Lecture 3

8 February, 2016

Announcements (2/8/16)

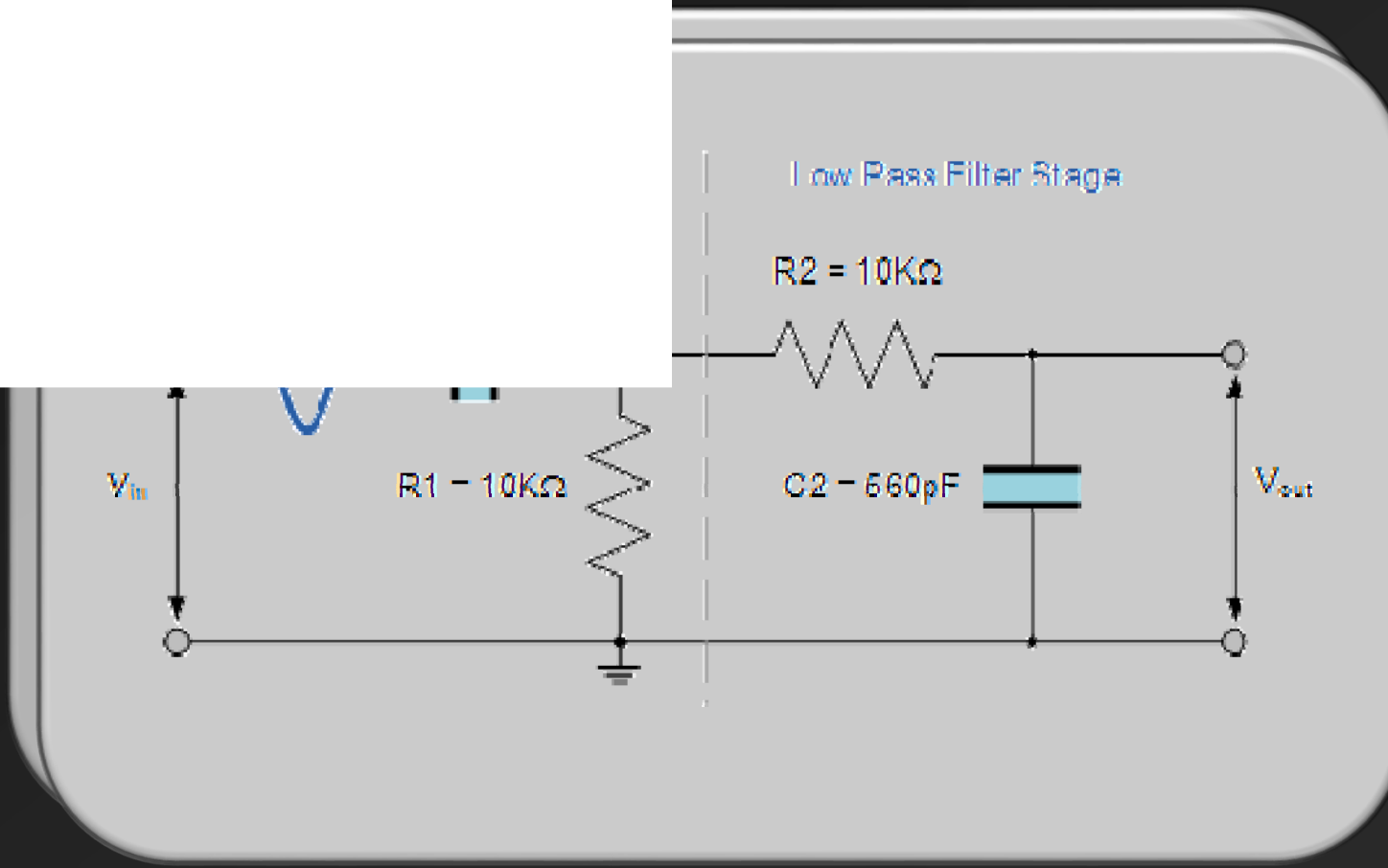
- Electricity Test next week (Feb 11)
- Information on Papers next week
- Lab: Logon problems?

Electricity Test Objectives

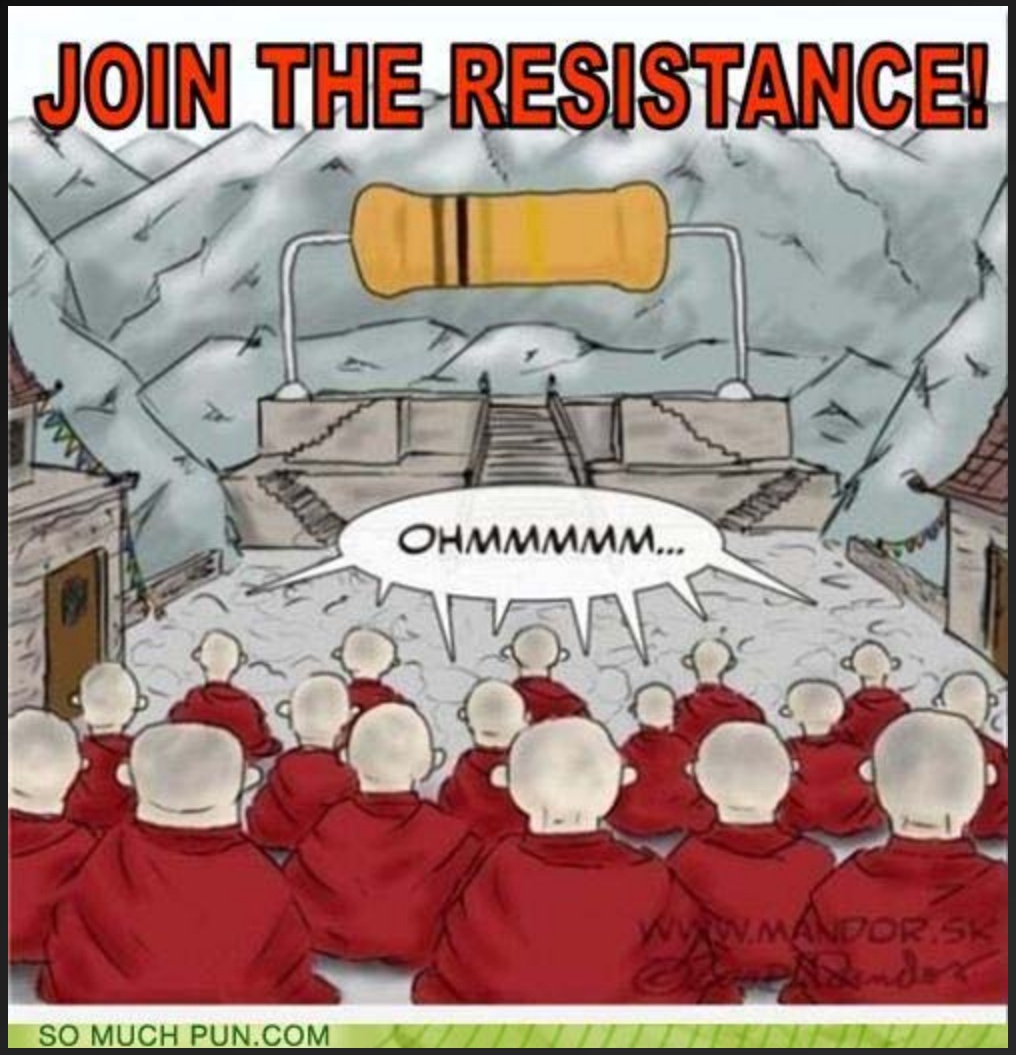
- Describe positive and negative charges
- State the law of attraction and repulsion
- Describe free electrons
- Describe the relationship between electromotive force, resistance, and flow (i.e. understand Ohm's Law)
- Draw a simple DC electric circuit comprised of a battery and:
  - Single resistor
  - 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

