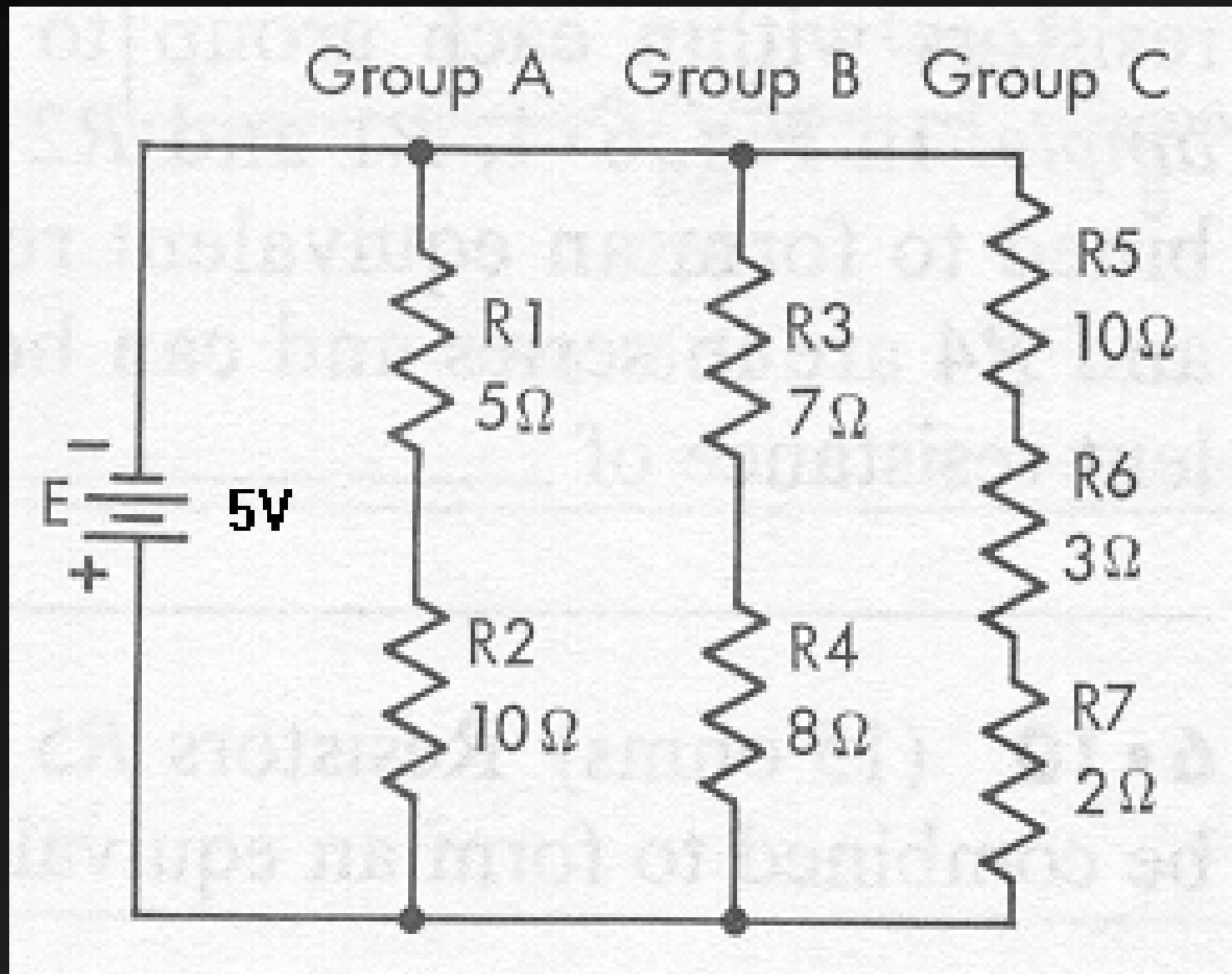


Lecture 3

11 February, 2008

Announcements (2/1/08)

- 401B and 501B:
 - Laboratory Meeting Thurs Feb 14, 4⁰⁰-7⁰⁰ pm
- Electricity Test next week (Feb 18)
- Information on Papers next week too
- 3x5 Cards



Electricity Test Objectives

- Describe positive and negative charges
- State the law of attraction and repulsion
- Describe free electrons
- Describe the relationship between electromotive force, resistance, and flow (i.e. understand Ohm's Law)
- Draw a simple DC electric circuit comprised of a battery and:
 - Single resistor
 - Resistors in series
 - Resistors in parallel
- Solve for voltage, current, or resistance in simple DC circuits:
 - In Series
 - In Parallel
- Reduce a compound circuit to a simple equivalent
- Describe the difference between alternating and direct current (AC/DC!)
- Describe the role of a capacitor in an AC and DC circuit

Today:

Brief and Basic Neuroanatomy
The Electrodermal Response System

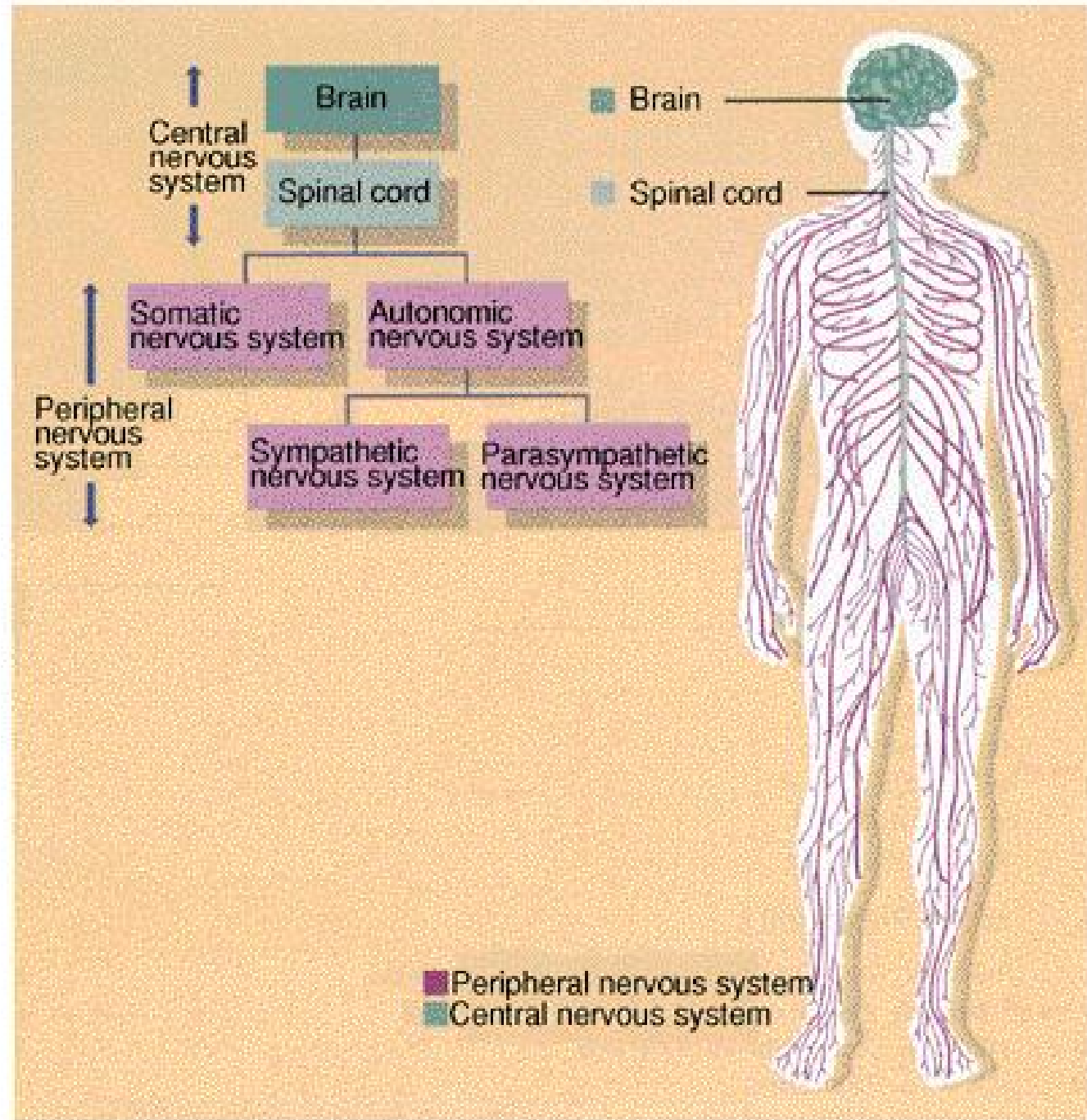
V. Organization of the nervous system

A. Central nervous system

1. Brain

2. Spinal cord

Human Nervous System



V. Organization of the nervous system

B. Peripheral nervous system

1. Somatic system

2. Autonomic system; two branches work in generally antagonistic fashion

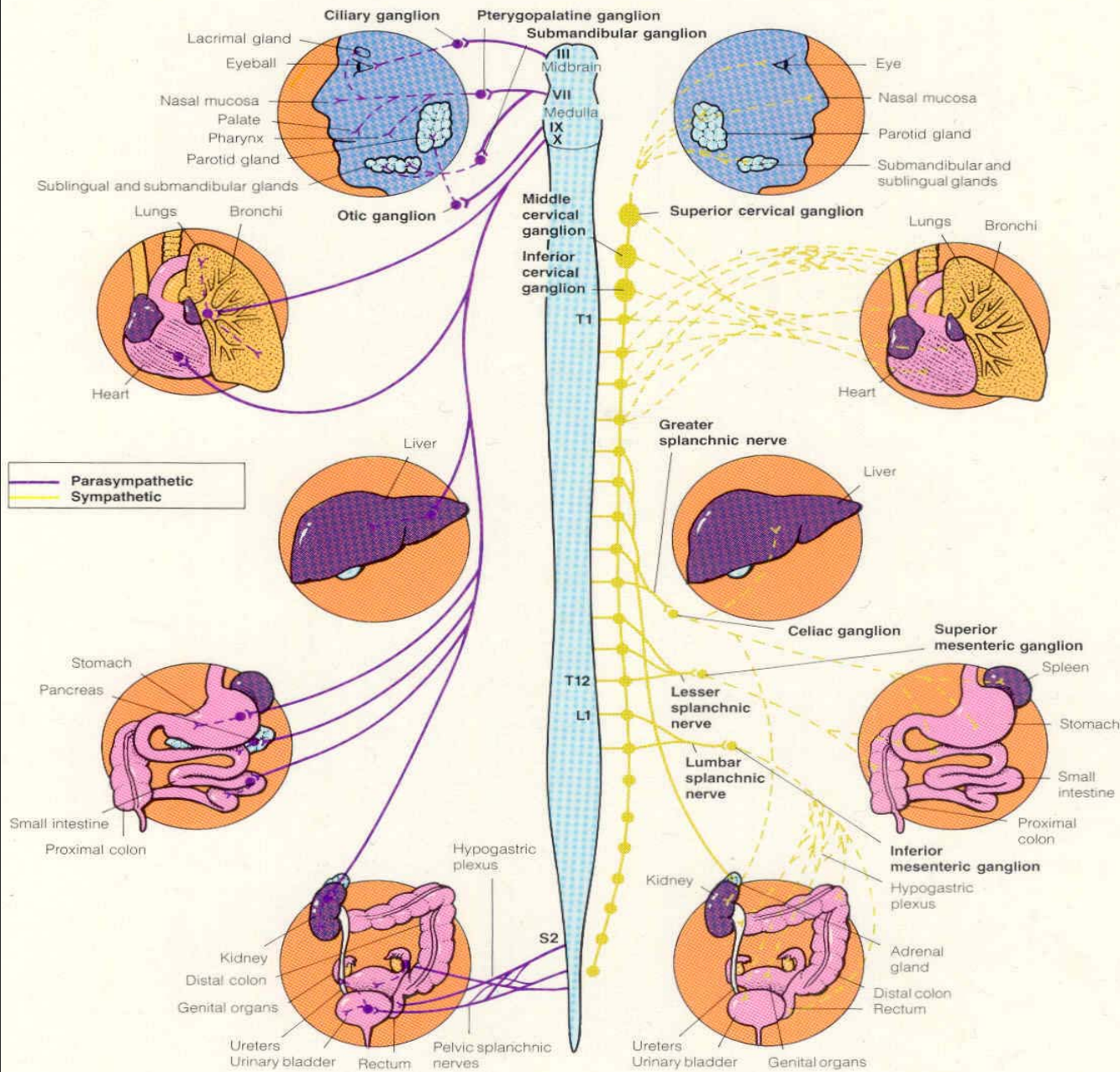
Somatic System

- Descending motor tracts within spinal cord synapse at approximate level of exit
- Post-synaptic neuron directly innervates target
- 2-neuron system

