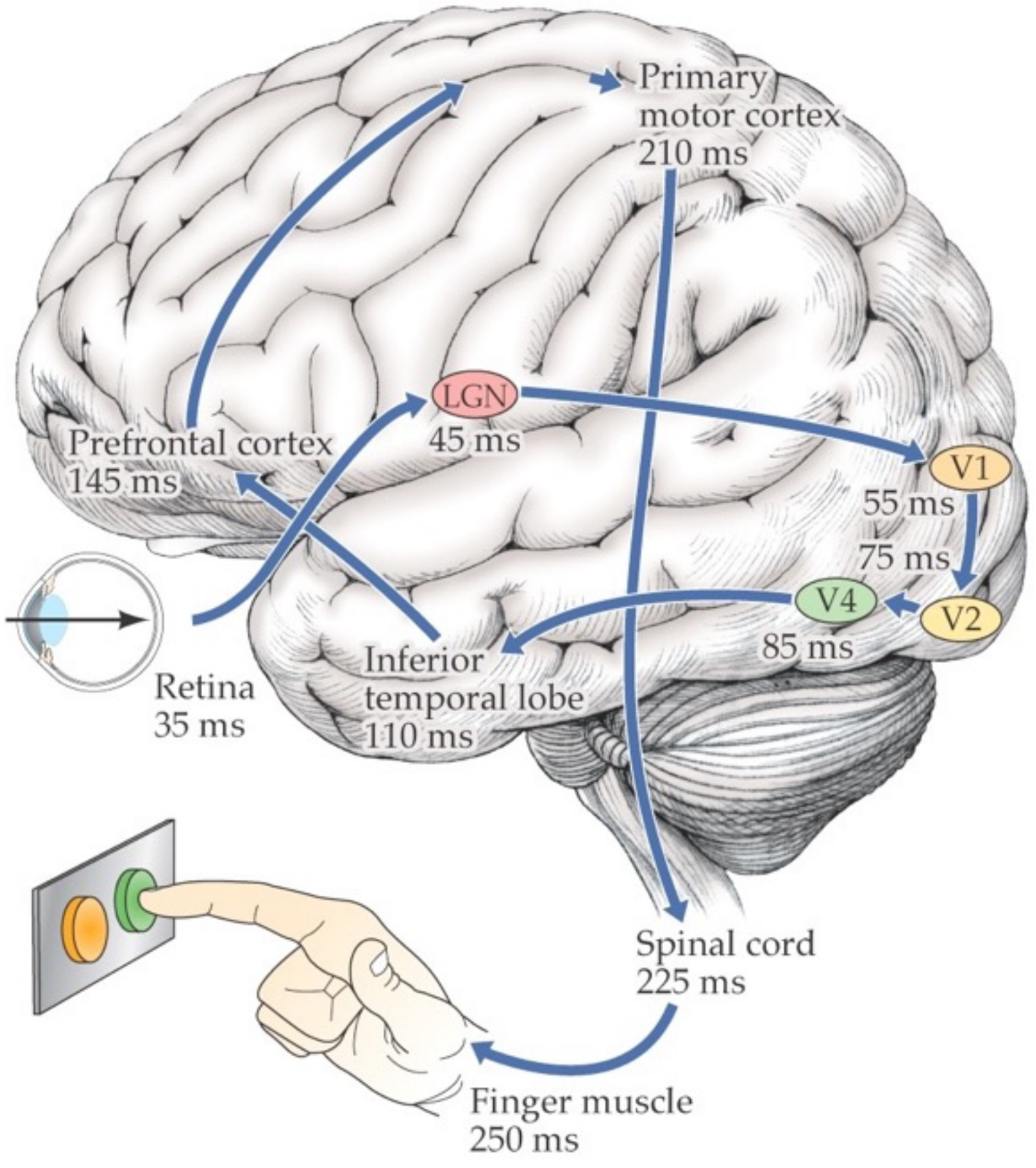
# Today’s topics

- Perception and action



# Sensory Information

- What is it?
- Where is it? Now? Moving?
- What should I do about it?

# Action types

- External
  - Space: Distal/proximal
  - Timing
- Internal

**TABLE 8.1** *Classification of Sensory Systems*

| Type of sensory system | Modality | Adequate stimuli |
|---|---|---|
| Mechanical | Touch | Contact with or deformation of body surface |
| | Hearing | Sound vibrations in air or water |
| | Vestibular | Head movement and orientation |
| | Joint | Position and movement |
| | Muscle | Tension |
| Photic | Seeing | Visible radiant energy |
| Thermal | Cold | Decrement of skin temperature |
| | Warmth | Increment of skin temperature |
| Chemical | Smell | Odorous substances dissolved in air or water in the nasal cavity |
| | Taste | Substances in contact with the tongue or other taste receptor |
| | Common chemical | Changes in $CO_2$, pH, osmotic pressure |
| | Vomeronasal | Pheromones in air or water |
| Electrical | Electroreception | Differences in density of electrical currents |

# Dimensions

- Exteroceptive
  - What's out there and where?
- Interoceptive
  - How'm I doin'?

# Visual

- Electromagnetic radiation
- What is it?
    - Shape, size, surface properties (color, texture, reflectance, etc.)
    - Wavelength/frequency, intensity
- Where is it?
    - Position: Left/right; up/down; near/far
    - Orientation, motion
- What should I do about it?

# Auditory

- Vibrations in air/water
- What is it?
  - Pattern of frequencies, amplitudes, durations
- Where is it?
  - Left/right; up/down; near/far
  - Orientation, motion
- What should I do about it?

# Chemosensory

- Chemicals in mouth, nasal cavity
- What is it?
    - Mixture of chemicals
- Where is it?
    - Left/right; up/down; near/far
- What should I do about it?

# Somatosensory

- Exteroceptive
  - Cutaneous (skin-based sensors)
  - Kinesthetic (joint, muscle sensors)
- Interoceptive

# Cutaneous

- Thermal or mechanical stimulation of skin
- What is it?
    - Shape, size, smoothness, temperature, heft, deformability
- Where is it?
    - Position on skin/body
    - Position of body
- What should I do about it?

# Interoceptive

- Hunger, thirst
- Temperature
- Mating interest
- Physical energy level
- Health/illness

# Interoceptive

- Hunger/thirst
  - Receptors for nutrient, fluid levels
- Temperature
- Mating interest
  - Receptors for hormones, NTs
  - ANS responses

