Perception

A simple story about us suggests that we have 5 senses

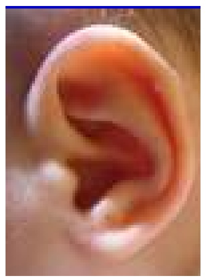
It turns out to be more complicated than that

The terms “sense” and “sensation” may be used in several different senses.

At stake is the manner in which the body is “plugged” into the world.

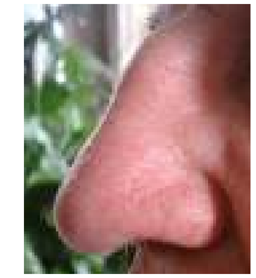
In a simplistic interpretation of the term “sense” we can easily show that we have very many different kinds of information available to us

Sensory data comes from at least the following systems:

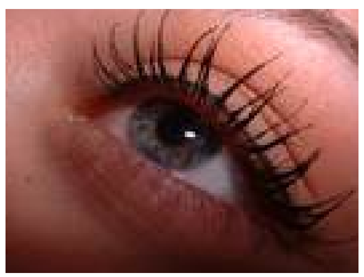


audition

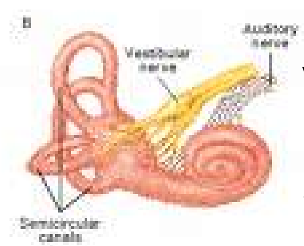
taste



olfaction

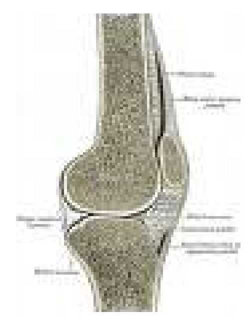


vision

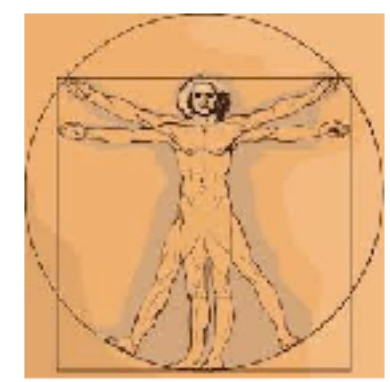


vestibular system

touch
pain
heat/cold
vibration



proprioception
kinaesthesia



interoception

Perception can be treated as a process by which we come to be aware of the world around us

or as the means by which we skilfully cope with the world as we act in it

or as a process of sense-making in the world

Different theoretical assumptions are available, and they will lead to different kinds of insights.

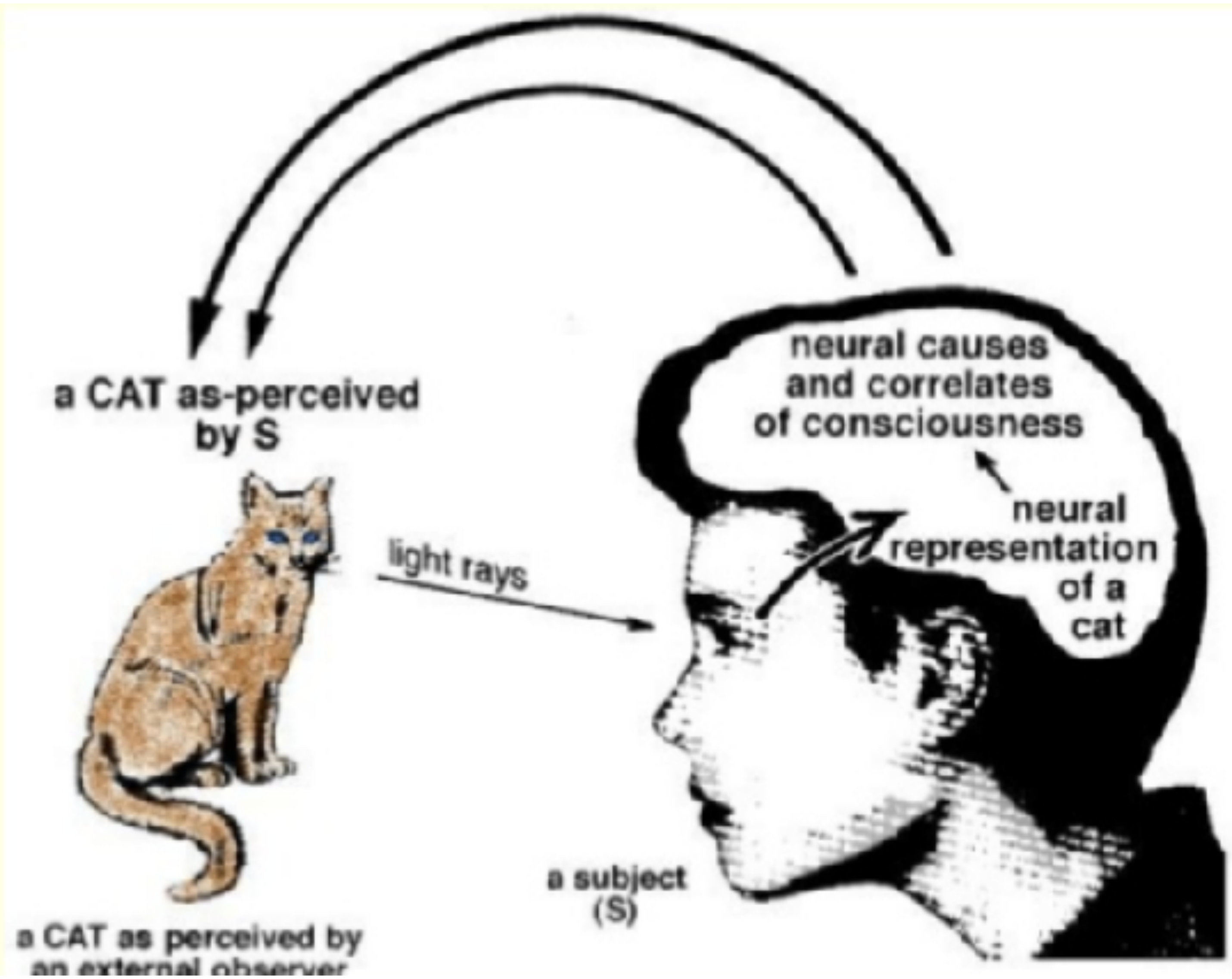
Theoretical approaches to perception may be broadly divided into two major camps (with lots of variation within each camp)

1. INTERNALIST theories: strong separation of experiencing subject and an “external” world

2. RELATIONAL: examine embedding of an active subject in the world

INTERNALIST approaches to perception

Internalist approaches tend to be most concerned with what is going on in the brain



The INTERNALIST view is compatible with much of our everyday language in which we speak of being “inside our heads”

Such view points are strongly Cartesian in character, emphasizing separation of subject and world

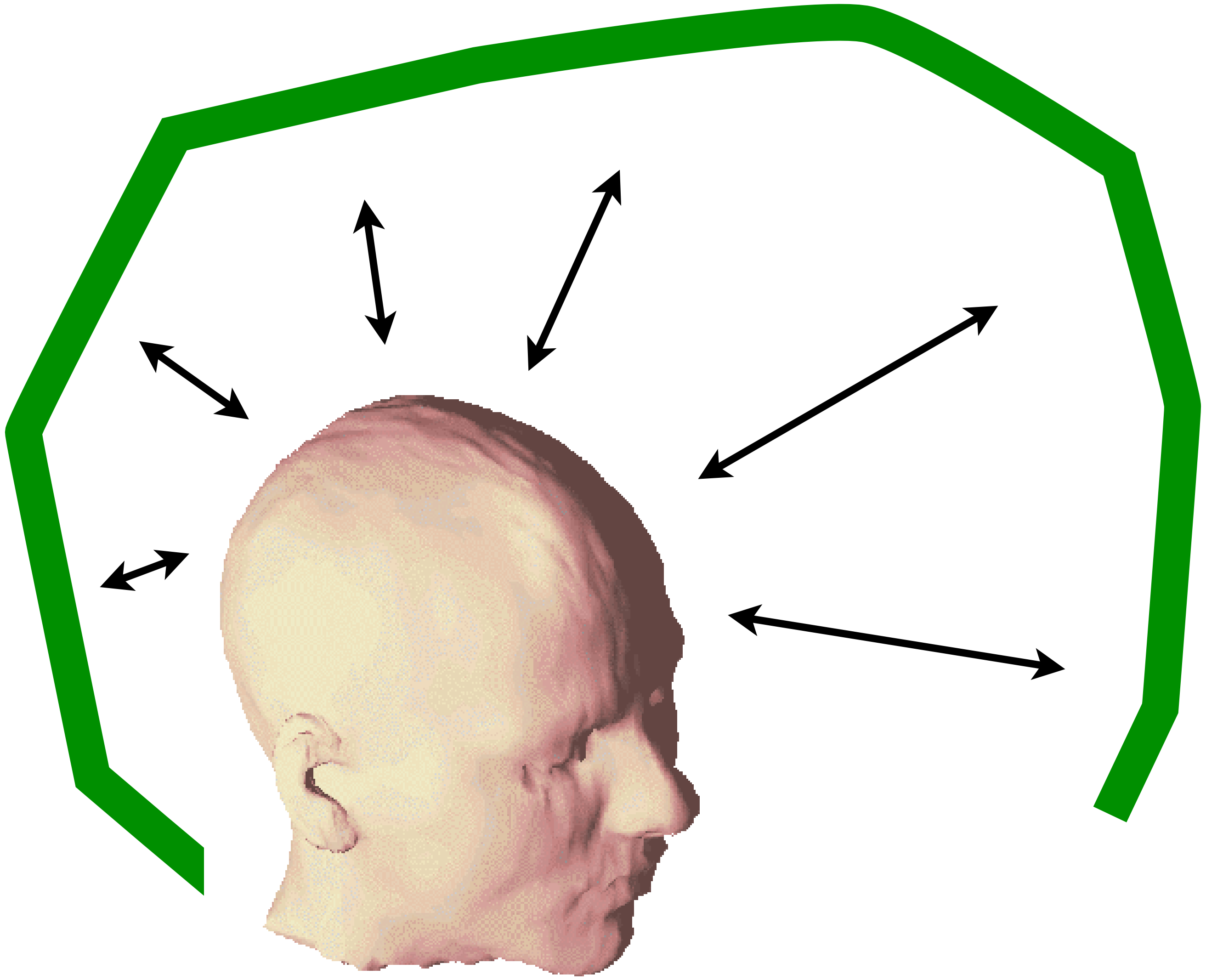
Internalist approaches often adopt a spectatorial view of the world

Relational approaches emphasize activity in the world

RELATIONAL approaches to perception

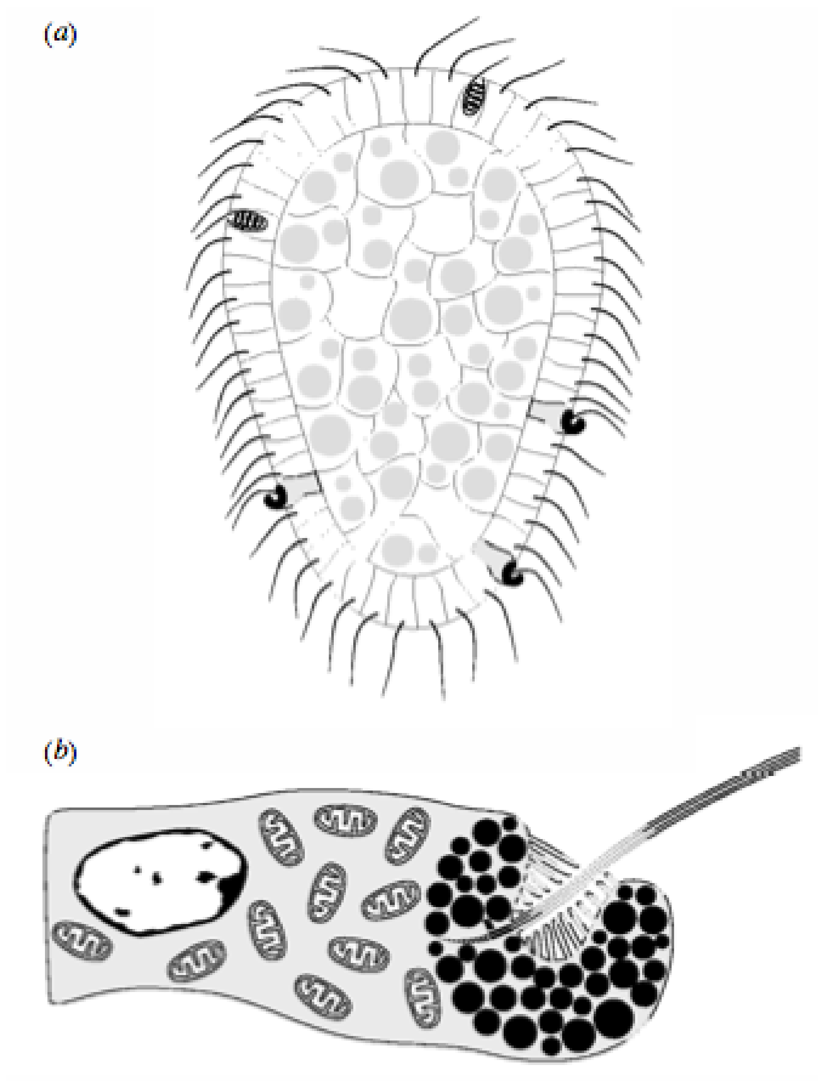
„Ask not what's in your head but what your head is inside of."

Mace, 1977



Relational approaches tend to be most concerned with the activity of the body in its environment

What's the simplest visual system we could imagine?



Tripedalia cystophora, a jellyfish larva, has 2 tissue types, 5 cell types and no nervous system. Photoreceptors in special cells, the ocelli, directly alter the direction of tiny hairs within the photoreceptor cell. These hairs steer the otherwise uncontrolled motion of the larvae.

Proc. R. Soc. Lond. B (2003) 270, 2349–2354

The box jellyfish uses its ability to sense the direction of the oncoming light to steer towards it.

The ocelli provide a distributed rudder system.

Note: this is a perception/action system, not perception alone.

“vision” here is purposeful

There is no boundary between “inside” and “outside”

Care is needed as we examine different sensory modalities. They are not really independent of one another.

Taste and smell are very closely linked

Vision and the vestibular system work closely together too to orient us with respect to the world

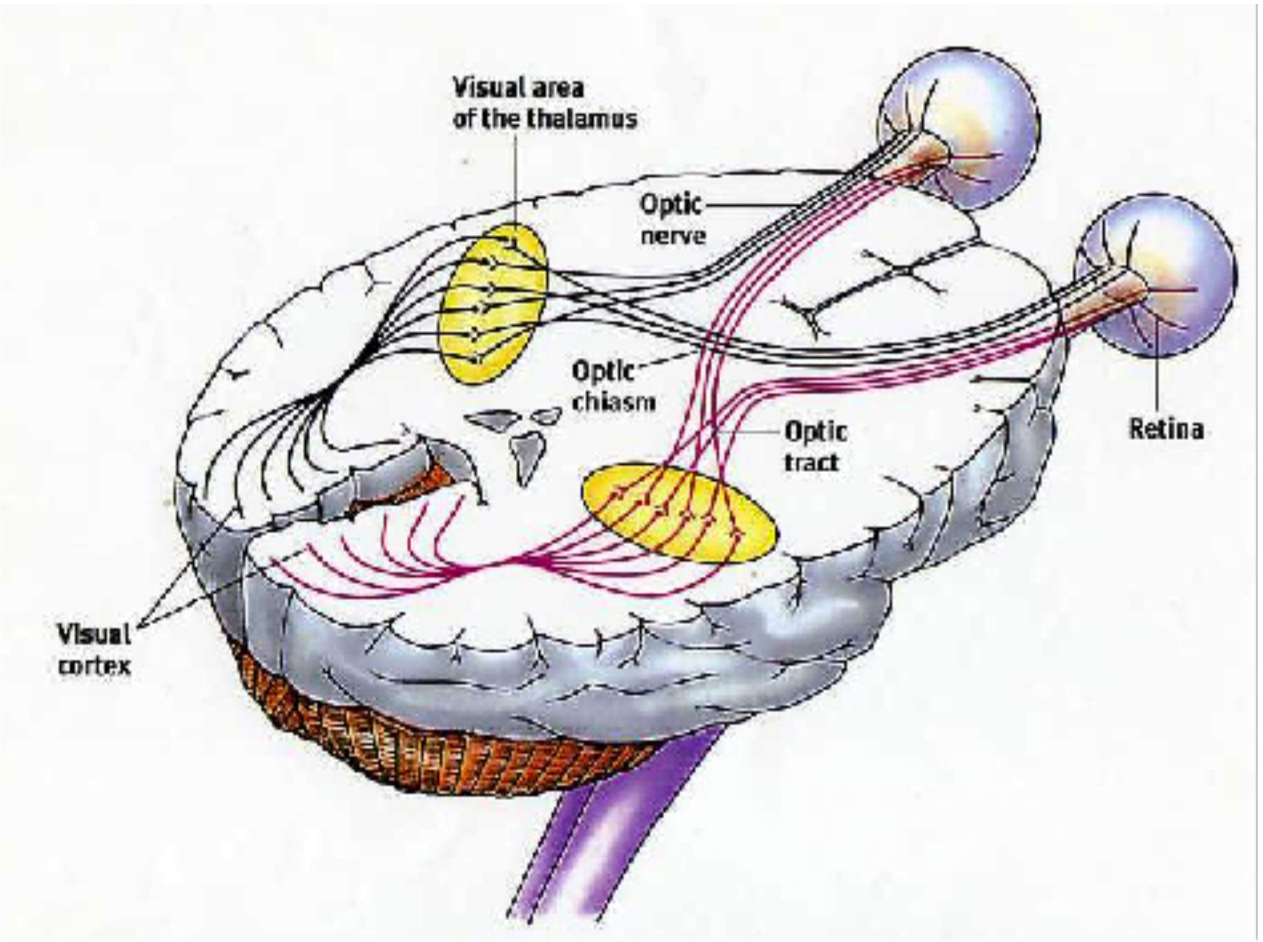
Various kinds of proprioception and interoception combine to provide a general sense of awareness of the state of the body

Three of these modalities have a very special relation to the central nervous system:

Vision
Audition
Touch (haptics)

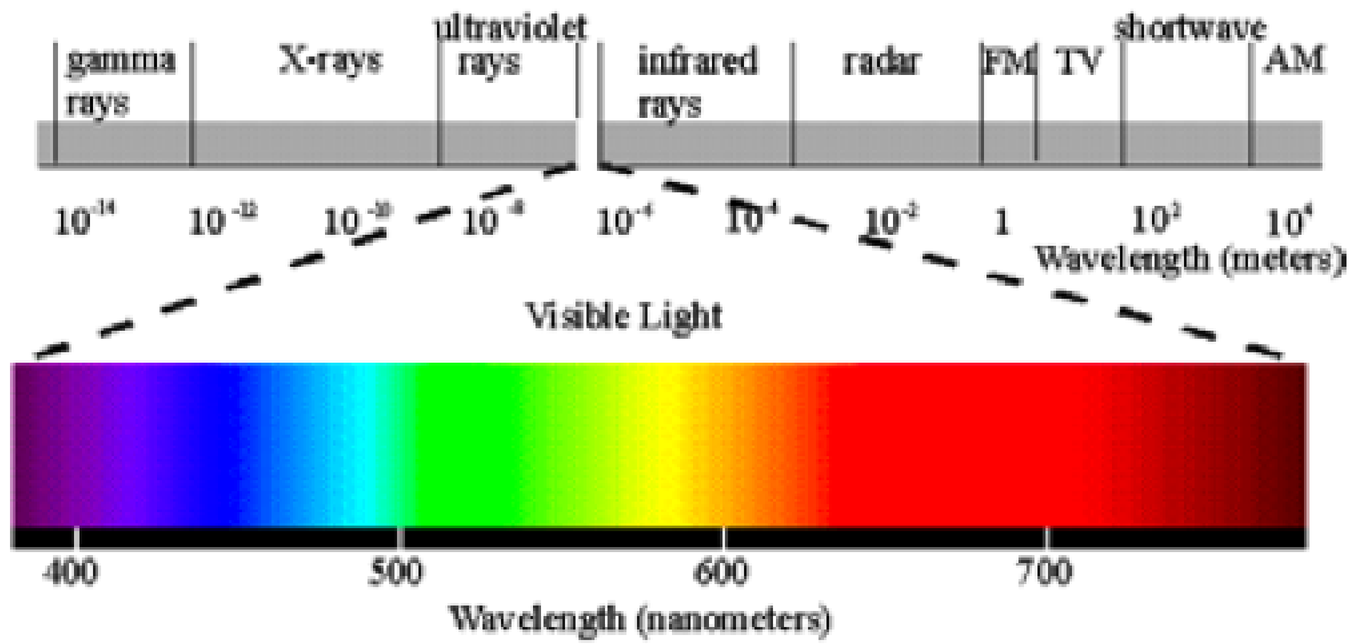
Each has a sensory surface that links directly to a *primary sensory cortex*

In vision, the *retina* is connected to the *primary visual cortex*

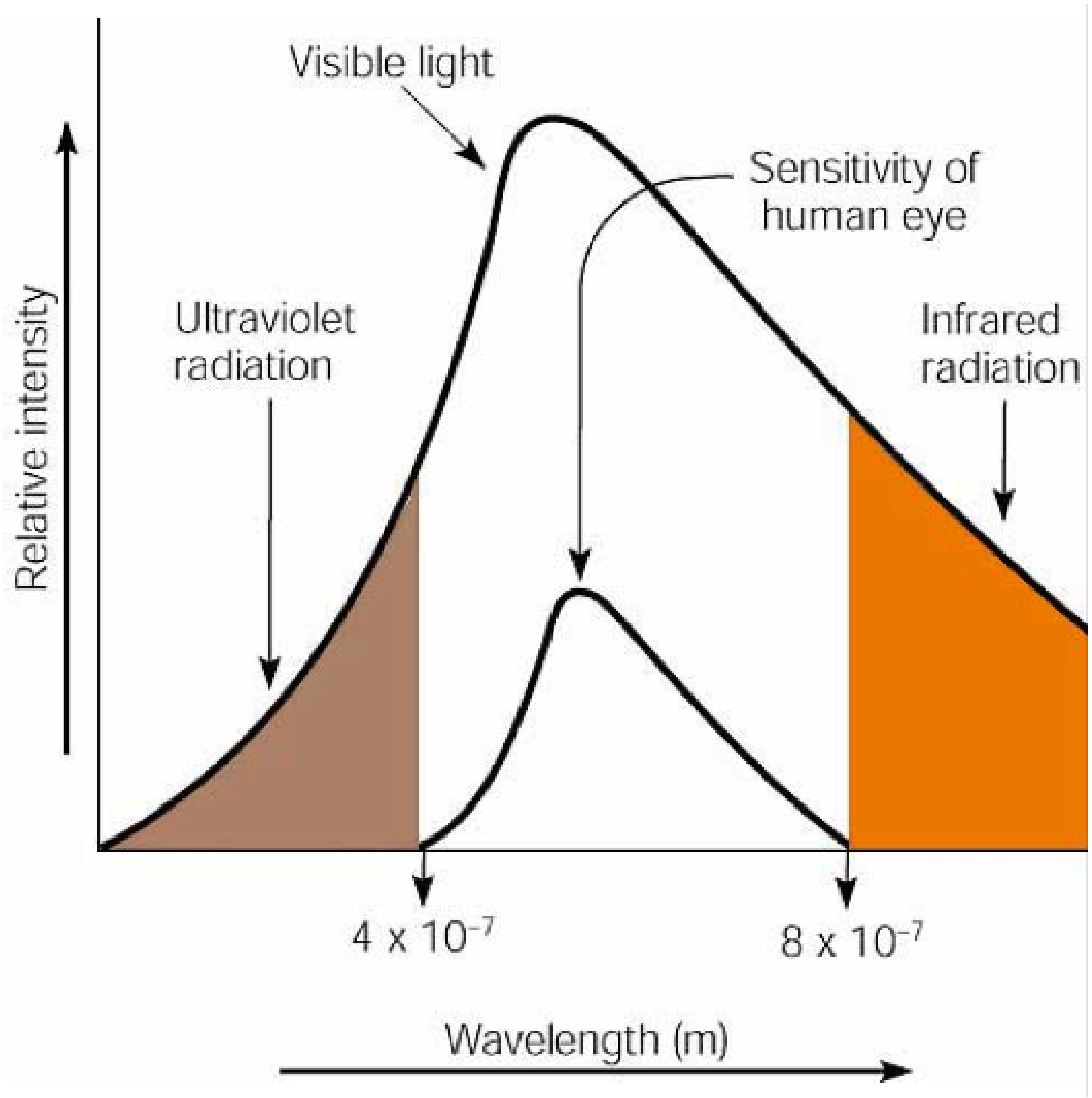


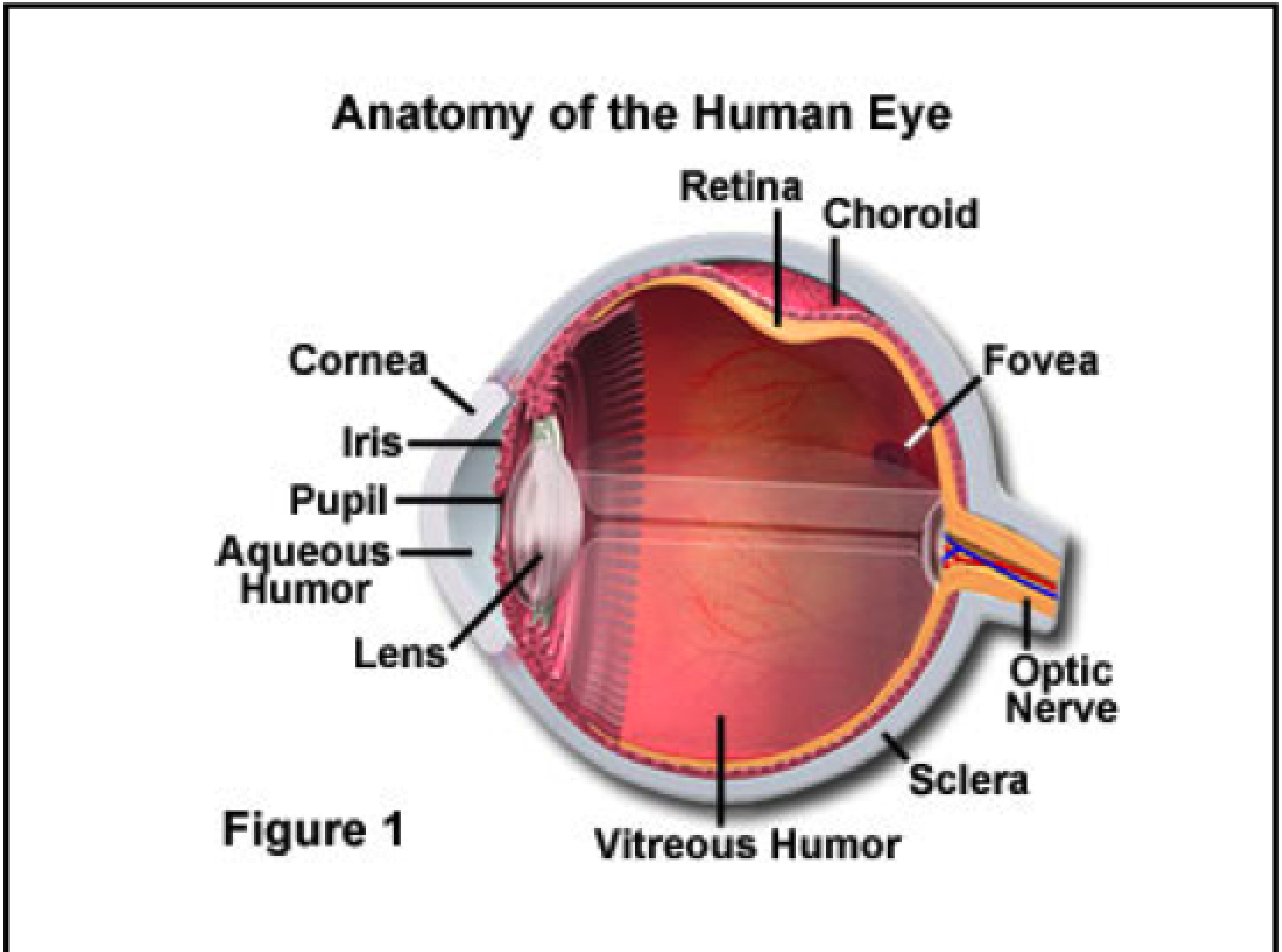
Vision: the eye, and primary visual cortex

