260-2017-10-30-sensation

Rick Gilmore

2017-10-30 08:18:01

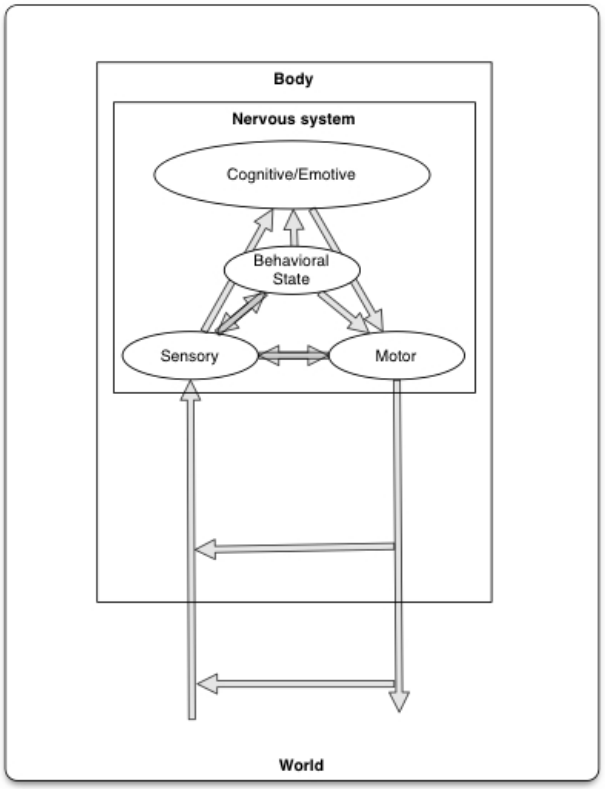
Prelude

THE WHO - See Me, Feel Me - Listening to You (1975)

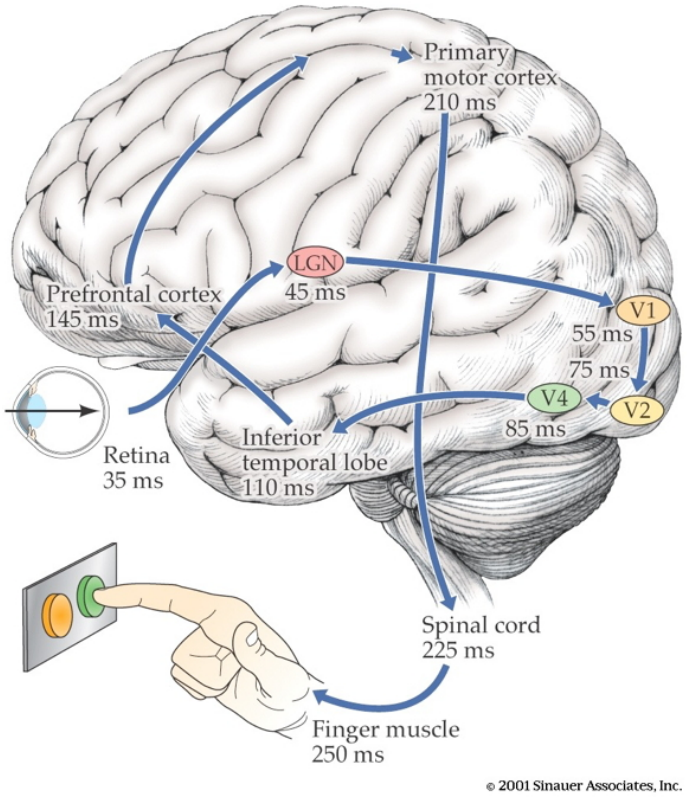
Today's Topics

- Sensory systems

Sensation/Cognition/Action



From sensation to action



Systems/information processing view

- Input
- Processing
- Memory
- Output

Let's design the Galaxy 20/iPhone XX

- What information do your users need to acquire?
- Why do they need to know it? In what context, for what purpose?
- What do they need to know about it?
- What types of information does your device need to gather, through which channels?

You vs. Your Smartphone

Multisensory processing in a smartphone

- Accelerometer
- Gyroscope
- Magnetometer
- Proximity sensor
- Ambient light sensor
- Barometer

http://www.phonearena.com/news/Did-you-know-how-many-different-kinds-of-sensors-go-inside-a-smartphone_id57885

Multisensory processing in a smartphone

- Thermometer
- Mic
- Camera
- Radios (Bluetooth, wifi, cellular, GPS)

http://www.phonearena.com/news/Did-you-know-how-many-different-kinds-of-sensors-go-inside-a-smartphone_id57885

Dimensions of sensory processing

- *Interoceptive*
  - How am I?
- *Exteroceptive*
  - What's in the world, where is it?