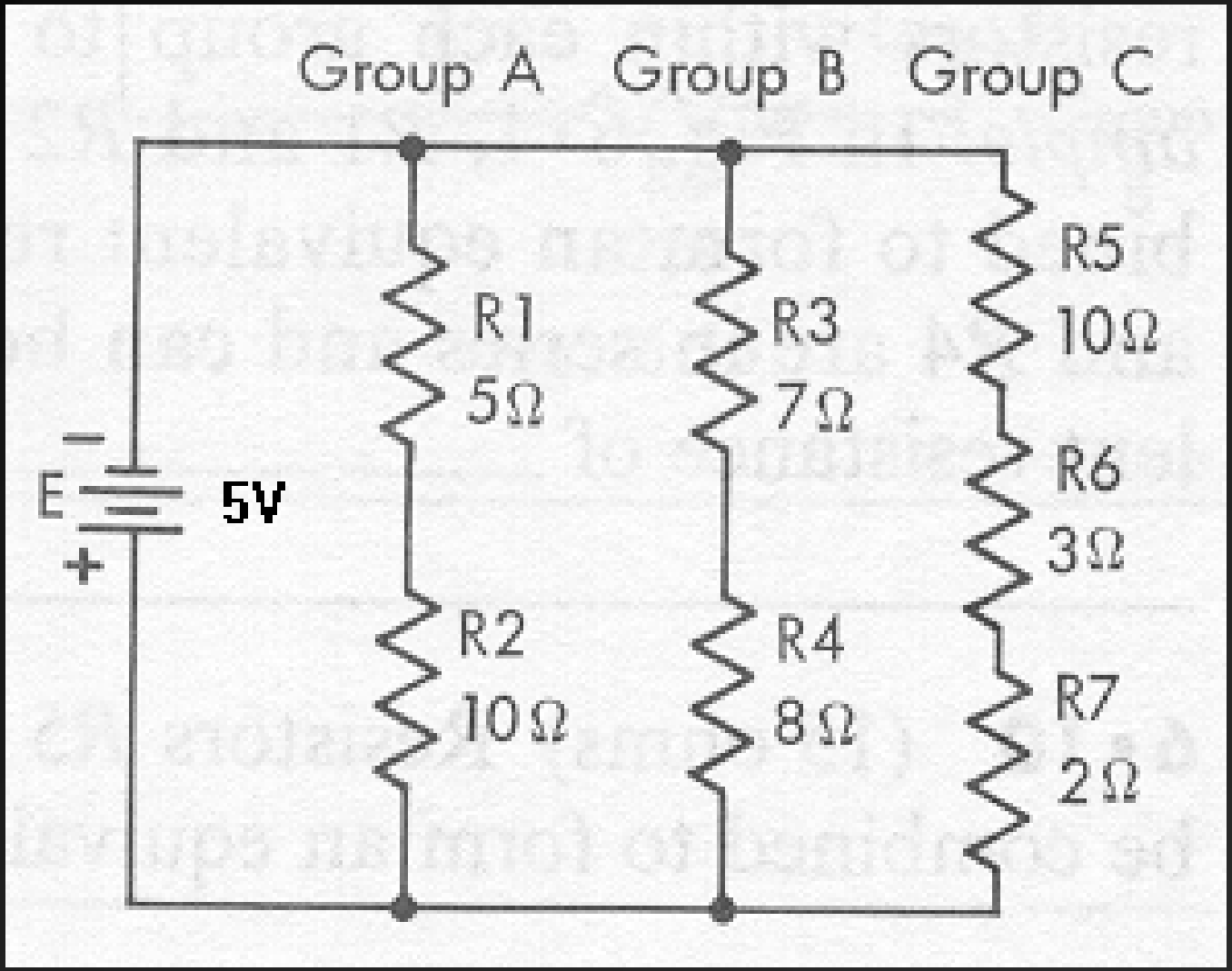
3x5 Time

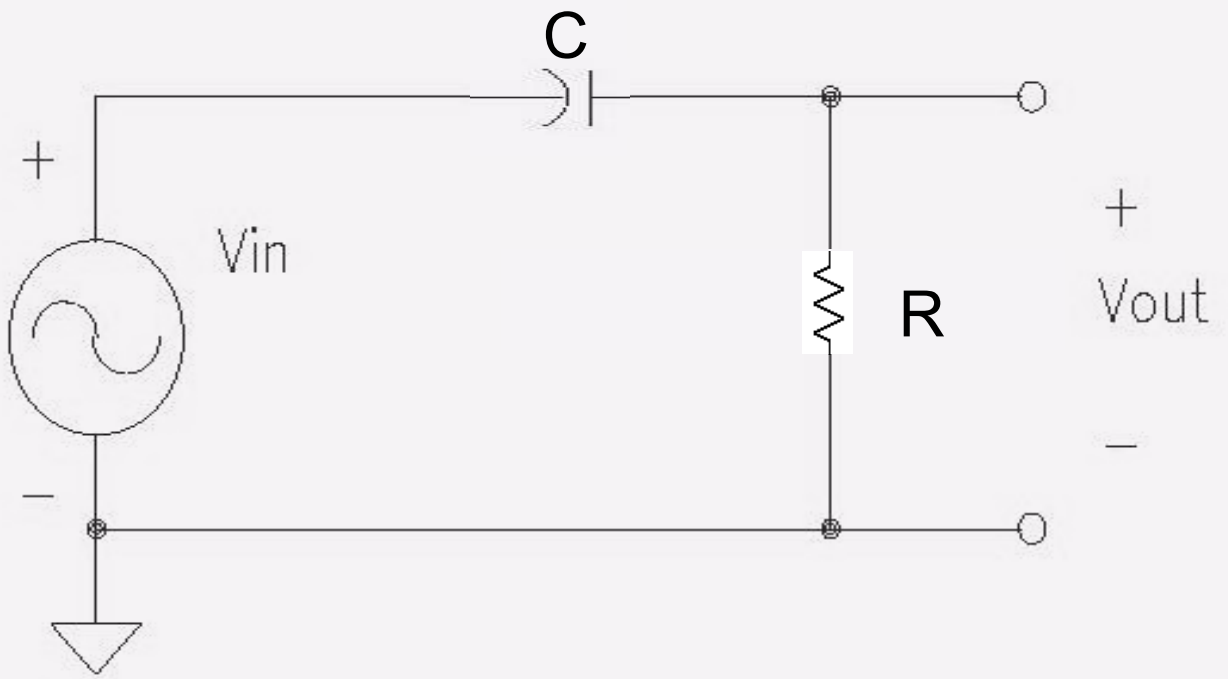
A couple questions asking for clarification on circuits (solving complex circuits, filters, TC) …



