

# **European Broadcasting Union**

## **Why are we able to see objects in 3D & Medical point of view of 3D**

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of the**



# Literature recommendation



Excellent explanation of medical and technical conditions of 3D

Author: Yvonne Thomas

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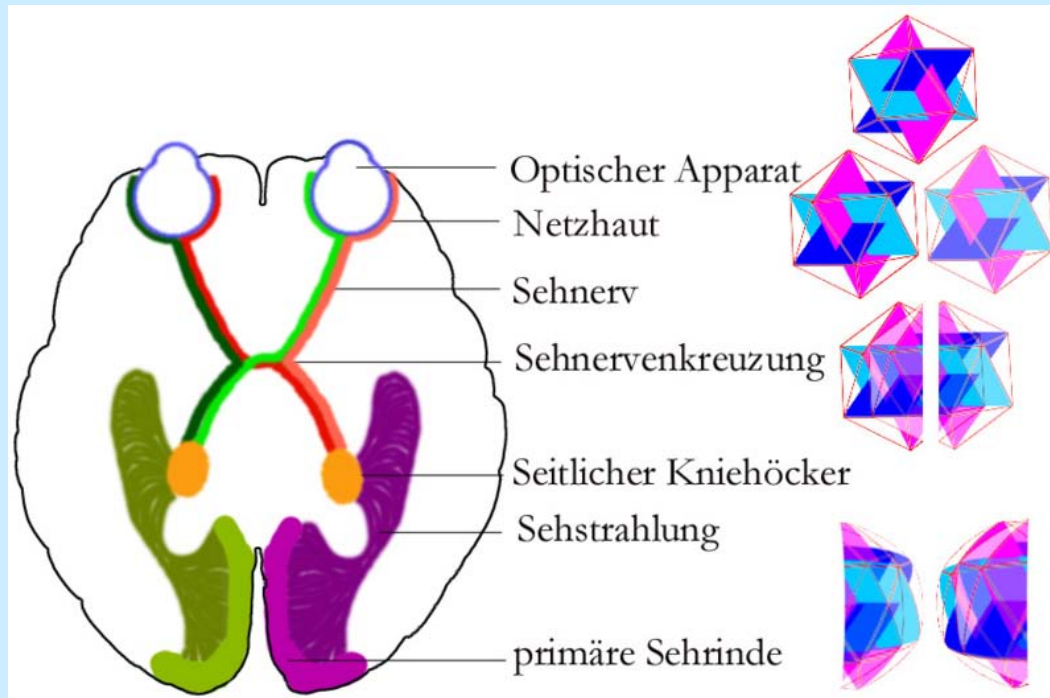
Quelle: Amazon

# Interesting numbers regarding 3D

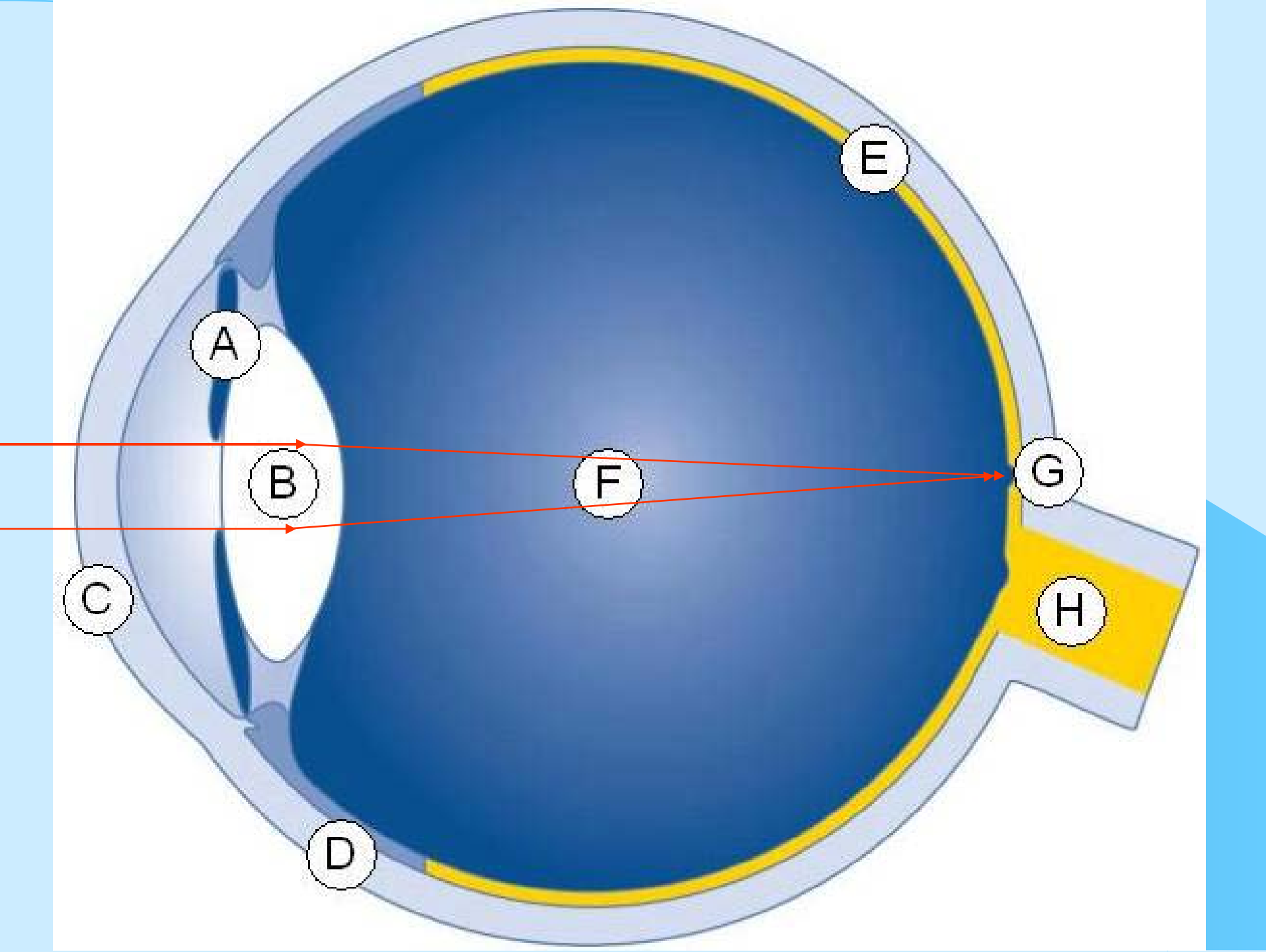
- Four million Germans cannot properly see three-dimensionally, approximately 8 – 12 million are stereoblind
- Reasons: Disturbed eye or brain functions
- Results: Headaches, dizziness, nausea
- There are already precautions from manufacturers as a warning to people with epilepsy or other abnormal reactions

