



# Human perception of images

Kurt Osterloh



5<sup>th</sup> BAM-DIN-WS: perception of images

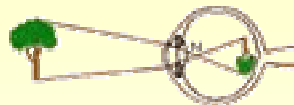


1

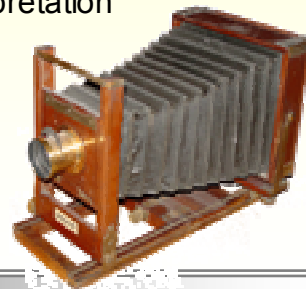
## How does perception work?



The optical sensory organ functions like a camera



- optical efficiency
- “detector” function
- information processing
- interpretation

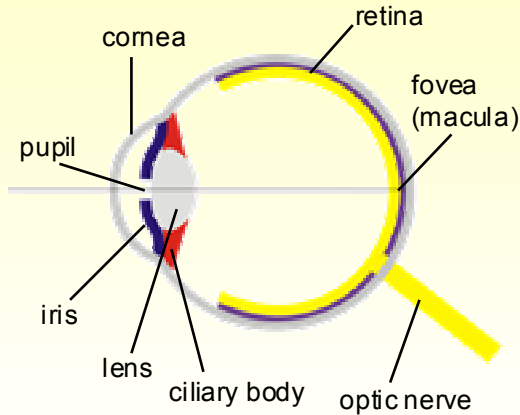


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## Efficiency of the Eye:



60 - 80 grey levels at a time

**but**

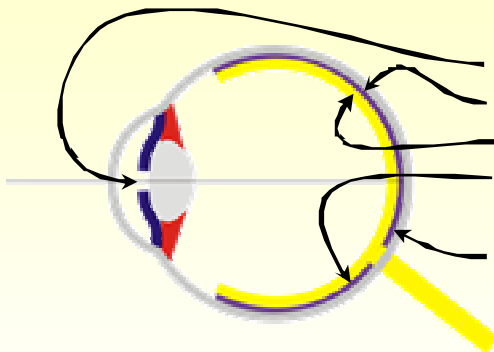
has to cope with a dynamic light range of **8 magnitudes**:

from  $10^{-3}$  cd/m<sup>2</sup> (starlight)  
to  $10^4$  cd/m<sup>2</sup> (sunlight)



***adaptation required***

## Efficiency of the Eye:



Several adaptation mechanisms:

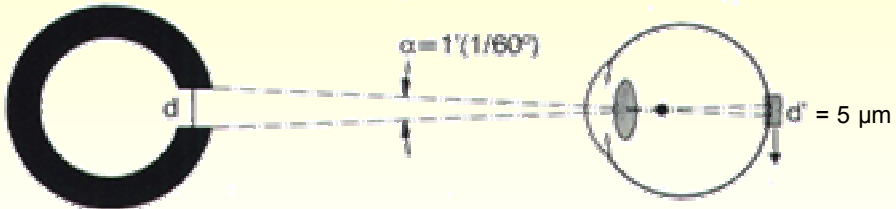
- Changing size of **pupil**
- varying **pigment** content
- altering **area** per neuron
- predominant activity of **cones/rods**
- different **exposure** length required for excitation



Different brightness and contrast distributions between image and perception

**Measuring visual acuity:**

visus =  $1/\alpha$  (angular minute<sup>-1</sup>)  
normal visus = 1  
length of d in 30 cm distance: 87  $\mu\text{m}$   
(equivalent to 291 dpi)