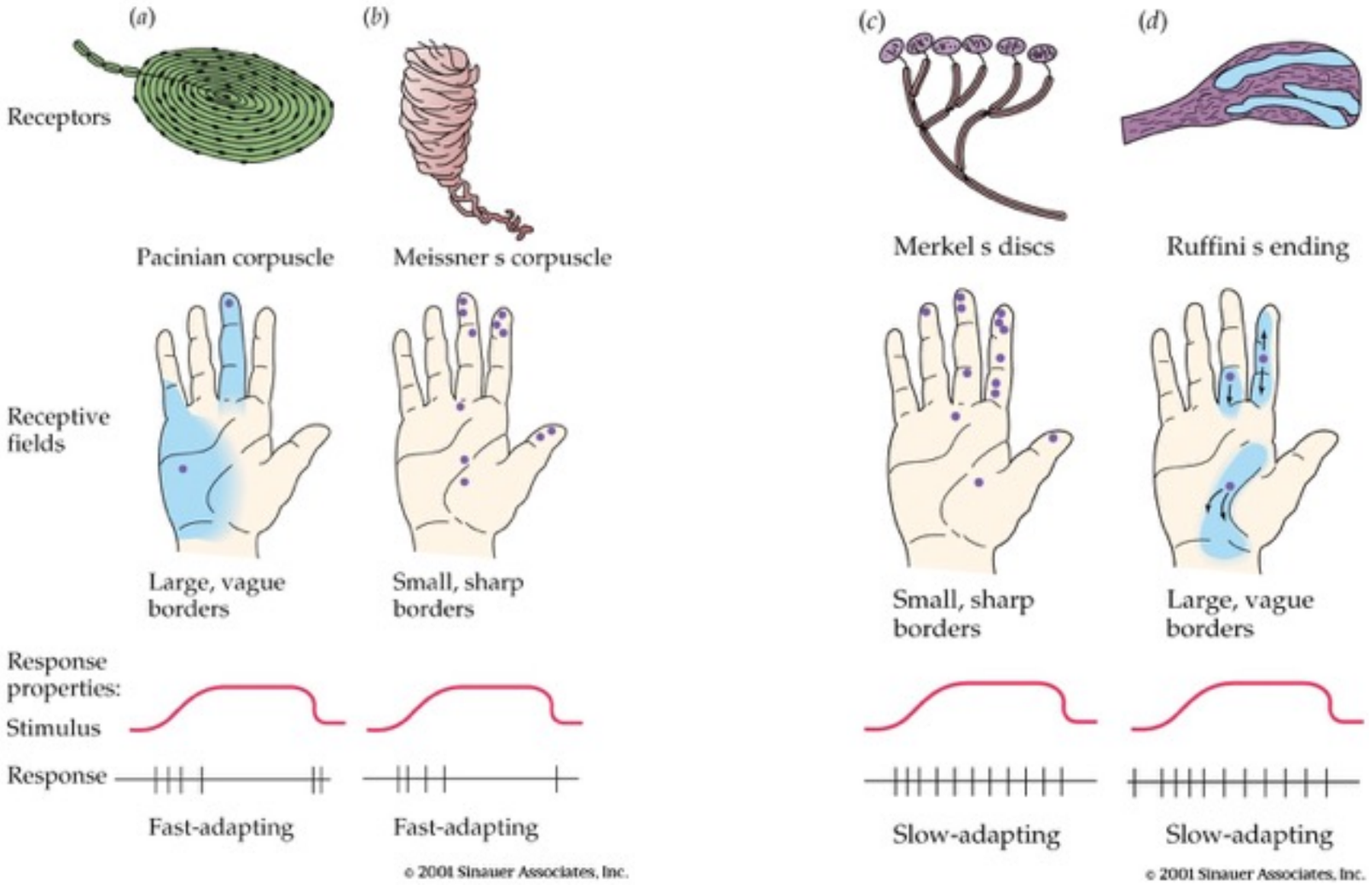
# Interoceptive

- Physical energy level
- ANS responses
- Hormones, NTs, nutrients

# Common Principles

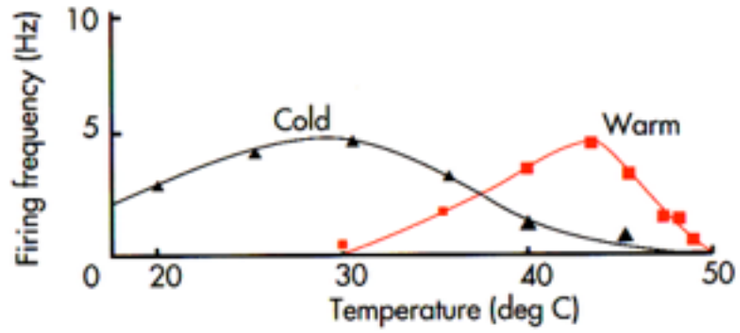
- Specialized receptors

# Receptor specializations



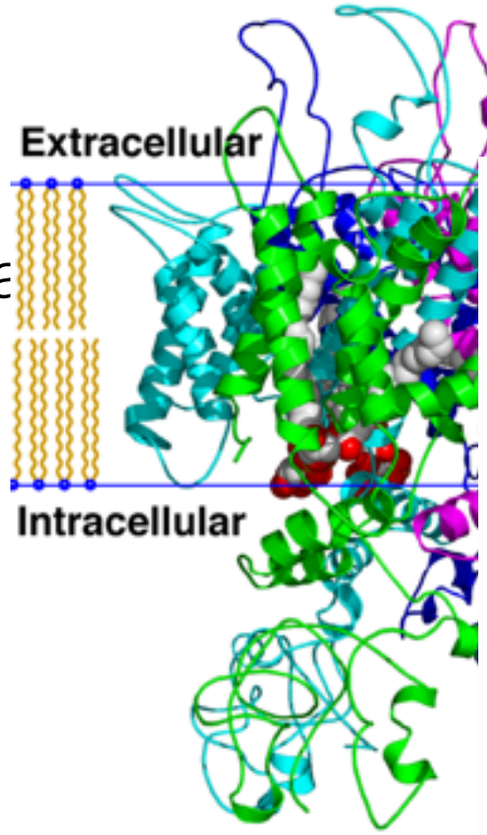
# Skin receptors

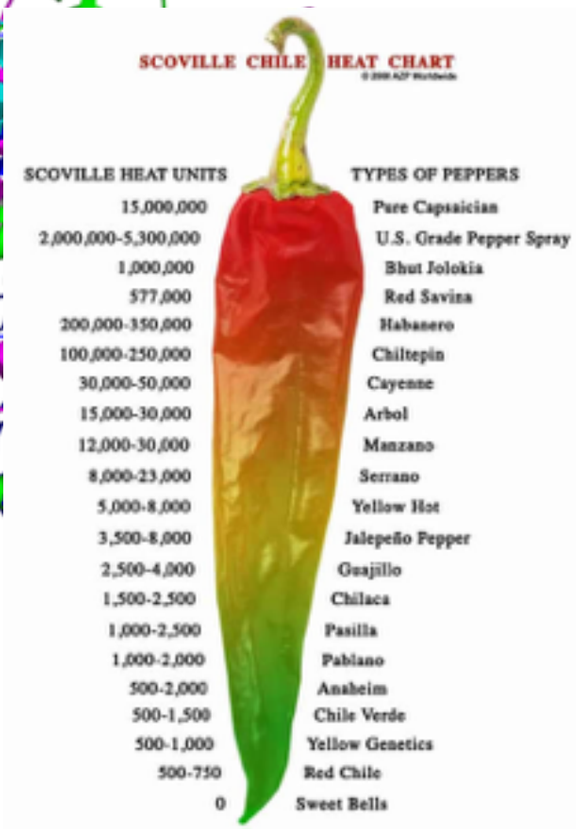
- Free nerve endings
  - Hot
  - Cold
  - Tissue damage (pain)
- Encapsulated endings
  - Stretching

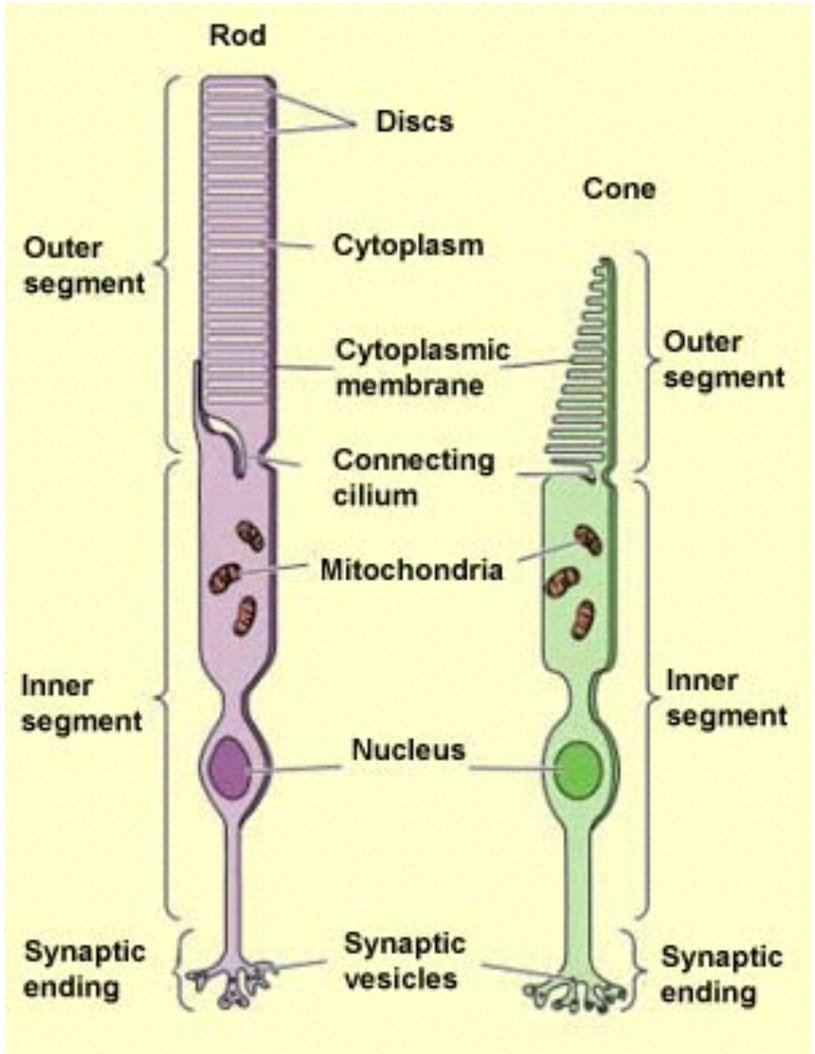


# One receptor, many signals

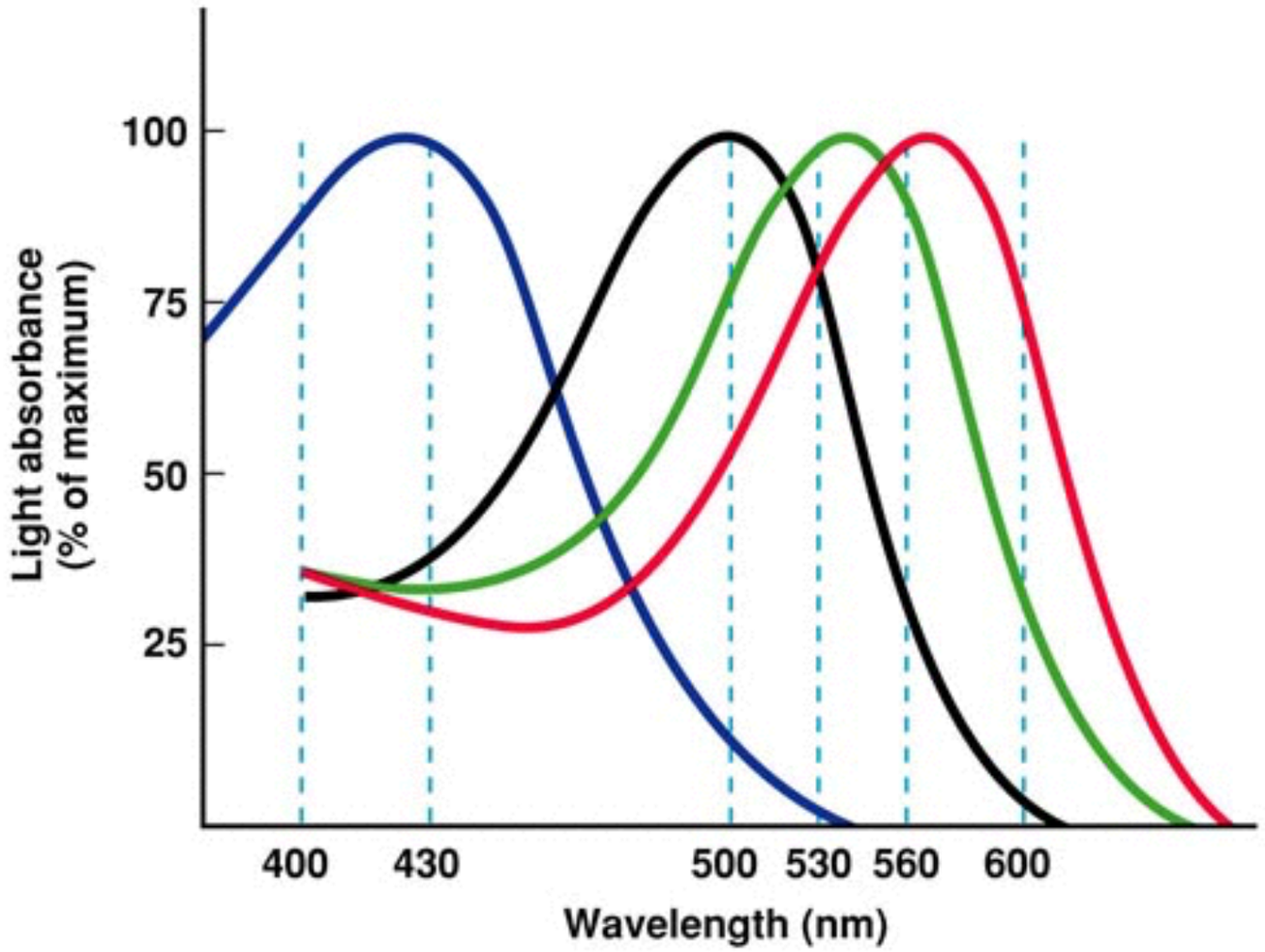
- Transient Receptor Potential Va
- Thermoreceptor AND
- Chemoreceptor






http://thebrain.mcgill.ca/flash/d/d_02/d_02_m/d_02_m_vis/d_02_m_vis_1a.jpg




http://www.d.umn.edu/~jfitzake/Lectures/DMED/Vision/Figures/Photoreceptors.jpg

# Features of sensory signals

- Tonic (sustained) vs. phasic (transient) responses
- Adaptation
  - Decline in sensitivity with sustained stimulation
  - Most sensory systems attuned to change