# What is the visual system?

- Optical apparatus
- Visual pathway
- Visual perception

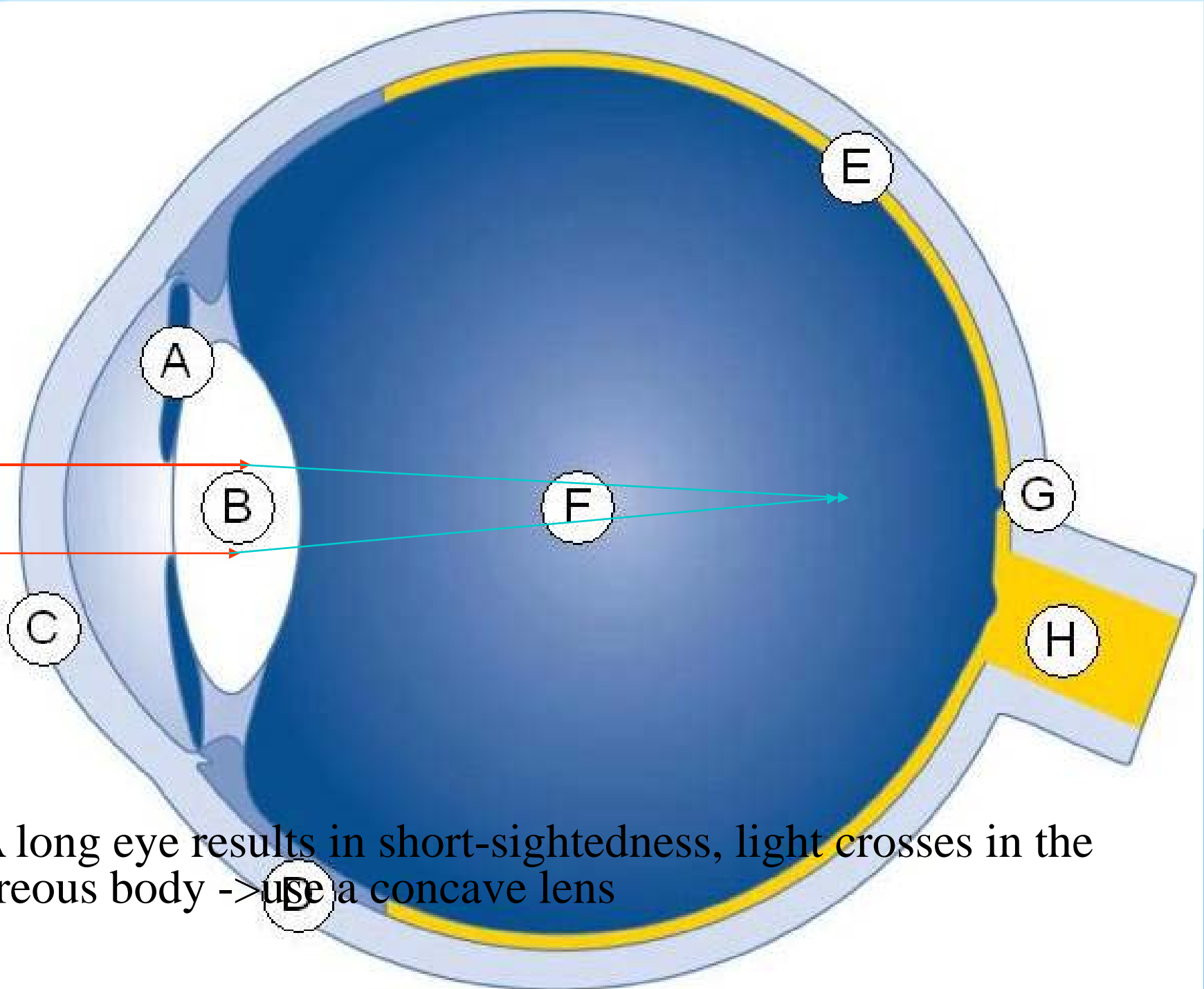


wikipedia

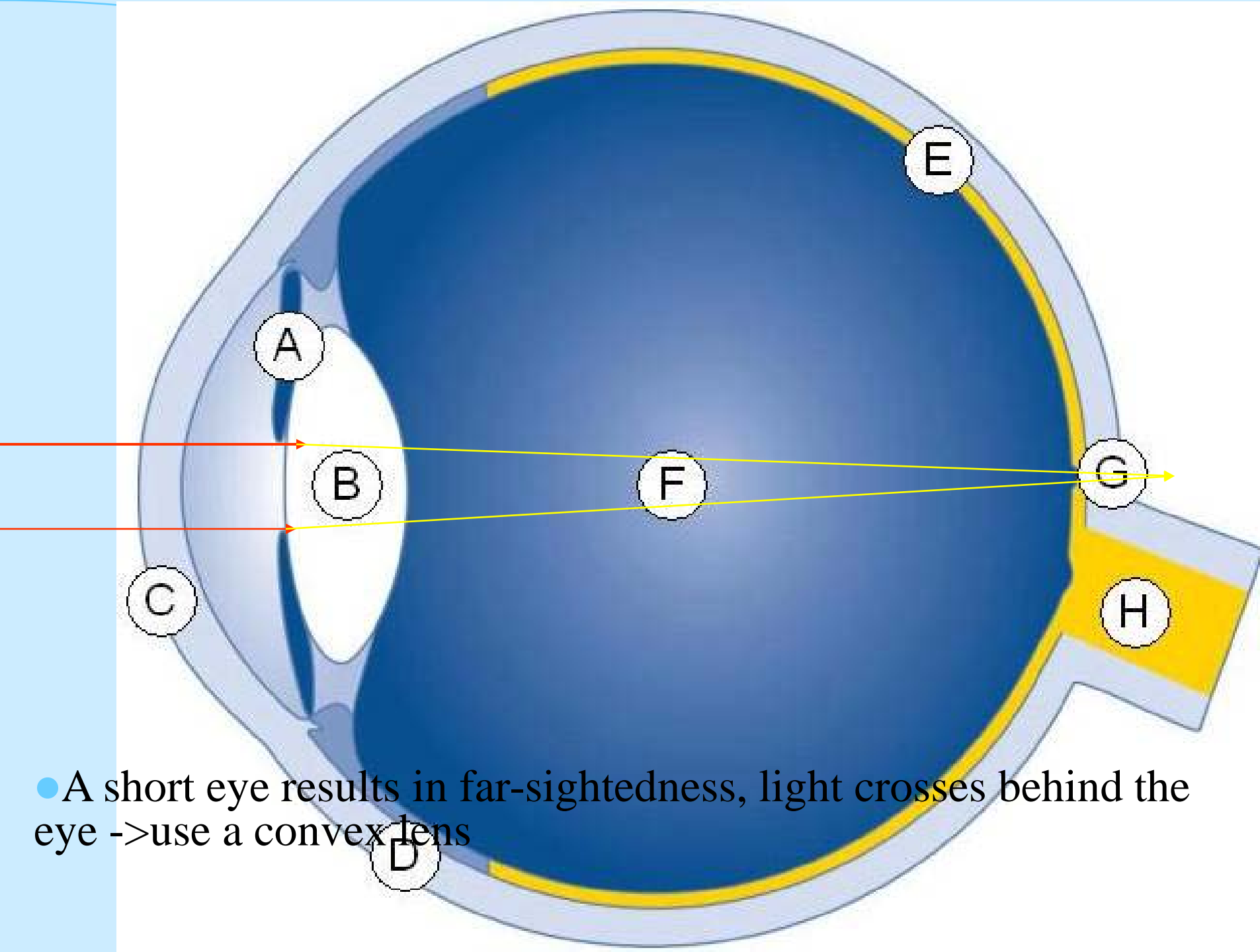


# Optical Apparatus

- The eye optically resembles a photo-camera
- Light enters the cornea, anterior chamber, pupil, lens, vitreous body and reaches the retina
- The corneal refraction concentrates the light to  $\frac{2}{3}$ , refraction of the lens is variable and controlled via the ciliary muscle (accommodation) and consists of approximately  $\frac{1}{3}$  of the total refraction



● A long eye results in short-sightedness, light crosses in the vitreous body -> use a concave lens

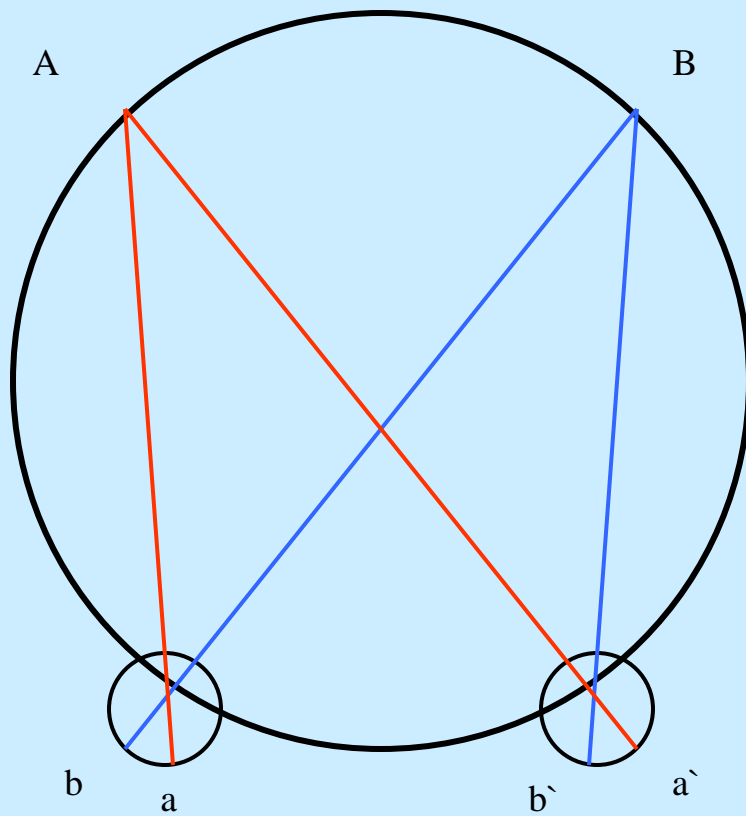




# Disparity, basis for three-dimensionality

- The misalignment of the lines-of-sight of both eyes by arcseconds when looking at an object produces slightly different images on the retina
- The misalignment becomes larger especially when looking at close objects
- An arcsecond or second of an arc is a unit of angular measurement ( $1/3,600$  of a degree)

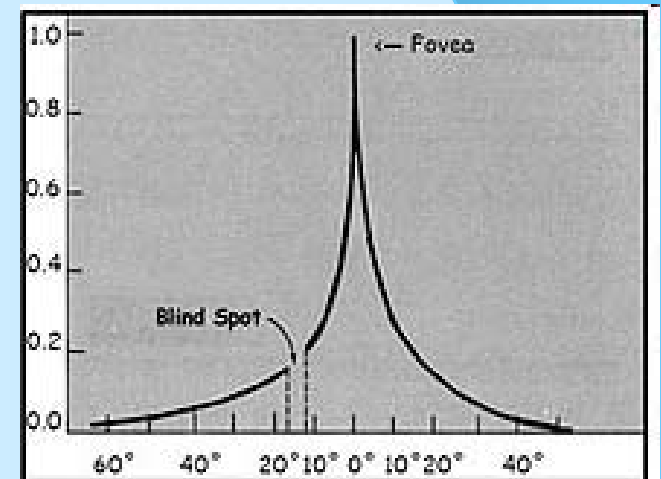
# Disparity



A disparity of more than 2 degrees (0.6mm) on the retina produces double images.

# Color Perception

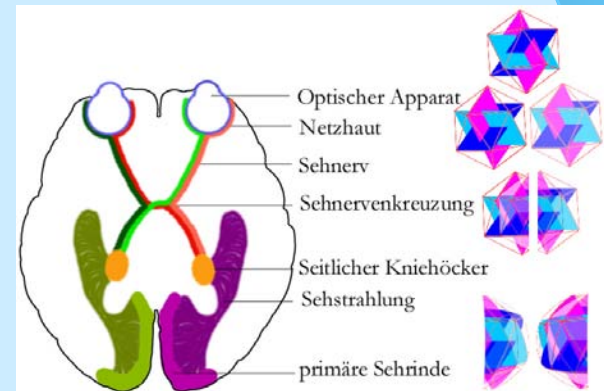
- 7 million cones mainly in the macula contain 3 different pigments and are active in daylight.
- S-Type at 420 nm (blue), M-Type 534 (green)  
L-Type 564 nm (yellow/red)
- The intensity of light entering the eye is controlled by pupillary light reflex
- Normal vision (100%) is only possible in the fovea
- 120 million rods in the entire retina except for the macula (no colors – all cats are grey by night)
- At 10 degrees next to the fovea, only 20% of visual acuity is available (macular degeneration)



wikipedia

# Visual Pathway

- Light hits the retina and excites 130 million light receptors, which connect to 1 million ganglion cells
- Information from the cones are transferred in the macula to nerve cells 1:1
- Further transport to the optic chiasm, to the lateral geniculate body, up to the visual cortex



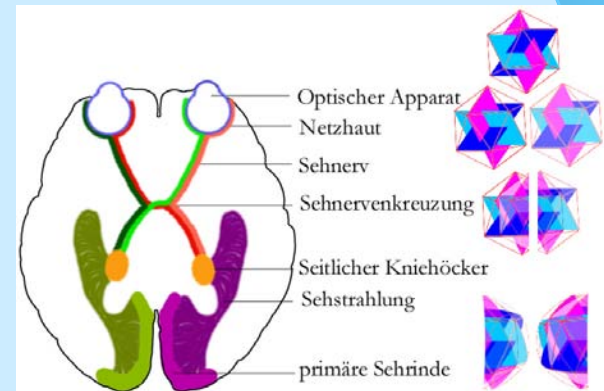
wikipedia

# Visual Depth Perception

- **Monocular cues**
- Oculomotor cues
- Binocular cues

# Monocular Vision

- Monocular = mono (one) ocular = (pertaining to the eye)
- In blindness of one eye, spatial orientation is possible through specific depth cues
- 15% of the population cannot see stereoscopically



wikipedia

# Criteria for depth perception with one eye

- Familiar proportions of various objects can be put into relation with other objects
- The relative size of identical objects which appear smaller although they are the same size. The further away they are, the smaller they appear
- Objects near the horizon appear closer
- The atmosphere creates a blurry image of structures near the horizon, such as the ocean. It appears darker and blurrier.