Brief Review

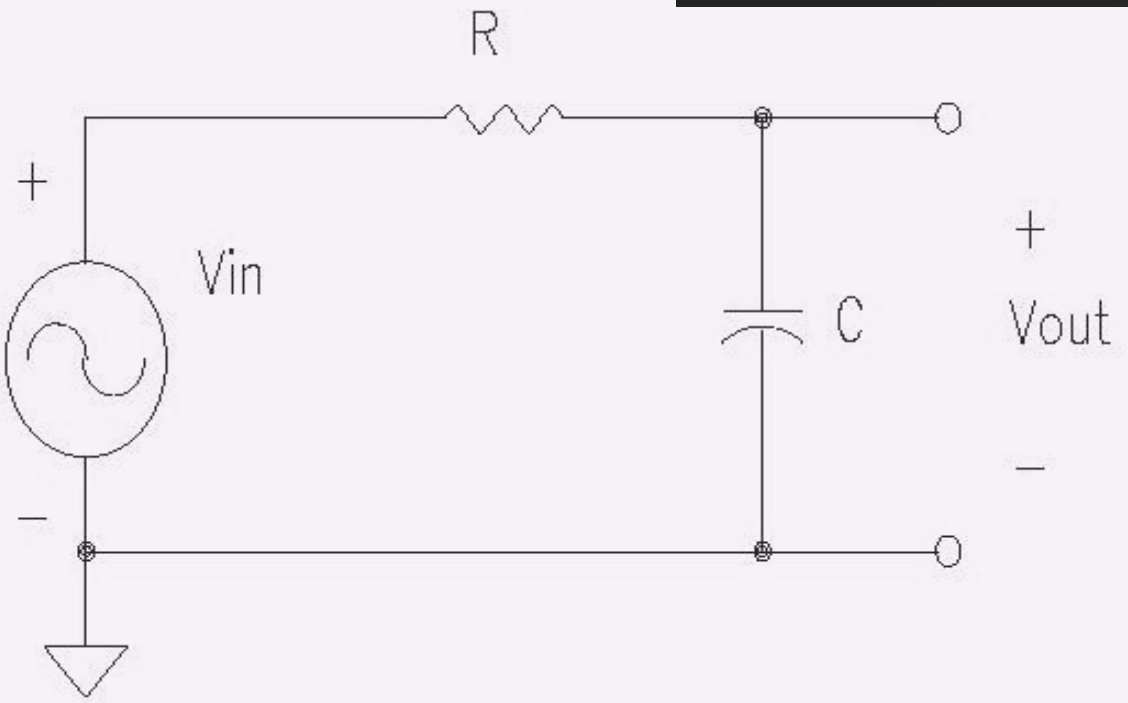


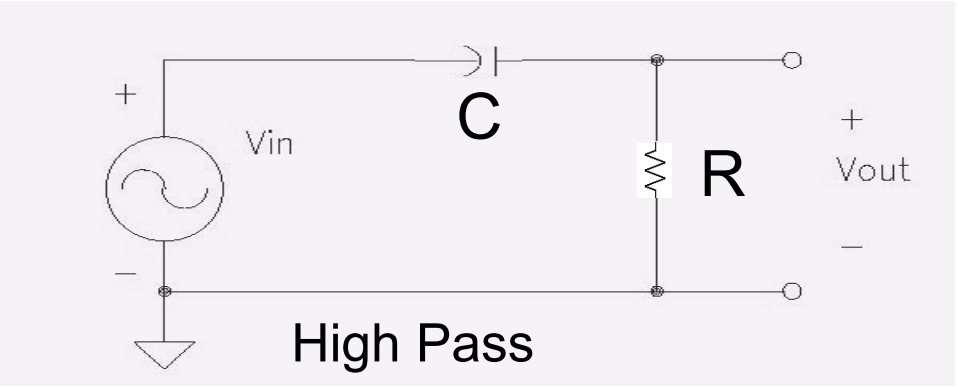

Group A
Group B
Group C
R1
5Ω
R2
10Ω
R3
7Ω
R4
8Ω
R5
10Ω
R6
3Ω
R7
2Ω
E
5V
−
+



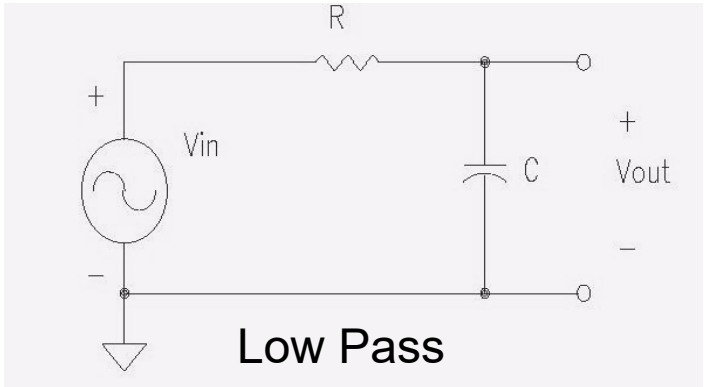
High Pass

Low Pass

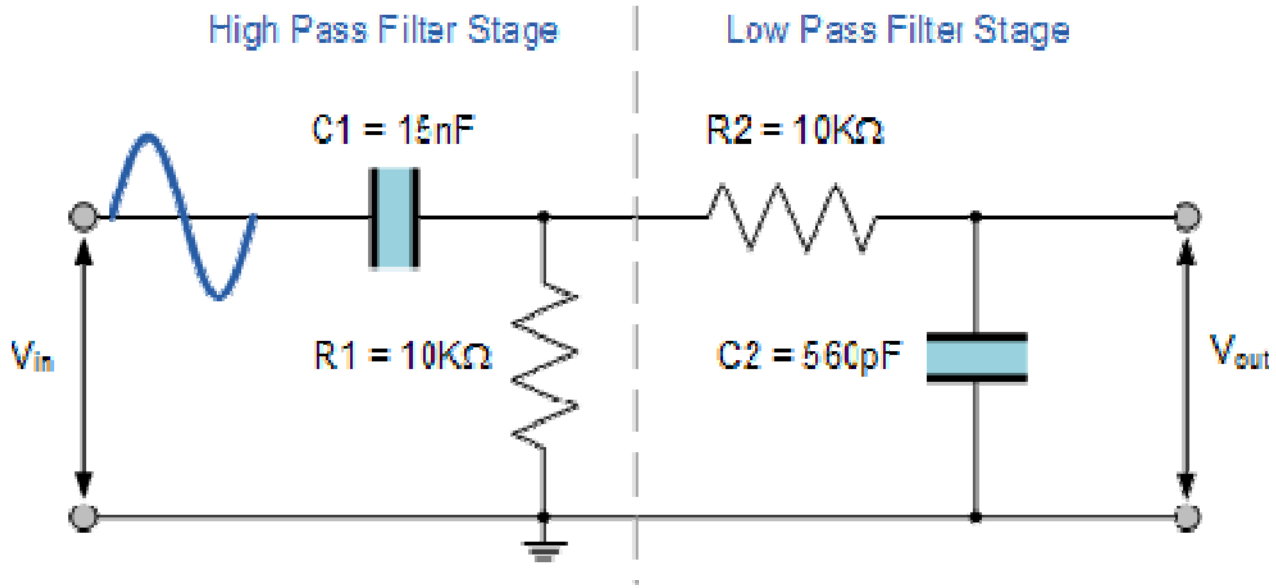




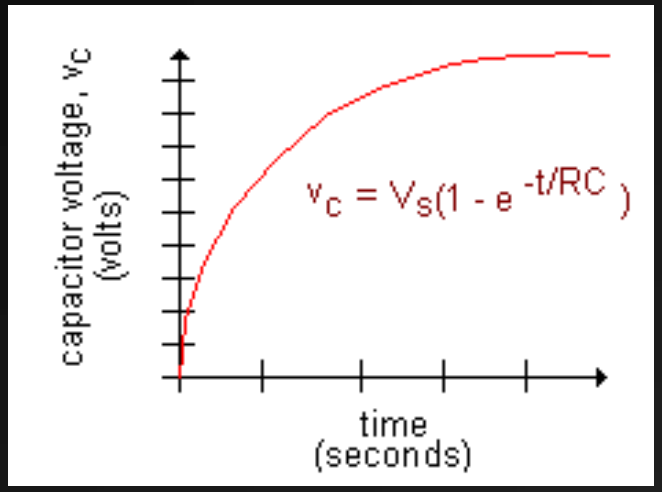
High Pass

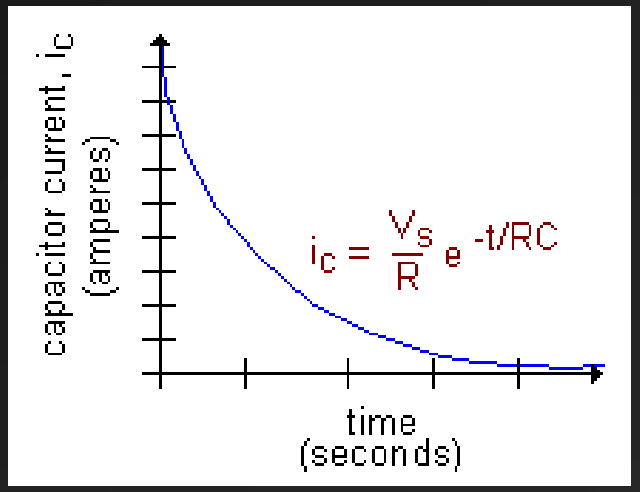


Low Pass



Capacitor Time Constants





Over time…

Capacitor's voltage increases

Current flow grinds to a halt

The capacitor's time constant TC=

- The time in seconds for it to become 63.2% charged ($1 - e^{-1} = .632$)
- The time in seconds for current flow have slowed by 63.2% from its starting value

Today:

Basic Neuroanatomy
The Electrodermal Response System

Part III: *Basic* Neuroanatomy

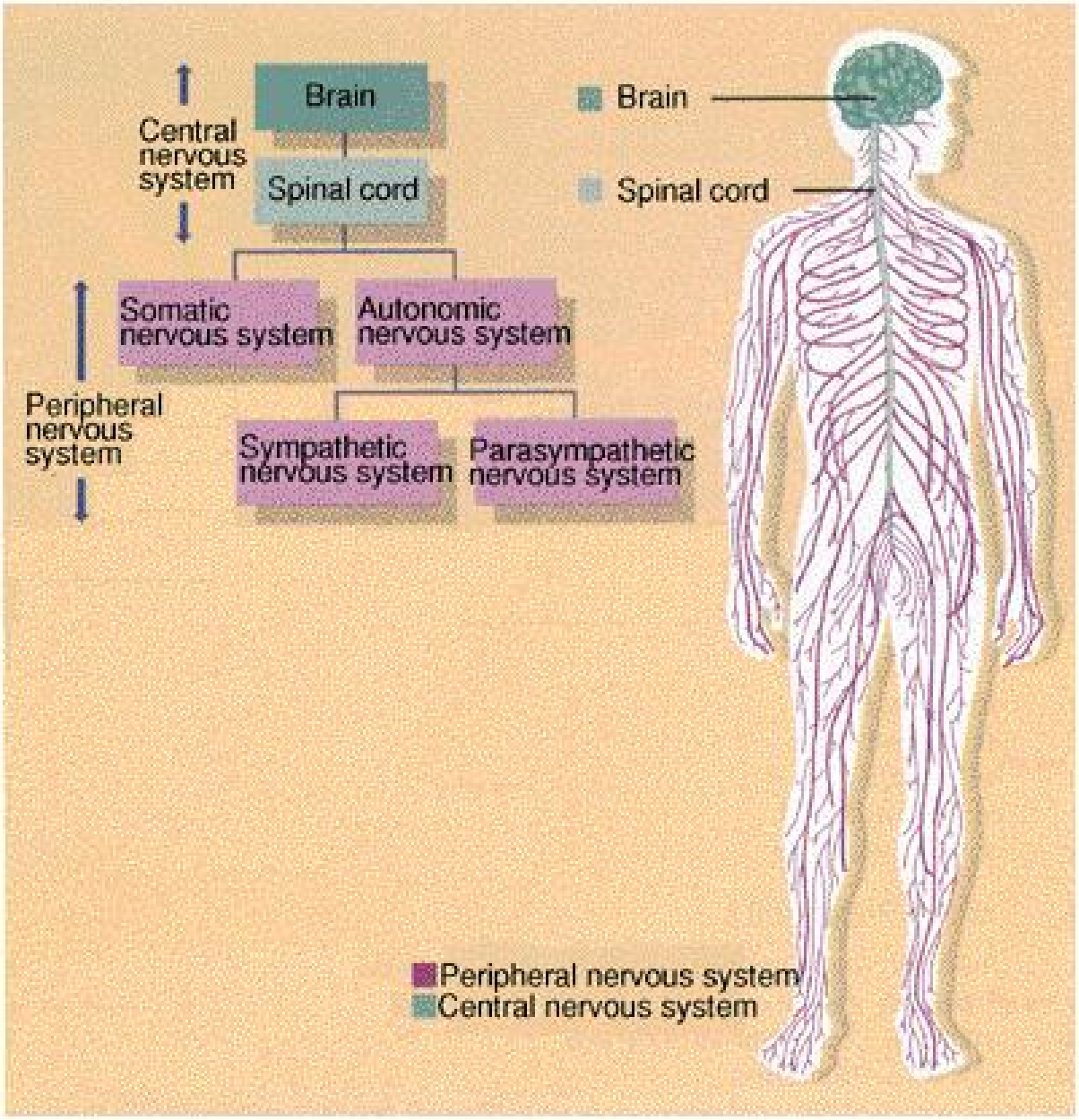
If the human brain were so simple that we could understand it,

we would be so simple that we couldn't.

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

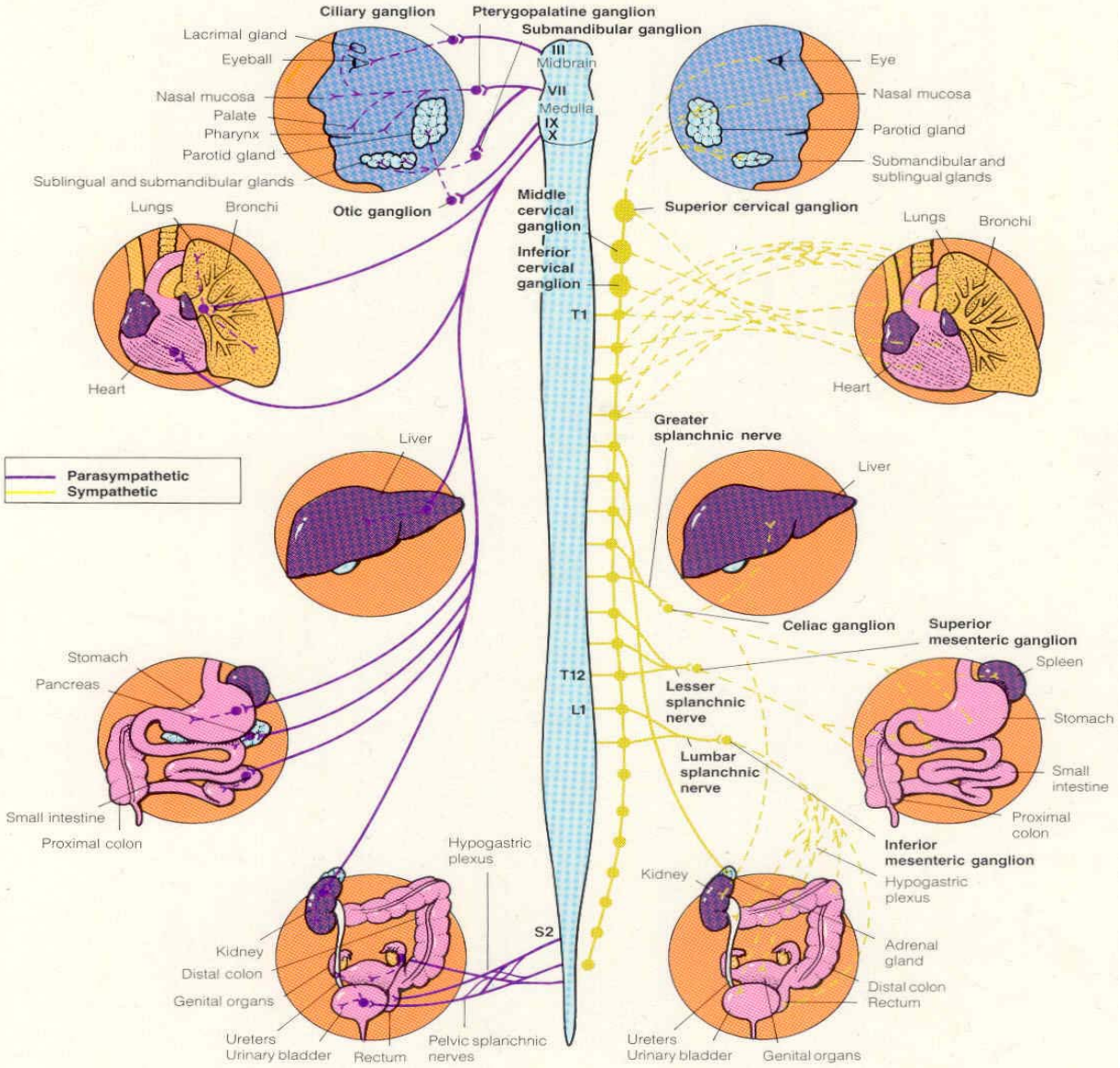
Somatic System

- 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



Transparency No. 8

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. flight or flight; activity

b. Parasympathetic nervous system

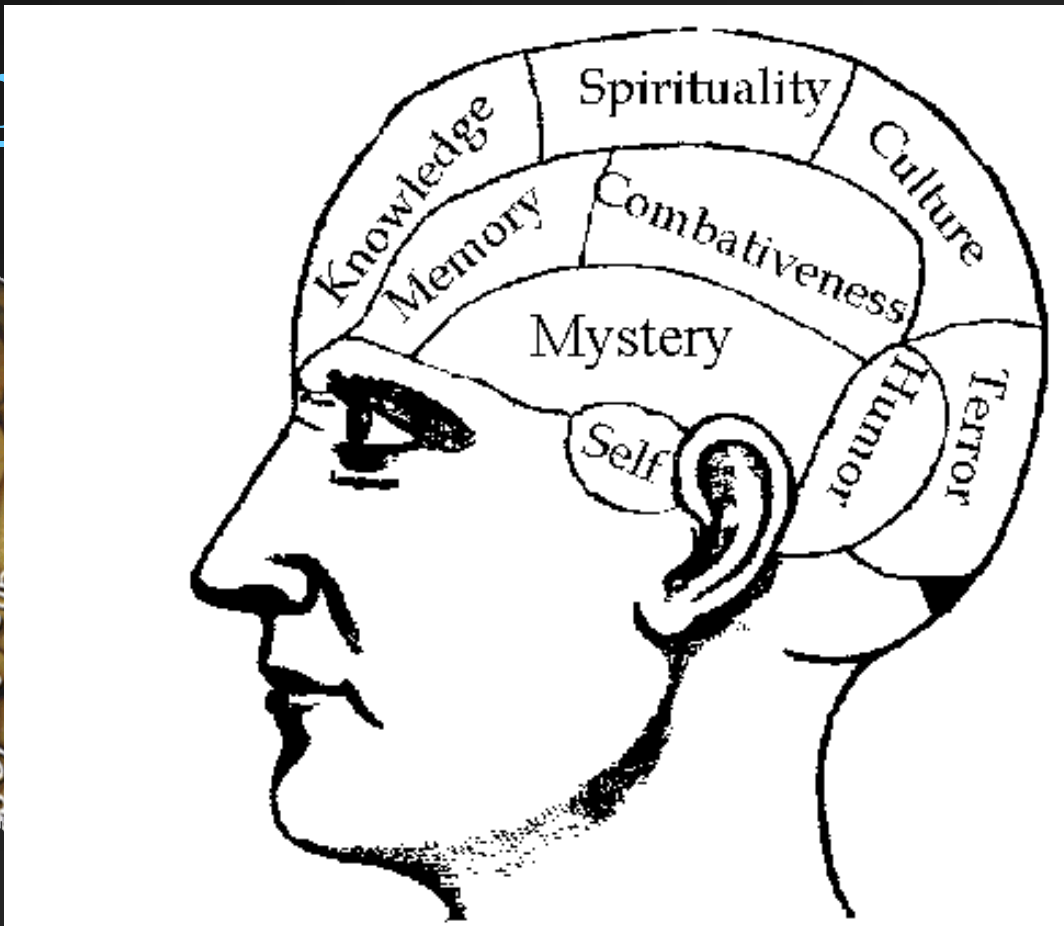
1. tends to affect one organ at a time
2. quiescent processes--digestion, protects and conserves energy
3. “rest and digest”