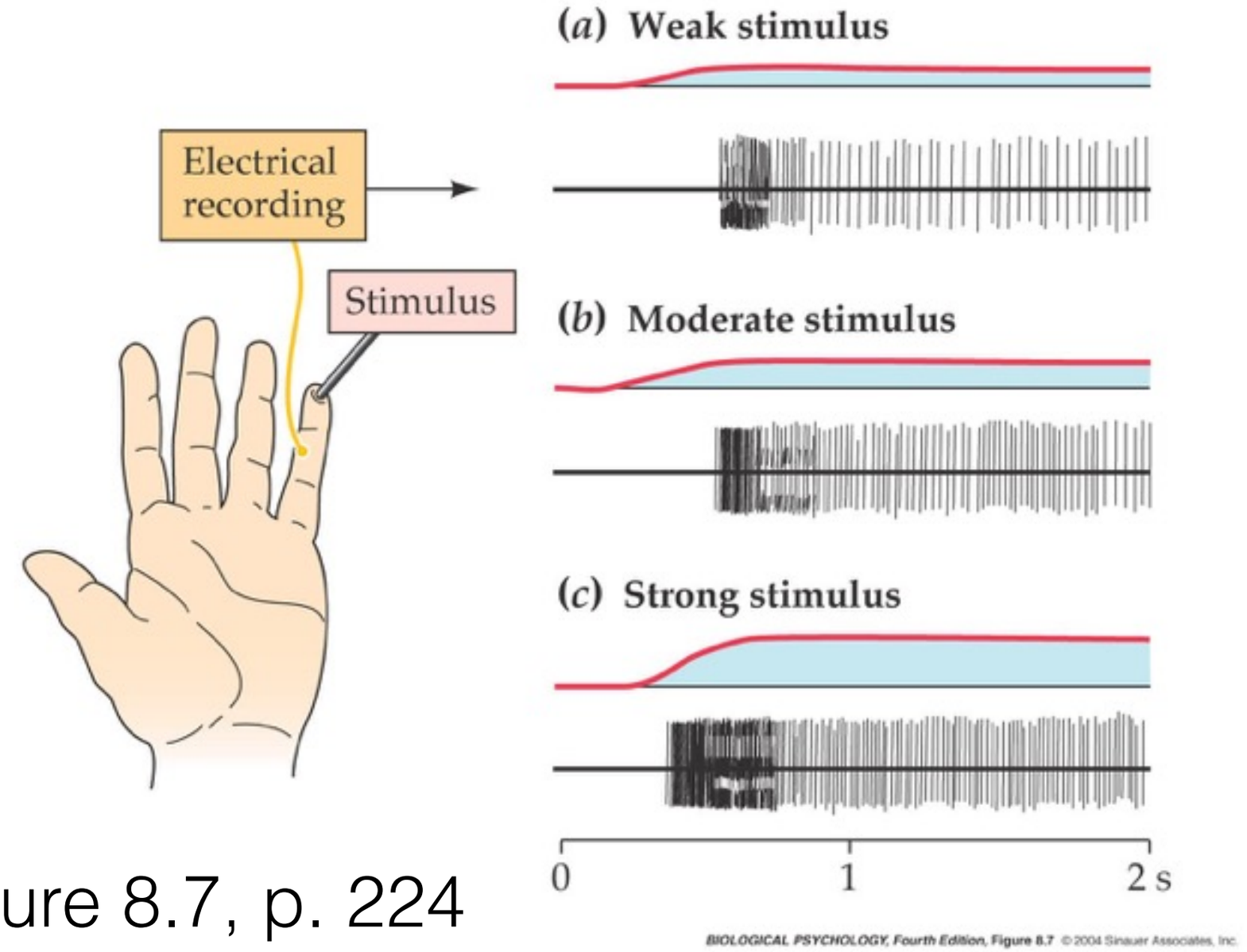


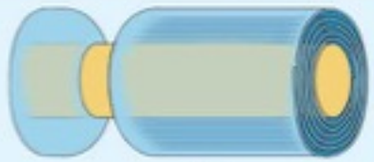
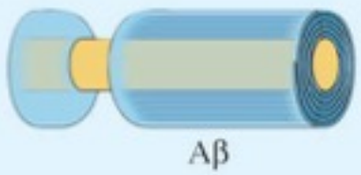

Figure 8.7, p. 224

# Common principles

- Information propagates at different rates

# Why you flinch before saying

**TABLE 8.2** *Fibers That Link Receptors to the CNS*

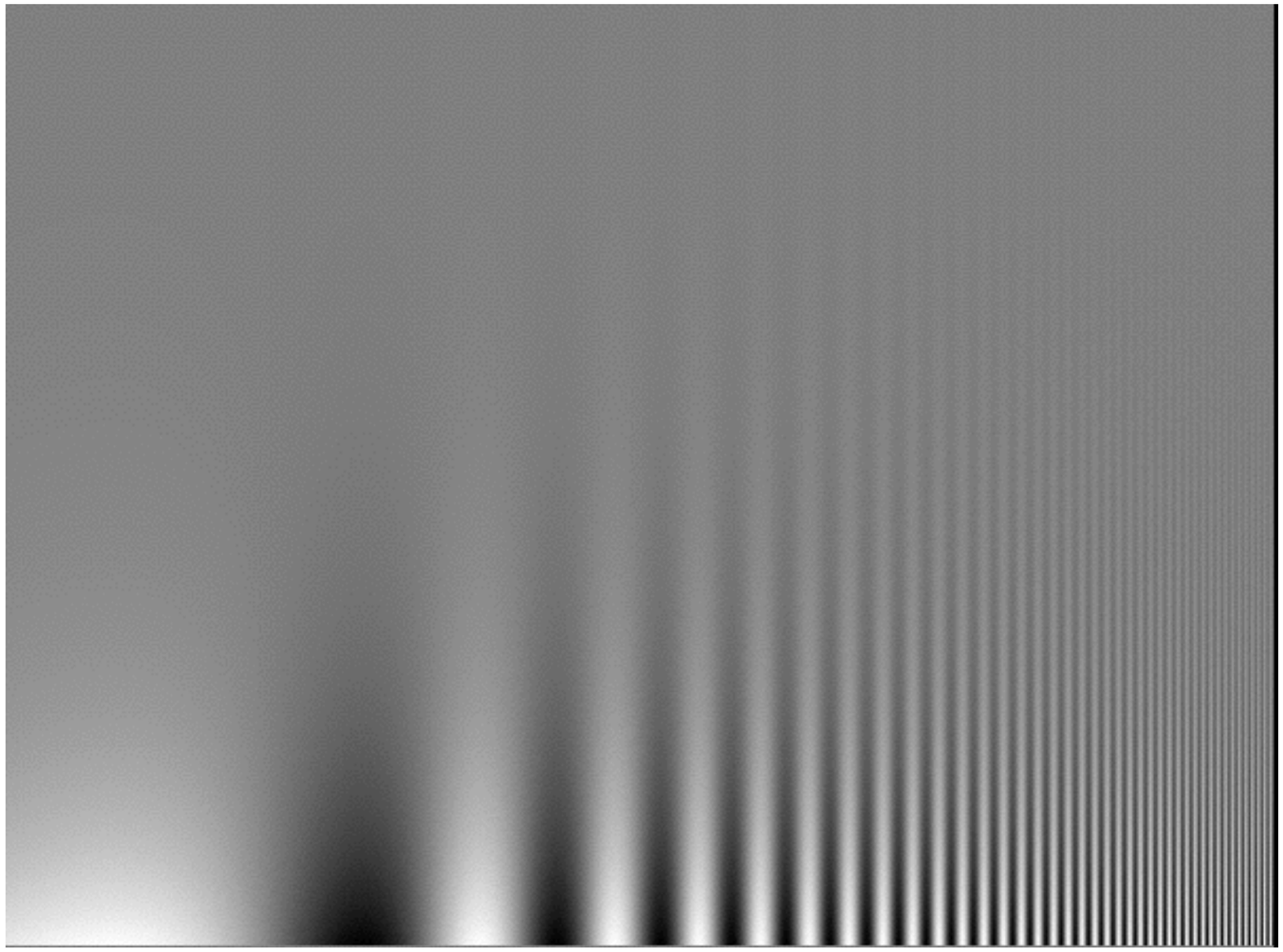
| Sensory function(s) | Receptor type(s) | Axon type | Diameter (μm) | Conduction speed (m/s) |
|---|---|---|---|---|
| Proprioception (see Chapter 11) | Muscle spindle |  Aα | 13–20 | 80–120 |
| Touch (see Figures 8.12 and 8.13) | Pacinian corpuscle, Ruffini's ending, Merkel's disc, Meissner's corpuscle |  Aβ | 6–12 | 35–75 |
| Pain, temperature | Free nerve endings; VRL1 |  Aδ | 1–5 | 5–30 |
| Temperature, pain, itch | Free nerve endings; VR1, CMR1 |  C | 0.02–1.5 | 0.5–2 |

