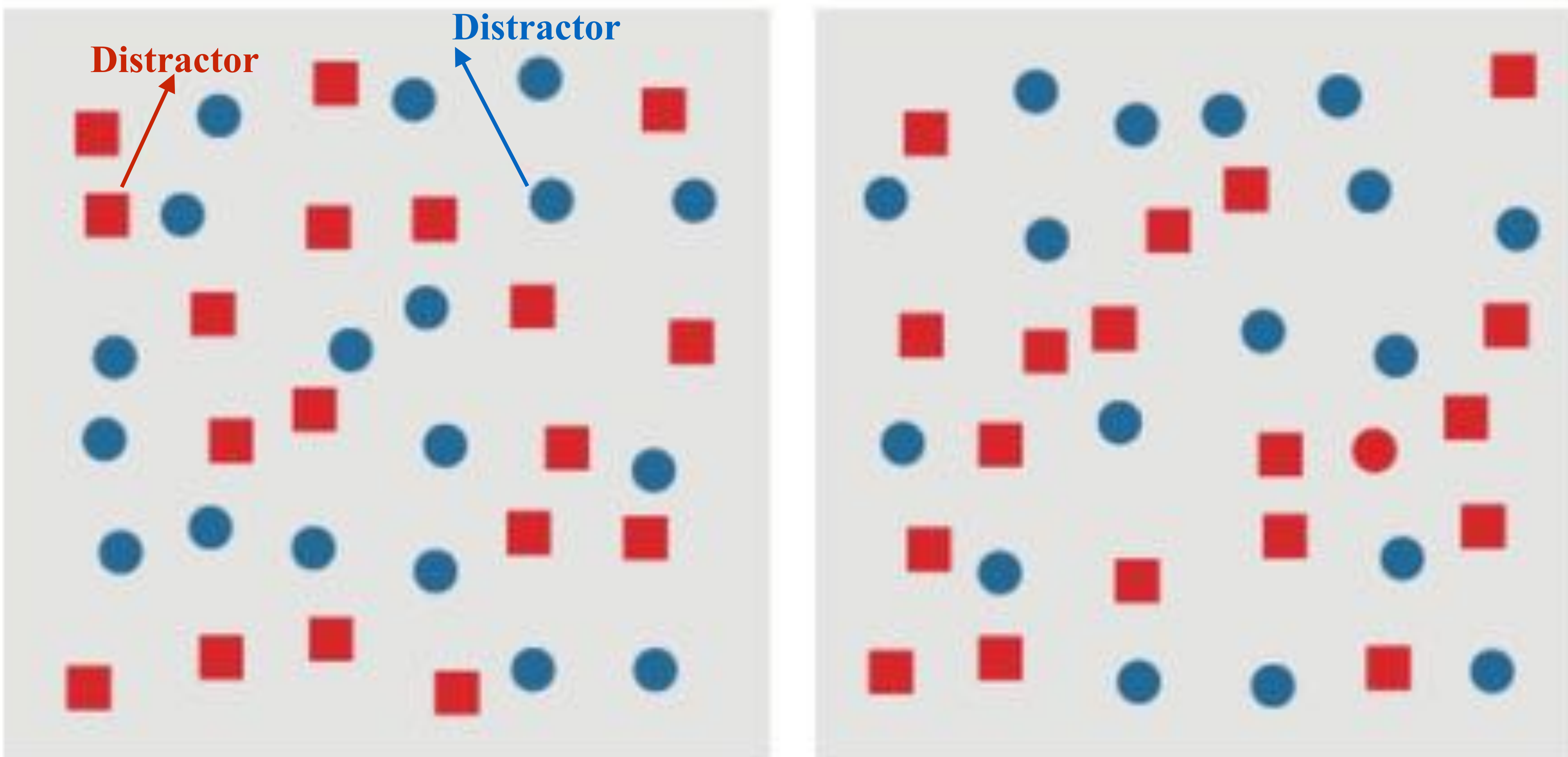

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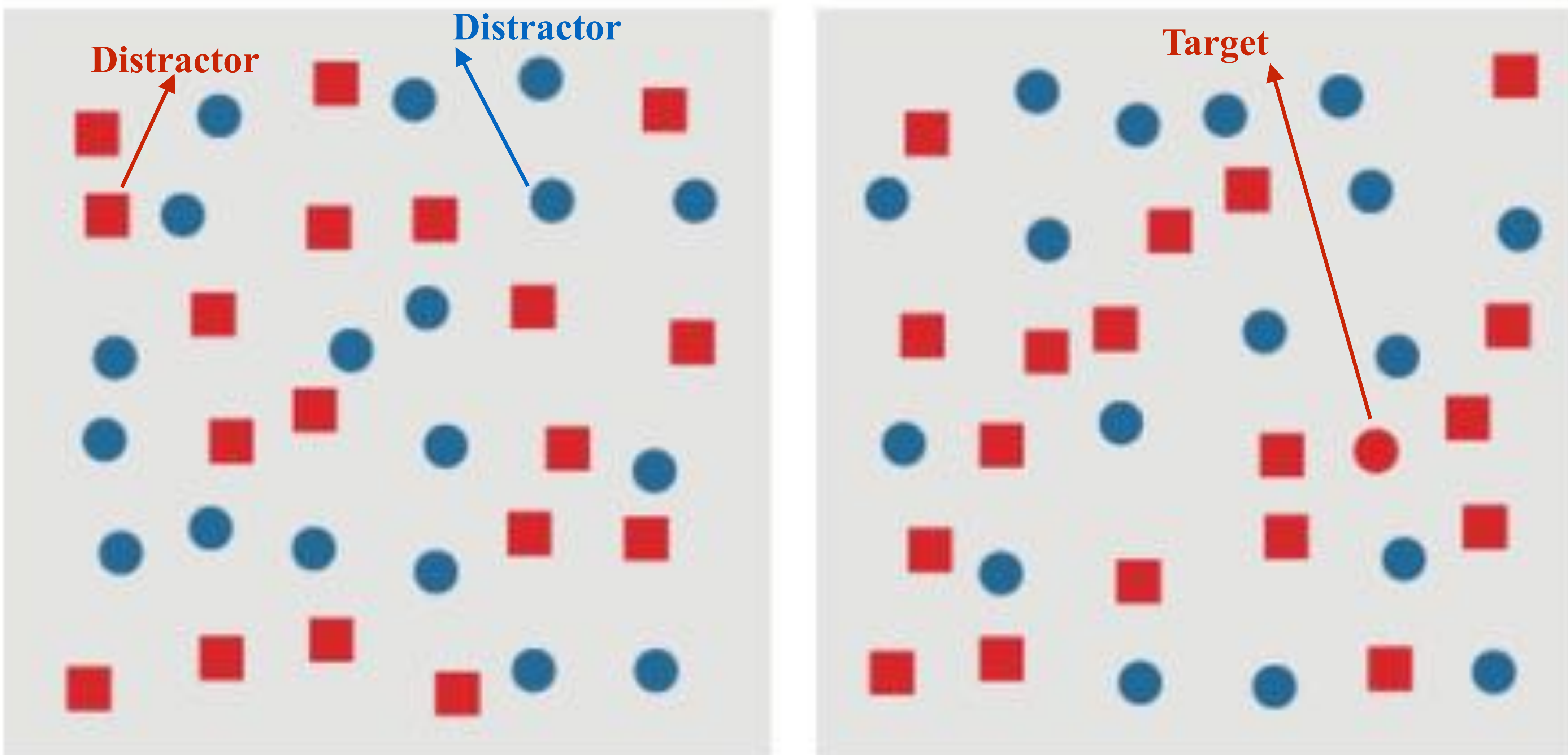