Autonomic System

- Descending motor tracts within spinal cord synapse not necessarily at level of exit
- After exit, synapse again before innervating target
- 3-neuron system

Autonomic Nervous System



V. Organization of the nervous system

B. Peripheral nervous system

2. Autonomic system

a. Sympathetic nervous system

1. tends to have system-wide effects
2. fight or flight; activity

b. Parasympathetic nervous system

1. tends to affect one organ at a time
2. quiescent processes--digestion, protects and conserves energy

Sympathetic

- Prepares body for action
- Catabolic processes that require energy expenditure

- After synapse within grey-matter of spinal cord, the post-synaptic (pre-ganglionic) neurons exit in thoracic or lumbar regions

- *Thoracolumbar system*
- pre-ganglionic neurons travel to sympathetic chain (series of connected sympathetic ganglia "*swelling or knot*", chain of neurons)
- post-ganglionic neurons generally travel a long distance to target organ

Parasympathetic

- Restores and maintains body resources
- Anabolic processes that increase the body's supply of stored energy

- After synapse within grey-matter of spinal cord, the post-synaptic (pre-ganglionic) neurons exit in cranial (especially cranial nerve #10, Vagus) or sacral regions

- *Craniosacral system*
- pre-ganglionic neurons travel some distance before synapsing in the parasympathetic ganglia located in the immediate vicinity of the target organ
- post-ganglionic neurons are therefore typically quite short

Sympathetic

Pharmacologically,

- All synapses within the sympathetic ganglia are acetylcholinergic
- Terminal buttons on target organs are noradrenergic (except sweat glands: acetylcholinergic)

- Quick diffuse action of system due to the sympathetic ganglionic chain prepares organism for *fight-or-flight*; in synchrony, many systems activate
- dilation of bronchioles
- dilation of pupils (the better to see you with my dear)
- constriction of blood vessels to skin and gastrointestinal system
- inhibition of gastrointestinal system
- increased BP, stroke volume, cardiac output
- increased sweating

Parasympathetic

Pharmacologically,

- All synapses acetylcholinergic: both pre- and post-ganglionic neurons

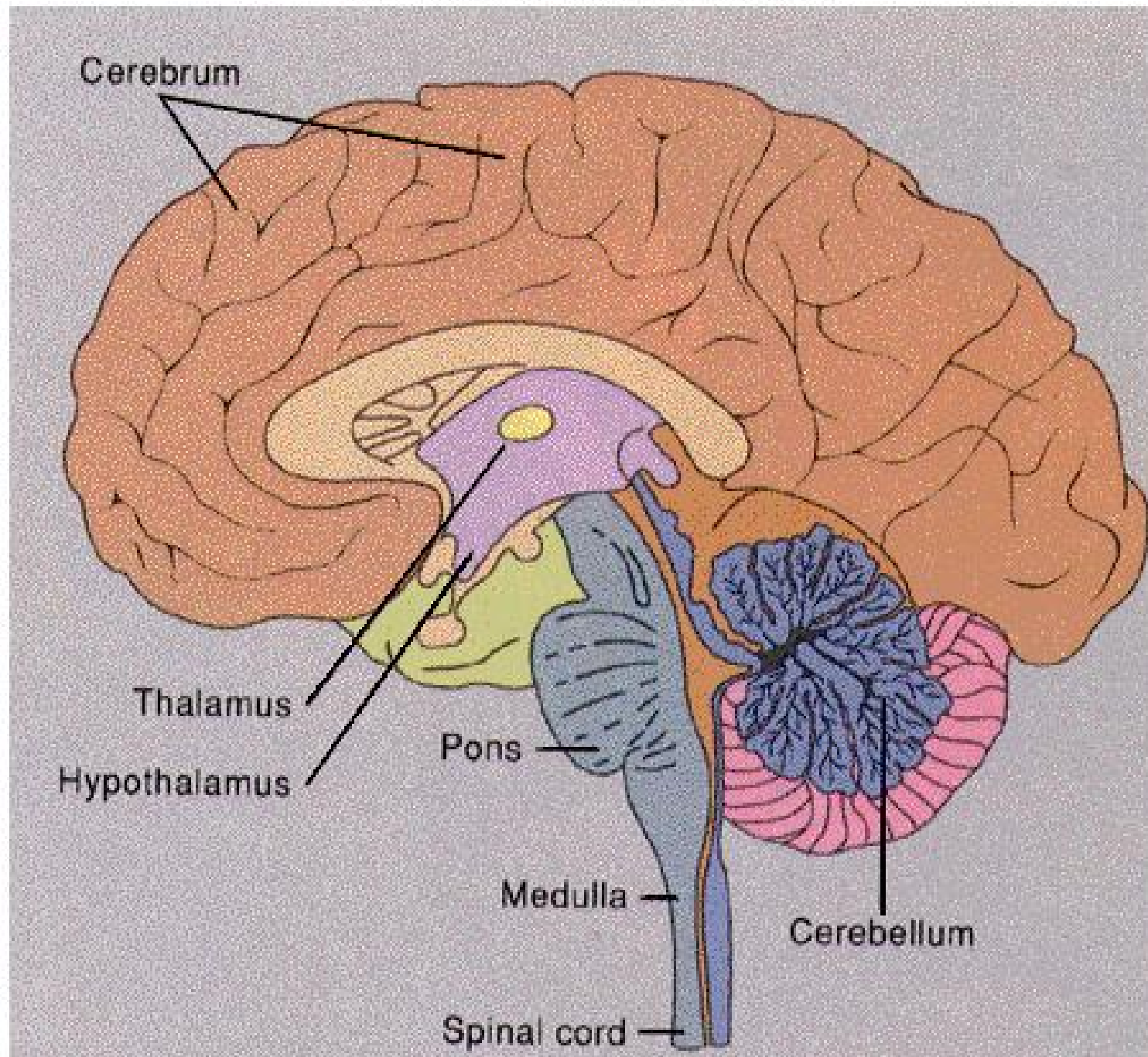
- Slower and more specific action of this system works to restore and maintain bodily resources; only changes that are necessary generally occur (not all systems in synchrony)
- decreased heart rate, blood pressure
- constriction of pupils and bronchioles
- increases in digestive functions

VI. The common household brain

➤ Commentary

➤ More commentary

Brain's Main Structures



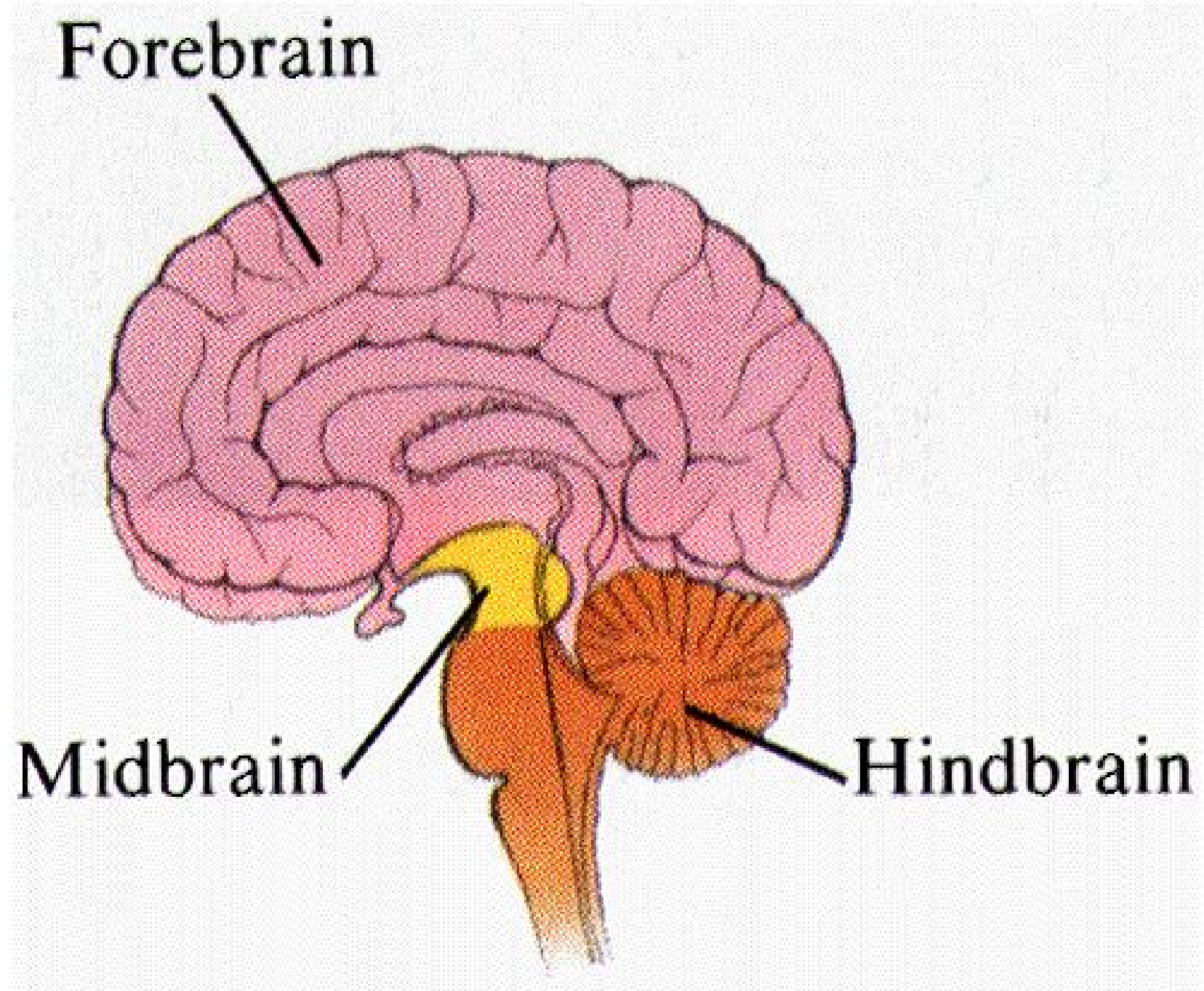
VI. The common household brain

A. Overview of brain

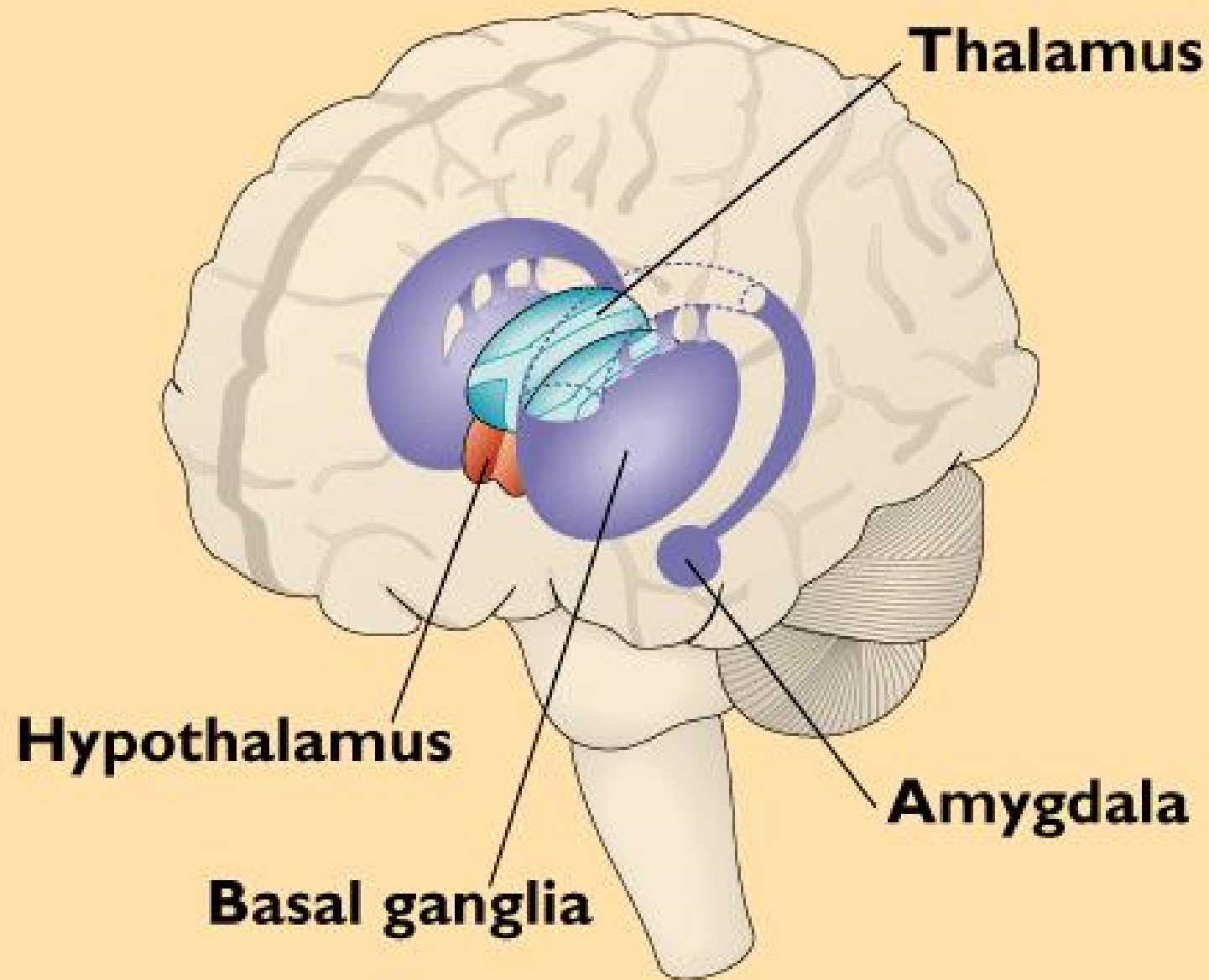
1. The primitive central core
2. Limbic system, or the “Inner Lizard”
3. Cerebrum (AKA cerebral hemispheres)
 - a. Ontogeny
 - b. Phylogeny
 - c. Ontogeny recapitulates phylogeny
4. These three layers are interconnected extensively; do not function independently