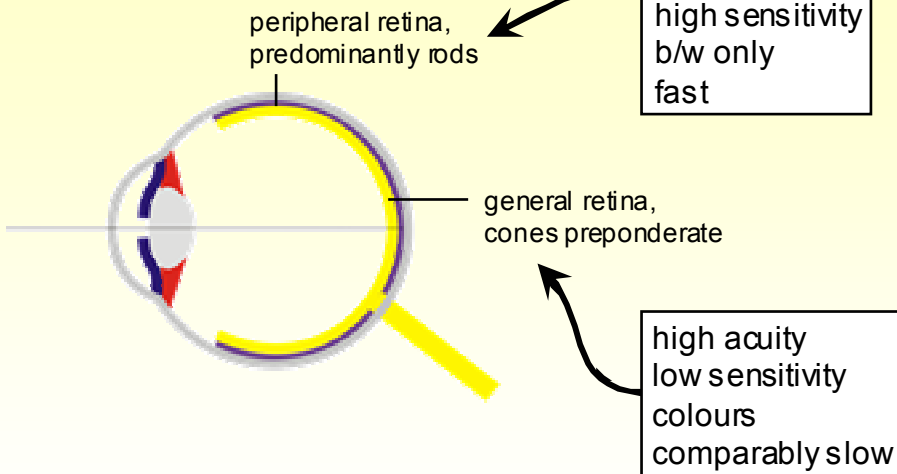


Fovea cross diameter = 1.5 mm,  
 $\sim 100 - 250$  thousand cones /  $\text{mm}^2$

EN ISO 8596/96 Visual acuity test types:  
**Landolt ring** optotype for non-clinical purposes



**Areas of specialisation:**



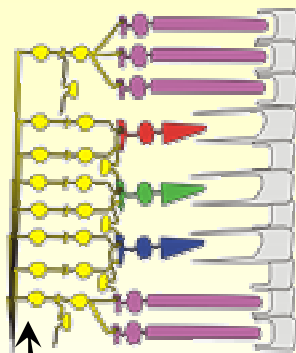
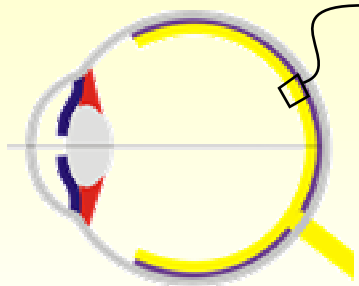
How do we perceive an image in total?



An Image is not just an arrangement of details



Eye:



110 million rods

6 million cones

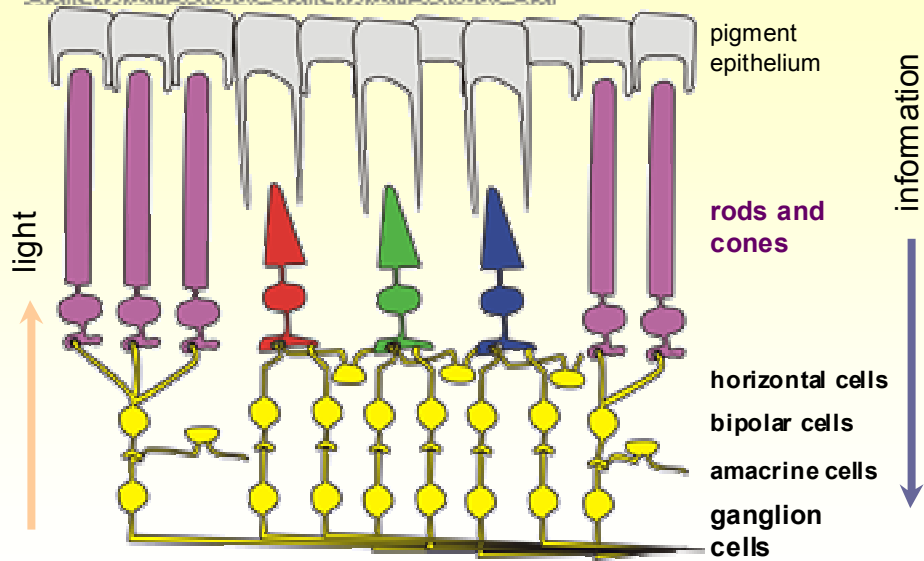
1 million ganglion cells

... an „intelligent“ detector



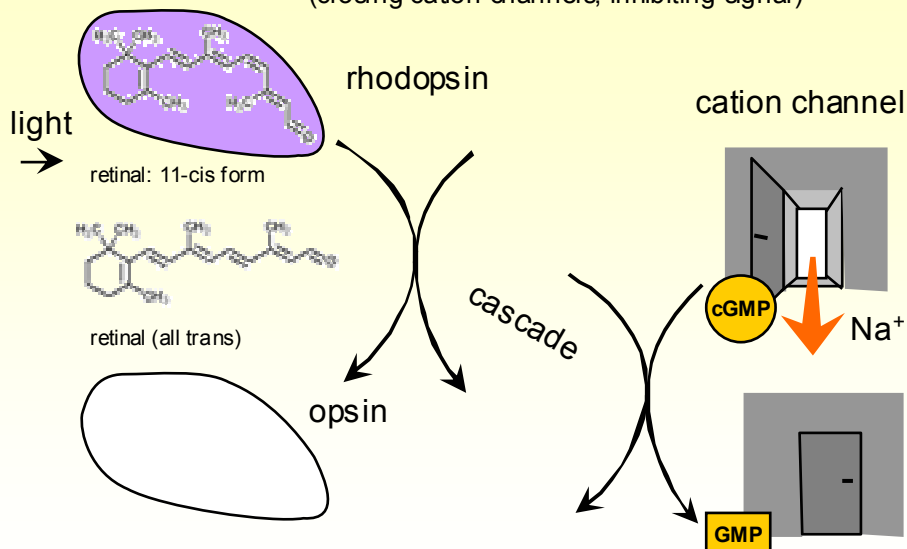
3 million pixels

## Retina structure and organisation



## Retina function

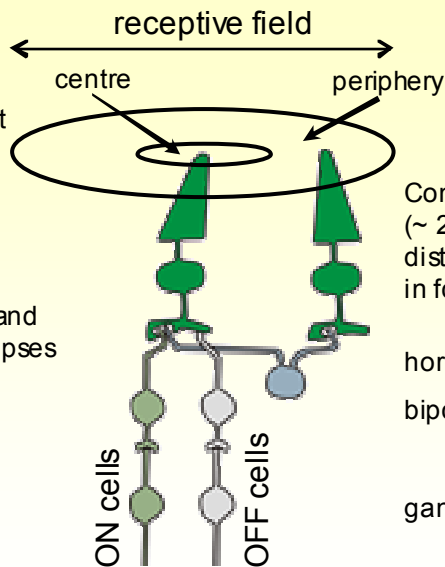
Receptors react upon light with **hyper-polarisation** (closing cation channels, inhibiting signal)



## Retina function

Receptors react upon light with **hyper-polarisation** (closing  $\text{Na}^+$  channels, reducing transmitter flux, inhibiting signal)

**inverting** and direct synapses



Cones  
(~ 2,5  $\mu\text{m}$   
distance  
in fovea)