Sympathetic	*Parasympathetic*
• Prepares body for action • Catabolic processes that require energy expenditure	• Restores and maintains body resources • Anabolic processes that increase the body's supply of stored energy

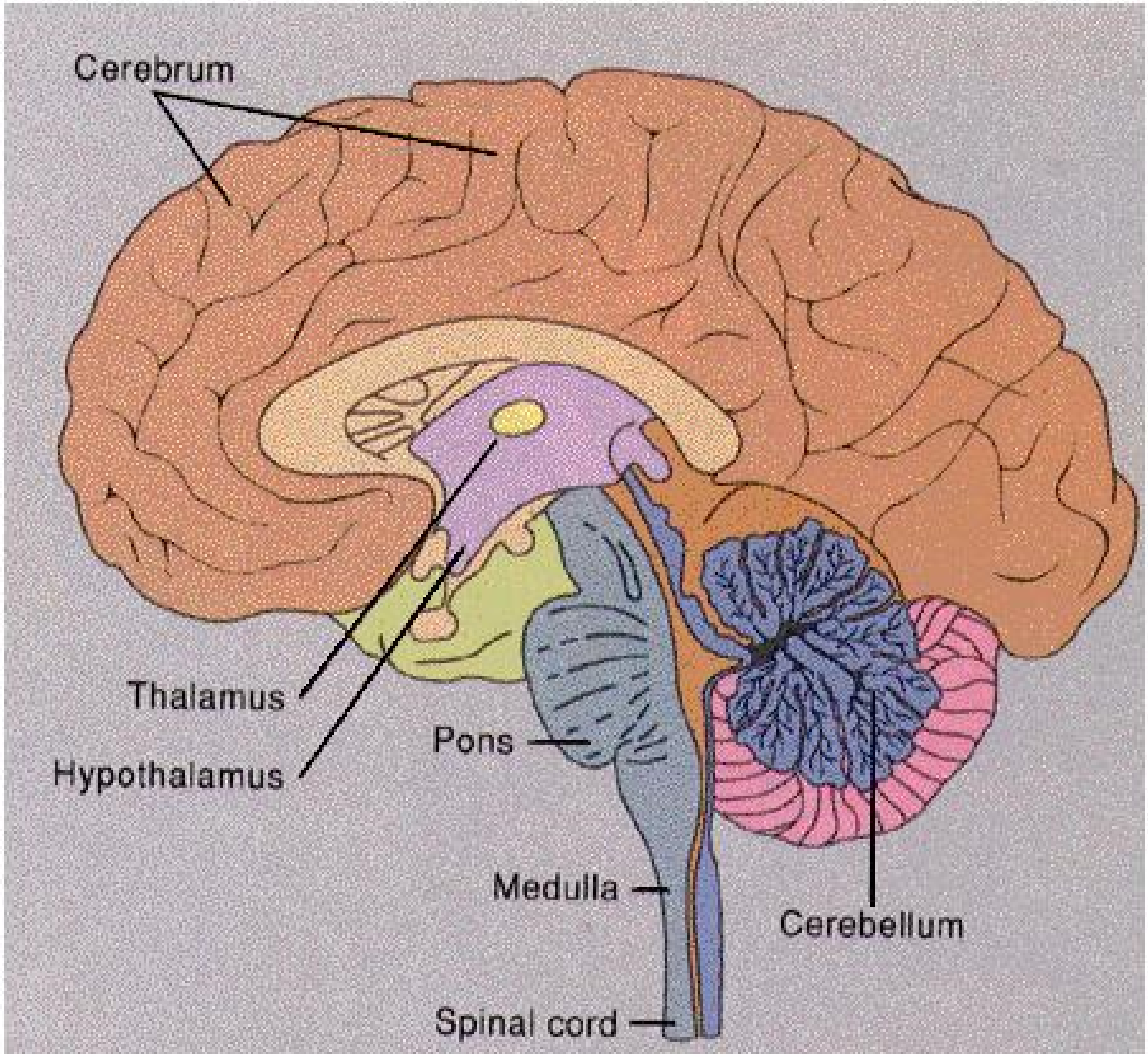
Sympathetic	*Parasympathetic*
Pharmacologically, • All synapses within the sympathetic ganglia are acetylcholinergic • Terminal buttons on target organs are noradrenergic (except sweat glands: acetylcholinergic)	Pharmacologically, • All synapses acetylcholinergic: both pre- and post-ganglionic neurons