Next

The Human Brain: Major Areas



Principal Structures of the Limbic System





3 weeks



4 weeks



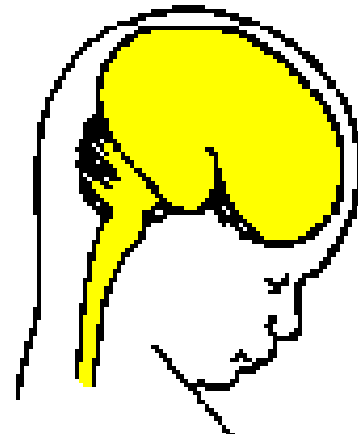
5 weeks



7 weeks



11 weeks



4 months



6 months

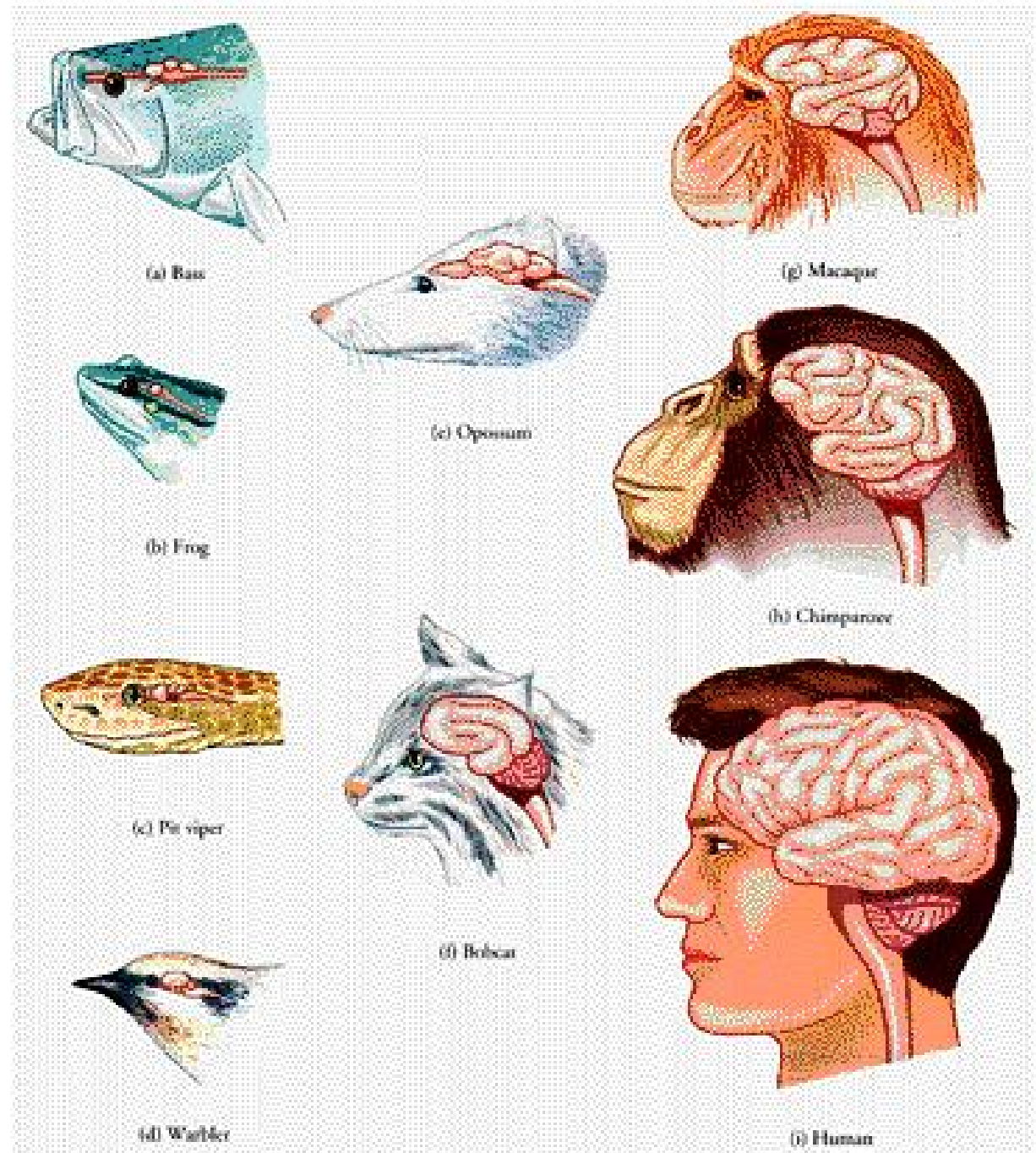


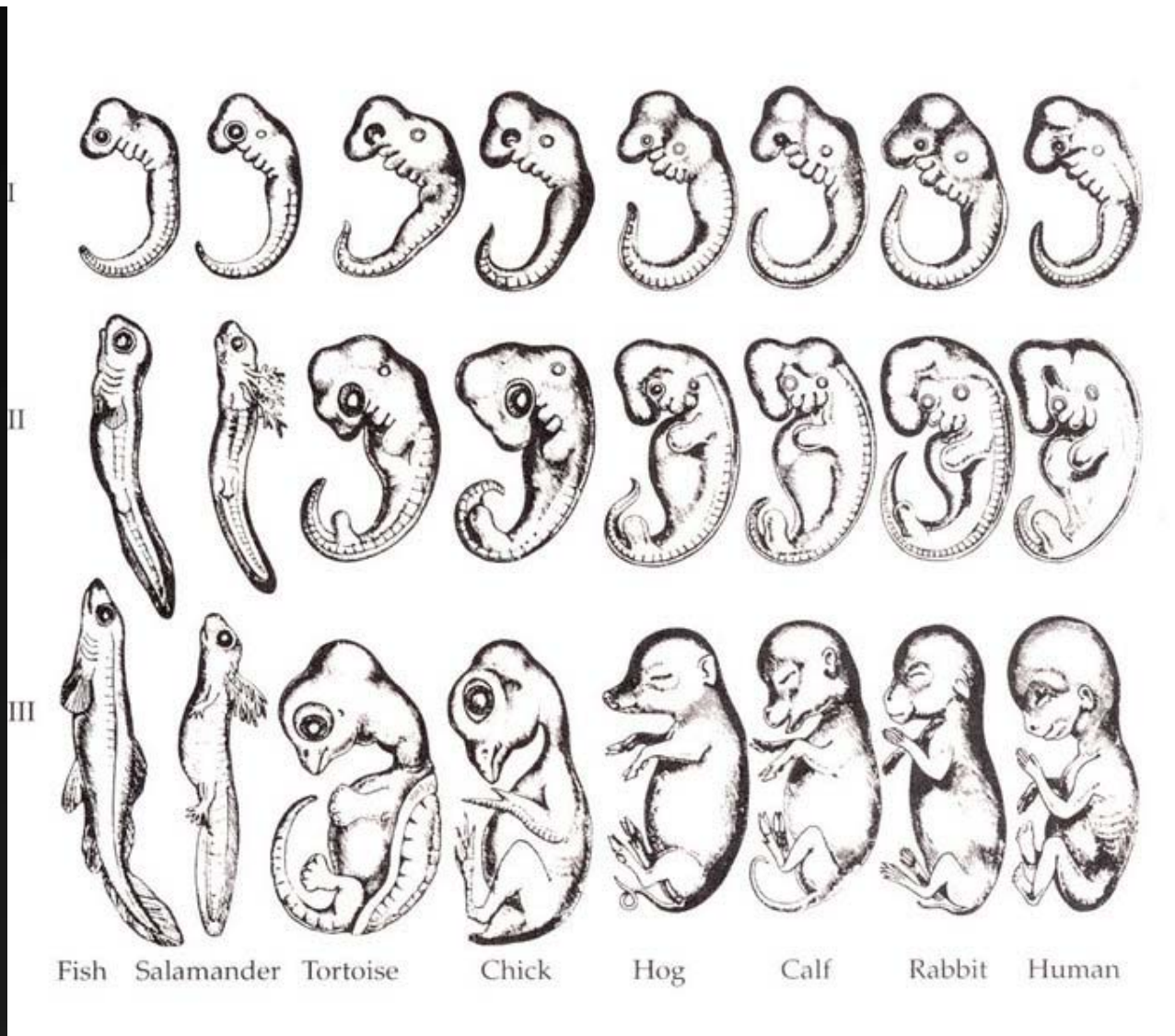
8 months



Newborn

The Evolution of the Cerebrum*





“... this history of the embryo (ontogeny) must be completed by a second, equally valuable, and closely connected branch of thought - the history of race (phylogeny). Both of these branches of evolutionary science, are, in my opinion, in the closest causal connection; this arises from the reciprocal action of the laws of heredity and adaptation... 'ontogenesis is a brief and rapid recapitulation of phylogenesis, determined by the physiological functions of heredity (generation) and adaptation (maintenance).”

Haeckel, E. 1899. *Riddle of the Universe at the Close of the Nineteenth Century*.

Directions please!

- lateral--side; medial--middle
- anterior--front; posterior/dorsal--back
- rostral--towards the nose; caudal--towards the tail
- ipsilateral--same; contralateral--opposite
- proximal--toward the soma; distal--away from the soma
- efferent--output/motor; afferent--receiving/sensory

B. Brain Specifics

1. Primitive central core

a. Cerebellum

1. "little brain" located to rear of brain stem
2. involved in smooth coordination of movements
3. learning of complex motor activities (e.g., piano, skiing)

B. Brain Specifics

1. Primitive central core

b. Thalamus & Hypothalamus: located just above the brain stem & tucked inside the cerebral hemispheres

1. Thalamus is a relay station for sensory information

a. "Gateway to the cortex"