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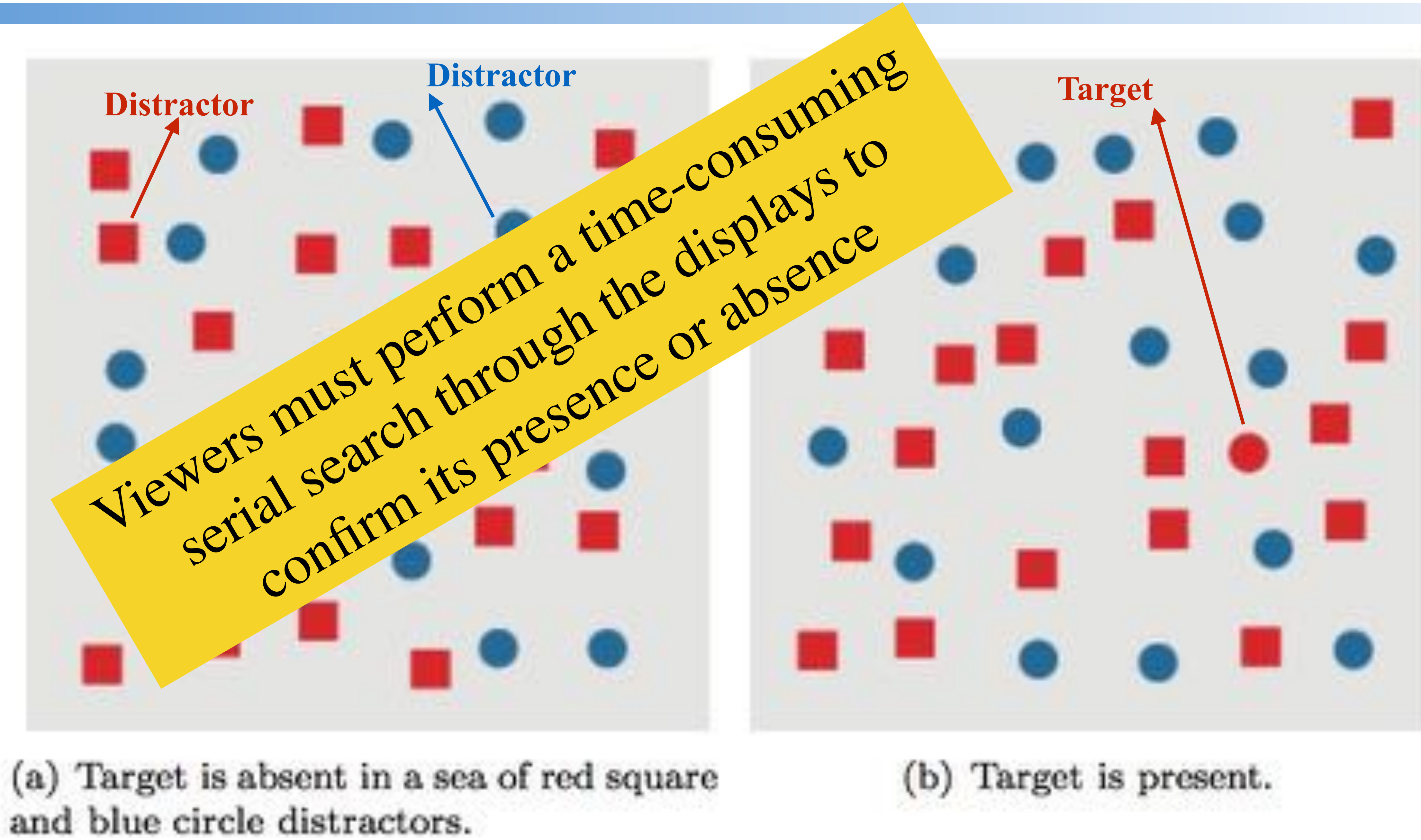

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  - **One of these features is present in each of the distractor objects (red squares and blue circles).**
  - **The visual system has no unique visual property to search for when trying to locate the target. If a viewer searches for red items, the visual system always returns true. Similarly, a search for circular items always sees blue circles.**

"Preattentive" properties

- **Visual features that have been identified as preattentive:**
  - **length, width, size, curvature, number, terminators, intersection, closure, hue, intensity, flicker, direction of motion, binocular luster, stereoscopic depth, 3D depth cues, and lighting direction.**

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- **The key perceptual attributes associated with the above include luminance and brightness, color, texture, and shape**
  - **Luminance is the measured amount of light coming from some place.**
  - **Brightness is the perceived amount of light coming from a source (is a nonlinear function of the amount of light emitted by the source) [Paper ≠ Screen].**
  - **Texture is the characteristic appearance of an area or surface.**

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  - **Users rapidly and accurately detect the presence or absence of a “target” element with a unique visual feature within a field of distractor elements.**

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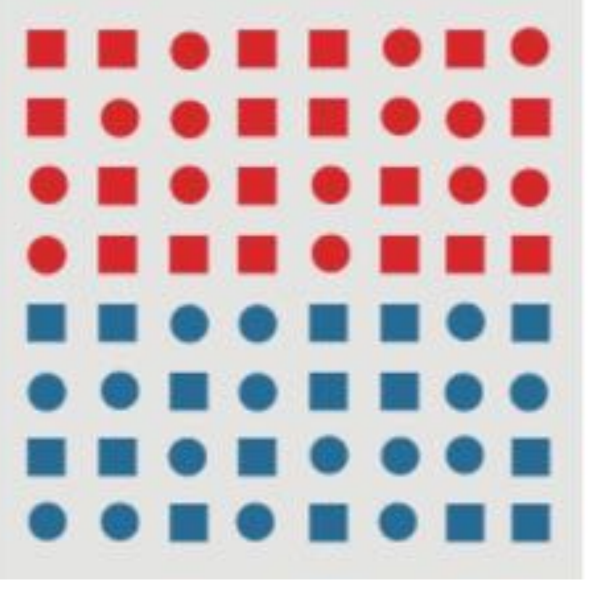

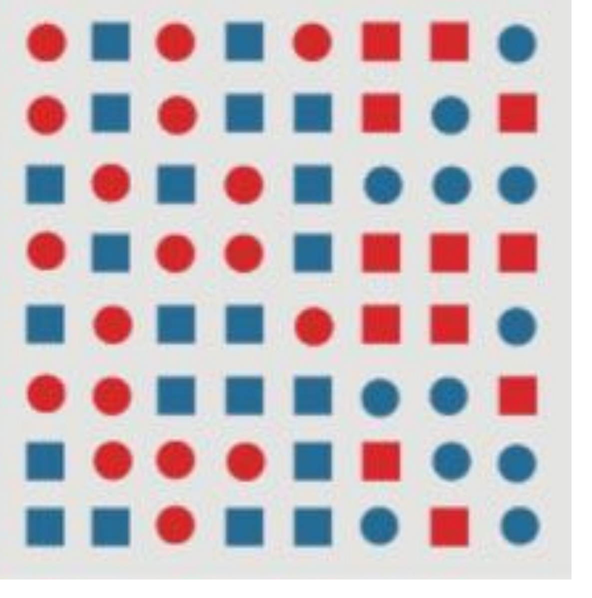

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- **Counting and estimation**
  - **Users count or estimate the number of elements with a unique visual feature.**

Theories of Preattentive Processing

- **Feature Integration Theory (Anne Treisman)**
- **Texton Theory**
- **Similarity Theory**
- **Guided Search Theory**

- **Postattentive Vision**

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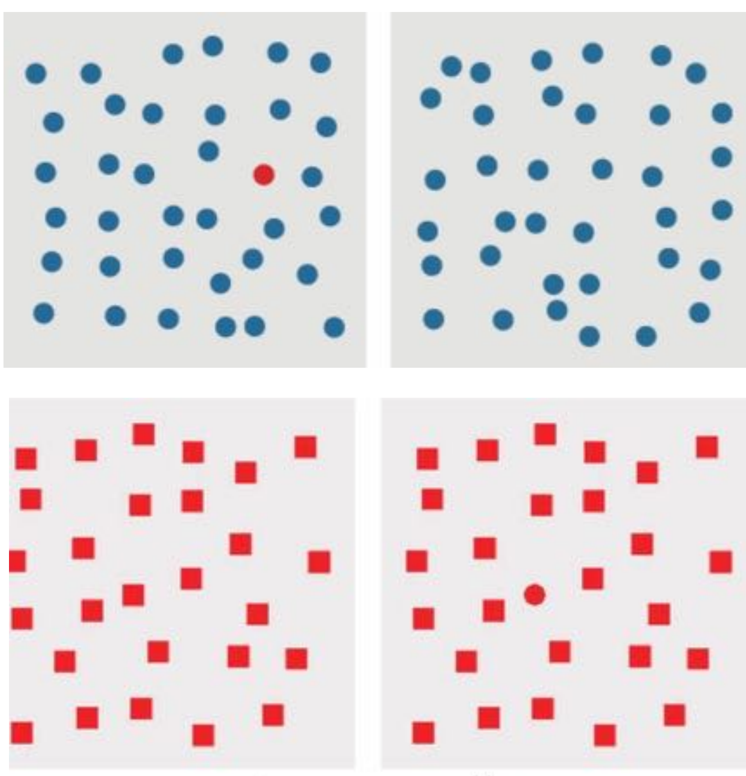
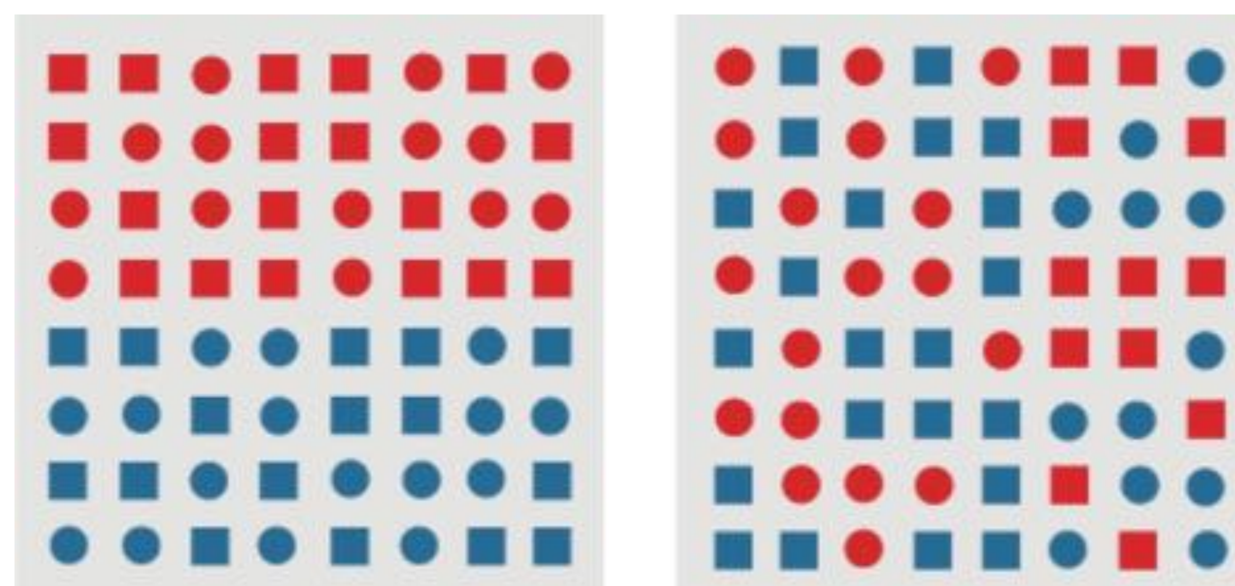
- **Treisman ran experiments using target and boundary detection**