VI. The common household brain

- Commentary
- More com



Brain's Main Structures



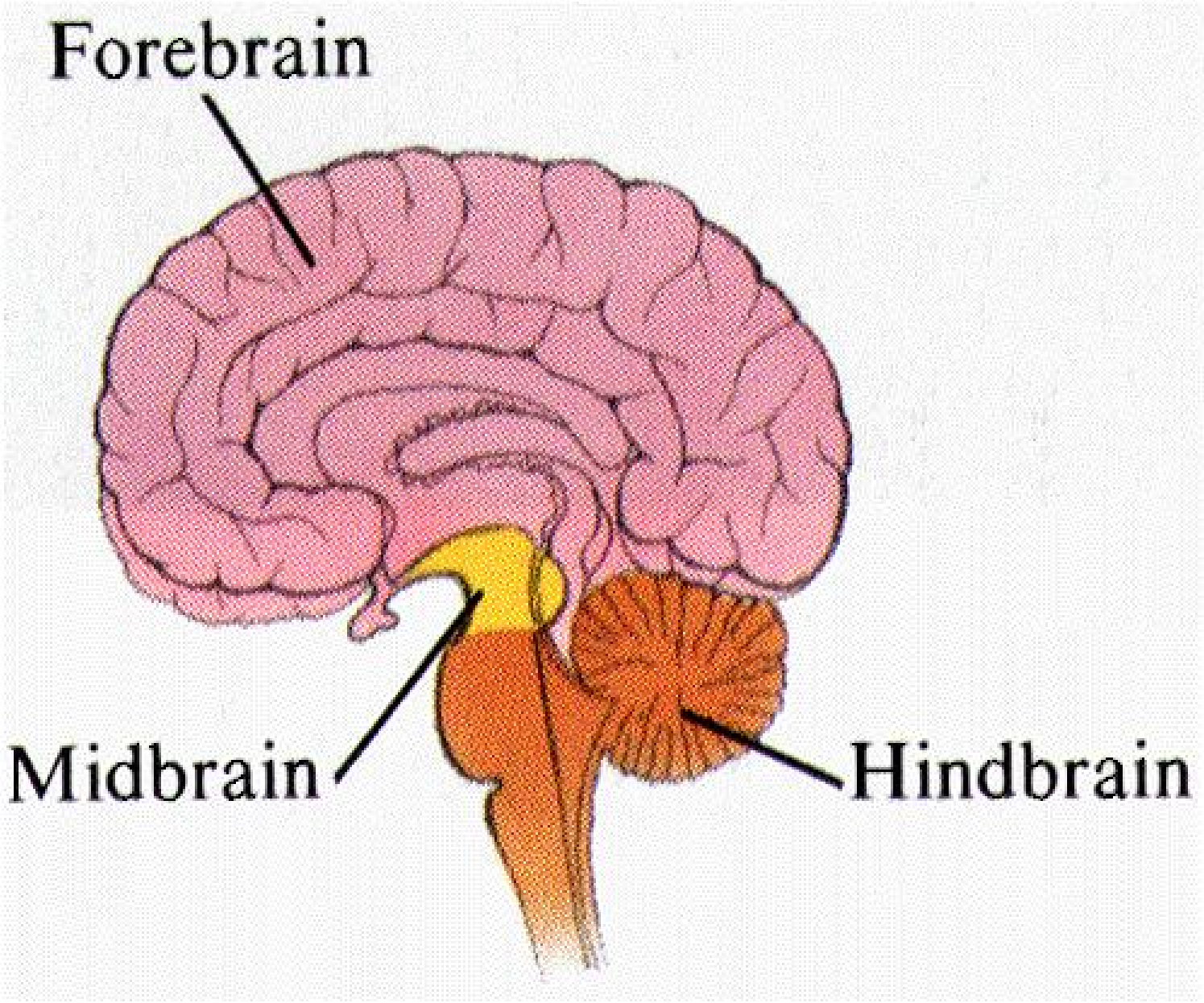
VI. The common household brain

A. Overview of brain

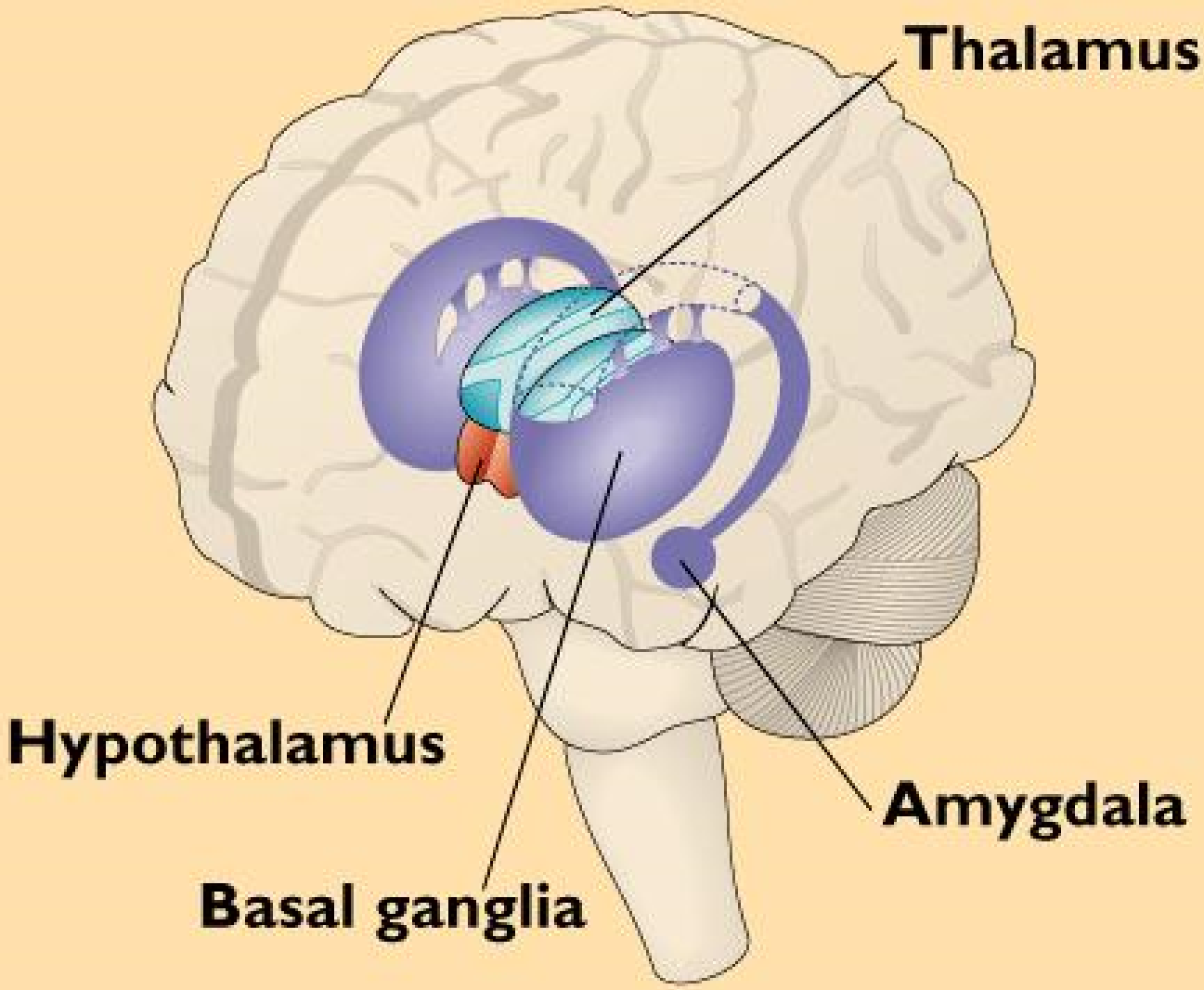
1. The primitive central core
2. Limbic system, or the "Inner Lizard"
3. Cerebrum (AKA cerebral hemispheres)
   a. Ontogeny
   b. Phylogeny
   c. Ontogeny recapitulates phylogeny
4. These three layers are interconnected extensively; do not function independently

