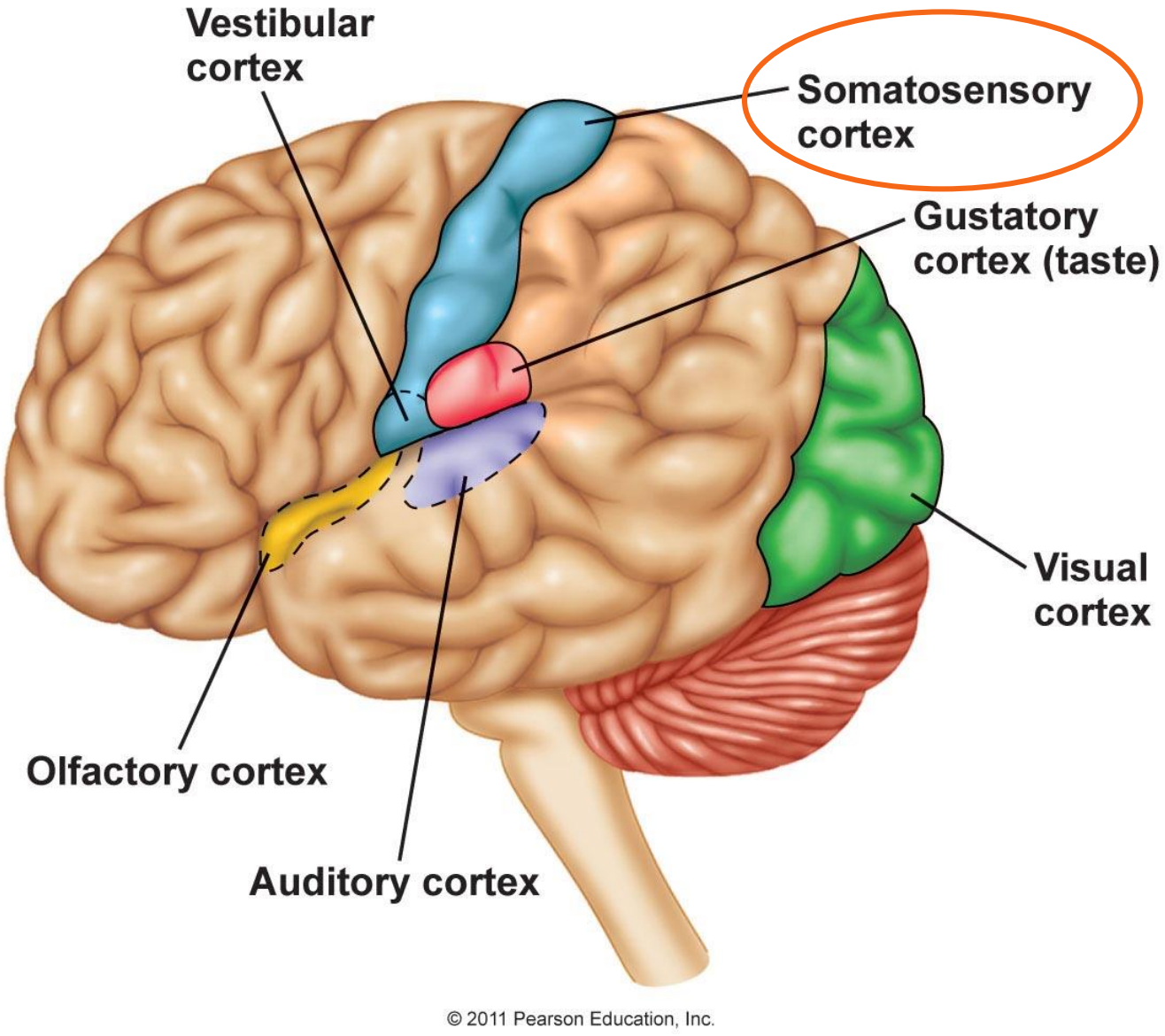
HUMAN SENSES, BRAIN, RECOGNITION, ILLUSIONS

SENSORY PERCEPTION

SENSORY PERCEPTION – BRAIN RESPONSE

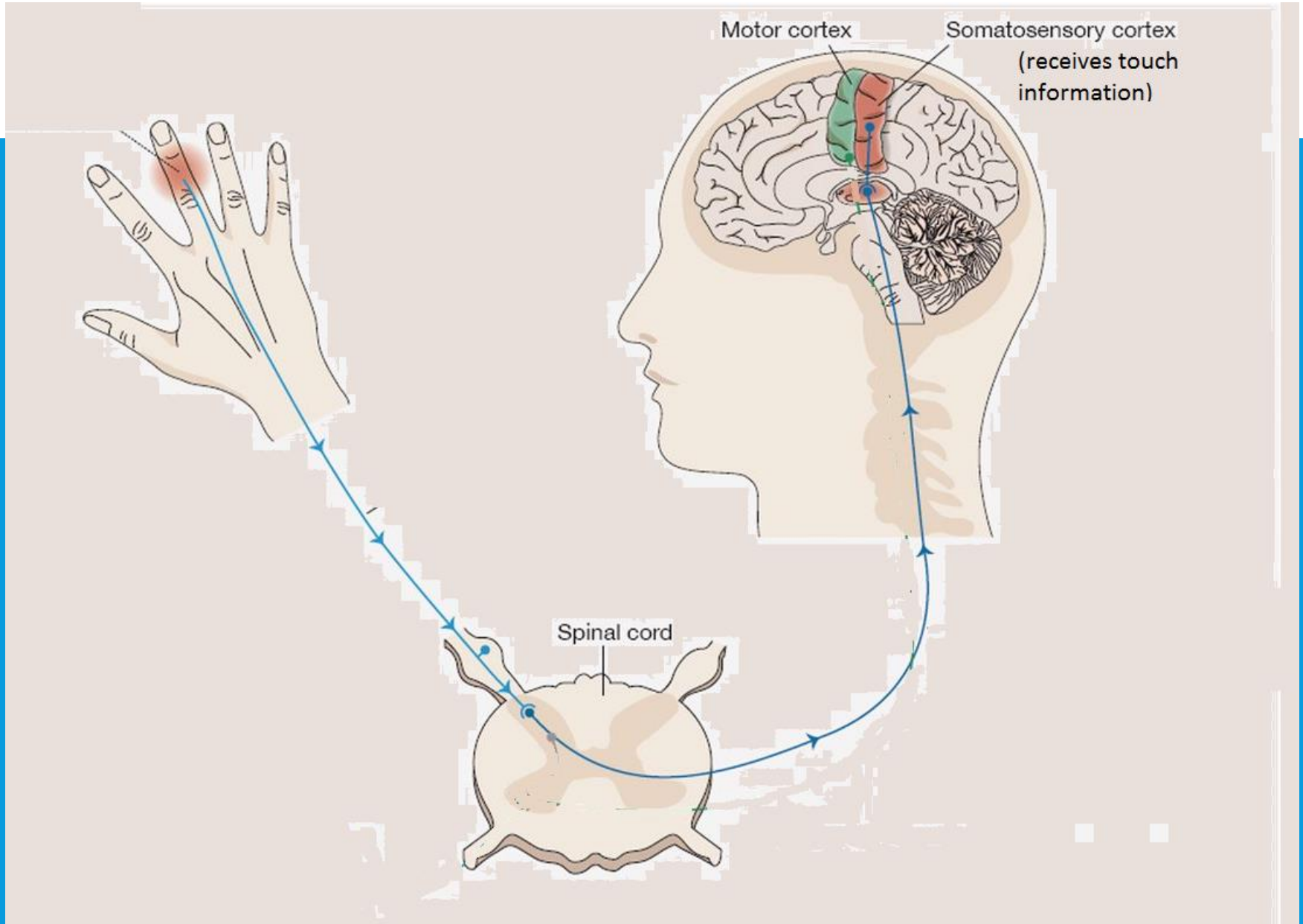


SENSORY CORTEX

Somatic senses: touch, pressure, temp, pain

Special senses – smell, taste, vision, equilibrium, hearing.

HAPTIC PERCEPTION



TYPES OF RECEPTORS

- Location based classification
  - *Skin receptors* (exteroceptors) are located close to the skin surface (e.g., touch-pressure, vibration, temperature, pain)
  - *Muscle and joint receptors* (proprioceptors) are located in tendons, muscles and joints (e.g., position & movement)
  - *Visceral receptors* (interoceptors) are associated with the internal organs (e.g., heart rate, blood pressure)

- Transduction mechanism based classification
  - *Mechanoreceptors* are responsive to any kind of mechanical skin deformation
  - *Thermoreceptors* are responsive to changes in skin temperature
  - *Chemoreceptors* are responsive to substances produced within the skin
  - *Nociceptors* are specialized for detecting painful stimuli