*BIOLOGICAL PSYCHOLOGY, Fourth Edition,* Table 8.2 

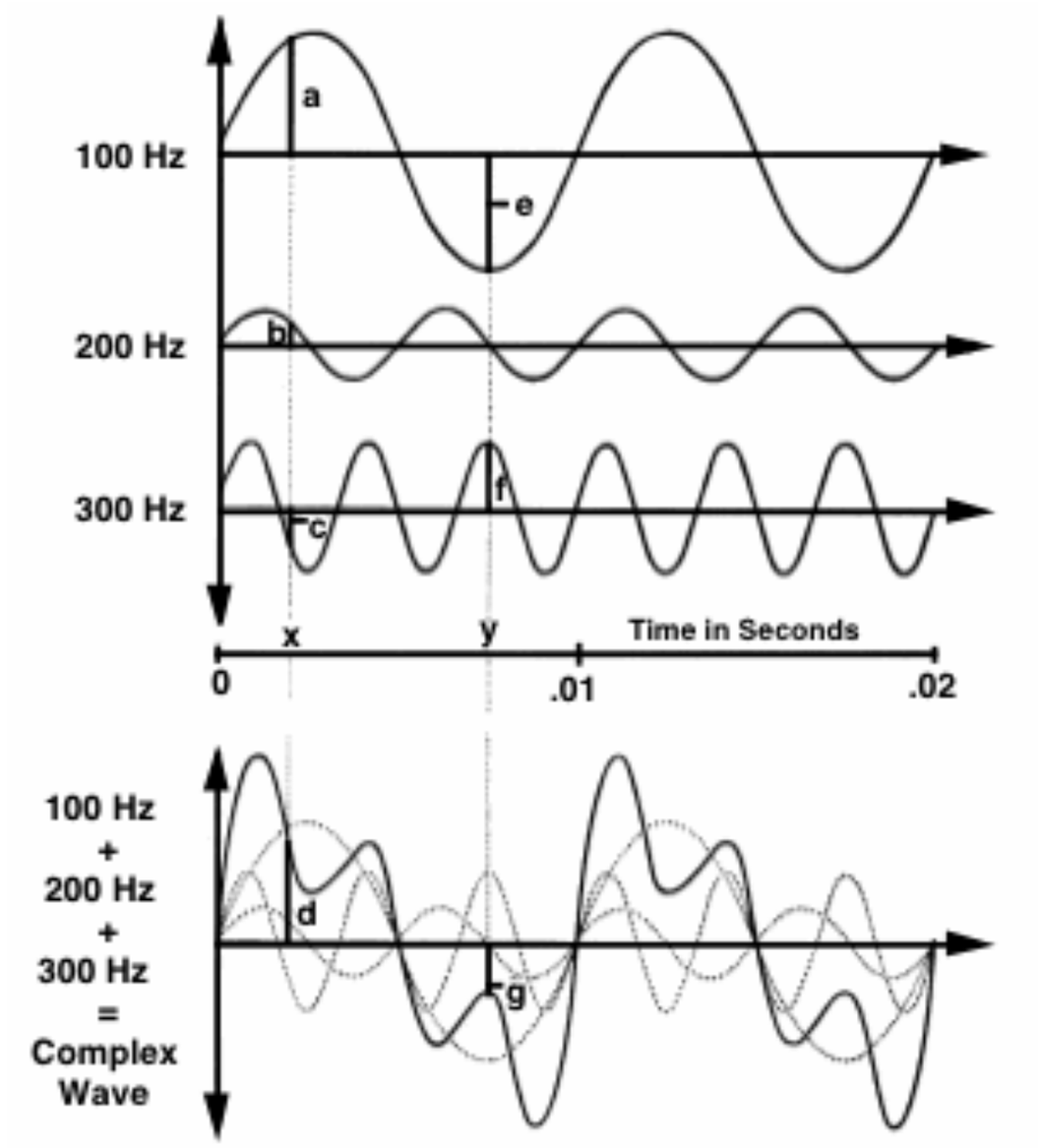
# Common principles

- Repeating patterns (spatial/temporal frequency)

- Triangulating on position (2 sensors)