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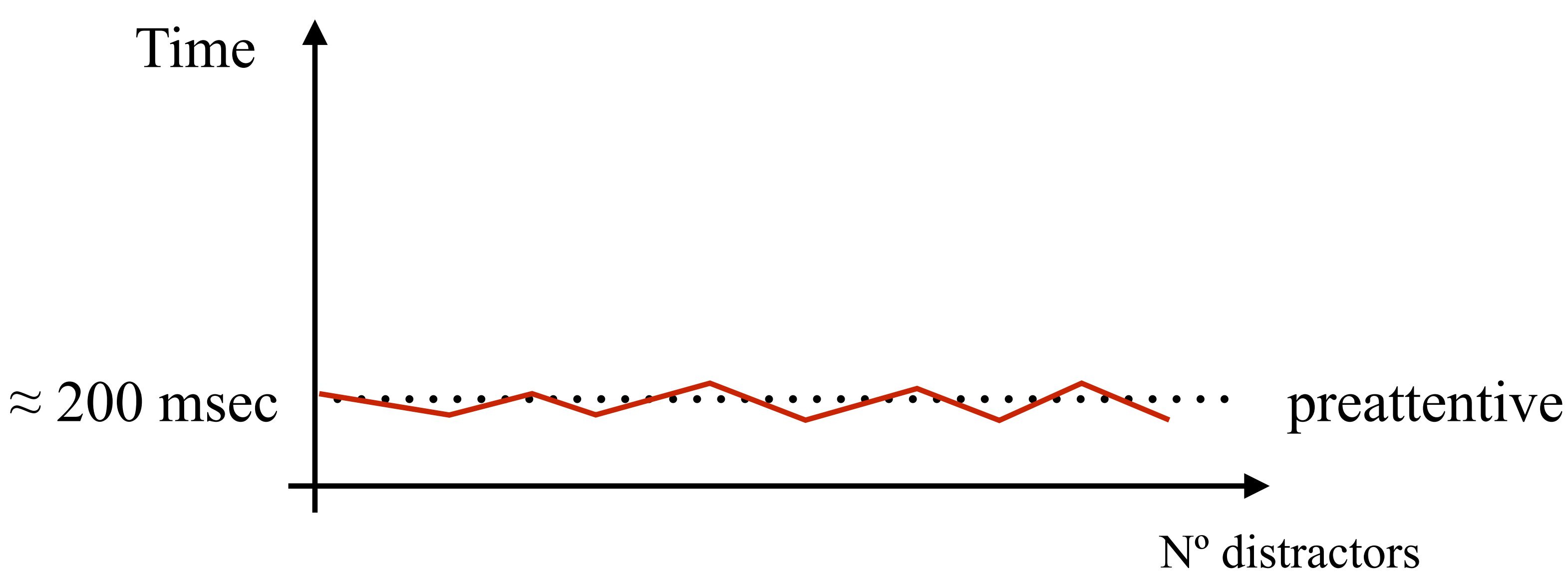

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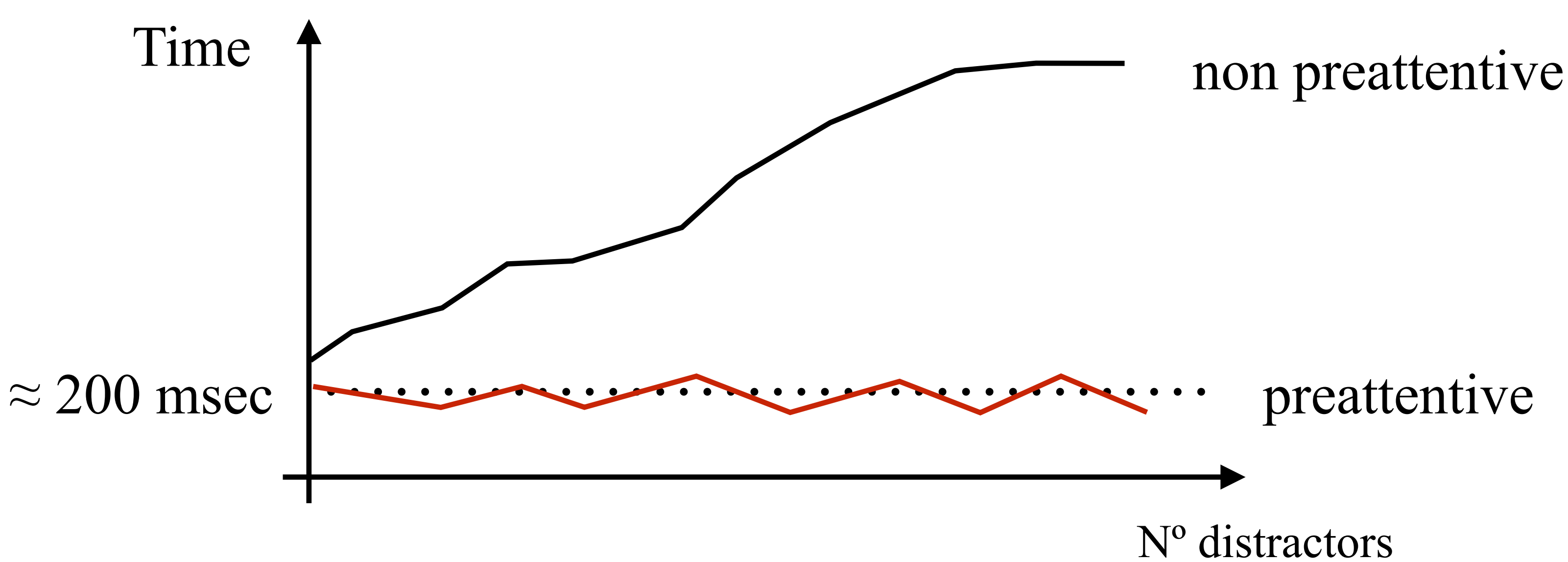

Feature Integration Theory (Anne Treisman)

- **Measuring preattentive task performance:**
  - **accuracy:**
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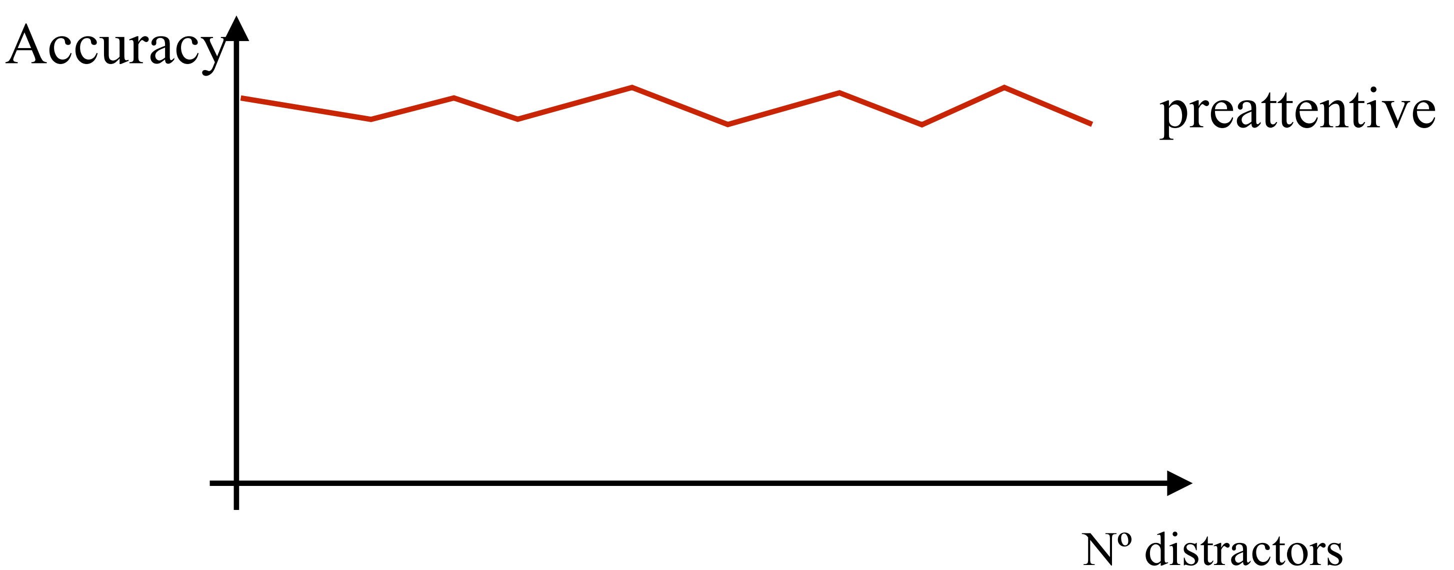