Electromagnetic Spectrum



Most of the radiation in raw sunlight is invisible to the human eye



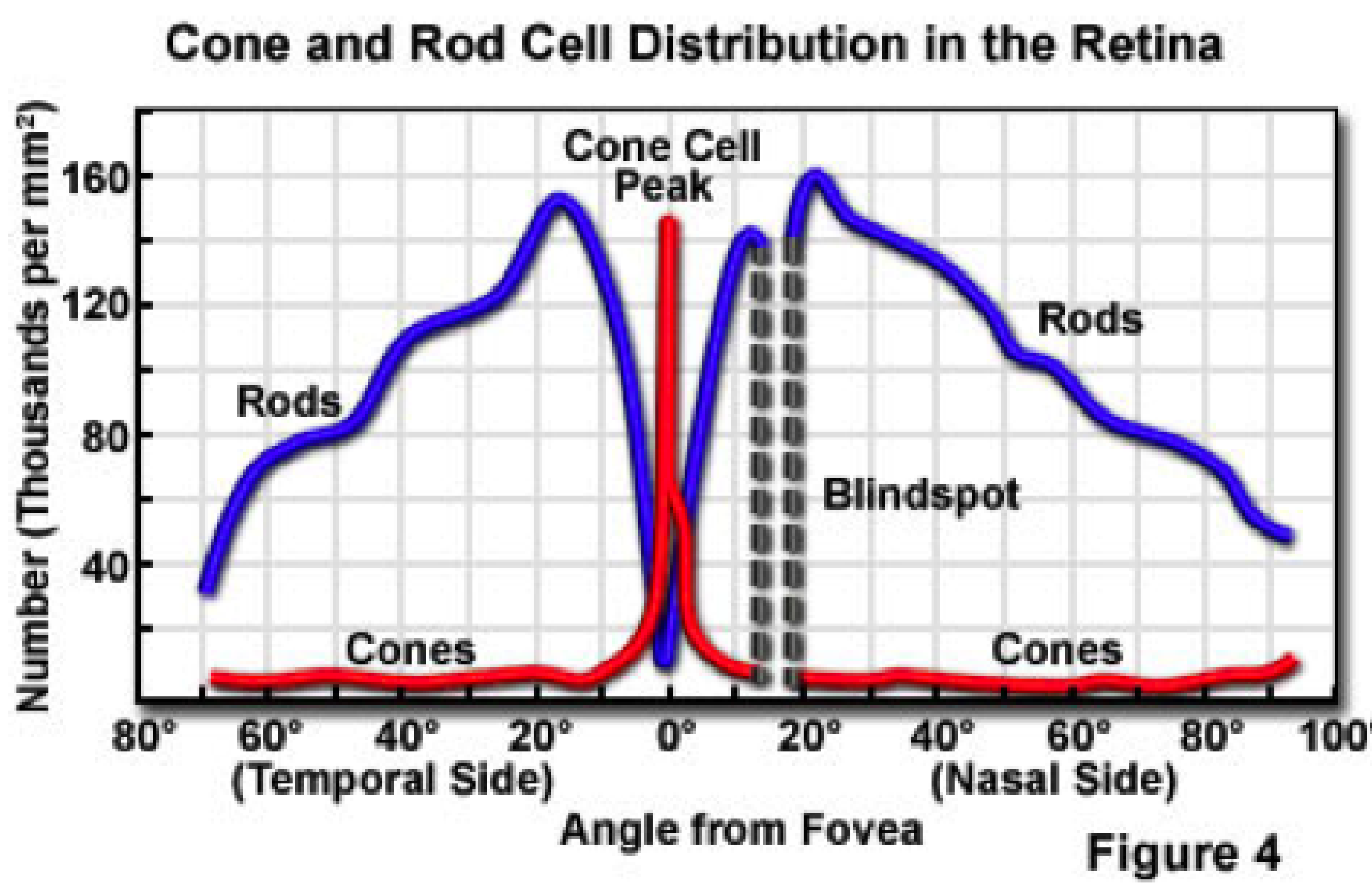

Anatomy of the Human Eye
Retina
Choroid
Cornea
Fovea
Iris
Pupil
Aqueous Humor
Lens
Optic Nerve
Sclera
Figure 1
Vitreous Humor

Distribution of rods and cones

150 Million Rods

7 Million Cones

1 Million Nerve Fibres

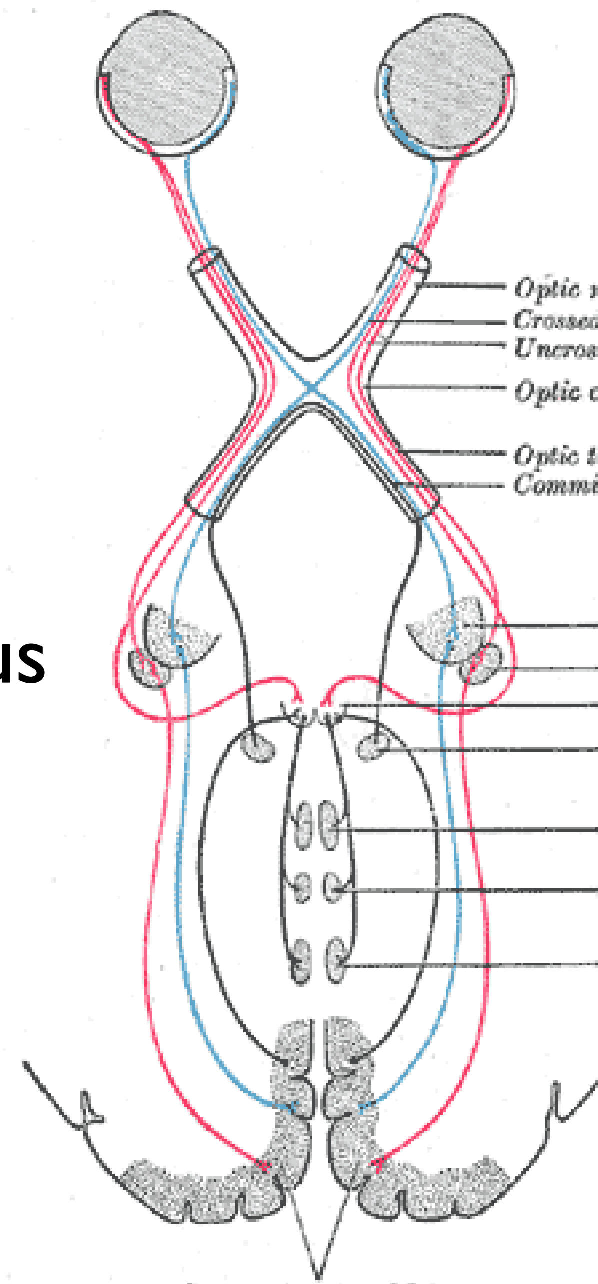


eye

optic chiasma

lateral geniculate nucleus

visual cortex

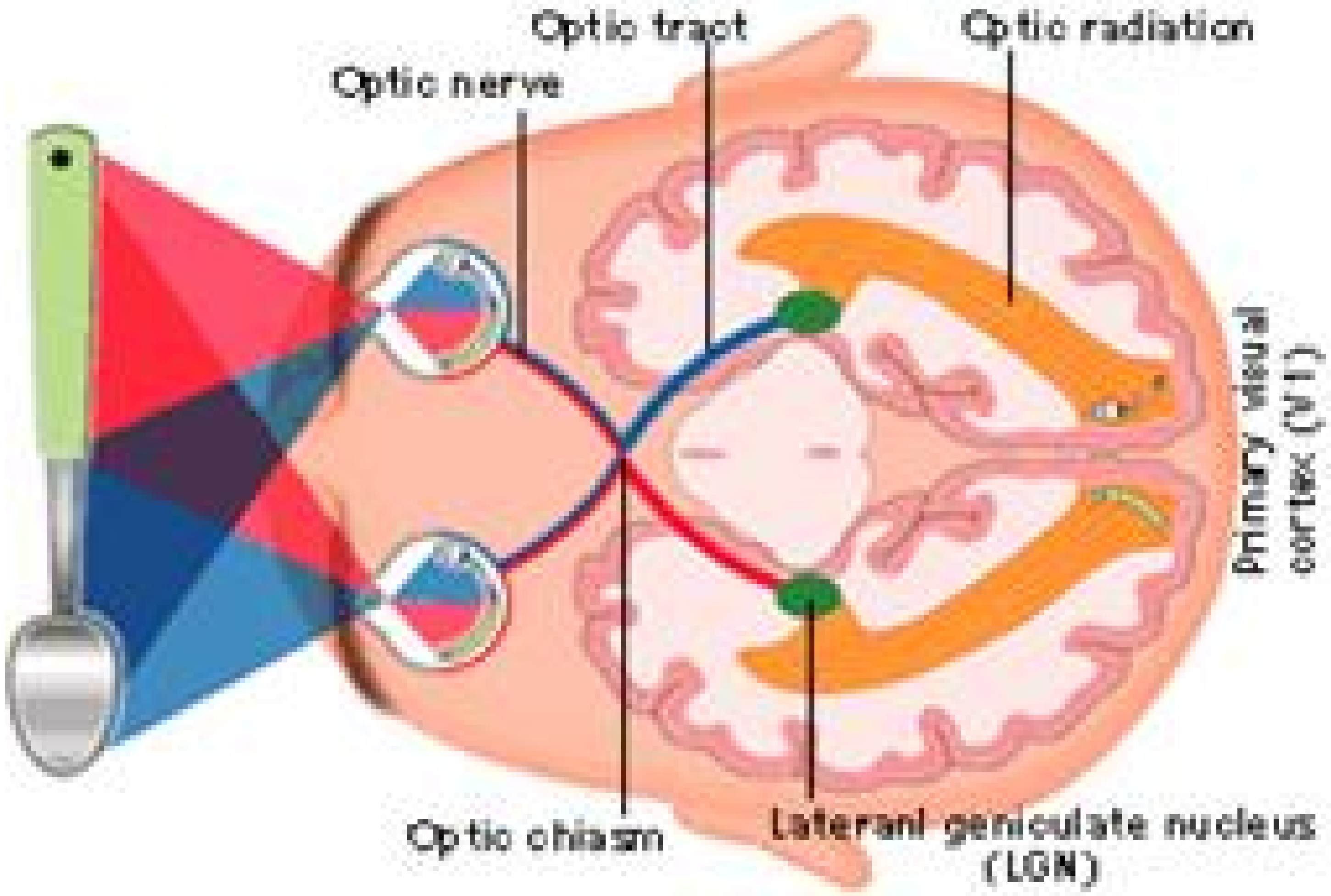


Pause for thought:

There are at least as many paths *from* the CNS *to* the eyes as there are from the eyes to the CNS

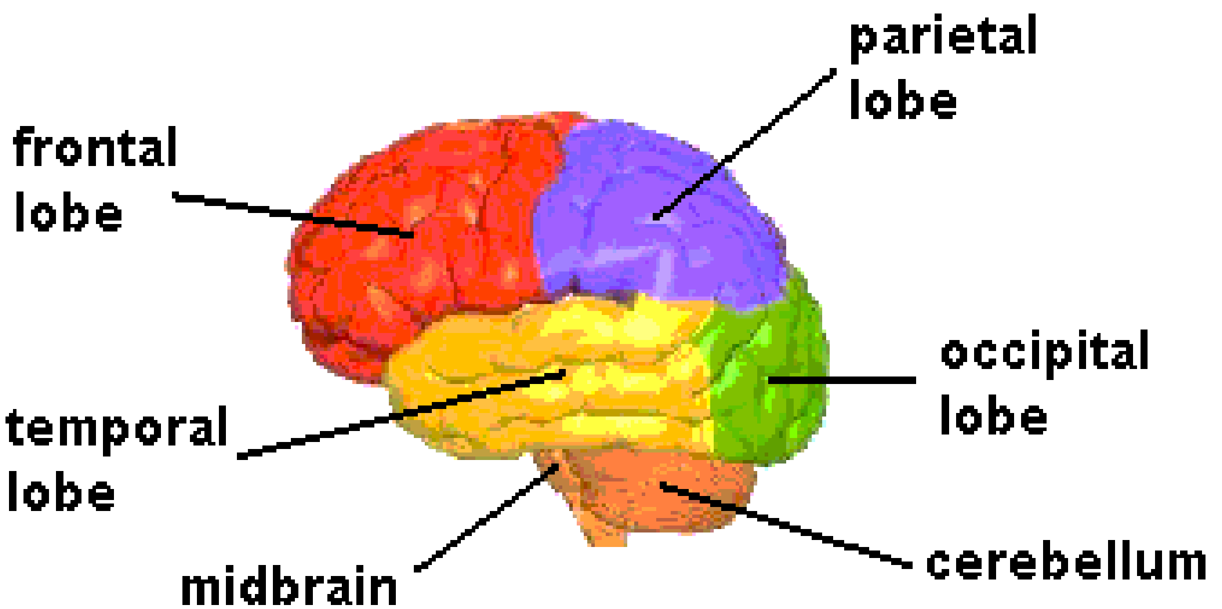
We tend to think of sensory modalities as simple *input* systems. But they the relation of the body to the world is not uni-directional. As we move, so the sensory information available changes.

CNS = Central Nervous System



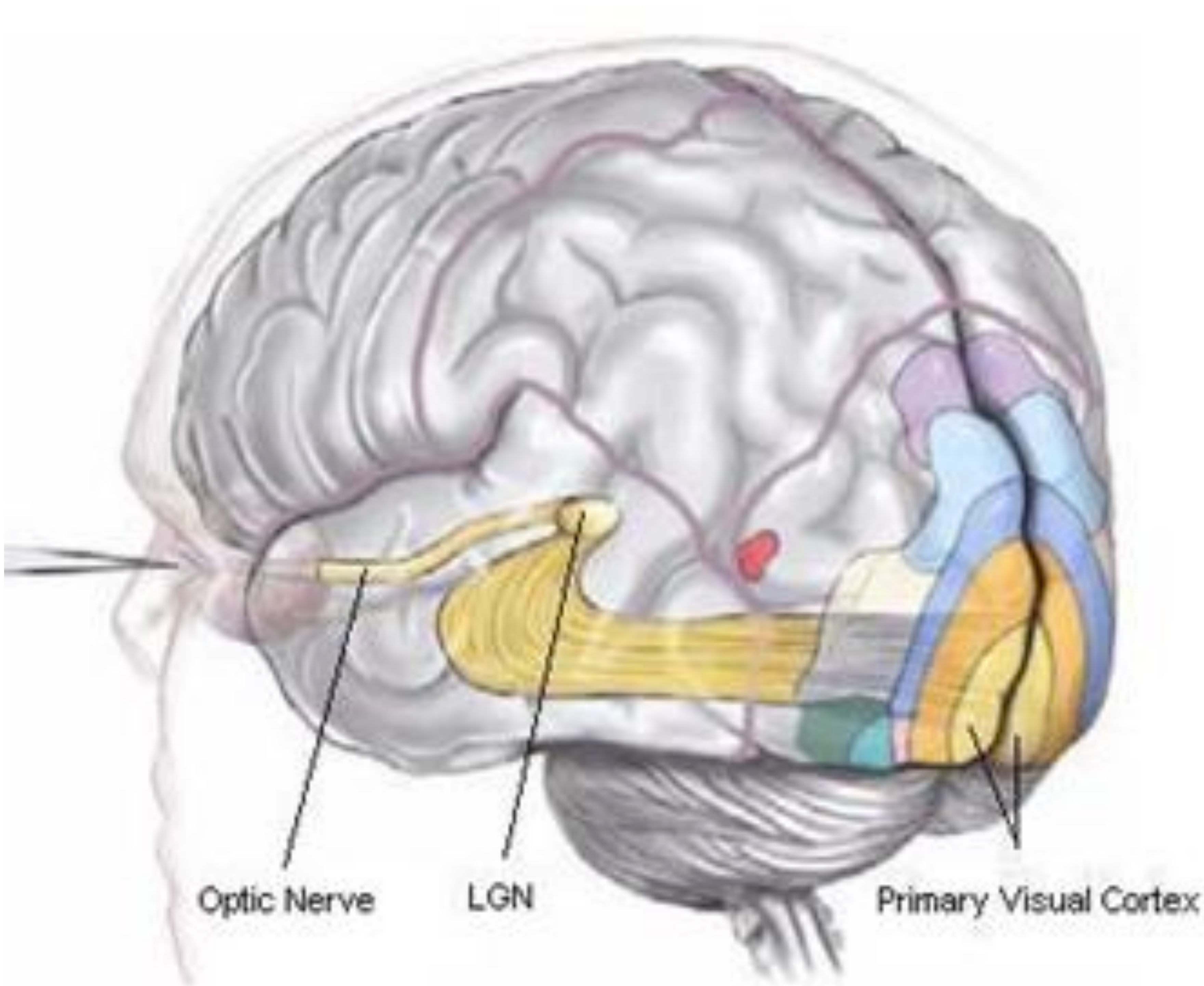
Right visual field maps to left occipital lobe

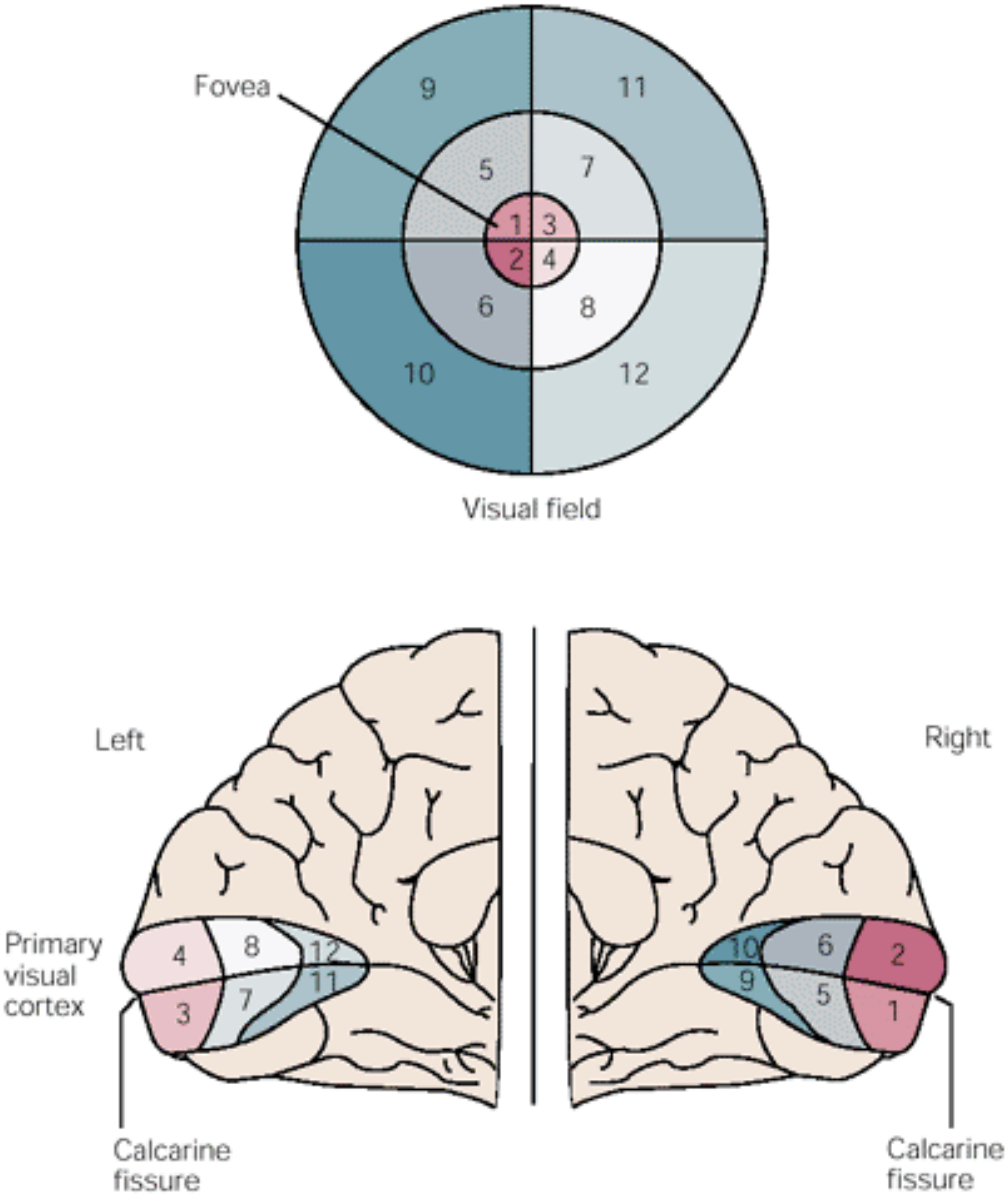
(*NOT* right eye to left lobe!!!)



Lobes of the cerebral cortex

Weird plumbing!





Spatial map: ordered by spatial layout

Pause for thought:

In what ways is the eye like a camera?

(consider projective geometry, optics, lens, aperture, structures)

In what ways is the eye unlike a camera?

(consider activity, eyes don’t record images, cameras don’t see, eyes are integrated in a larger visual system, vision is purposive, etc)

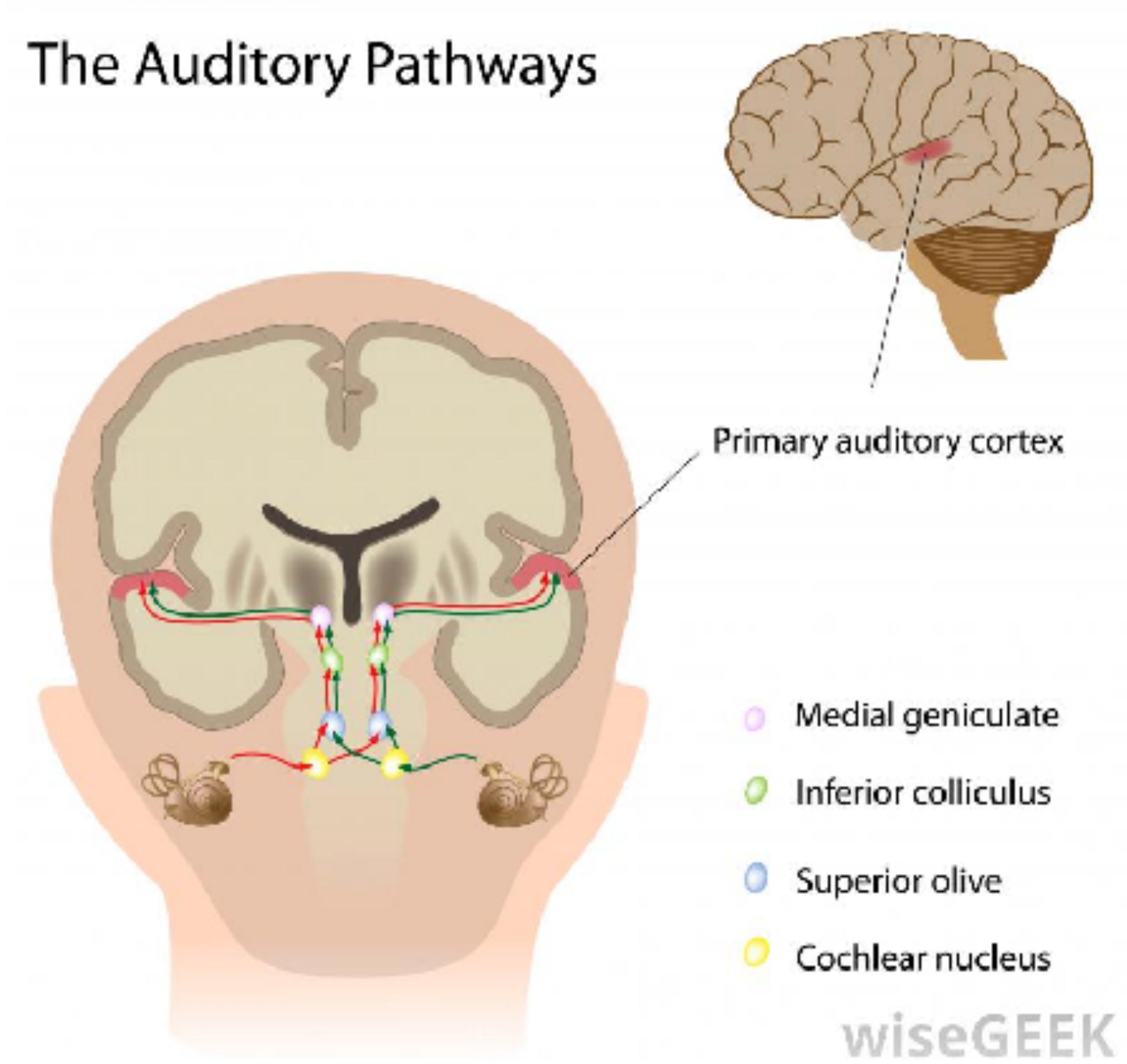
A word about images

Images are objects in the world. Vision is NOT the transmission of images (from where to where?)

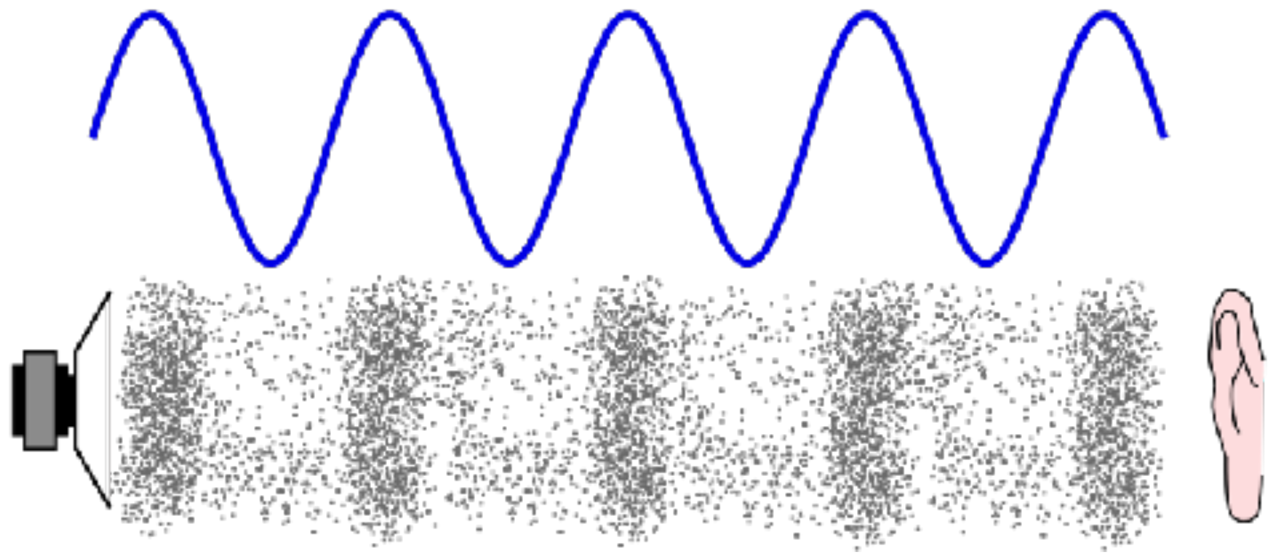
The way you interpret an image is hugely influcenced by your culture, education, and experience of other images

“There is no such thing as the innocent eye” (Ernst Gombrich) . . . meaning that you see always, using your full understanding, which itself has a long and complex history within a specific cultural and historical setting

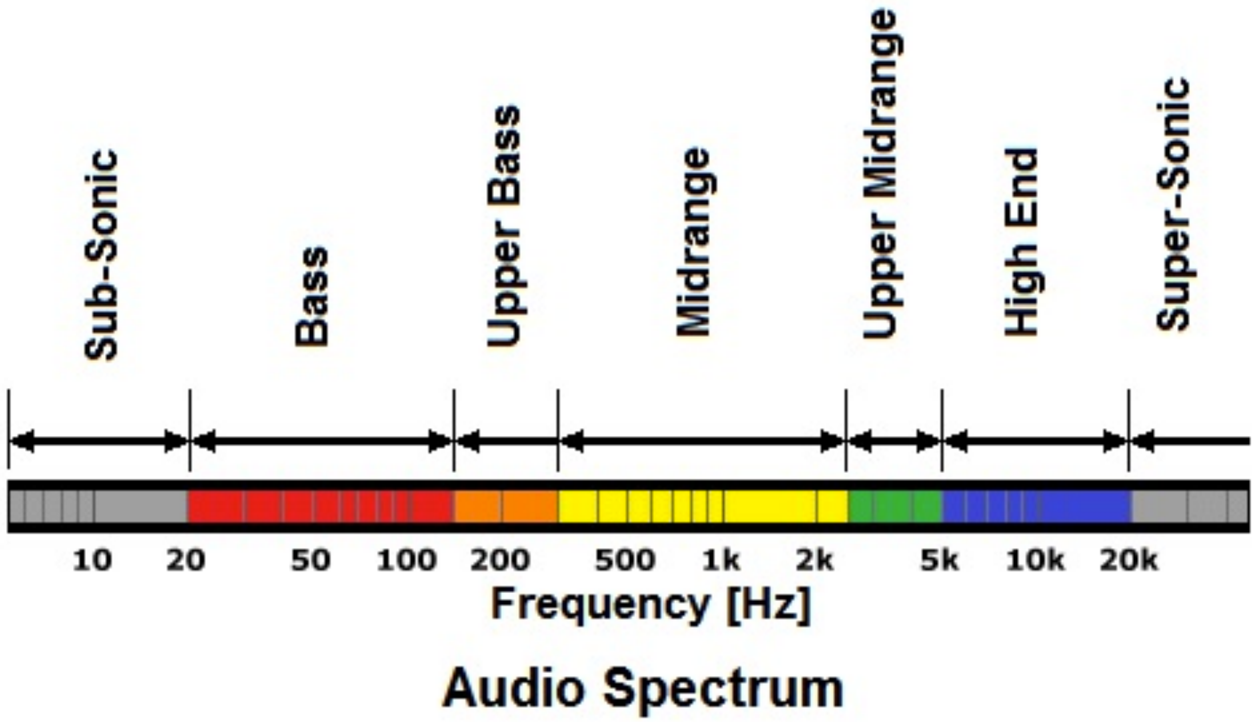
In audition, the *basilar membrane* in the cochlea is connected to the *primary auditory cortex*