Questions for interoception

- Tired or rested?
- Well or ill?
- Hungry or thirsty or sated?
- Stressed vs. coping?
- Emotional state?

Questions for exteroception

- Who/What is out there?
- Where is it?

Who/what

- Animate/inanimate?
- Conspecific (same species)/non?
- Threat/non?
- Familiar/un?
- Mate/non? or Friend/not?
- Food source/non?

Where

- Distance
- Elevation, azimuth
- Coordinate frames
    - Self/ego (left of me)
    - Object (top of object)
    - Allo/world (North of College Ave)
- Where moving?

How

- What kind of response?
  - External
  - Internal
- Approach/avoid/freeze
- Signal/remain silent
- Manipulate

More than 5 senses

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

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From world to brain

- How do events/entitities generate patterns that sensors can detect?
  - Chemical
  - Photic/electromagnetic
  - Mechanical/acoustic

How sensory channels differ

- What is the energy/chemical source
- How does the channel inform
    - What is out there
    - Where it's located

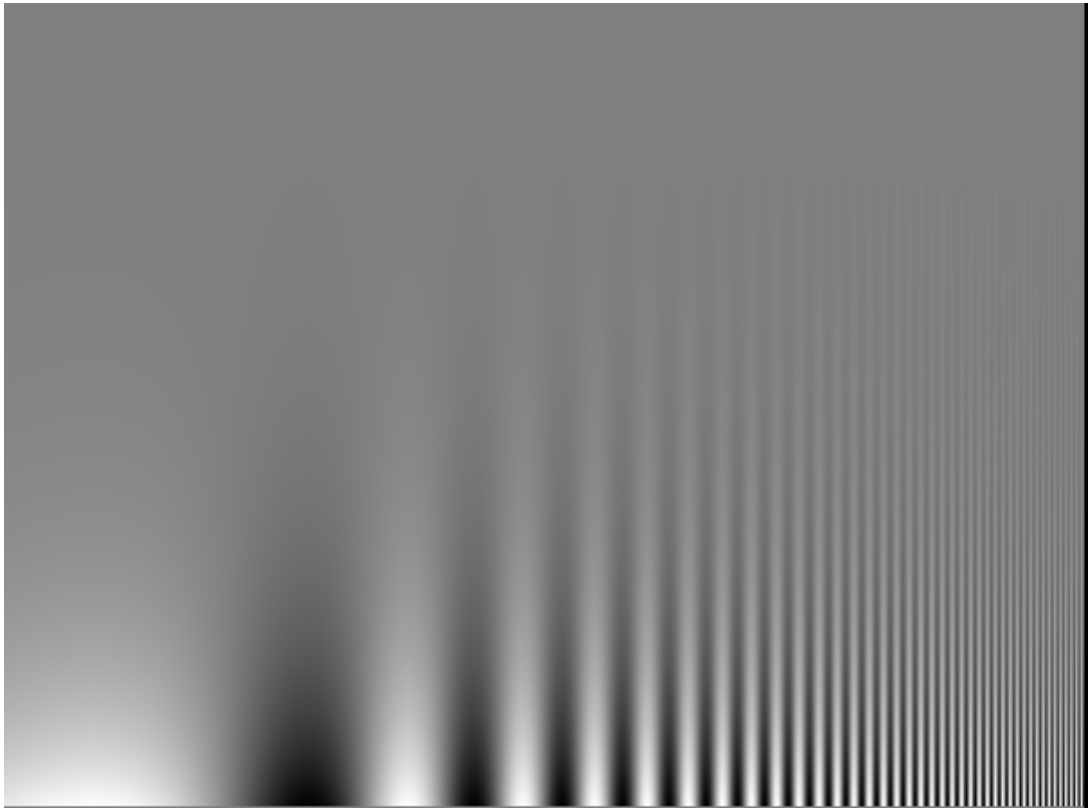
Features of sensory signals

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

Common principles

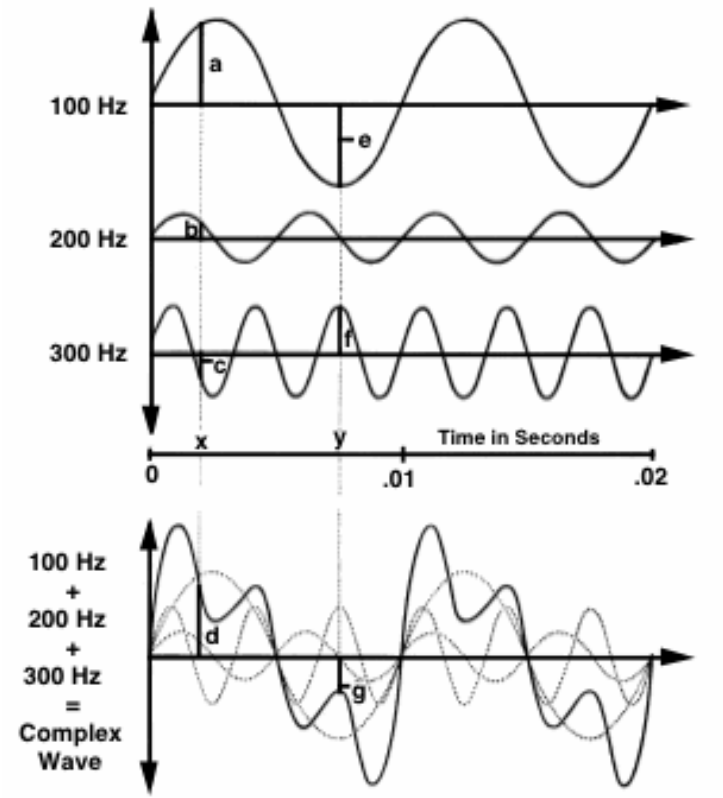
- Sensors detect repeating signals
  - In space (textures)
  - In time

Spatial frequency/contrast sensitivity



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

Frequencies in sound



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

Common principles

- Compare (>1) sensor for each channel
  - Eyes
  - Ears
  - Nostrils
  - Skin surface

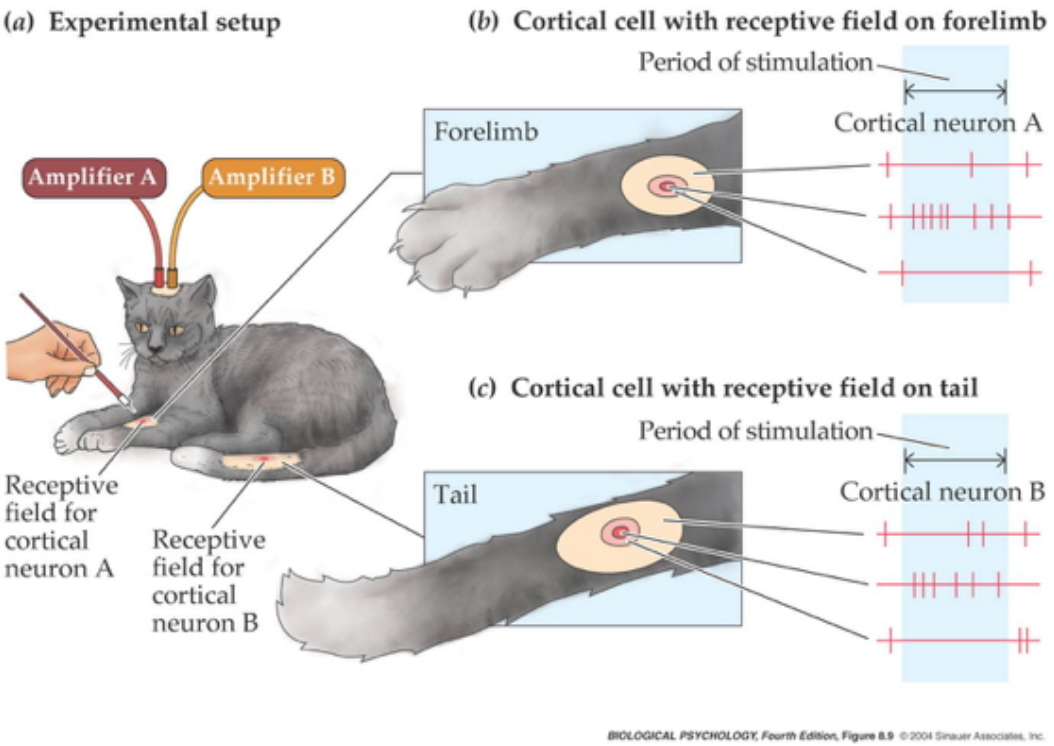
Why is the snake's tongue forked?