SOMATIC AND SPECIAL SENSES

Sensory receptors detect environmental changes and trigger nerve impulses

RECEPTORS

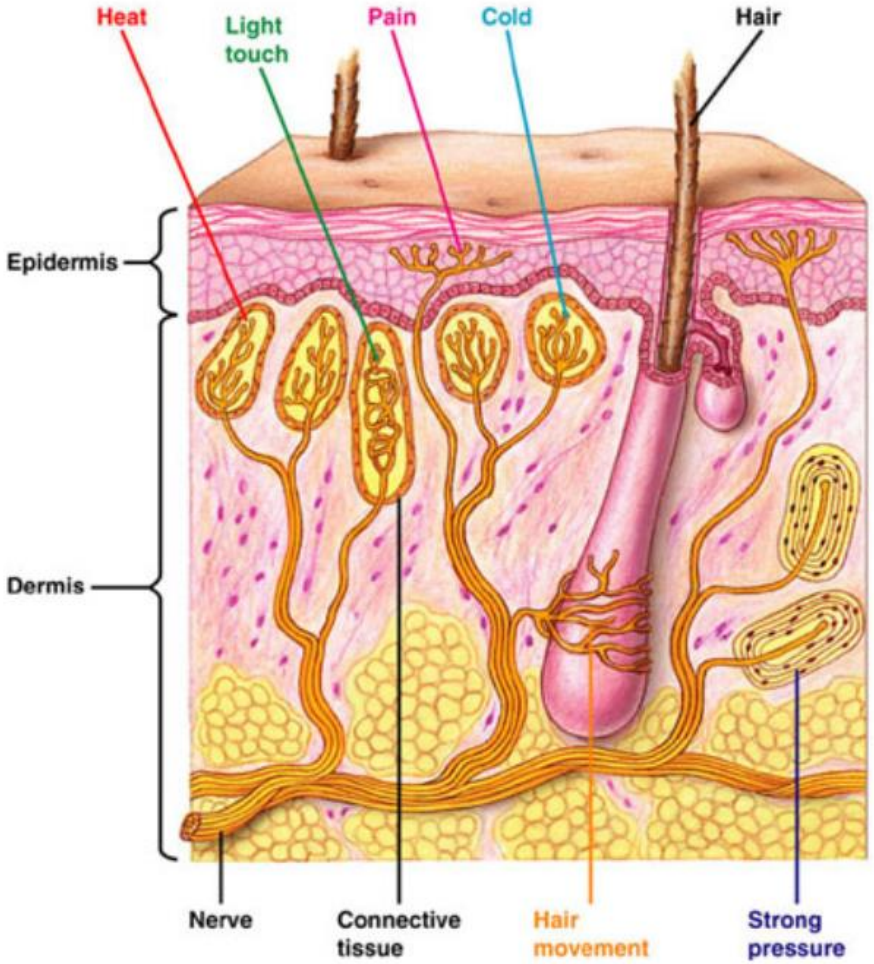
Chemoreceptors = chemical

Pain receptors = pain

Thermoreceptors = heat

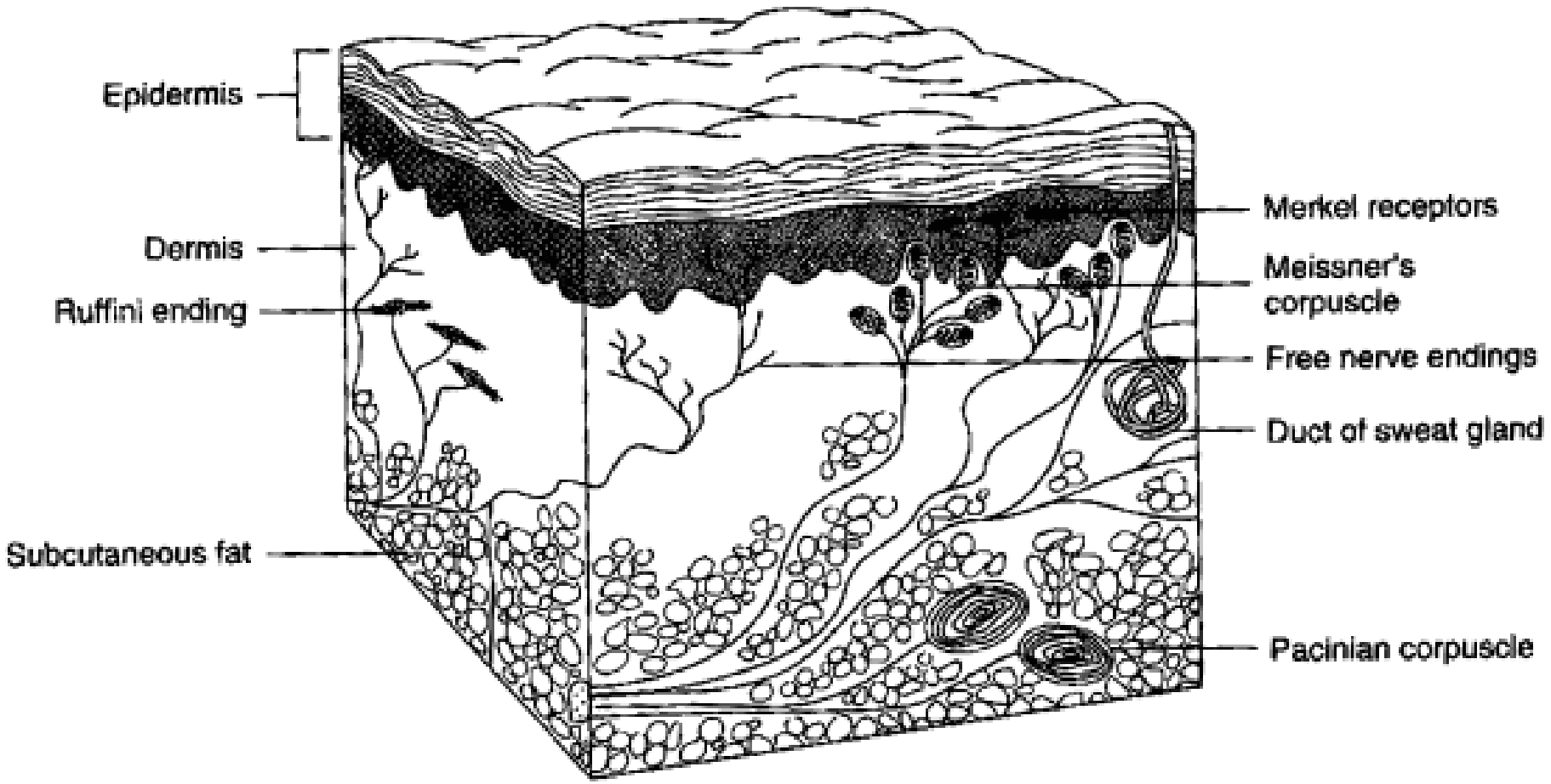
Mechanoreceptors = pressure location

Photoreceptors = light



MECHANORECEPTORS

- **Meissner corpuscles** (RA) respond to "taps" within 3–50 Hz
- **Ruffini cylinders** (SA) respond to stretching of skin or movement of joints at 0–10 Hz
- **Pacinian corpuscles** (RA) respond to rapid vibration within 100–500 Hz.
- The "sweet spot" for vibrotactile sensitivity is considered to be 250 Hz (Shimoga, 1992).