Audition: The ear and primary auditory cortex



Below 20 Hz, we hear discontinuous events



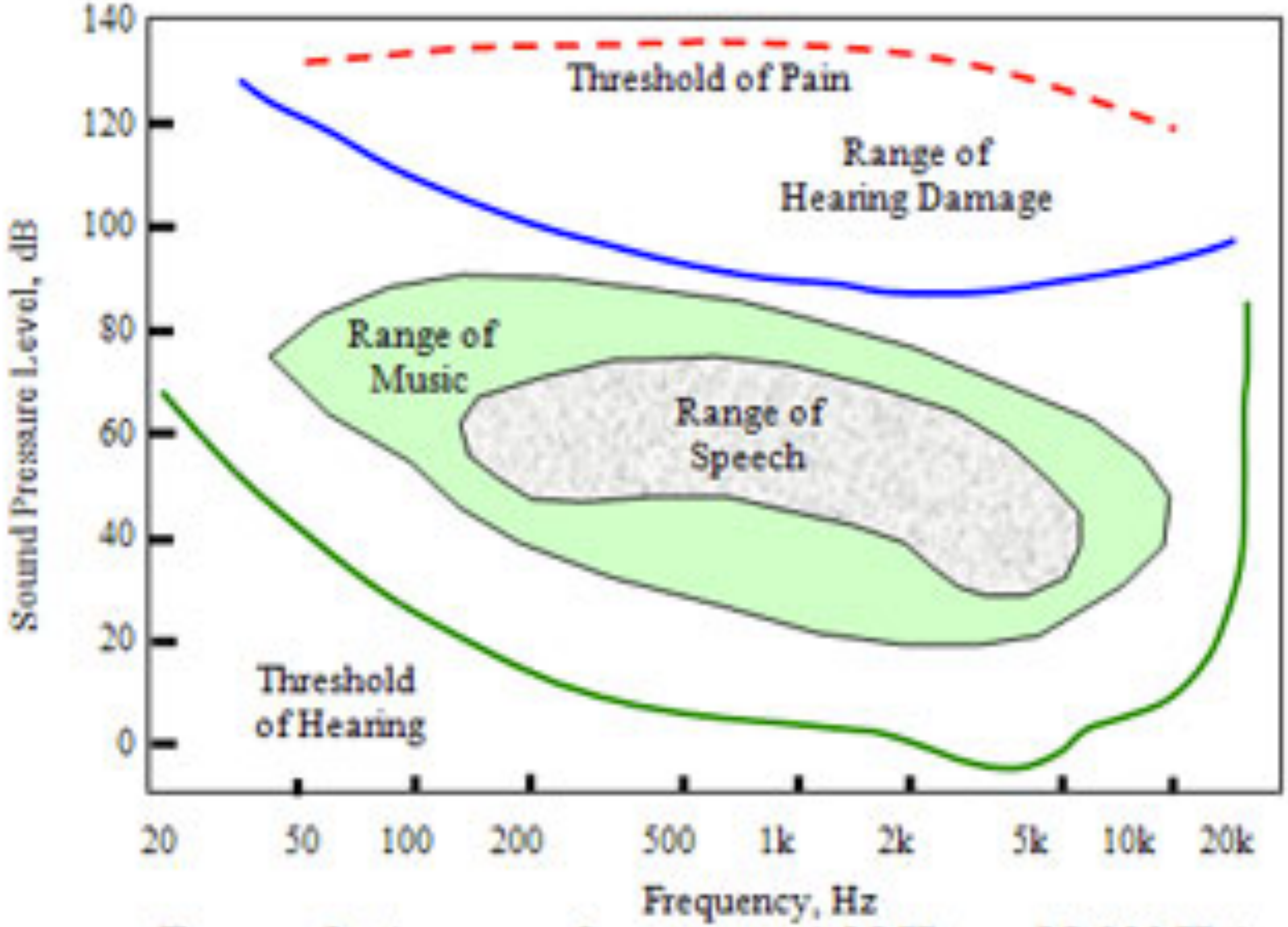
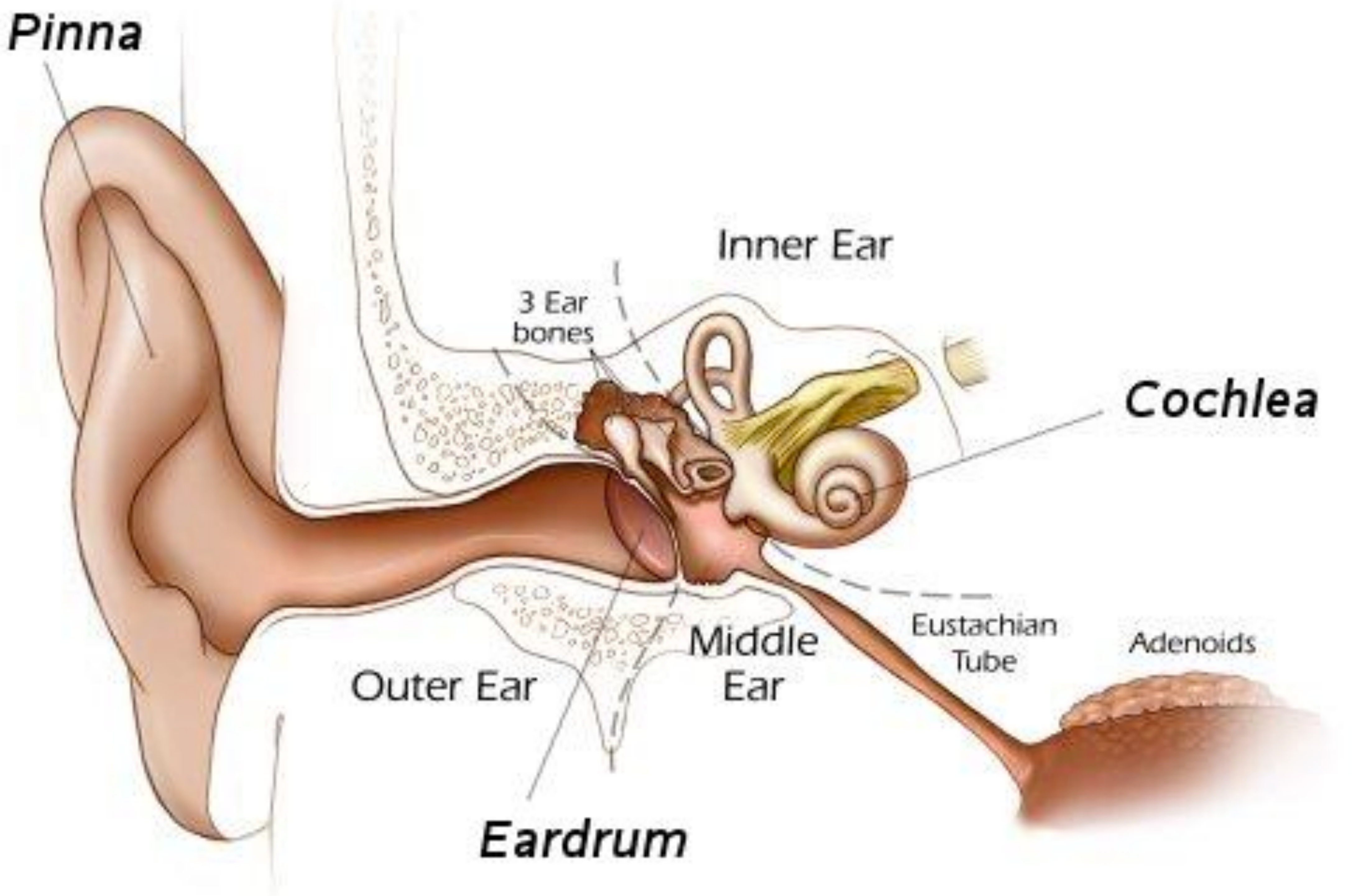


FIGURE 1 - AUDIBLE SPECTRUM (~18 HZ TO 18,000 HZ)


Pinna
Inner Ear
3 Ear
bones
Cochlea
Eustachian
Tube
Adenoids
Middle
Ear
Outer Ear
Eardrum

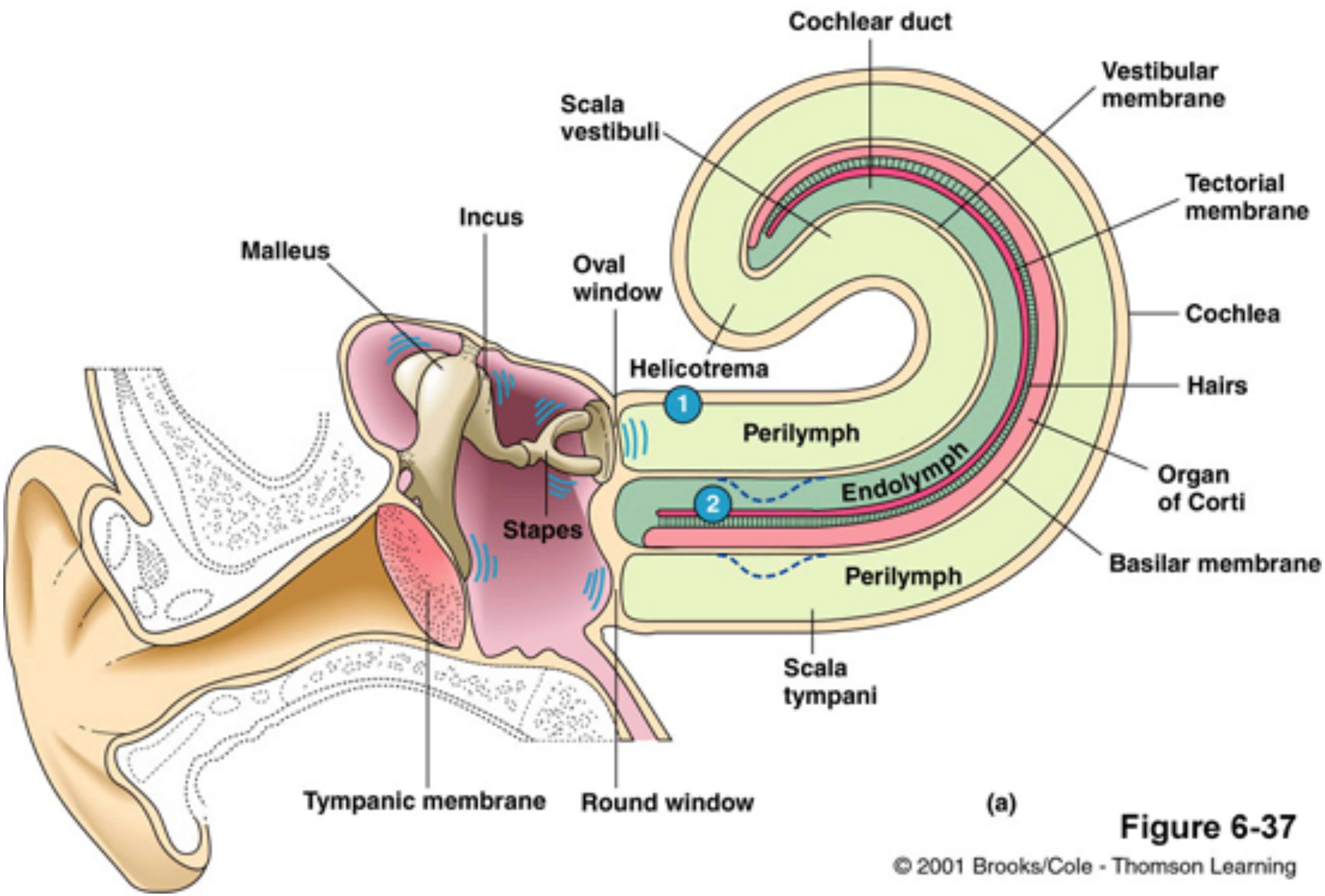
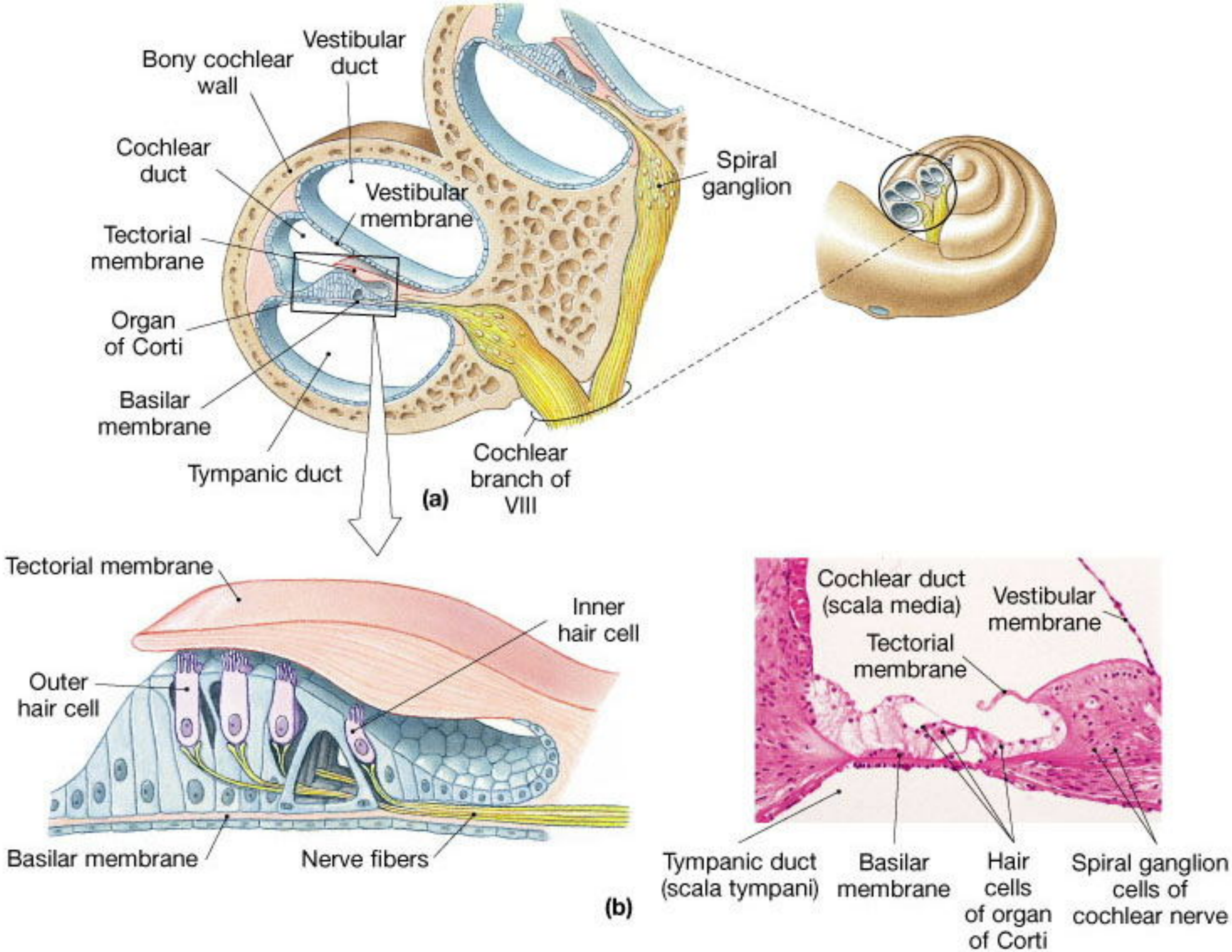
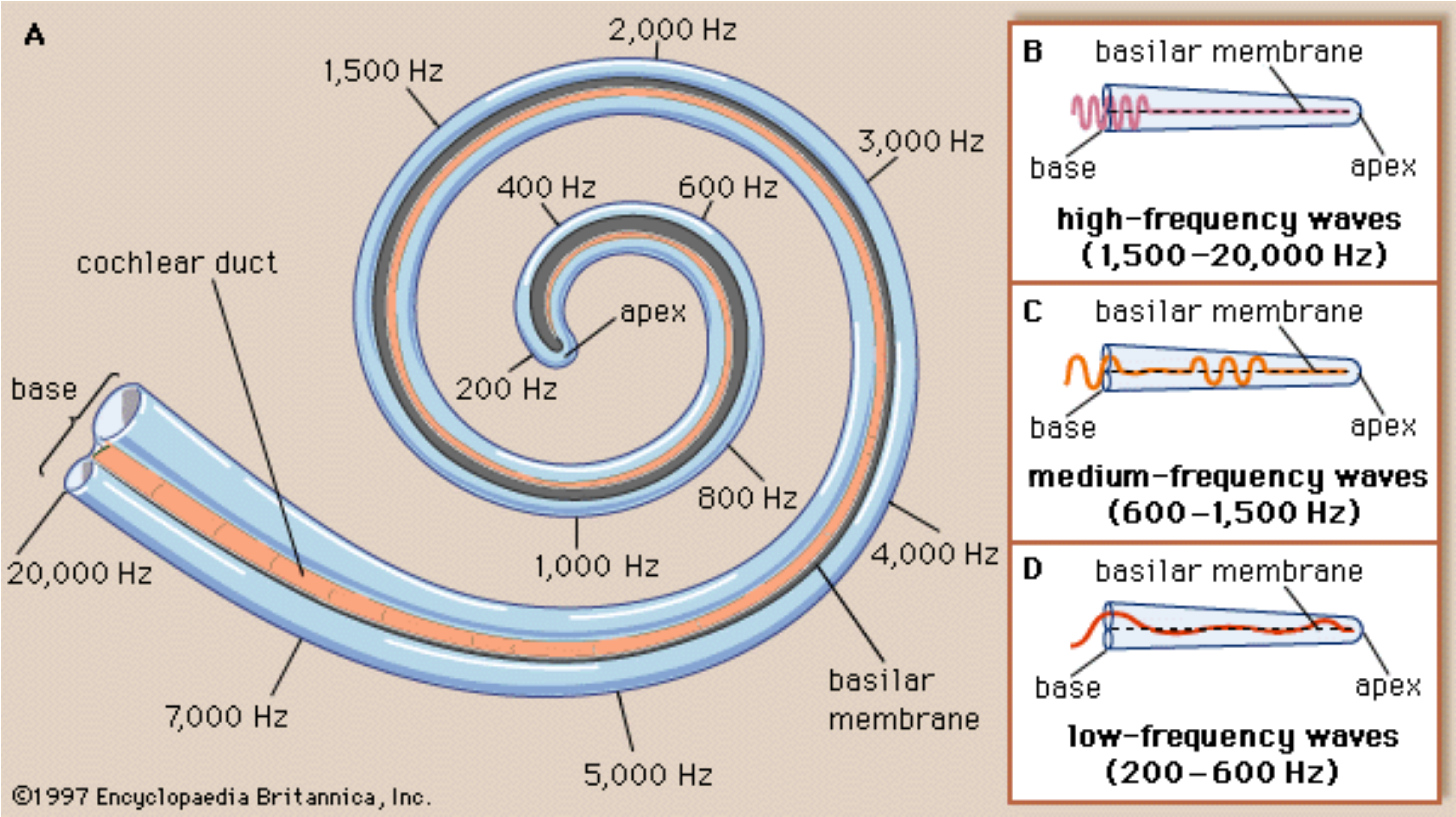
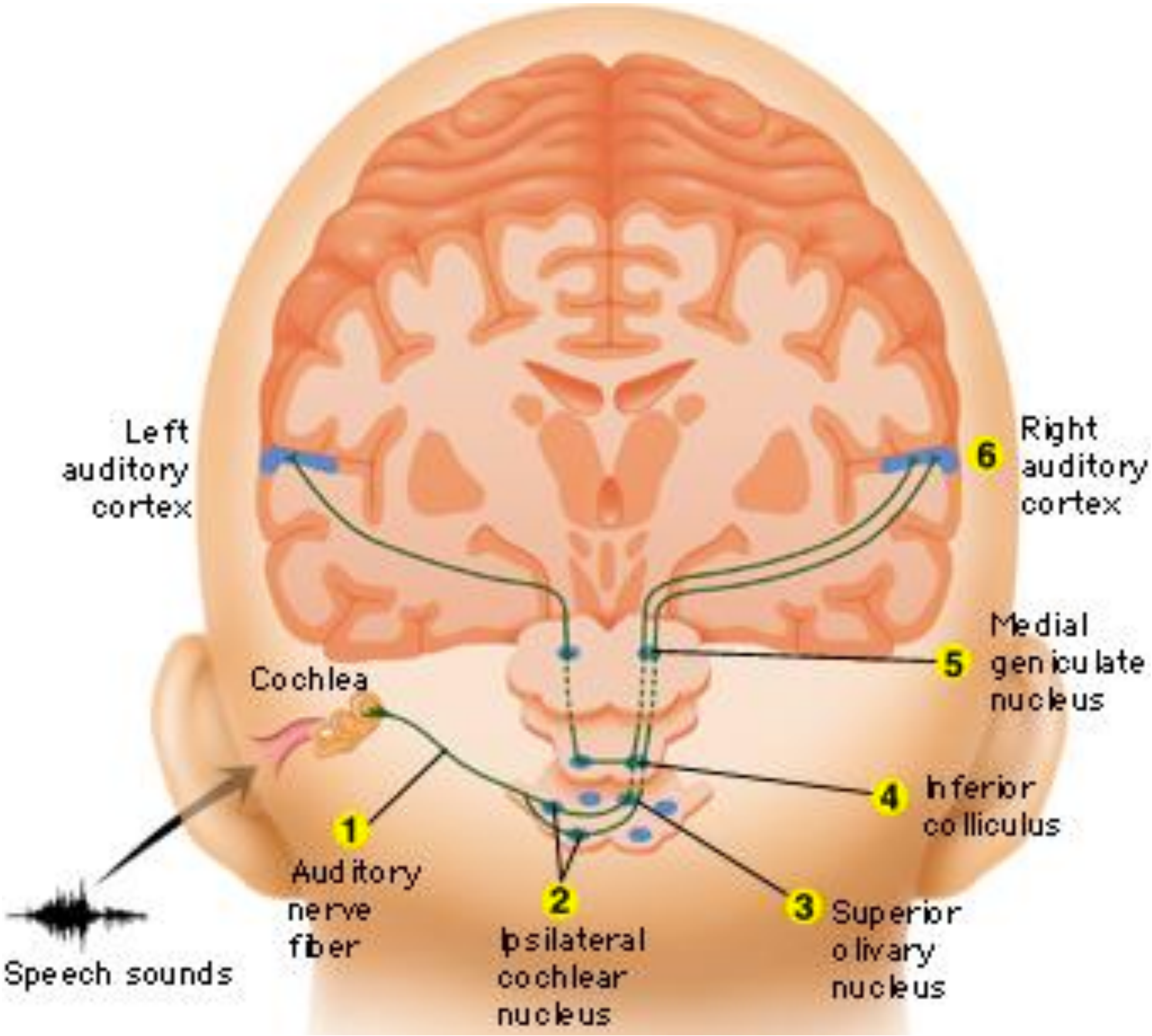

Cochlear duct
Vestibular membrane
Scala vestibuli
Tectorial membrane
Incus
Malleus
Oval window
Cochlea
Helicotrema
Hairs
1
Perilymph
Endolymph
2
Organ of Corti
Stapes
Basilar membrane
Perilymph
Scala tympani
Tympanic membrane
Round window
(a)

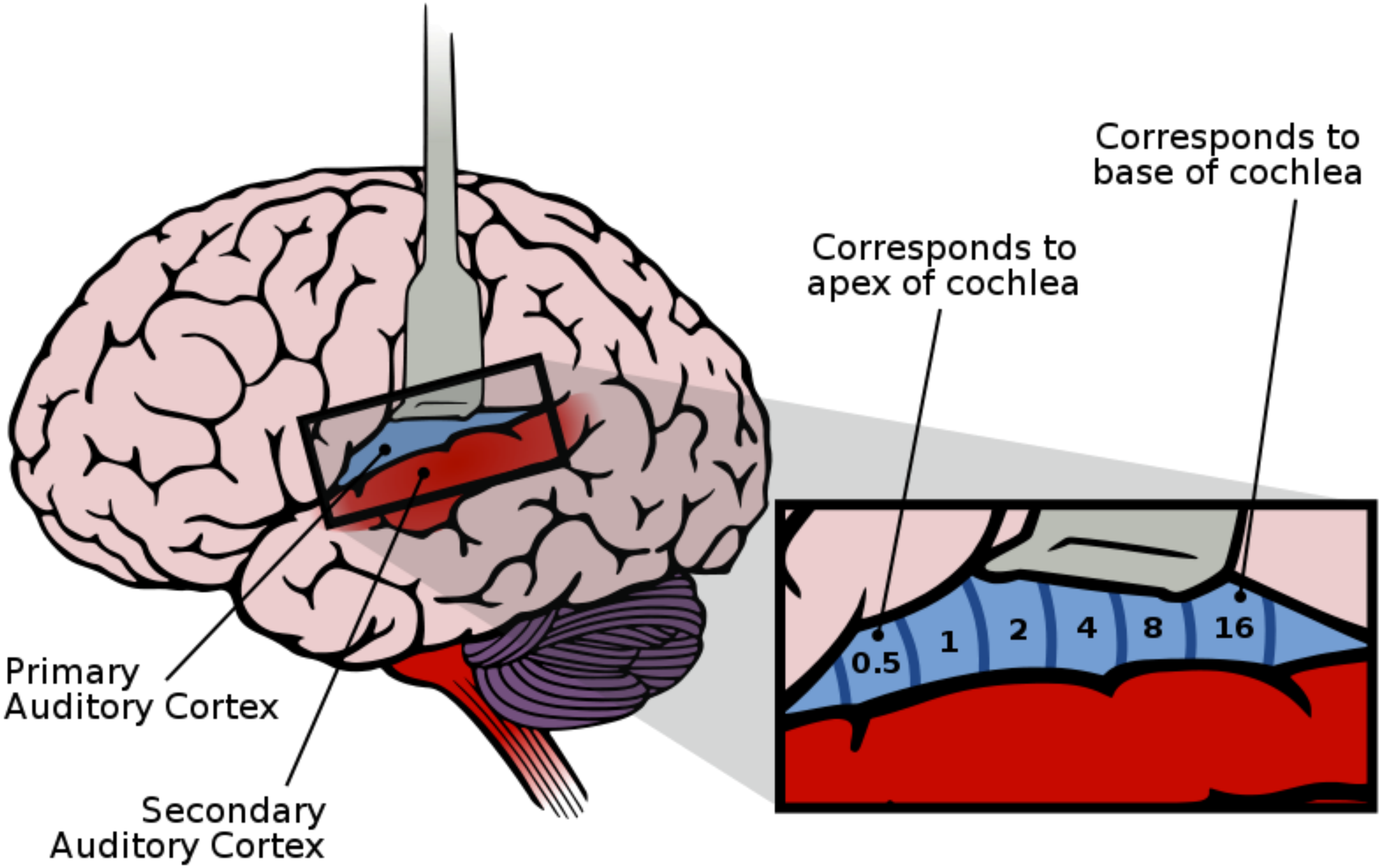
Figure 6-37



Bony cochlear wall
Vestibular duct
Cochlear duct
Vestibular membrane
Tectorial membrane
Organ of Corti
Basilar membrane
Tympanic duct
Spiral ganglion
Cochlear branch of VIII
(a)
Tectorial membrane
Inner hair cell
Outer hair cell
Basilar membrane
Nerve fibers
(b)
Cochlear duct (scala media)
Vestibular membrane
Tectorial membrane
Tympanic duct (scala tympani)
Basilar membrane
Hair cells of organ of Corti
Spiral ganglion cells of cochlear nerve


A
2,000 Hz
1,500 Hz
3,000 Hz
400 Hz
600 Hz
cochlear duct
apex
200 Hz
base
800 Hz
20,000 Hz
1,000 Hz
4,000 Hz
basilar membrane
7,000 Hz
5,000 Hz
©1997 Encyclopaedia Britannica, Inc.
B
basilar membrane
base
apex
high-frequency waves (1,500–20,000 Hz)
C
basilar membrane
base
apex
medium-frequency waves (600–1,500 Hz)
D
basilar membrane
base
apex
low-frequency waves (200–600 Hz)


Left auditory cortex
Right auditory cortex
6
Medial geniculate nucleus
5
Cochlea
4
Inferior colliculus
1
Auditory nerve fiber
2
Ipsilateral cochlear nucleus
3
Superior olivary nucleus
Speech sounds



Tonotopic map: ordered by frequency

Important note: we think of the ears as non-directed, and always on (contrast that with the eyes).

But:

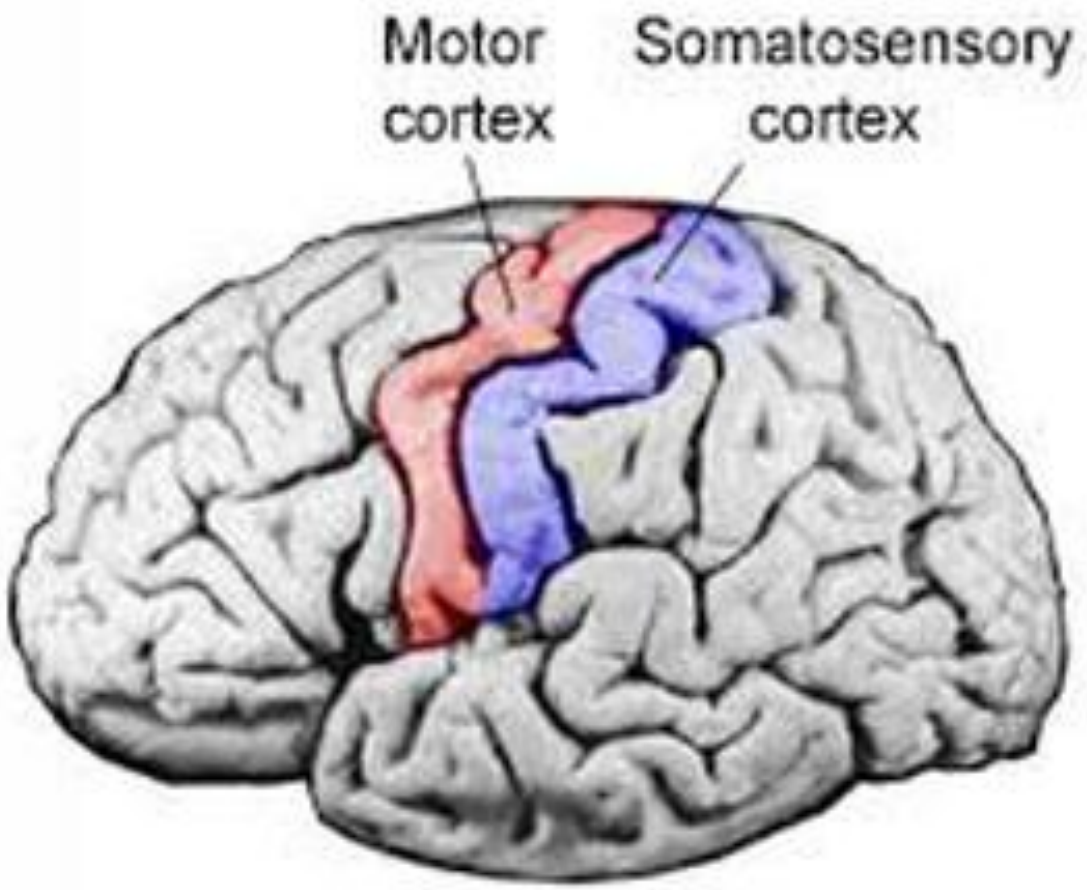
The sensitivity of the hair cells in the cochlea is actively modulated all the time.