http://indianapublicmedia.org/amomentofscience/files/2010/06/tongue_111.jpg

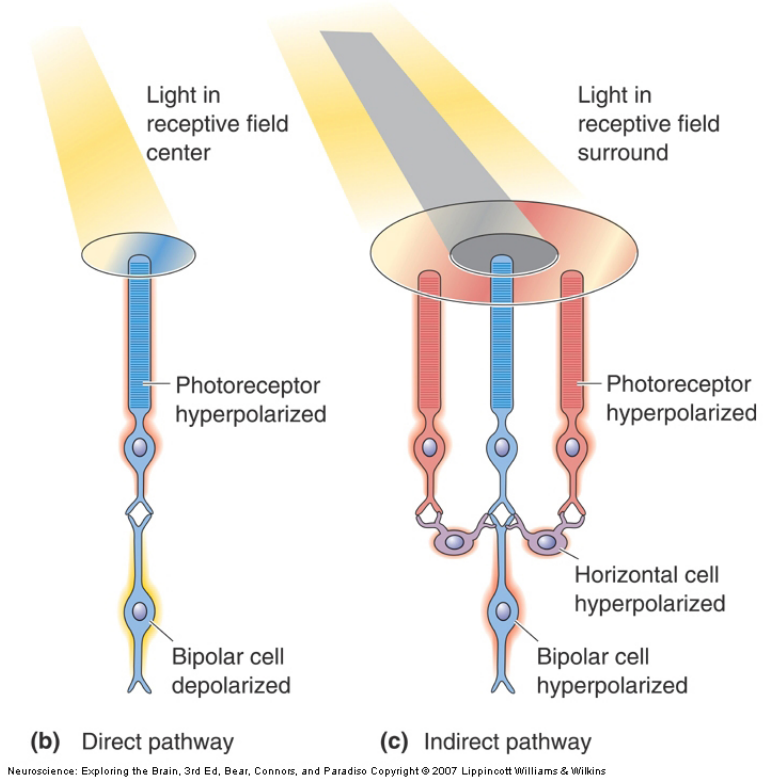
Common principles

- Sensory neurons have "receptive fields"
  - Area on sensory surface that when stimulated changes neuron's firing

Tactile receptive field



Visual receptive field

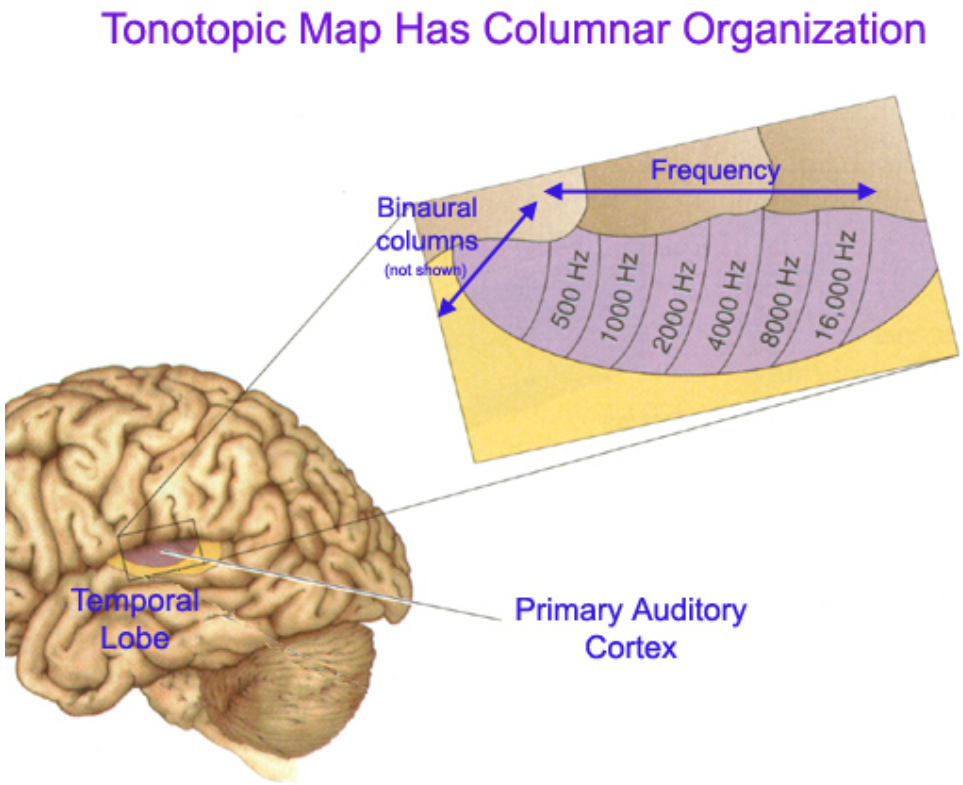


https://classconnection.s3.amazonaws.com/594/flashcards/1450594/png/untitled_picture51356035996428.png