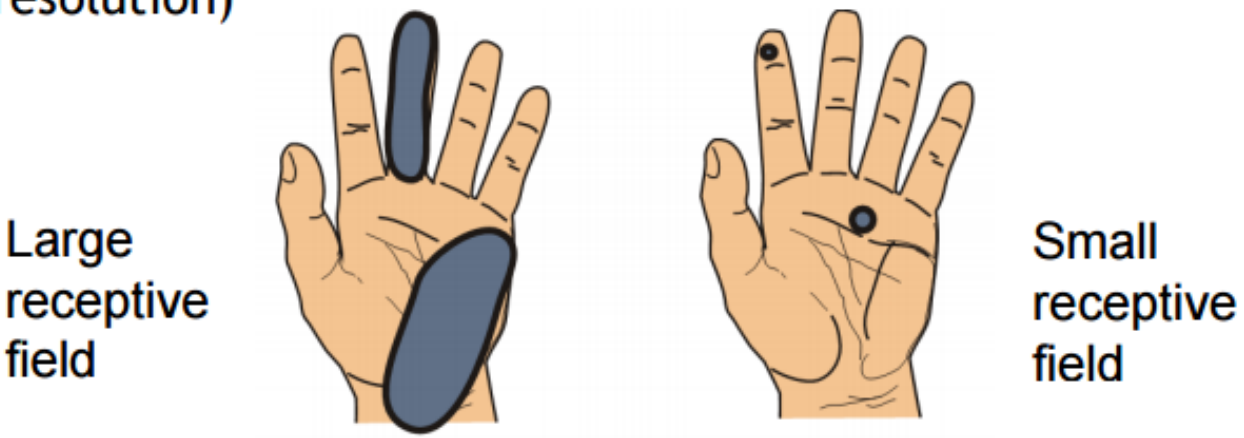

Epidermis
Dermis
Ruffini ending
Subcutaneous fat
Merkel receptors
Meissner's corpuscle
Free nerve endings
Duct of sweat gland
Pacinian corpuscle

SPATIAL RESOLUTION OF MECHANORECEPTORS

- Mechanoreceptors have different spatial resolutions
  - *Spatial resolution* depends on the skin location (i.e., what and how many receptors are found in the locus)
  - The size of the receptive field depends on how deep in the skin the particular receptor type lies (i.e., the deeper the receptor lies the larger is the receptive field)

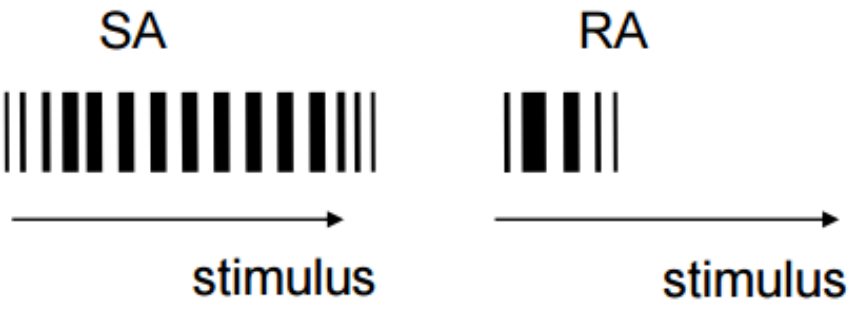
type I receptors have large receptive fields (low spatial resolution)