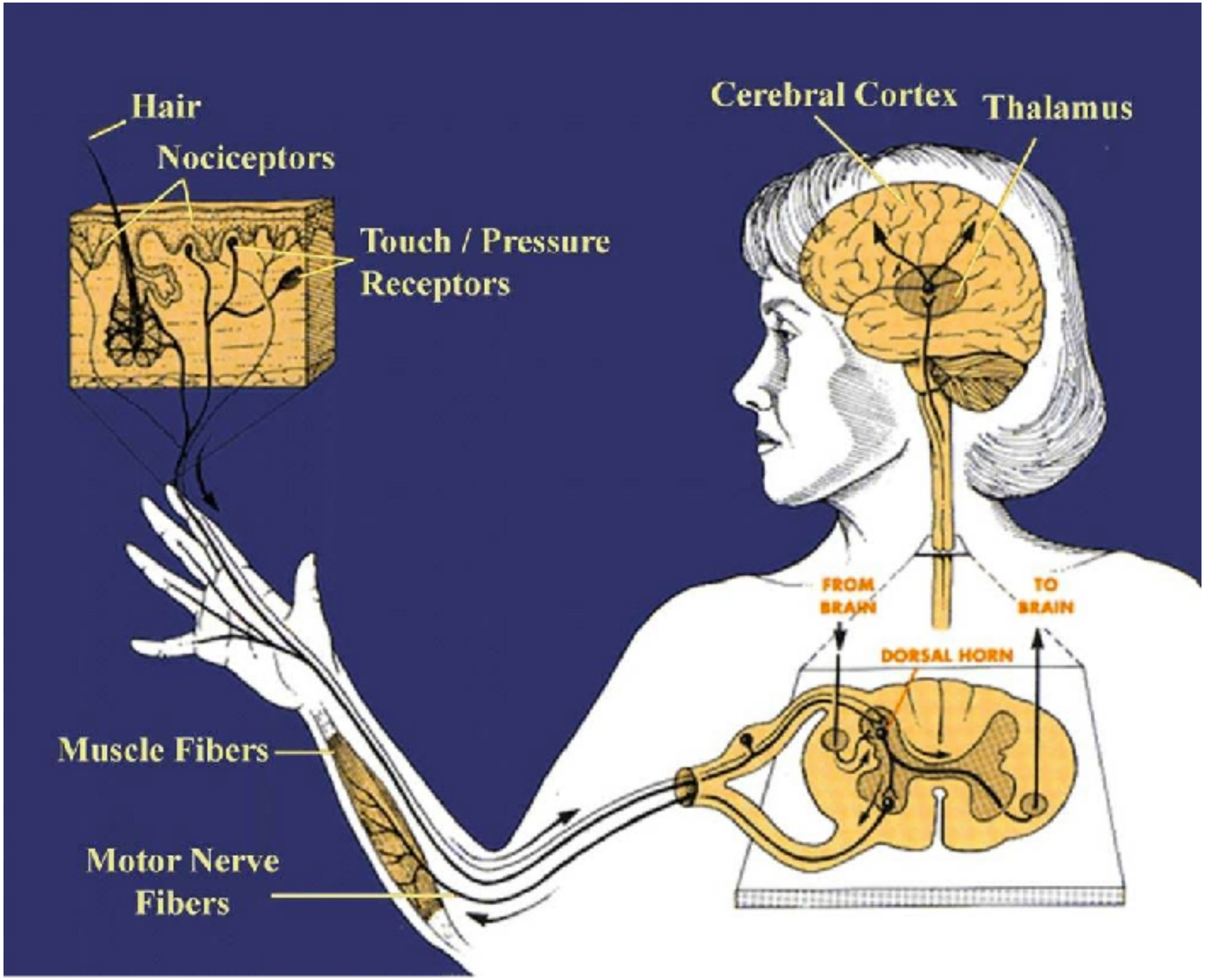
There are as many fibres descending from the CNS to the ear as there are ascending from the ear.

Not just an input channel!

In the haptic modality (touch), the *skin* is linked to *primary somatosensory cortex*

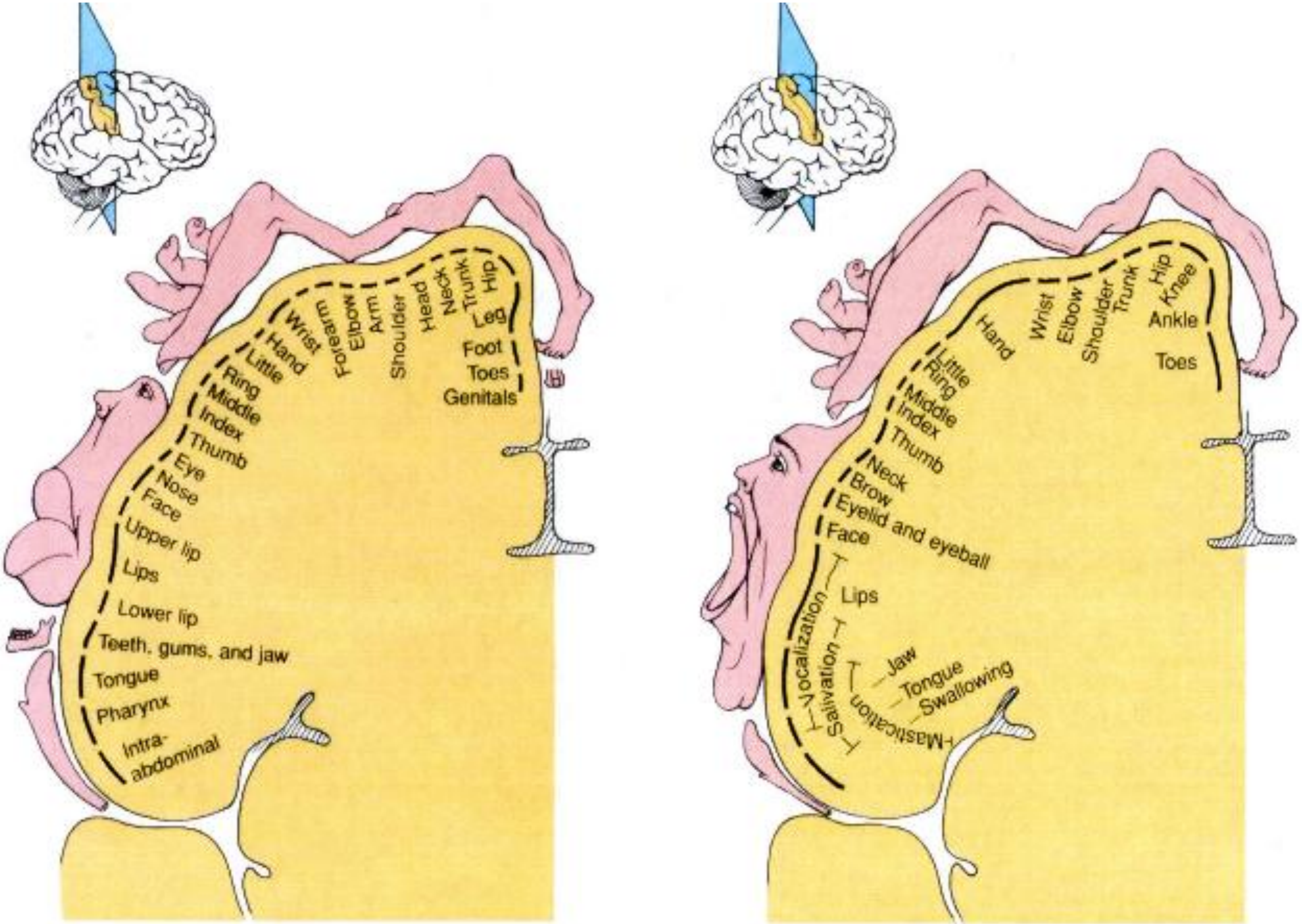
Figure F-3: Motor and Somatosensory Cortex





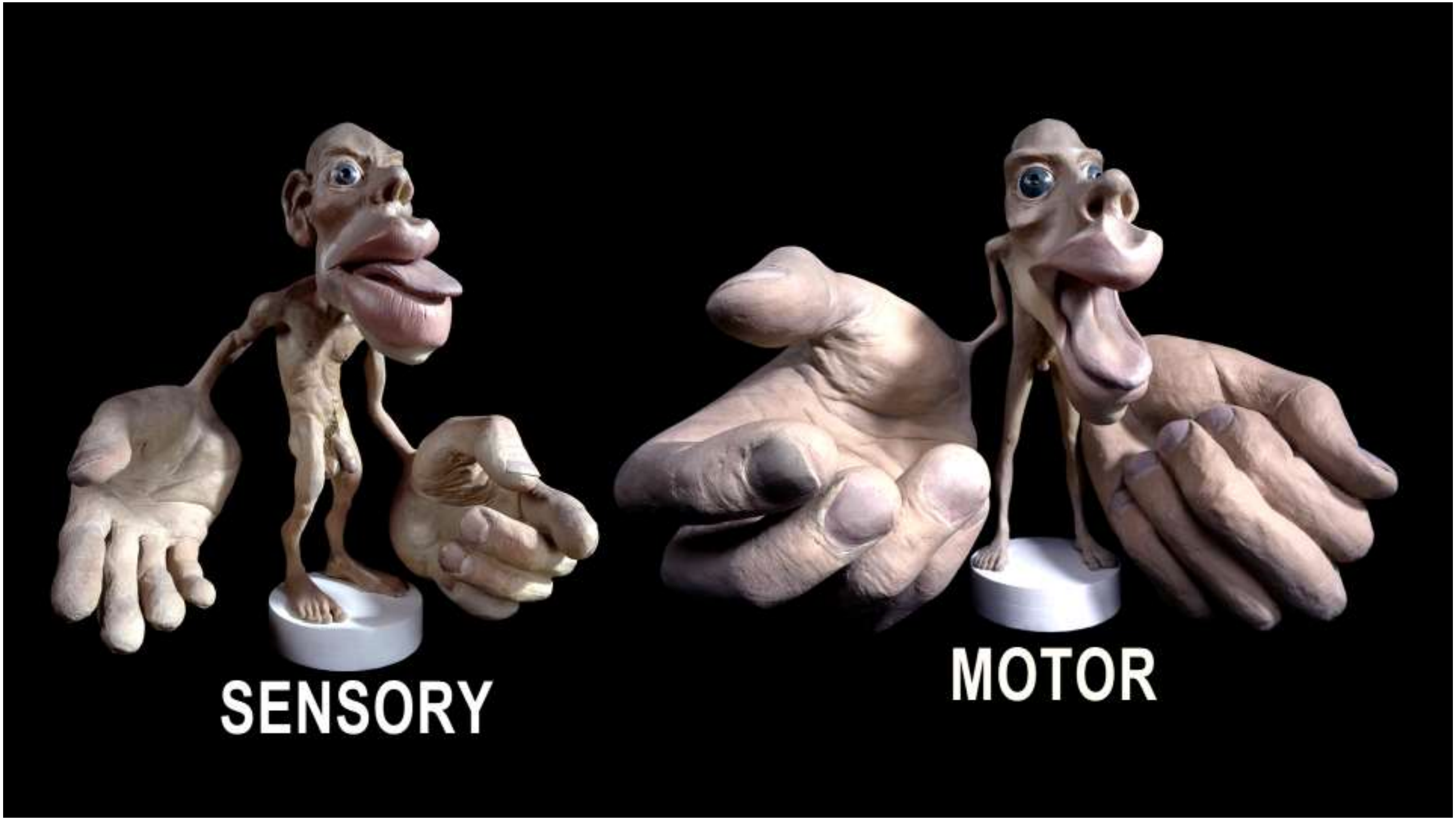
Note the role
of the Thalamus!

Most sensory
channels have
branches
going through
the thalamus



(a) Somatosensory cortex in right cerebral hemisphere

(b) Motor cortex in right cerebral hemisphere


SENSORY
MOTOR

Again we have a spatial map in which adjoining areas in primary sensory (& motor) cortex are derived from adjoining areas on the exterior of the body, and lawfully related to properties of the world.

Vision   Audition   Touch

- Primary Sensory Cortex with map-like relation to properties of the world
- As much action from CNS to periphery as incoming (senses as inputs?)
- Pathways are vastly more complex than simple conduits, and include Thalamus
- Different from other sensory modalities

Vision considered as the construction of representations of the world

Milner & Goodale (Dual Stream Theory)

David Marr (Computation & Representation)

Hubel & Wiesel (Feature Detection & Combination)

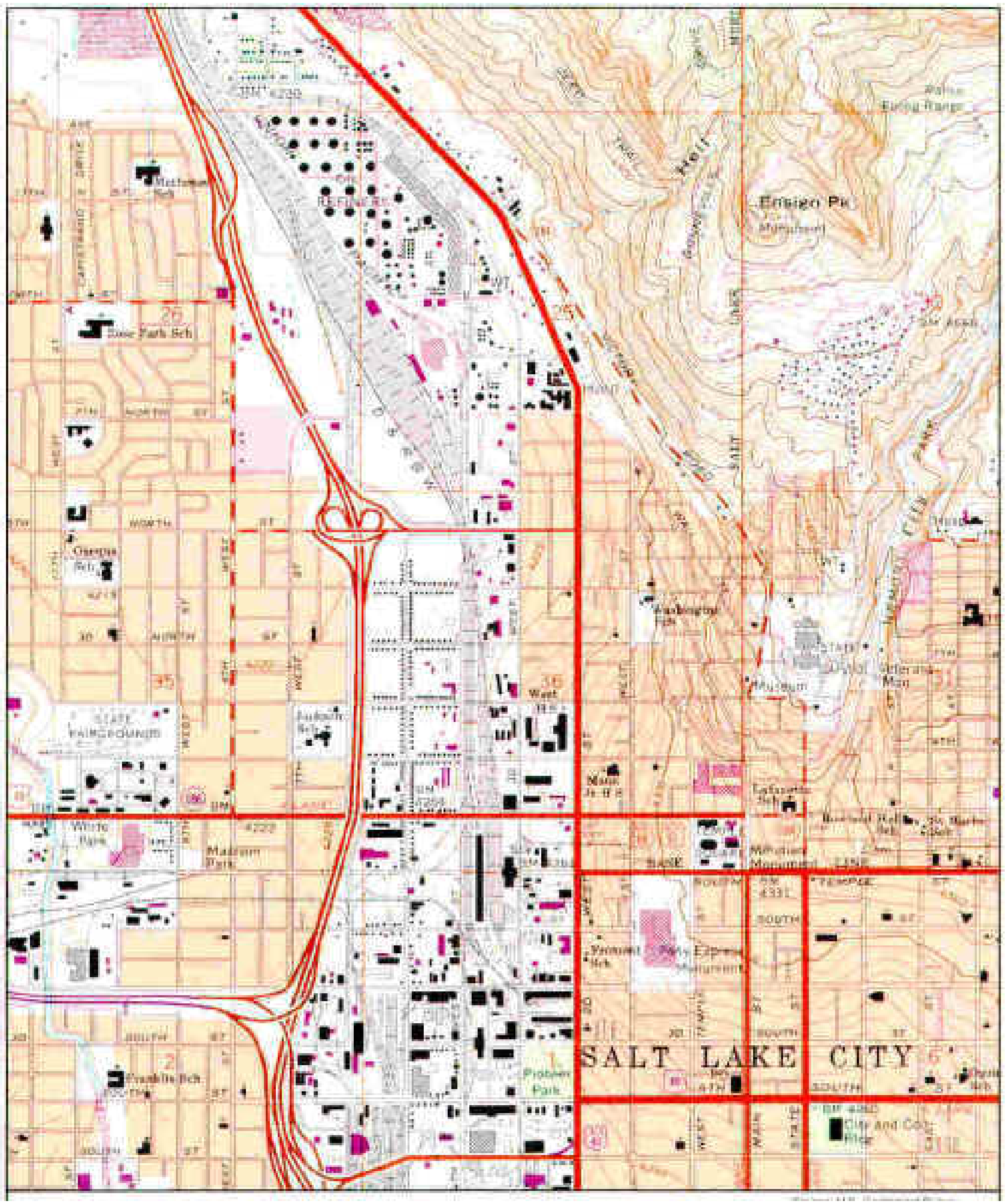
If we treat mind/experience and world as separate,

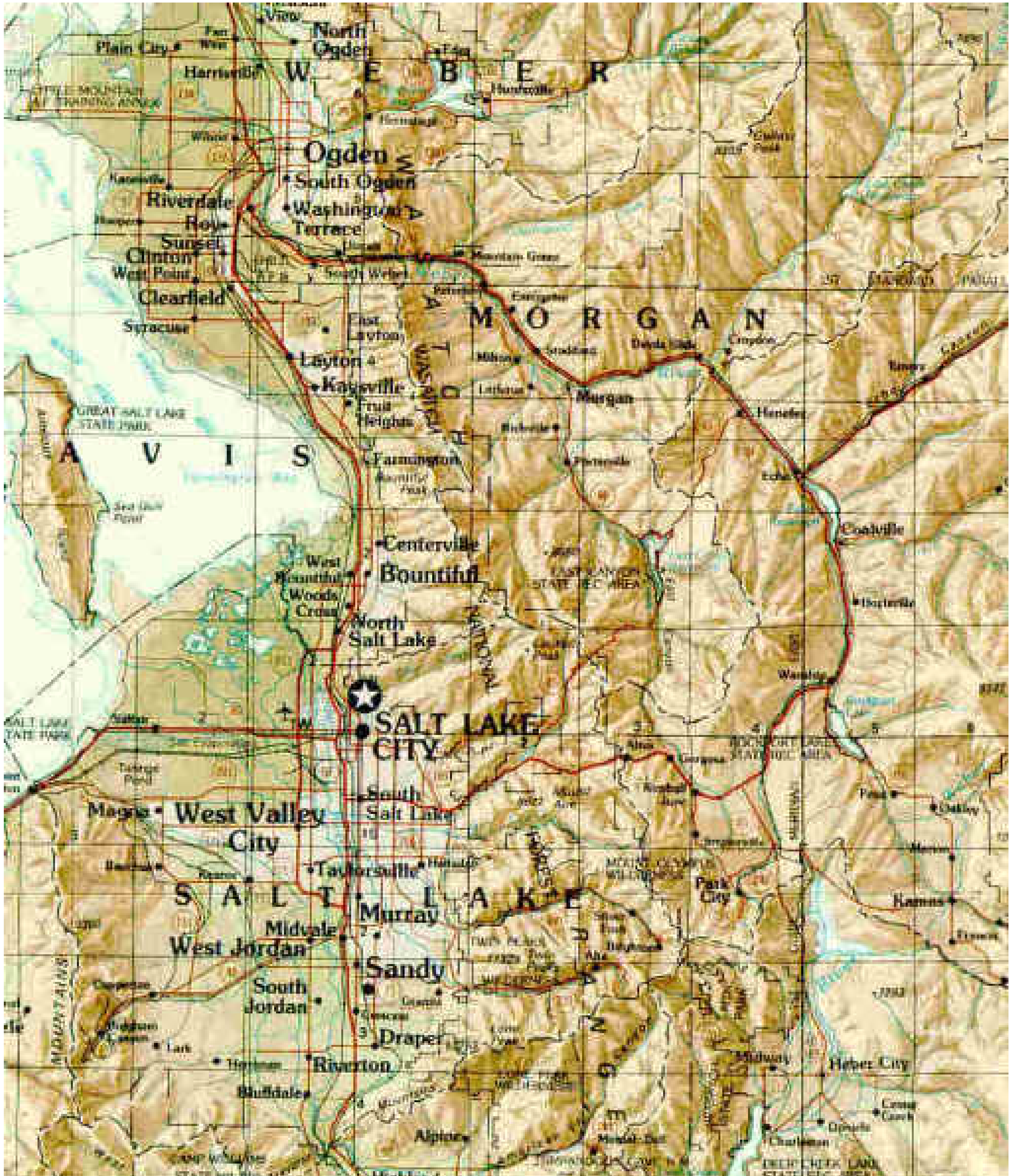
then we must provide a story of how it is that mind comes to know world

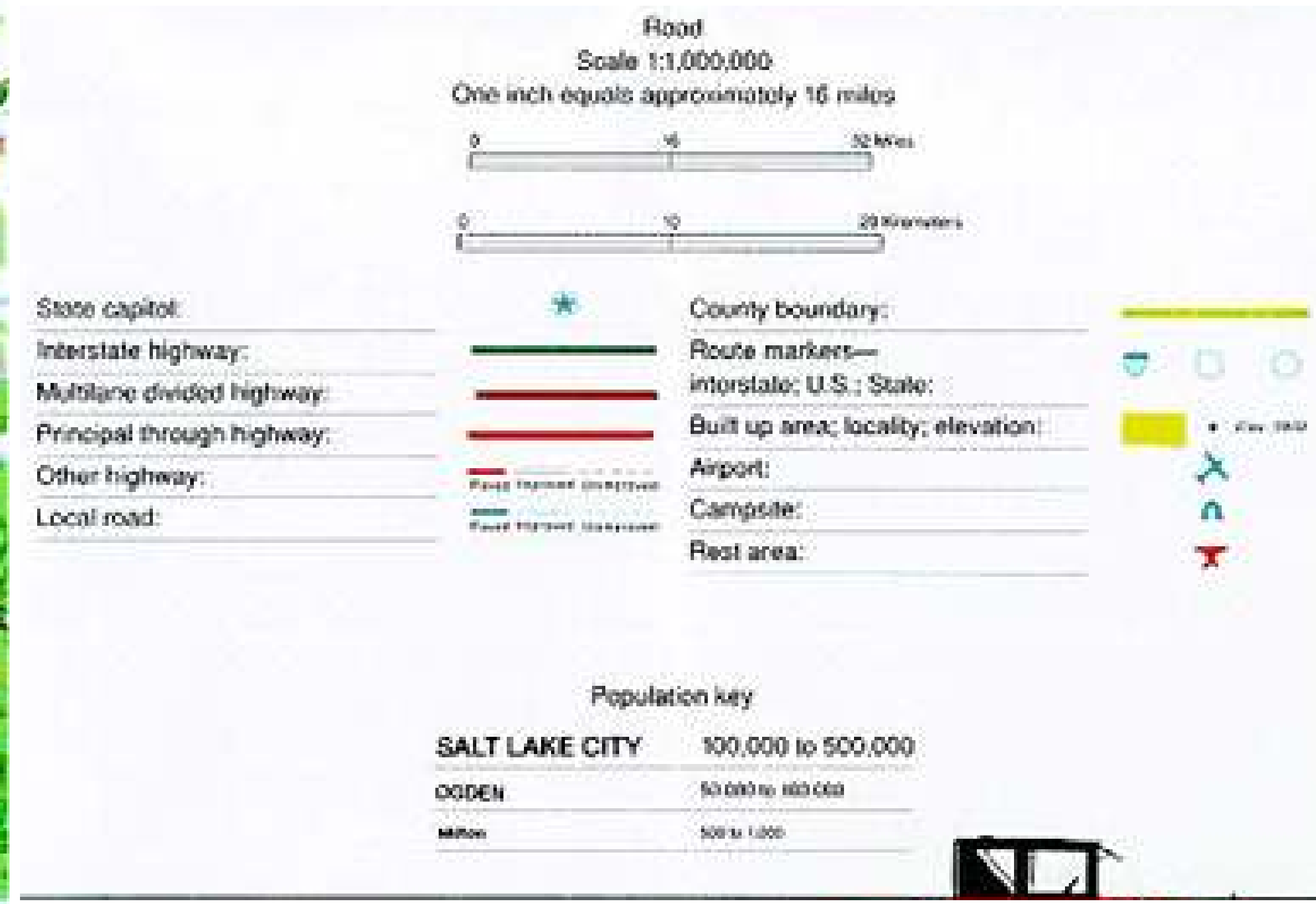
Most such accounts involve the creation of *mental representations* of the world

The notion of *representation* thus needs some unpacking. It is not a simple unitary concept.

Salt Lake City


Ensign Pk
Rose Park Sch
State Fairgrounds
Washington Sch
Museum
Lafayette Sch
Madison Park
Franklin Sch
Pioneer Park
Pony Express Monument
SALT LAKE CITY
BASE LINE
Veterans Mon


Plain City
Harrisville
North Ogden
WEBER
Ogden
South Ogden
Riverdale
Roy
Washington Terrace
Sunset
Clinton
West Point
Clearfield
Syracuse
Layton
Kaysville
Fruit Heights
DAVIS
Farmington
MORGAN
Morgan
Henefer
Coalville
Centerville
Bountiful
West Bountiful
Woods Cross
North Salt Lake
SALT LAKE CITY
South Salt Lake
Magna
West Valley City
Taylorsville
SALT LAKE
Murray
Midvale
West Jordan
Sandy
South Jordan
Draper
Riverton
Bluffdale
Alpine
Highland
Park City
Kamas
Midway
Heber City



Symbols stand for things

What is explicit, and what can you figure out but is not explicit?

A symbol stands in *correspondence* to something else

Do you think a symbol has to look like the thing is corresponds with?

Which symbols you are familiar with do *not* look like the thing they refer to?

These are imprints. They also stand in correspondence to something.

What aspects of the lips/hand are captured by the imprints?

What aspects are not captured?

REPRESENTATION

We say that something *represents* something else if:

[1] It stands in correspondence to that thing, and

[2] It plays a role within a system *because* it has that relationship of correspondence.

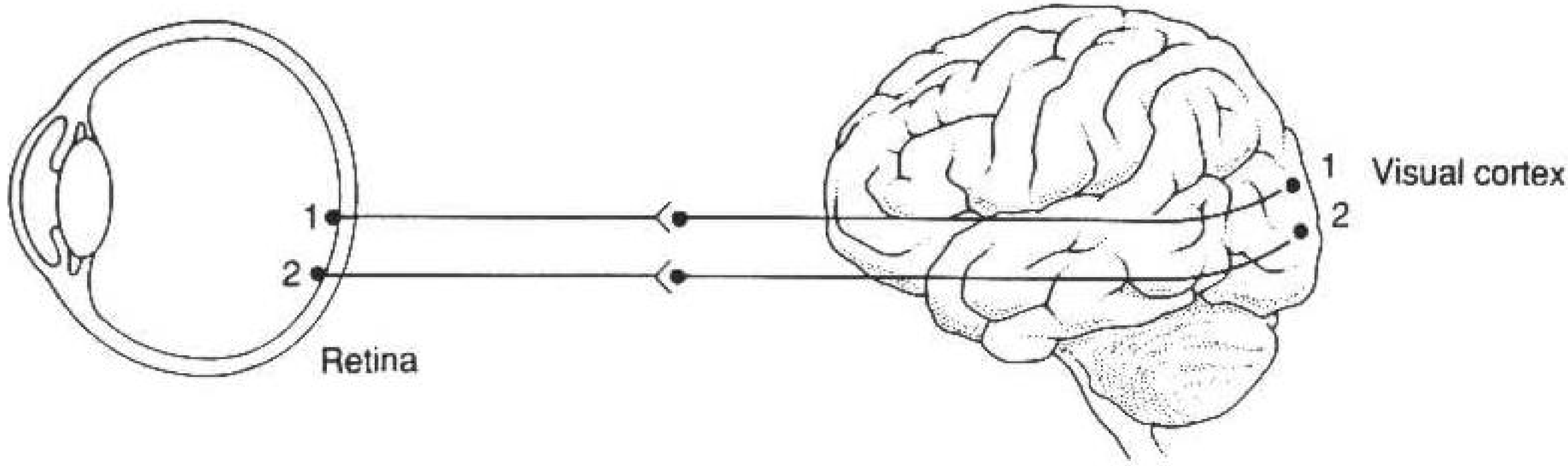
The relationship between a representation and its referent can be arbitrary

π

... or non-arbitrary

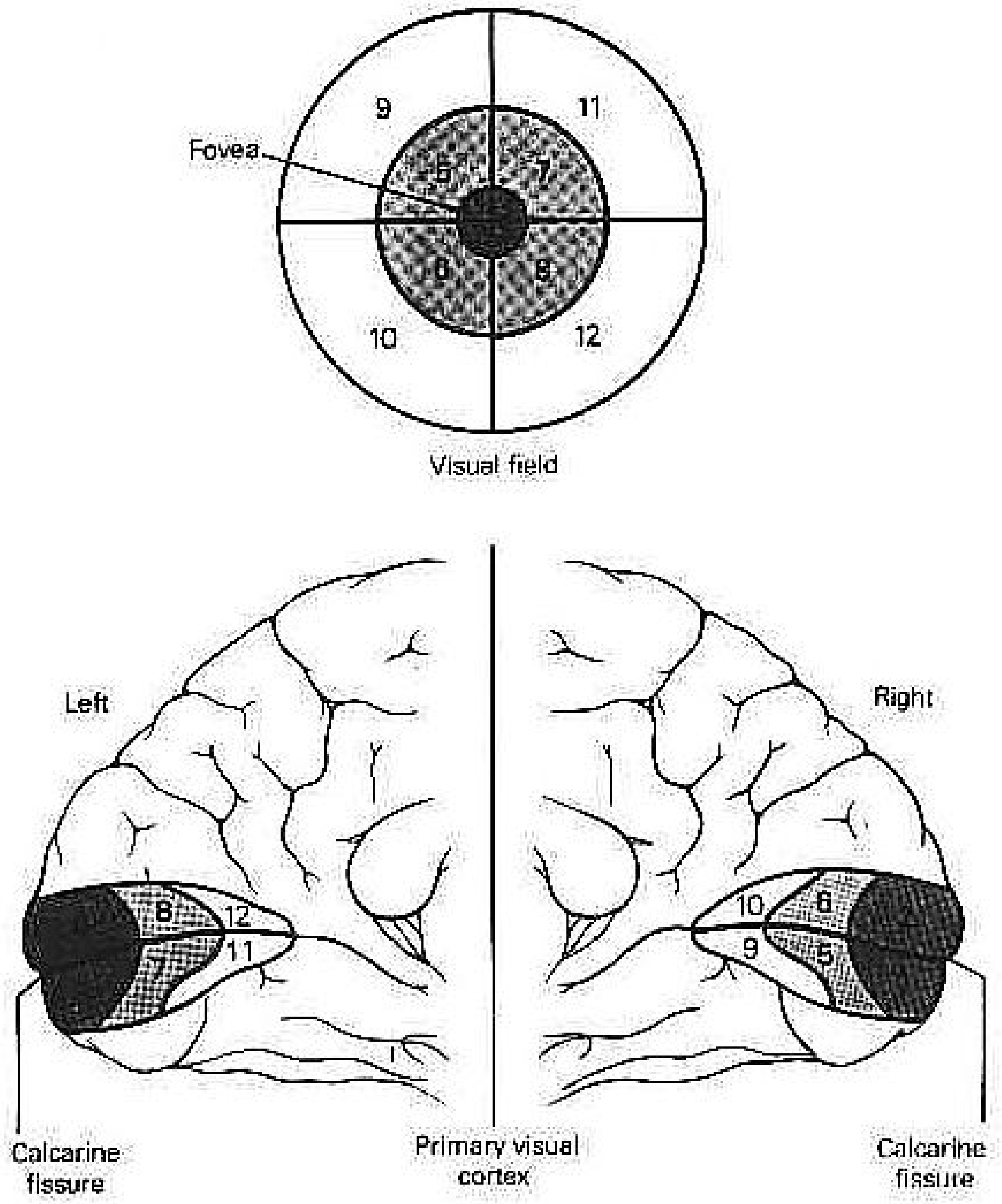
Which systems do these symbols function in?