b. coming from spinal cord to cortex

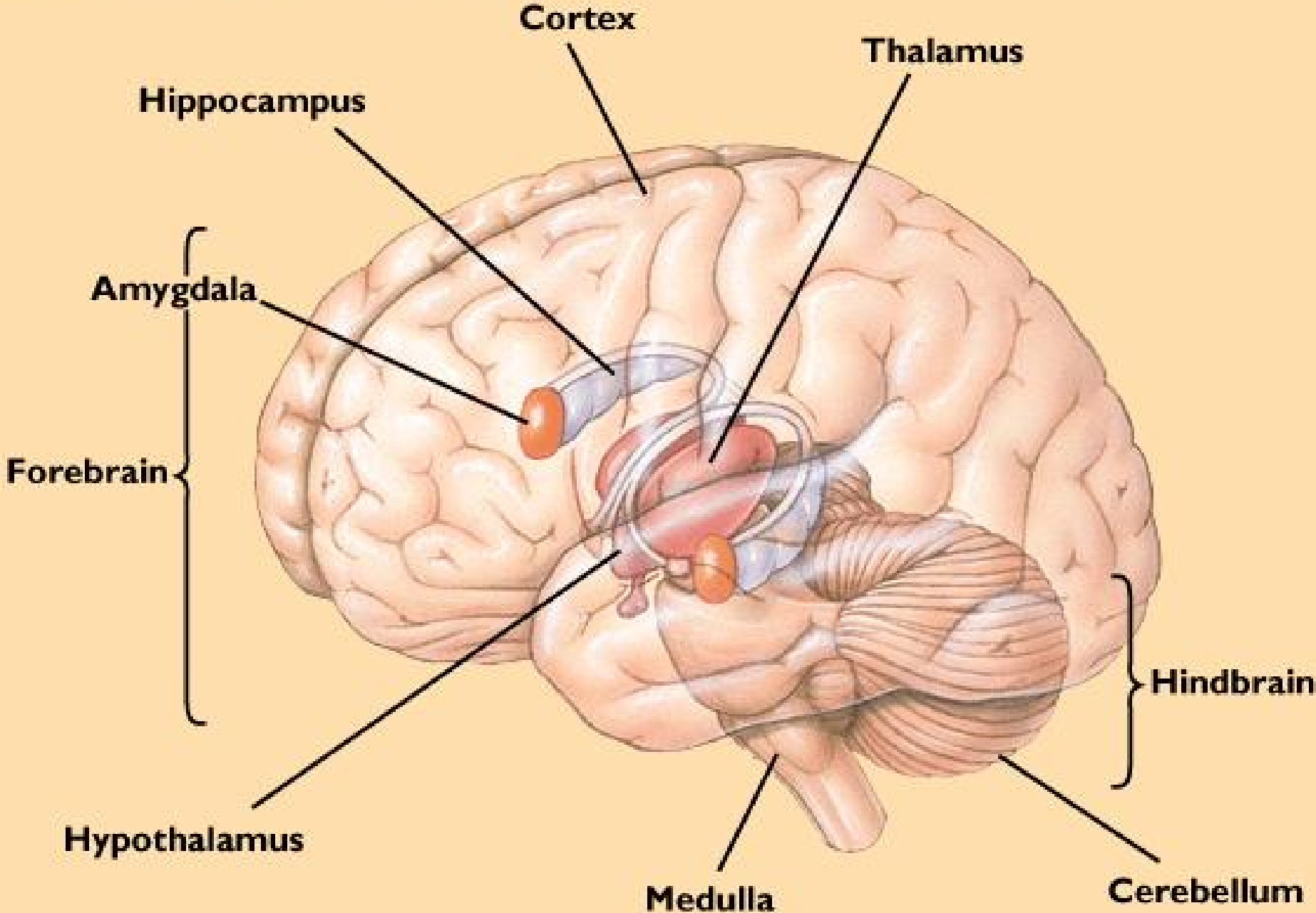
c. taste touch hearing vision -- olfaction is exception

2. Hypothalamus

a. literally = "under thalamus" ; much smaller, but very important

b. 4 F's:

Structures of the Brain



Forebrain

Cerebral cortex



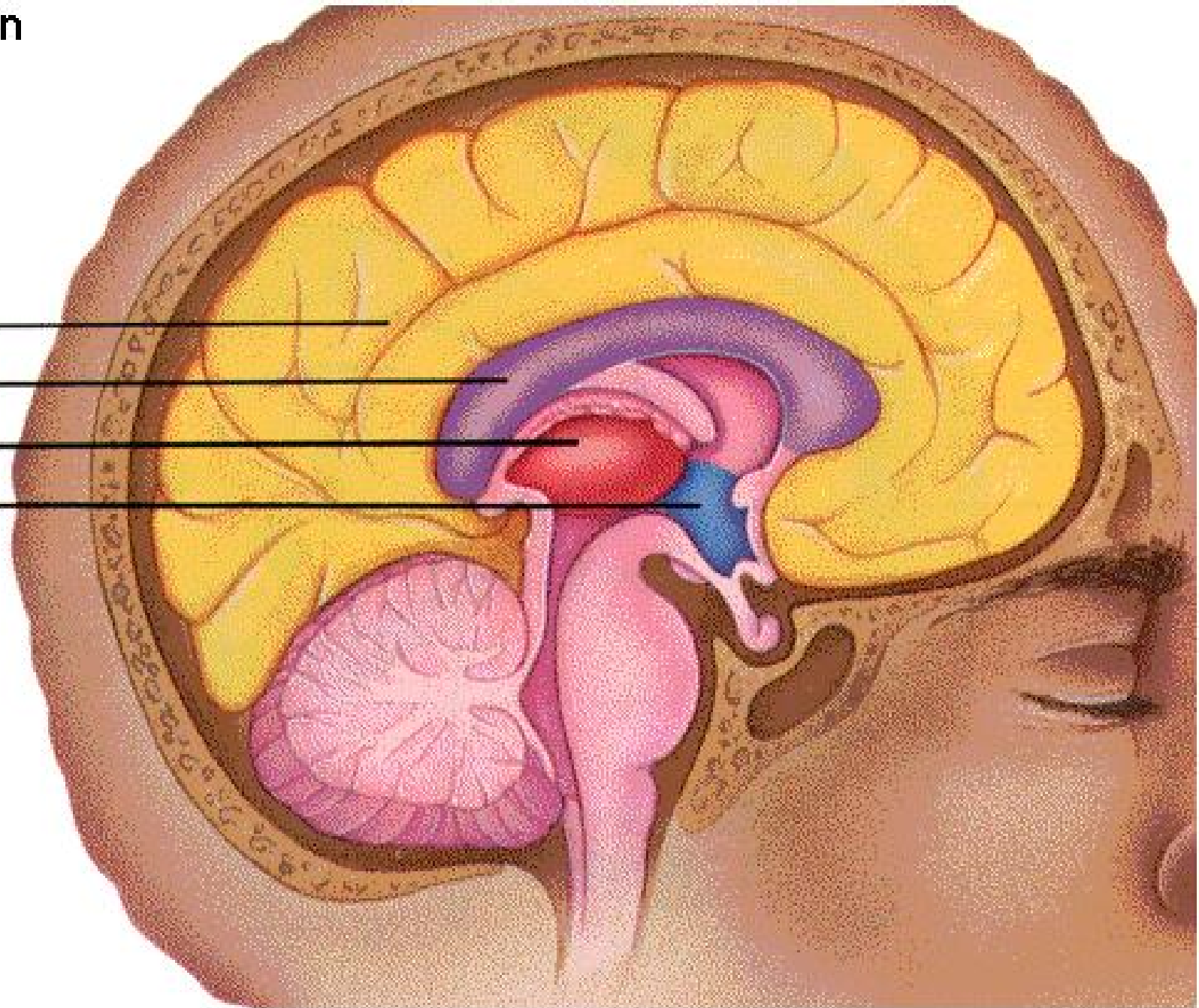
Corpus callosum



Thalamus



Hypothalamus



B. Brain Specifics

1. Primitive central core

c. Reticular system

a. diffuse from brainstem to thalamus

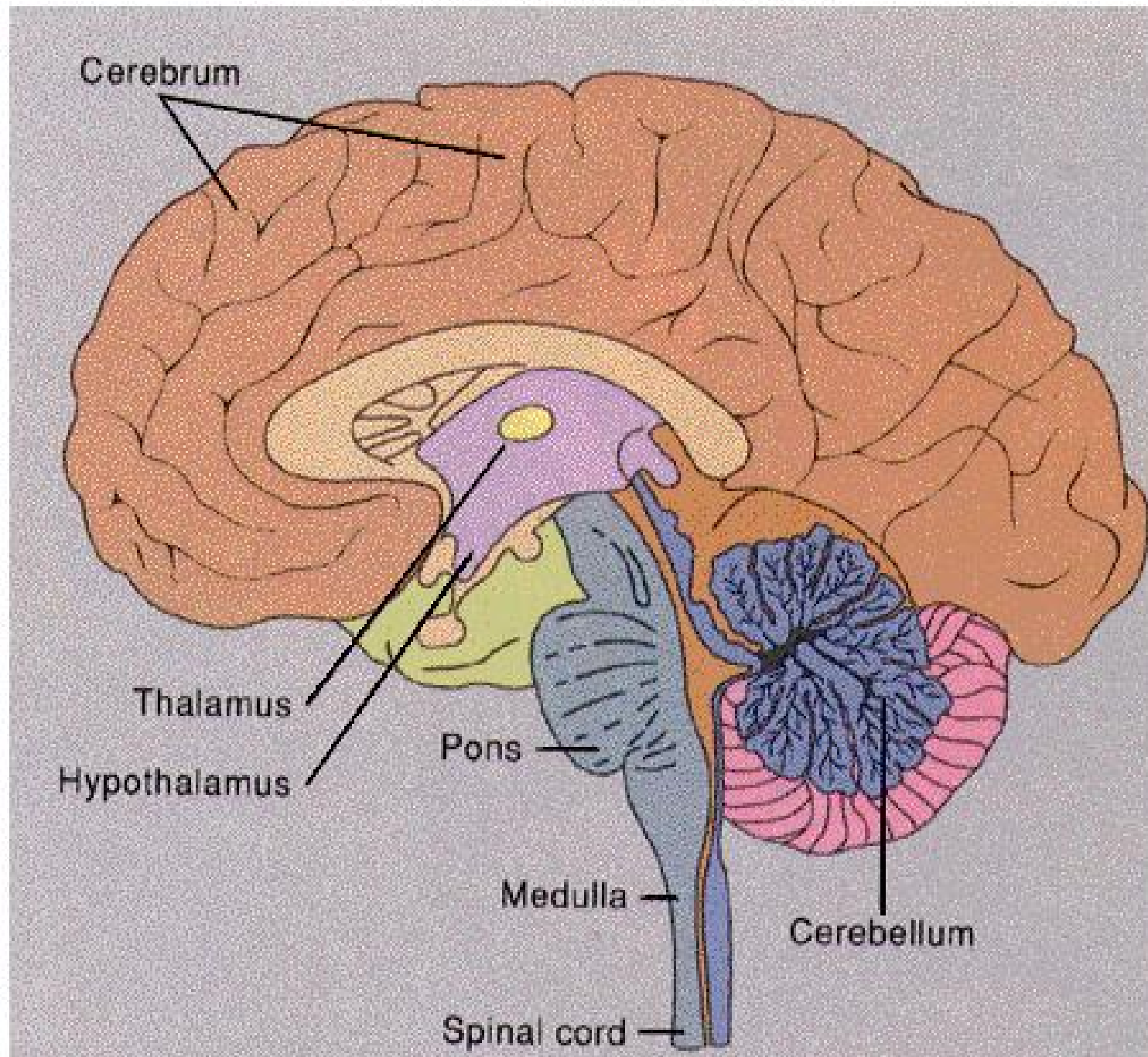
b. 3 A's, arousal, awareness, attention

B. Brain Specifics

2. Limbic system

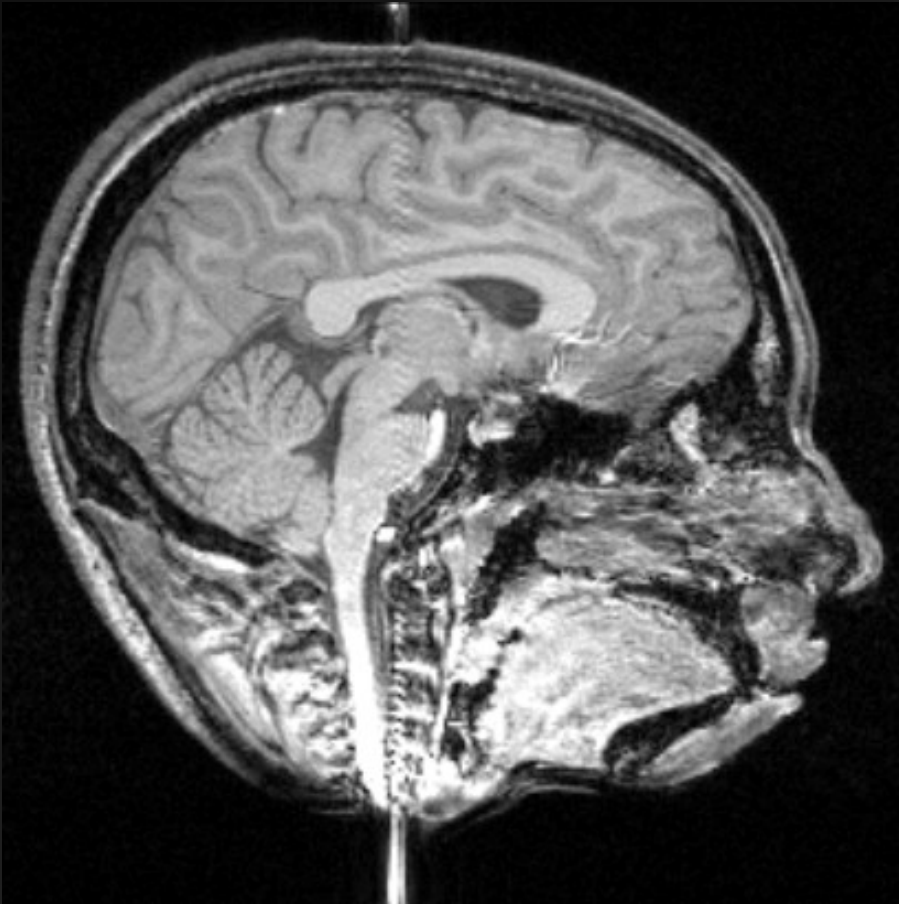
- a. a group of structures lying along the innermost edge of the cerebral hemispheres
- b. involved in instinctual behaviors in lower animals (caring for young, mating, fleeing from attackers, fleeing from prey)
- c. involved in memory and emotion in humans
- d. Especially important structures within the Limbic system:
 - i.. Hippocampus
 - ii. Amygdala