http://fourier.eng.hmc.edu/e180/lectures/figures/csf_image.gif

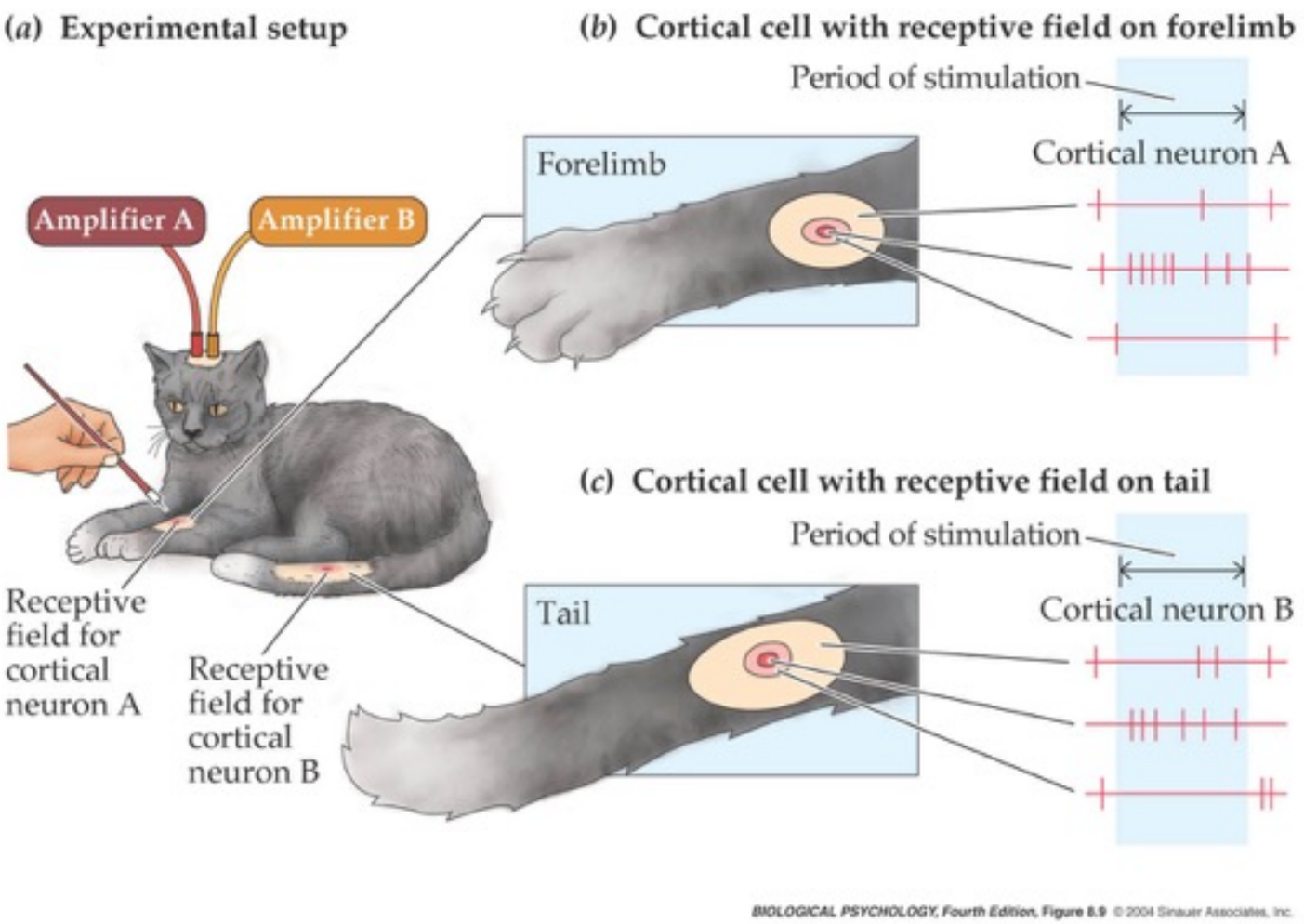



http://hearinghealthmatters.org/waynesworld/files/2012/06/Fourier-Analysis.gif

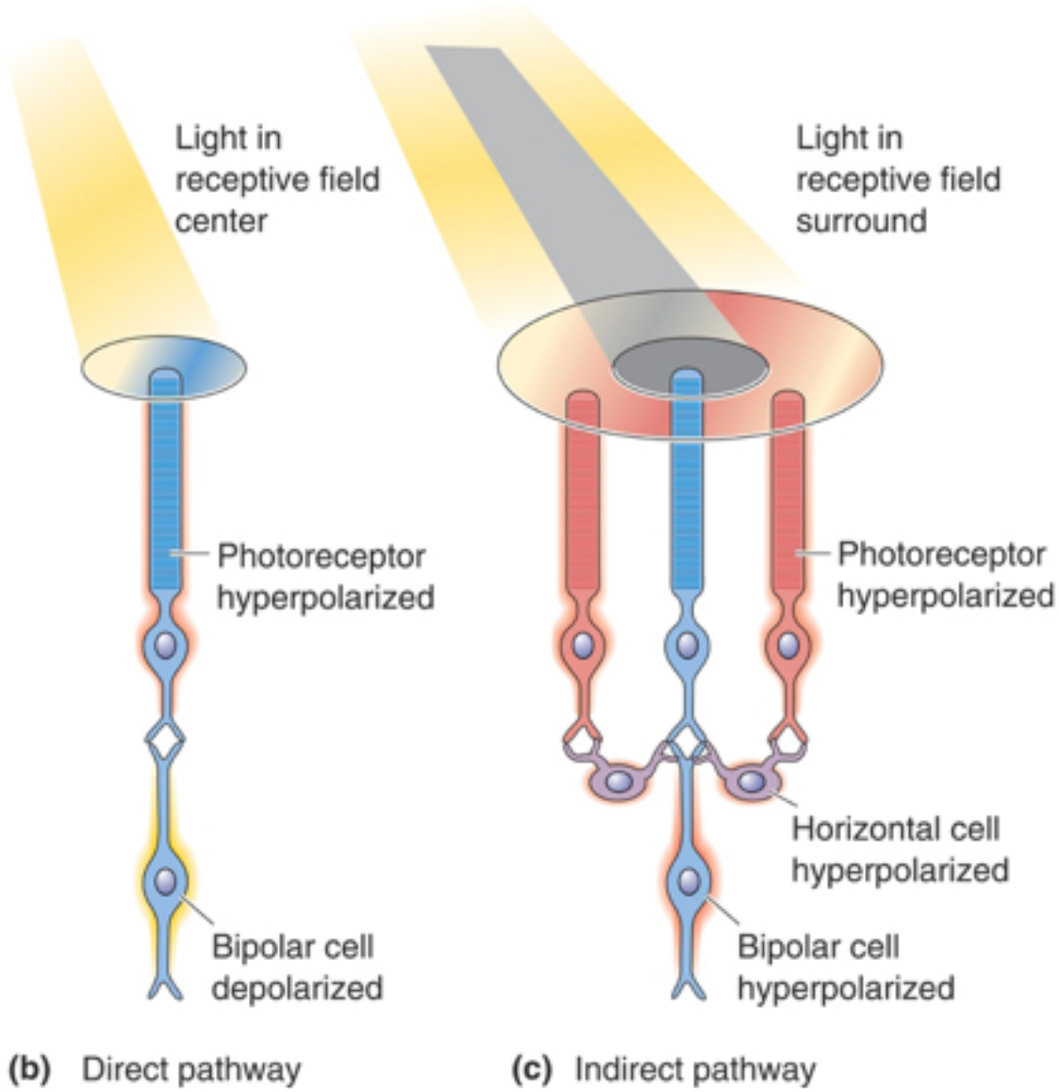
# Common principles

- Receptive fields

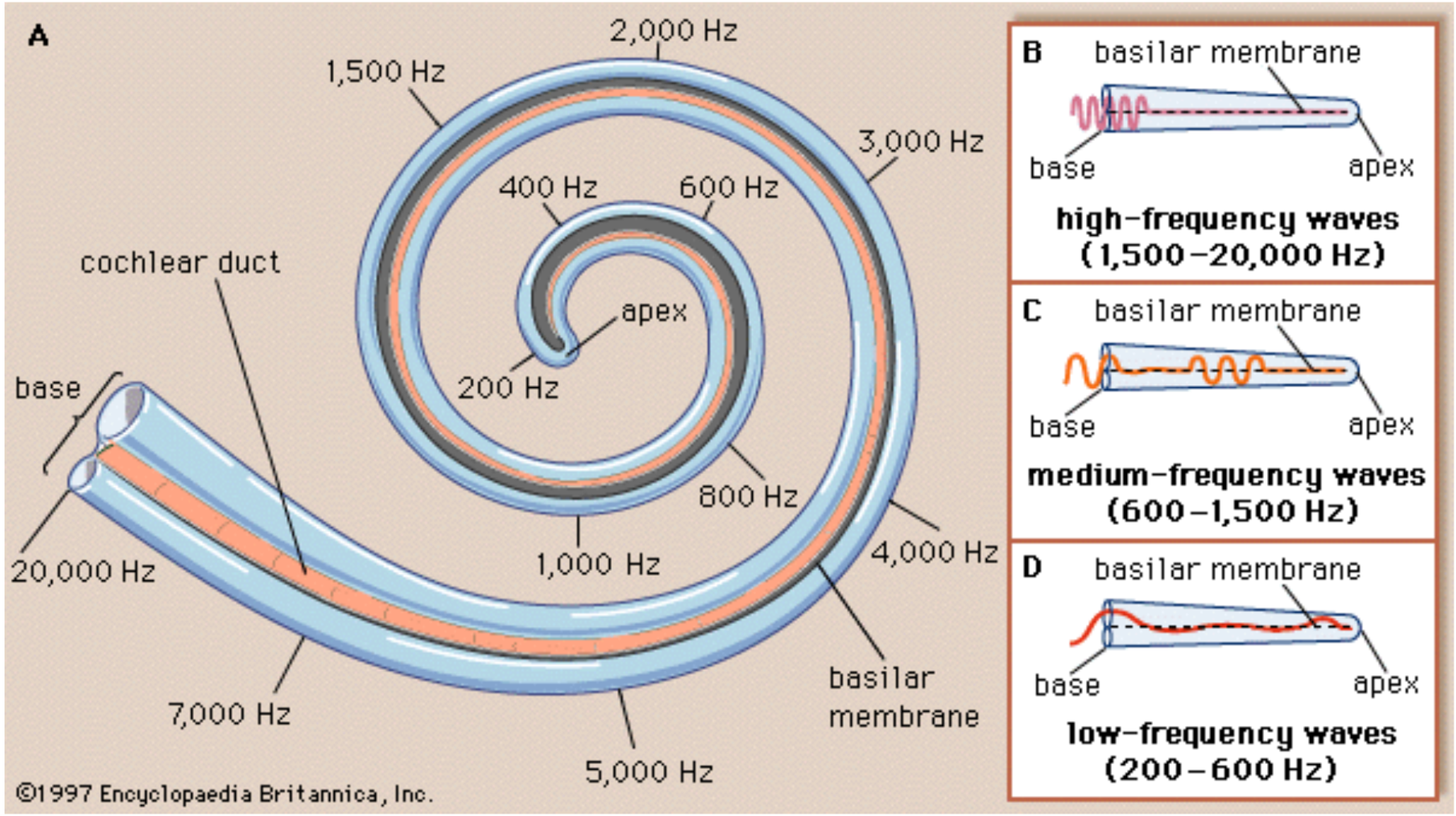
- Area on sensory surface that changes neural activity




BIOLOGICAL PSYCHOLOGY, Fourth Edition, Figure 8.9 © 2004 Sinauer Associates, Inc.




https://classconnection.s3.amazonaws.com/594/flashcards/1450594/png/untitled_picture5135603599642 8.png

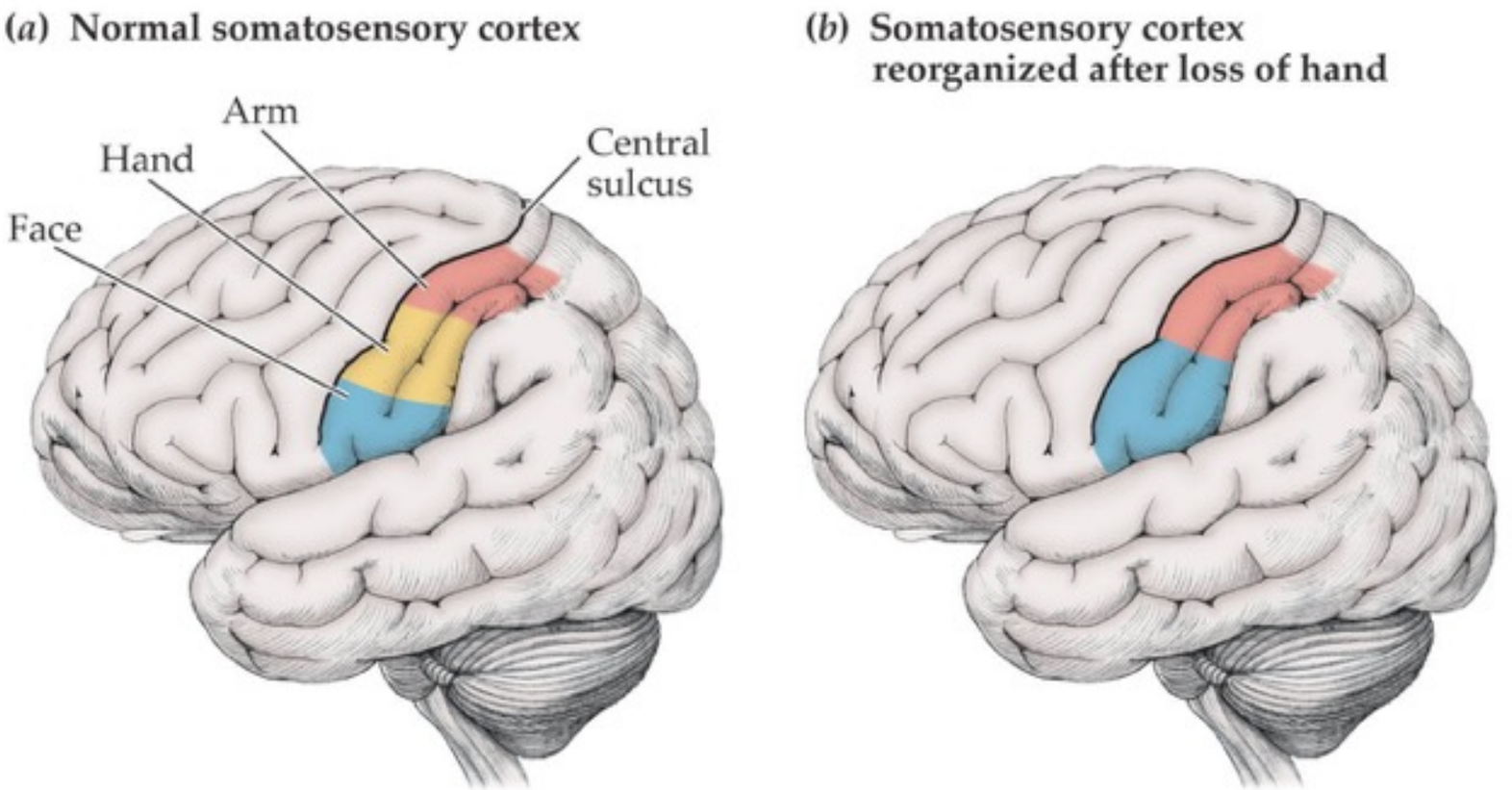



http://3.bp.blogspot.com/-gAio3iTtgMw/TW23AytUzMI/AAAAAAAAADE/MqfWBPo1ZxU/s1600/14298-004-99934987.gif