horizontal cells  
bipolar cells

ganglion cells

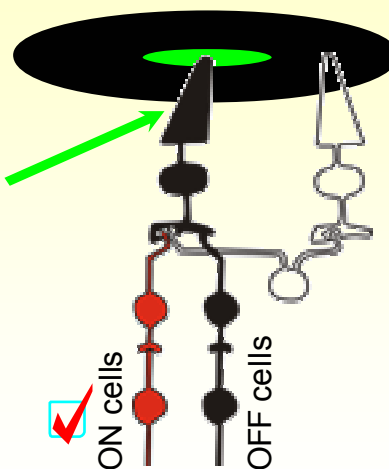
## Retina function

light to the centre

**hyper-polarisation**  
as an answer to light

**inversion** at the  
invaginated synapse

**Excitation** of the  
ON cells



ON cells

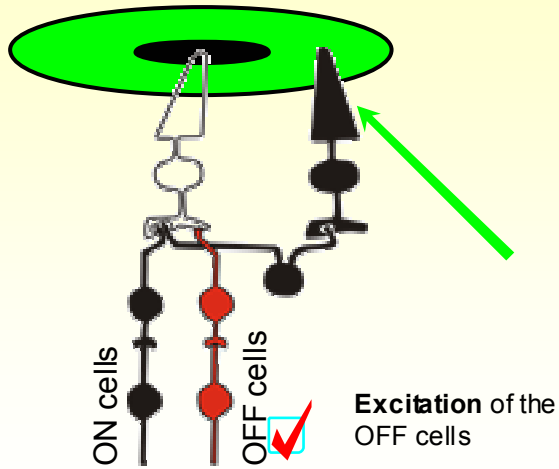
OFF cells

# Retina function

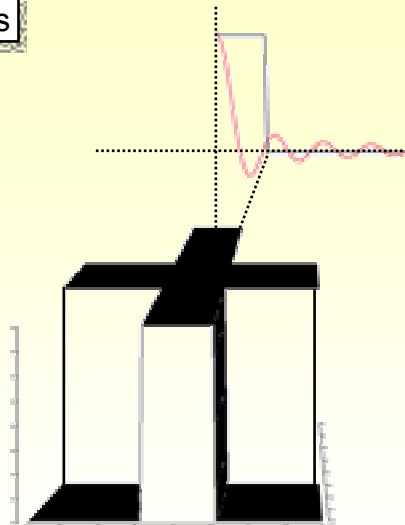
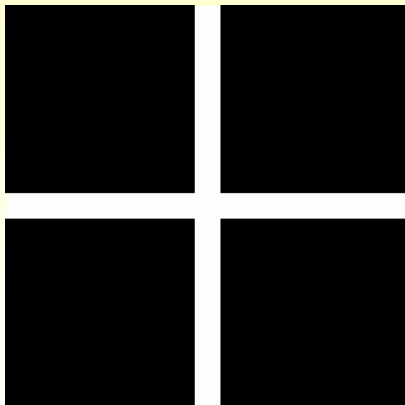
light to the periphery

hyper-polarisation  
as an answer to light

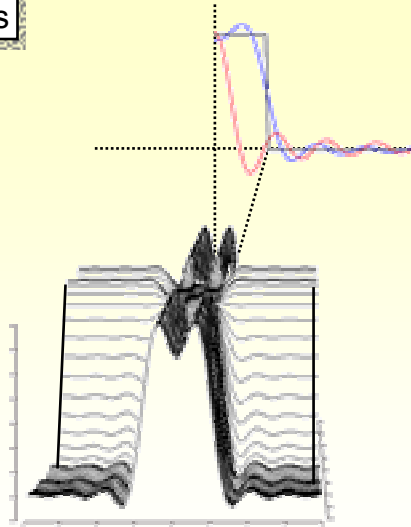
inversion through  
the base of the  
central cone



# Filtering by ON/OFF-ganglions



## Filtering by ON/OFF-ganglions

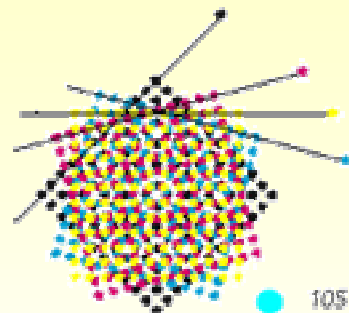
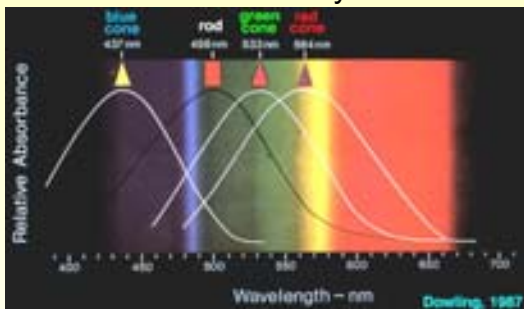


filtering: recognising edges rather than grey values

## Colours:

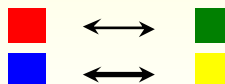
human eye: RGB

print media: CMYK



but:

exclusive antagonism:



Perception of colours is based on:

- hue (200 different)
- saturation (26 steps)
- brightness (about 500 steps) → Up to 1 million distinctive levels



## Colour “consistency”:

colours within the number plate:



daylight,  
automatic setting

artificial light (bulb),  
daylight setting

artificial light (bulb),  
white balance setting

Differences between  
object and perception

2BA 1311

histograms



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## Image, impression, impressionism



But perception of colours might be  
also dependant on light (weather)  
conditions and mood.

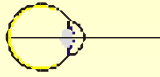


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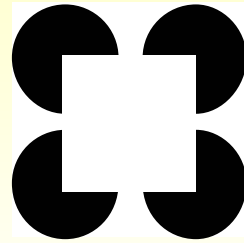
## Visual perception of images:



### Vision (visual sensation):

- optical detector,
- adaptation, filtering,
- most precious orientation tool.

illusory contours



failure to  
co-  
operate:  
agnosia



### Perception (receiving the message):

- motion control, modulation, attention,
- directions, extensions, shapes, colour,
- interpretation of optical image,
- recognition.