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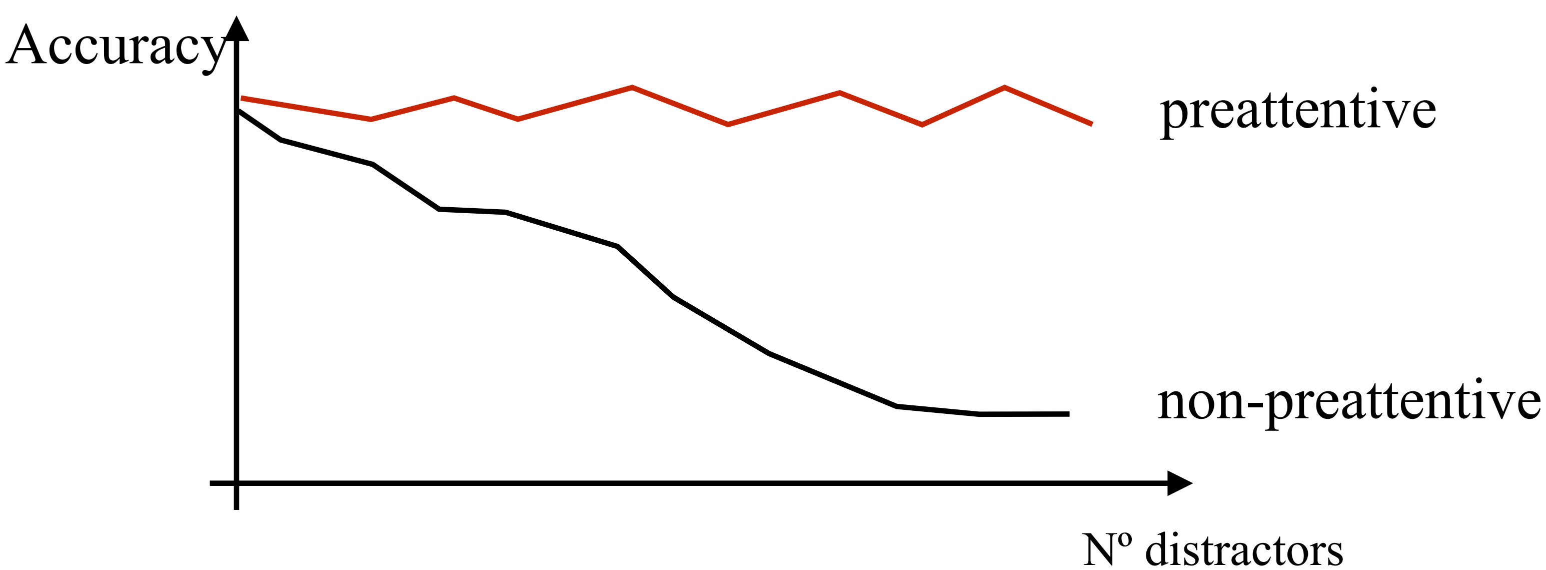

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- **List of visual features that are detected preattentively**
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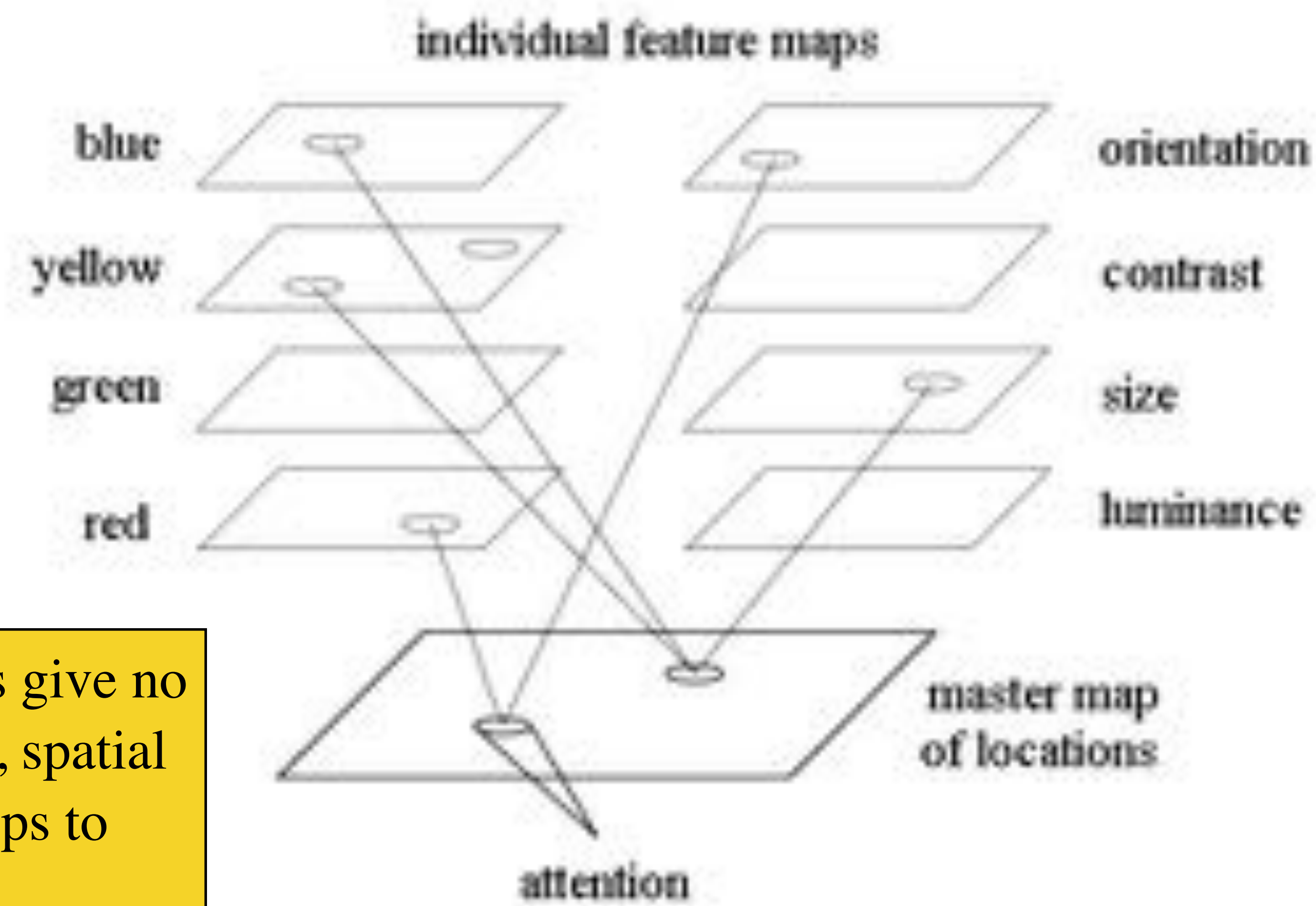
- **To explain the preattentively features and processing they propose a "Feature Integration Theory"**
  - **A model of low-level human vision made up of a set of feature maps. Each feature map registers activity in response to a specific visual feature**
  - **and a master map of locations.**

Feature Integration Theory (Anne Treisman)



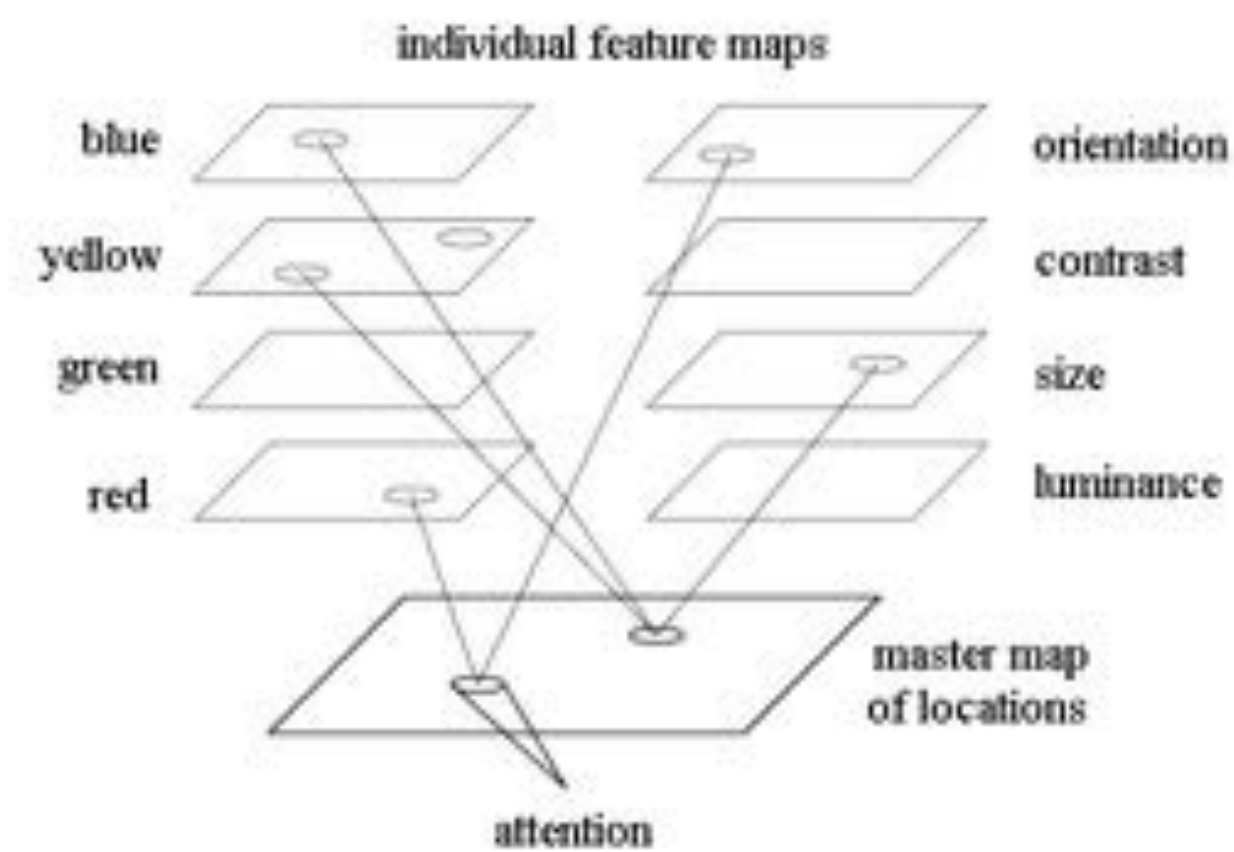
the individual feature maps give no information about location, spatial arrangement, or relationships to activity in other maps.