Brain's Main Structures

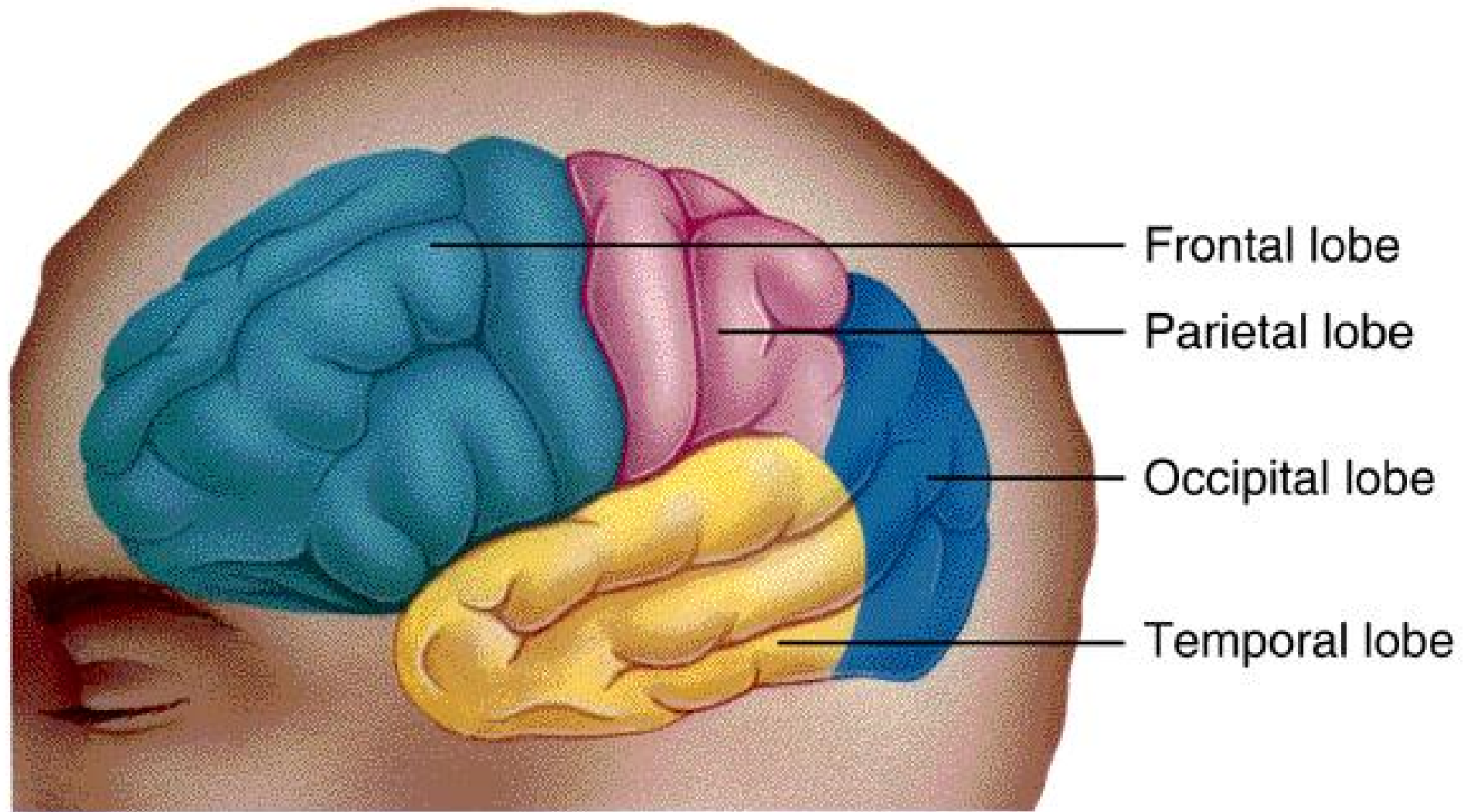


The common household brain

- 3. The cerebral hemispheres
 - a. Grey matter vs white matter



Four Lobes of the Cerebral Cortex



Frontal lobe

Parietal lobe

Occipital lobe

Temporal lobe

The common household brain

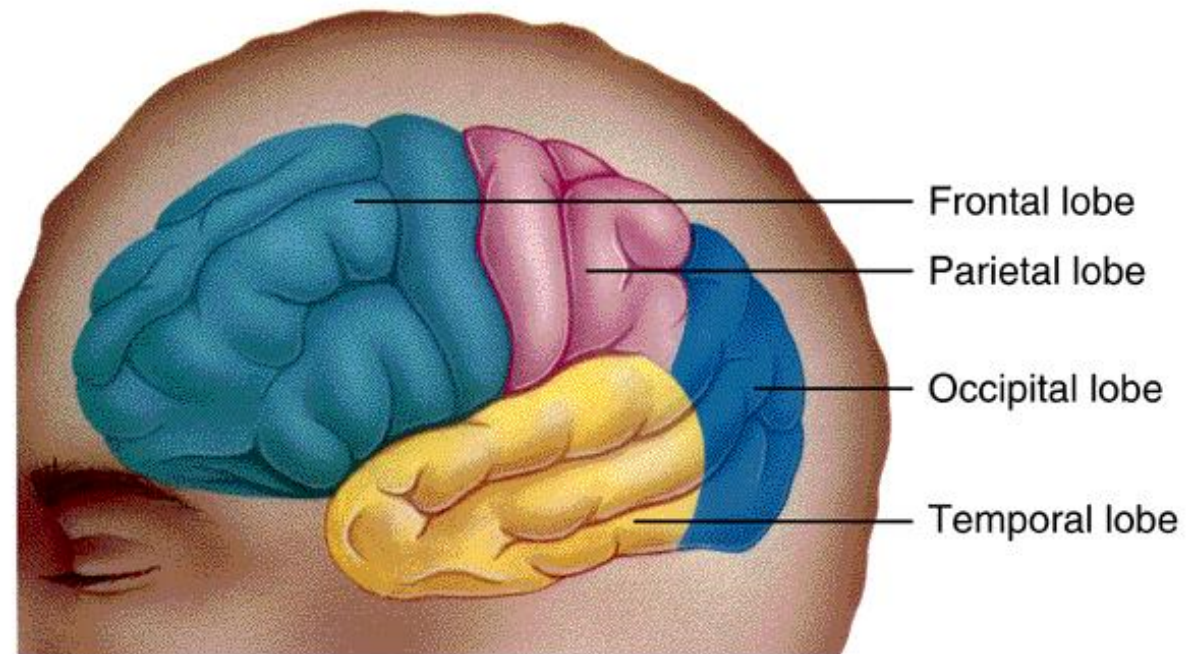
3. The cerebral hemispheres

b. Four lobes:

1. frontal
2. parietal
3. occipital
4. temporal

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Four Lobes of the Cerebral Cortex