# Criteria for depth perception with one eye

- Through the visual masking effect one can recognize which object is in front of or behind the other
- Perspectives such as parallel railway tracks lead to one point in the distance



Wikipedia



# Criteria for depth perception with one eye

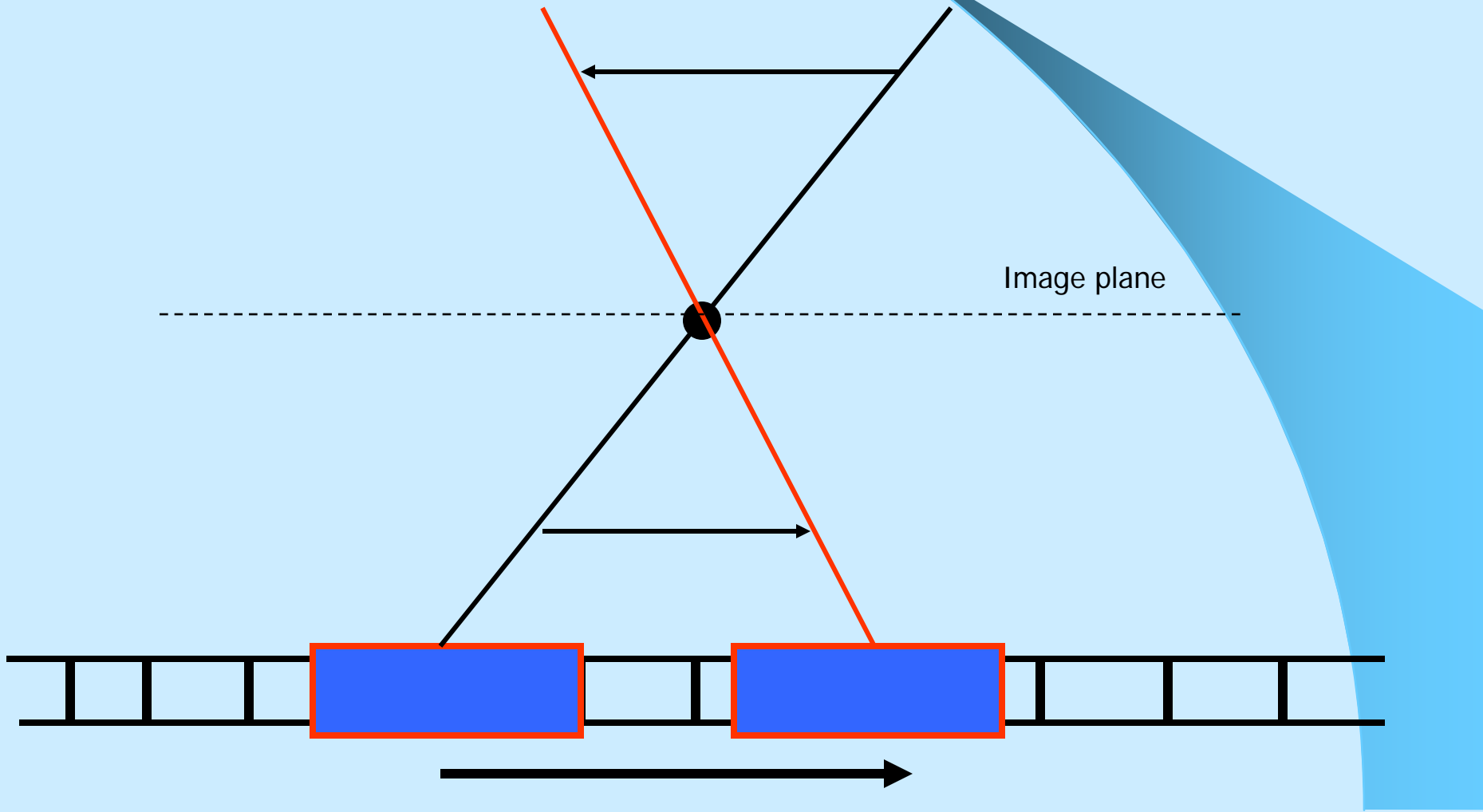
- Homogenous structures (rocks) become smaller with increasing distance
- Using the shadow an object projects, the brain calculates the position of the light source and creates a spatial picture in relation to other objects



# Criteria for depth perception with one eye

- The brain can estimate distances while looking out of a moving train or car in a dynamic parallax, since closer objects move faster than distant objects
- Special feature of projection: Objects behind the image plane move in opposite direction of the observer, objects in the image plane don't move, objects in front of the image plane move with the observer

# Criteria for depth perception with one eye



# Types of Depth Perception

- Monocular cues
- **Oculomotor cues**
- Binocular cues

# Oculomotor Cues

- Take place within the eye
- With increasing distance from the object, depth cues and clarity decrease (depending on visual acuity 0.6-1.6)
- The plane of convergence is found where both lines of sight cross, the range of convergence is the distance to the observer, which provides depth cues for up to 3 meters
- Accommodation allows the fixation and focusing of an object only within a defined distance of up to 2 meters
- Convergence is more important for binocular vision than accommodation

# Types of Depth Perception

- Monocular cues
- Oculomotor cues
- **Binocular cues**

# What is spatial vision?

- Observation with both eyes leads to true depth perception and shows the true surroundings
- Essential conditions are
  - a) two functioning eyes with muscle control and
  - b) a vision center in the brain which can merge images into spatiality

# What is spatial vision?

- Every eye has a slightly different angle to the object
- The further away the object is, the more parallel the eyes are
- At a close distance, convergence assists in turning the eyes inward towards the nose, and an adjustment of the lenses of the eye to a close distance
- The development during early childhood has created this fully automatic process according to anatomical and functional conditions at that time



# Binocular cues

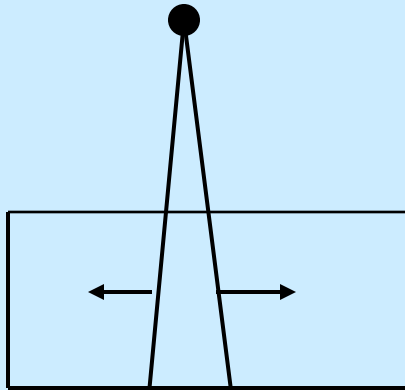
- Binocular depth cues are only present when both eyes are functioning and working together
- The brain can calculate distances of diagonal disparity as horizontal differences (misalignment) of both retinal images. It becomes smaller with increasing distance.
- The parallax describes the relative position of an object within the two partial images in relation to the observer

## Positive Parallax

Visual axes behind image plane

Left partial image further left

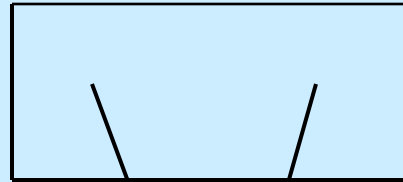
Right partial image further right



## Negative Parallax

Visual axes, object in front of image plane

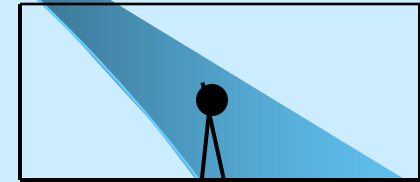
Partial images have switched sides



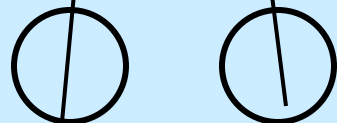
## Zero Parallax

Visual axes in image plane

Objects in partial images in the same place



● = Object



Base distance

# Technical causes for side-effects of 3D

- In normal vision vergence depth and focal depth are identical
- In movies, the screen is fixed, meaning vergence depth and focal depth are adjusted to the screen
- In 3D, objects are in front of or behind the screen, so the fixation point is shifted
- Vergence depth and focal depth are different and stimulate the brain
- The resolution of the image influences the accommodation behavior of the viewer (maximum focus advised when filming)
- Error messages cause illness, headaches, dizziness, nausea, vomiting

# Technical precautions with 3D

- High resolution of cameras in production and equal calibration without vertical or torsion misalignment
- Image plane not distanced too far from screen
- Removal of disagreeable edges of partial image
- Dynamic design of the location of the convergence point in moderation
- No shutter glasses in epileptics

# Side-effects of 3D in children?

- **Previous theory:** It is feared that because of the disconnection of vergence depth and focal depth, partial significant side effects can occur in terms of the development in children
- On the other hand, medical experience with children in orthoptics shows: Proper stimulation leads to improvement of sight, even in advanced anisometropia with weakness of sight, normal sight develops, which no longer would be possible in adults
- **Thesis:** Especially children up until 6 years of age profit from 3D training, since the eye-brain system is still in learning stage and by seeing an additional „dimension“, such as artificial 3D, can be easily learned with normal eye and brain function

# Medical causes for side-effects of 3D

- Eye-dependent causes
- General health impairments

# Medical causes for side-effects of 3D (Eyes)

- Visual defects (far- and shortsightedness, astigmatism, anisometropia)
- Glasses, contact lenses, Lasik, PRK
- Decrease in visual acuity, image perception problems (scars on the cornea, cataract, visual defects)
- Sensitivity to glare and contrast
- Disruptions in muscle balance (phoria, tropia) and muscle strength (myasthenia)
- Problems with accommodation (age, glaucoma, cataract)

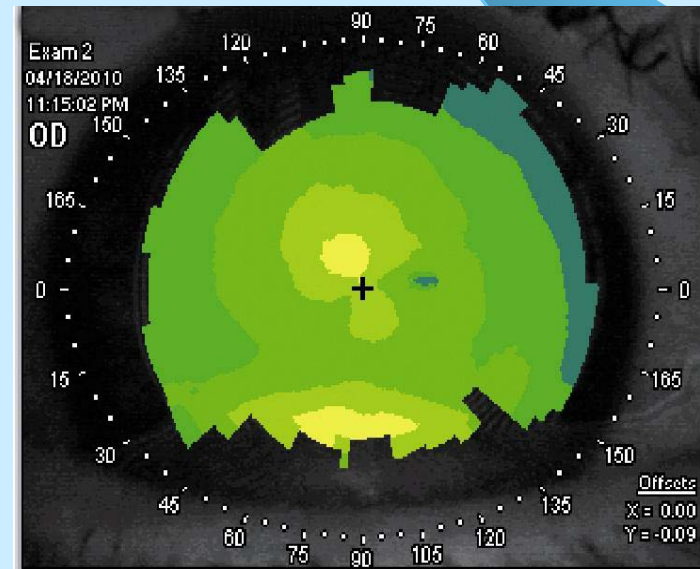
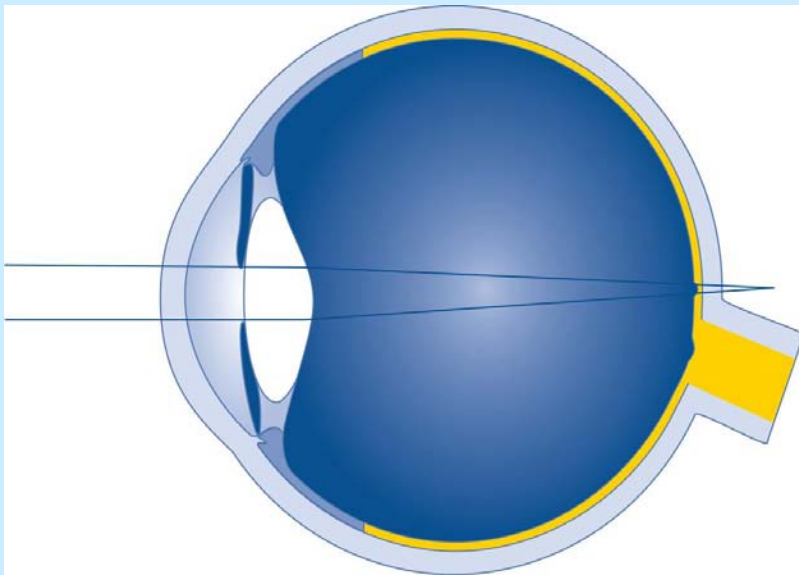
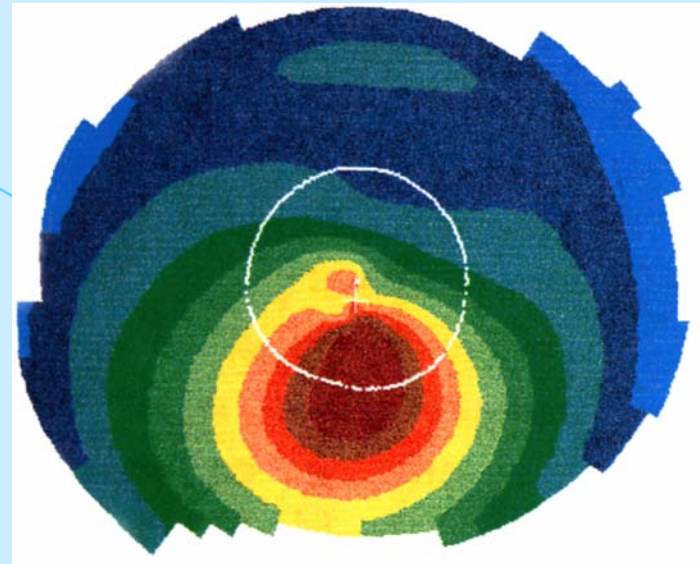
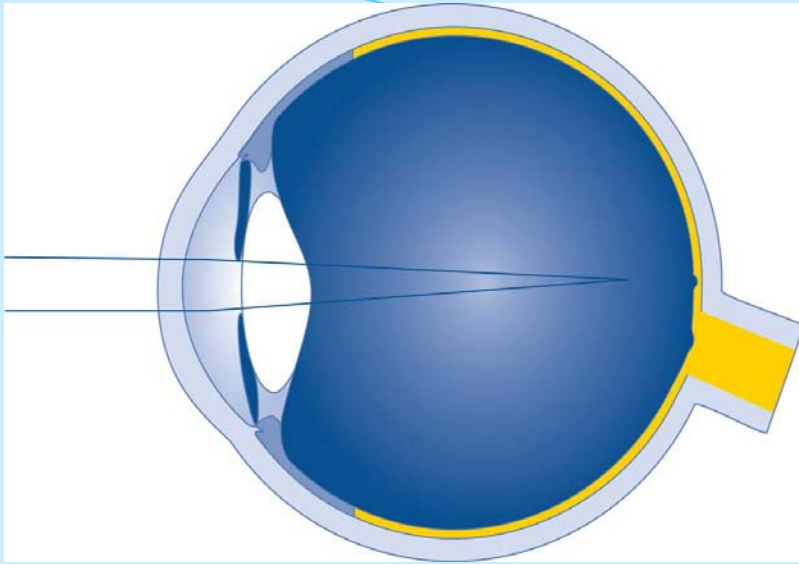
# Medical causes for side-effects of 3D (Eyes)