Which elements on a map stand in arbitrary relationship to their referents, and which are non-arbitrary?



The spatial layout of the retina is retained through several transformations.

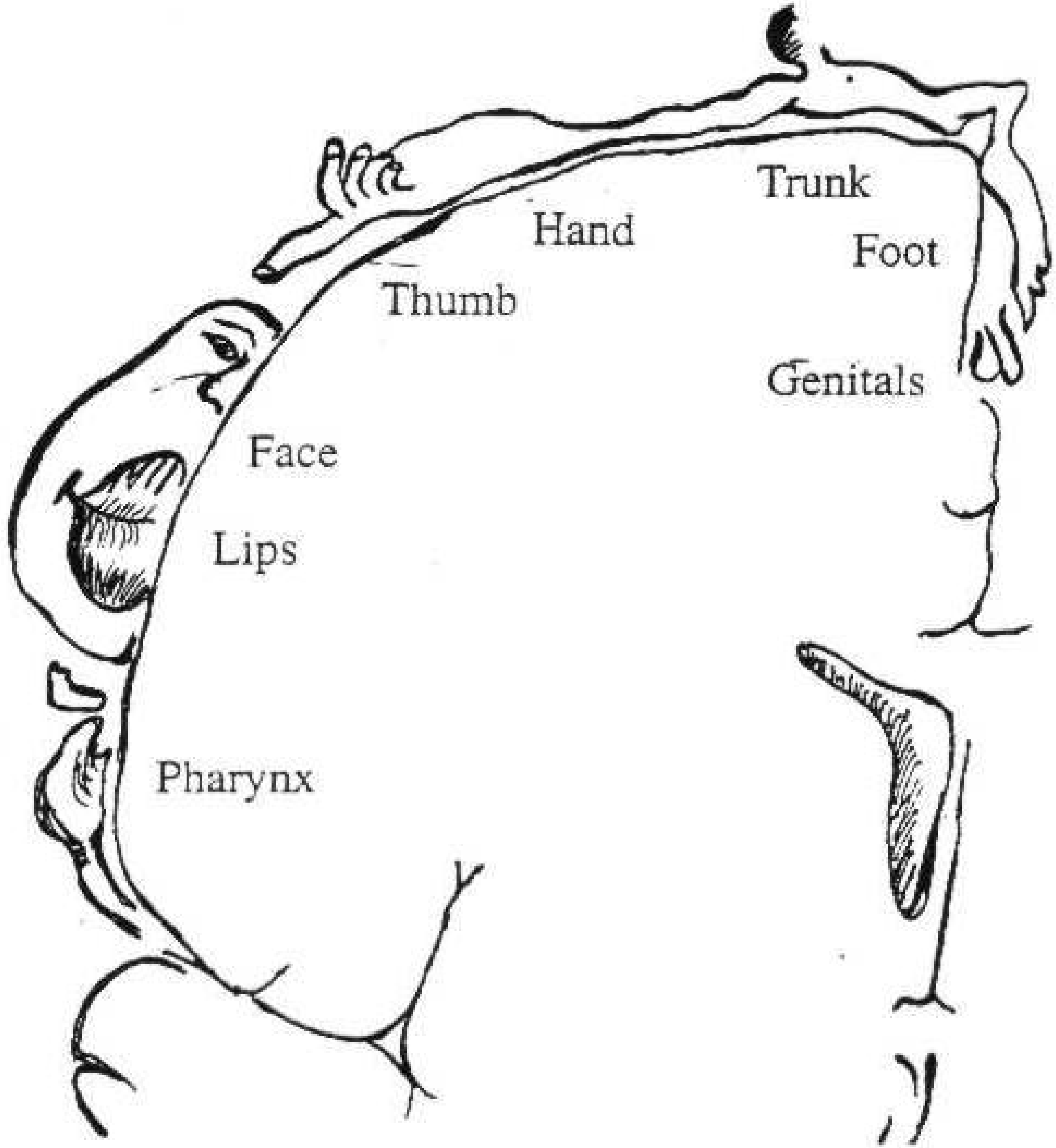
Places that are near each other stay near each other in the initial stages of processing.

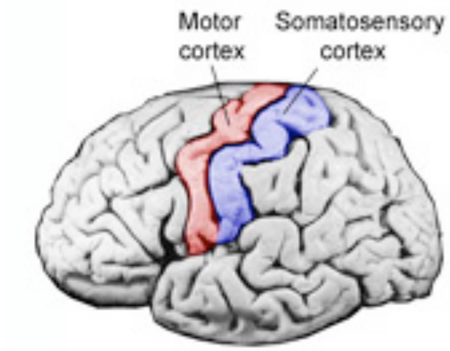


A retinotopic map in primary visual cortex of a monkey

What is preserved between retina and cortex?

What is altered or distorted?





In primary somato-sensory cortex, we also find a mapping.

This is one way the word *representation* is used.

Some would say that this shows a *cortical representation of sensation in the skin*

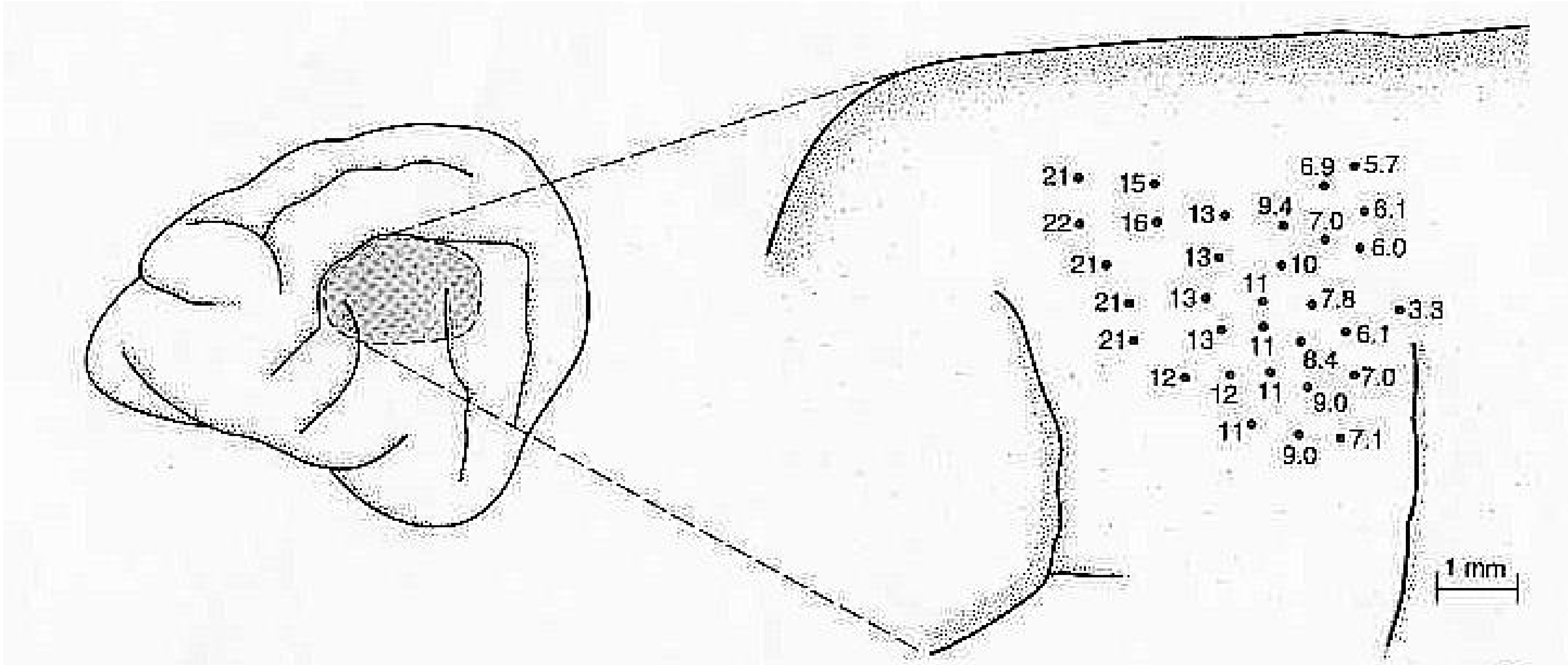


Figure 8.32
Left: The cat's brain, showing the location of the auditory receiving area (shaded). Right: A close-up of the auditory receiving area, showing the tonotopic map on the cortical surface. Each large dot represents a single neuron, and the number beside each dot represents the characteristic frequency of that neuron in thousands of Hz. (From Abeles & Goldstein, 1970, and Gulick, Gescheider, & Frisina, 1989.)

A tonotopic map in cat auditory cortex. The numbers refer to the frequencies each area is sensitive to. (All naturally occurring sounds are composed of a mixture of frequencies from low to high)

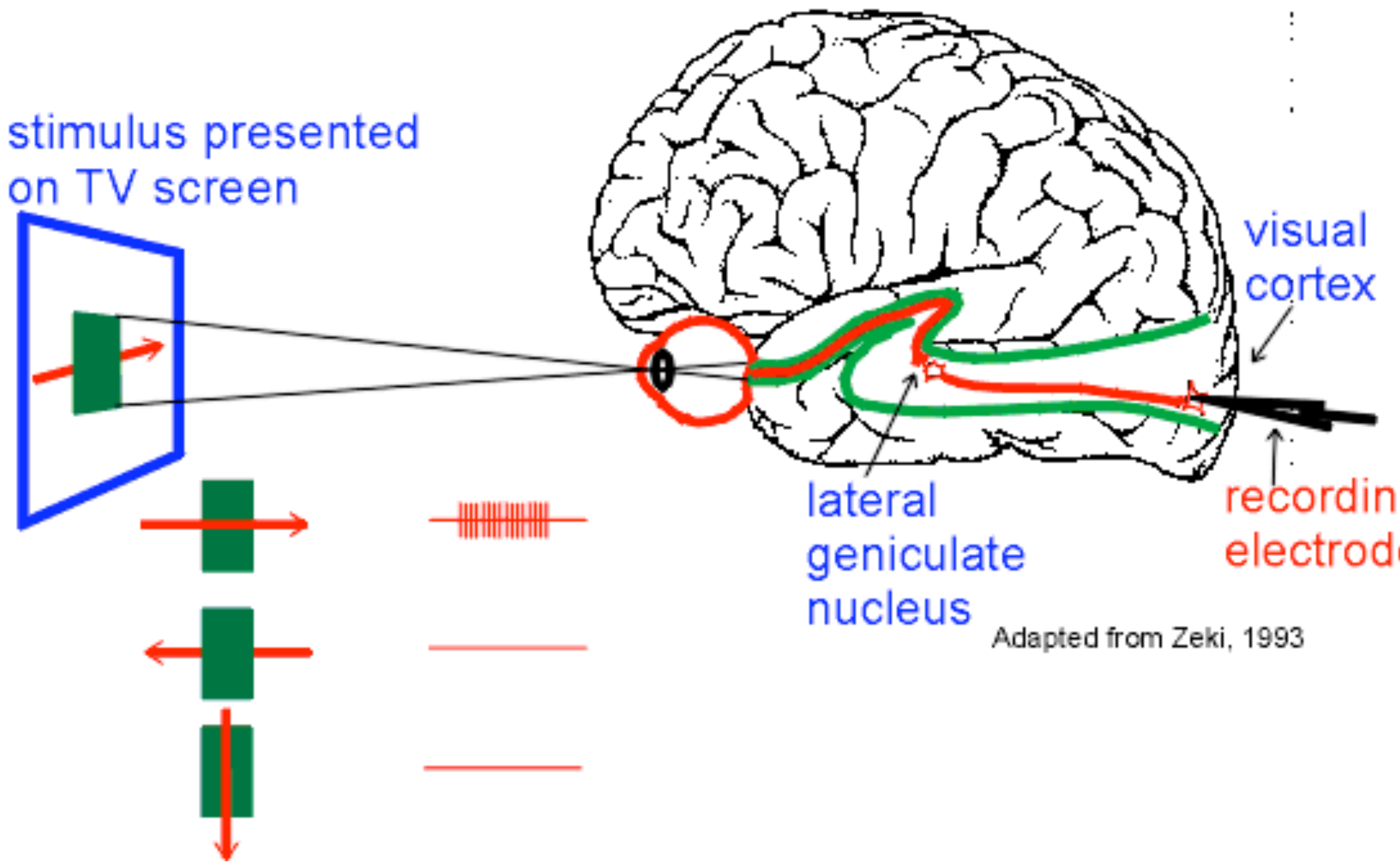
These examples are all of primary sensory cortex. We have somatotopic, retinotopic and tonotopic maps.

The structure of the stimulus is somewhat preserved in the pattern of neural sensitivities.

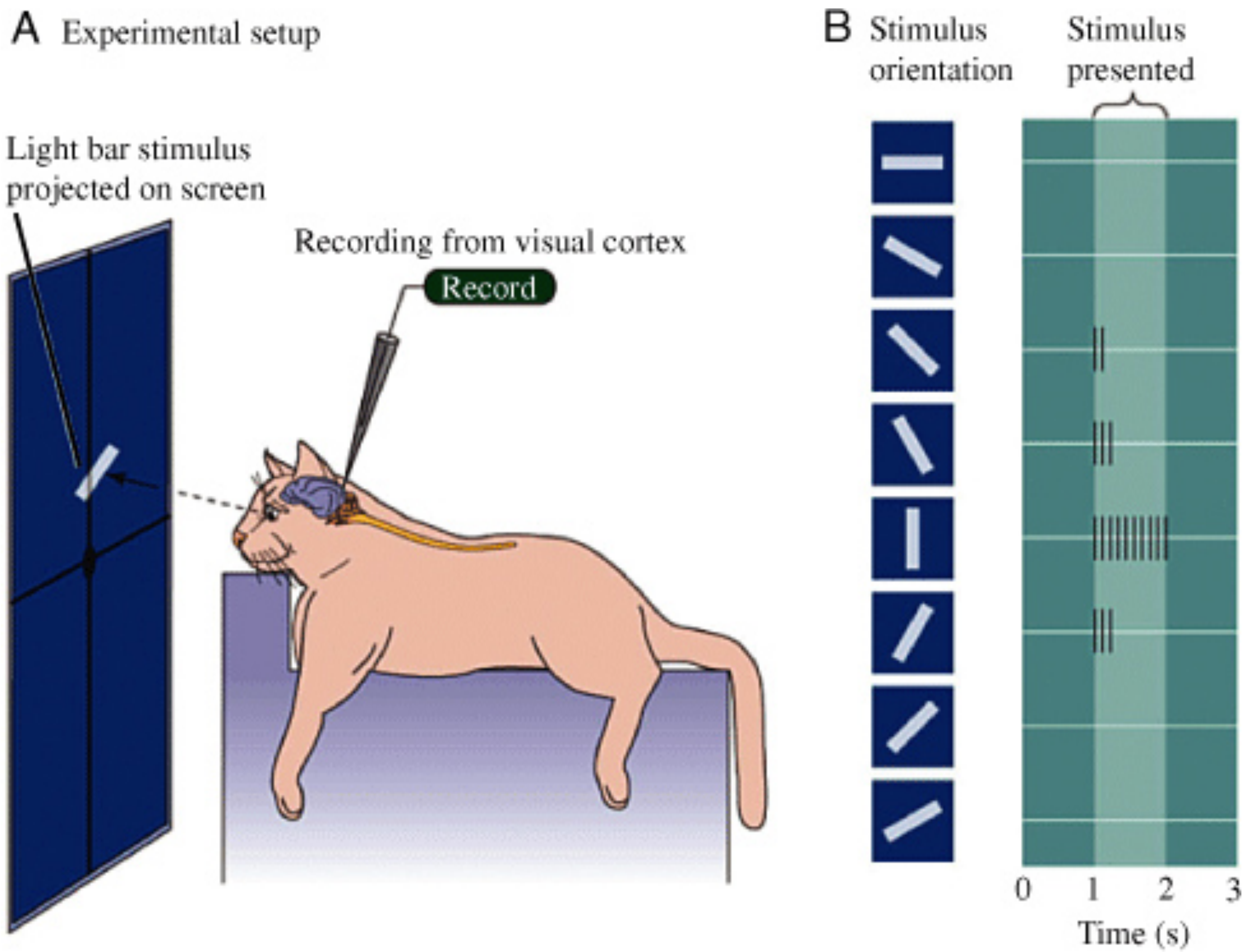
Distortions occur, because some aspects of a signal are more important than others. Compare sensitivity of lips to heels. Compare foveal vision (high focus, where you are looking directly) with peripheral vision (what you see out of the corner of your eye).

Hubel and Wiesel: Feature Detectors

Nobel Prize (Medicine & Physiology) 1981

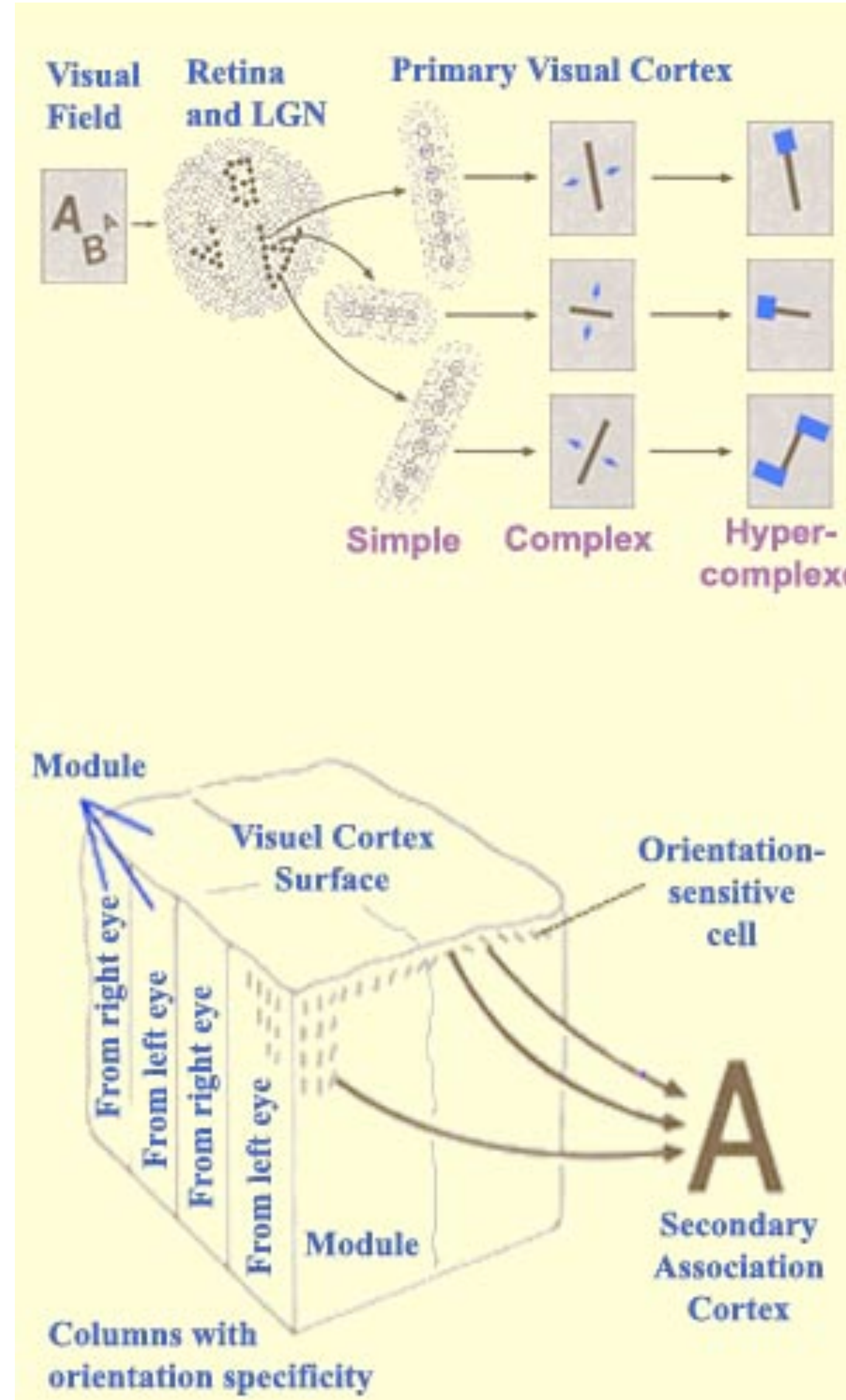


Selective response to visual stimuli



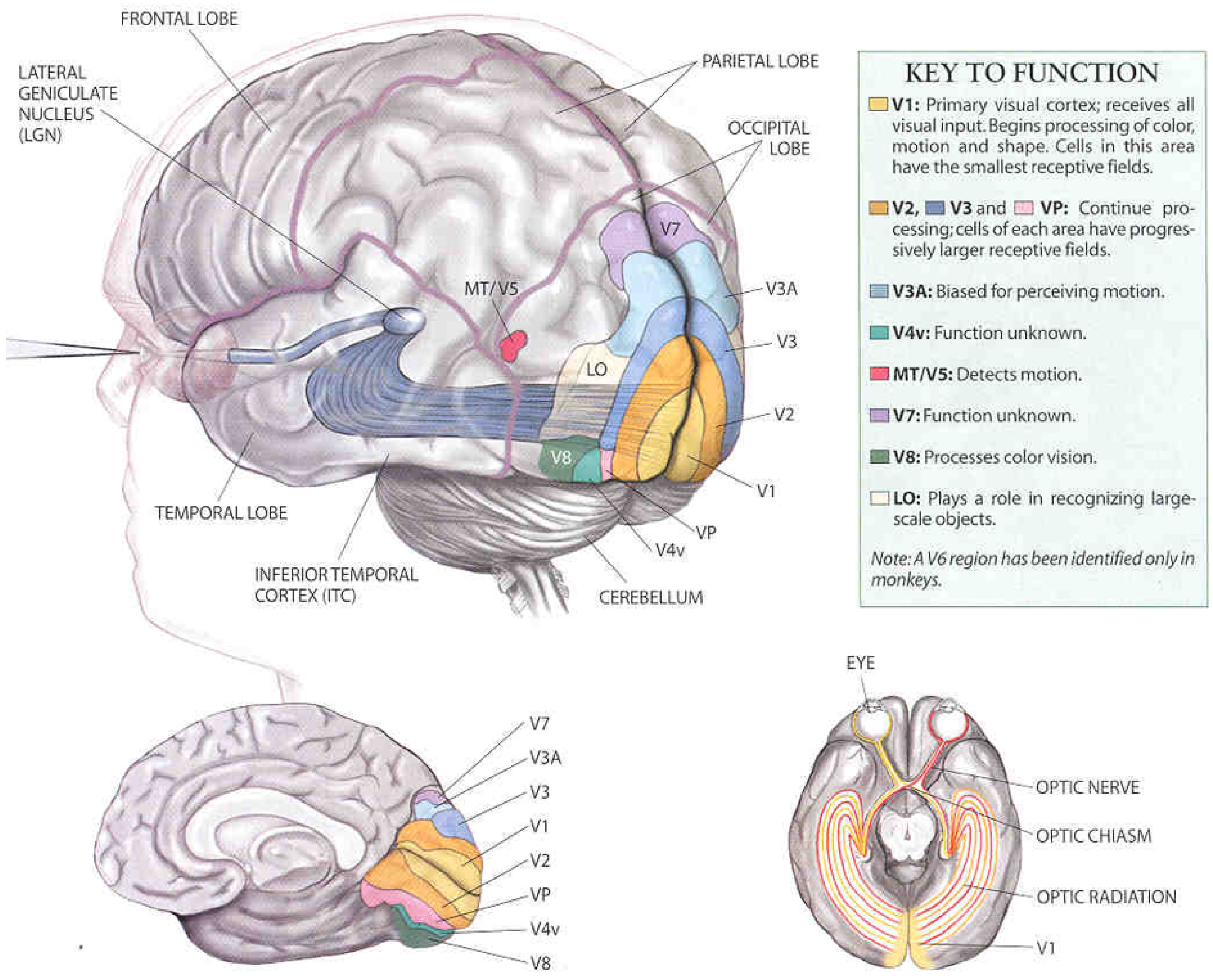
Anesthesised cat

Hypothetical construction of a complex representation from simple parts



As we move from the retina towards the depths of the CNS the activity of neurons is found to depend on every more complex properties of the "stimulus"

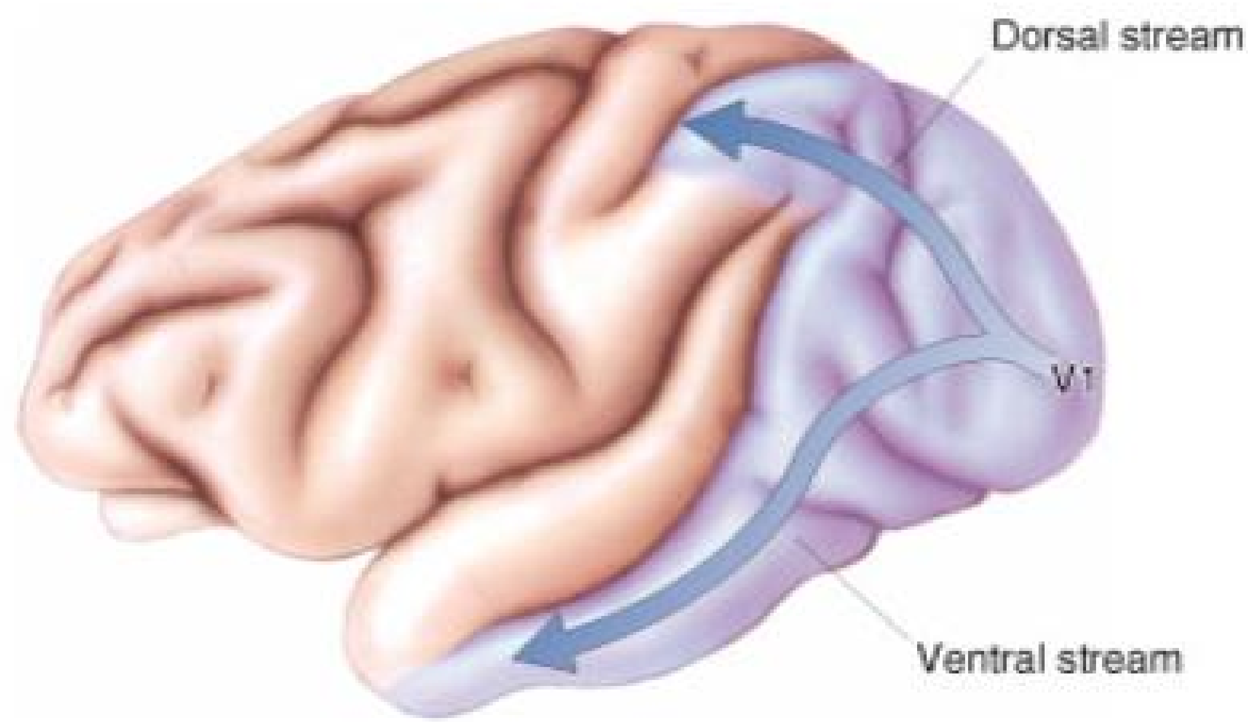
The nervous system is not wired as a simple series of ordered stages. This makes it difficult to be clear about the relation of the activity of neurons with events in the world.



Vision scientists have identified very many areas that are important in vision

Goodale & Milner (1991)

After the primary visual area (V1), visual processing has been described as continuing in 2 major pathways: the *dorsal stream* and the *ventral stream*.