Treisman's feature integration model for early vision; individual maps can be accessed to detect feature activity; focused attention acts through a serial scan of the master map of locations.

Figure 3.22 - (Matthew Ward, et. all)

Feature Integration Theory (Anne Treisman)

- **If the target has a unique feature, one can simply access the given feature map to see if any activity is occurring**
- **Feature maps are encoded in parallel, so feature detection is almost instantaneous.**
- **A conjunction target cannot be detected by accessing an individual feature map.**



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- Relaxing the strict dichotomy of features being detected as being either in parallel or in serial
  - For example, a long vertical line can be detected immediately among a group of short vertical lines.
  - As the length of the target shrinks, the search time increases, because the target is harder to distinguish from its distractors.
  - At some point, the target line becomes shorter than the distractors. If the length of the target continues to decrease, search time decreases, because the degree of similarity between the target and the distractors is now decreasing.

Feature Integration Theory (Anne Treisman)

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    - **Example: green horizontal bar within a set of red horizontal bars and green vertical bars. Wolfe showed that search times are independent of display size!**

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    - **Example: green horizontal bar within a set of red horizontal bars and green vertical bars. Wolfe showed that search times are independent of display size!**
    - **If color constituted a significant feature difference, the red color map could inhibit information about red horizontal bars. Thus, the search reduces to finding a green horizontal bar in a sea of green vertical bars.**

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  - **elongated blobs (e.g., line segments, rectangles, ellipses) with specific properties such as hue, orientation, and width;**
  - **terminators (ends of line segments);**
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- **Julesz believed that only a difference in textons or in their density can be detected preattentively.**

Texton Theory (Bela Julesz)

- **Even when each appear very different in isolation, it may be difficult, if not impossible, to differentiate any pattern when in a texture or grid.**

Two simple textons, easily differentiable.

Figure 3.23 - (Matthew Ward, et. all)

Texton Theory (Bela Julesz)

- **Julesz used texture segregation**

A target group of b-textons is difficult to detect in a background of a-textons when a random rotation is applied.

Although the two objects look very different in isolation, they are actually the same texton. Both are made up of the same set of line segments, and each has two terminators.

Figure 3.24 - (Matthew Ward, et. all)

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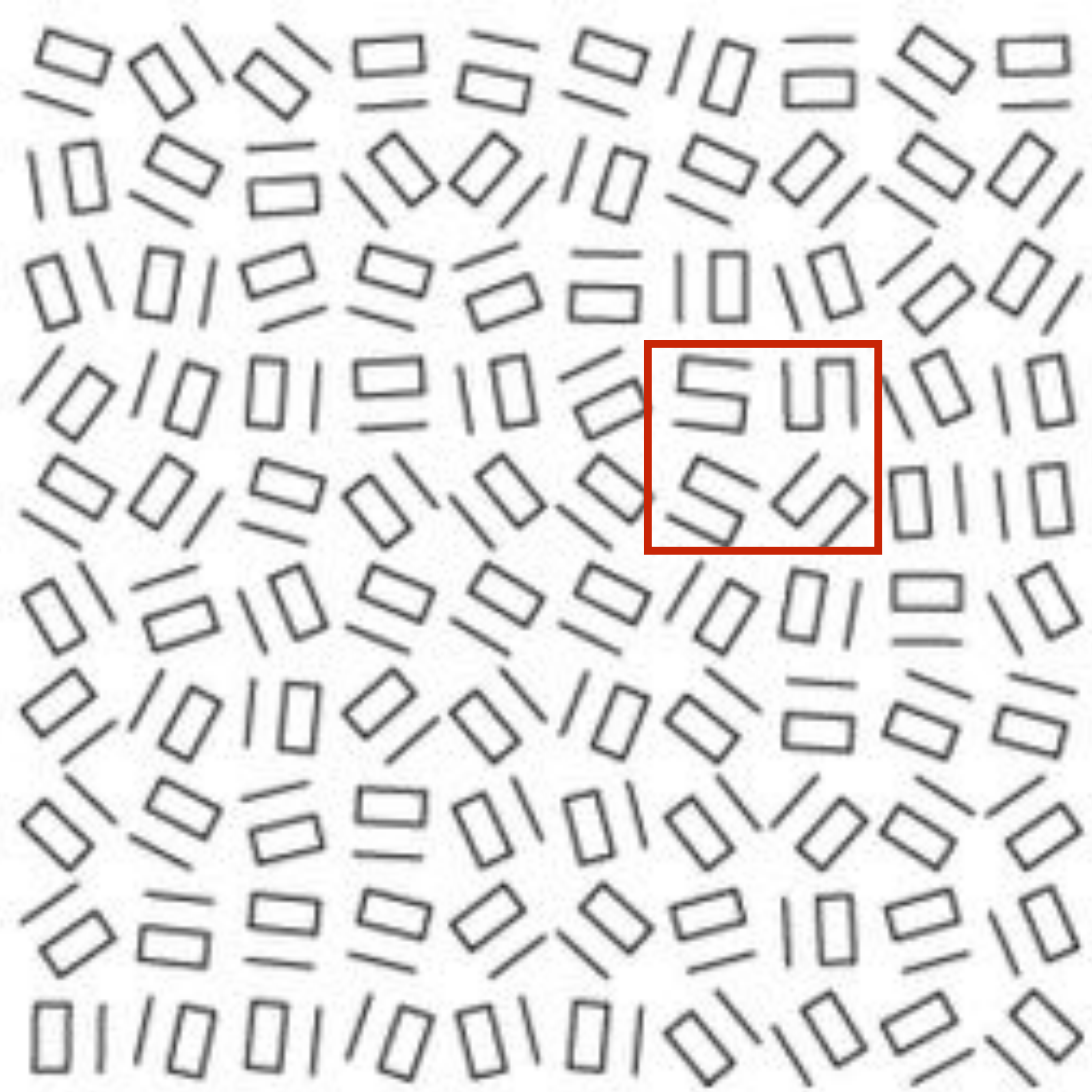

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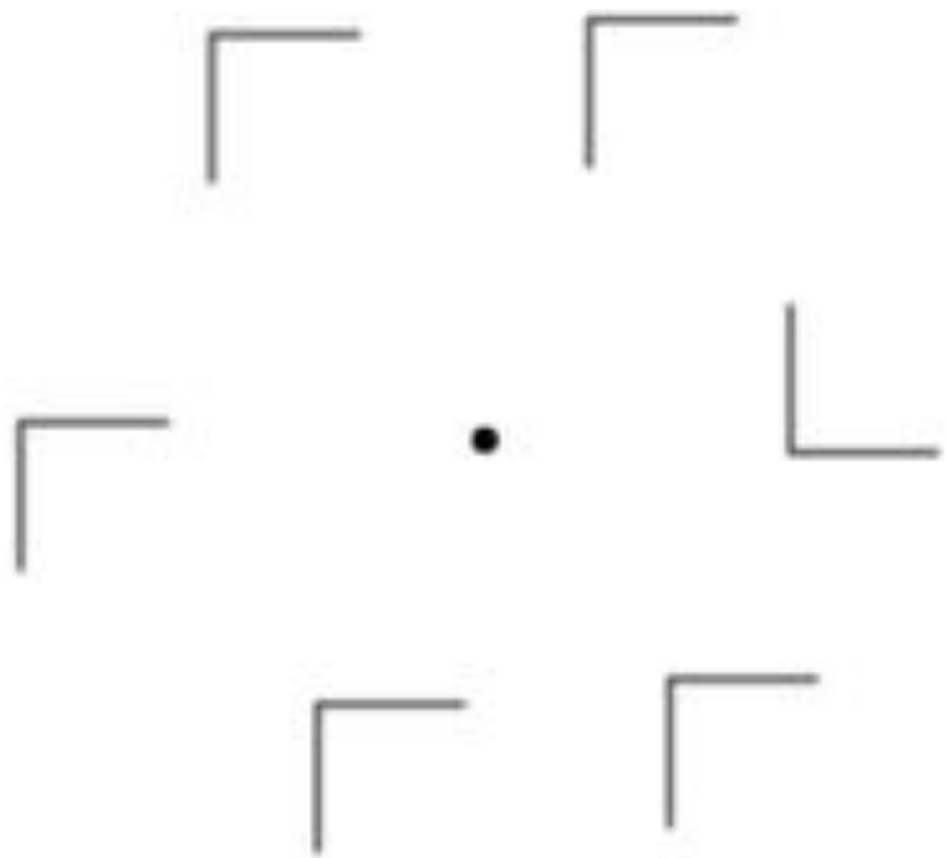

(a) High N-N (nontarget-nontarget) similarity allows easy detection of target L.