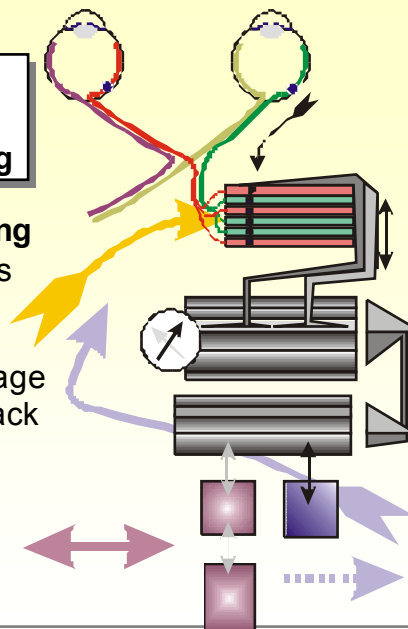


## Perception: simultaneous image processing

parallel processing  
of colours, patterns  
and motion

modulation of image  
sensation, feed-back  
control

information  
exchange with  
related areas



### eye

- detector
- contrast
- filter

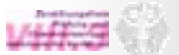
### thalamus

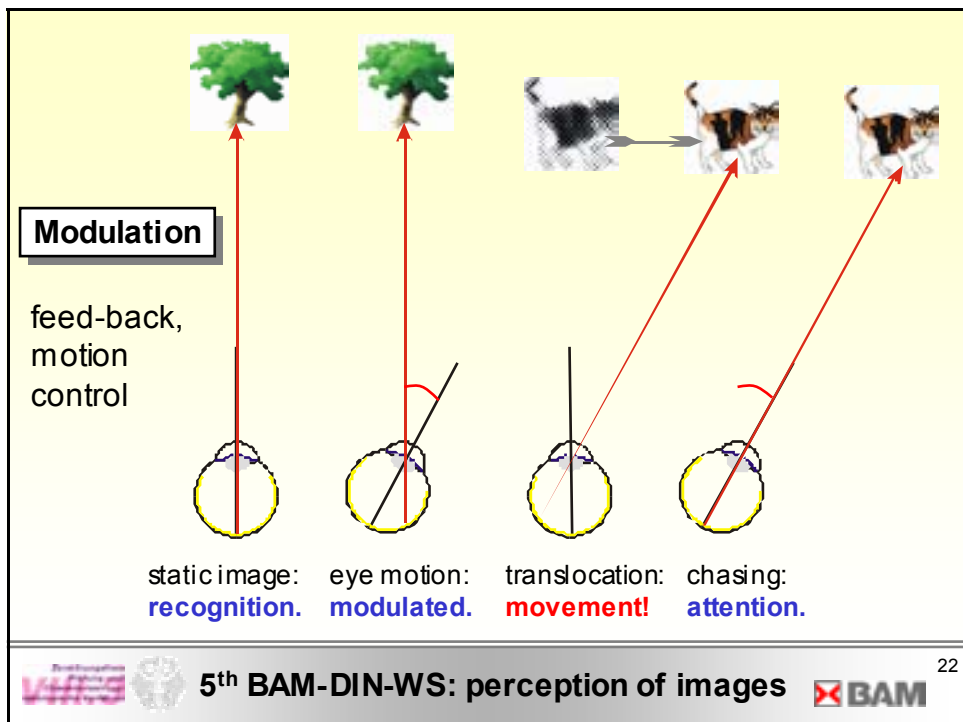
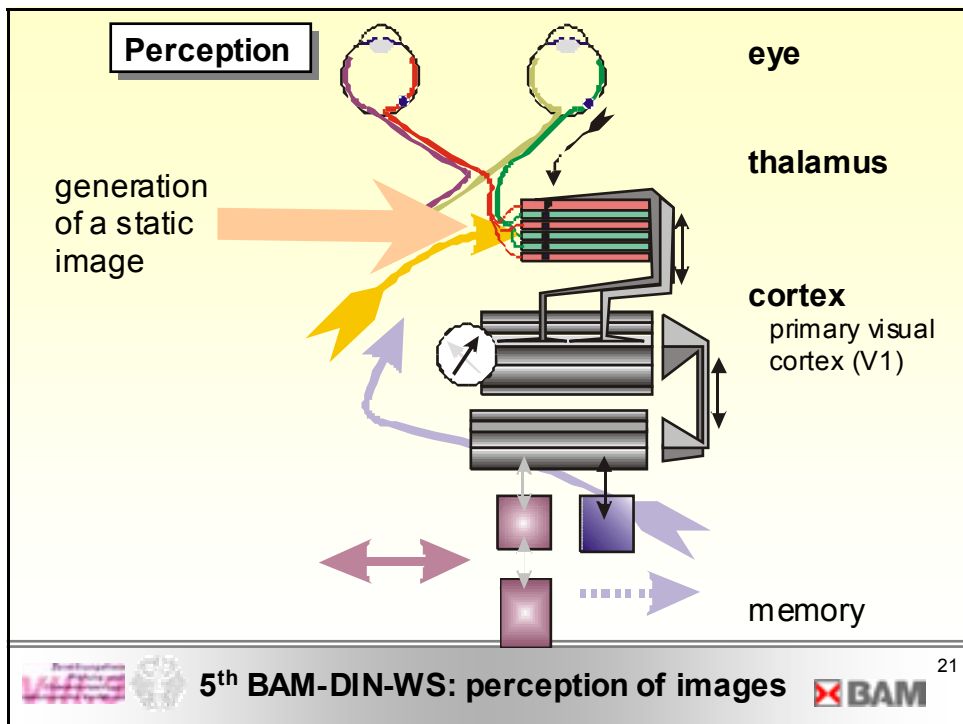
- copies (MTFs)
- modulation