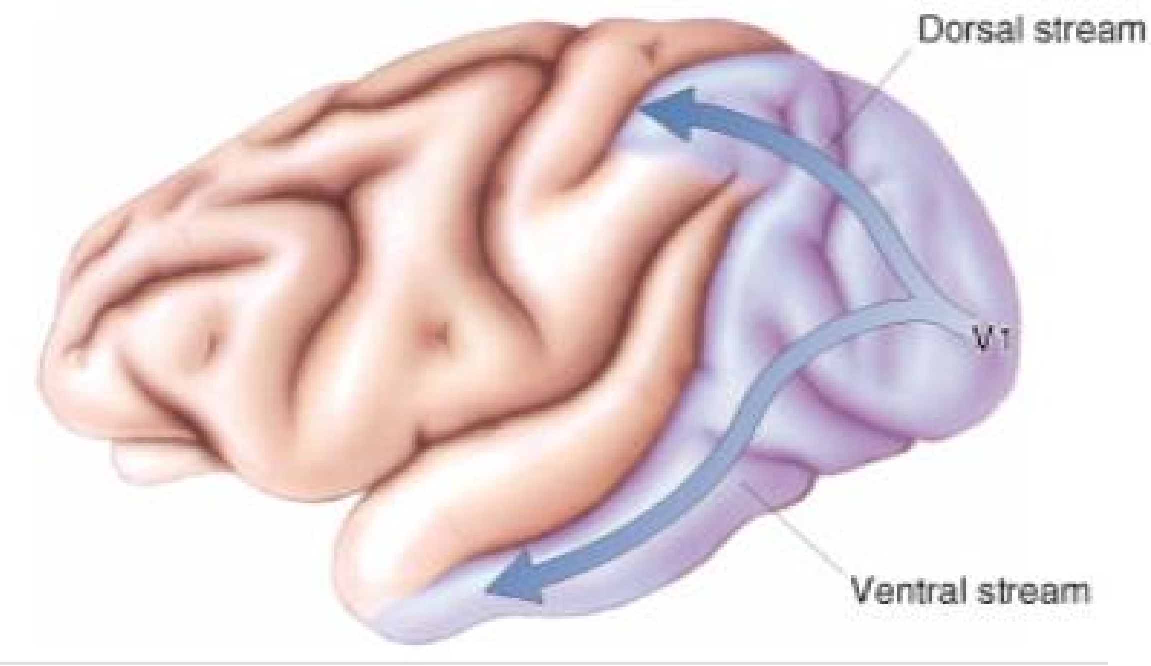


(cat brain, not human)

At each stage of processing, more information is combined, incorporating high-level knowledge, expectations, information from other modalities, etc

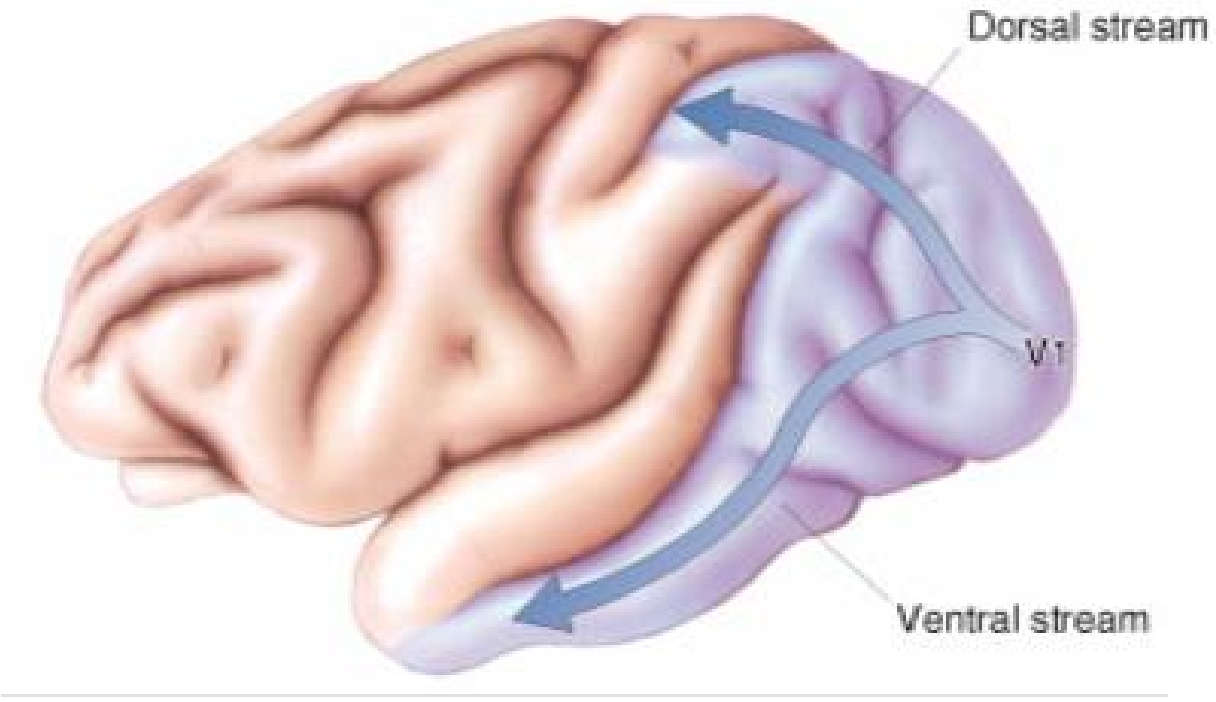
The Dorsal Stream

The “WHERE” stream
Keeping track of multiple objects
Relating your movements to your environment
Guiding action



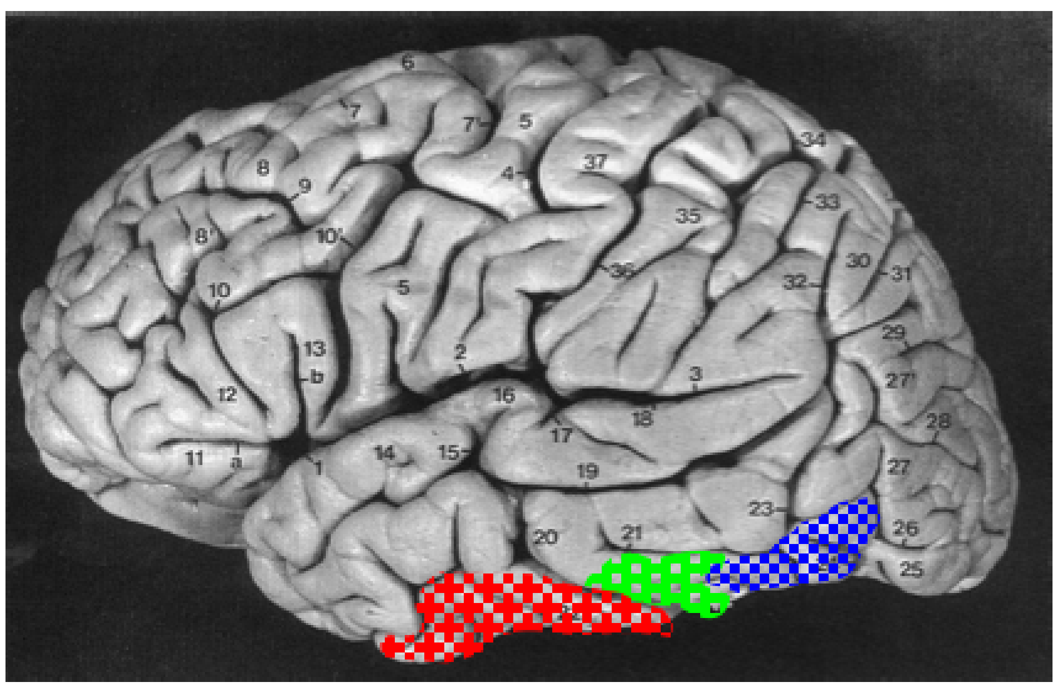
The Ventral Stream

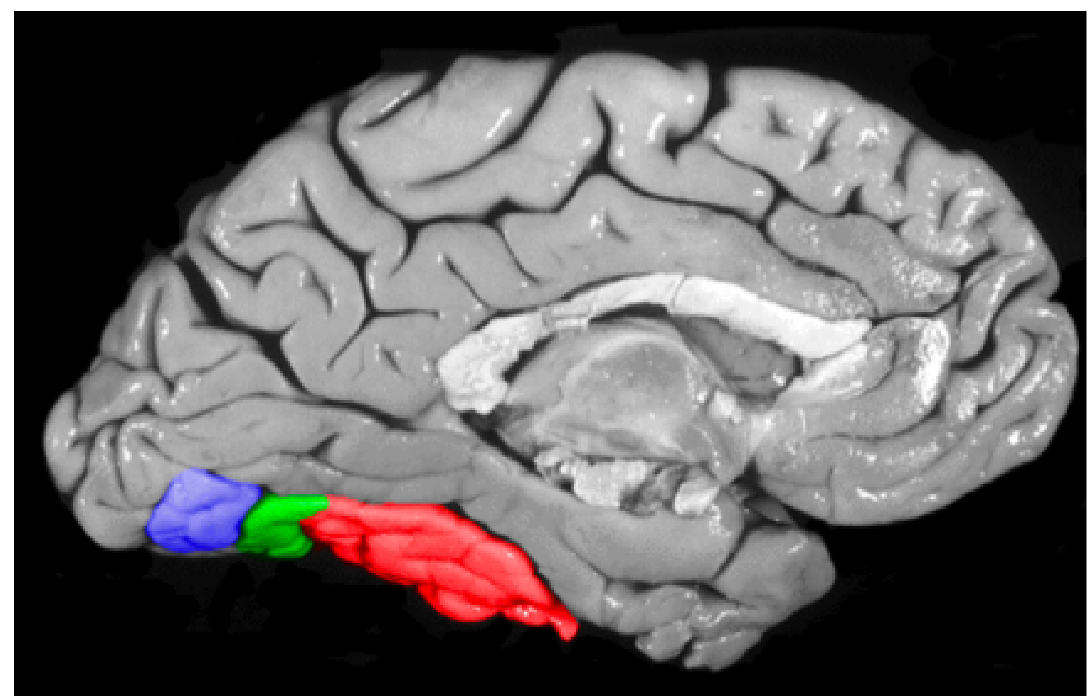
The "WHAT" stream
Object recognition
Face recognition



Some Neurophysiology

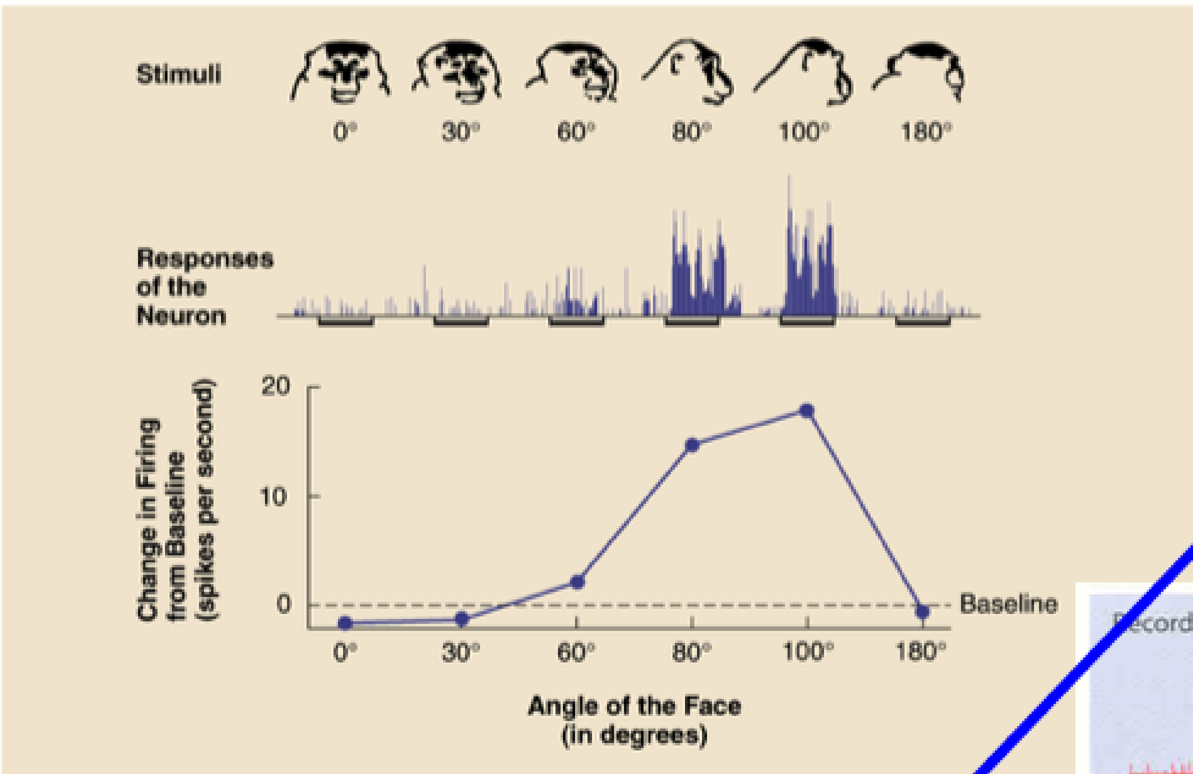
- The inferotemporal cortex (IT) contains neurons that respond selectively to particular objects, or complex shapes
  - like bananas or a circle with a T shape attached to it - different studies find different sensitivities.





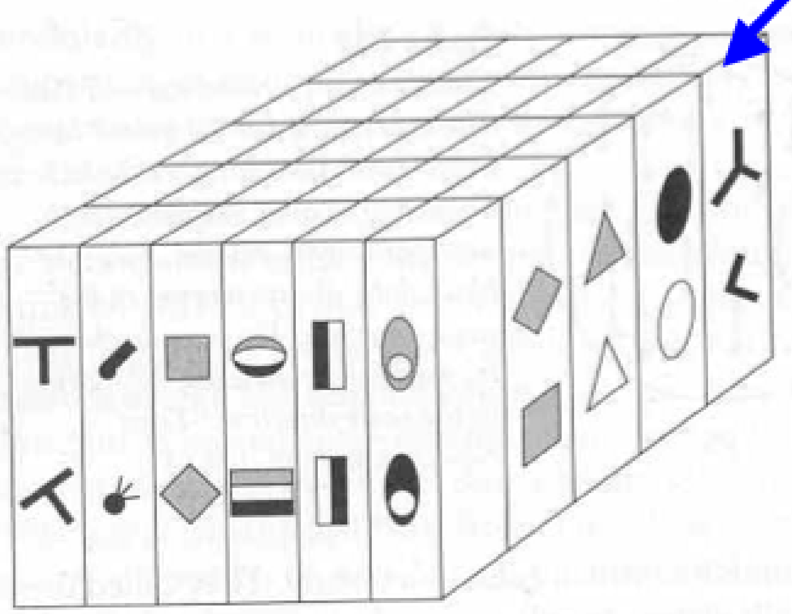
Tuning in monkey IT

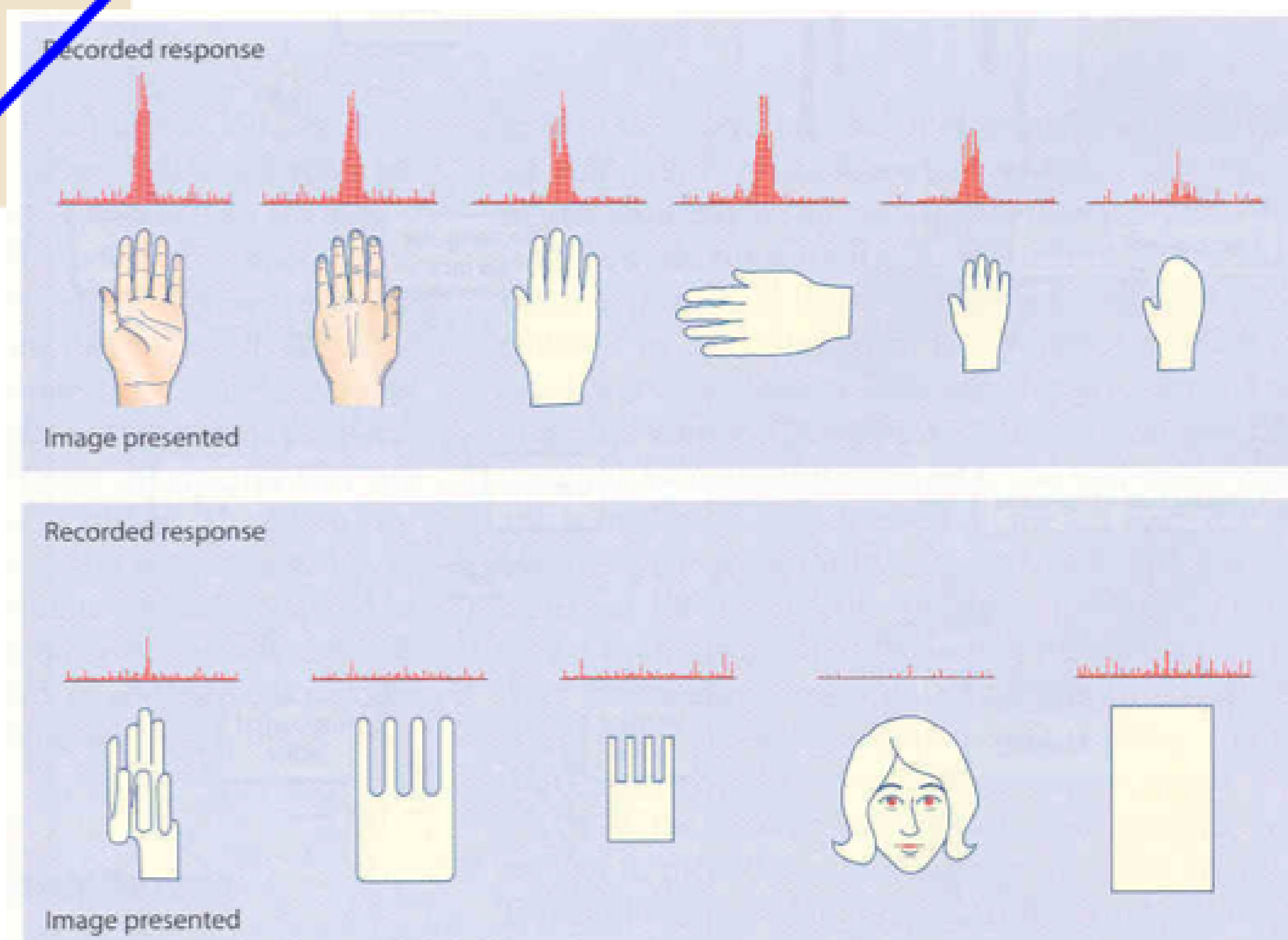
▸ **Firing Rate of a Monkey Inferotemporal Cortex Neuron**



Source: Adapted from Gross et al., *Pattern Recognition Mechanisms*, p. 179-201. Berlin: Springer-Verlag 1985.

Cells respond to specific stimuli
And are clustered into columns with similar tuning





As we ascend the processing pathways, cells are selectively responsive to more and more abstract properties

Nobody has yet found the “Grandmother Cell’

...But some cells are very specific to high-order properties of the input.. e.g. face specificity

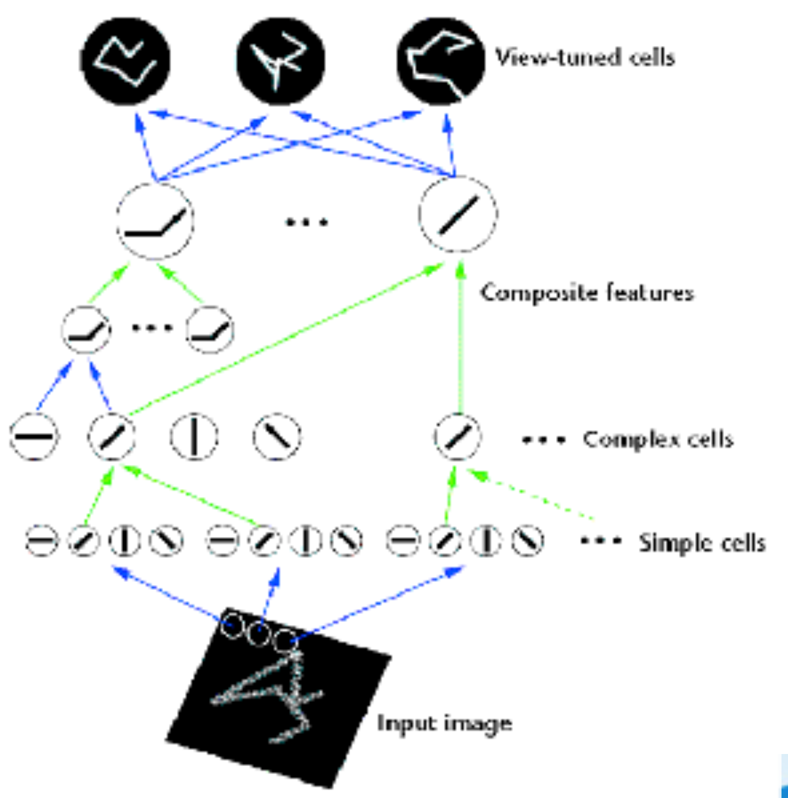
Computational Vision: David Marr

1945 - 1980 (died at 35!)

Regarded vision as a form of information processing, in which patterns of light on the retina form inputs, and the final result is a 3-D model of the world.

Founded the field of Computer Vision.

Drew hugely on Hubel & Wiesel's work



Viewing the brain as a kind of computer, and mind as the software, he distinguished three levels of representation”

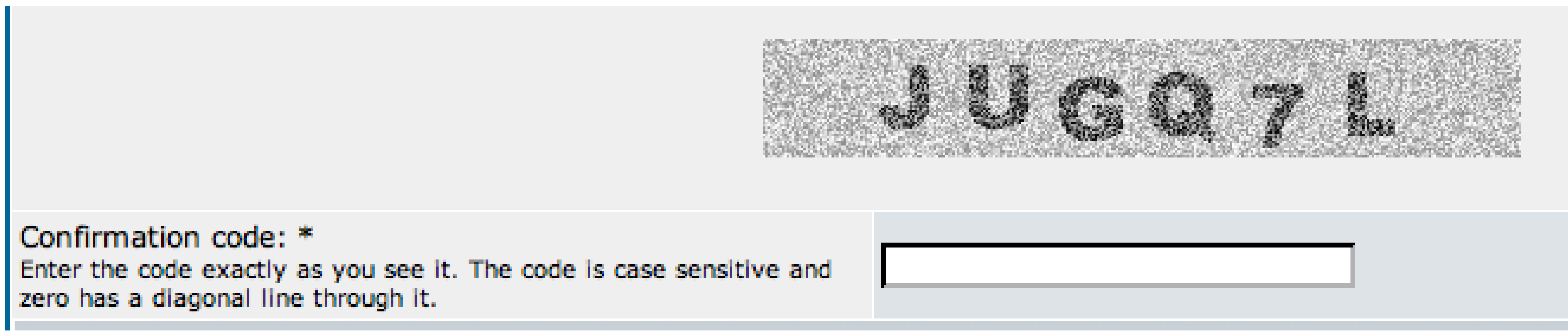
Computational: what does the system do? Why?

Algorithmic: How is the problem represented and how are those representations used?

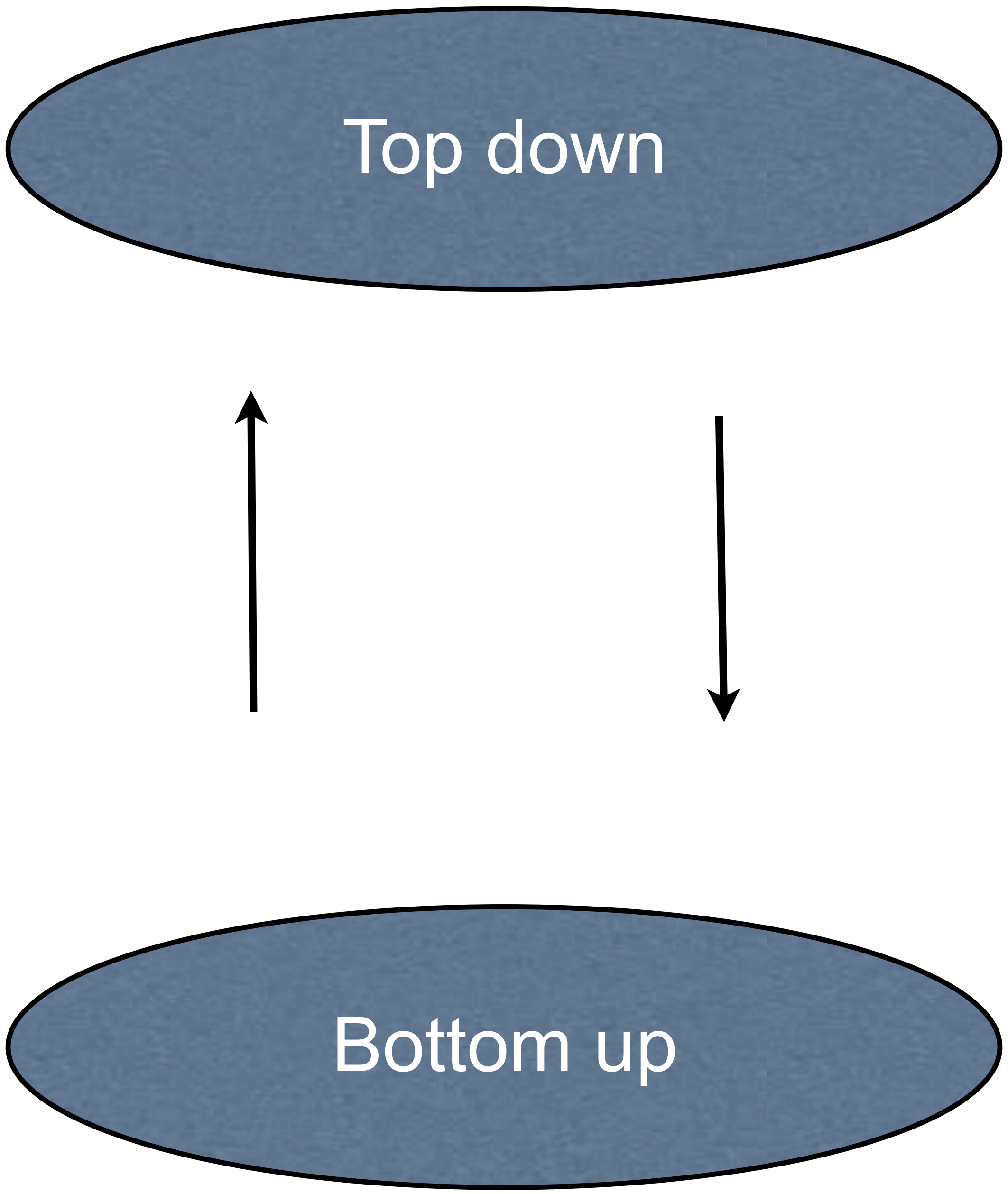
Physical: How is the system physically realised?

He believed scientists could work on any of these levels independently of the others.

Computational approaches to vision



Some things we find very easy have proved remarkably hard to do with computers (and vice versa)



Expectations

Attention

World knowledge

Motion

Edges

Shape from shading

Perceptual Coherence

A great deal of current experimental work is done in this tradition.

Most contemporary cognitive neuroscience uses the information processing metaphor without qualification

On this view, perception involves the construction of representations through the analysis and combination of sensory inputs together with the top-down effects of knowledge and expectations.

A few caveats

Anesthetized cats are a bit special

Nature **291**, 554 - 561 (18 June 1981); doi:10.1038/291554a0

Effects of sleep and arousal on the processing of visual information in the cat

Margaret S. Livingstone* & David H. Hubel

Quick and dirty summary: Livingstone and Hubel made history simply by pinching the tail of their anesthetized cat, thereby waking it up, and observed that the same visual neurons now fired differently.