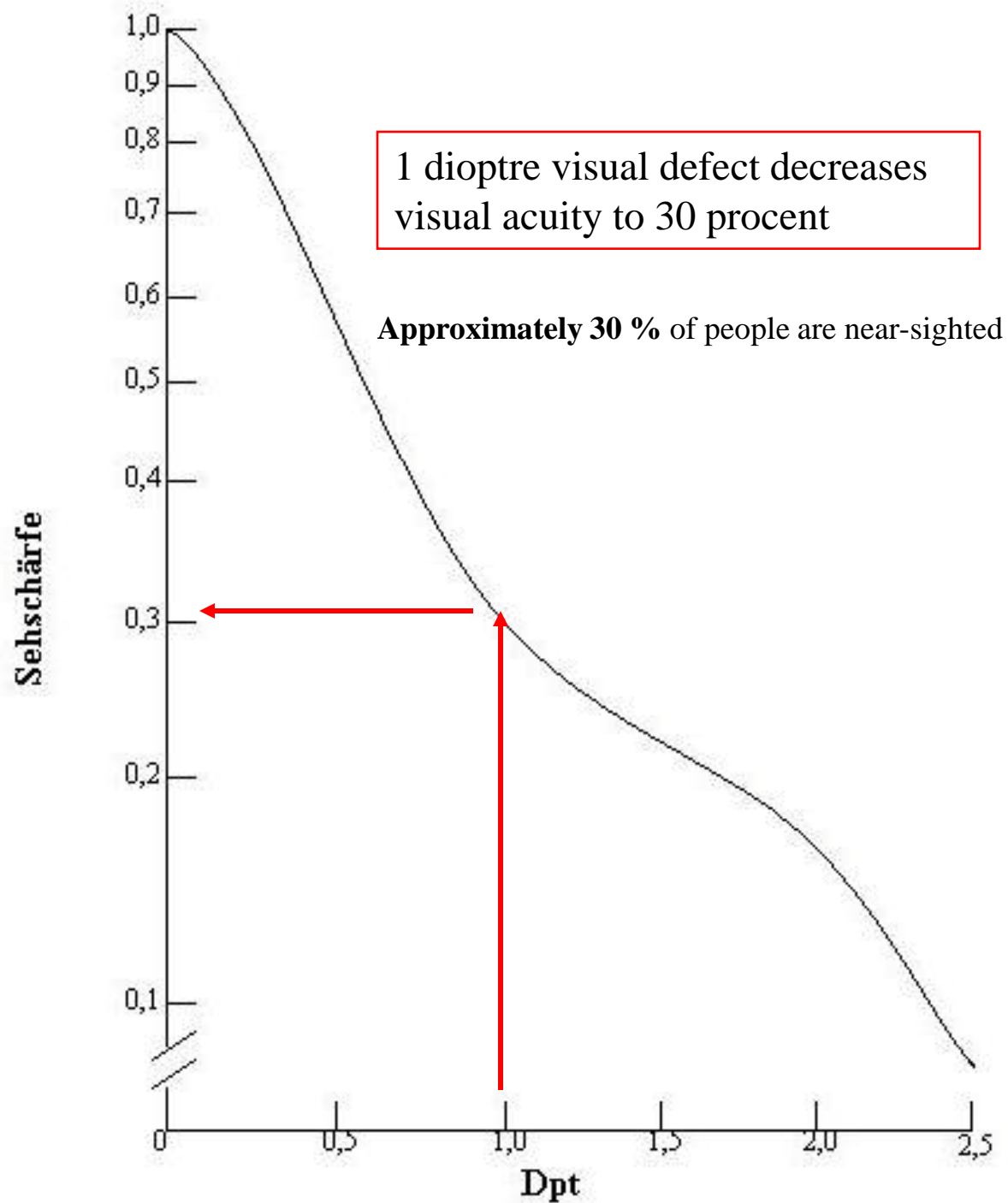
- Nystagmus (involuntary eye movement)
- Amblyopia („lazy eye“)
- Strabismus, phoria (difference in muscle strength)
- Sicca (dry eyes)



# Medical reasons for side-effects of 3D (eyes)

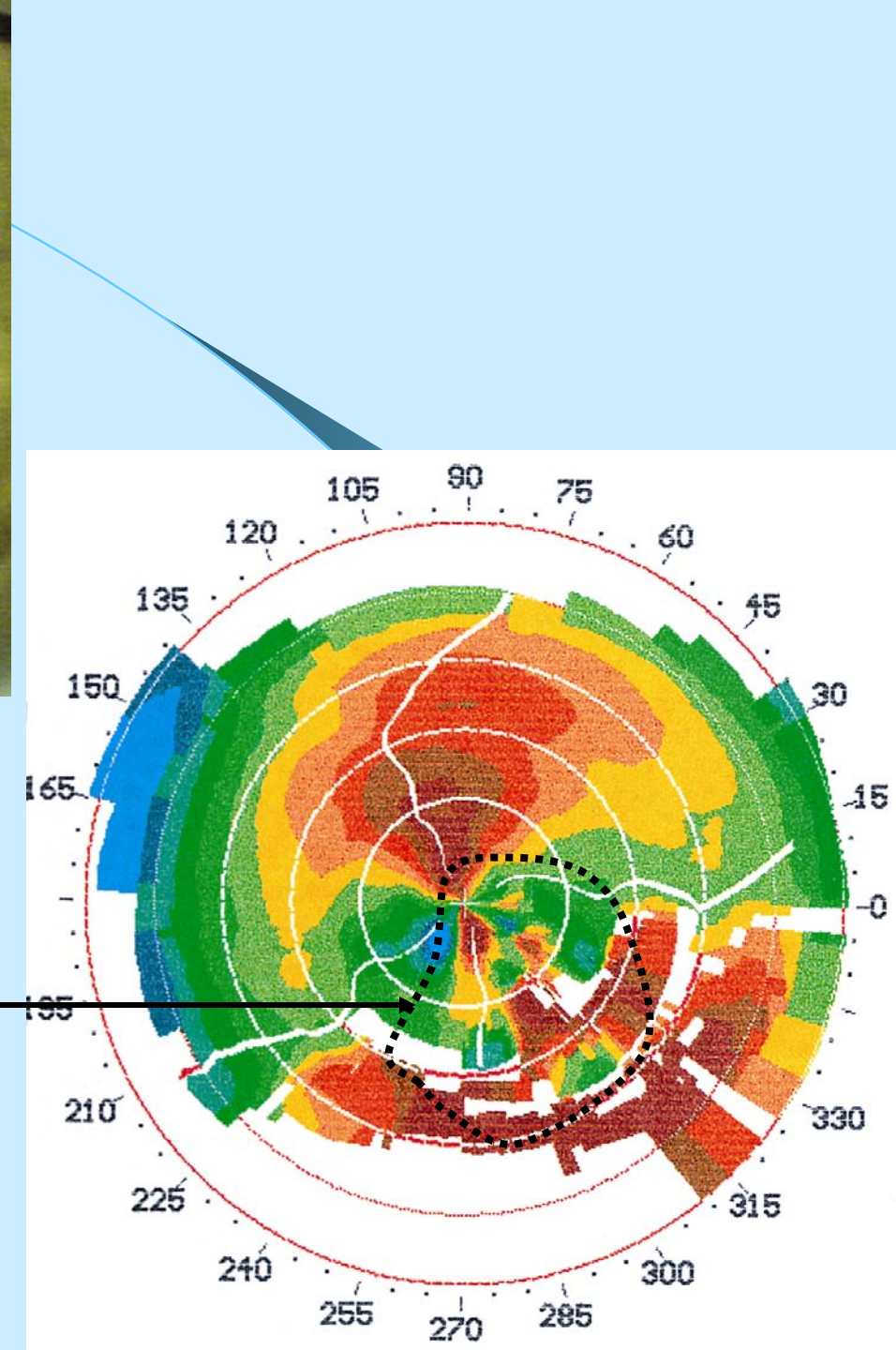
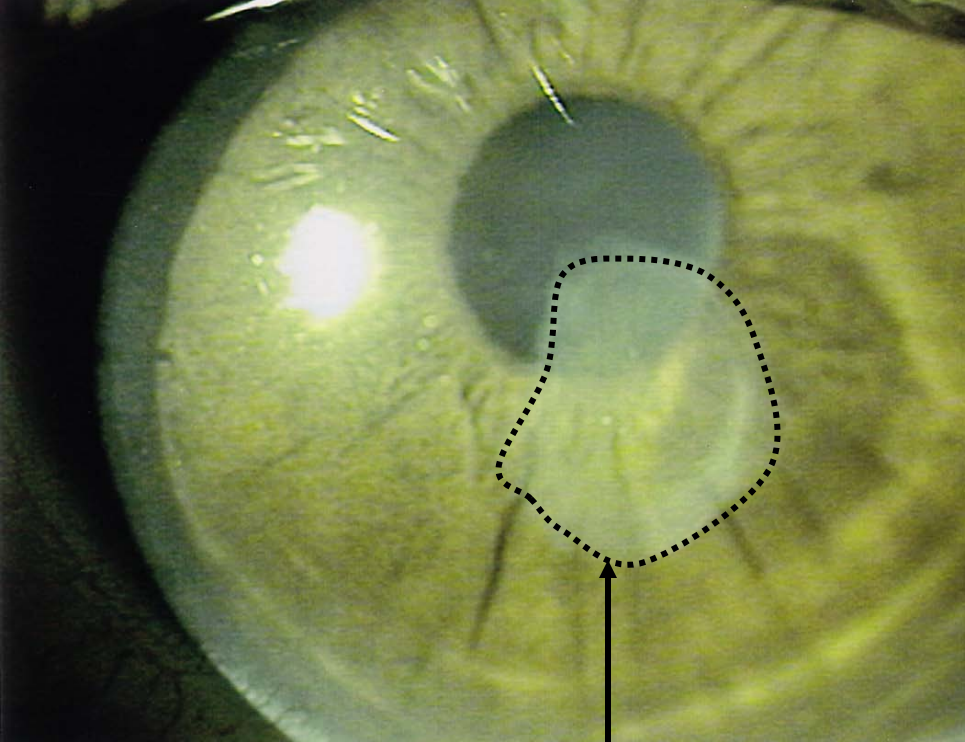
- Cataract (grey star) and secondary cataract
- Macular degeneration
- Diabetes mellitus in the eye (bleedings, macular damage)
- Optic nerve damage (Diabetes, Neuritis, MS)
- Brain malfunction (Diabetes, MS...)





