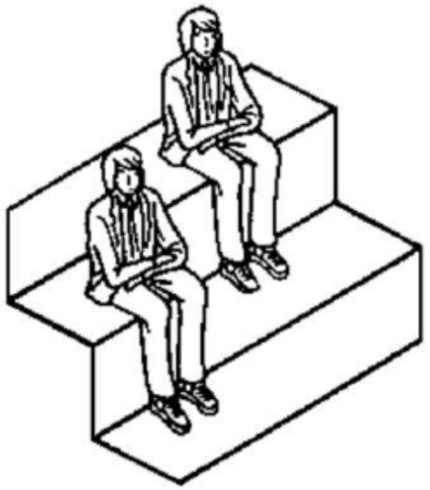
FAV,Talk no.11, Visual Disorders and Illusions



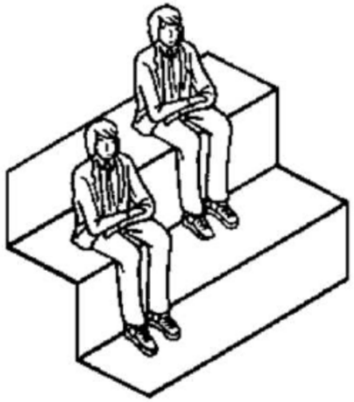
Petr Maršálek

Academic Year 2020/ 2021

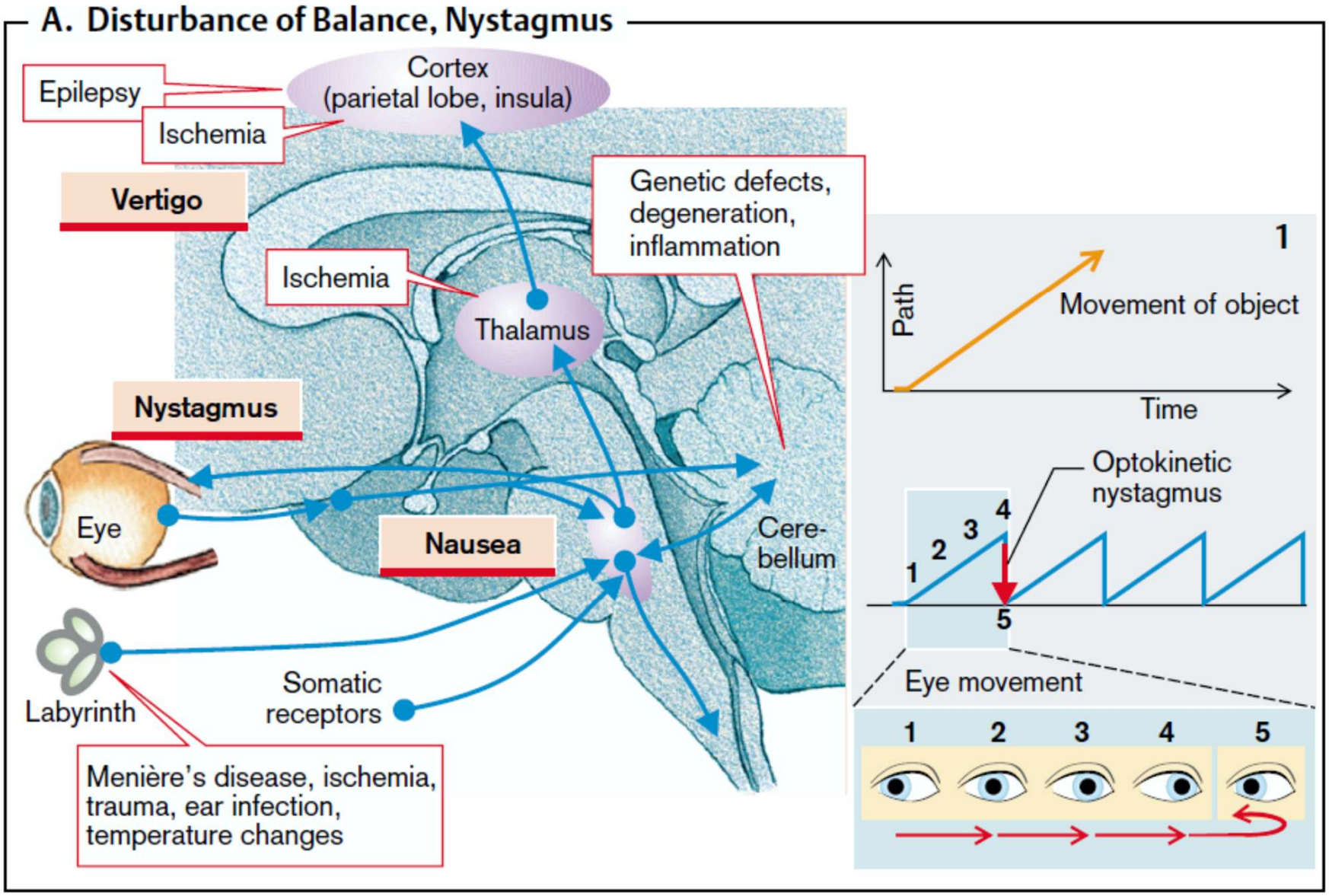
Outline 11 – Vision Disorders, Visual Illusions, Visual Prostheses

- Common Retinal and Cortical Disorders
- On Types of Glasses We Wear
- Color Blindness, Night Blindness (Vitamin A Deficiency) and Presbyopia (already covered)
- Illusions, Hallucinations, Pseudo-hallucinations
- Classification of Illusions
- Rare Neuro-Visual Disorders Let Us Get Insights Into Central Visual Processing, Some Are Caused by Carbon Monoxide Poisoning
- Split Brain, Hemi-Neglect and Other Cognitive deficits
- Illumination Hygiene, Age Related Macular Degeneration and Retinitis Pigmentosa
- Auditory vs. Visual Prostheses, Cochlear Implants
- Augmented Images, Augmented Sound

- This is spatially unreal scene, we can call these and alikes simply „Eschers“ →
or „Escher motives“.
These can be found on drawings by
Maurits Cornelis Escher (1898-1972)



Added slide to previous talk:
Pathways Associated with Vestibular System, Nystagmus



Functional classification of vision impairment

1 normal vision 6/6

2 low vision worse than (<) 6/18

(on the best eye with corrective lenses)

3 (practical) blindness < 3/60

or narrowing of visual angle less than < 10*10^{o}

other norm < 6/60, < 20*20^{o}

4 *amblyopia*

Causes of blindness and vision impairment

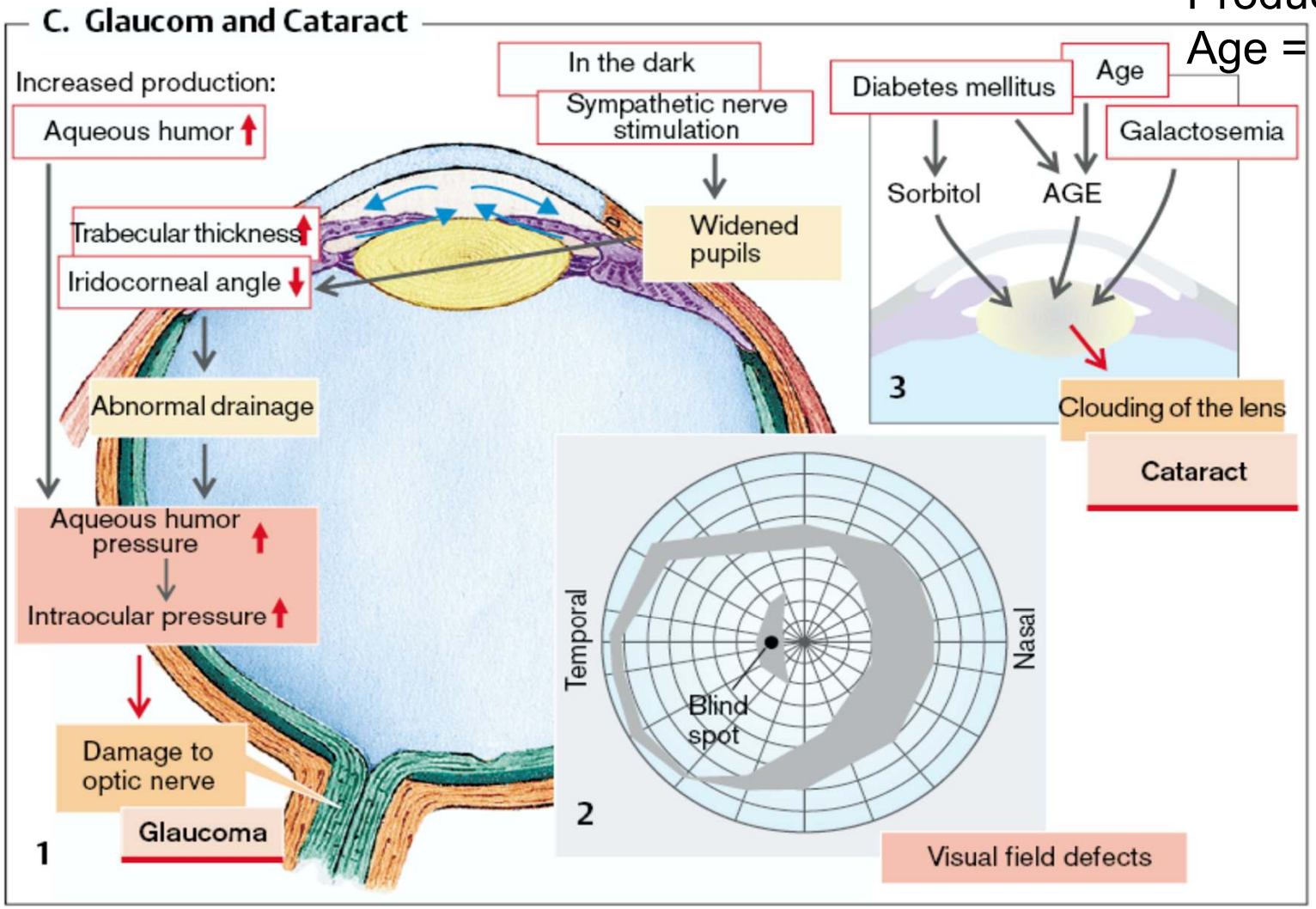
A ordered by frequency in the developed countries:
1 diabetes: retinopathy, 2 glaucoma, 3 disorders
– age related, like macular degeneration,
4 injuries, 5 other causes, neurologic

B ordered by frequency in the third world countries:
1 trachoma (chlamydia trachomatis), 2 onchocercosis
(onchocerca volvulus),
3 xeroftalmia (vit. A avitaminosis), 4 cataract, 5 glaucoma,
6 injuries, 7 senile macular degeneration, 8 diabetic retinopathy
9 genetic causes, 10 neurologic causes

C overall incidence:
developed countries 0,2 %, worldwide 1 %,
some undeveloped countries several %

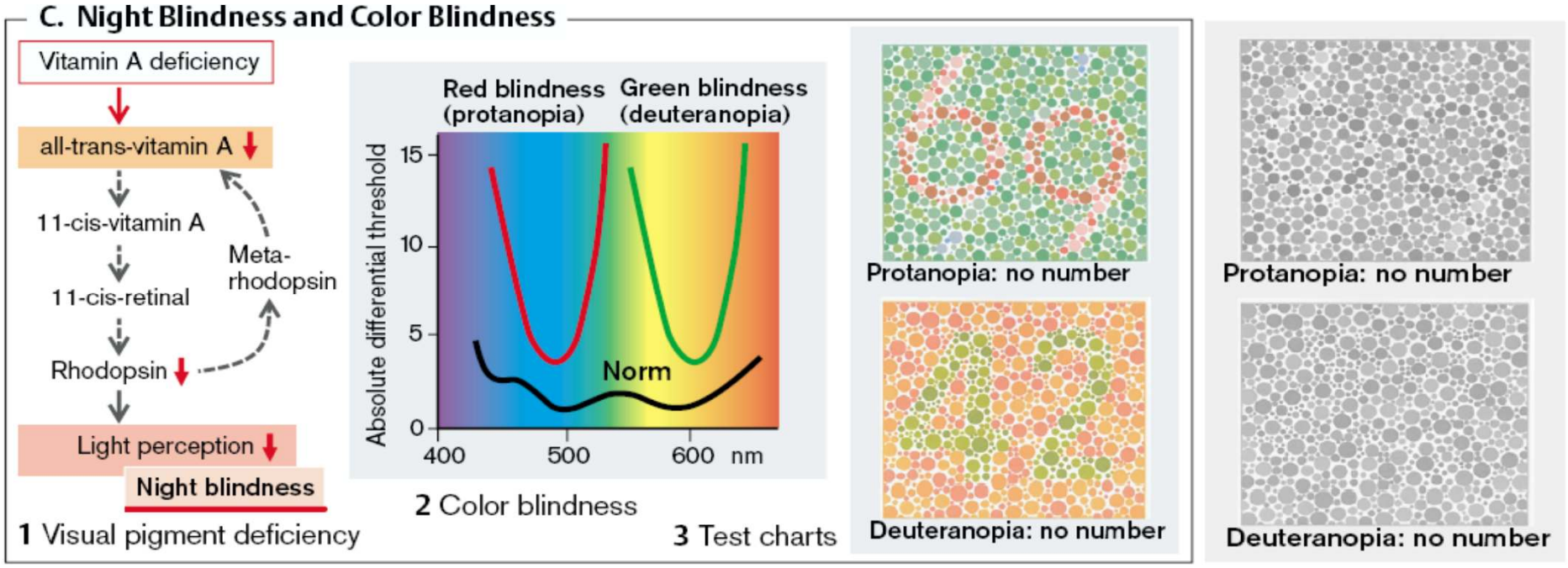
Short-sightedness, Long-sightedness, Astigmatism, Glaucoma and Cataracta