Common Principles

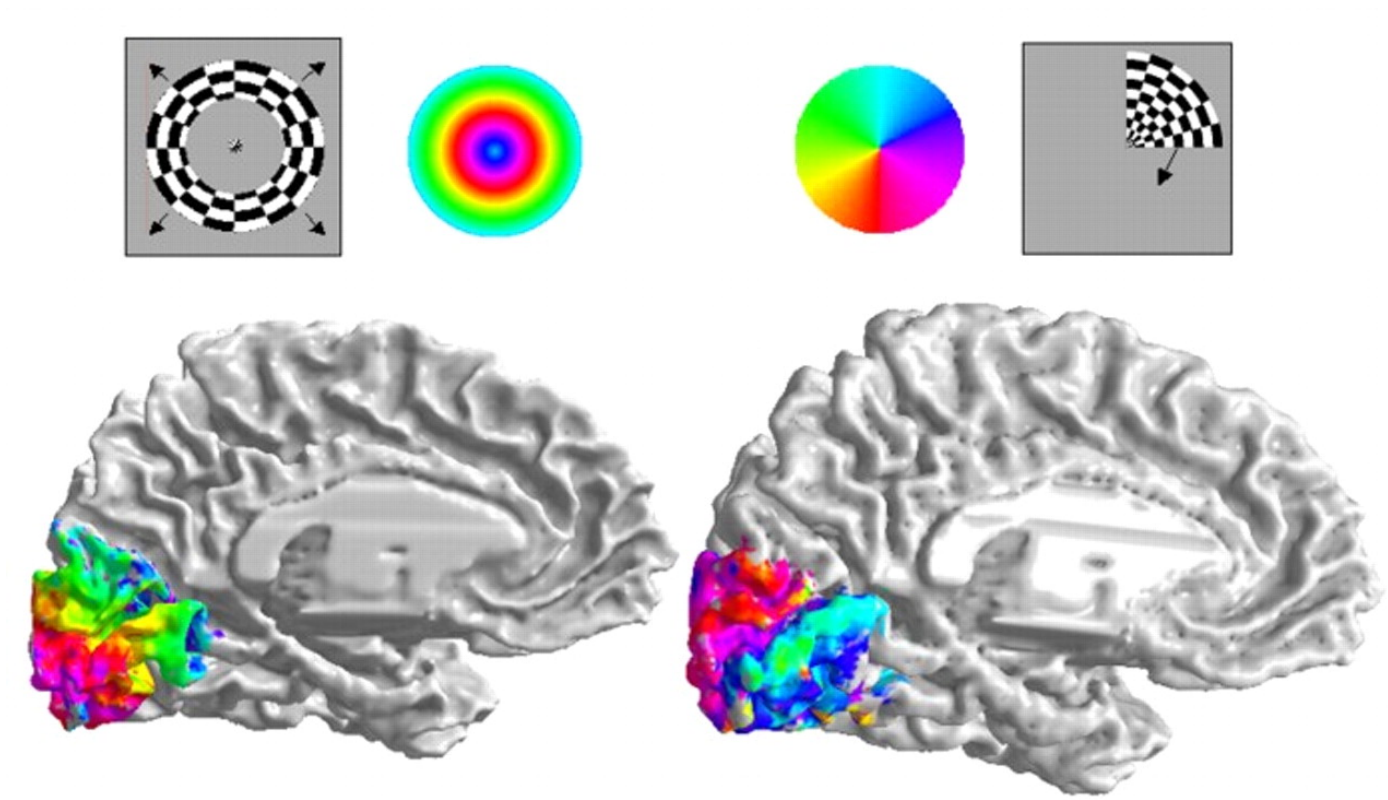
- Topographic maps

Tonotopic (frequency) maps in auditory cortex



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

Retinotopic maps in visual cortex

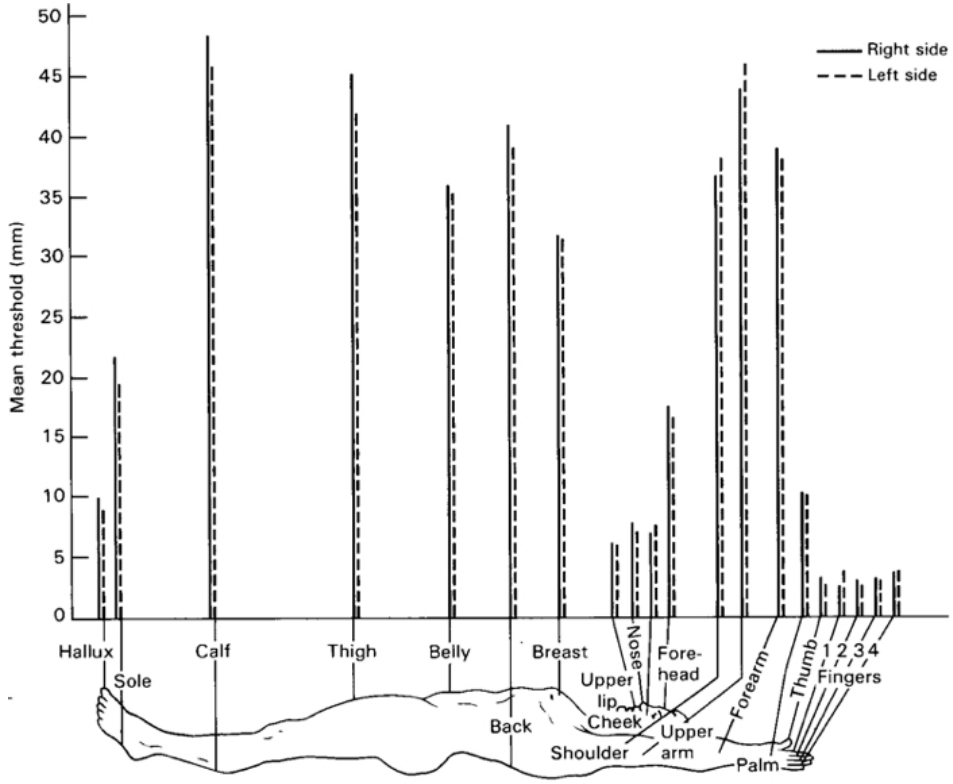