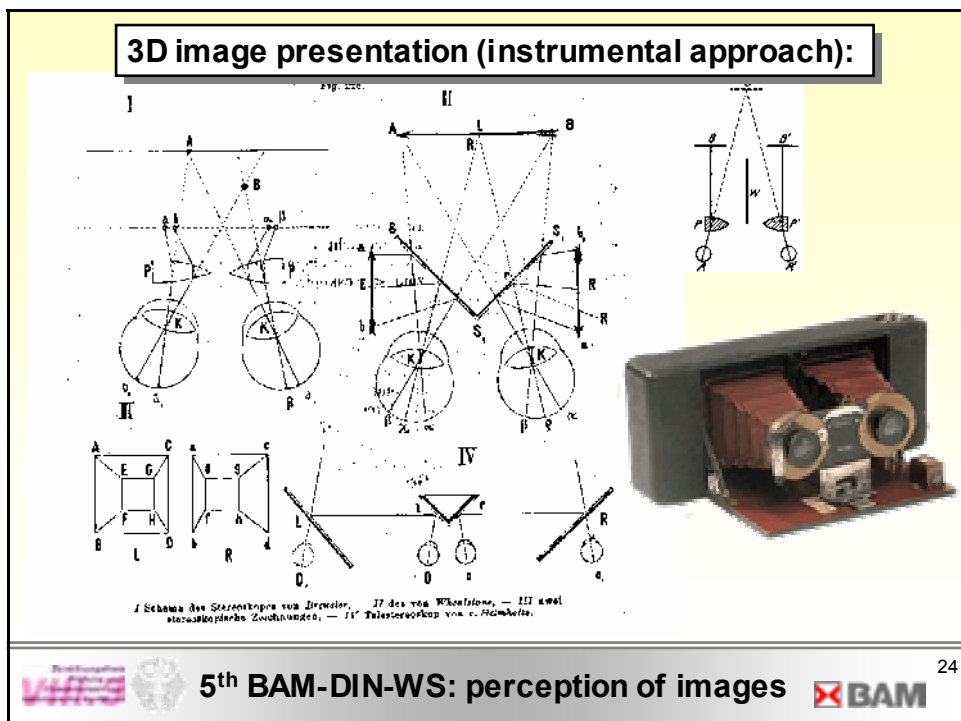
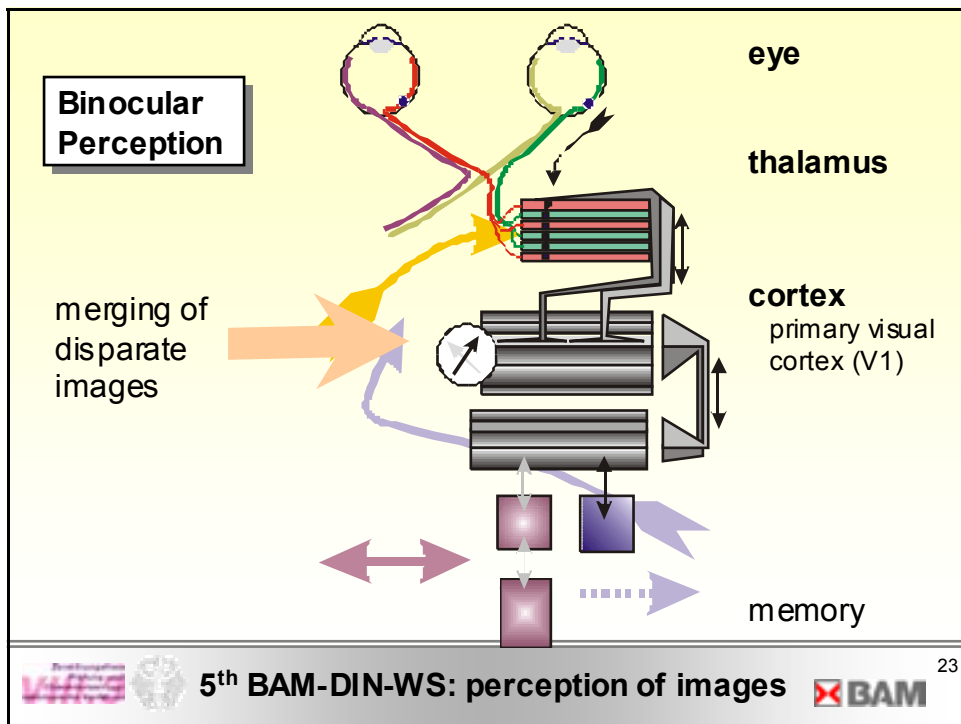
### cortex