A.G.E. – Advanced Glycation End Products,
Age = as ageing…

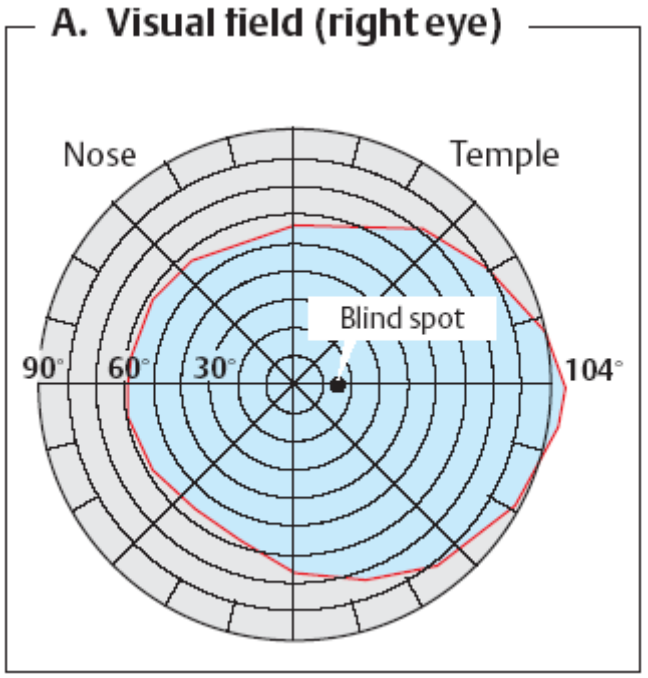


Night blindness and color blindness

Vitamin A deficiency/ cone pigment disorders

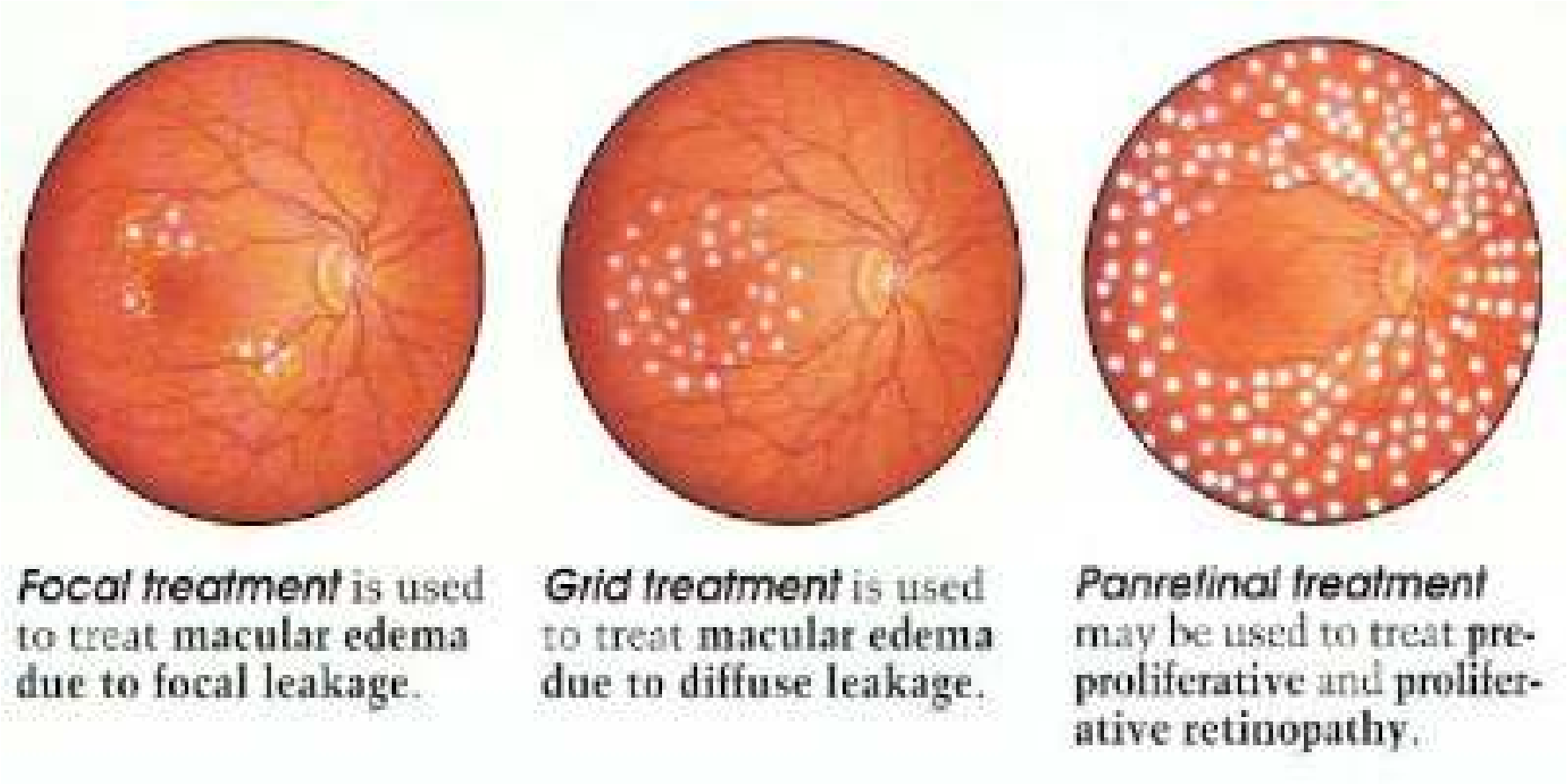


What We See Results from Expectations



Comment:
when we see and when we don't see yellow banana?

Laser coagulation of many points to attach detached retina in diabetic retinopathy