http://jov.arvojournals.org/data/Journals/JOV/933499/jov-3-10-1-fig001.jpeg

Common principles

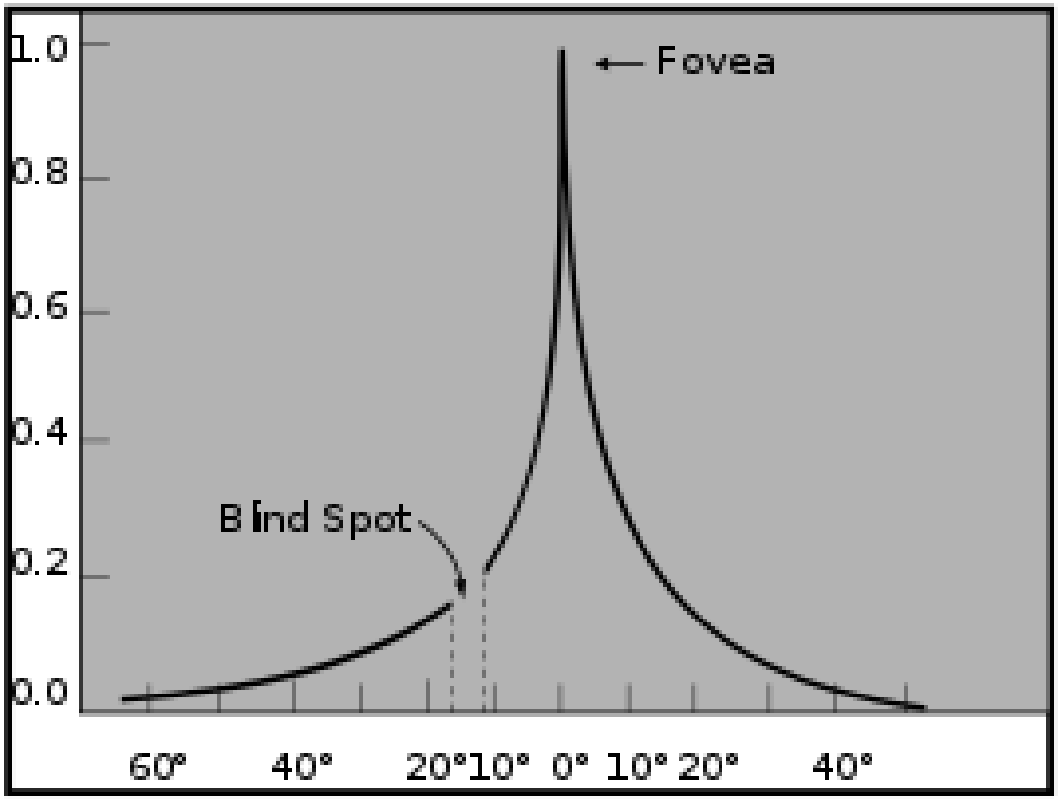
- Non-uniform sensitivity

Two-point touch thresholds



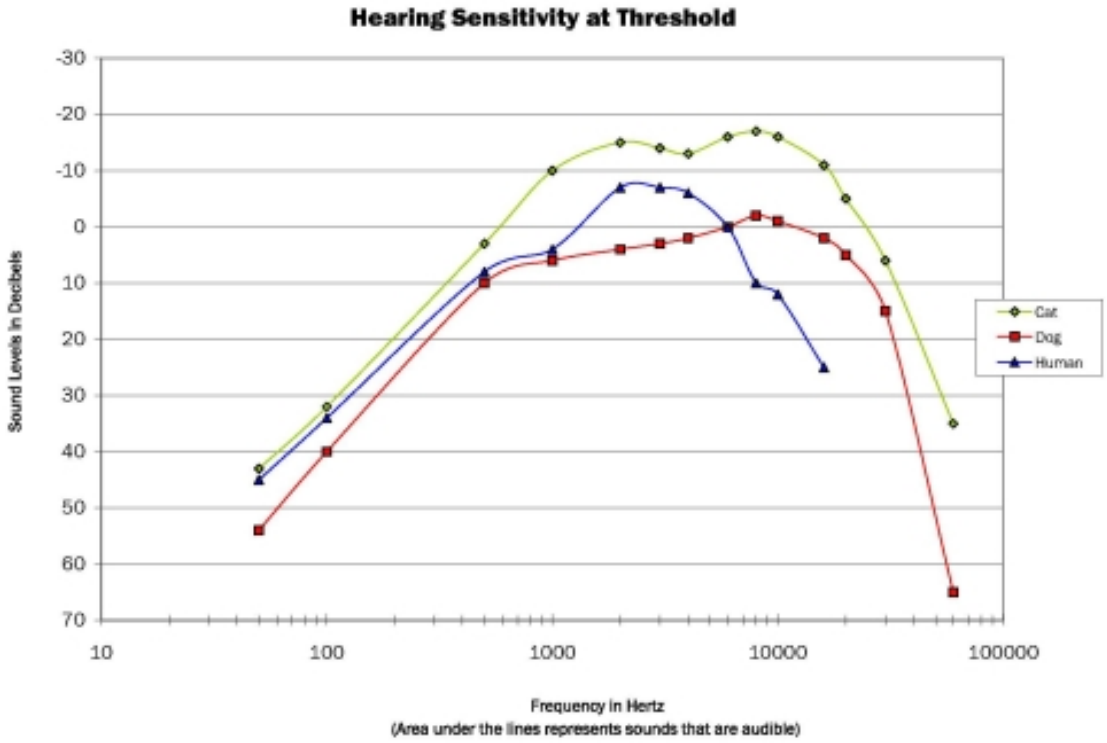