# Common principles

- Topographic maps

# Sensory maps in cortex

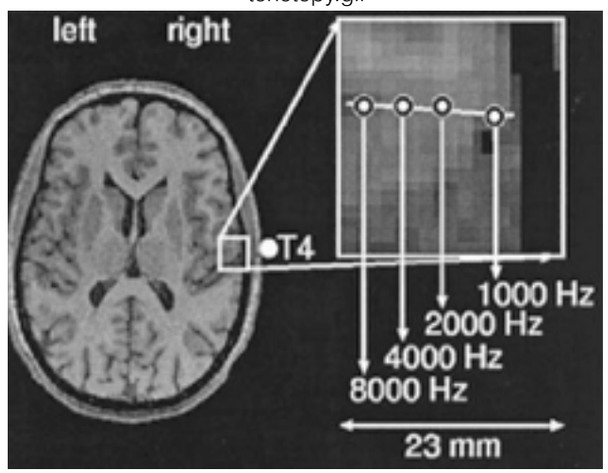


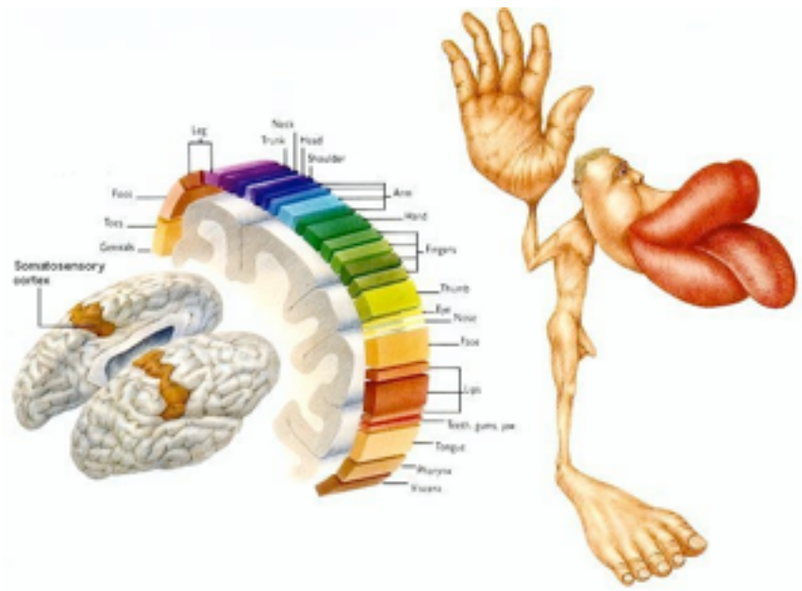

*BIOLOGICAL PSYCHOLOGY, Fourth Edition*, Figure 8.10 

# Topographic maps

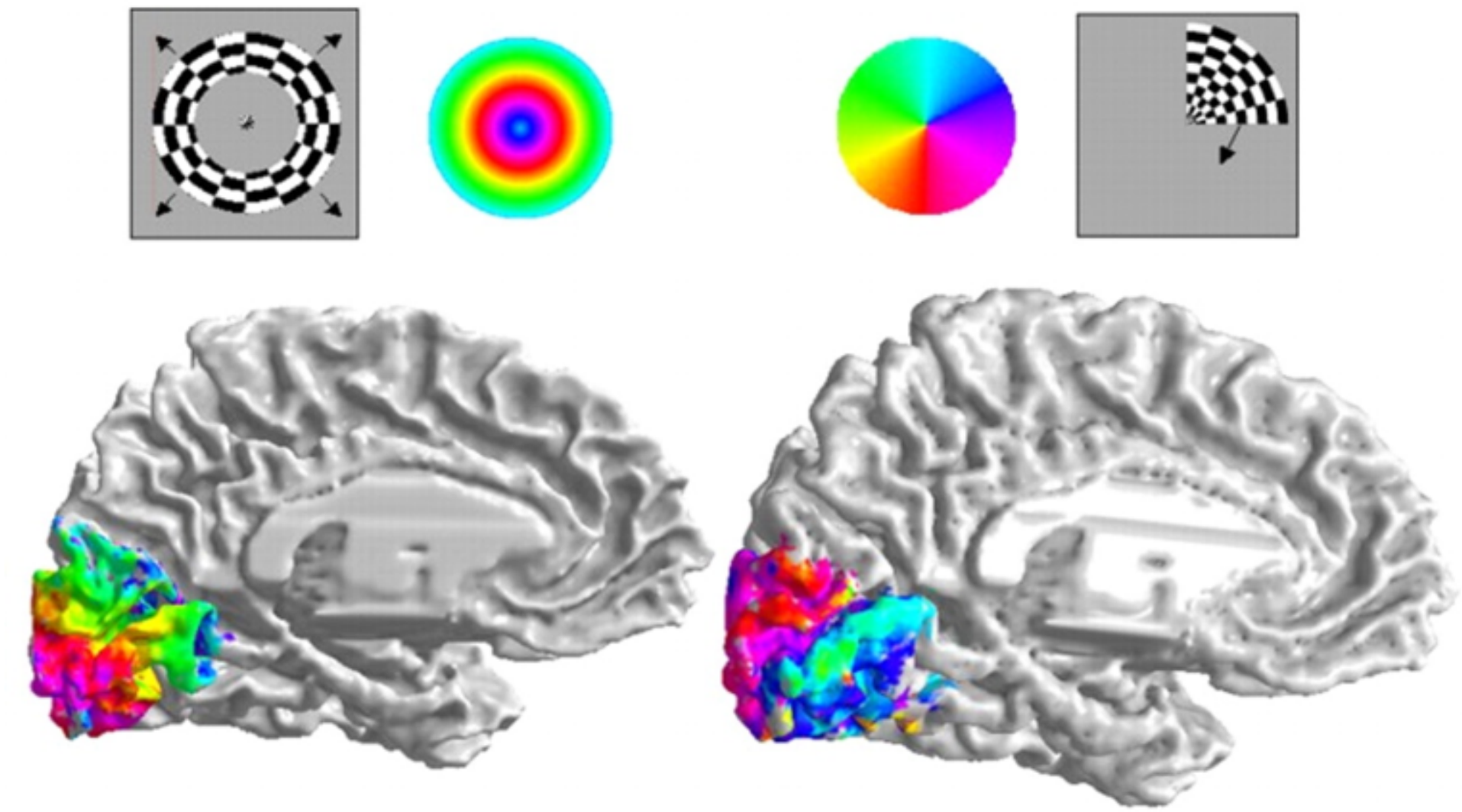
- Retinotopy
- Tonotopy
- Somatotopy
  - Somatosensory
  - Motor
- Chemo?
- Place fields?

http://www.his.kanazawa-it.ac.jp/~tomi/public/MEGLab/Auditory/tonotopy.gif




http://universe-review.ca/I10-13-homunculus.jpg



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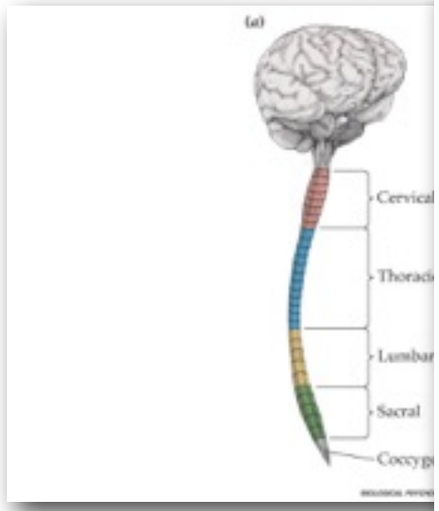
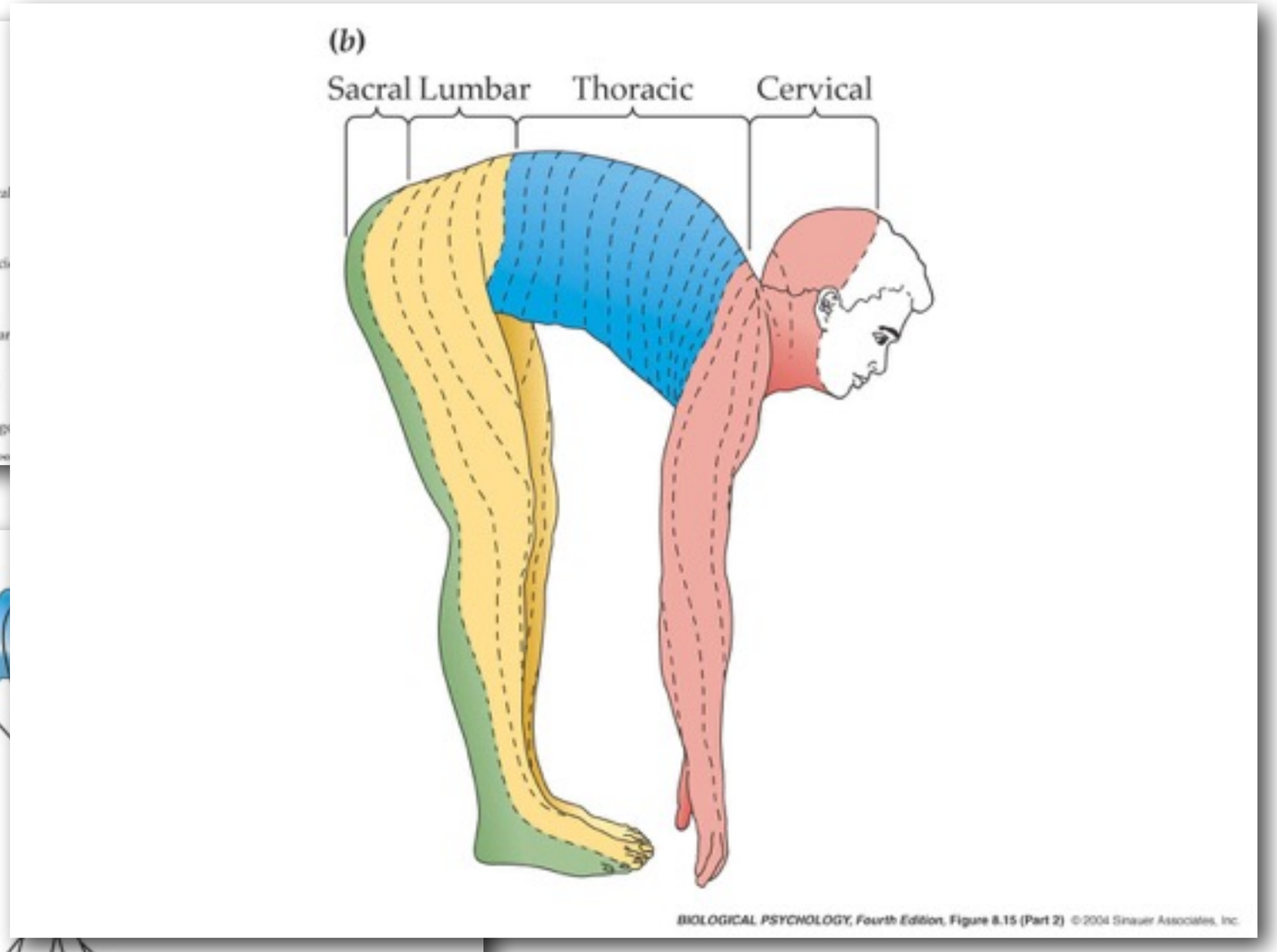
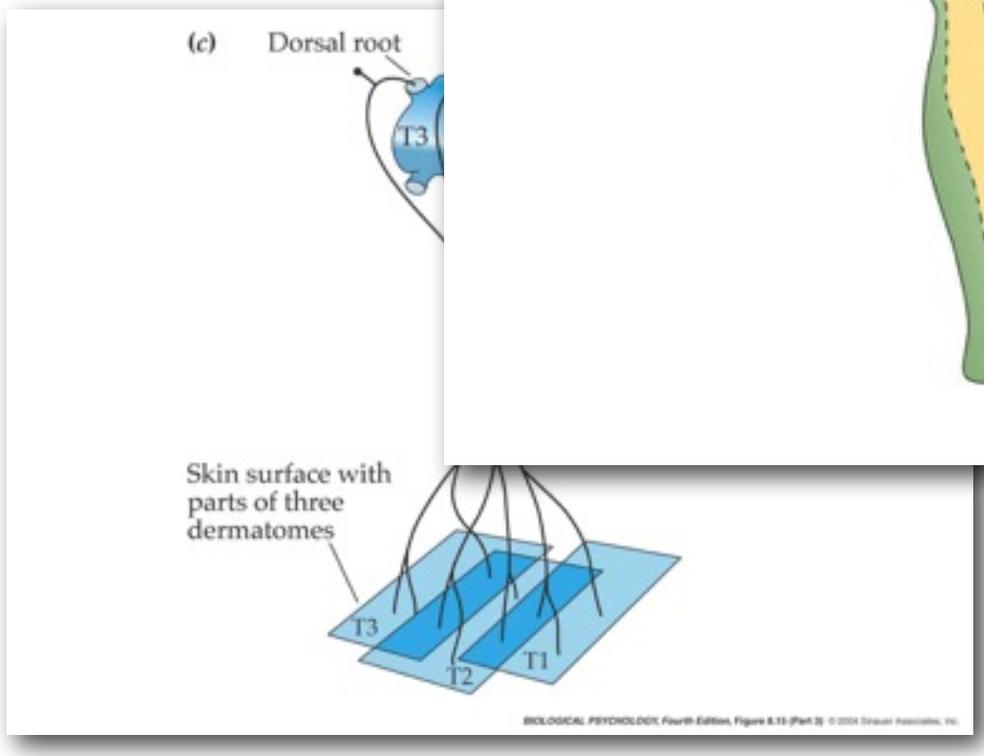

(a)
Cervical
Thoracic
Lumbar
Sacral
Coccygeal


(b)
Sacral Lumbar
Thoracic
Cervical
BIOLOGICAL PSYCHOLOGY, Fourth Edition, Figure 8.15 (Part 2) © 2004 Sinauer Associates, Inc.