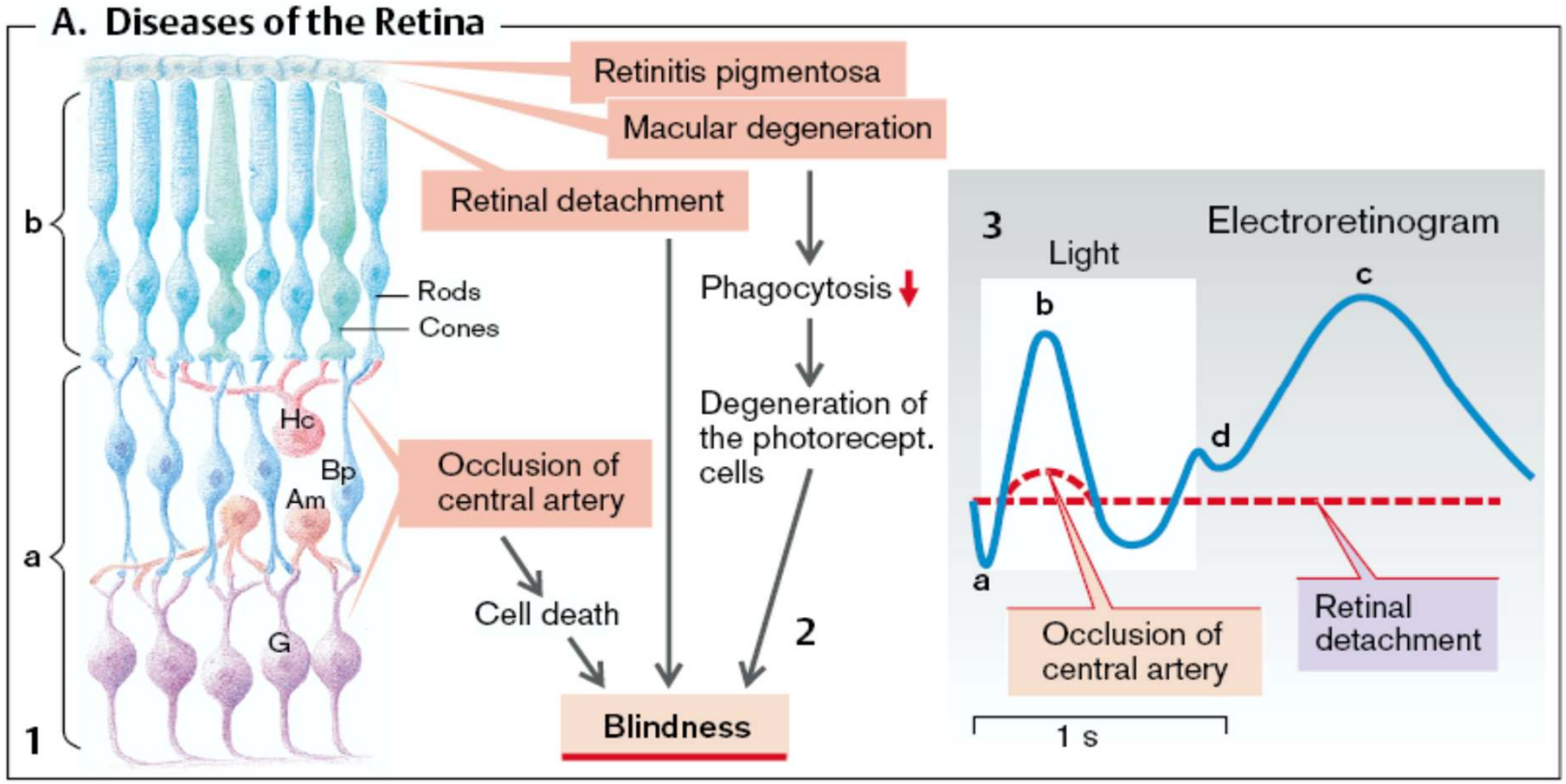


Focal treatment is used to treat **macular edema due to focal leakage.**

Grid treatment is used to treat **macular edema due to diffuse leakage.**

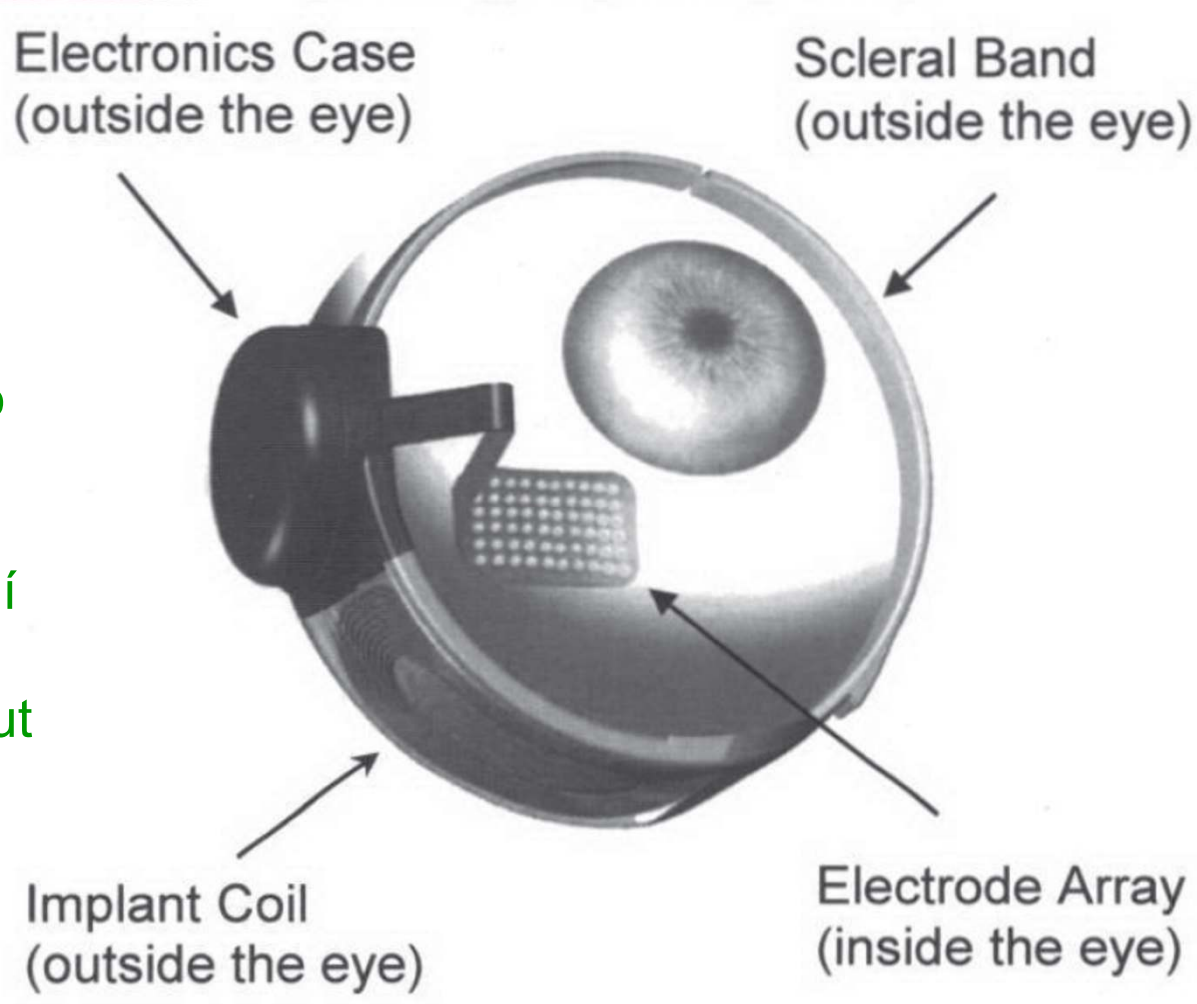
Panretinal treatment may be used to treat **pre-proliferative** and **proliferative retinopathy.**

Other defects of retina



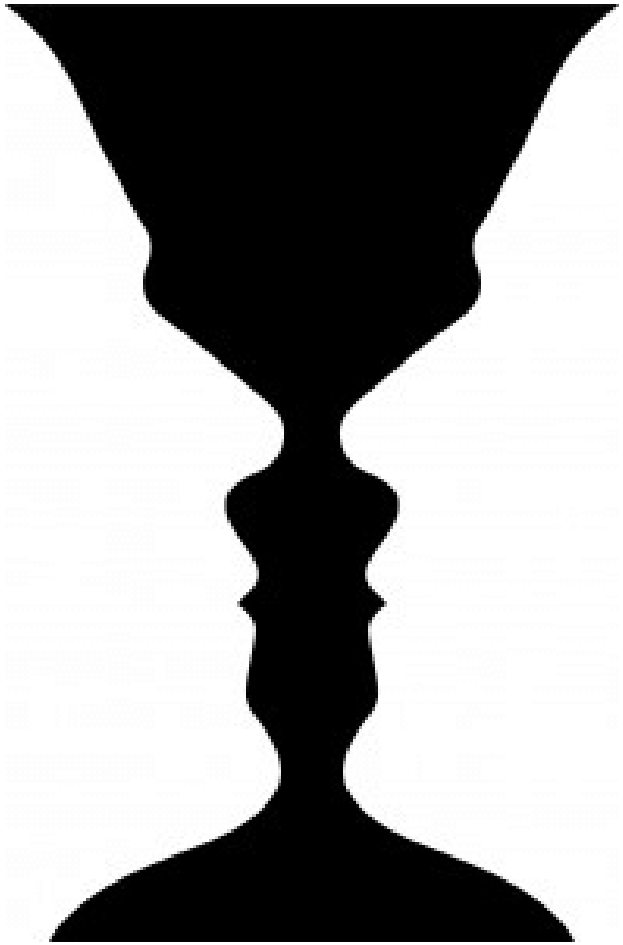
Retinální implantát

Pouze experimentální:
Retinální implantát je postaven analogicky jako kochleární, avšak současnou digitální technologií není kódování v sítnici uchopitelné. Neumožňuje to dosáhnout stejně praktických výsledků jako u sluchu.
(Stav v roce 2020...)



Face/ Vase (Gestalt Illusion)

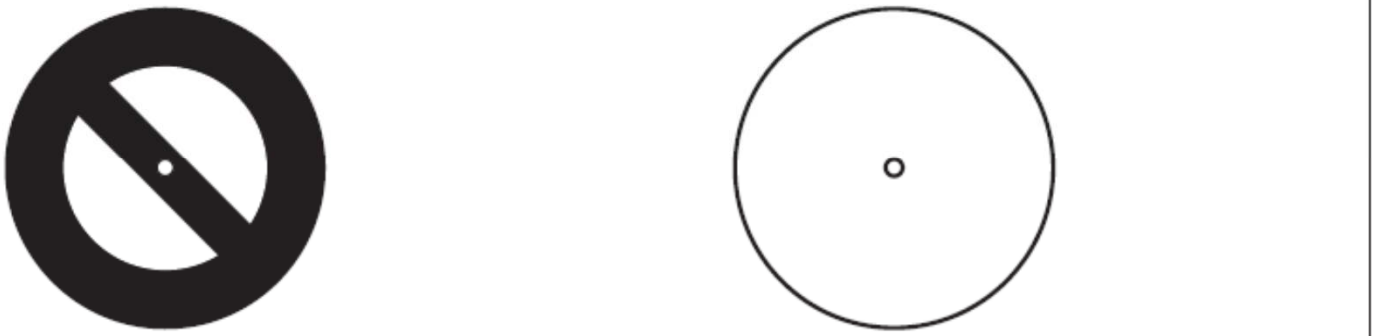
Definitions:
What are
1/ illusions
2/ pseudo-hallucinations
3/ hallucinations



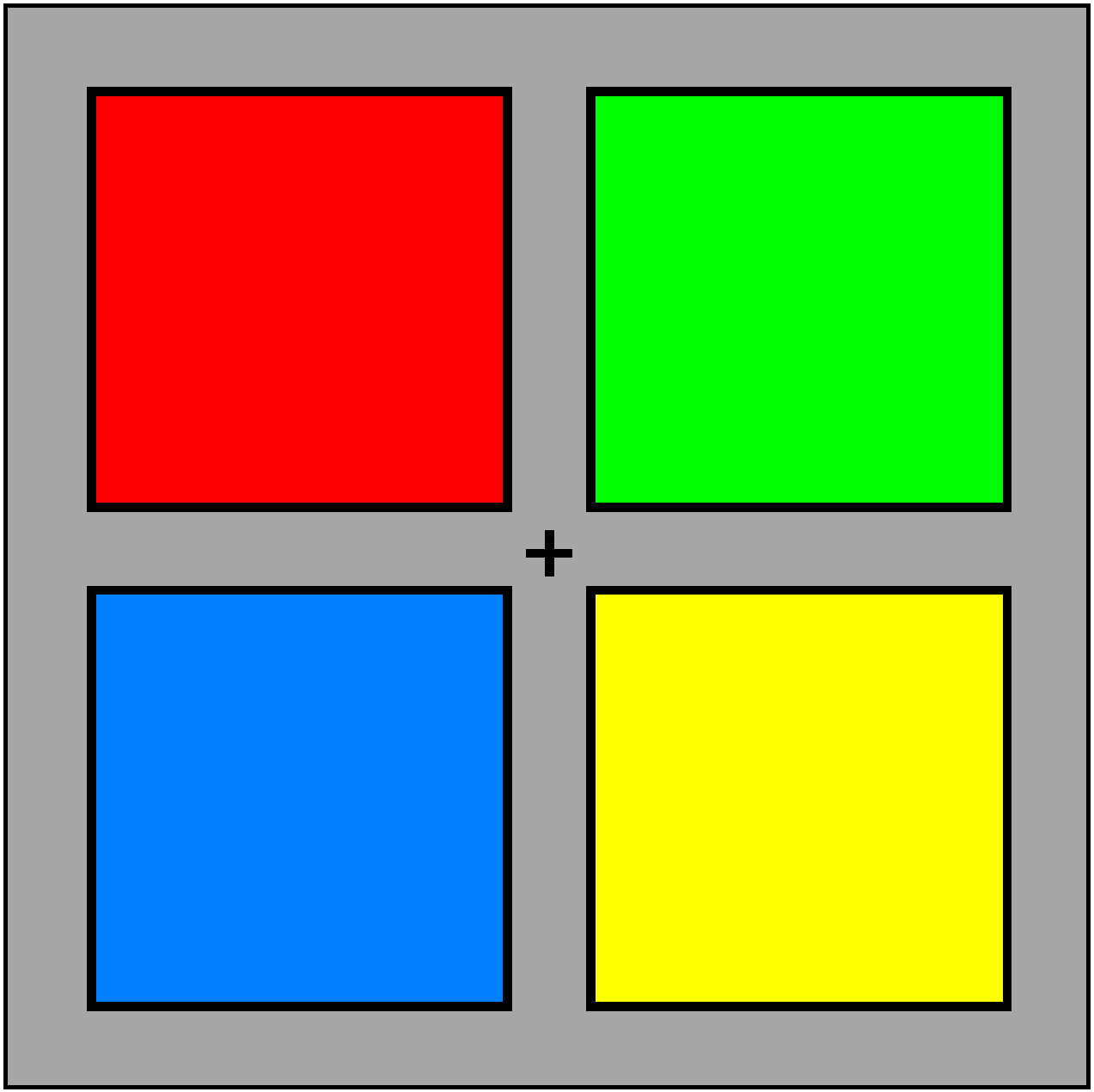
Comment:
figure and ground alternate, based on to what we attend.

Mechanisms in visual cortex are powerful in constructing, what we see, and sometimes in constructing illusions

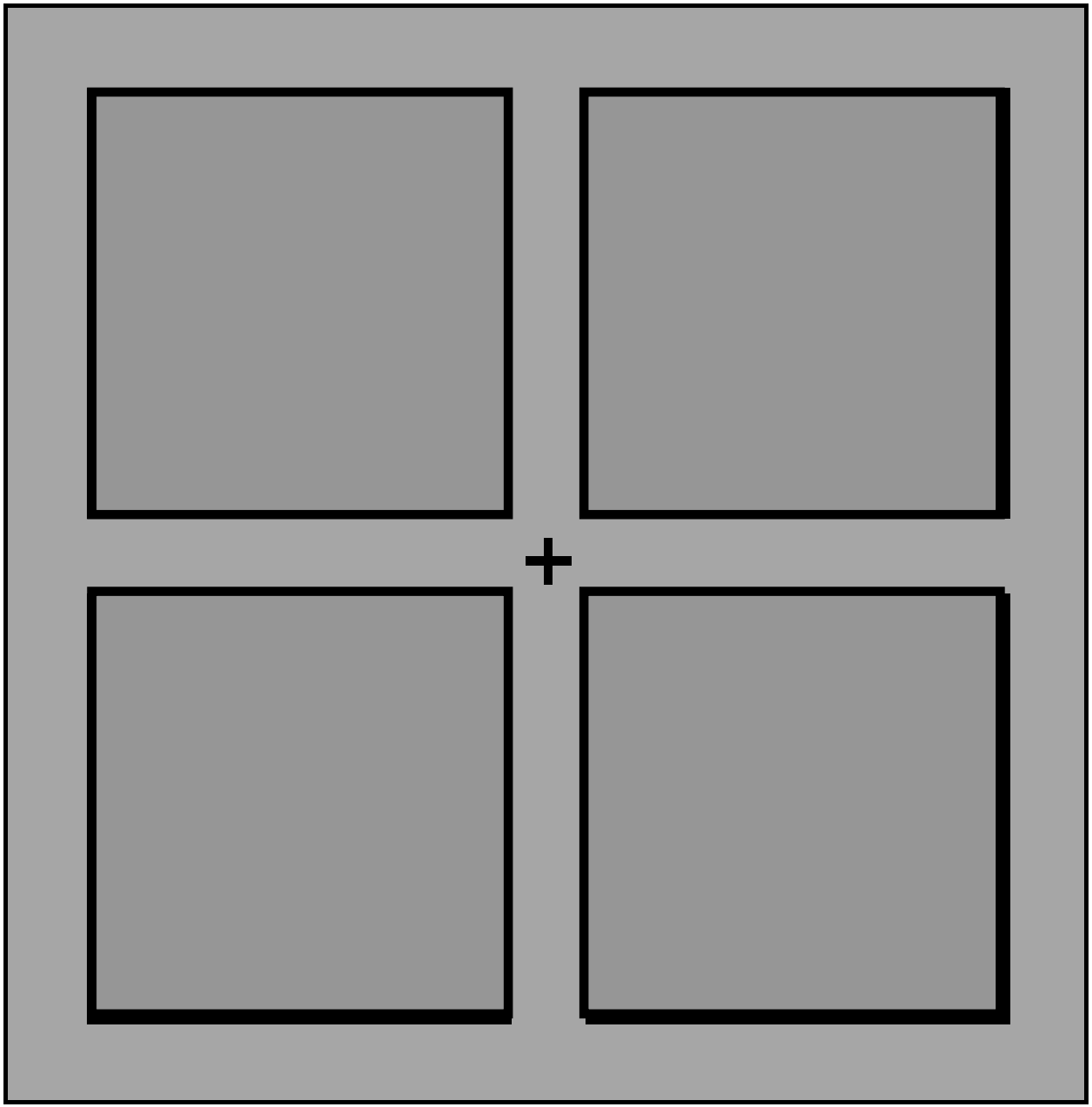
D. Successive contrast ("local adaptation") (see text)



Comment:
first fix the center of the left image, after circa 10 second move your eyes to fixate the center of the right image.