http://jov.arvojournals.org/data/Journals/JOV/933499/jov-3-10-1-fig001.jpeg

Acuity variations across visual field



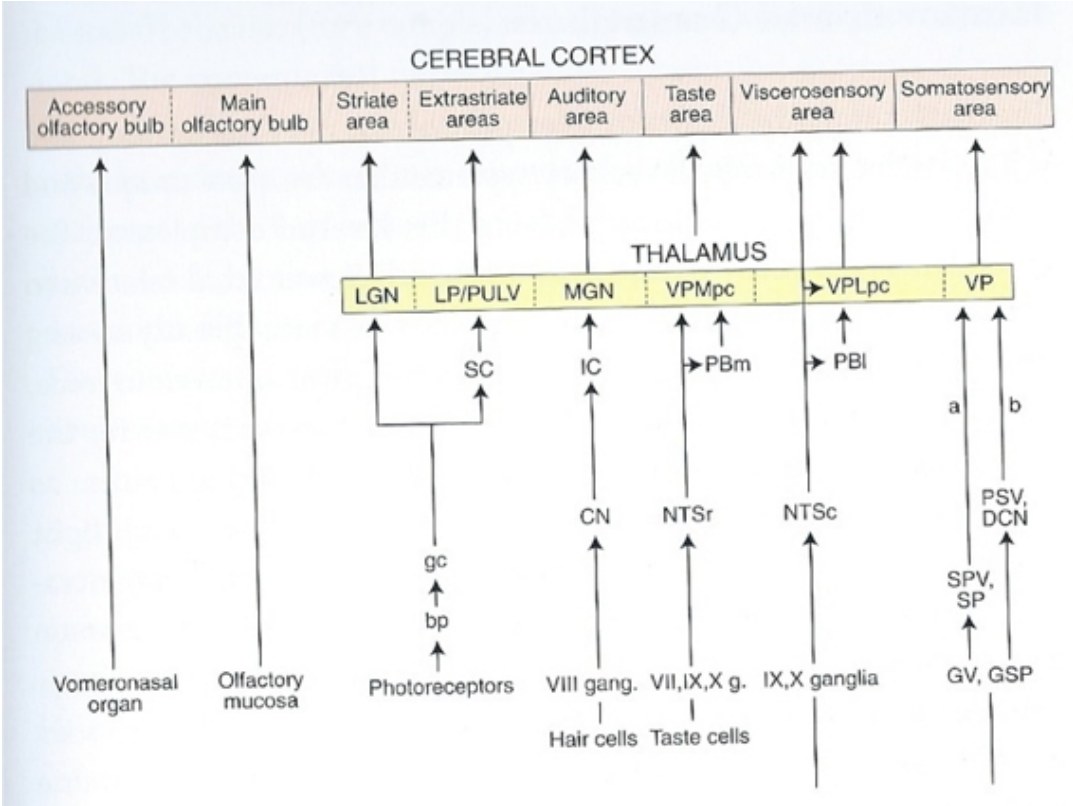
https://upload.wikimedia.org/wikipedia/commons/thumb/2/27/AcuityHumanEye.svg/270px-AcuityHumanEye.svg.png