Example of N-N similarity affecting search efficiency for a target shaped like the letter L.

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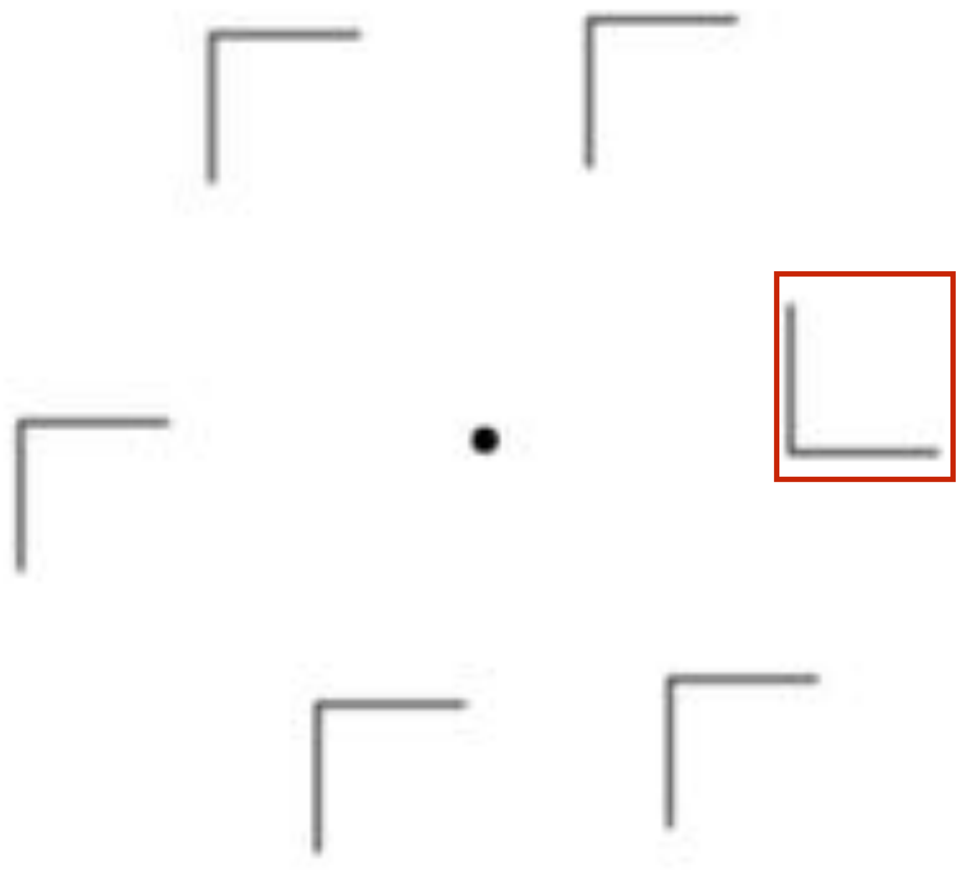

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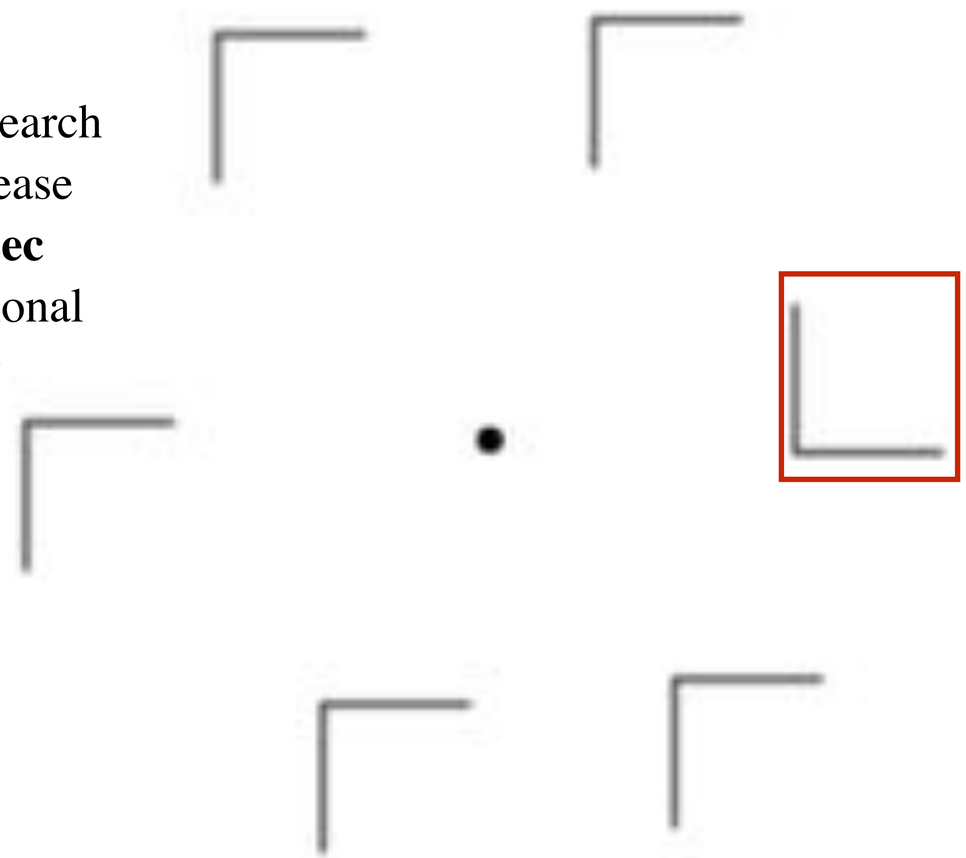

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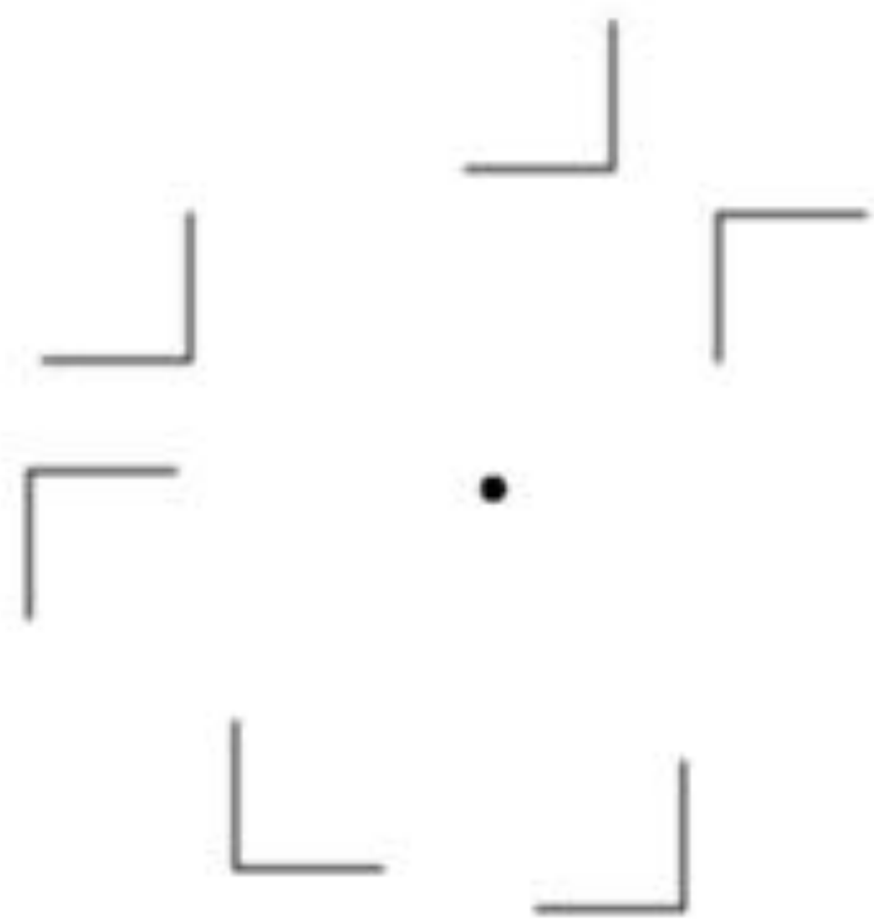