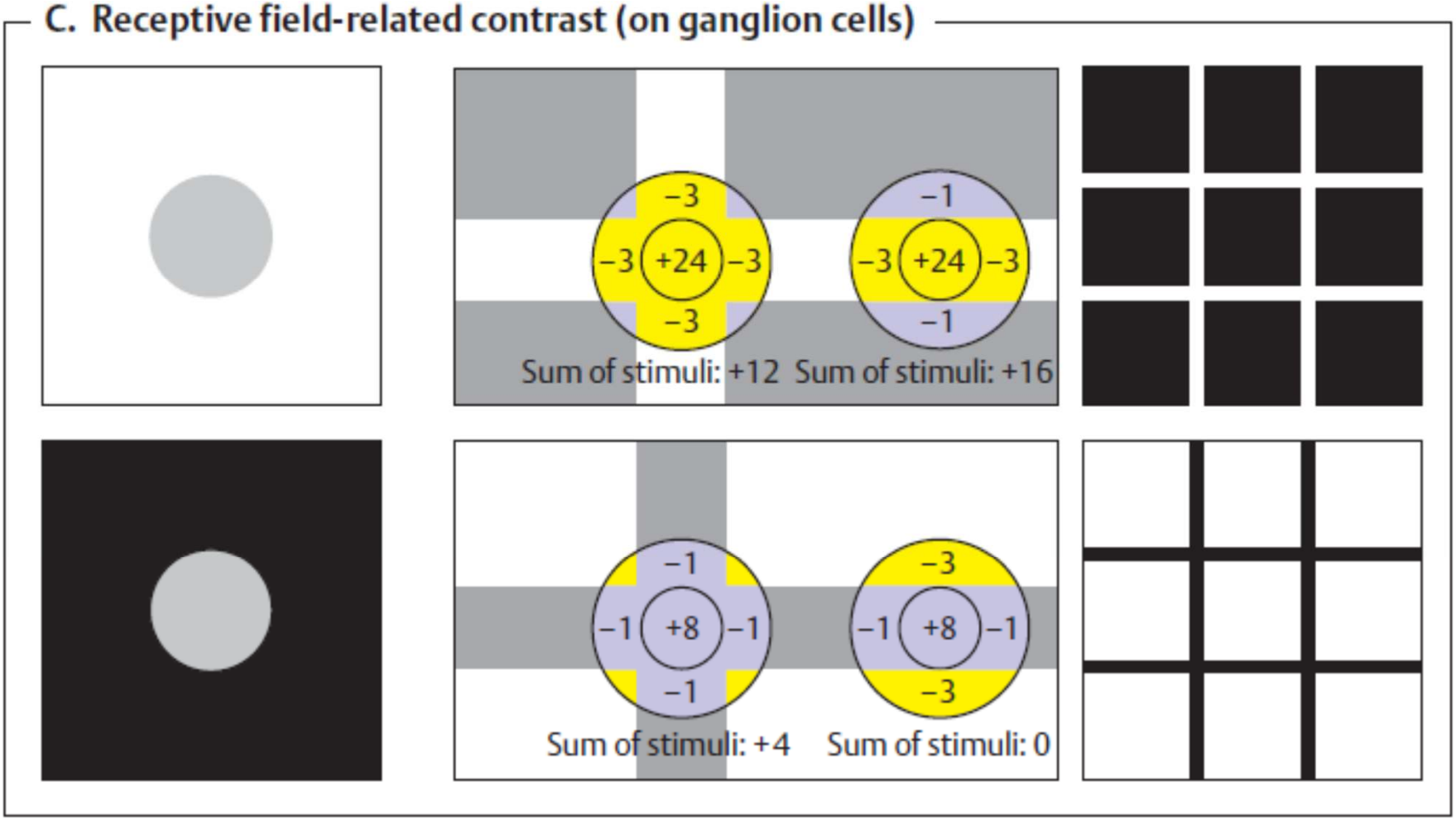


Comment:
fixate cross 10 secs. Then move to next slide



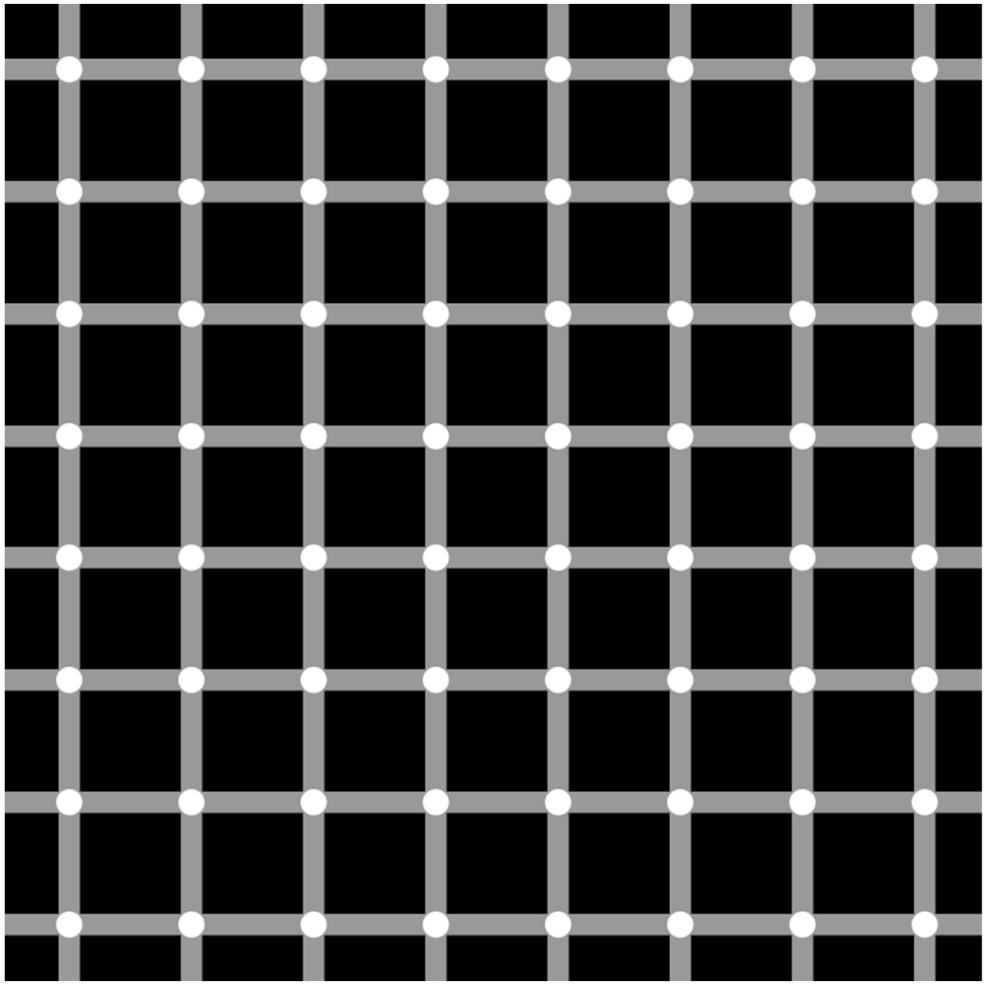
Comment:
fixate cross 10 secs. When colors fade go to the previous slide

From Light Through Receptor Potential to Action Potentials and Coding in Optical Nerve



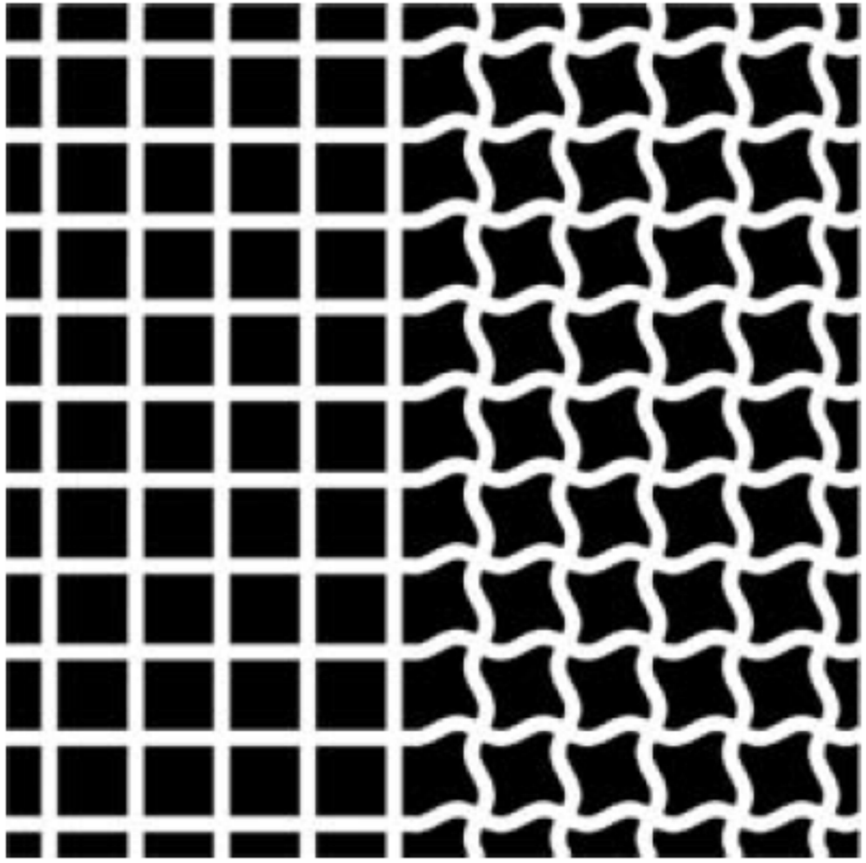
Comment: right – Look at the luminance of bar crossings.
left - Grey areas have the same luminance.

The (Ludimar) Hermann Grid Illusion, 1870



Comment: same as the previous slide…

The (Ludimar) Hermann Grid Illusion, 1870

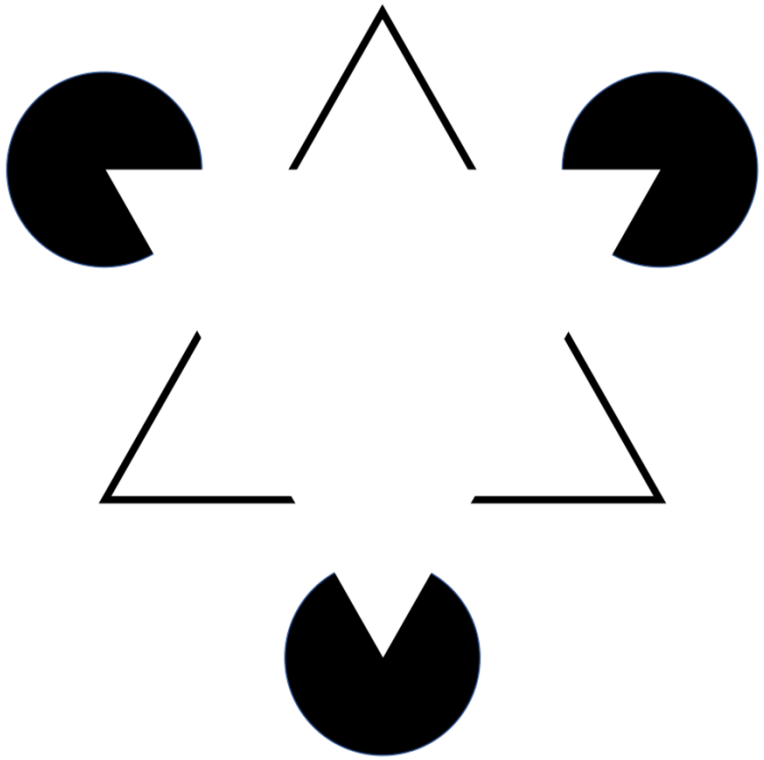


Comment:
right side does not show illusory darkened centers compared to the left side. The illusion producing mechanism acts probably only on perpendicular neighbourhoods.