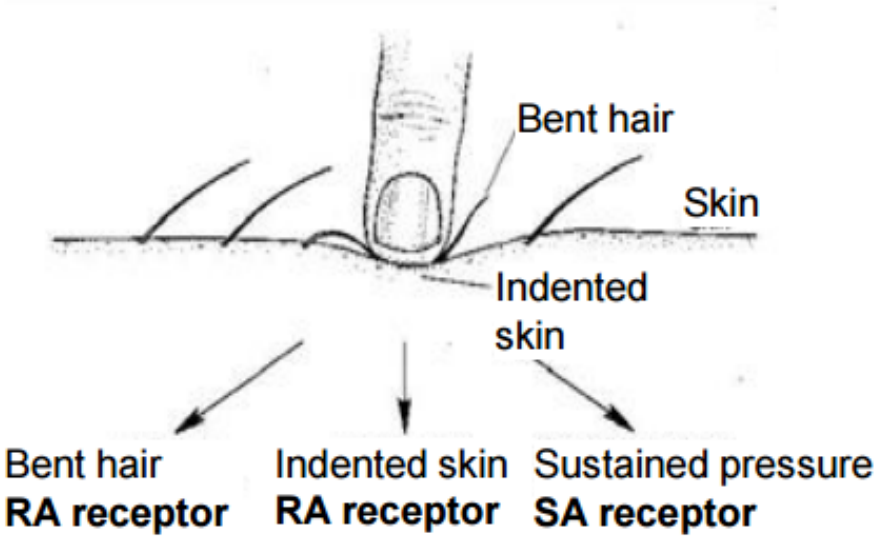
type II receptors have small receptive fields (good spatial resolution)



SPEED OF RECEPTORS ADAPTATION

- Receptors are divided into two categories based on their *speed of adaptation*
  - *Slowly adapting (SA)* receptors detect constant stimulus (e.g., pressure & skin stretch)
  - *Rapidly adapting (RA)* ones detect only short pulses (e.g., initial contact & vibration)



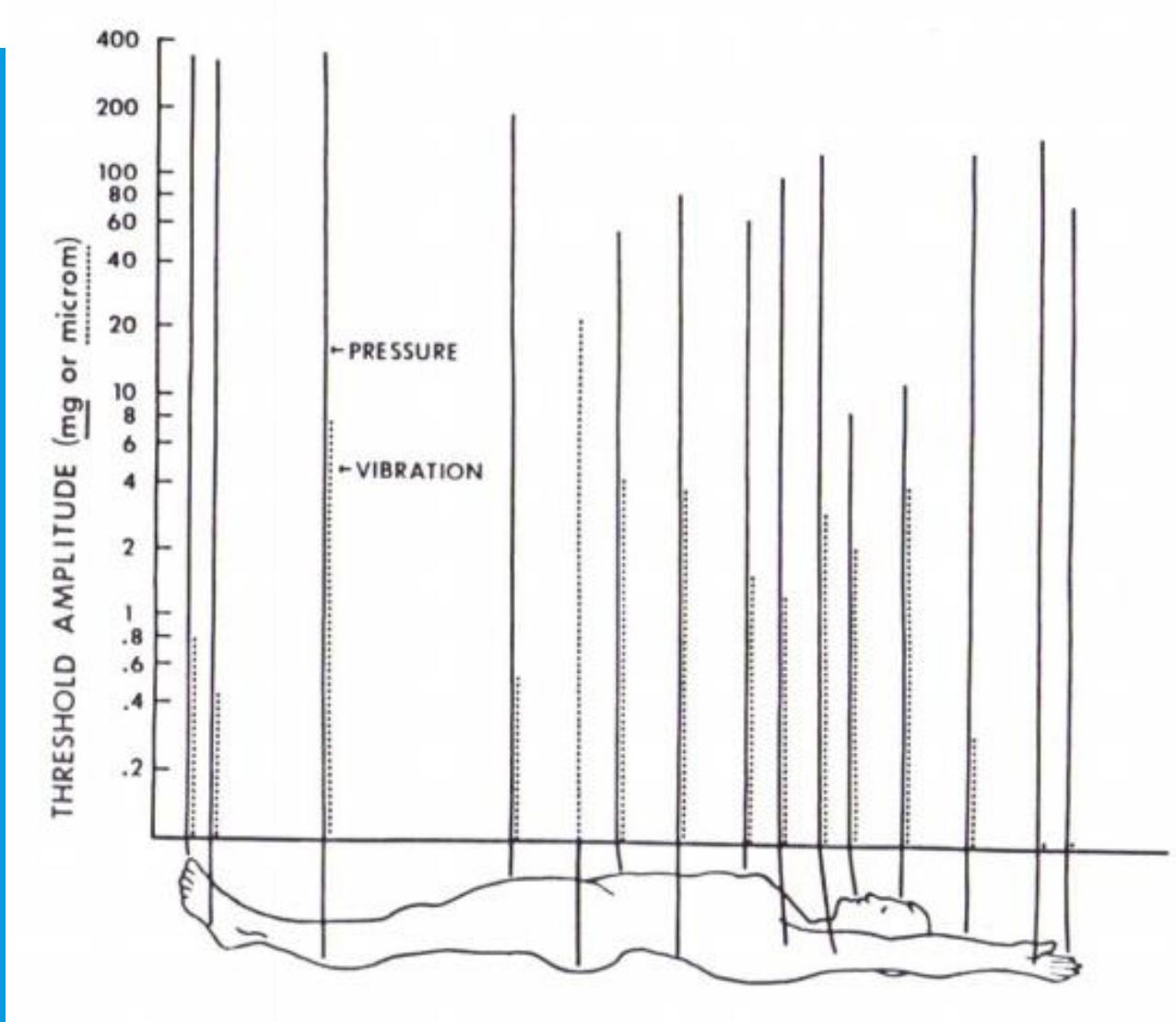


VIBRATION PERCEPTION SPECTRUM

- Perception of vibration – 0.04 to 500 Hz (hearing – 20 to 20000 Hz)
- Over 500Hz is felt more like texture
- Sensitivity of mechanical vibration increases above 100 Hz and decreases above 320 Hz (250 – approximate optimum)

PRESSURE AND VIBRATION

High sensor density correlated to body regions involved in exploration and manipulation.