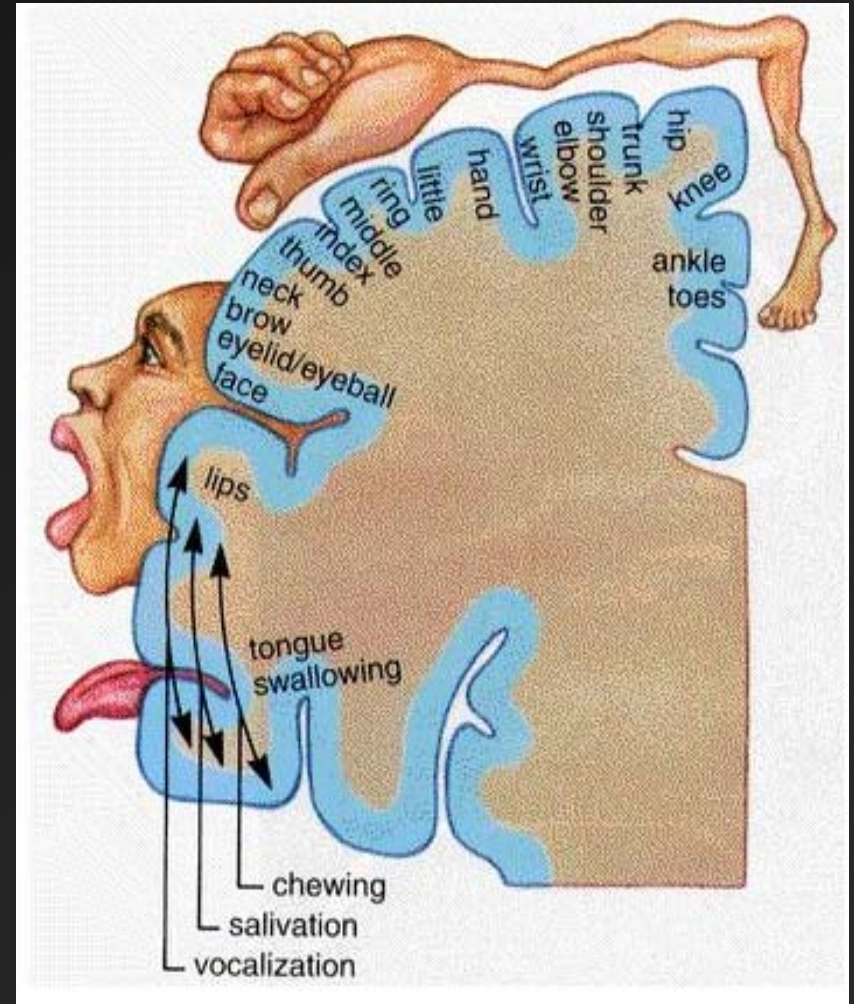


The common household brain

3. The cerebral hemispheres

b. Motor area

1. topographic organization--
Homunculus
2. contralateral control of body

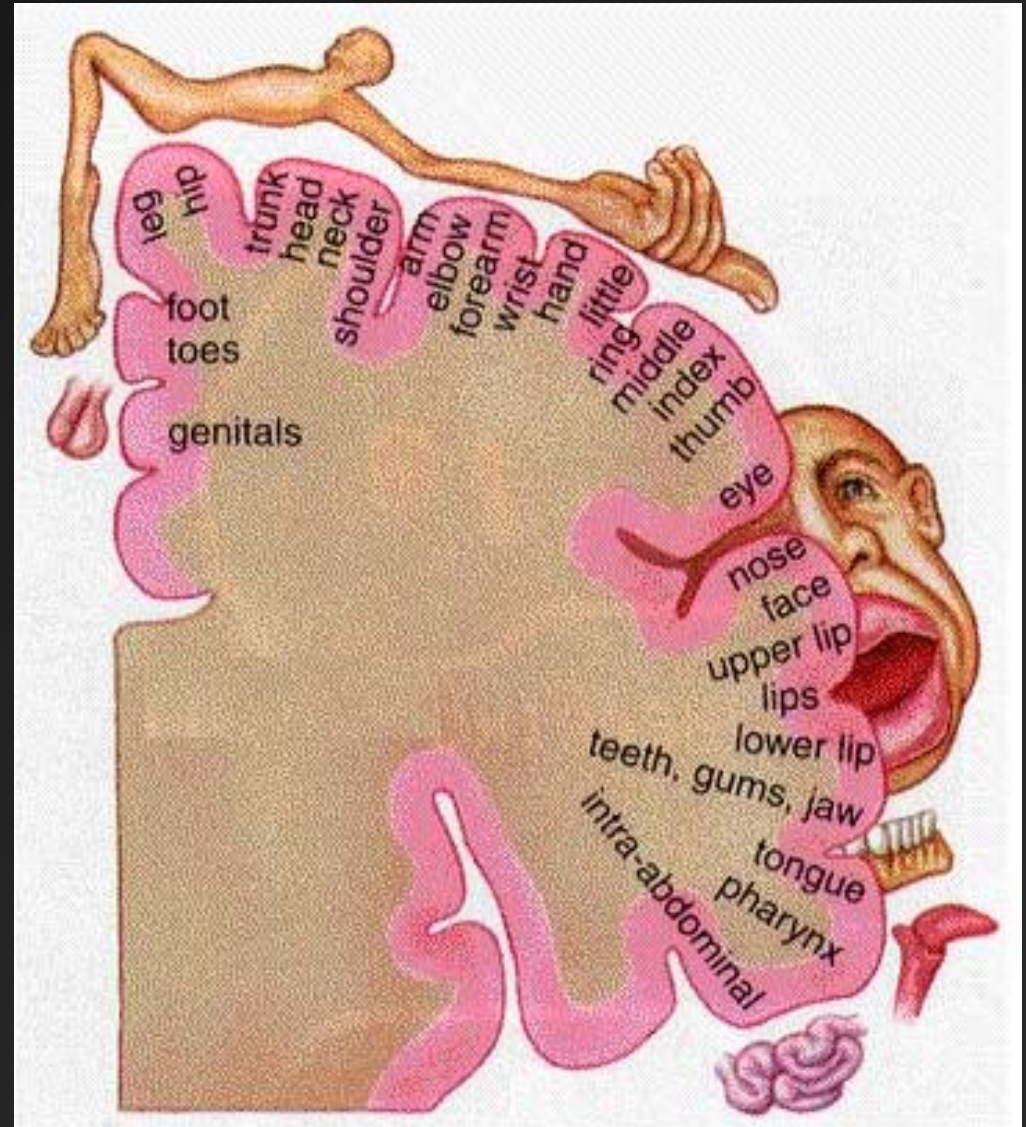


The common household brain

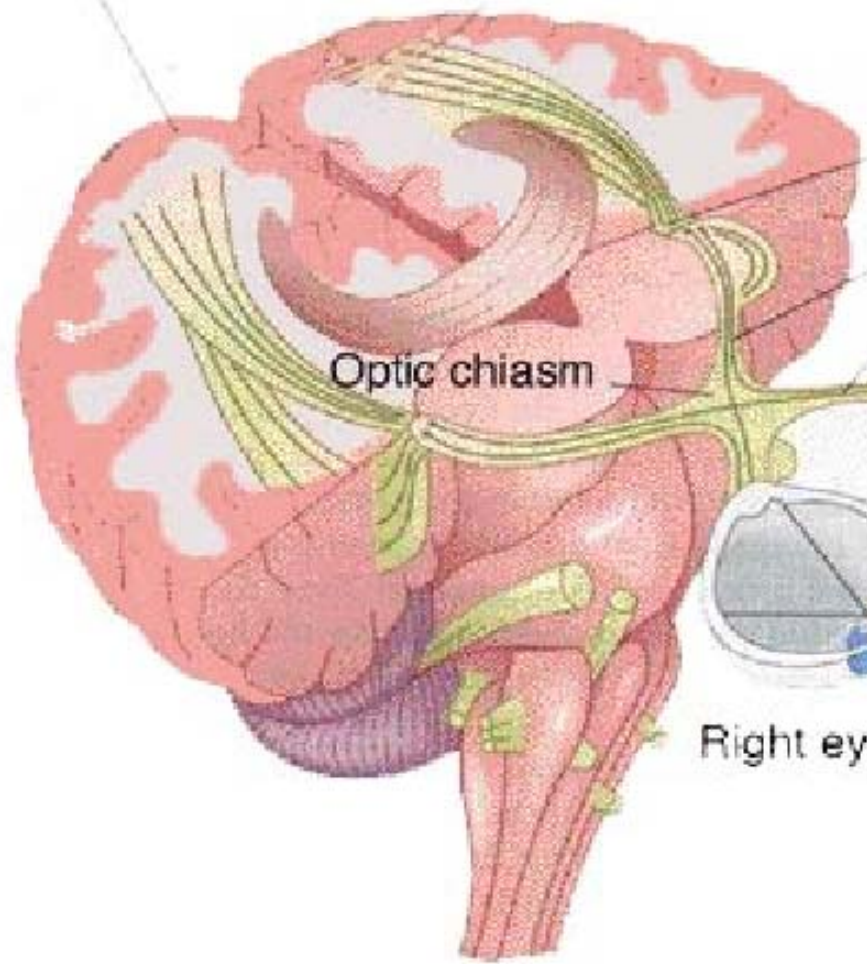
3. The cerebral hemispheres

d. Somatosensory area

1. heat, cold, touch, pain, sense of body movement
2. contralateral
3. space appropriated in accord to amount of use or need



Visual cortex



Lateral geniculate nucleus

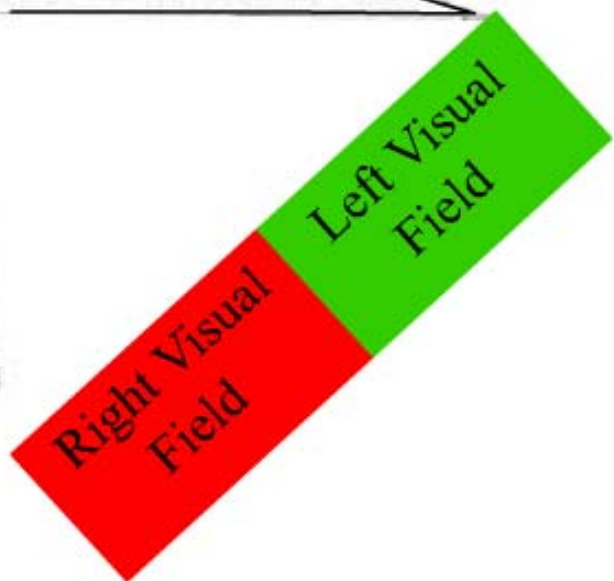
Optic tract

Optic nerve

Optic chiasm

Left eye

Right eye



Right Visual Field

Left Visual Field

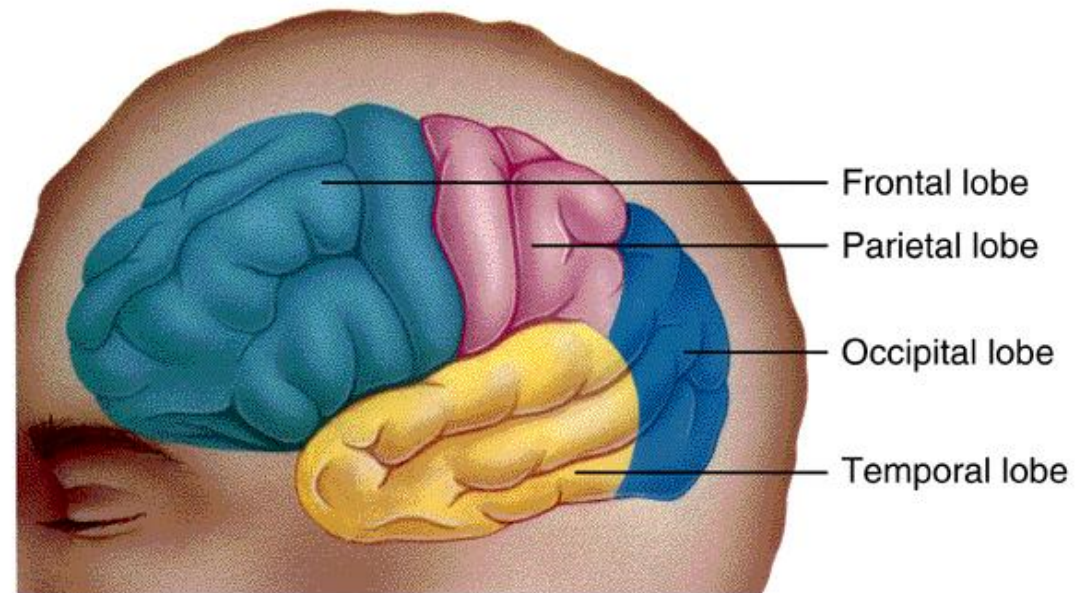
The common household brain

f. Auditory area

1. bilateral representation
2. contralateral stronger

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Four Lobes of the Cerebral Cortex



The common household brain

g. Association areas

1. functions which are not directly sensory or motor
2. Examples:
 - a. motor planning
 - b. thought
 - c. speech
 - d. problem solving
 - e. complex object recognition (e.g. prosopagnosia)
 - f. Phylogeny of Association Cortex

Luria's Functional Systems

1. Primary

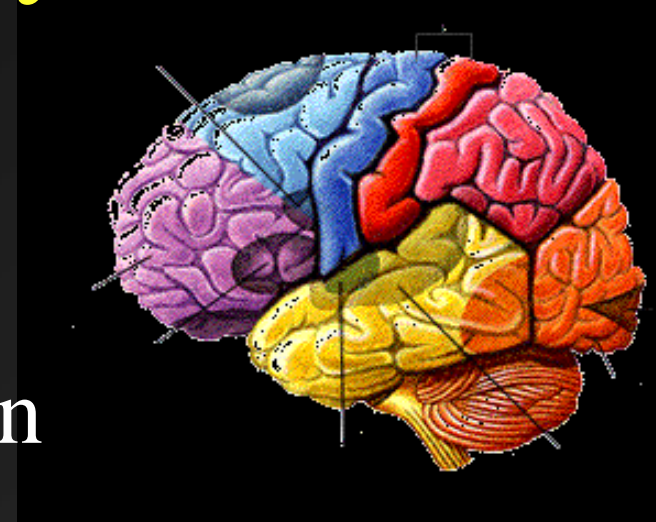
a. Motor (precentral gyrus);
(1) topographic organization

b. Sensory

(1) Somatosensory (post central gyrus)

(2) Visual (Occipital cortex)

(3) Auditory (Banks of Lateral Sulcus)

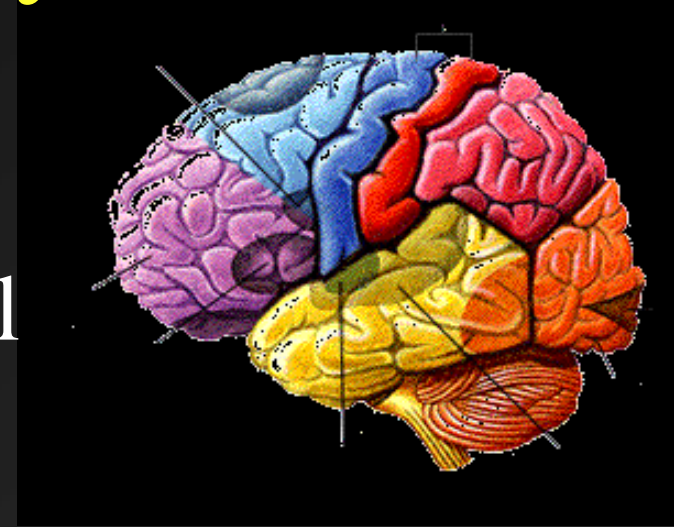


Luria's Functional Systems

2. Secondary

a. Motor (rostral to precentral gyrus): motor programming, sequences of movements

b. Sensory (caudal to postcentral gyrus): **unimodal** sensory integration

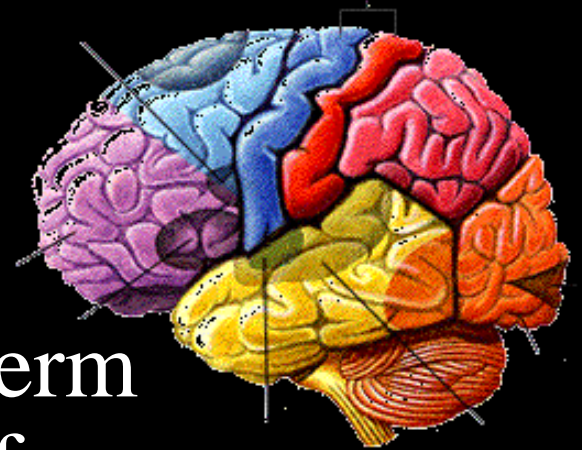


Luria's Functional Systems

3. Tertiary

a. Motor (frontal lobes): goal directed acts, long-term & short-term planning, internal manipulation of "ideas" and representational systems that are basic to abstract thought

b. Sensory (parietal-temporal-occipital junction): **cross-modal** integration of sensory information



Skin Conductance:

Pontificating about sweat

Two types of Sweat Glands

➤ Eccrine

- forms basis of skin conductance recording
- located all over body, but dense concentrations on surface of hands and feet
- has many functions