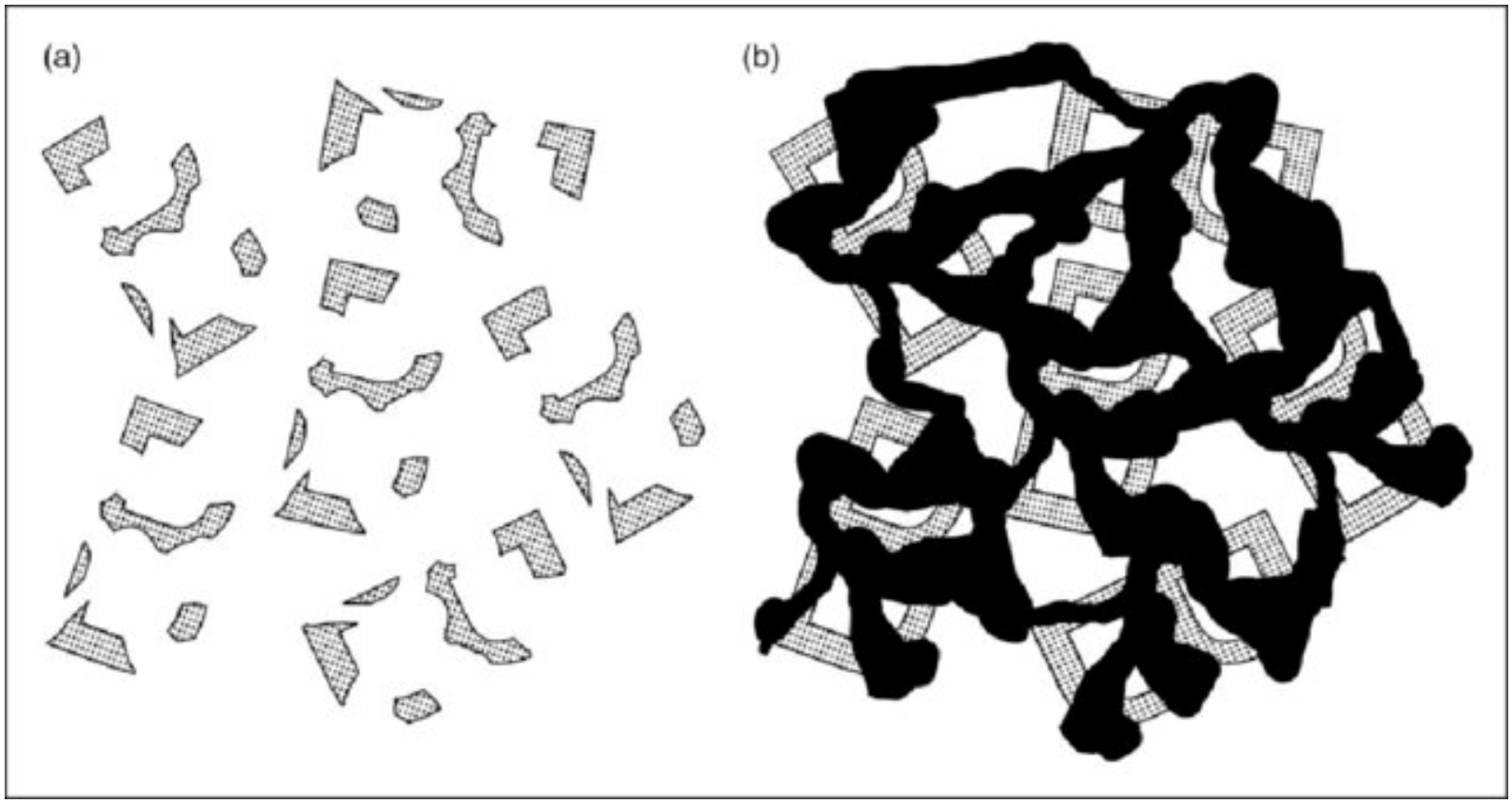
[M. Bach and C. M. Poloschek, Visual Neuroscience 2006]

Kanisza Triangle

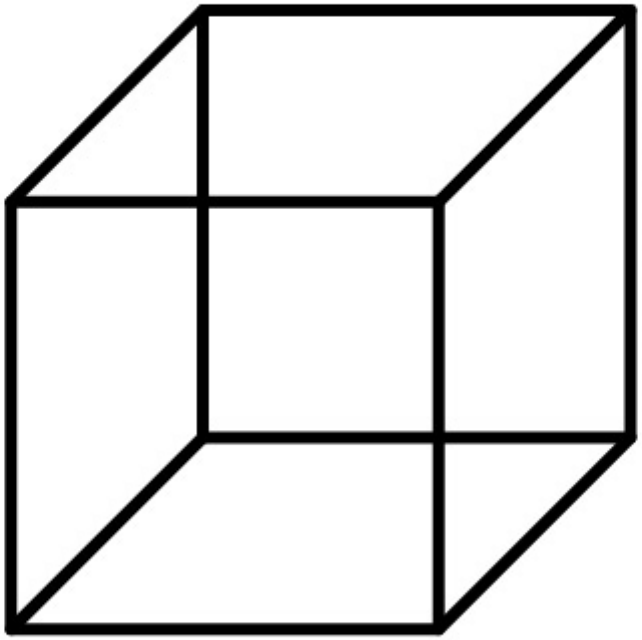
Recall the ‘Visual Cortex’ talk, V2 workings are illustrated by this illusion
Experimental Construction of Receptive Fields:
Simple and Complex Cells in Primary Visual Cortex, Area V1,
Illusory Contours by Rudiger von der Heydt, Area V2, and Higher Areas

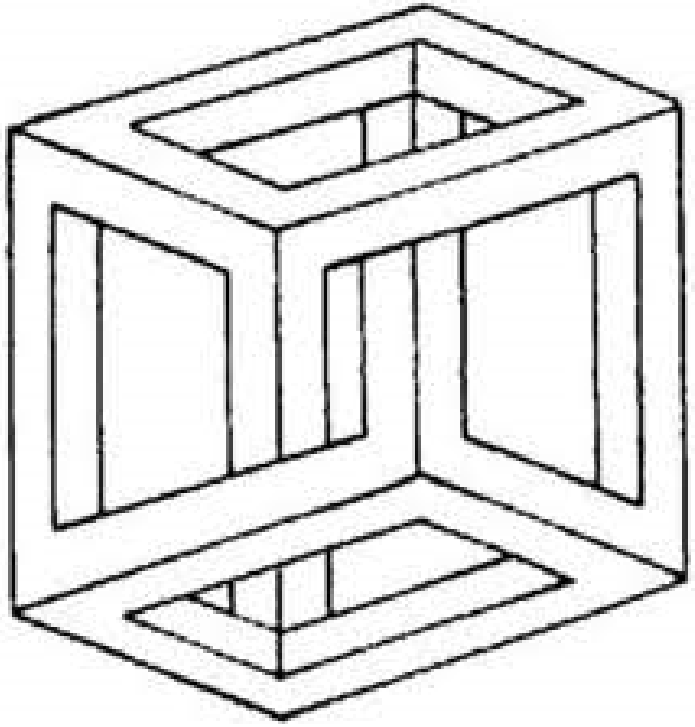


Bregman - Kanisza Illusion



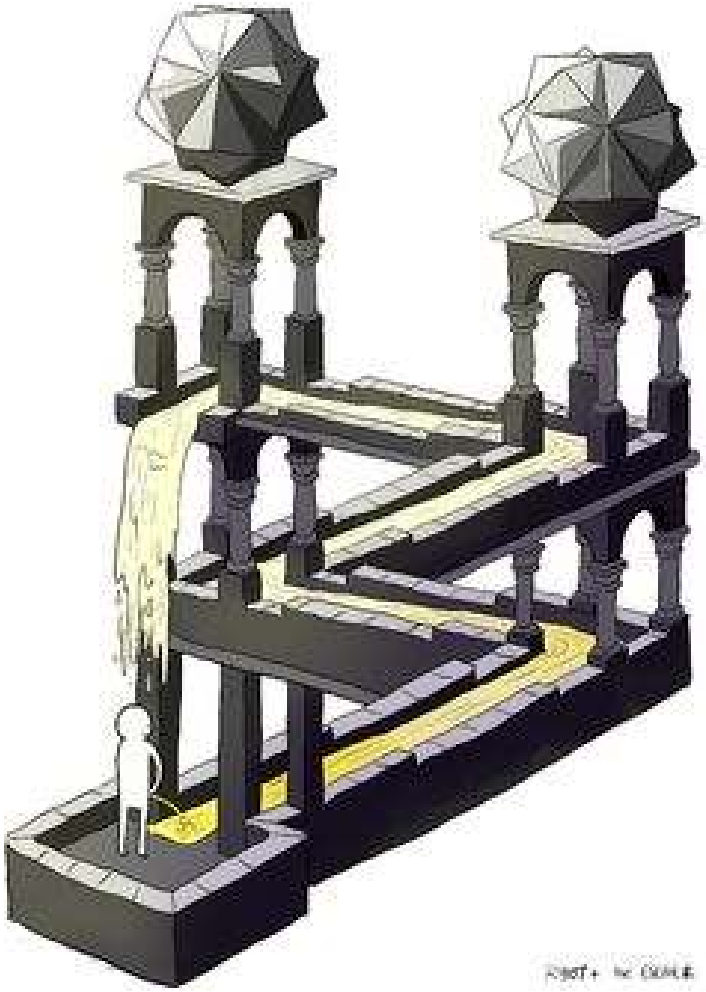
Necker Cube/ Impossible Necker Cube



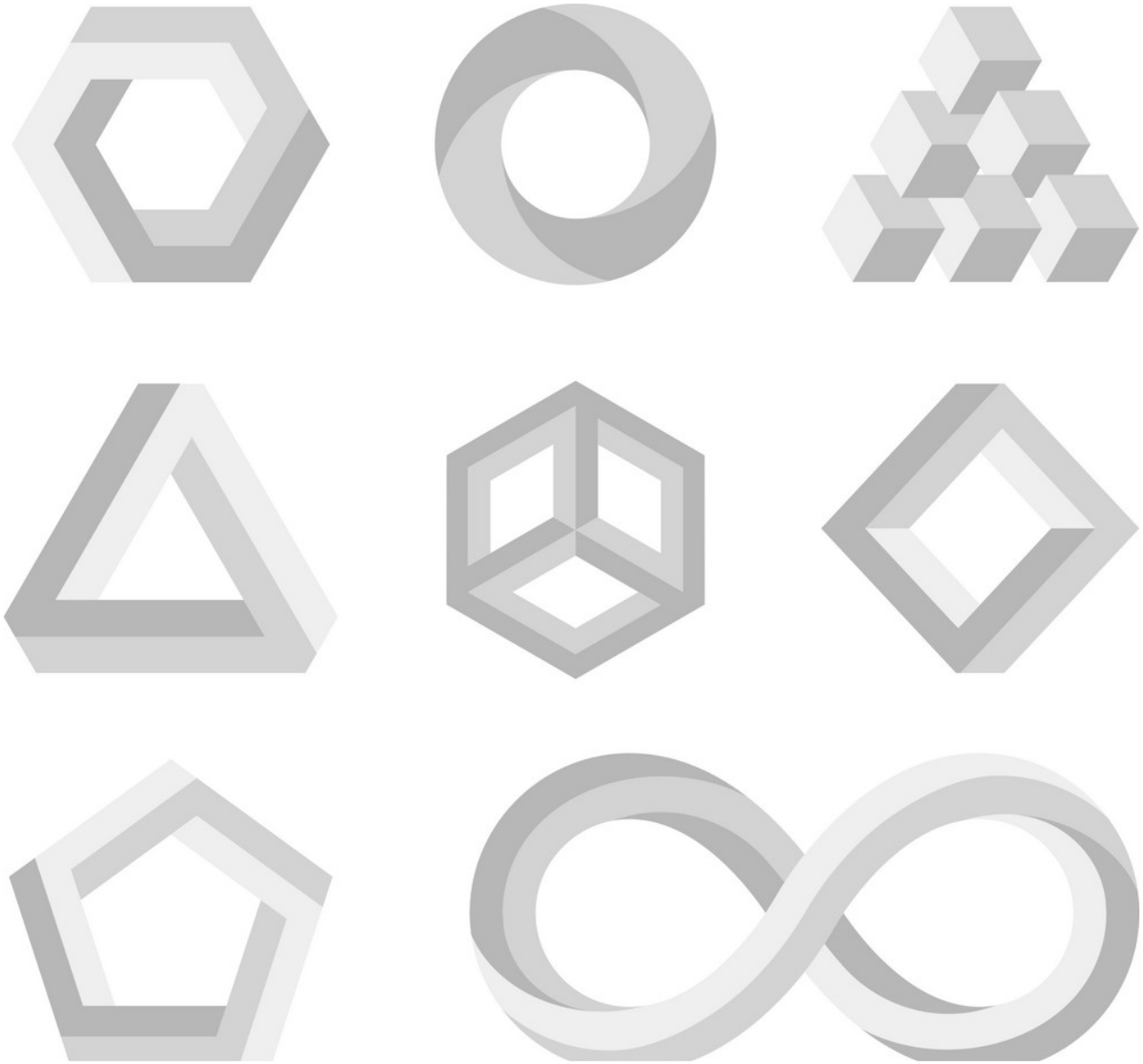


Paintings by
Maurits Cornelis Escher (1898-1972)