SENSATIONS

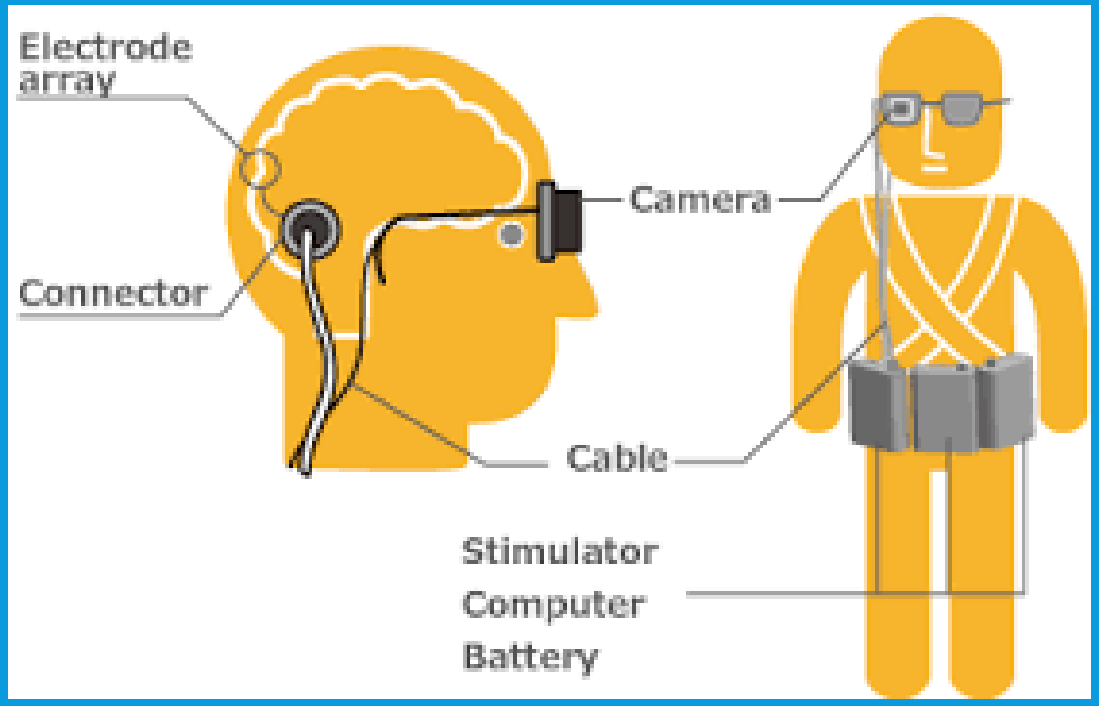
- Sensation – feeling that occurs when brain interprets sensory impulse.
- Projection – process where the cerebral cortex causes a feeling to stem from a source (eyes, ears)
- Sensory adaptation – sensory receptors stop sending signals when they are repeatedly stimulated.

SOME OTHER FACTS

- Fingertips are the most sensitive part of human hand to vibrations
- Vibrotactile detection of fingertips reduces with age
- Pressure sensitivity is function of age
- Tactile sensations are very individual
- Many things about the touch remain unknown

TIPS FOR INDIVIDUAL PRESENTATIONS

- Artificial vision system



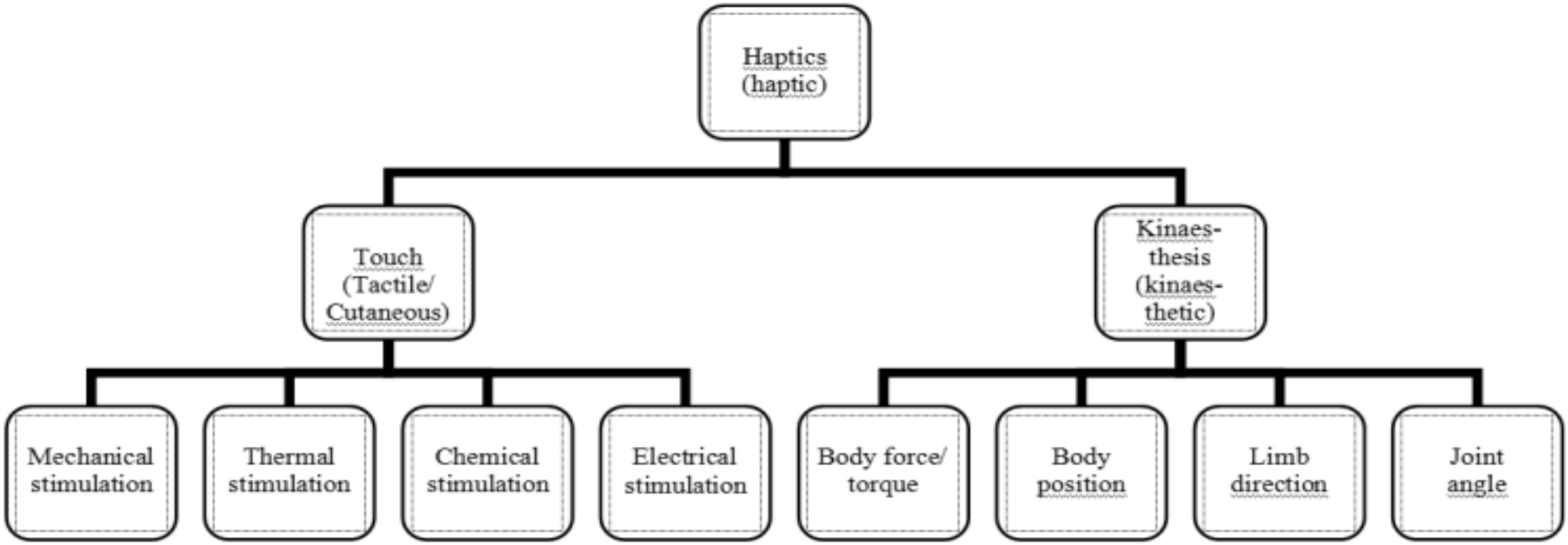
TACTILE AND HAPTIC INTERFACES

- Are regulated by the standards:

ISO 9241-900, ISO 9241-910, ISO 9241-920, ISO 9241-930, ISO 9241-940, ISO 9241-971.

THE COMPONENTS OF HAPTICS

- "Touch" includes such diverse stimuli as mechanical, thermal, chemical and electrical stimulation to the skin. The "kinaesthetic" sense can be matched by kinaesthetic activity by which a user exerts force or torque on an object external to the active body part. (*Source: A.M.L. Kappers et al. , 2010*)



GUIDANCE ON TACTILE AND HAPTIC INTERACTIONS *(PER ISO ISO 9241-920:2009)*

- Applicability considerations for haptic interactions, including: limits to effectiveness, workload considerations (efficiency), user acceptance considerations (satisfaction), meeting user / environmental needs (accessibility), health and safety considerations, and security and privacy.
- Tactile/haptic inputs, outputs, and/or combinations, including: unimodal and multimodal use of haptic interactions, intentional individualization, and unintentional user perceptions.
- Attributes of tactile/haptic encoding of information, including: using properties of objects, using perceptual attributes, and combining attributes.

GUIDANCE ON TACTILE AND HAPTIC INTERACTIONS *(PER ISO 9241-920:2009)*

- Content-specific encoding (what to encode), including: encoding and using textual data, encoding and using graphical data, encoding subjective data, and encoding and using controls.
- Layout of tactile/haptic objects, including: resolution, separation, and consistency.
- Interaction, including: interaction tasks (such as navigation, selection, and manipulation) and interaction techniques (such as moving objects, possessing objects, and gesturing). Guidance for specific haptic interactions related to reading tactile alphabets and notations suitable for blind or deafblind people are handled by Unicode and other national standards.