(c)
Dorsal root
T3
Skin surface with parts of three dermatomes
T3
T2
T1

(a)

(b)

Sacral Lumbar Thoracic Cervical

(c)

Dorsal root

Segment of spinal cord

T3 T2 T1

First thoracic ventral root

Peripheral nerve

Skin surface with parts of three dermatomes

T3

T2

T1

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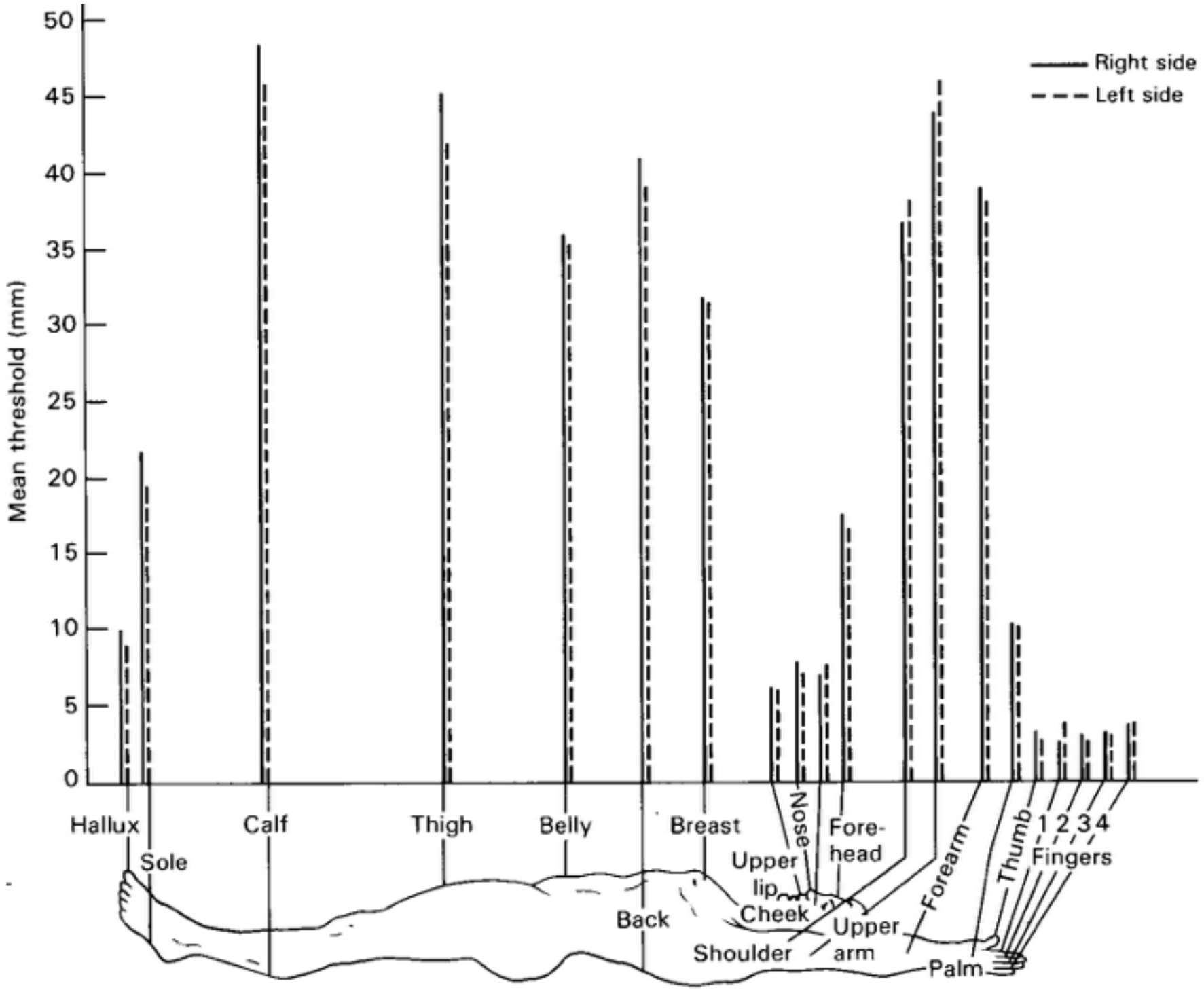
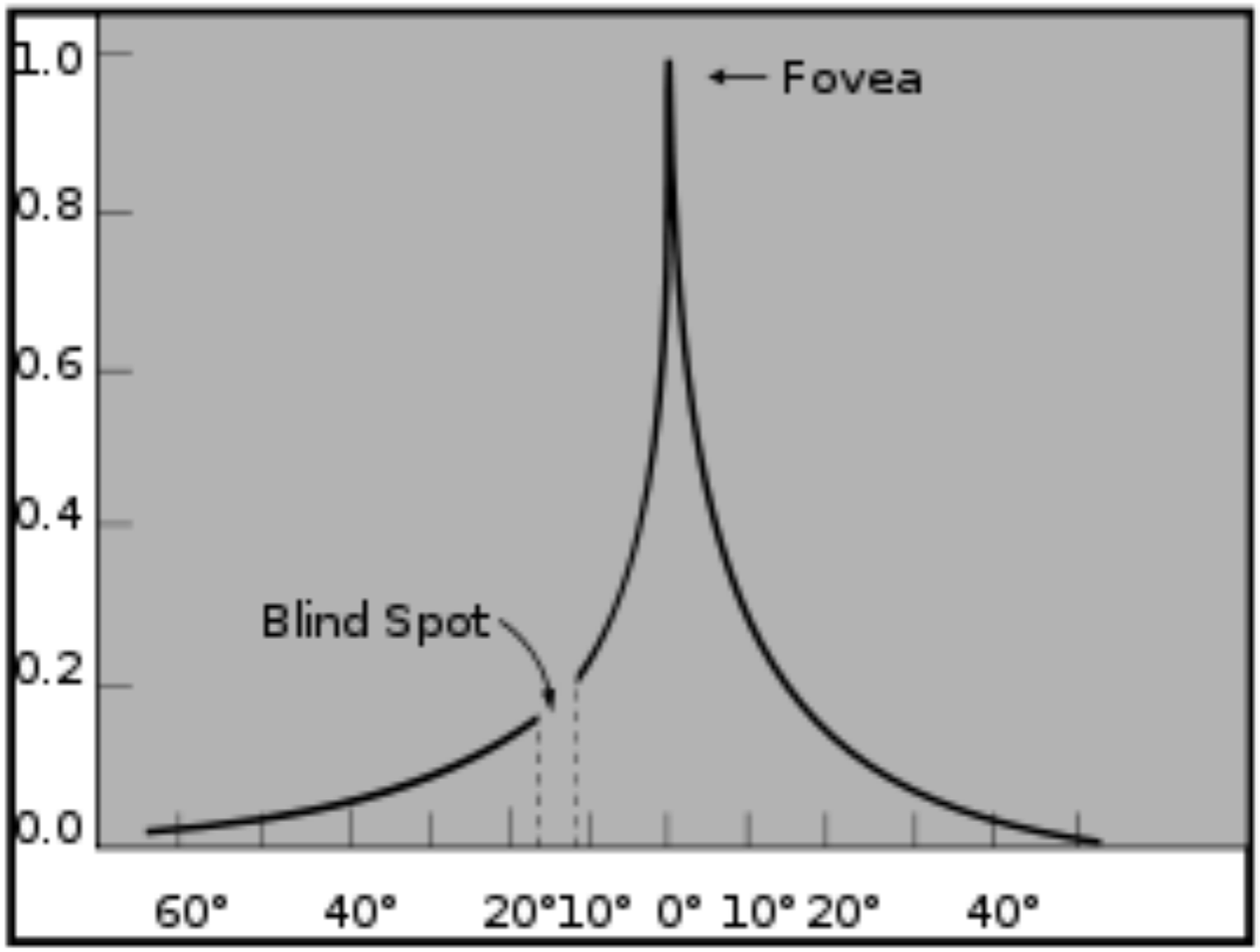
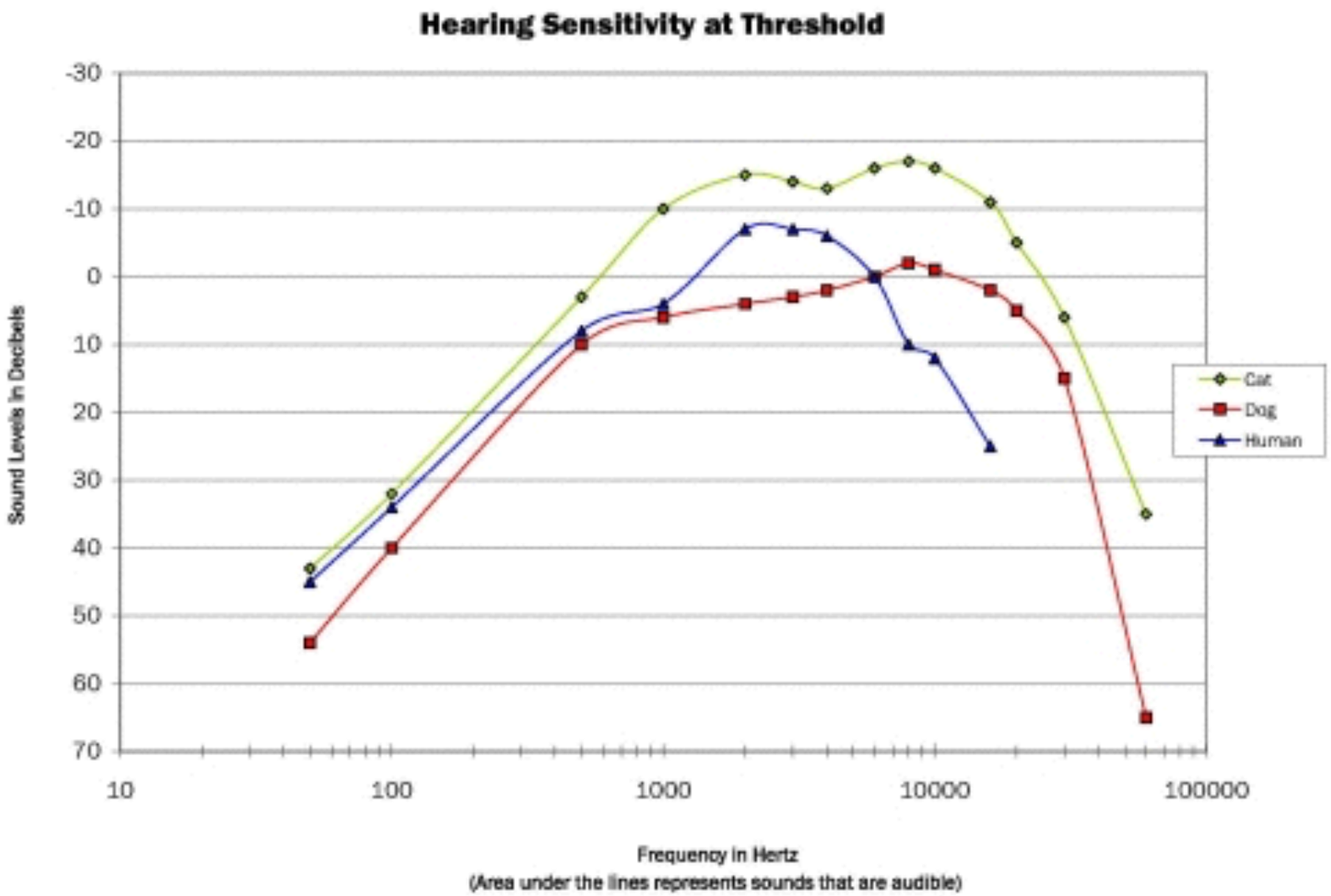
# Common principles