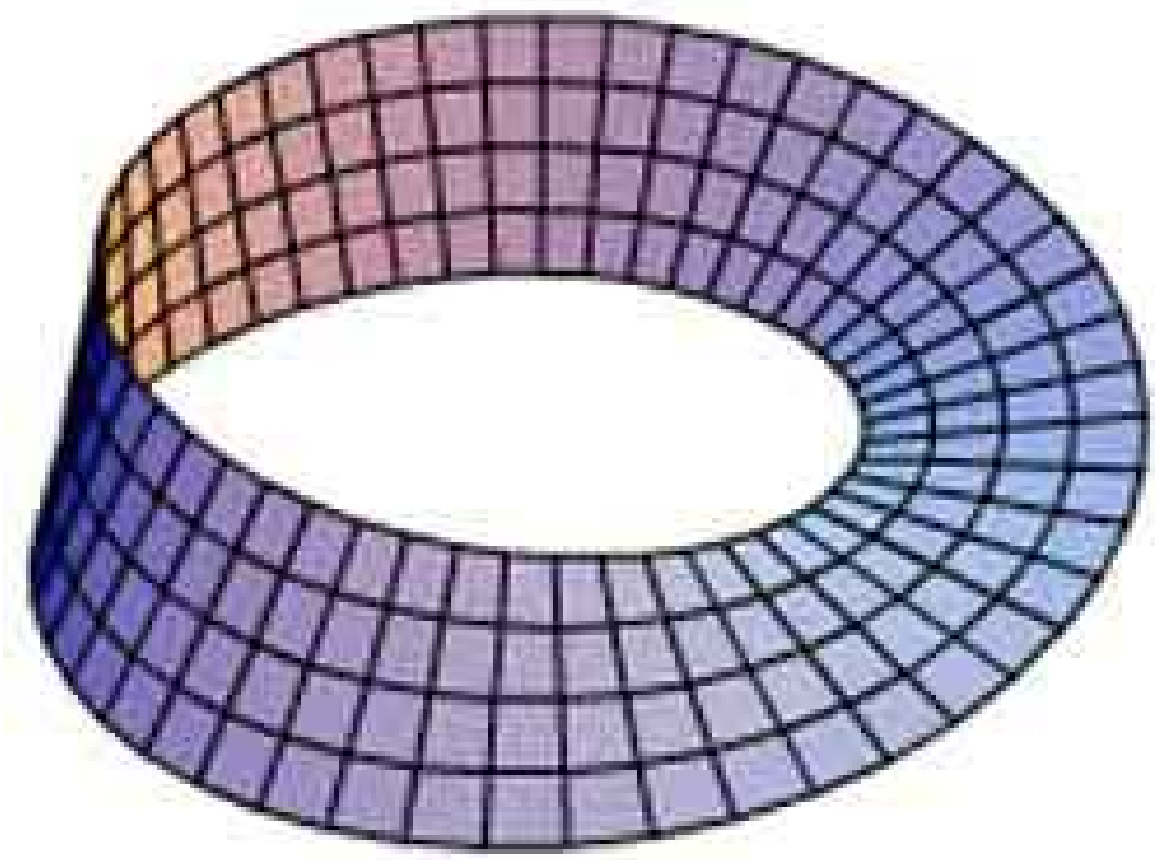
More Alike Escher Motives…



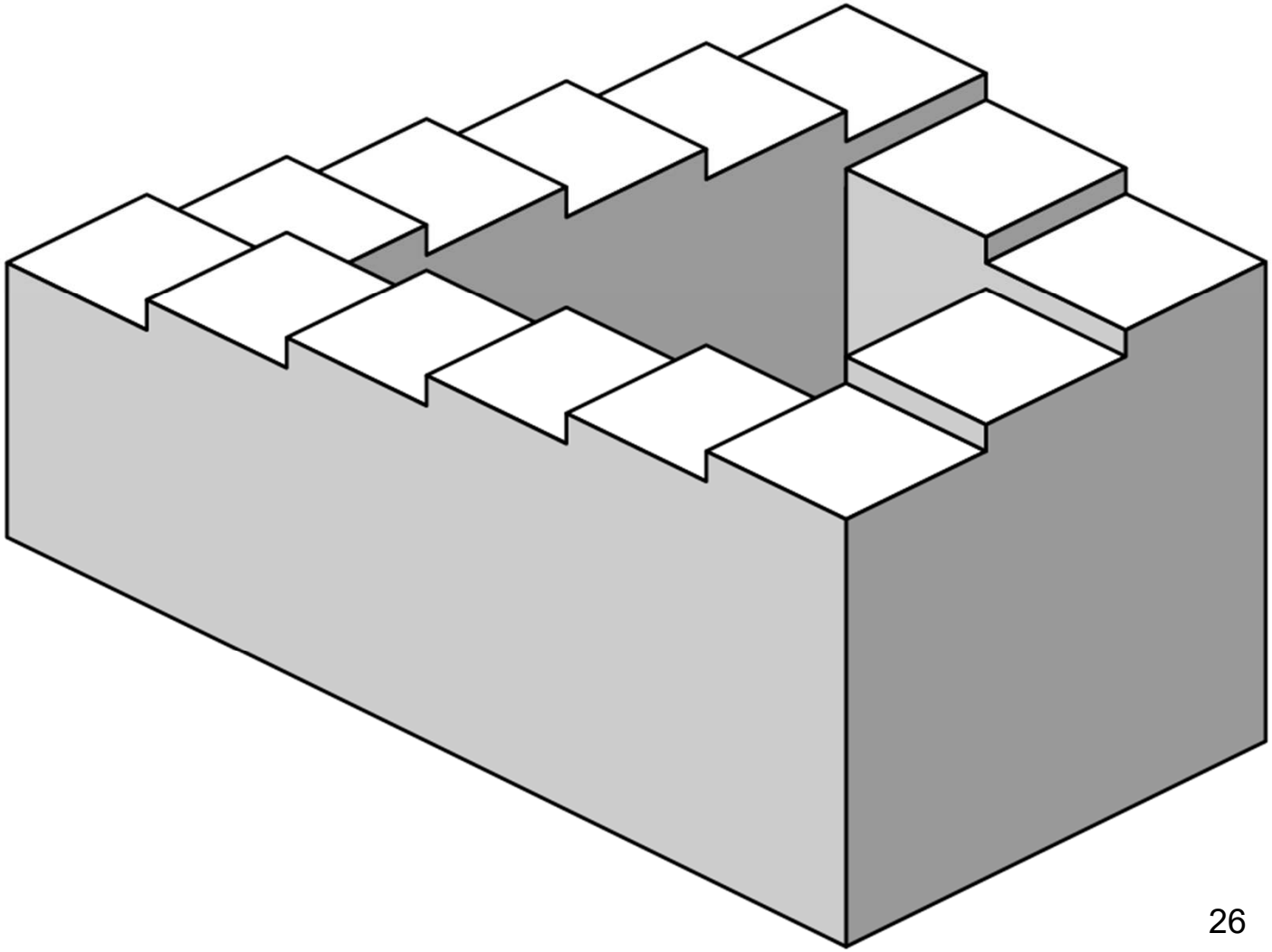
Impossible 3D Objects/ = another Escher motives



Some 3D Objects Are Real, Yet They Have Unexpected Properties, Like Moebius Strip



Impossible Stairway, Another Escher Motive



Change Blindness 1

Comment:

Change Blindness 2 and a half…

Comment:

Change Blindness 2

Comment:

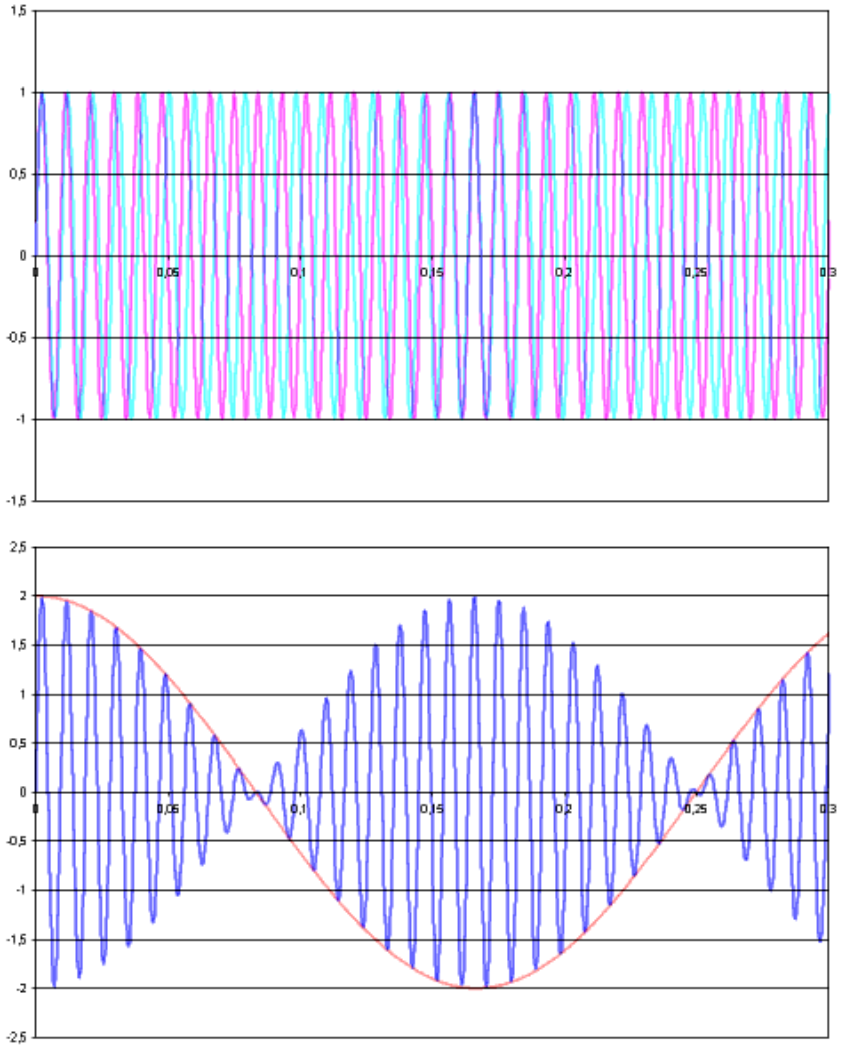
Auditory Illusions

Examples of auditory illusions/ Some of these are binaural

- Binaural beats (comment: this is rather a regular sound perception)
- The constant spectrum melody
- Scale illusion by (Diana Deutsch in1973), this is a binaural melody presentation potentially usable as a diagnostic for some neocortical defects
- Illusory continuity and illusory discontinuity of tones
- Hearing a missing fundamental frequency, given other parts of the harmonic series
- Illusory „circular pitch scale (octave)“
- Various effects using a lossy audio compression

  (Octave illusion/ Deutsch's high–low illusion)
- Auditory pareidolia: hearing indistinct voices in random noise (comment: Recall babble noise).
- perceptually ambiguous stimuli (analogy to Necker cube)