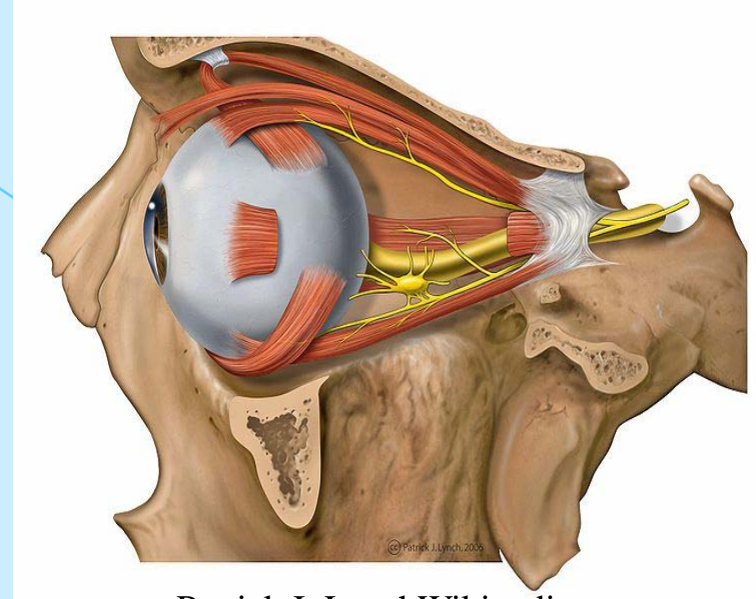






**Corneal scar with breakdown of optical properties of the cornea**

# Hetereophoria



Patrick J. LynchWikipedia

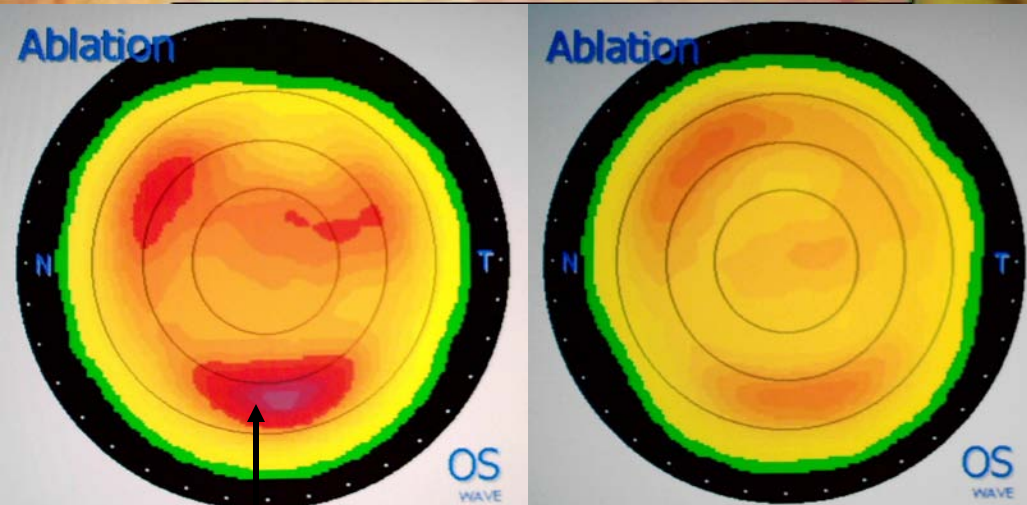
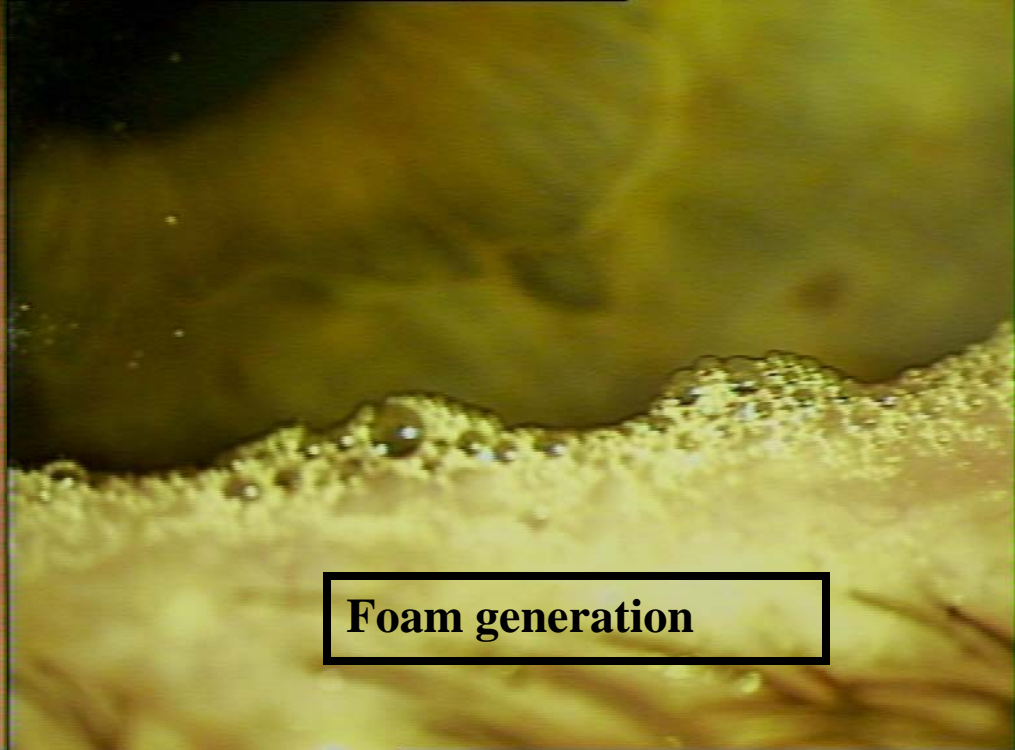
- Schober test: Through red/green glasses, visual input of the right and left eyes are separated by color at a distance of 5 meters.
- Heterophoria can be seen in a total 45% of all people
- In exophoria the eye deviates outward towards the temple
- In esophoria the eye deviates inward towards the nose