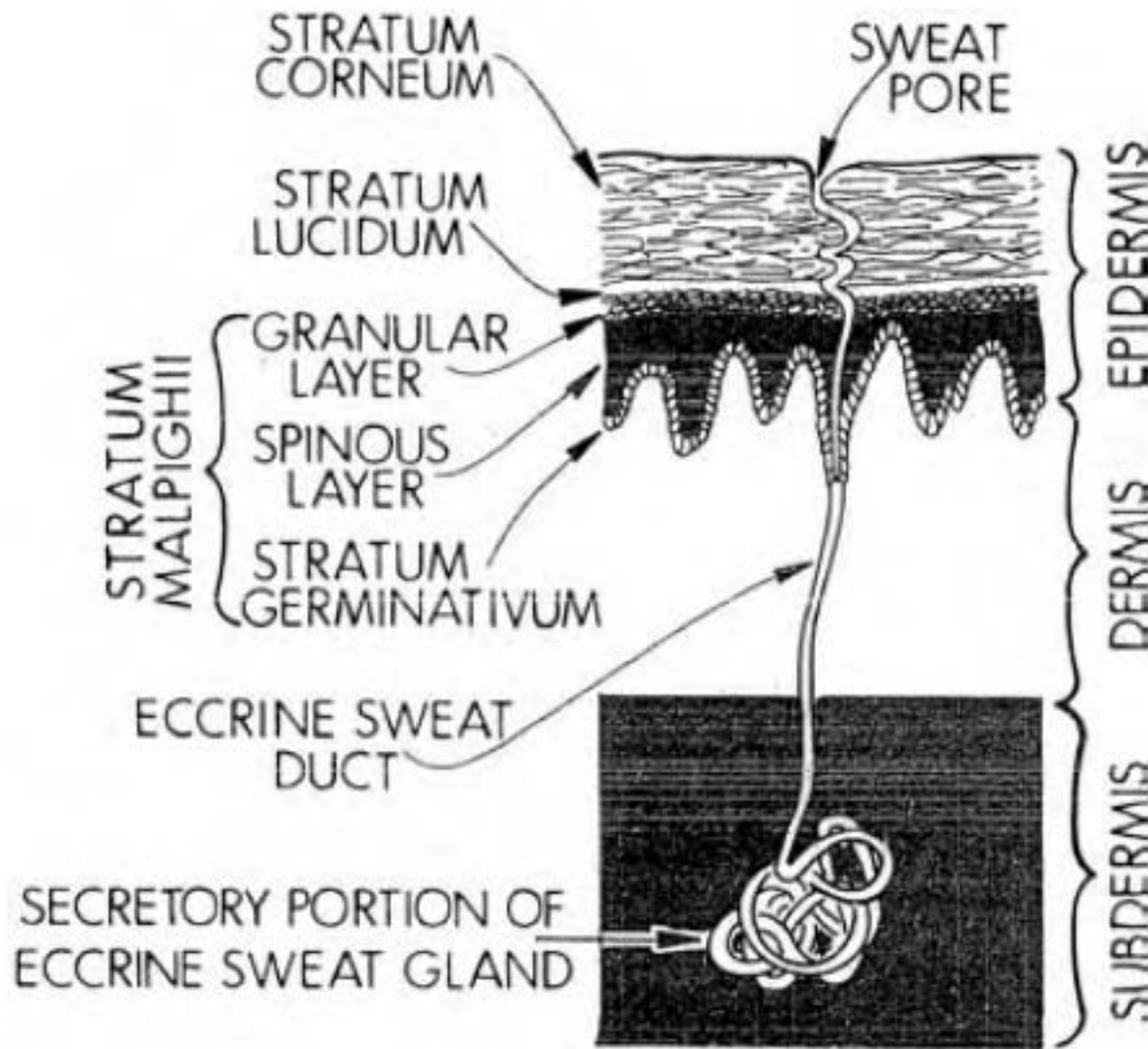
➤ Apocrine

- found under armpits and genital areas
- function a matter of debate
- not of great interest to psychophysicologists

Functions of Sweat Glands

- Thermoregulation
- Thermal Preparation
- Facilitate manipulative contact
- Minimize abrasion
- Accentuate Tactile Acuity
- Odiferous communication? (Apocrine)

Anatomy of a Gland and the Skin

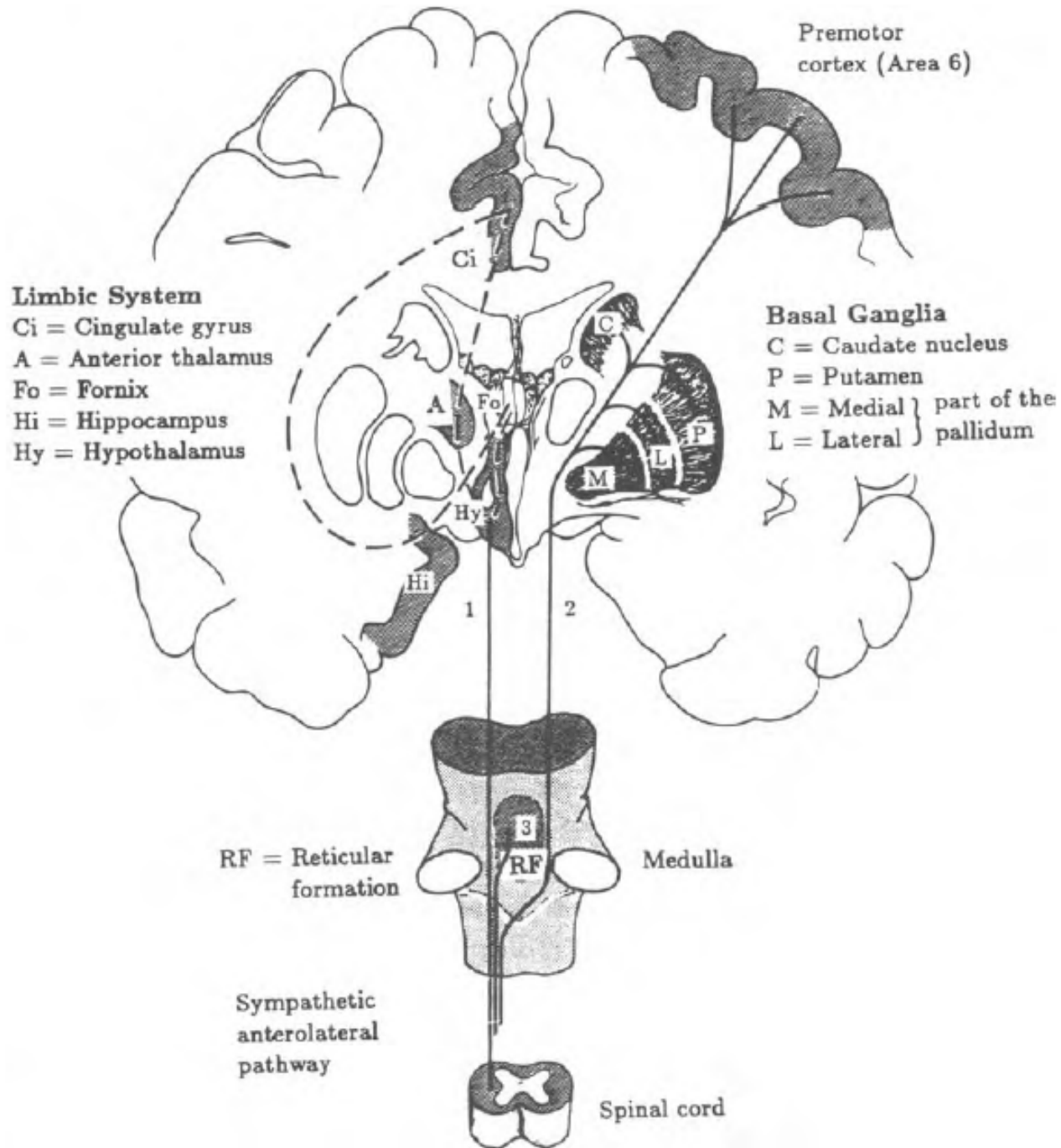


- Sweat glands primarily driven by sympathetic innervation that is cholinergic
- Sudomotor fibers originate in the sympathetic chain, terminate on sudomotor cell of sweat gland
- Stratum Corneum acts as a variable resistor, with decreased resistance due to sweat

Figure 7.1. Anatomy of the eccrine sweat gland in various layers of skin. (Adapted from Hassett, 1978).

From
Dawson et al 2007

Central Control



From Dawson et al 2007

Figure 7.2. Central nervous system determinants of EDA in humans (From Boucsein, 1992).

Acronym Glossary

➤ Generic terms

- EDA = electrodermal activity
- GSR = galvanic skin response

➤ Skin Resistance

- SRL = skin resistance level (tonic); 10,000-500,000 Ω
- SRR = skin resistance response (phasic); 100-10,000 Ω

➤ Skin Conductance

- SCL = skin conductance level (tonic); 2-50 μ siemens
- SCR = skin conductance response (phasic); .05-5 μ siemens
- SSCR or NSSCR = spontaneous or non-specific skin conductance response

➤ Skin Potential

- SPL = skin potential level (tonic); 0-60 mV
- SPR = skin potential response (phasic); .1-10 mV

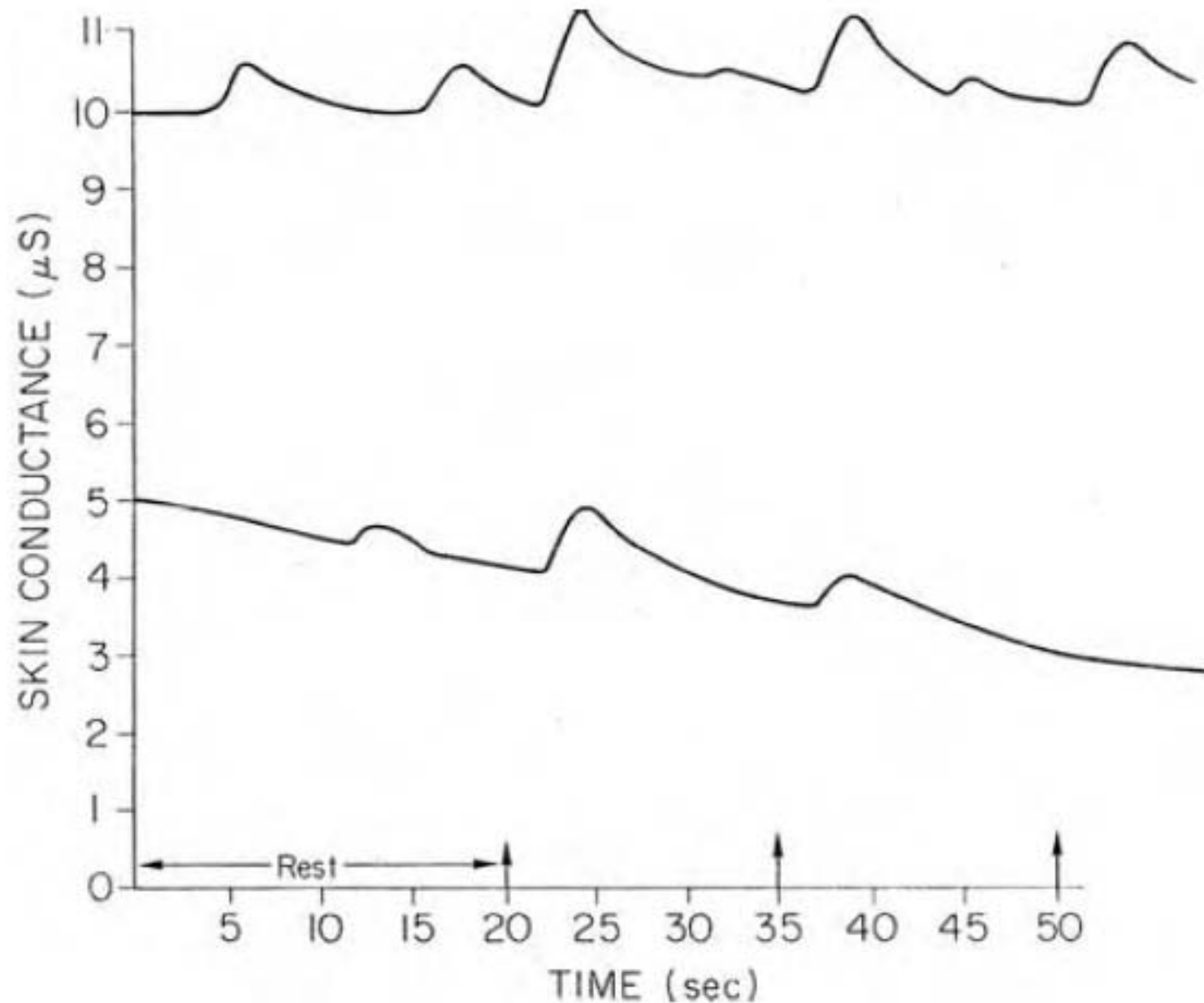


Figure 7.4. Two hypothetical skin conductance recordings during 20 s of rest followed by three repetitions of a simple discrete stimulus. Arrows represent the presentation of a stimulus (From Dawson & Nuechterlein, 1984).

Table 7.1. Electrodermal measures, definitions, and typical values

Measure	Definition	Typical Values
Skin conductance level (SCL)	Tonic level of electrical conductivity of skin	2–20 μS
Change in SCL	Gradual changes in SCL measured at two or more points in time	1–3 μS
Frequency of NS-SCRs	Number of SCRs in absence of identifiable eliciting stimulus	1–3 per min
SCR amplitude	Phasic increase in conductance shortly following stimulus onset	0.1–1.0 μS
SCR latency	Temporal interval between stimulus onset and SCR initiation	1–3 s
SCR rise time	Temporal interval between SCR initiation and SCR peak	1–3 s
SCR half recovery time	Temporal interval between SCR peak and point of 50% recovery of SCR amplitude	2–10 s
SCR habituation (trials to habituation)	Number of stimulus presentations before two or three trials with no response	2–8 stimulus presentations
SCR habituation (slope)	Rate of change of ER-SCR amplitude	0.01–0.5 μS per trial

Key: SCL, skin conductance level; SCR, skin conductance response; NS-SCR, nonspecific skin conductance response.