Binaural Beats



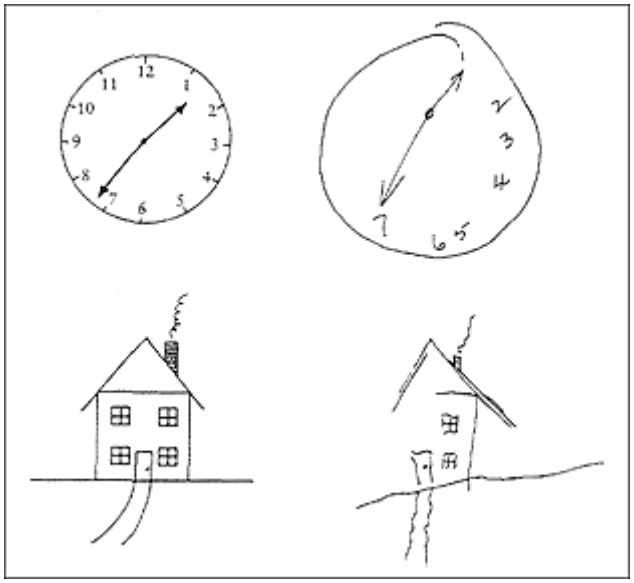
Circular pitch

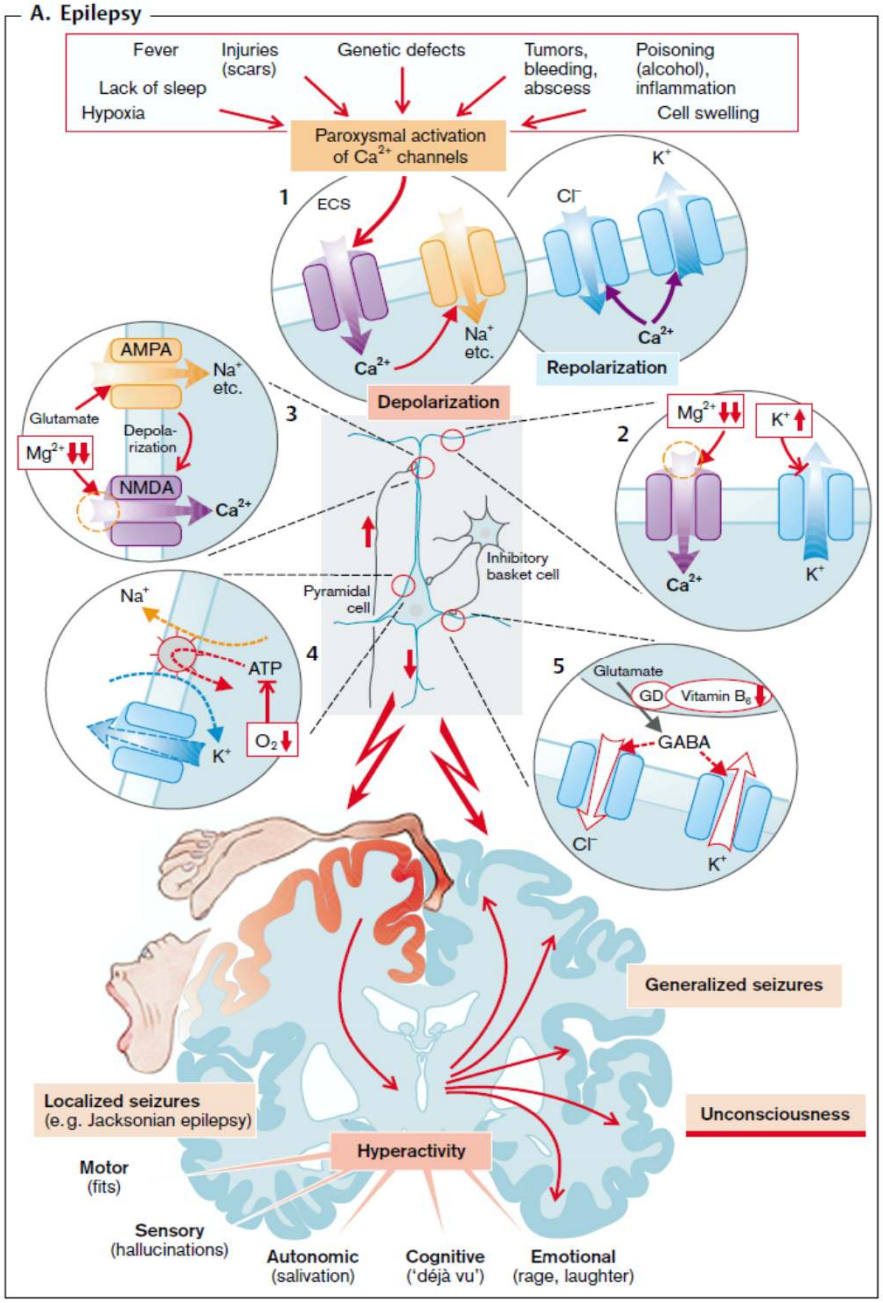
This continuum is known as pitch height. However pitch also varies in a circular fashion, known as pitch class: as one plays up a keyboard in semitone steps, C, C♯, D, D♯, E, F, F♯, G, G♯, A, A♯ and B sound in succession, followed by C again, but one octave higher. Because the octave is the most consonant interval after the unison, tones that stand in octave relation, and are so of the same pitch class, have a certain perceptual equivalence—all Cs sound more alike to other Cs than to any other pitch class, as do all D♯s, and so on;

Combined Visual and Auditory Stimuli

- Visual and auditory objects are localized in the same quadrant/ location of outer space
- Ventriloquism effects are based on „binding“ visual and auditory disparate parts of „speech“
- Other perceived object can be „multisensory“ /including touch objects/ and „synesthetic“
- Augmented /Sound /Image /Video /Reality
- Unity of outer space is disturbed in rare condition: hemineglect

Cognitive defects (A): „Hemineglect“





Epilepsy: Cortico-thalamic and Thalamo-cortical feedback system modulates sensory inputs.

„Aura“ is often olfactory, seizures are rarely solely visual or auditory, some are motor

Migraine – phosphenes

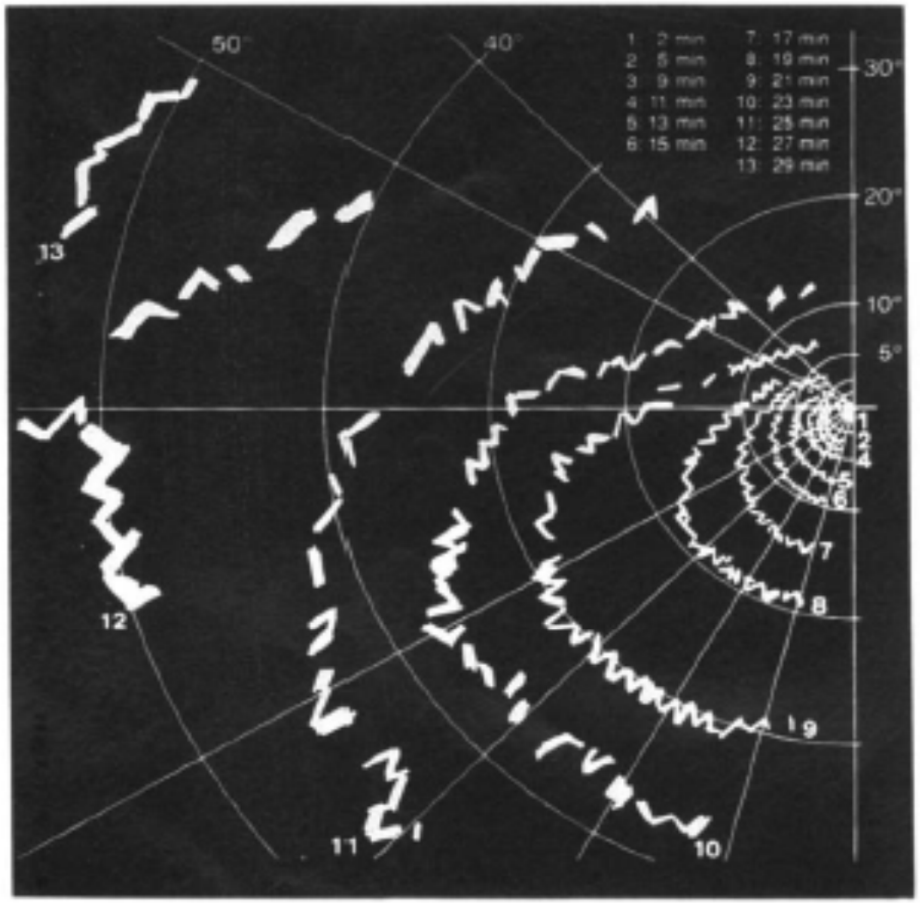
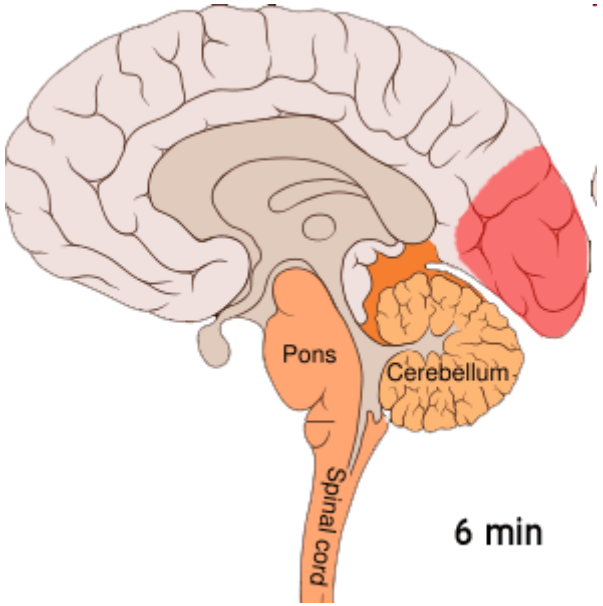


FIGURE 1. Photographic negative of a *migraine phosphene protocol.* The scintillating phosphene was progressing through the lower quadrant and part of the upper quadrant of the left visual hemifield. Thirteen drawings were made between 2 and 29 min after the phosphene appeared near the centre of the visual field. To evaluate the distance between the migraine phosphene and the centre of the visual field, several radii were drawn across the protocol. The angular distance from the fovea centre, computed in degrees of visual angle, is indicated by circles. Circles and radii were added to the protocol sheet after the observations were made. Observation distance, 34 cm.