Hearing threshold varies across frequency

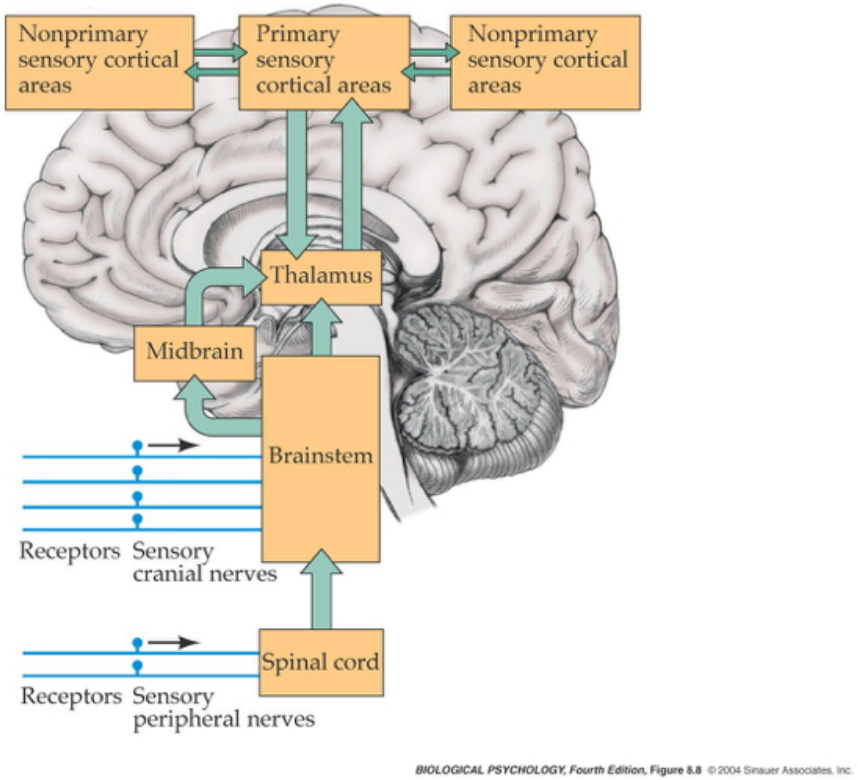


http://www.hearforever.org/userfiles/image/tools_to_learn/SS4_Hearing_Sensitivity.jpg

Hierarchical processing



Parallel processing



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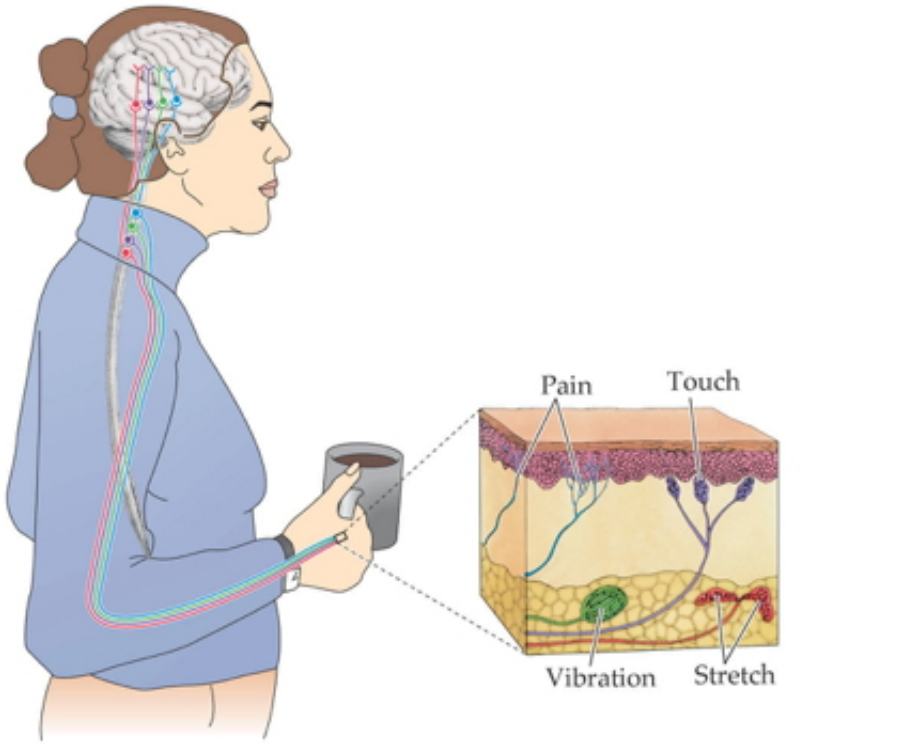
Parallel processing



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Next time…

- Somatosensation