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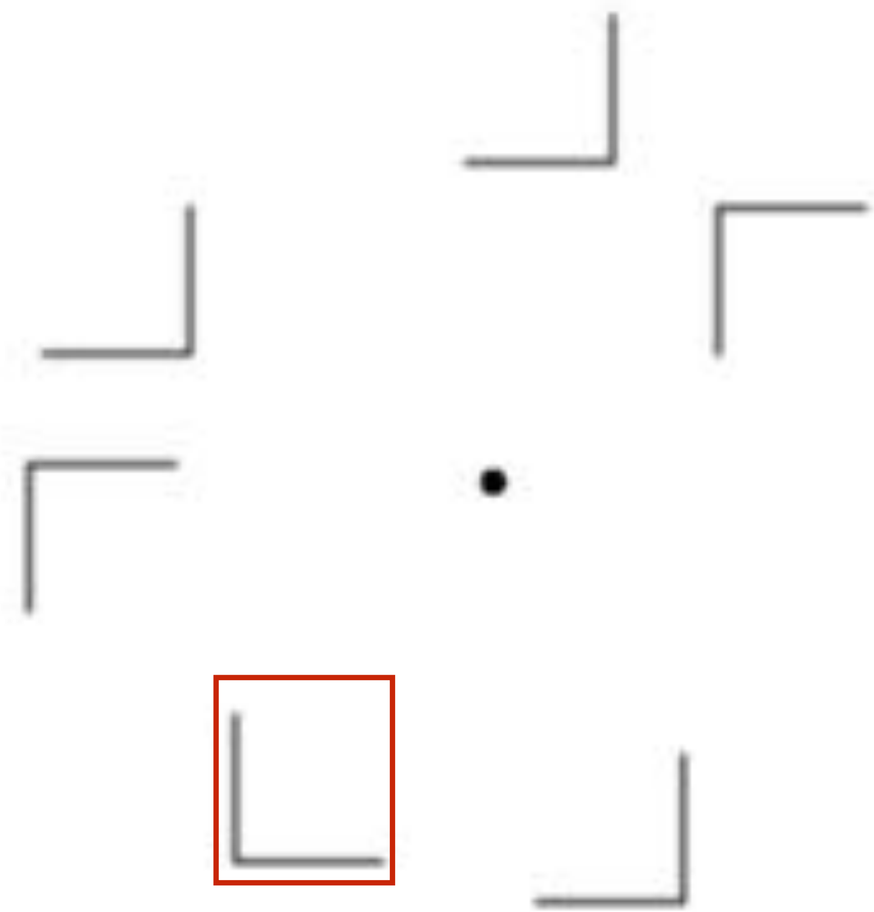

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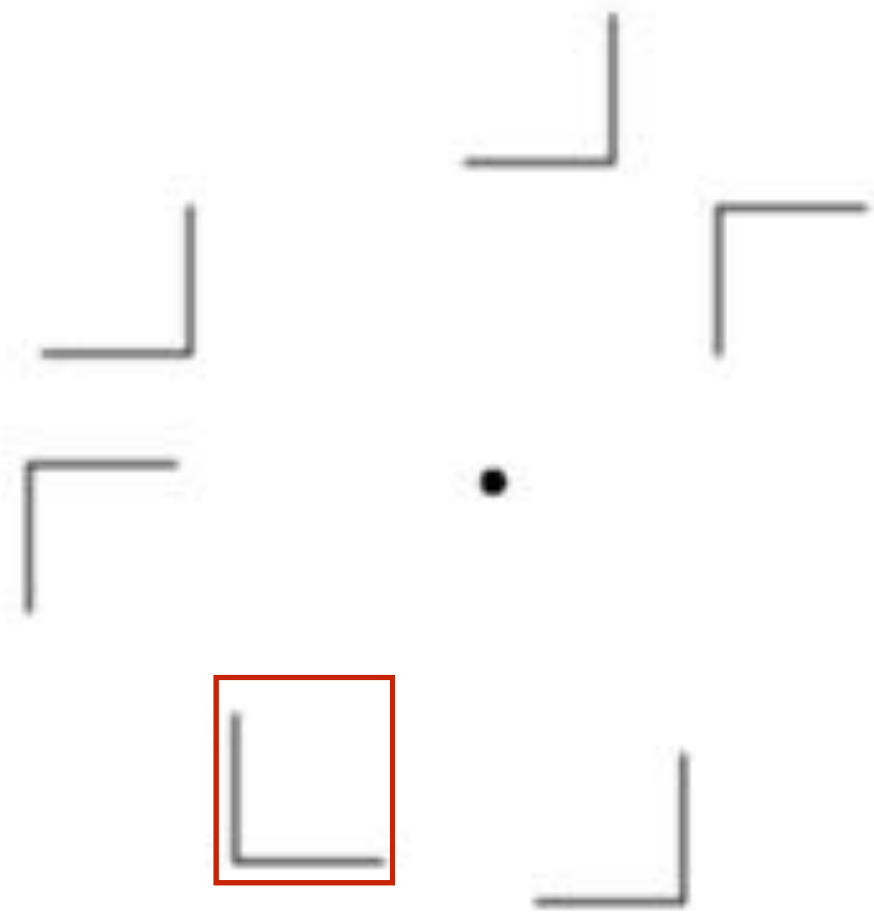

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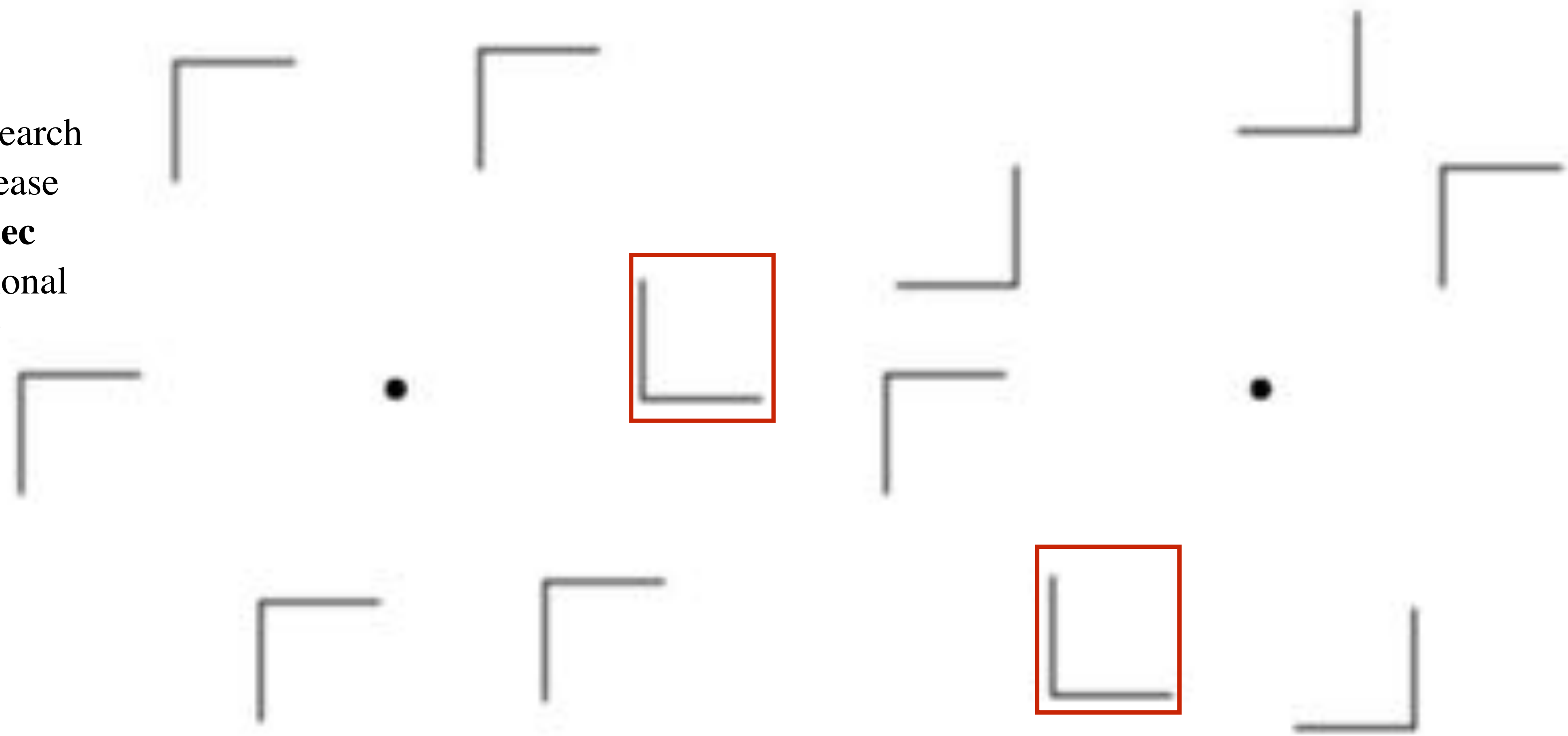