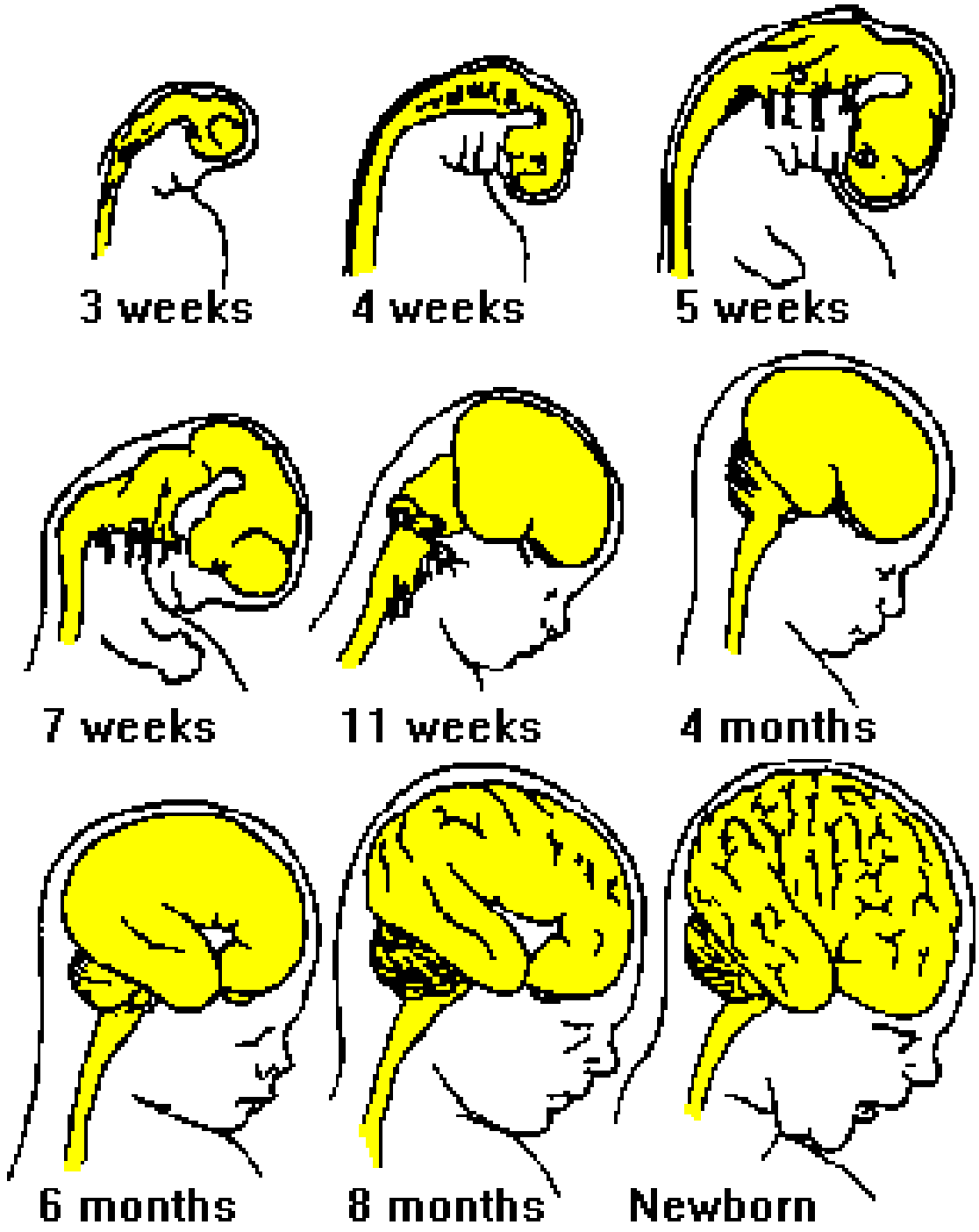
Next

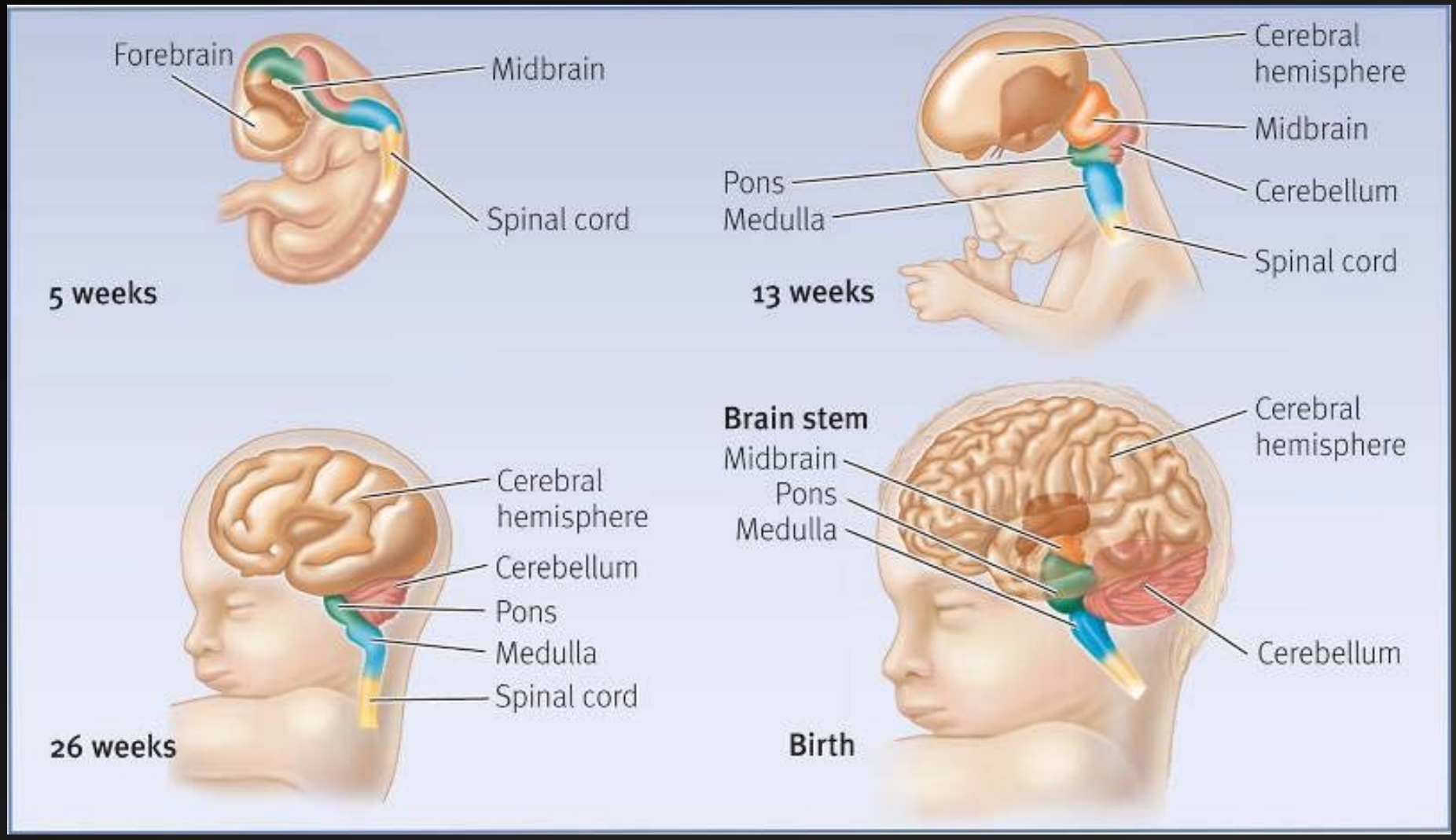
The Human Brain: Major Areas



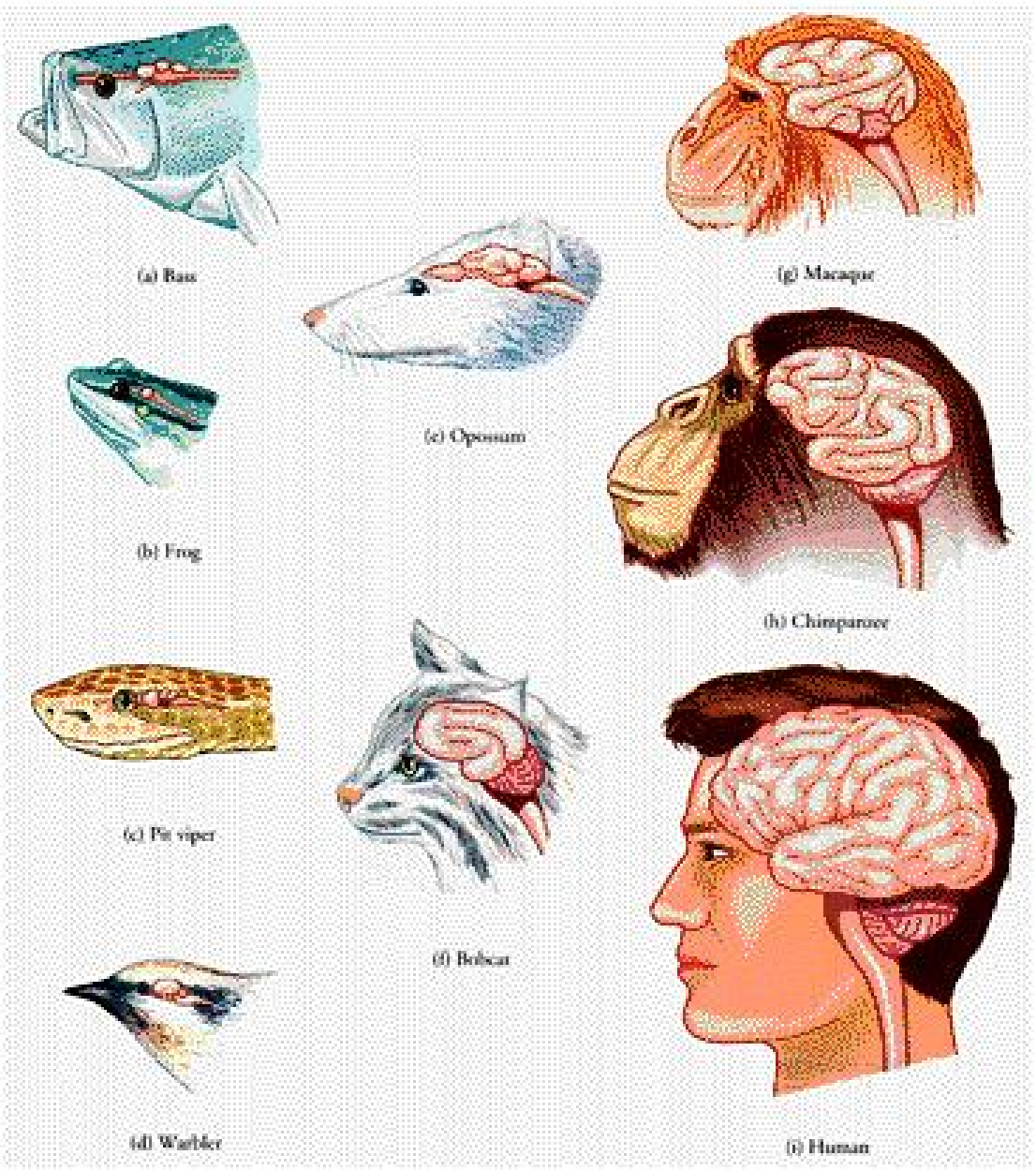
Principal Structures of the Limbic System