- Sensitivity non-uniform


Mean threshold (mm)
50
45
40
35
30
25
20
15
10
5
0
Right side
Left side
Hallux
Sole
Calf
Thigh
Belly
Breast
Back
Nose
Upper lip
Cheek
Fore-head
Shoulder
Upper arm
Forearm
Thumb
1 2 3 4
Fingers
Palm



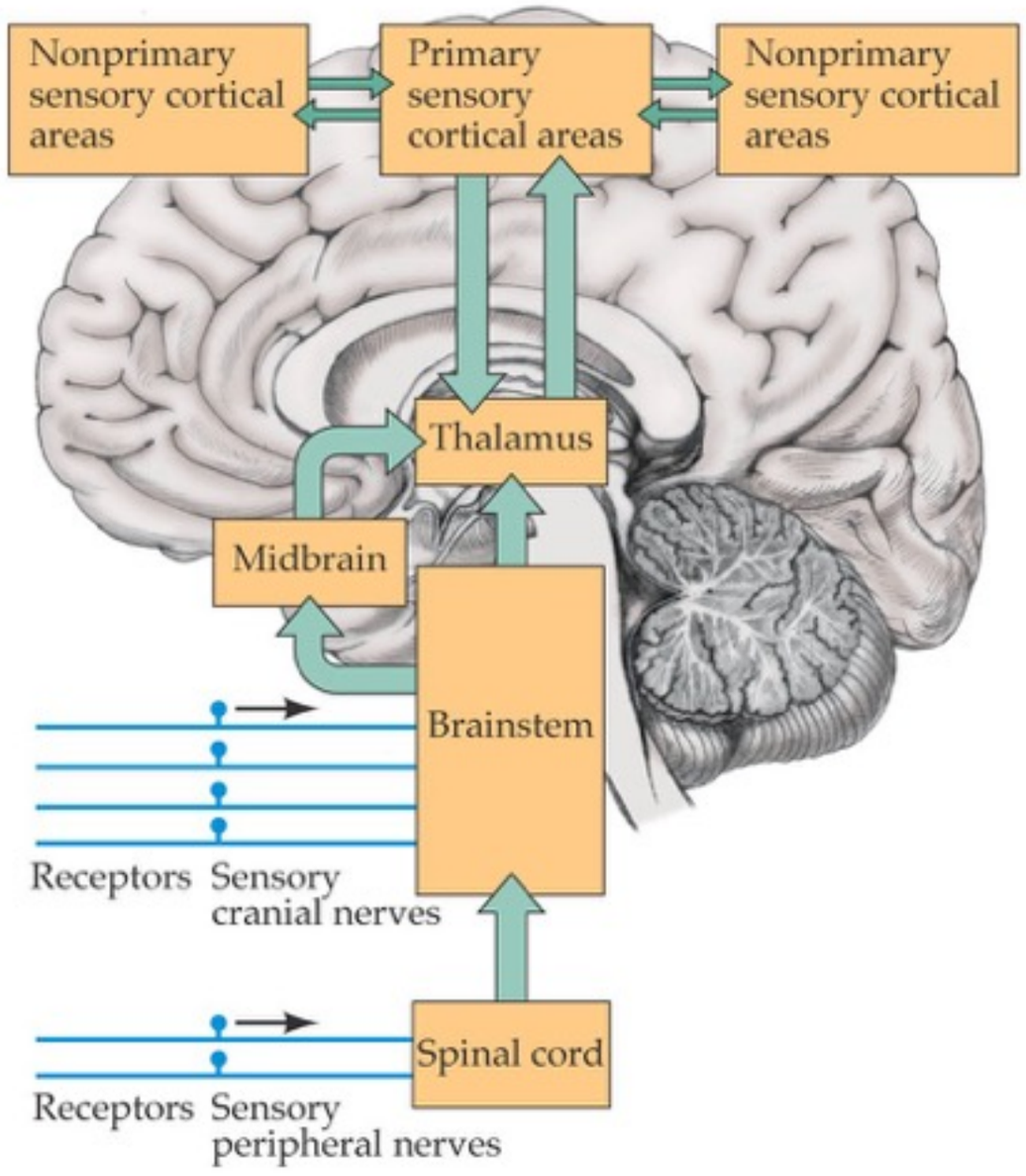

https://upload.wikimedia.org/wikipedia/commons/thumb/2/27/AcuityHumanEye.svg/270px-AcuityHumanEye.svg.png




http://www.hearforever.org/userfiles/image/tools_to_learn/SS4_Hearing_Sensitivity.jpg

# Parallel processing

- Receptors
- Brainstem
- Thalamus
- Cerebral cortex

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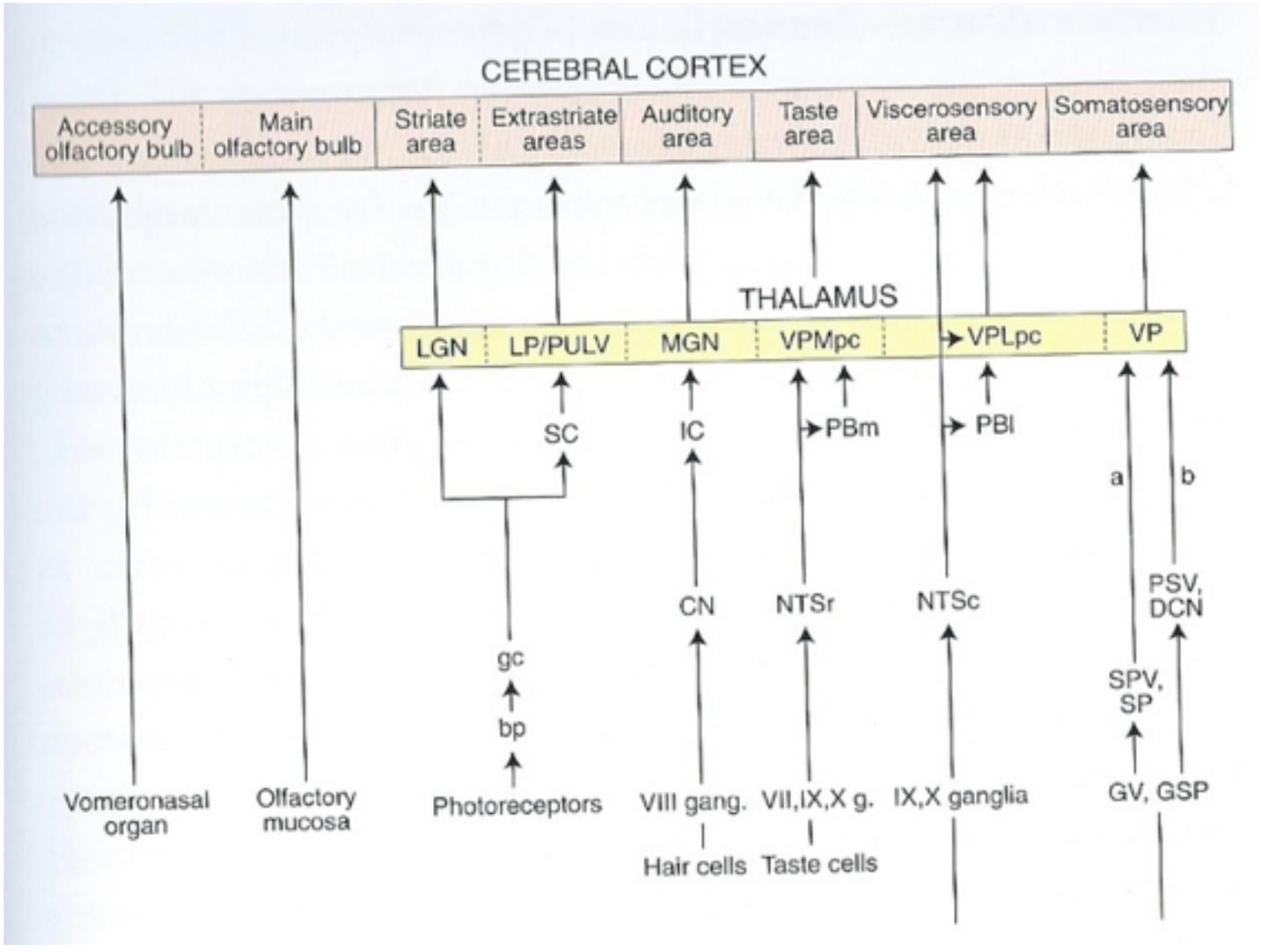
CEREBRAL CORTEX
Accessory olfactory bulb
Main olfactory bulb
Striate area
Extrastriate areas
Auditory area
Taste area
Viscerosensory area
Somatosensory area
THALAMUS
LGN
LP/PULV
MGN
VPMpc
VPLpc
VP
SC
IC
PBm
PBl
a
b
CN
NTSr
NTSc
PSV, DCN
SPV, SP
gc
bp
Vomeronasal organ
Olfactory mucosa
Photoreceptors
VIII gang.
VII,IX,X g.
IX,X ganglia
GV, GSP
Hair cells
Taste cells

Swanson 11.4