Held, R., & Hein, A. (1963). Movement-produced stimulation in the development of visually guided behavior. Journal of Comparative and Physiological Psychology, 56(5), 872–876

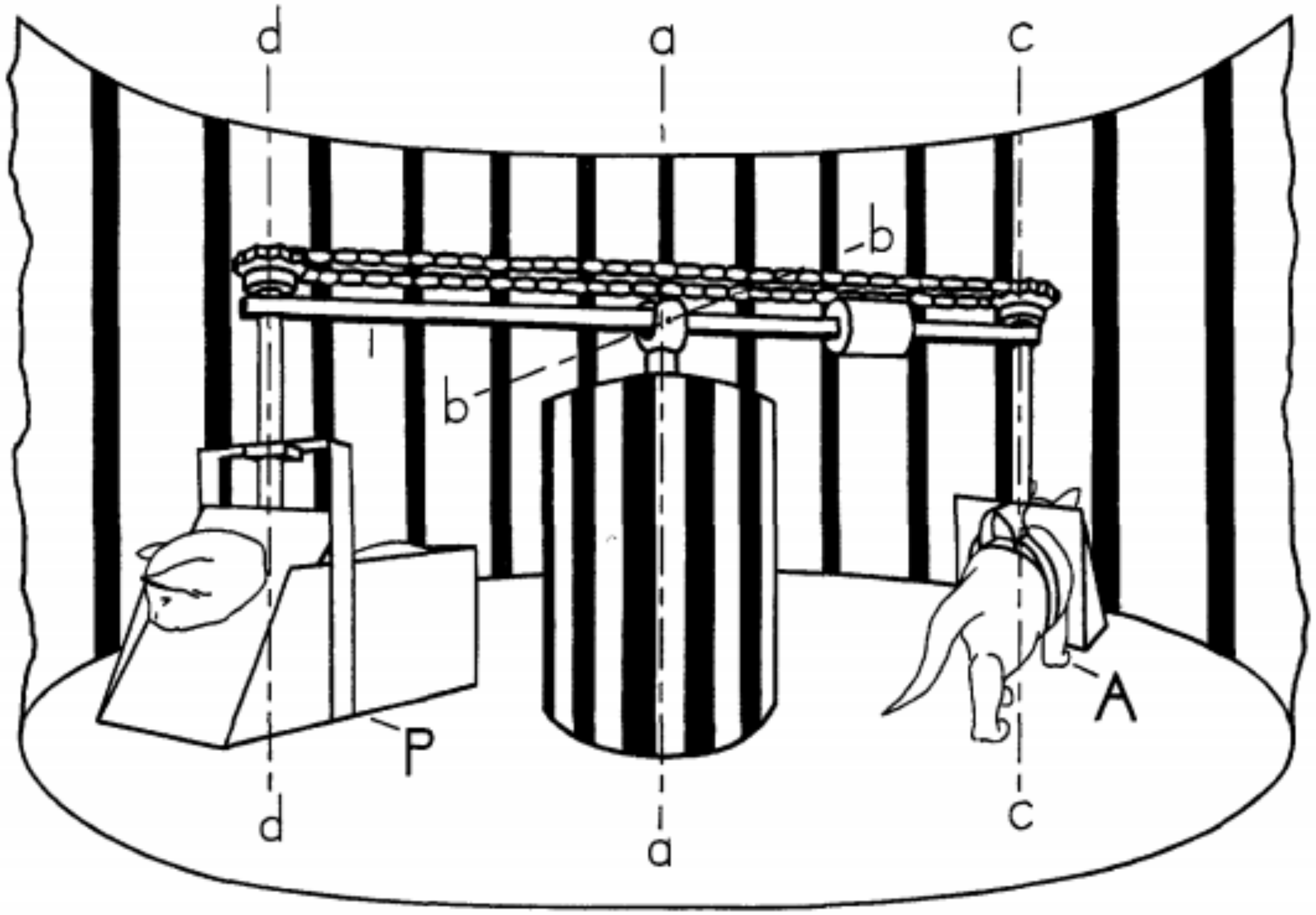
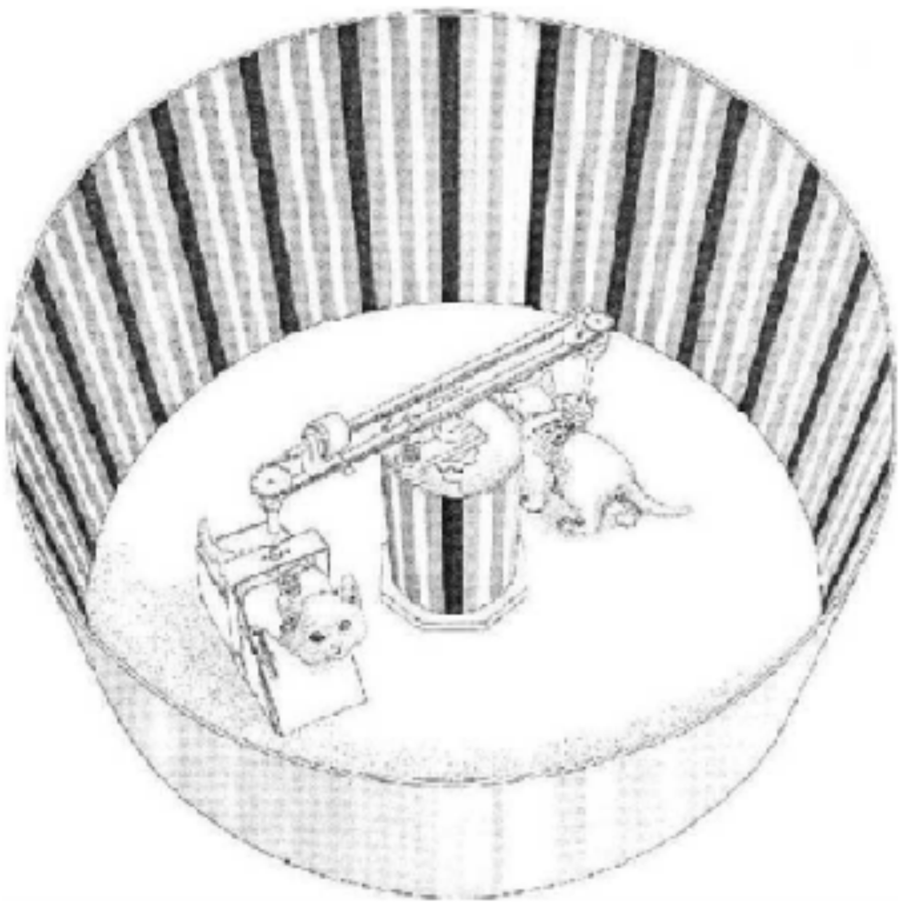


FIG. 1. Apparatus for equating motion and consequent visual feedback for an actively moving (A) and a passively moved (P) *S*.

10 pairs of kittens.



Kittens received identical visual stimulation, but only one of them received that stimulation as a result of self-movement. Importantly, only the active kitten developed normal behavior in several visually guided tasks, such as paw extension on approaching horizontal surface from above and blinking at object put in front of its eyes, while the passive one failed

The binding problem

If we view perception as the construction of a model of the world based on diverse sensory inputs (and knowledge/expectations)

How do we perceive a single world?

Even in vision, if we accept the dual stream model, how is it that vision seems to be a single modality, and not 2?

Representational models of perception are strongly *internalist*.

They focus on what is going on in the nervous system

They typically invoke representations, assumed to be constructed by perceptual systems

Relational accounts of perception examine the relationship between the ongoing activity of an organism and its environment.

Activity and *Patterns of Change* are the focus here, not representation

Simple example: I give you a sponge and ask you is it hard or soft. To find out, you squeeze it. Your activity generates the information to understand the object.

All perception is based on change.

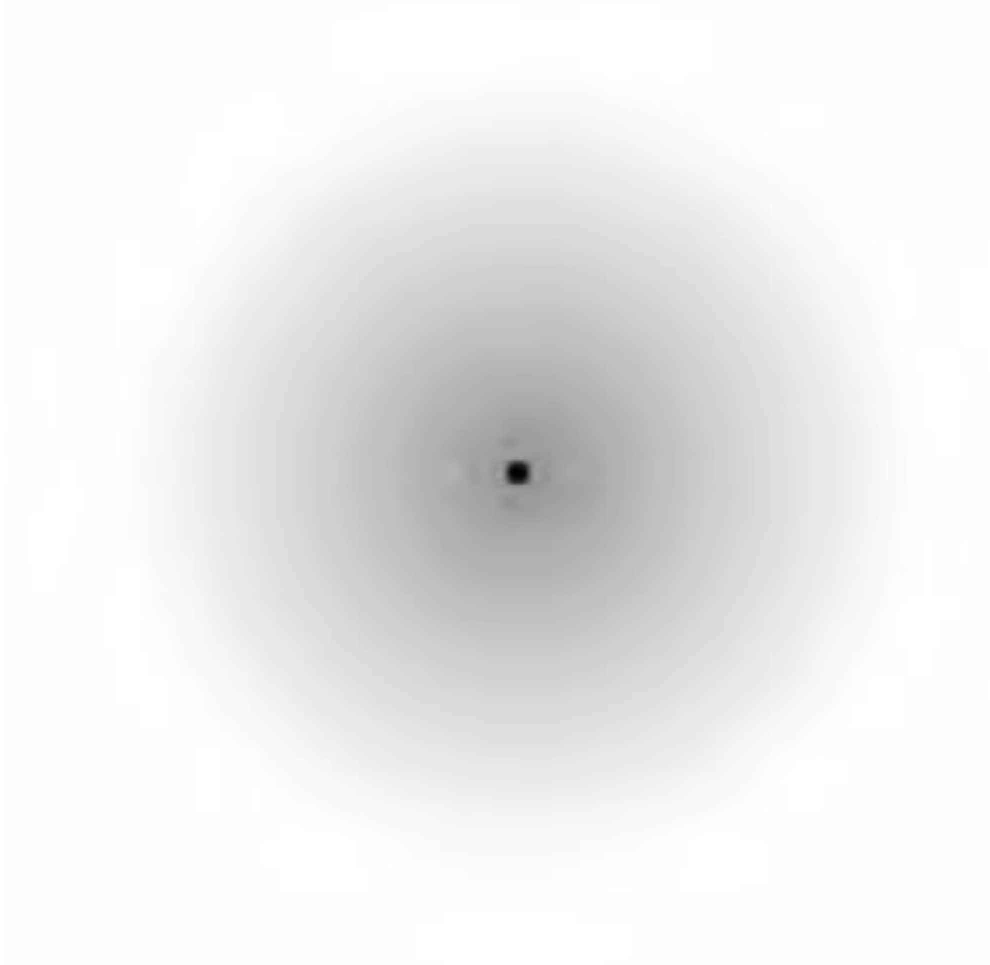
Change may arise because the state of the world changes

Or change may be due to your own activity

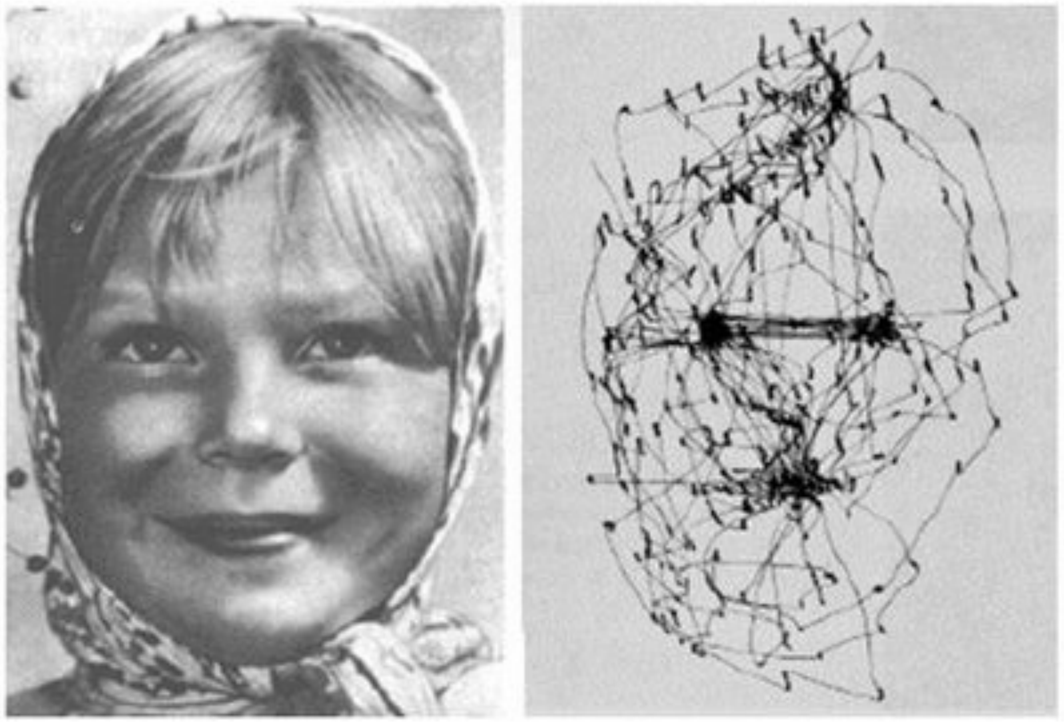
Change is necessary to perceive.
A stabilized image fades away......

During normal vision, the eyes are in constant motion, and this motion causes continuous shifts of the retinal image with respect to the retina. To investigate the effects of such movement, a method called the 'stopped' or 'stabilized image' has been employed in a number of laboratories. This method allows the eye to move normally, but prevents the movements from producing corresponding shifts of the retinal image across the retina.[1] The basic finding is this: when the retinal image of an object is stabilized, the object rapidly fades out and disappears.

Keep staring at the black dot. After a while the gray haze around it will appear to shrink.



Types of Eye Motion



- Saccades
- Nystagmus (smooth pursuit
- + retrograde saccade)

- Drift + microsaccade
- Tremor (80 Hz)

Motion is not a problem to be overcome. It is the way an eye works! In this respect, the eye is unlike a camera.

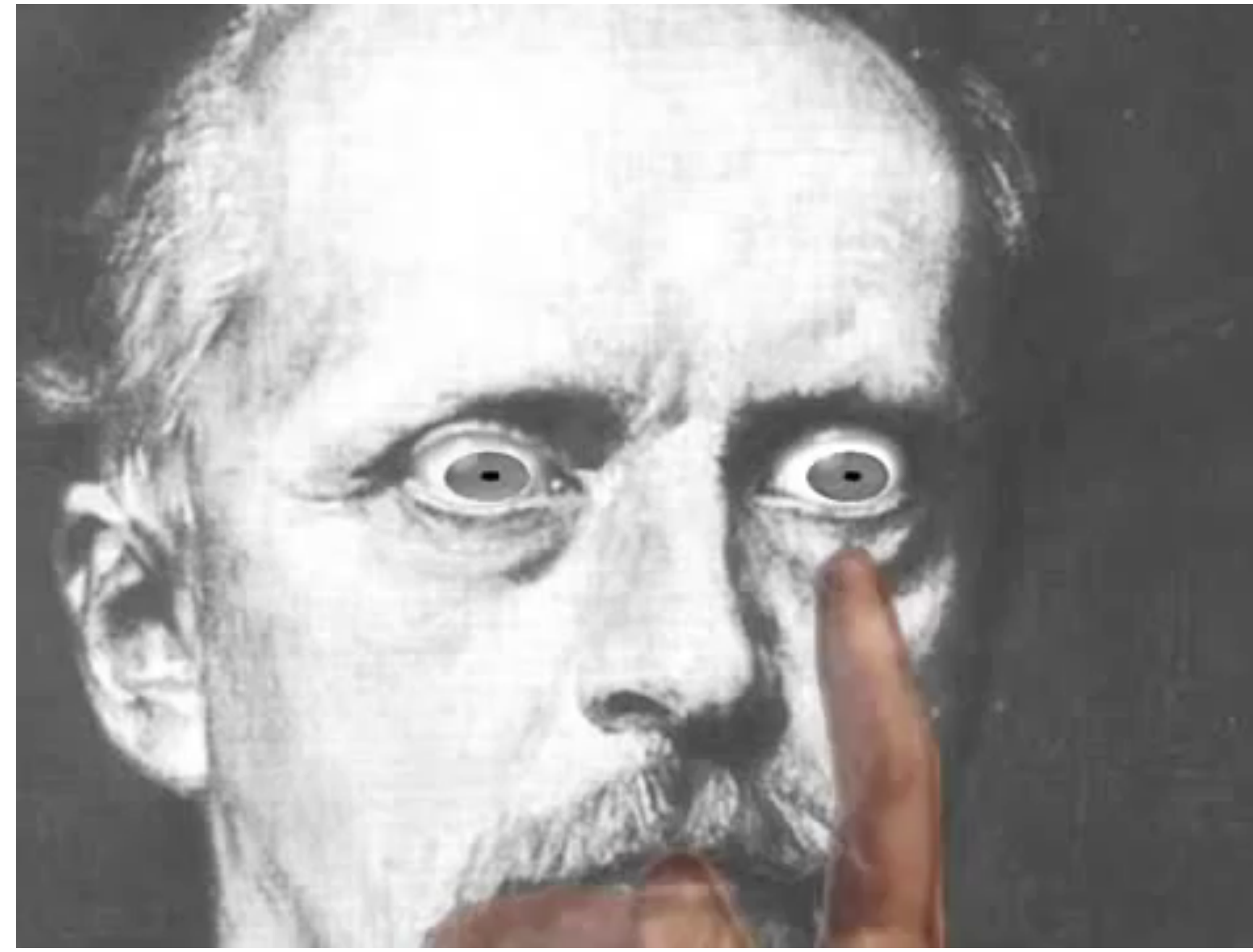
Here are two types of change in vision.

An internalist approach will treat them as two different processes

A relational approach will see them as virtually identical

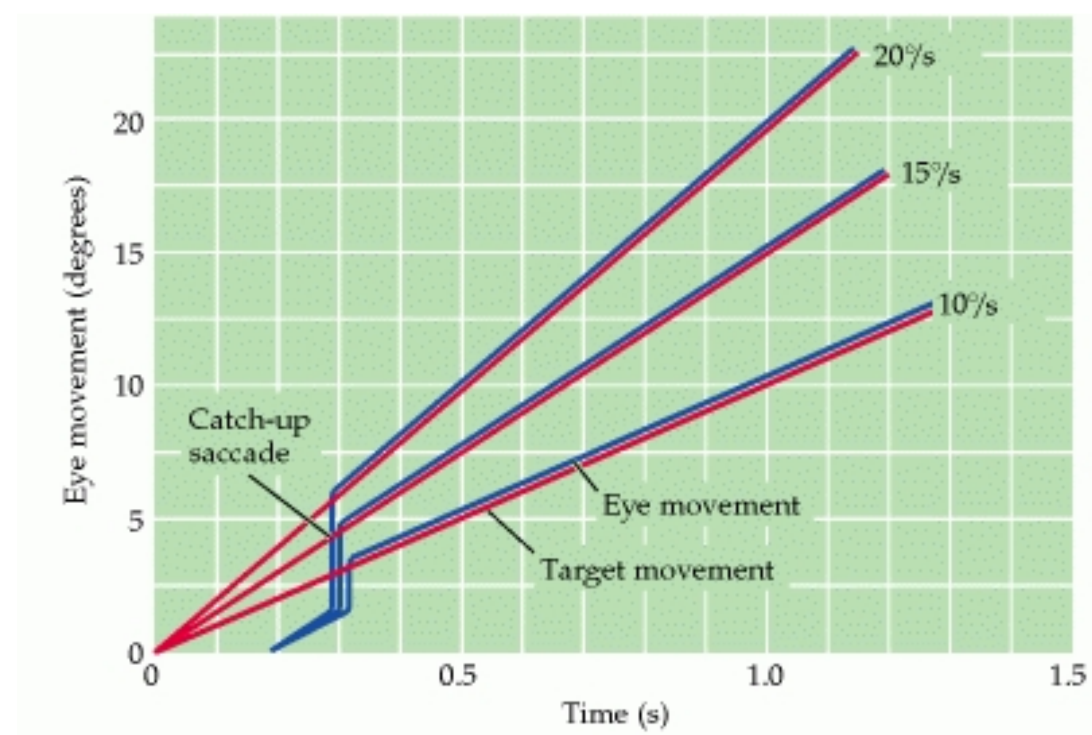
1. Smooth Pursuit Tracking
2. Vestibulo Ocular Reflex

Smooth Pursuit Movement



Slow tracking movements that keep a moving target on the fovea.

Can't be done without a target (people produce a saccade instead)



Vestibulo Ocular Reflex

Keeps the eye on target when the head moves.

This is very like a steady cam.

Birds offload the vestibulo ocular reflex to the head and neck, which looks . . . interesting

“Smooth Pursuit Tracking” identifies a function (following something in the world)

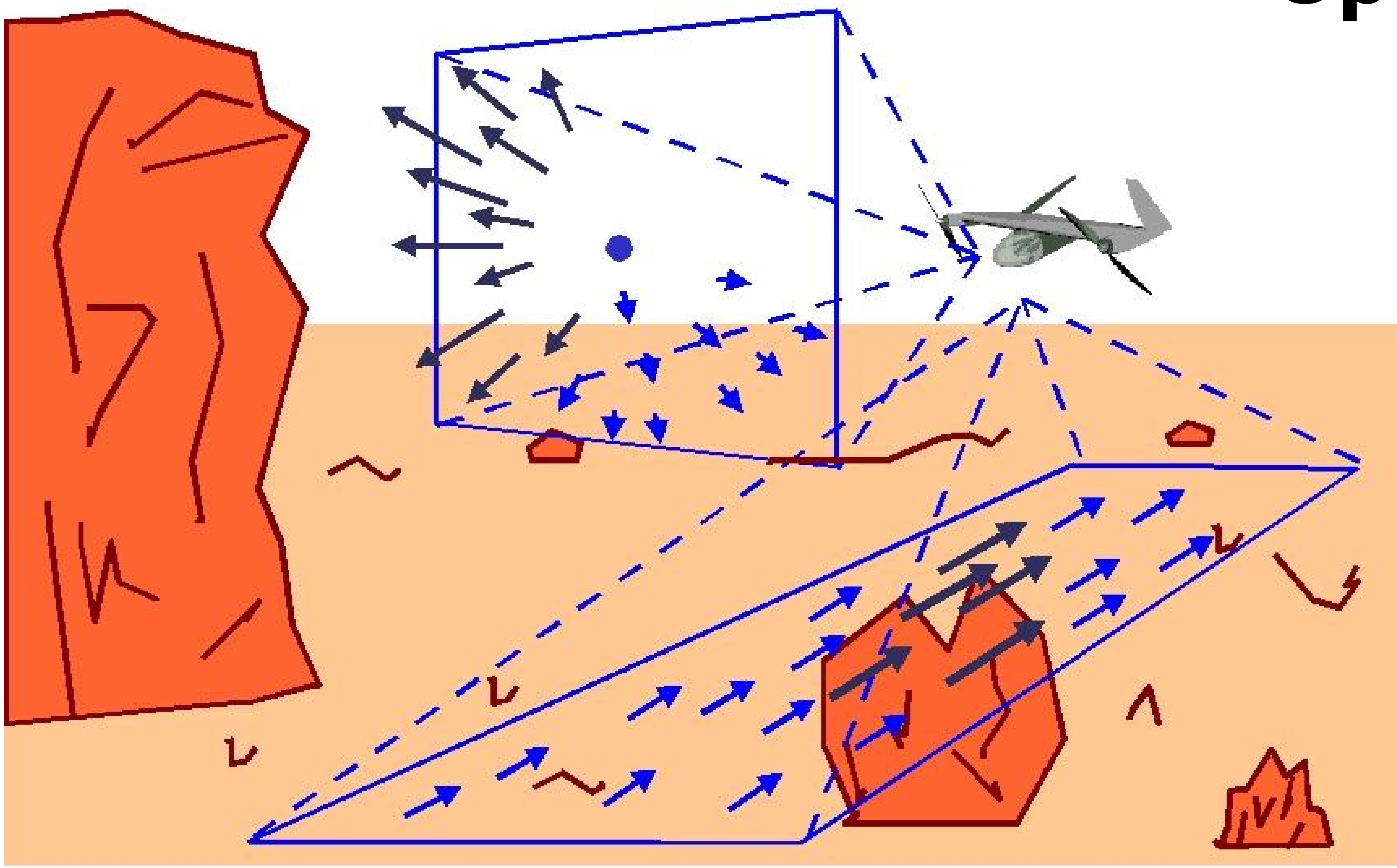
“Vestibulo-Ocular Reflex” identifies an internal mechanism

But they both serve to maintain a stable relation between the organism and the world.

James J. Gibson developed the field of Ecological Optics, from which grew Ecological Psychology

While centered in visual perception, his work explores the lawfulness of the relation between the active, goal-directed activity of an organism and the properties of the environment as they are relevant to that goal.

Optic flow



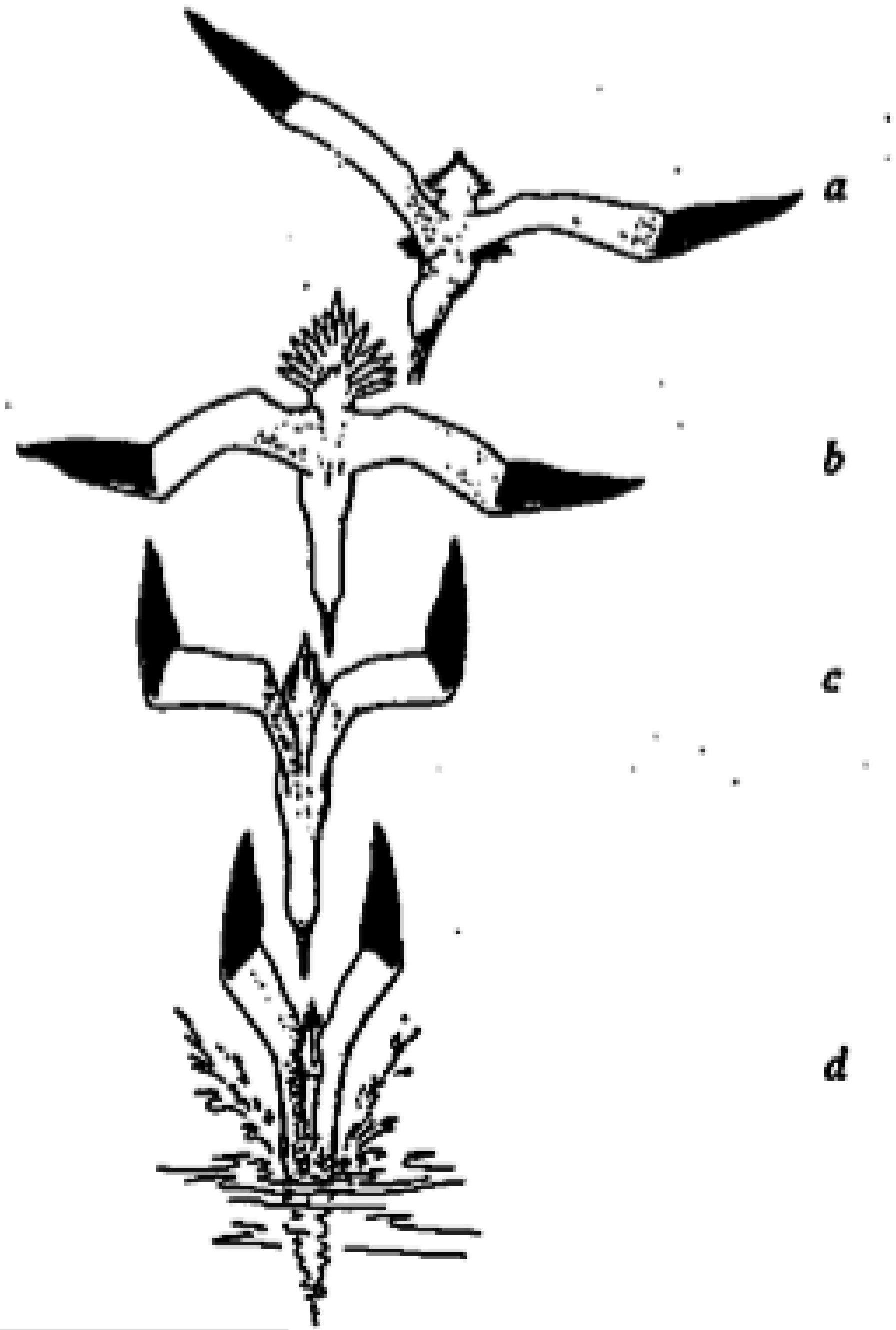
Gibson's early work tried to understand how pilot's used vision to land planes.

One index of change is the pattern of expansion and flow found on the retina

E.g. as you walk towards a wall, there is a pattern of expansion on the retina

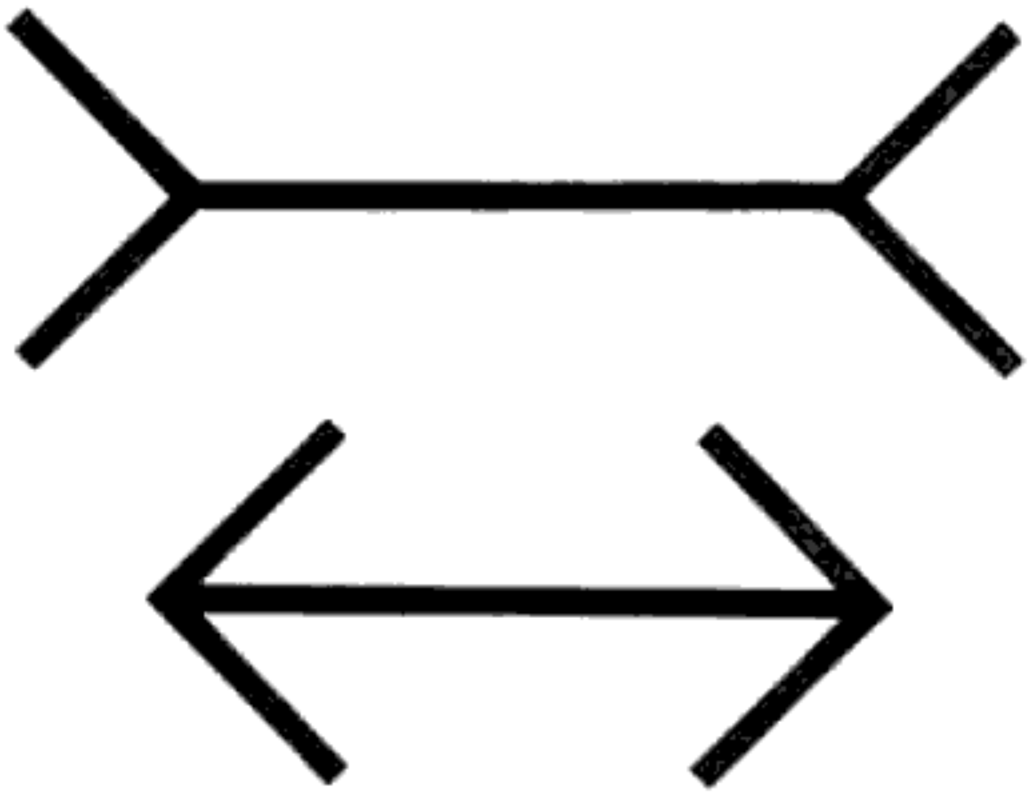
The same pattern arises if the wall comes towards you!

In one landmark study, David Lee found that this pattern of expansion contained information necessary to time the retraction of a diving gannet's wings



Rate of expansion = time to contact

Müller-Lyer Illusion



This hoary old chestnut can still teach us something new.
What can we learn from illusions?