- directions
- colours
- patterns
- motion
- col. constancy
- attention
- associations
- "Gestalt"

memory

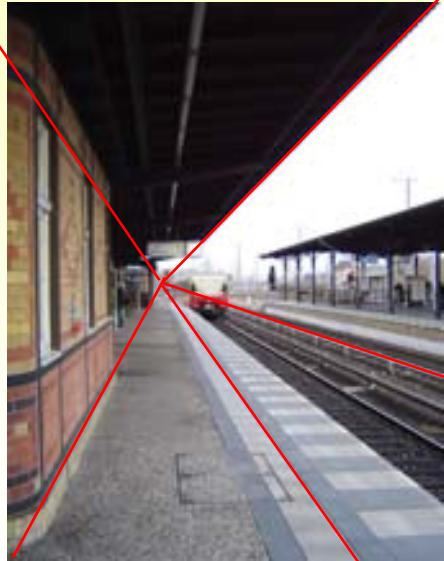
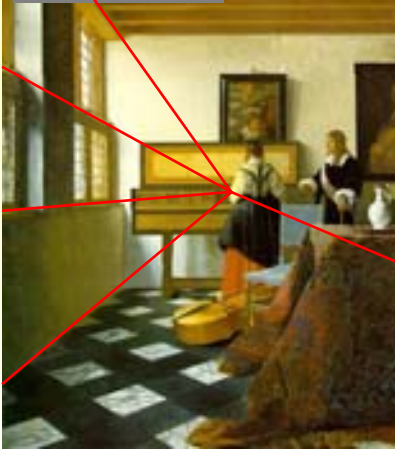