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Postattentive Vision

- Preattentive processing asks in part:
  - What visual properties draw our eyes, and therefore our focus of attention, to a particular object in a scene?
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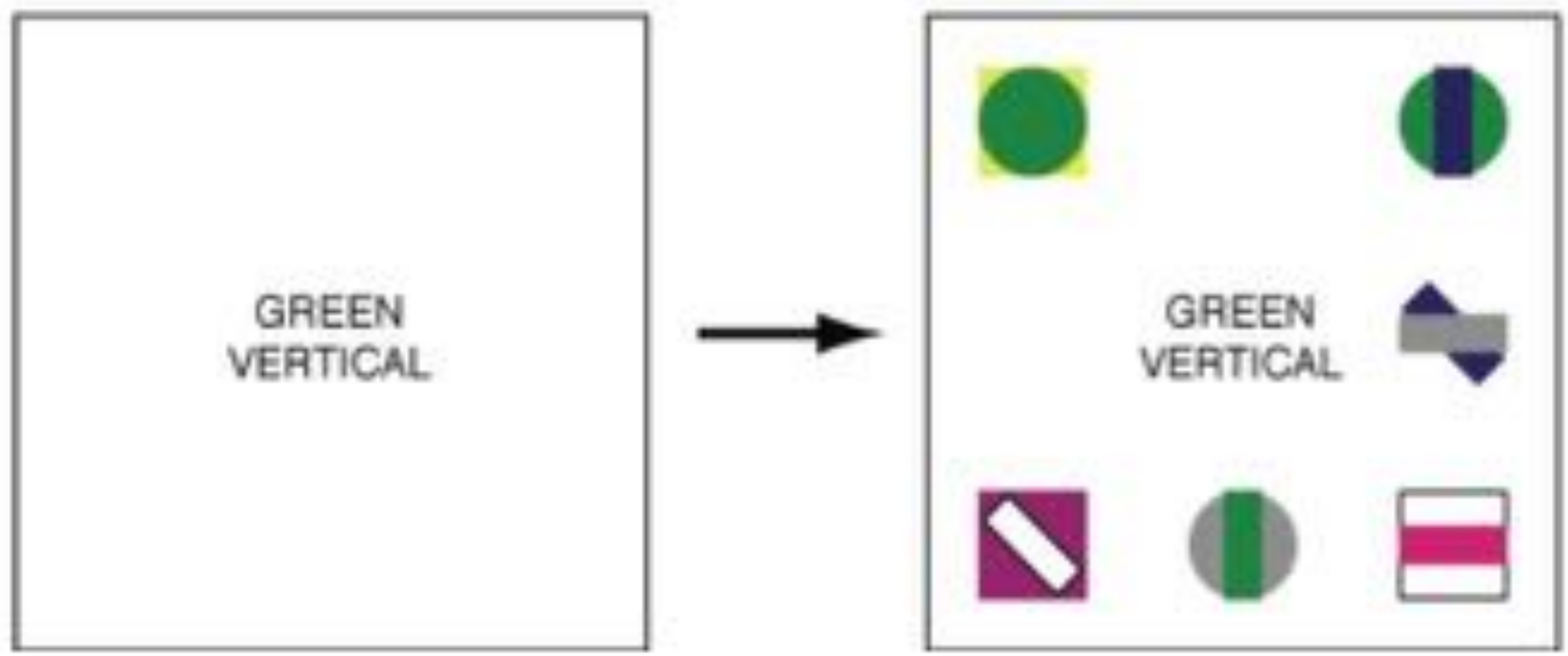
  - **The targets were arbitrary combinations of colors and shapes (e.g., they were not objects that could be semantically recognized and remembered on the basis of familiarity).**
- **Wolfe initially tested two search types (response-time search)**
  - **Traditional search: Text on a blank screen was shown to identify the target. This was followed by a display containing 4, 5, 6, 7, or 8 potential target objects in a 3 × 3 array (formed by combinations of seven colors and five shapes).**
  - **Postattentive search**

Postattentive Vision

- **Traditional search**



Search for color-and-shape conjunction targets:

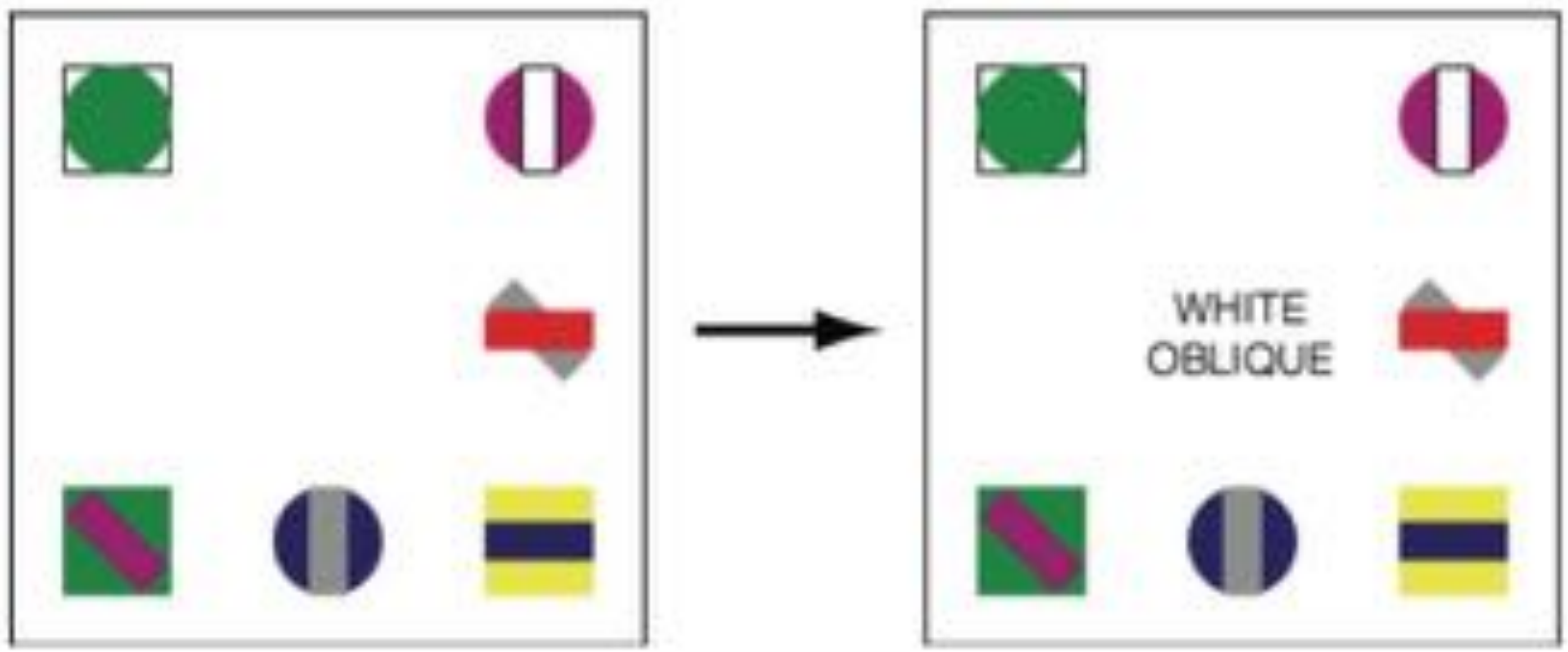
- no preview of the scene is shown (although text identifying the target is shown prior to the search)

- in this case, the green vertical target is present

Figure 3.27 - (Matthew Ward, et. all)

Postattentive Vision

- **Postattentive search**



Search for color-and-shape conjunction targets:
- a preview of the scene is shown, followed by text identifying the target;
- in this case, a white oblique target is not present

Figure 3.27 - (Matthew Ward, et. all)

Postattentive Vision

- **Postattentive search**
  - **The display to be searched was shown to the user for a specific duration (up to 300 msec)**
  - **Text identifying the target was then inserted into the scene**
  - **Results showed that the postattentive search was as slow (or slower) than the traditional search, with approximately 25–40 msec per object required for the target present trials.**

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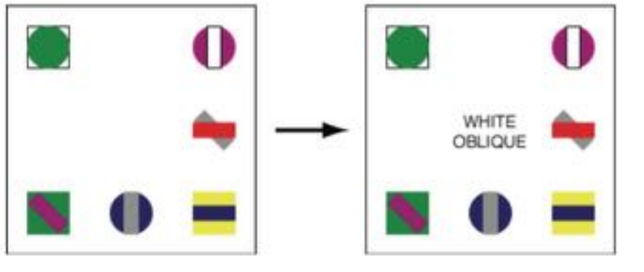
- **Previewing the scene provides no advantage to the viewer for finding a conjunction target**



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- **What we "see" when confronted with a new scene depends as much on our goals and expectations as it does on the array of light that enters our eyes.**

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- **New research in psychophysics has shown that an interruption in what is being seen (i.e., a blink, an eye saccade, or a blank screen) renders us "blind" to significant changes that occur in the scene during the interruption**

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Figure 3.30 - (Matthew Ward, et. all)

Change Blindness

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- A list of possible explanations for why change blindness occurs in our VS:
  - Overwriting: information that was not abstracted from the first image is lost.
  - First Impression: hypothesis that only the initial view of a scene is abstracted.
  - Nothing Is Stored: after a scene has been viewed and information has been abstracted, no details are represented internally.
  - Everything Is Stored, Nothing Is Compared: only compared is requested
  - Feature Combination: details from an initial view might be combined with new features from a second view.

Summary

Q&A

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Q&A

Further Reading and Summary

Q&A

Further Reading

- **Pag 81 - 117 from Interactive Data Visualization: Foundations, Techniques, and Applications, Matthew O. Ward, Georges Grinstein, Daniel Keim, 2015**

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- **The eye main components and their role in the human vision system**
  - The motion control muscles; cornea, pupil, iris and the crystalline;
  - Retina: Rods and cones; the differences, the roles, the placement, the relative quantities.

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- **The concept of Preattentive Processing.**
  - Why the name Preattentive is not completely correct?
  - Examples of visual properties
  - Examples of tasks (Target detection, Boundary detection, Region tracking, …)
  - Time to performed on large multi-element displays in less than 200 to 250 milliseconds
  - What is the meaning of conjunction target
  - key perceptual attributes: luminance, brightness, color, texture, and shape.

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- **How to Measuring preattentive task performance (response time and accuracy)**

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  - Texton Theory (elongated blobs, terminators, crossings). Difference in textons or in their density
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