**Capillary regeneration**

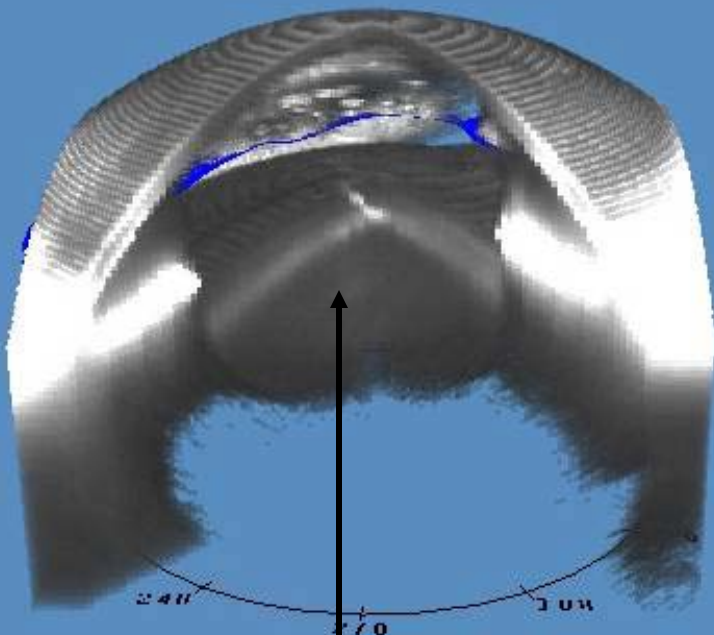


**Foam generation**

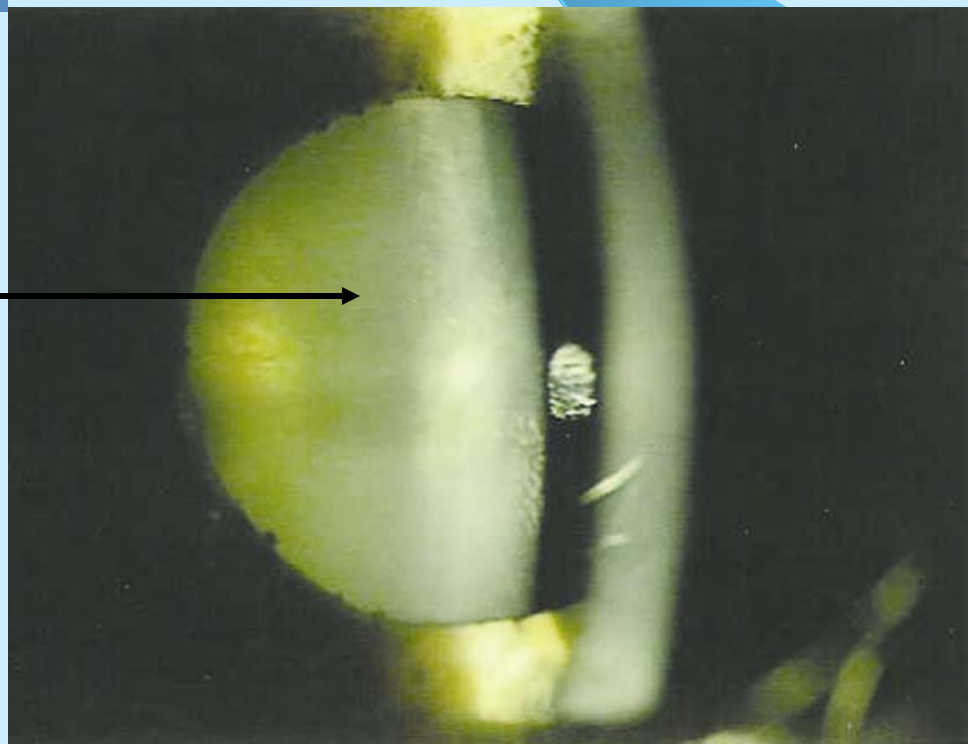


**Sources of glare**

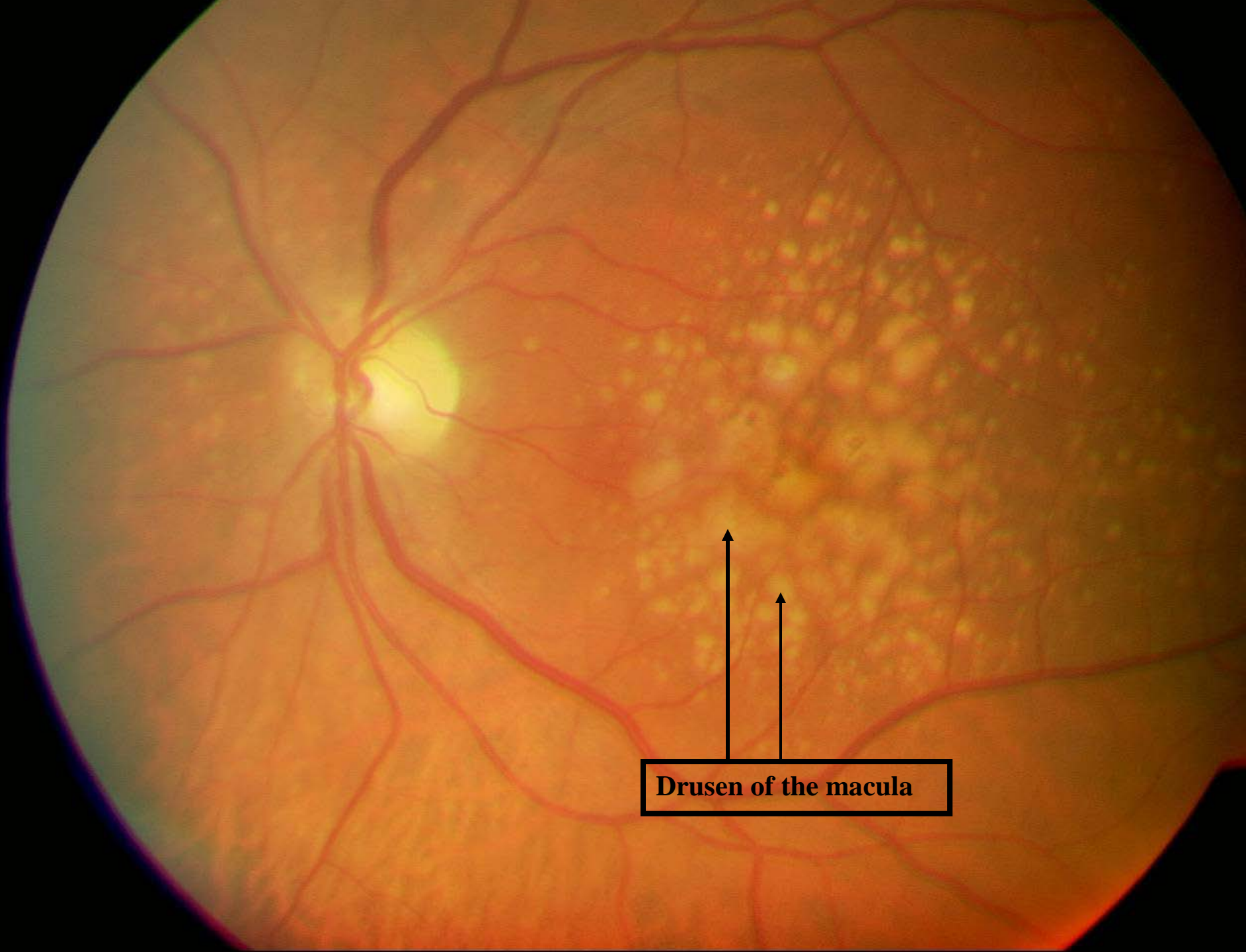
**20 % suffer from  
dry eyes**



**Cataract**







**Drusen of the macula**

# Medical reasons for side-effects of 3D (overall)

- Low blood pressure (water deficiency or dehydration)
- High blood pressure (water deficiency or dehydration)
- Diabetes (Hyper- and hypoglycemia, pre-diabetes)
- Dizziness (primary, due to blood pressure, meniere's disease, time after sudden hearing loss)
- Circulatory weakness in case of water deficiency, improper regulation with abuse of coffee, tea, cola

# Medical reasons for side-effects of 3D (overall)

- Circulatory weakness in allergies (in spring), side effects of medications (anti-histamines)
- Increased cholesterol with plaque
- Thyroid dysfunction (hyper- or hypoactive)
- Cerebral diseases

The background of the image is a detailed medical illustration of a blood vessel, likely an artery, showing its internal structure with various colored layers and branches. A prominent yellowish, irregular mass representing a cholesterol plaque is visible on the left side of the vessel wall. Three black arrows originate from the text 'Cholesterol plaques' and point to different locations on the vessel wall: one points to the plaque itself, another points to a section of the vessel wall above it, and the third points to a section of the vessel wall below it.

**Cholesterol plaques**

**Circulation examination by means of vessel analysis**



# Headache and dizziness

A universal problem not only in terms of 3D!

- Headache, nausea and vomiting represent migraine characteristics
- 10 % of the German population is suffering from migraine
- In Europe, 27 billion Euros in damages per year caused by migraine
- 50 % of all people suffer from tension-type headaches
- Migraine and tension-type headaches account for 90 % of all headaches
- Causes are so far unknown and treatments are mostly symptomatic

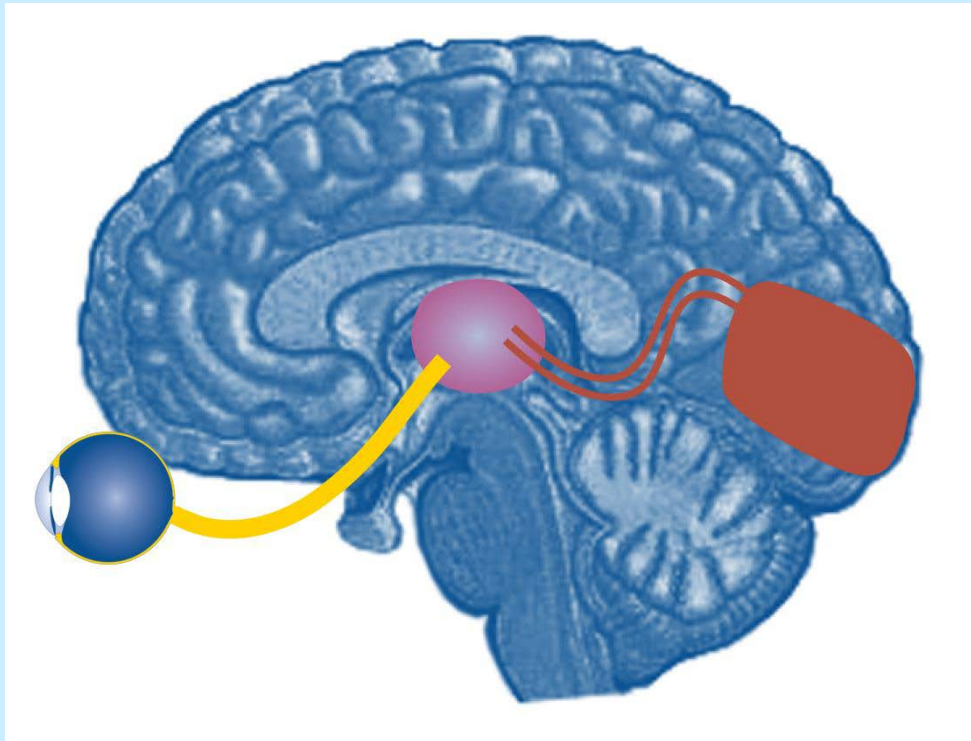
Objectives: Reduction in the occurrence of headaches worldwide  
accelerates the future 3D culture

# Headache - A universal problem not only in terms of 3D!

- Questioning patients who are characterized with a tendency to migraine and chronic headaches provided indications to react particularly sensitive to 3D cinema by occurrence of headache, nausea, vomiting and dizziness
- It is likely that this group is part of the privileged problem clientel in the 3D cinema.
- Therefore, the initial examination of the eyes as primary organ of perception for problems with 3D is natural (→3D eye examination)
- During the continuing process, headache and migraine can be eliminated in certain cases via the eyes (Cephlas method)