**Perspective:**

perception of spatial depth



Johannes Vermeer  
(1632 -1675)  
The Music Lesson

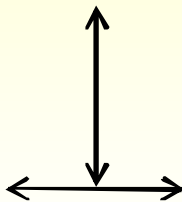
photography  
focus on signal



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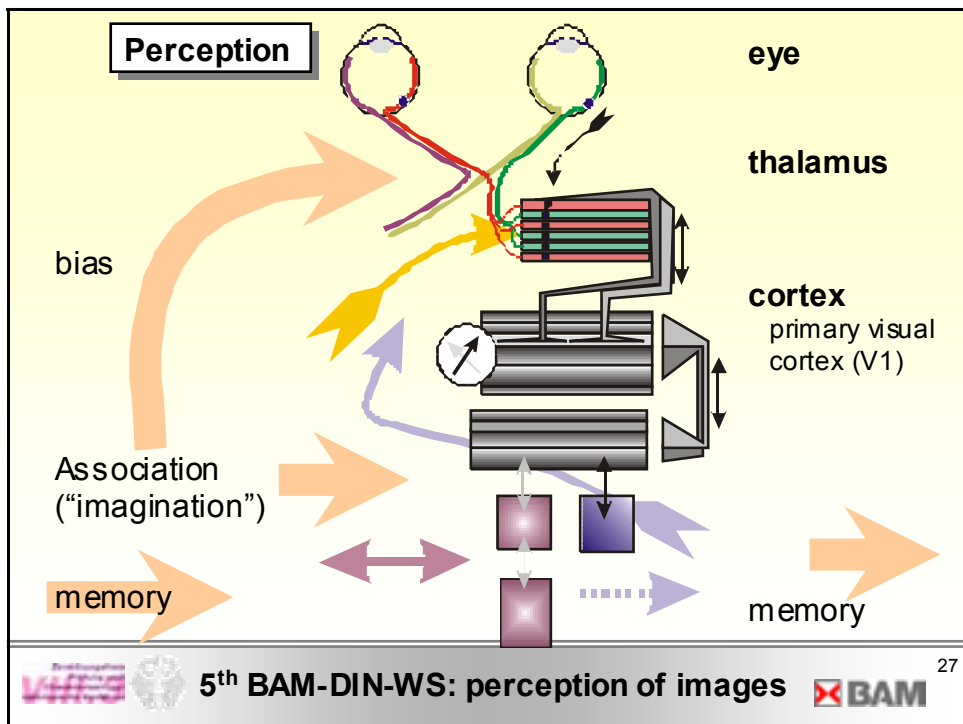


**Anisotropy of directions**



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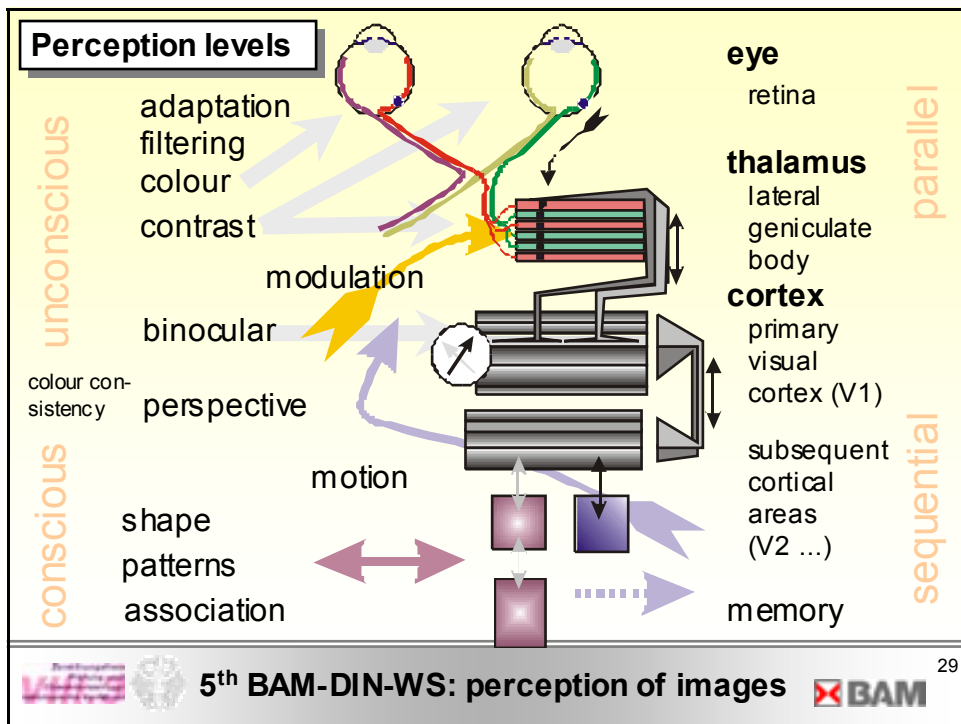
**Perception:**

**light and shadow**  
facilitating impressions

Joseph Mallord William Turner (1775-1851),  
Fishermen at Sea (1796)

**Sorry, who's this?**

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**Conclusion:**

Visual **sense** has to cope with various conditions and to comply with different demands such as acuity and velocity.

Visual **perception** is a tool for **recognising** the environment adequately and for **orientation**.

↖ Influence and setting of priorities?

**Discrepancies** between **presentation** and **perception** of objects encountered.

Creating a **Gestalt** completes visual perception

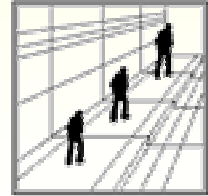
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Thank you very much

**for** your attention



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