Glands Act as Resistors in Parallel

- Resistance will therefore decrease with increased recording surface area – **keep surface area constant across subjects**
- Resistance is not linearly related to the # of resistors

$$\frac{1}{R_t} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \dots$$

- Conductance, however, is linearly related to the number of resistors in the circuit
 - Therefore, there exists a linear relation between measures of conductance and sweat secretion
 - Not so for Resistance
 - The metric of conductance more accurately reflects the activity of the system

	SRL	SCL	SRR	SCR
R1 Pre	100,000	10		
R1 Post	99,000	10.1	1000	0.1
R2 Pre	20,000	50		
R2 Post	19,000	52.6	1000	2.6

- Conductance is the Reciprocal of Resistance
- This shows how two vastly different responses will appear the same using skin resistance response metrics

Recording -- Placement

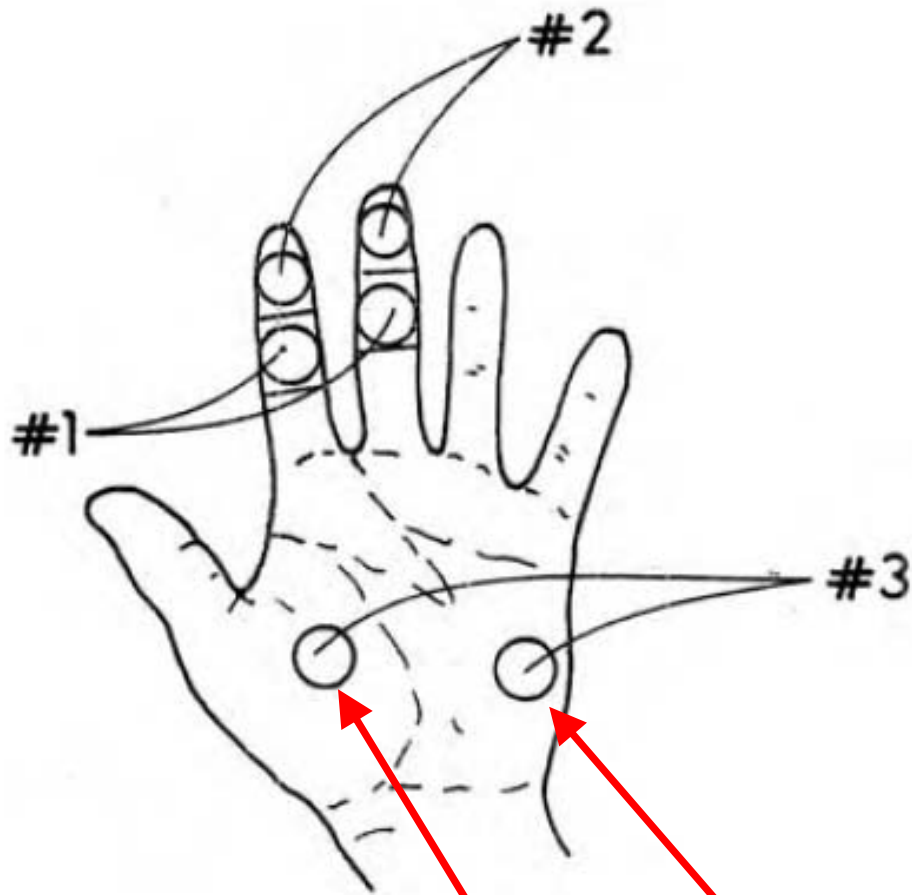


Figure 7.3. Three electrode placements for recording electrodermal activity. Placement #1 involves volar surfaces on medial phalanges, placement #2 involves volar surfaces of distal phalanges, and placement #3 involves thenar and hypothenar eminences of palms.

From Dawson et al 2007

Recording Considerations

- Prep the Skin?
 - Never abrade
 - Don't use other agents (ETOH)
 - Washing with soap and H₂O recommended to standardize across subjects
- Electrodes – Ag-AgCl
 - More expensive and fragile (unless sintered)
 - But well worth it – resist polarization
- Conductive Paste
 - Because current passed continuously, can interact with with the tissue
 - Unibase + physiological saline (Fowles et al, 1981) will keep properties of tissue and paste constant over duration of recording session
 - Other gels are bad news;
 - highly conductive, but saturated with NaCl,
 - over time will migrate to skin tissue, inflating SCL
- Surface Area Exposed
 - Keep constant across subjects and session
- Constant Voltage Amplification
 - Preferred over Constant current (Lykken and Venables, 1971)
- Temporal responsivity – SC system is S...L...O...W

The Generic SCR

- Latency typically 1-3 secs
- Rise time typically 1-4 secs

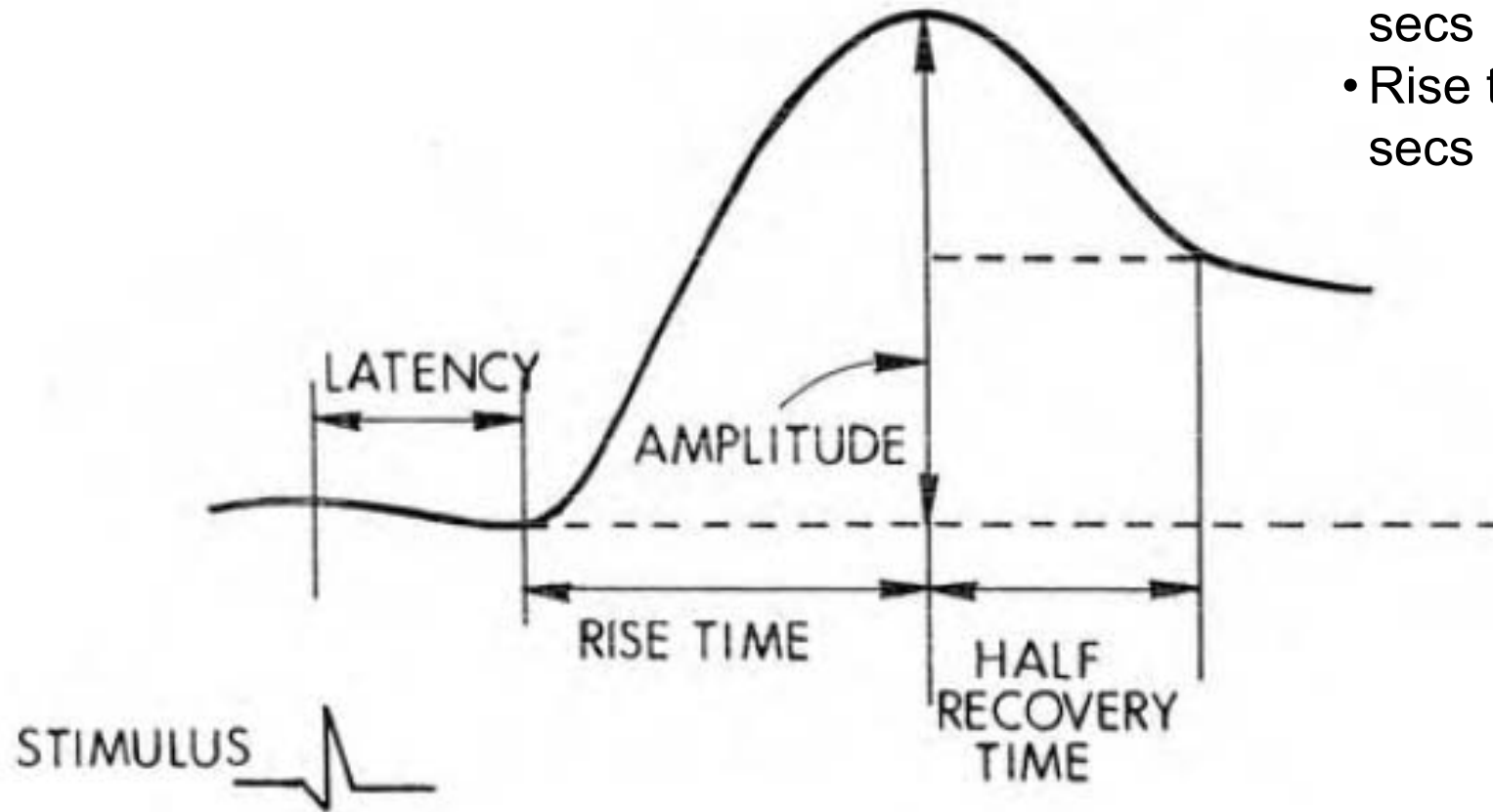


Figure 7.5. Graphical representation of principal EDA components.

Scoring Issues

- Responses that ride on responses
- Range Correction (Lykken et al., 1966)

- Level

$$\frac{(SCL_{observed} - SCL_{min})}{(SCL_{max} - SCL_{min})}$$

- Response

$$\frac{(SCR_{observed})}{(SCR_{max})}$$

- Note also slope and intercept regression approaches

Applications

- Orienting (Bauer, 1984; Tranel and Damasio, 1985)
- Fear conditioning (Öhman)
- Individual Differences in Neuroticism
- Deficient anticipatory anxiety in psychopathy (Hare)
- Deception Detection (Myriad authors)

Neuroticism

- A trait-like tendency to experience negative affect and for increased reactivity to stress and aversive stimuli
- Would skin conductance reflect greater physiological reactivity to negative stimuli, and poorer physiological recovery?

Norris, Larsen, & Cacioppo (2007), *Psychophysiology*

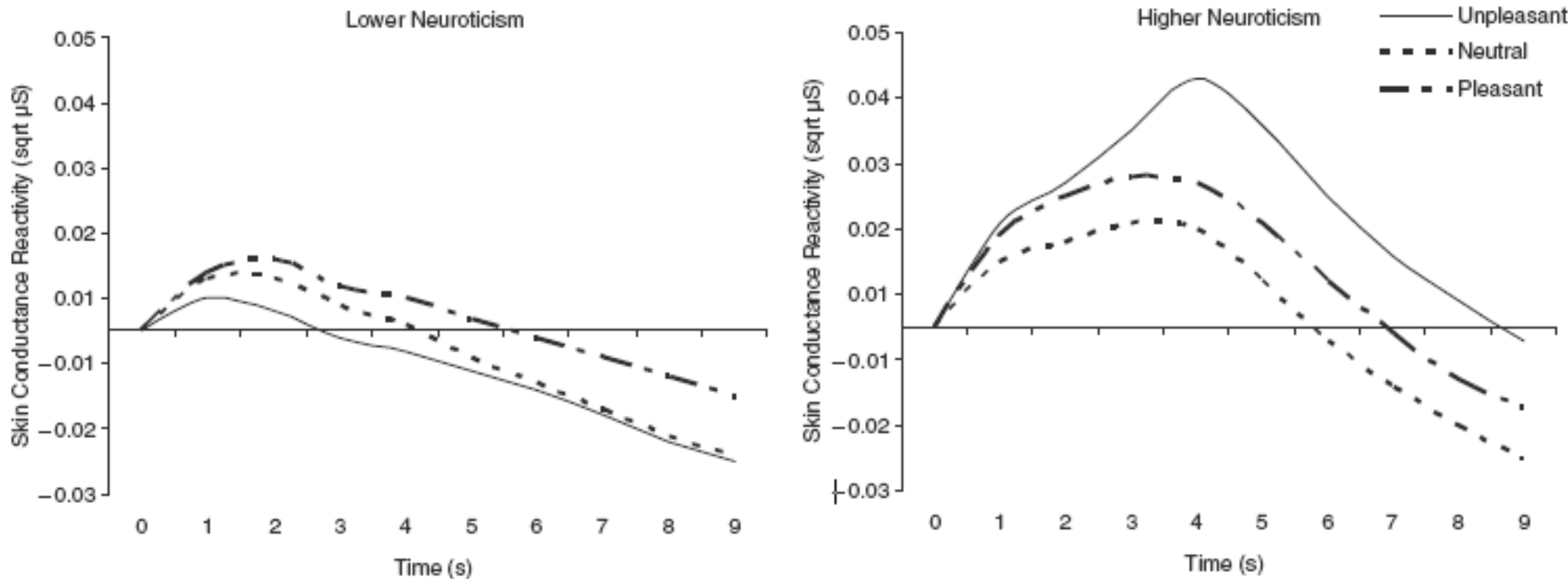


Figure 1. Skin conductance reactivity as a function of picture valence, time, and neuroticism. Pictures were presented from 1–6 s. Estimated means for participants lower (1 *SD* below the mean) and higher (1 *SD* above the mean) in neuroticism are plotted separately.

Anticipatory Arousal in Psychopathy

- Hare Countdown Task (1965)
- #'s appear from 1..8
- At "8" punishment is given (shock):