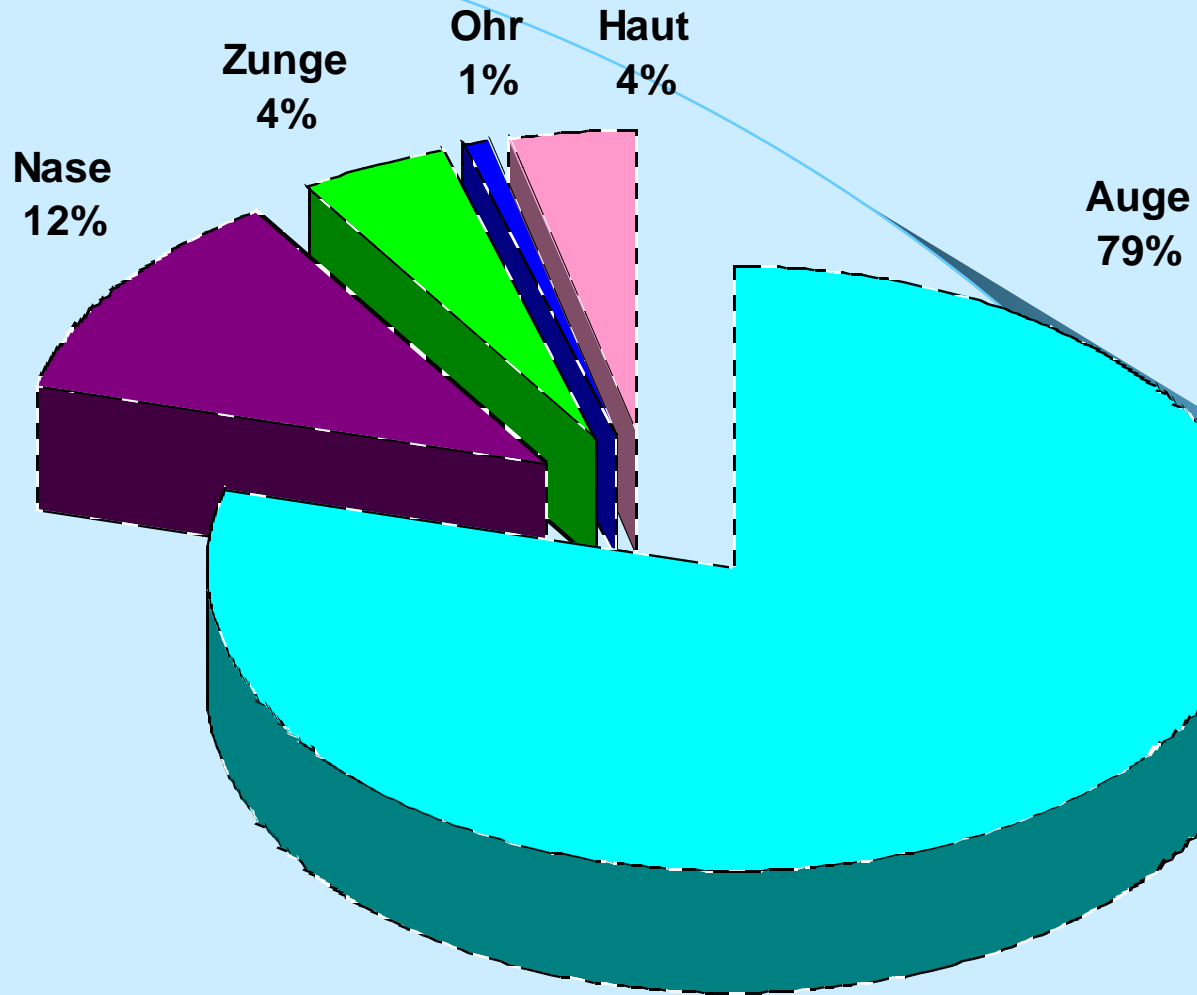
# Why is the eye so important for the emergence of pain ?



- Evacuated part of the brain
- Close functional connectivity to the brain
- Main data supplier for the brain



## Bedeutung der Organe am Datenimport ins Gehirn



Data source: Georg Berner 2004 Management in 20XX

# Mechanisms for the emergence of pain

- Trigeminal nerve (sensitive supply of the eye, irritation, inflammation)
- Optic nerve (light appearance, glare, stray light)
- Light receptors with pain transmittance to the brain (Specialist journal "Nature Neuroscience", ....a connection between light-sensitive cells in the eye and cells in the brain that are responsible for pain perception).
- Muscle imbalance  
(N. abducens, N. oculomotorius, N. trochlearis)
- Pathological pain receptors in the eye (theory)  
iris movement in case of brightness fluctuations,  
micro-pressure waves in the eye, sleeping position

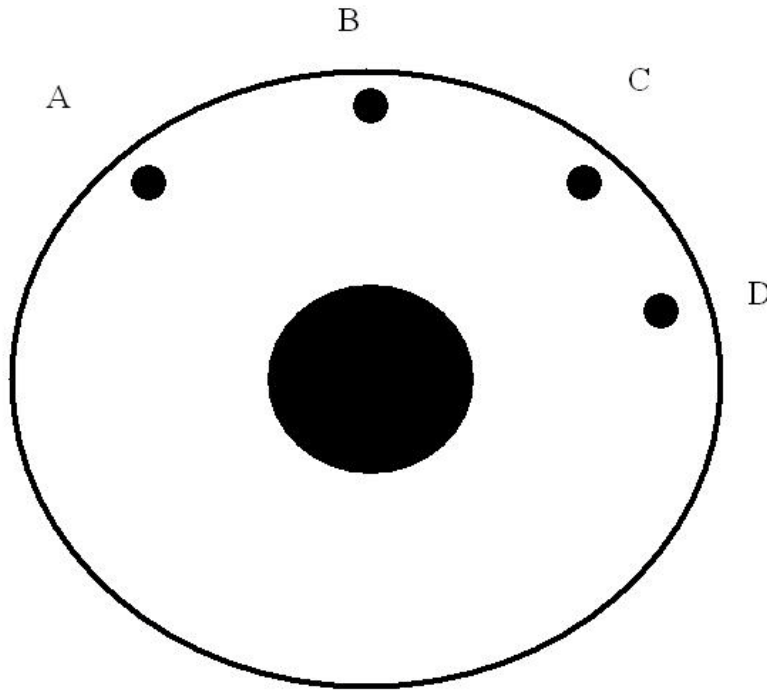
# Interesting self-observations

- Headache initiated by the administration of eye drops for pupillary control (mydriatic/pilocarpine)
- The painful iris of the headache patient (trigger point search via eye laser acupuncture)
- Pain transmittance into the head (trigger points on the iris)
- Reactions after performing the Cephas treatment method



# The painful iris of a headache patient

## Trigger point search by means of “eye laser acupuncture”



Projection of trigger locations on the  
**right** eye of the migraine patient:

A = back of the head

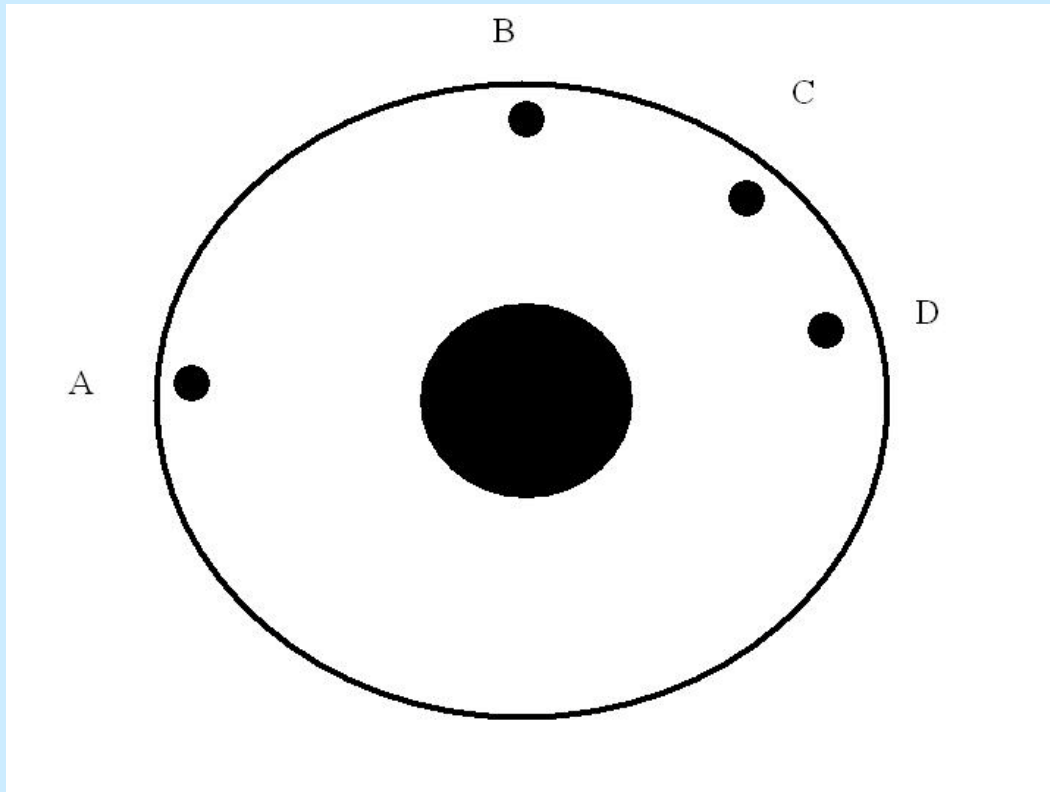
B = forehead

C = eye brow

D = nose

# The painful iris of a headache patient

## Trigger point search by means of “eye laser acupuncture”



Projection of trigger locations on the  
**left** eye of the migraine patient:

A = nose

B = eyebrow

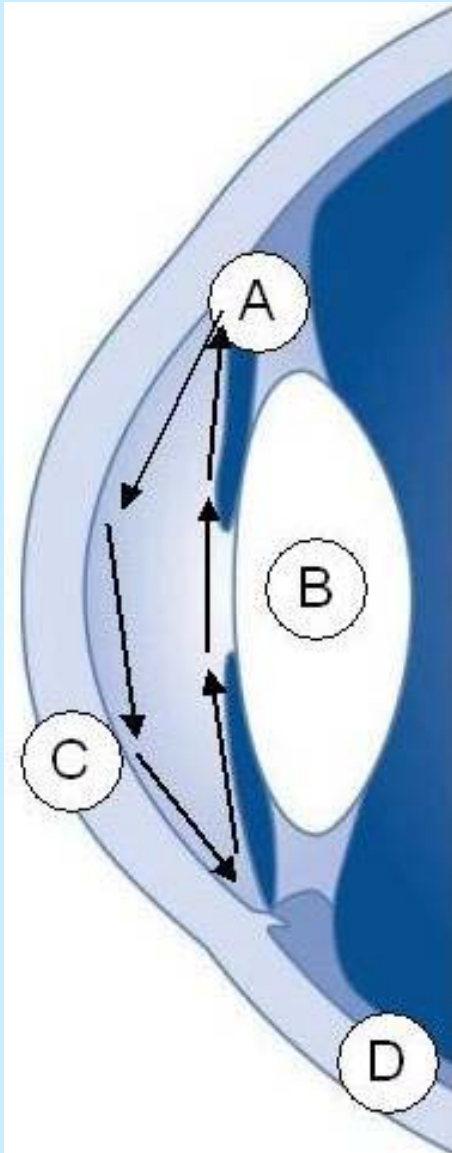
C = lateral eyebrow

D = temple

# Pressure wave receptor hypothesis

- Pressure waves alter the cornea
- Pressure waves irritate the iris
- Iris trigger sustain in continuous operation by repeated irritations
- Increasing brain excitement produces further increased pressure waves (positive back coupling)