Table 1. Details for Samples

Group	Country/City	Sample Size
Ankole Adults/Kids	Uganda	131/93
Toro Adults/Kids	Uganda	49/37
Suku Adults/Kids	Congo Republic	40/21
Songe Adults/Kids	Congo Republic	45/44
Fang Adults/Kids	Gabon Republic	42/43
Bete Adults/Kids	Ivory Coast	38/37
Ijaw Adults/Kids	Nigeria	47/37
Zulu Adults/Kids	South Africa	21/14
San Adults	Kalahari Desert	36
S.A. European Adults	Johannesburg	36
S. A. Miners	South Africa	60
Senegal Adults/Kids	Senegal	74/51
Dahomey Kids	Guinea Coast	40
Hanunoo Adults/Kids	Philippines	37/12
Evanston Adults/Kids	U.S., Illinois	111/77
Bassari Adults/Kids	Eastern Senegal	50/50
Yuendumu	Central Australia	52

Not everybody reacts in the same way.

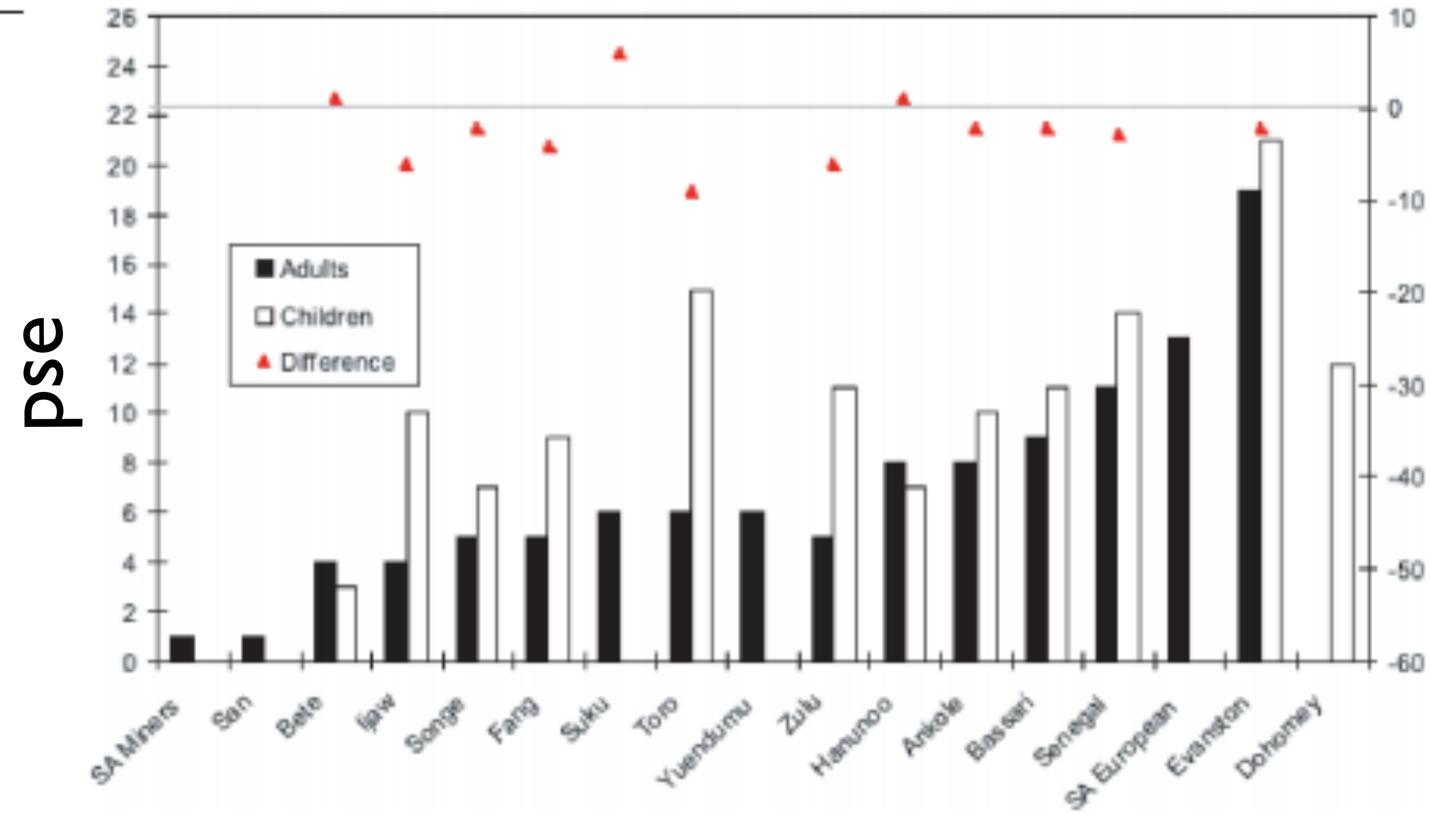
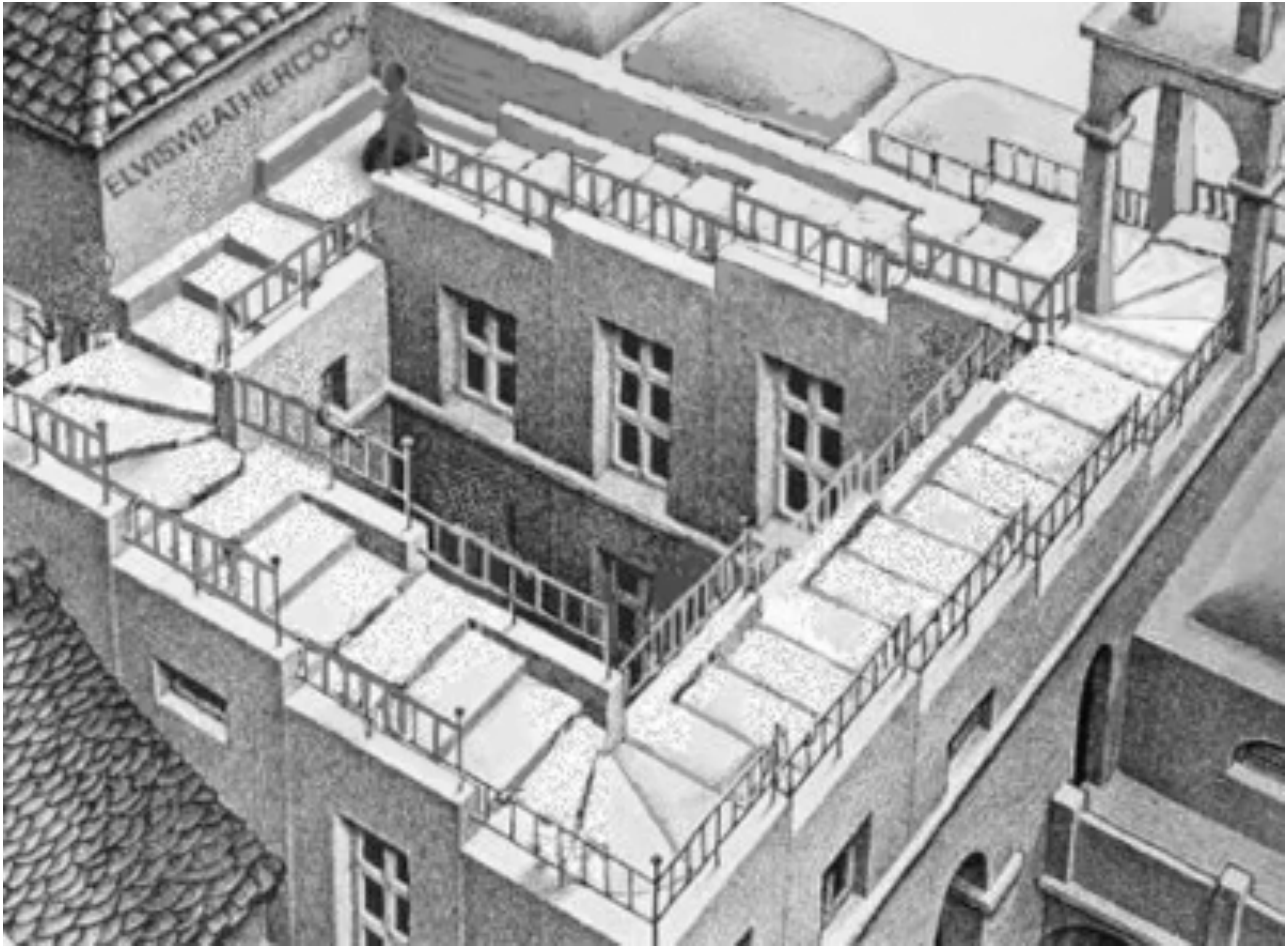
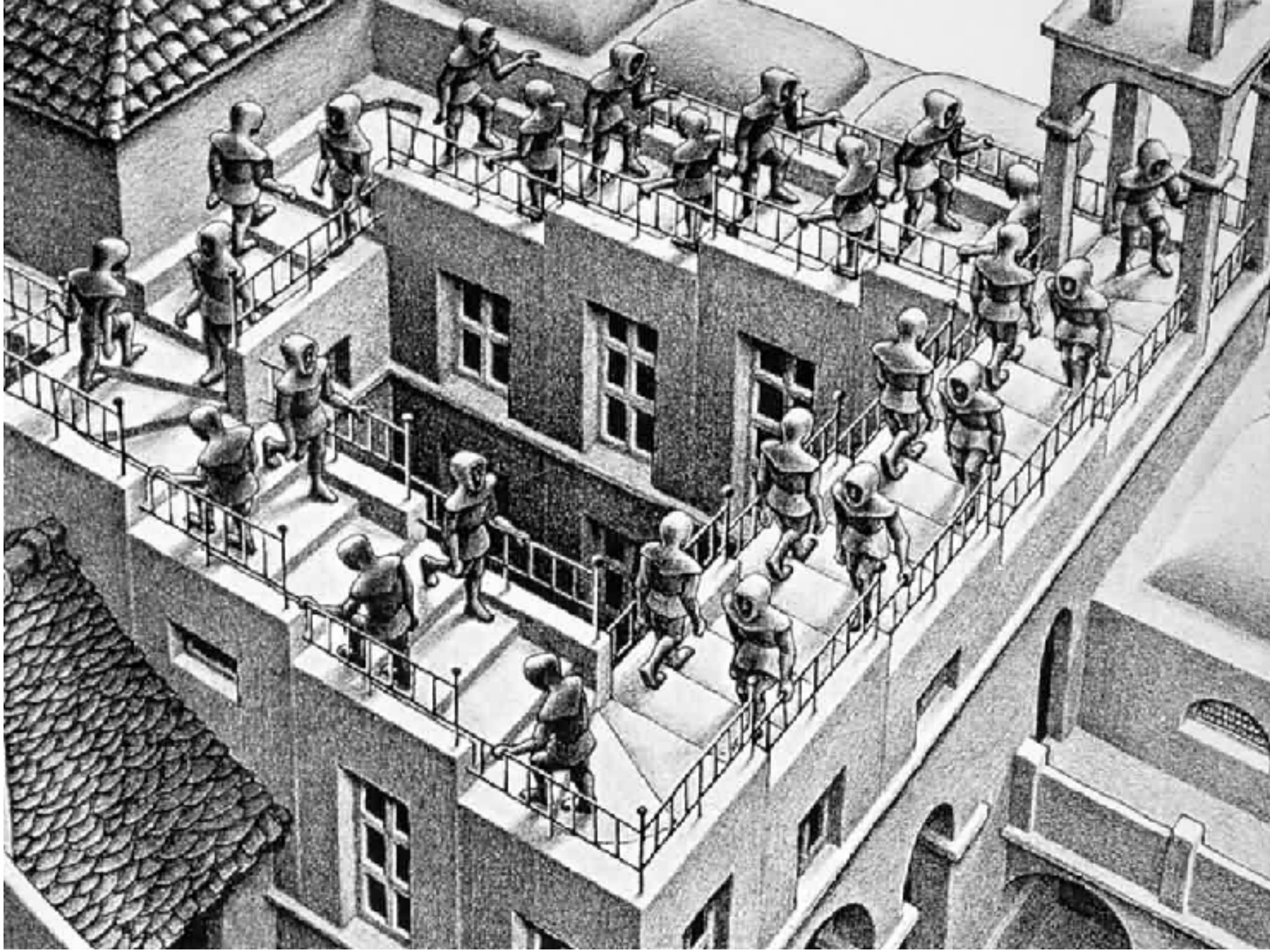


Figure 2 Müller-Lyer Results from Segall et al.'s (1966) cross-cultural project. PSE is the percentage that segment *a* must be longer than *b* before individuals perceive them as equal.


ELVISWEATHERCOCK



There are some remarkable similarities across some modalities. Could you imagine an olfactory equivalent?

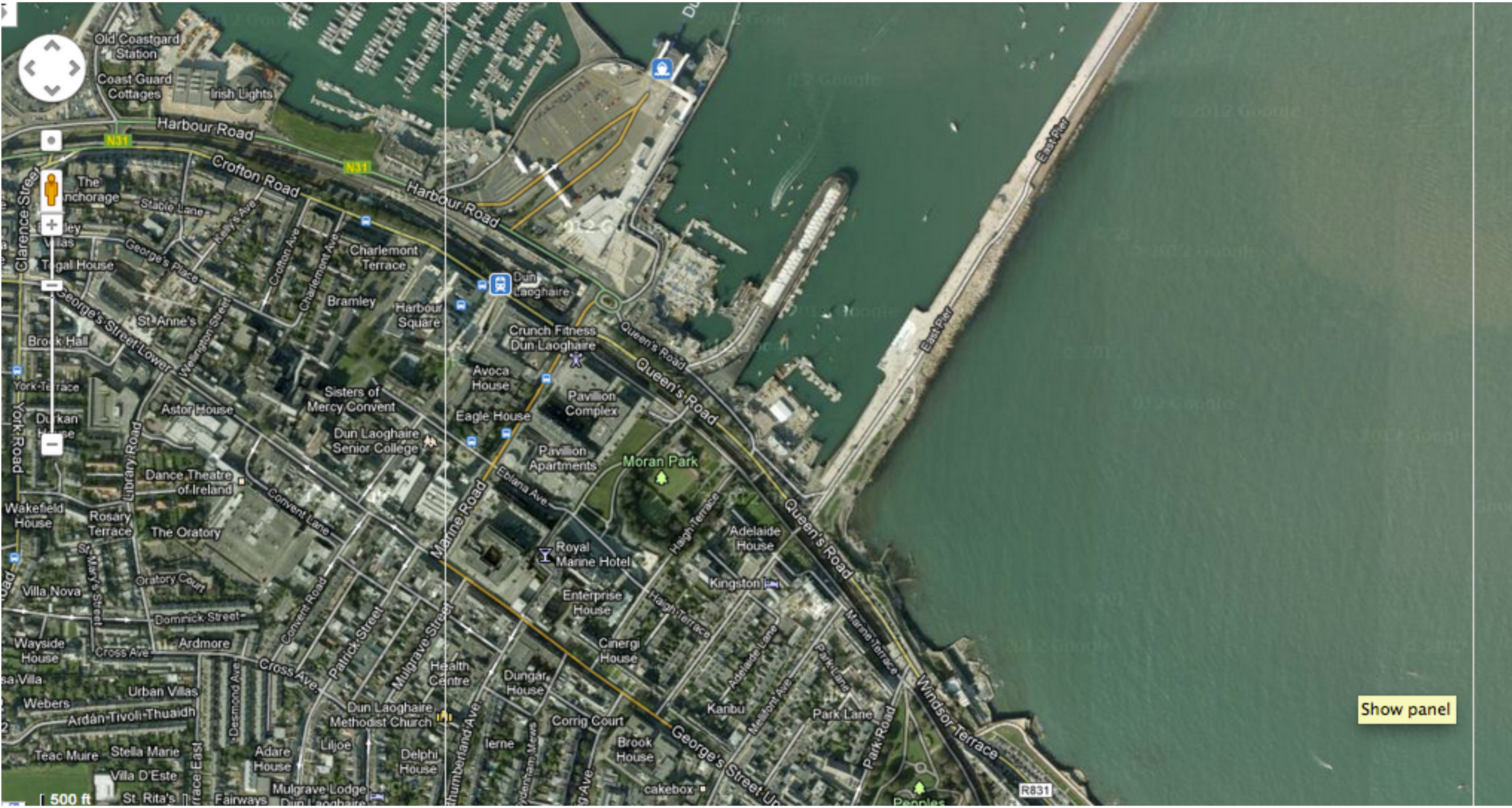
The metaphor of “eye = camera” can be misleading.

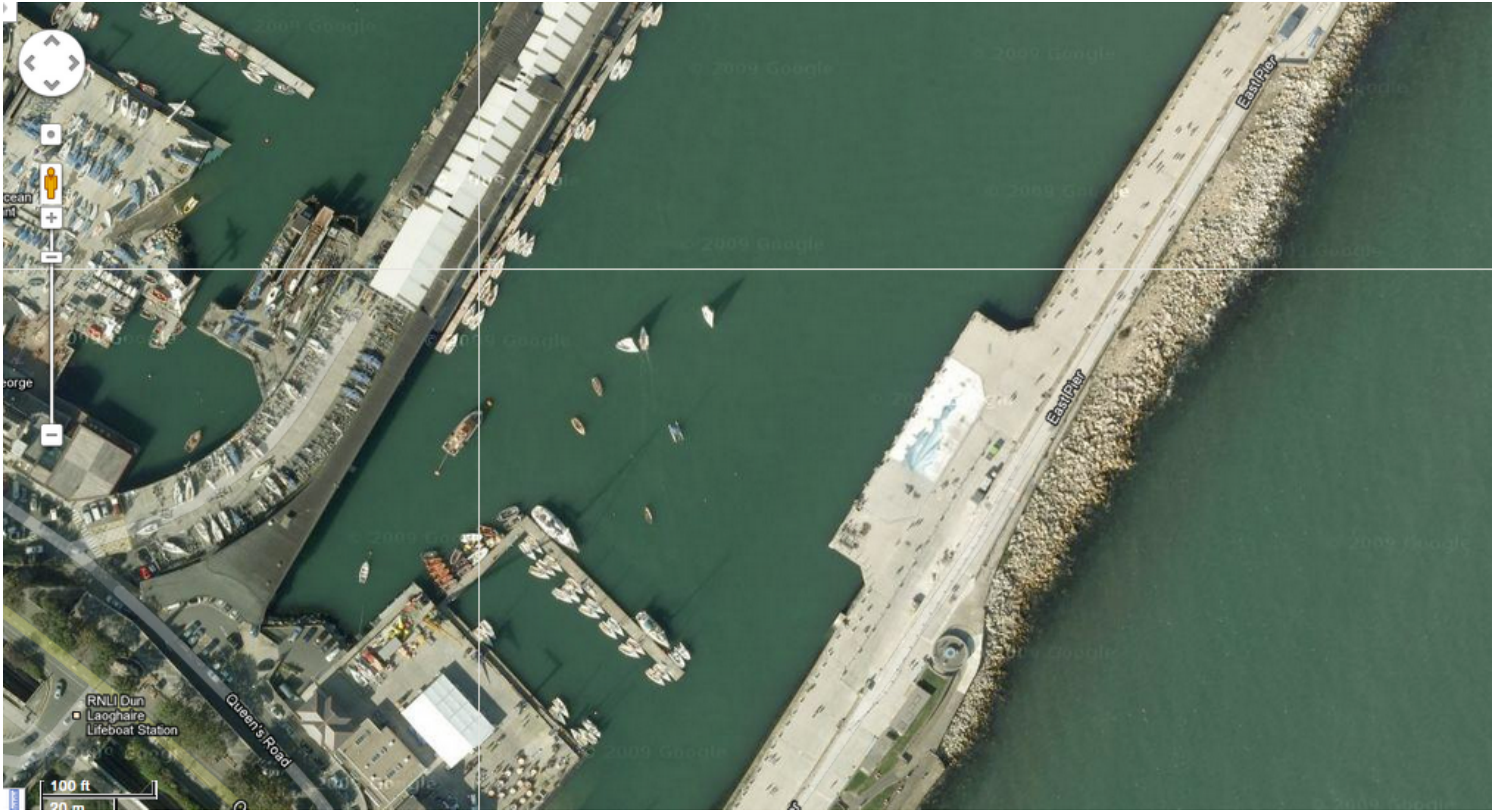
One way in which it misleads is to suggest that vision is associated with a single fixed, immobile, point in isometric space.

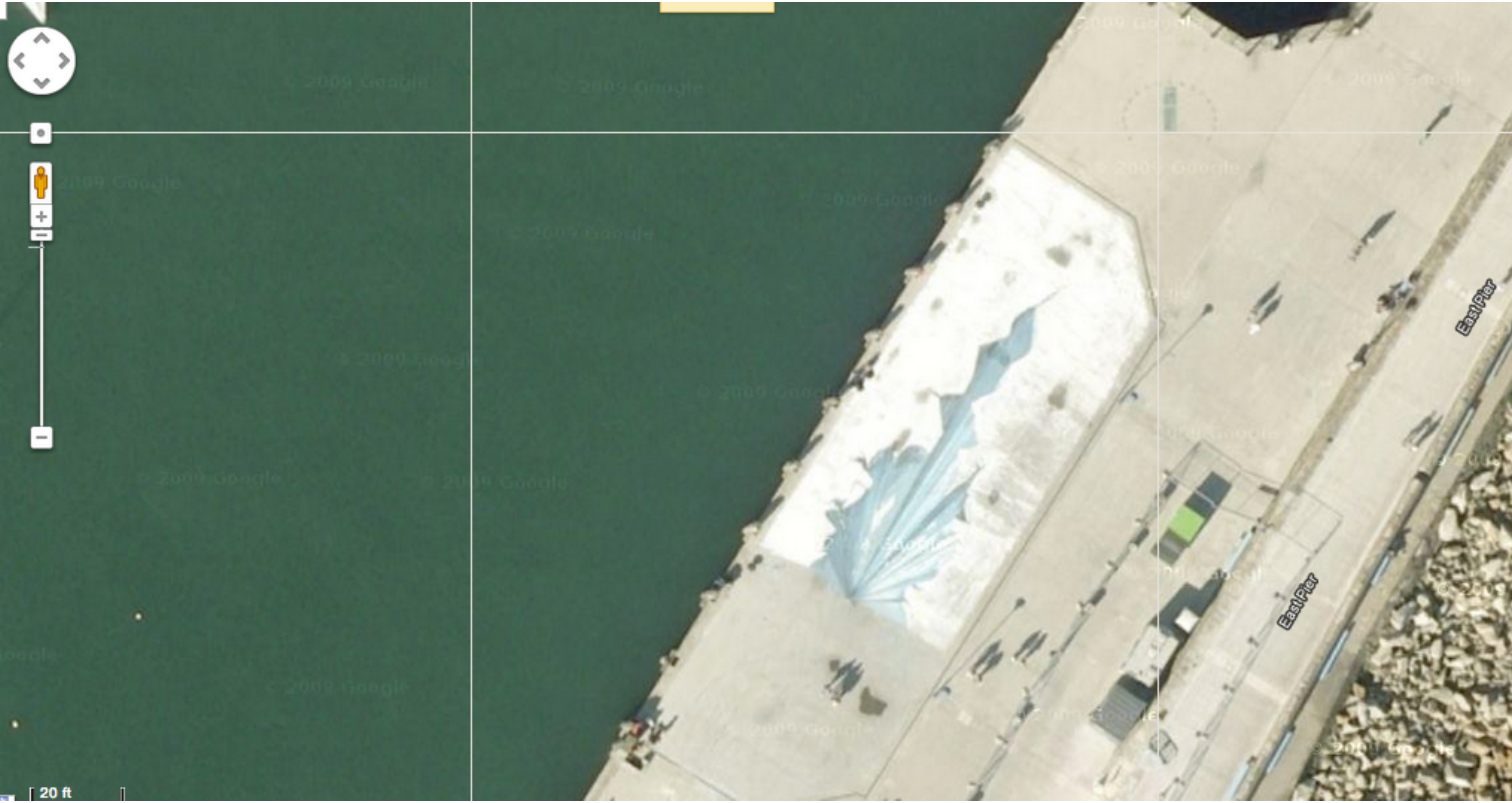
Real vision is an activity, conducted by an active subject, engaging in rich ways with their world.

Anamorphic art exploits the illusion that we see from a fixed point (we don’t!).

Dun Laoghaire, IE - Holyhead, UK
Harbour Road
Crofton Road
Old Dunleary Road
Cumberland Street
Longford Terrace
Monkstown Road
Monkstown
De Vesci Gardens
Dun Laoghaire
Crunch Fitness Dun Laoghaire
Dun Laoghaire Senior College
Moran Park
Royal Marine Hotel
Queen's Road
Peoples Park
Mulgrave Lodge Dun Laoghaire
Richmond Hill
Tivoli Terrace North
Tivoli Terrace South
York Road
Cross Ave
Mountown Road
N31
R119
1000 ft
200 m


Old Coastgard Station
Coast Guard Cottages
Irish Lights
Harbour Road
N31
Crofton Road
Harbour Road
The Anchorage
Stable Lane
Kelly's Ave
Clarence Street
George's Place
Tigal House
Charlemont Terrace
Crofton Ave
Charlemont Ave
Bramley
Harbour Square
Dun Laoghaire
St. Anne's
Wellington Street
George's Street Lower
Brock Hall
Crunch Fitness Dun Laoghaire
Queen's Road
Avoca House
Sisters of Mercy Convent
Pavillion Complex
Eagle House
York Terrace
York Road
Astor House
Dun Laoghaire Senior College
Pavilion Apartments
Moran Park
Durkan House
Library Road
Dance Theatre of Ireland
Eblana Ave
Marine Road
East Pier
Wakefield House
Rosary Terrace
The Oratory
Convent Lane
Royal Marine Hotel
Adelaide House
Haigh Terrace
Kingston
Villa Nova
St. Mary's Street
Oratory Court
Convent Road
Enterprise House
Dominick Street
Wayside House
Cross Ave
Ardmore
Cross Ave.
Patrick Street
Mulgrave Street
Health Centre
Cinergi House
Marine Terrace
Adelaide Lane
Urban Villas
Webers
Ardán Tivoli Thuaidh
Dun Laoghaire Methodist Church
Dungar House
Mellifont Ave
Park Lane
Kanbu
Park Road
Windsor Terrace
Corrig Court
Teac Muire
Stella Marie
Adare House
Liljoe
Delphi House
Ierne
Brook House
George's Street Up
Villa D'Este
500 ft
St. Rita's
Fairways
Mulgrave Lodge
cakebox
R831
Show panel


East Pier
East Pier
RNLI Dun
Laoghaire
Lifeboat Station
Queen's Road
100 ft



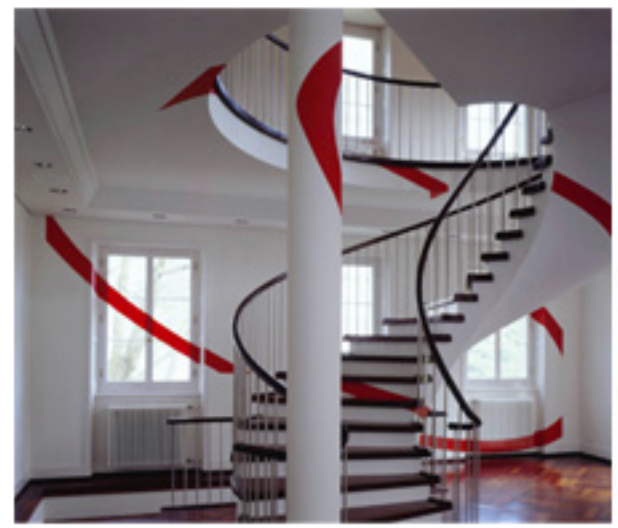
© 2009 Google
East Pier
East Pier
20 ft

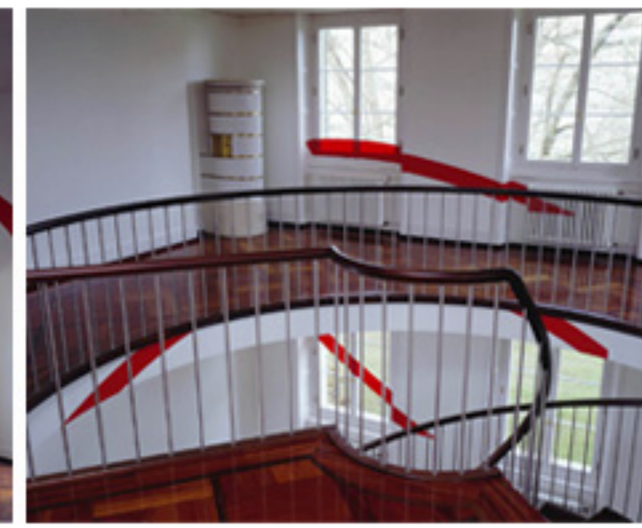
Edgar Müller 2008

The photograph makes this illusion absolutely compelling

In reality, it requires you to close one eye, and keep the other immobile. As soon as you move, or open the other eye, the illusion weakens or vanishes.

Felice Varini





Anamorphic Art

fixation cross

Many optical illusions, and many vision experiments done in the laboratory, require the subject to remain immobile.

Frequently a fixation cross is used to ensure the head is still.

All neuroscientific study of vision has employed subjects who were required to be immobile.

This has greatly skewed our understanding of theway vision works.

When we think about vision, we become self-conscious about seeing.

But usually we just get on with our business, unaware of “seeing” anything.

E.g. we might drive for hours while chatting with a friend, unaware of the role of vision in driving

We can contrast aesthetic, contemplative seeing with what we might call seeing in the wild. Wild seeing is active, embedded, subordinate to task, an openness to our world rather than, if you like, a state of reflection on or contemplation of the world. Most seeing, most of the time, is precisely not contemplative; not, in any sense, aesthetic. It does not rest on deliberate acts of looking and inspection. We drive, we tie our shoes, we prepare dinner and then eat it. And we use our eyes and our other senses when we do all this. Wild seeing is spontaneous and engaged; it is direct and involved. Wild seeing is acting in concert with the stuff around us. Aesthetic seeing, in contrast, is something more like the entertainment of thoughts about what one is looking at.

(Alva Noë, Strange Tools, p. 51/52)