EXAMPLES OF PHYSICAL MEASURES

(*A.M.L. KAPPERS ET AL. , 2010*)

Level of complexity	Measure	Example/ application
Elementary measures	force, time, temperature, distance, …	perceptual thresholds, maximal/minimal capabilities of users and devices, resolutions, …
Compound measures	speed	e.g. maximal speed of a device's handle
	frequency	perception of vibration is frequency depended, e.g. [10]
	thermal conductivity, …	material constant, …
Derived measures	impedance	e.g. mechanical behaviour of a user
	transparency	transmission performance
	roughness, …	various measures such as R_a, R_z, R_q, and R_{sk} , …

EXAMPLES OF ACTIVE HAPTIC DEVICES

- Cell phone vibrators
- Force feedback game joysticks
- Steering wheel
- Computer mouse

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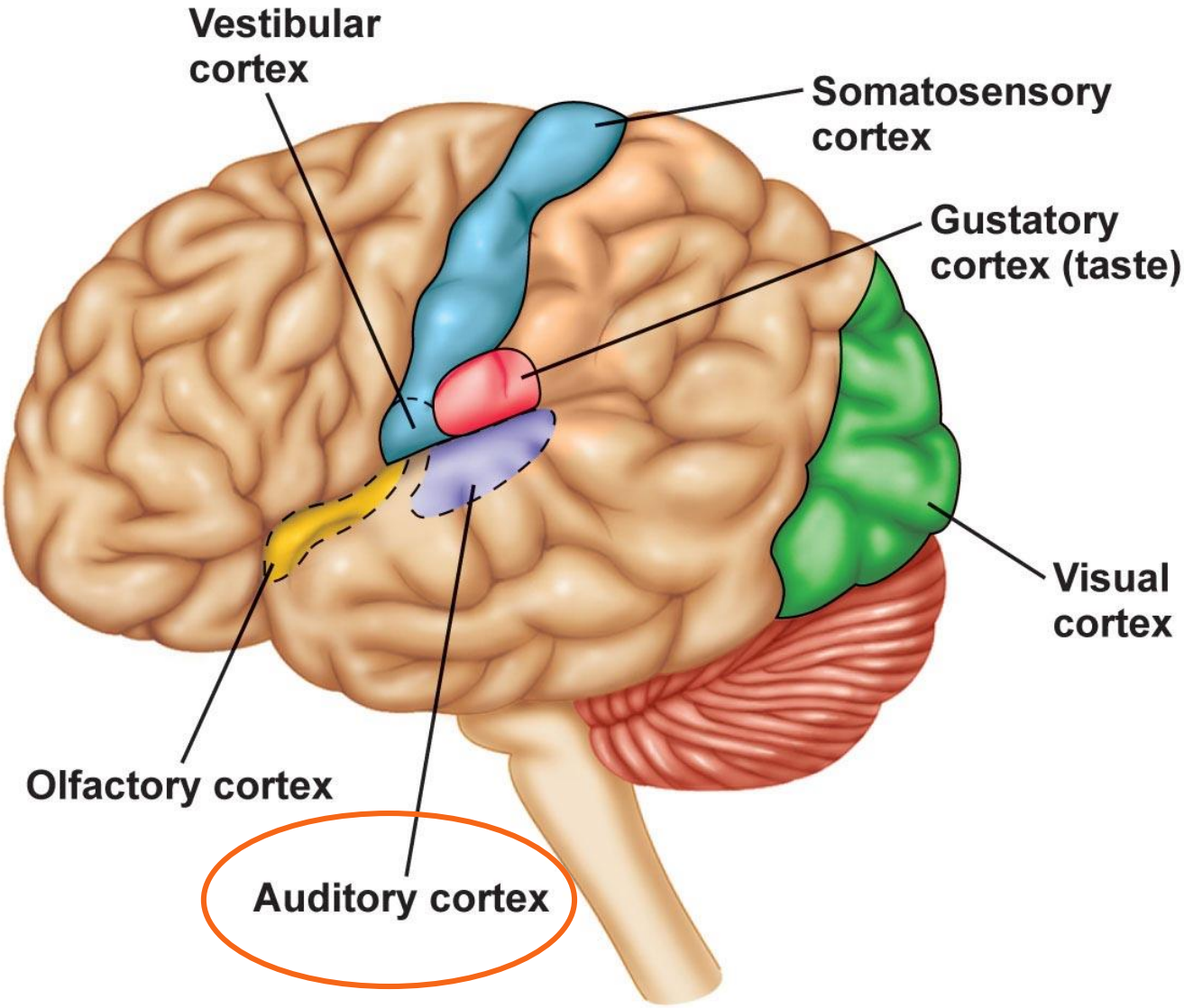
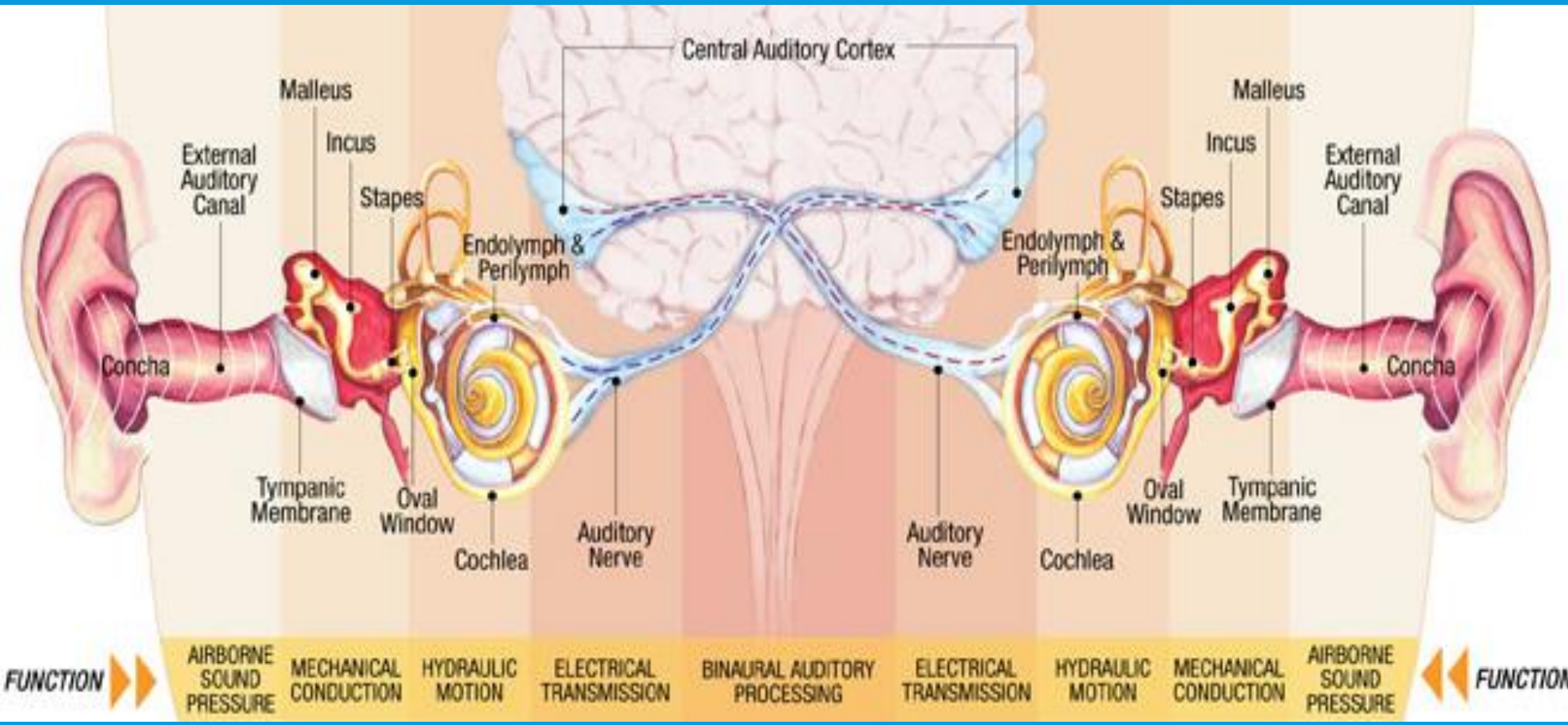
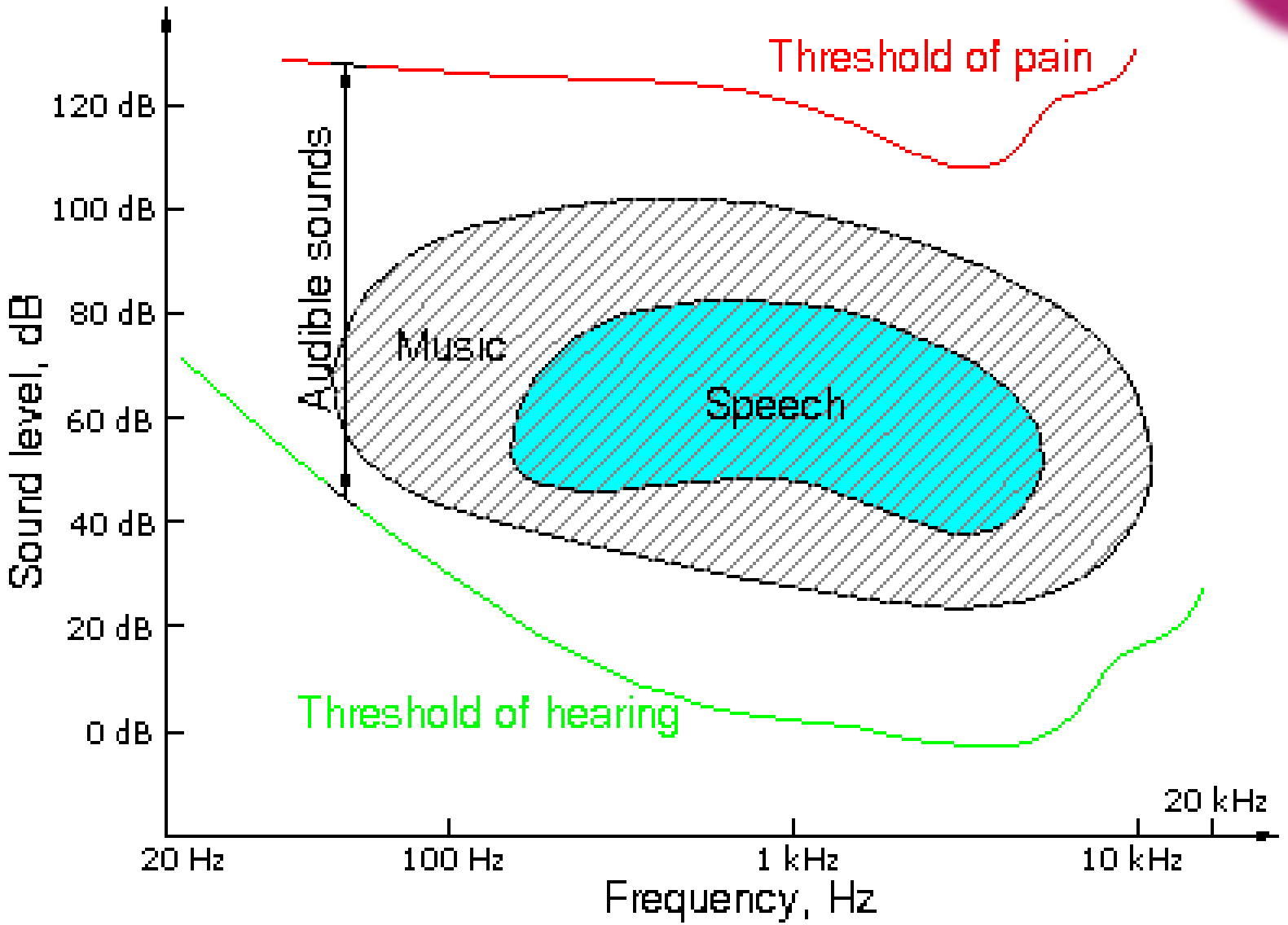