# Pressure wave receptor hypothesis



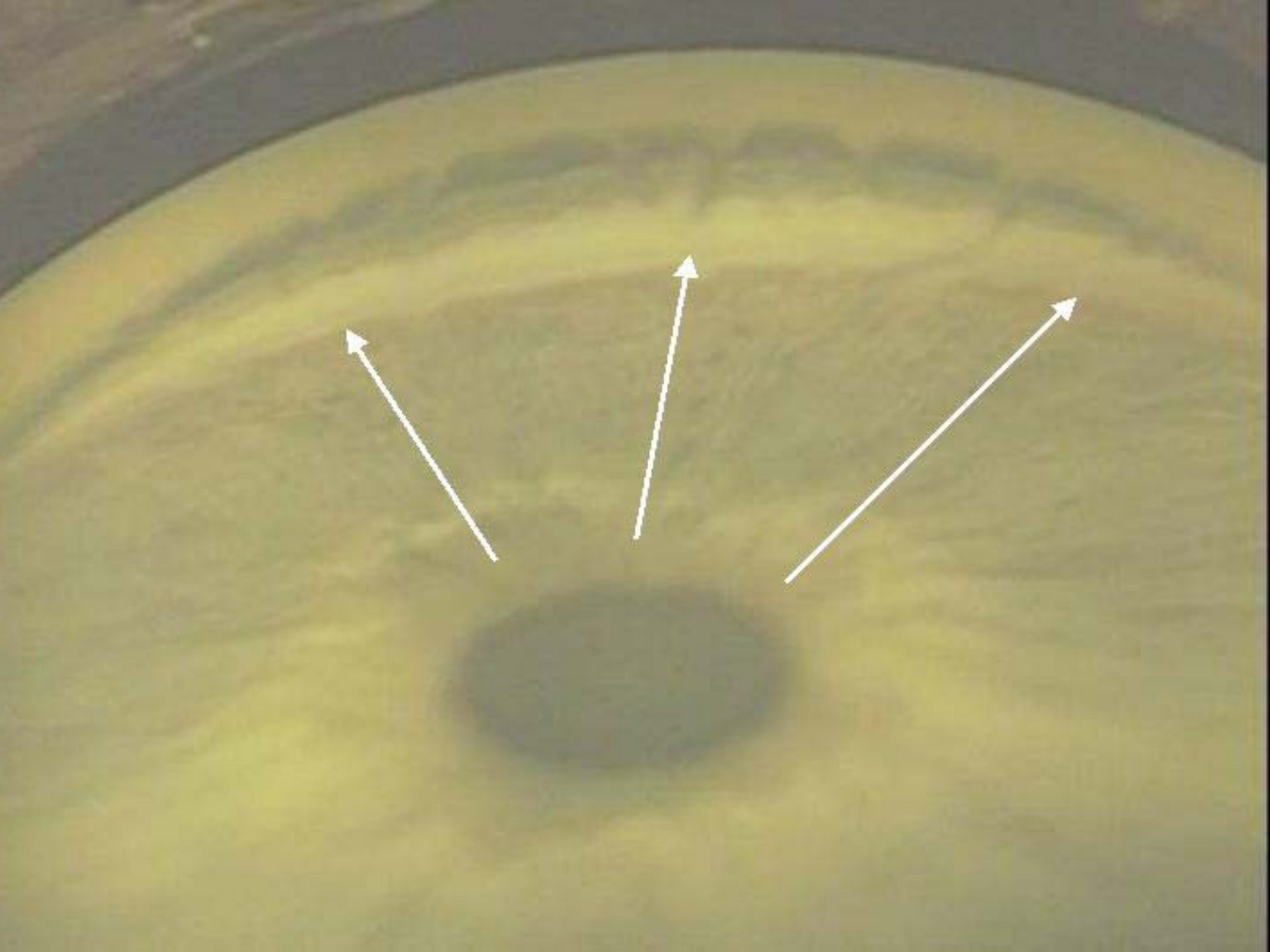
**Where do pressure waves come from?**

- Pupillary light reflex
- Targeted eye movements
- Saccades during reading
- REM phases during sleep
- Permanent heat flow in the eye
- Production flow

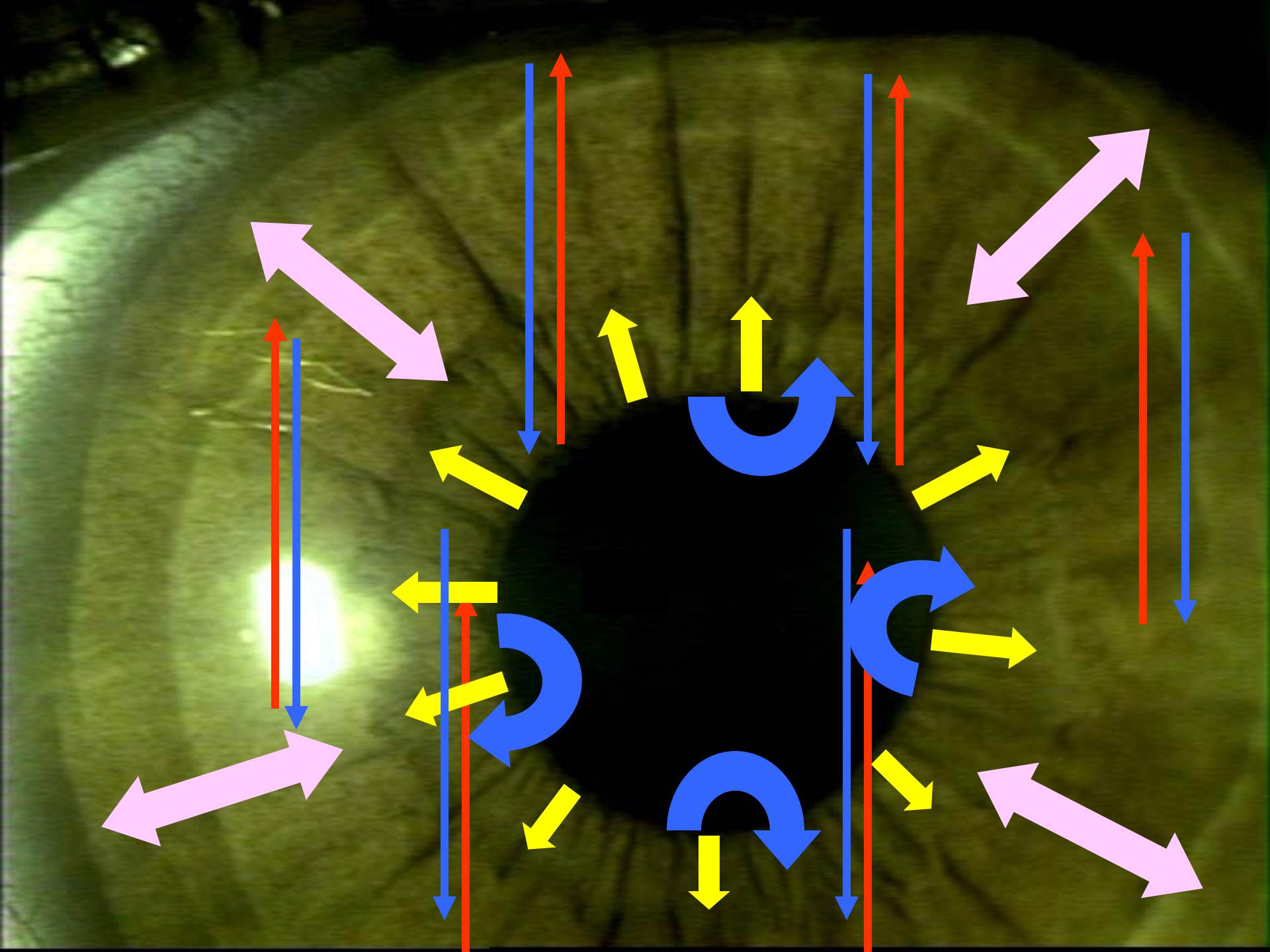
3-9 ml /day = exchange 10-30x KW 0,3 ml GK 6ml



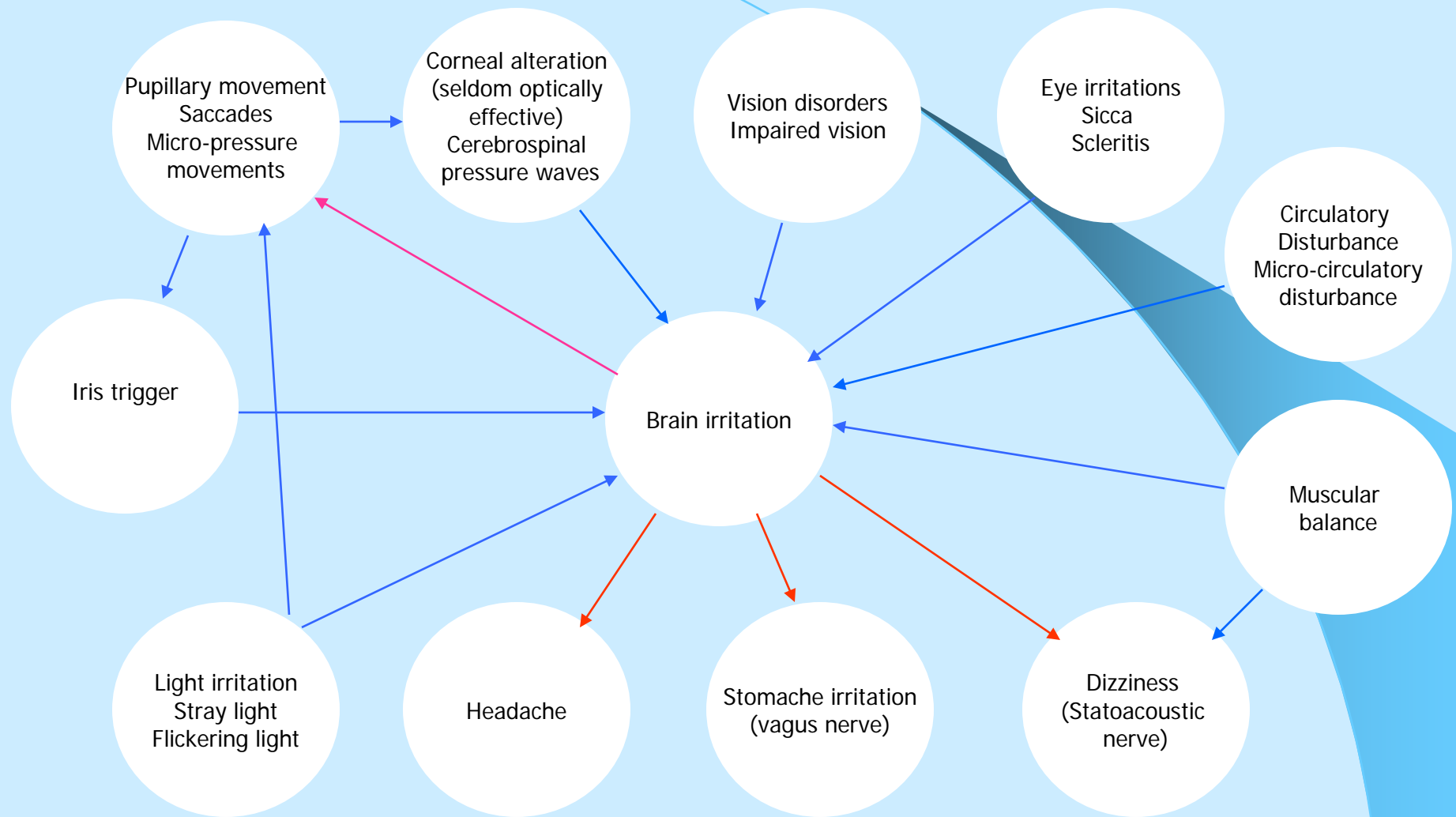








# Emergence model of headache including “pressure wave receptor hypothesis”



# Future objectives

- Utilization of 3D eye examination to improve optical interference and optimizing eye muscle activity
- Initiating of studies of 3D Problems
- Reduction of existing disposition for headache by the Cephas method
- Research in the exact mode of action of the “pressure wave receptor mechanism”



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