Migraine - scotomas

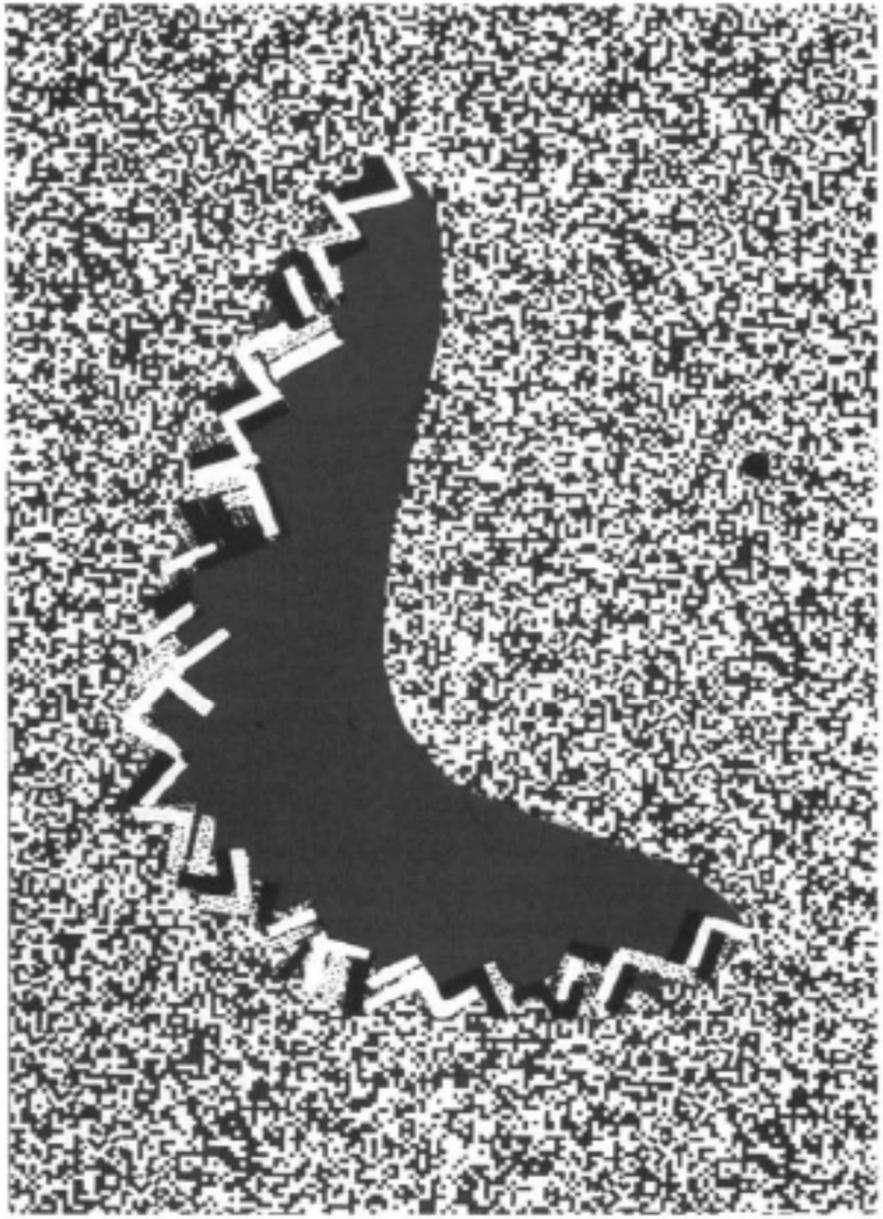
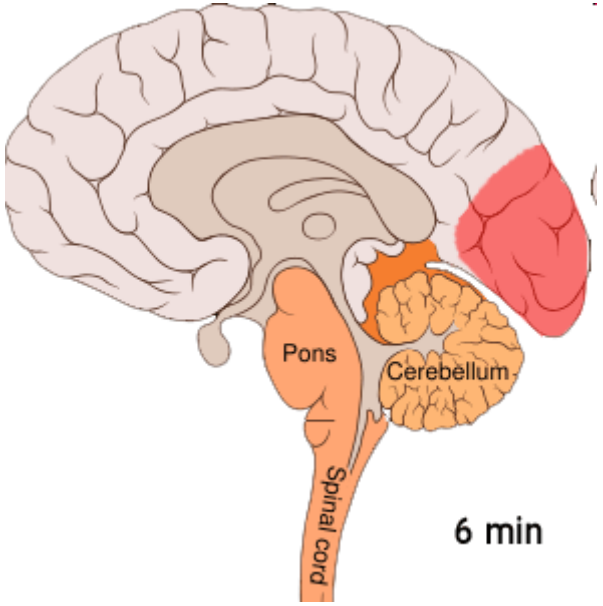
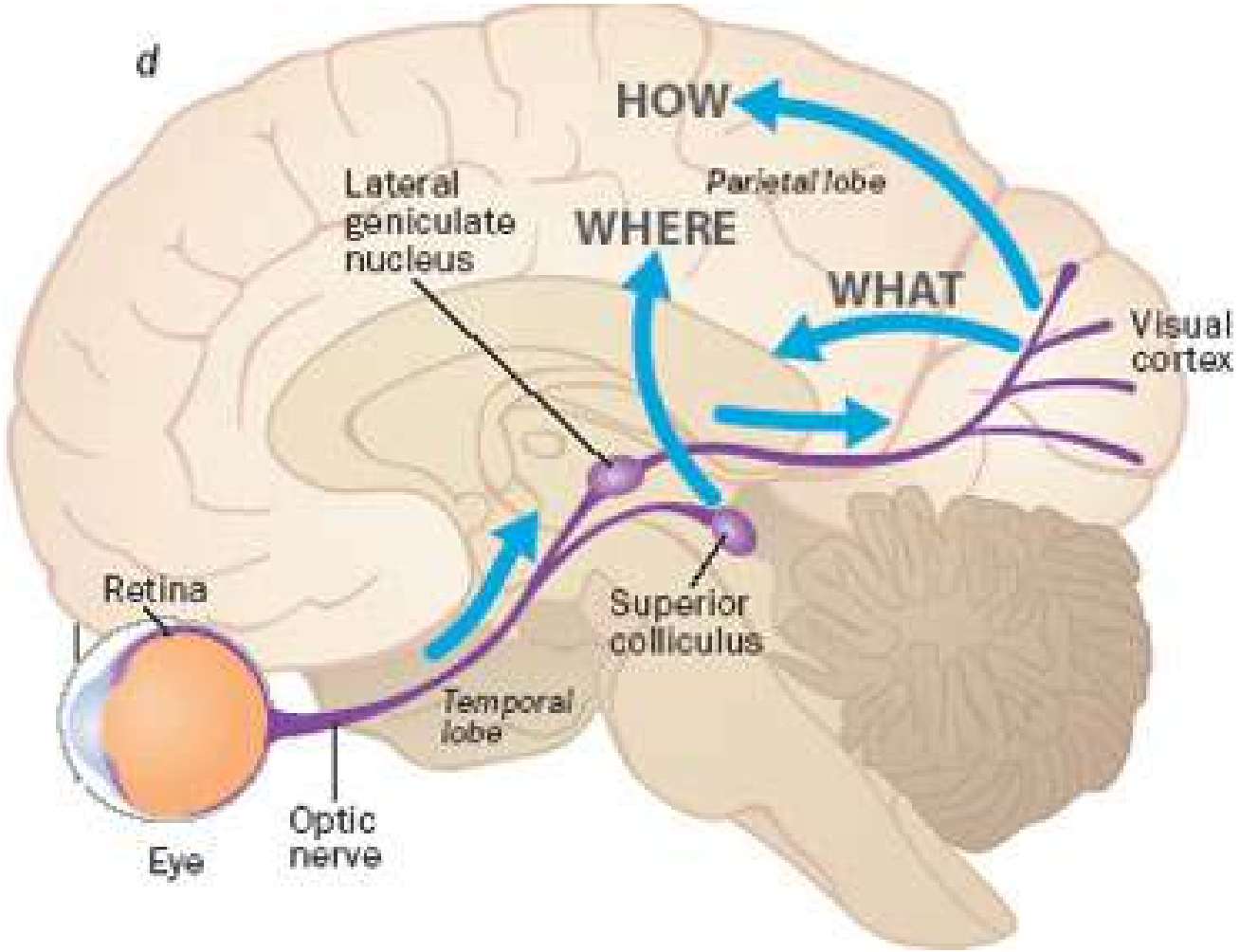


FIGURE 4. Illustration of a scintillating migraine phosphene and its trailing scotoma observed on a *dynamic random-dot noise pattern* (TV screen without program). The scotoma is perceived as a homogeneous neutral grey. Some of the phosphene particles (dotted) appeared in a pure red or green colour, some in deep black (Grüsser & Landis, 1991).



Blindsight (= slepo-zrakost…)



Analogous chart for hearing:
Functional classification of hearing loss

(measured without hearing aid)

1 normal hearing (threshold about 4 phon)

2 hardness of hearing

(hearing aid may be indicated:
at the band 500 Hz - 2 kHz bilaterally
threshold rise of 35 - 40 dB,
speech audiometry –threshold rise of more than 35 dB
low comprehension of loud speech at less than 4 m)

3 (practical) deafness

(does not hear loud voice at the ear, own voice,
threshold rise of 75 - 80 dB)

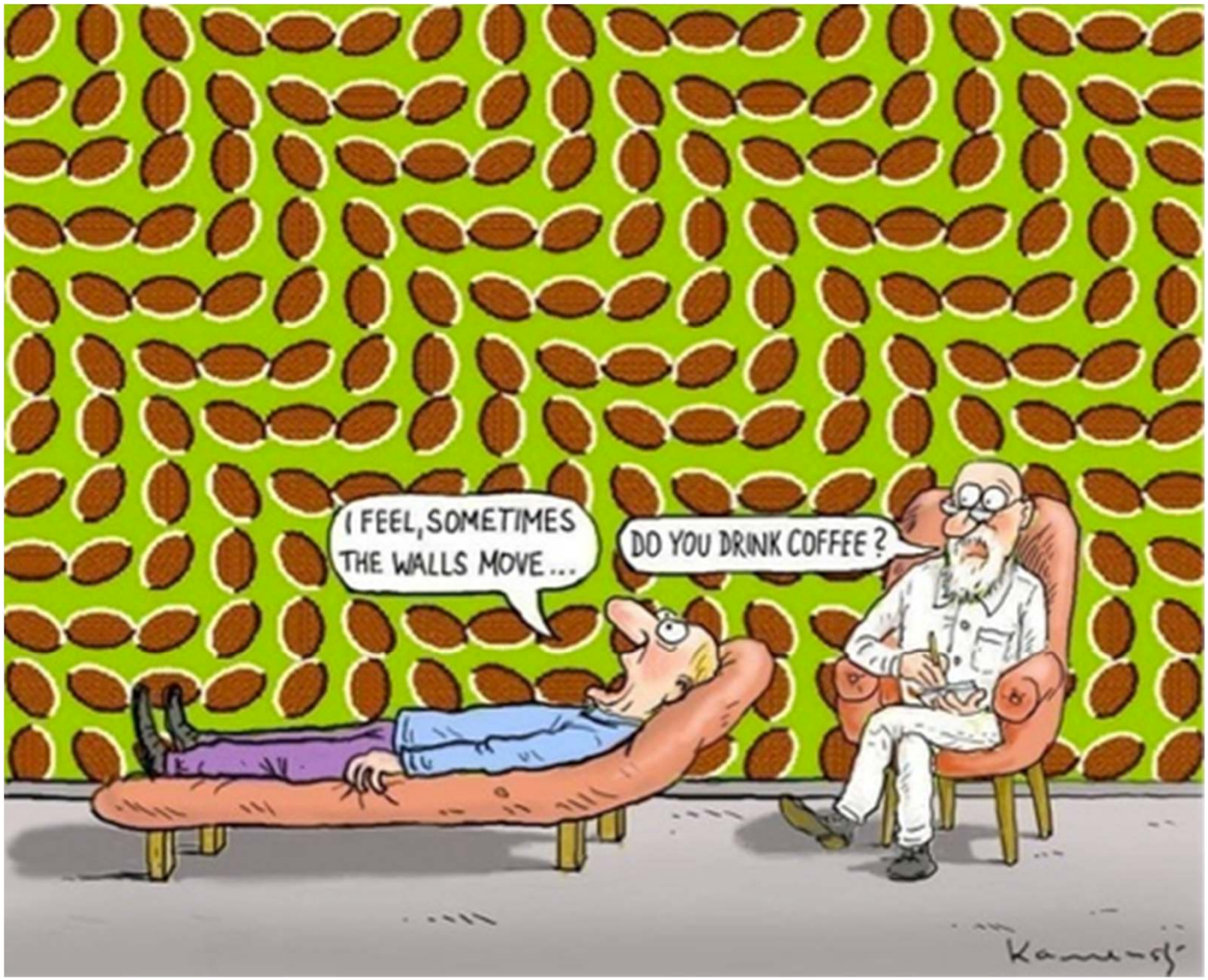
4 *deaf-and-dumbness*

(when the speech is not rehabilitated with inborn deafness)

Causes of hearing loss

- otosclerosis (in 0,5 - 1 % of elderly)
- conductive disorders
- hereditary and inborn disorders
- toxic damage
- meningoencefalitis
- profesional damage
- presbyakusia
- Menier’s disease

Cartoon: Drinking coffee and illusions



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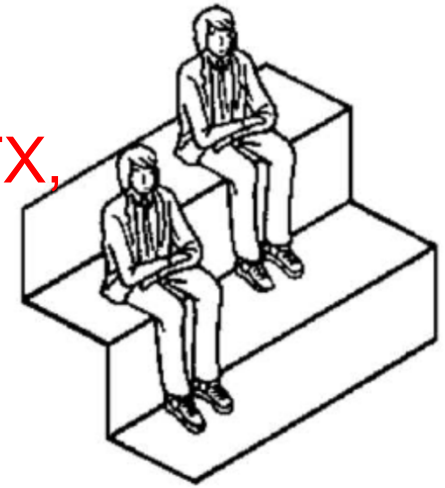

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https://michaelbach.de/ot/

END

OF THE LECTURE

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Comment:

E. A. Poe: The pit and the pendulum
Jáma a kyvadlo

I had been deceived, too, in respect to the shape of the enclosure. In feeling my way I had found many angles, and thus deduced an idea of great irregularity; so potent is the effect of total darkness upon one arousing from lethargy or sleep! The angles were simply those of a few slight depressions, or niches, at odd intervals. The general shape of the prison was square.

Také v odhadování tvaru vězení mne cosi zmátlo. Když jsem tápal vpřed, nahmatal jsem ve zdi množství hran, což mi vnuklo představu velké nepravidelnosti - tak mocný má účinek naprostá tma na člověka, který procitá z_letargie či spánku! Byly to prostě hrany několika porůznu rozložených, mírně propadlých či vyklenutých míst. Tvar žaláře byl zhruba čtverec.