AUDITORY CORTEX

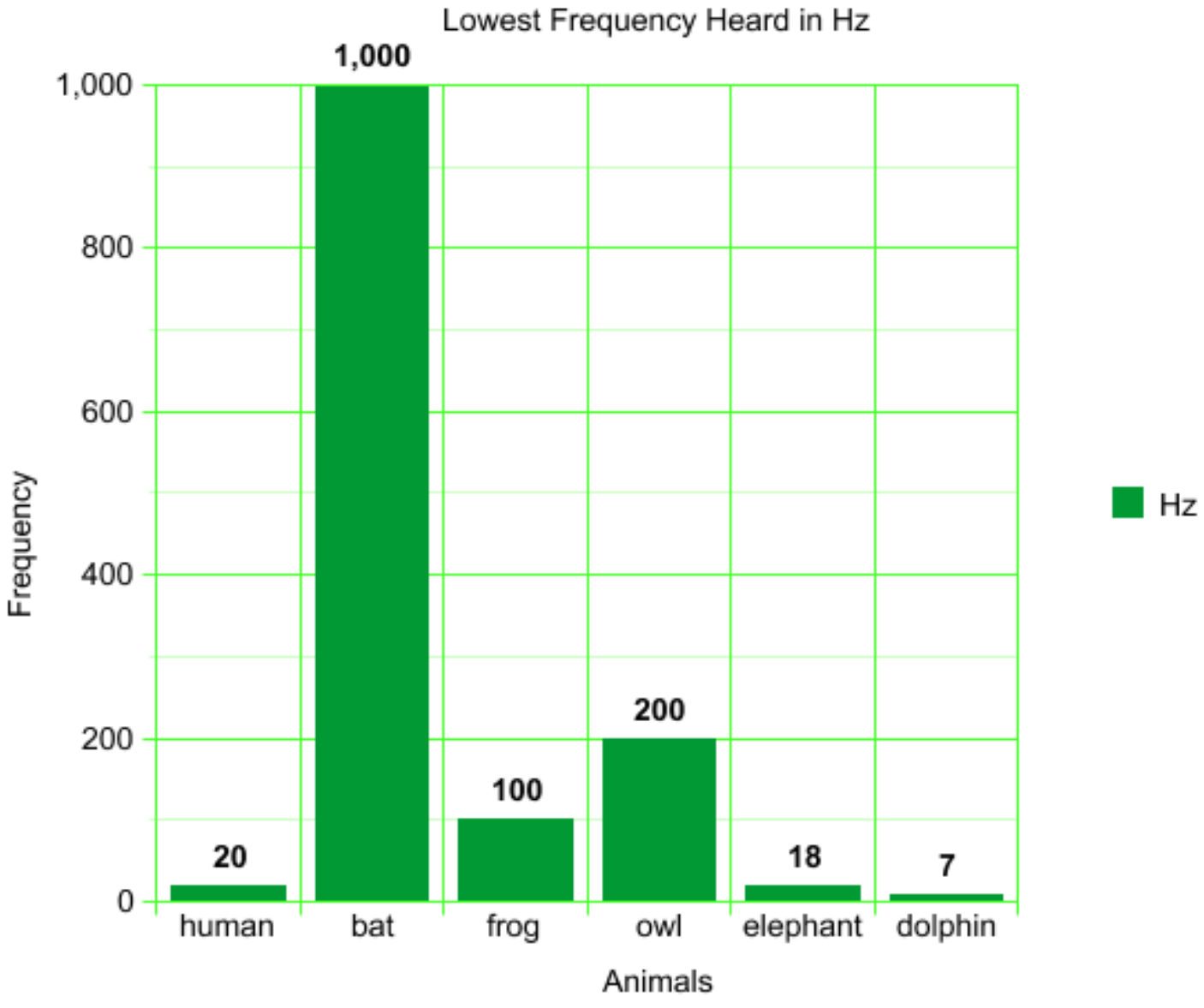
HEARING, LANGUAGE, MUSIC



HUMAN HEARING – SPECTRUM RANGE



HEARING – HUMANS AND ANIMALS



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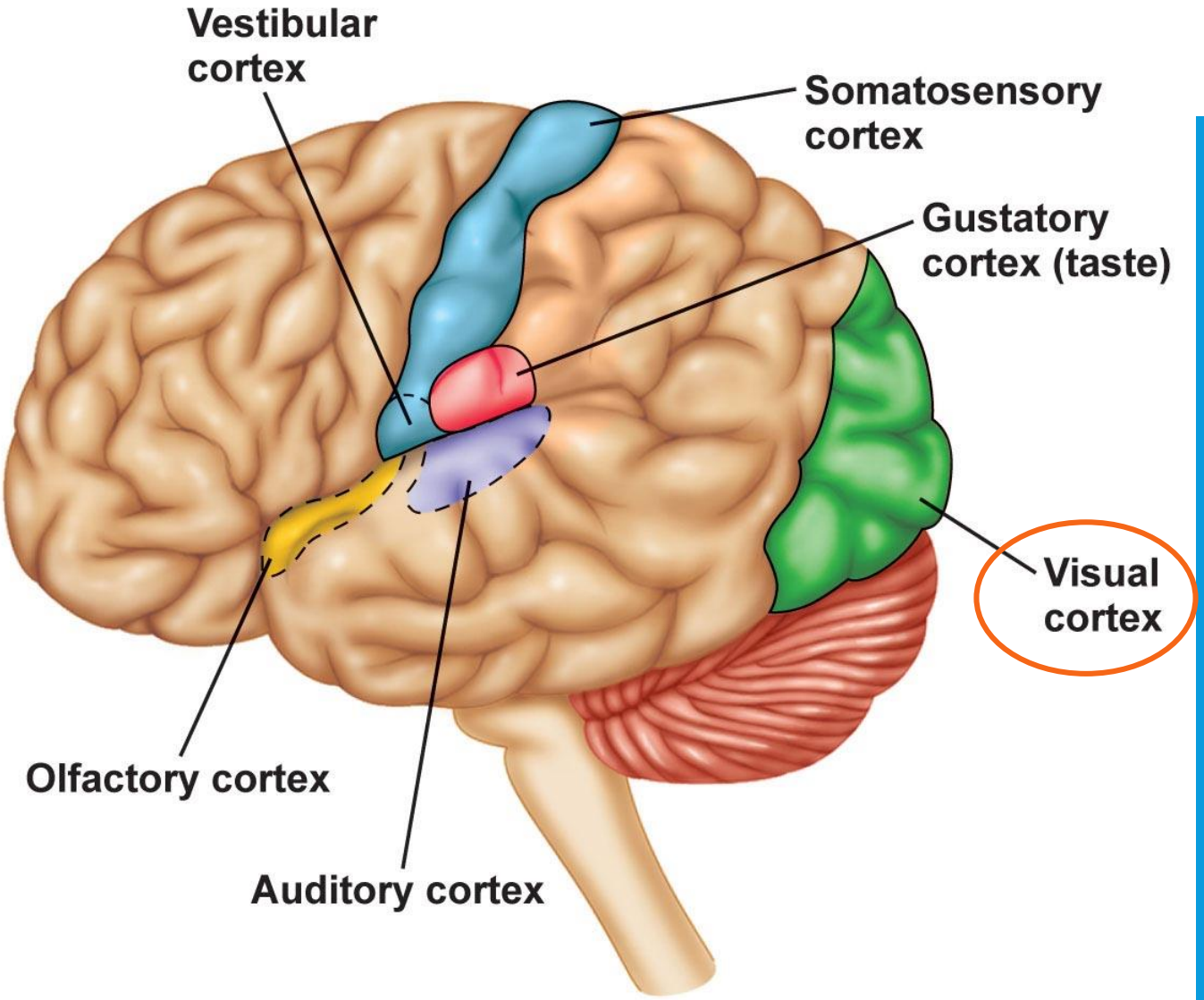

EXCLUSIVE OR/AND ENHANCED SIGNAL SYSTEMS

- No color
- No visual stimuli
- No audio stimuli

Example: traffic lights for color blind people.

Suggested topic: ways of realization of communication systems without visual or audio stimuli or color.

- Tactile systems. Different efficiency tactile systems based on most sensitive body regions