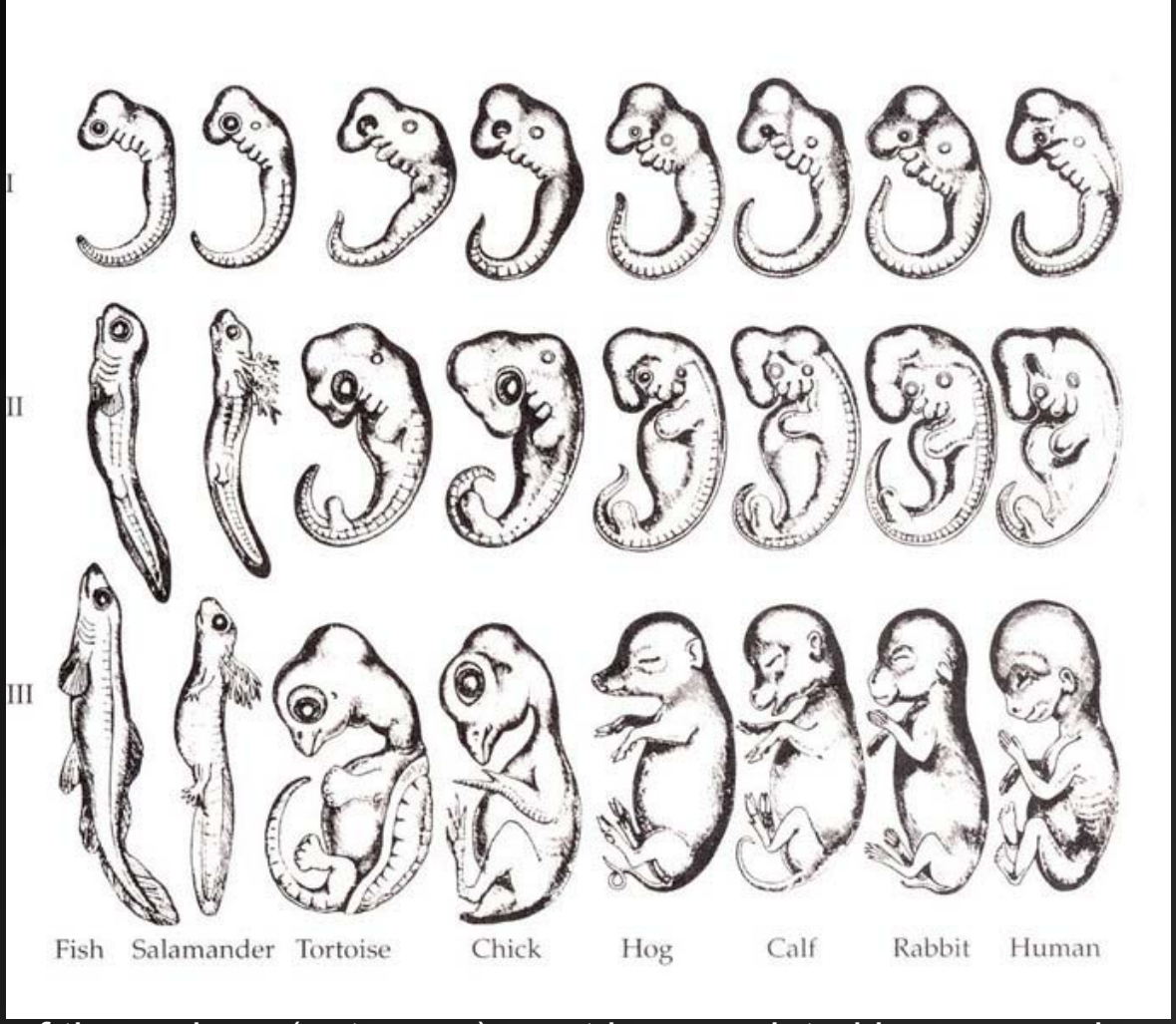



3 weeks
4 weeks
5 weeks
7 weeks
11 weeks
4 months
6 months
8 months
Newborn


Forebrain
Midbrain
Spinal cord
5 weeks
Cerebral hemisphere
Midbrain
Pons
Cerebellum
Medulla
Spinal cord
13 weeks
Cerebral hemisphere
Cerebellum
Pons
Medulla
Spinal cord
26 weeks
Brain stem
Midbrain
Pons
Medulla
Cerebral hemisphere
Cerebellum
Birth

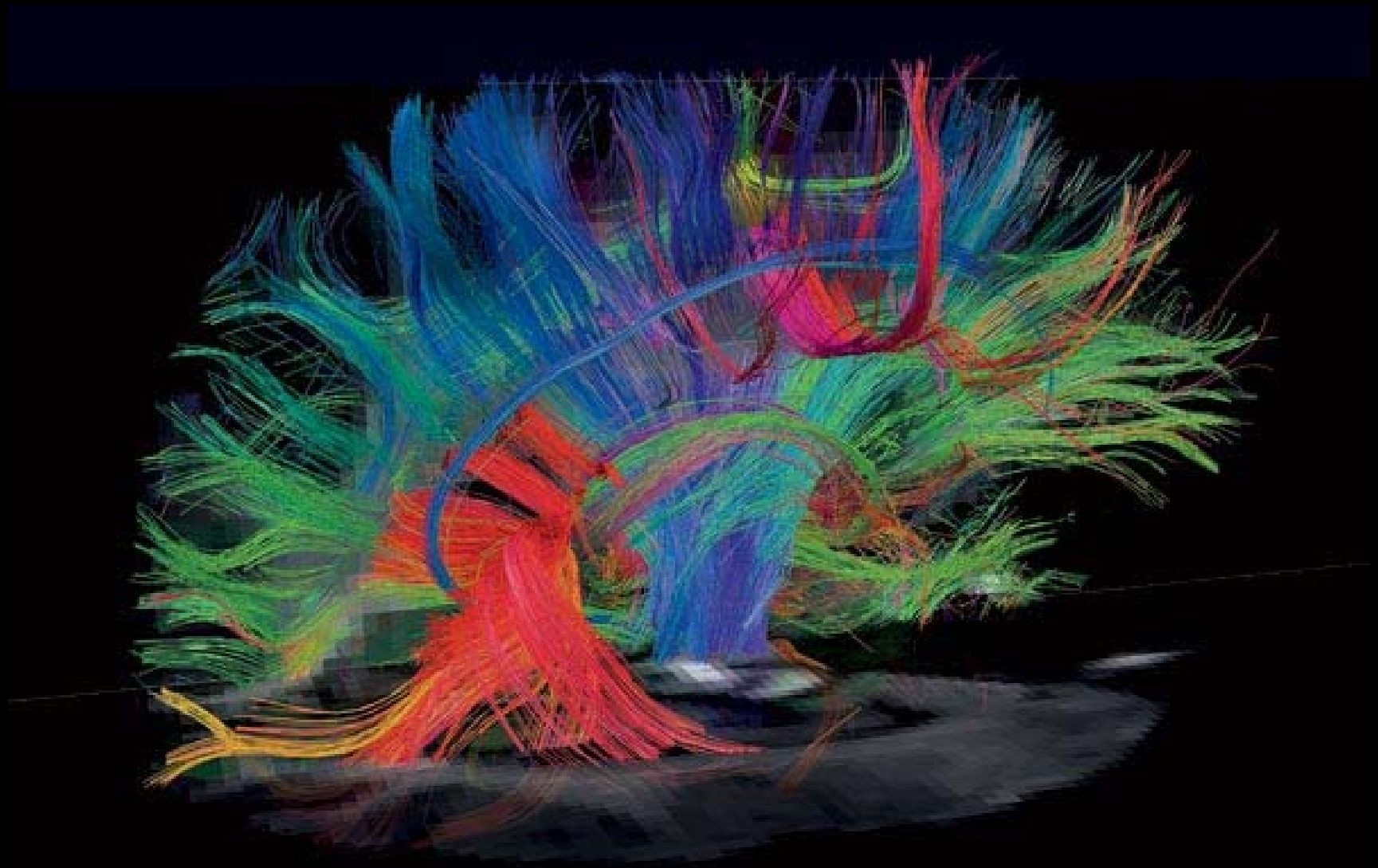
The Evolution of the Cerebrum*





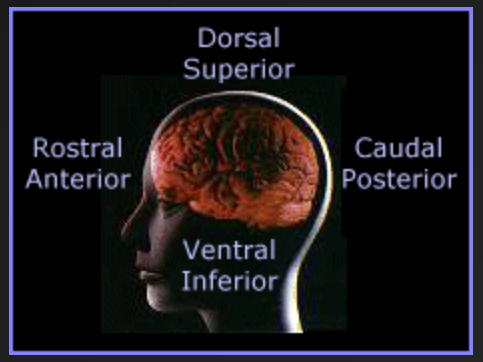
"… this history of the embryo (ontogeny) must be completed by a second, equally valuable, and closely connected branch of thought - the history of race (phylogeny). Both of these branches of evolutionary science, are, in my opinion, in the closest causal connection; this arises from the reciprocal action 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).'"

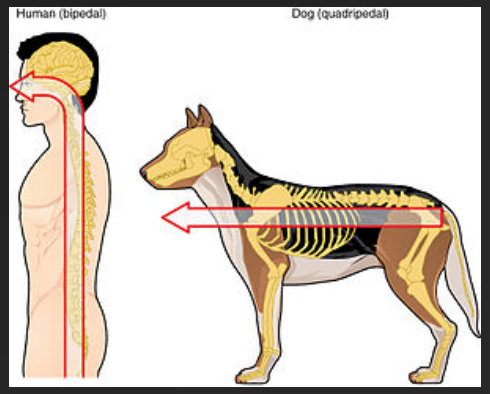
Haeckel, E. 1899. *Riddle of the Universe at the Close of the Nineteenth Century.*



Directions please!

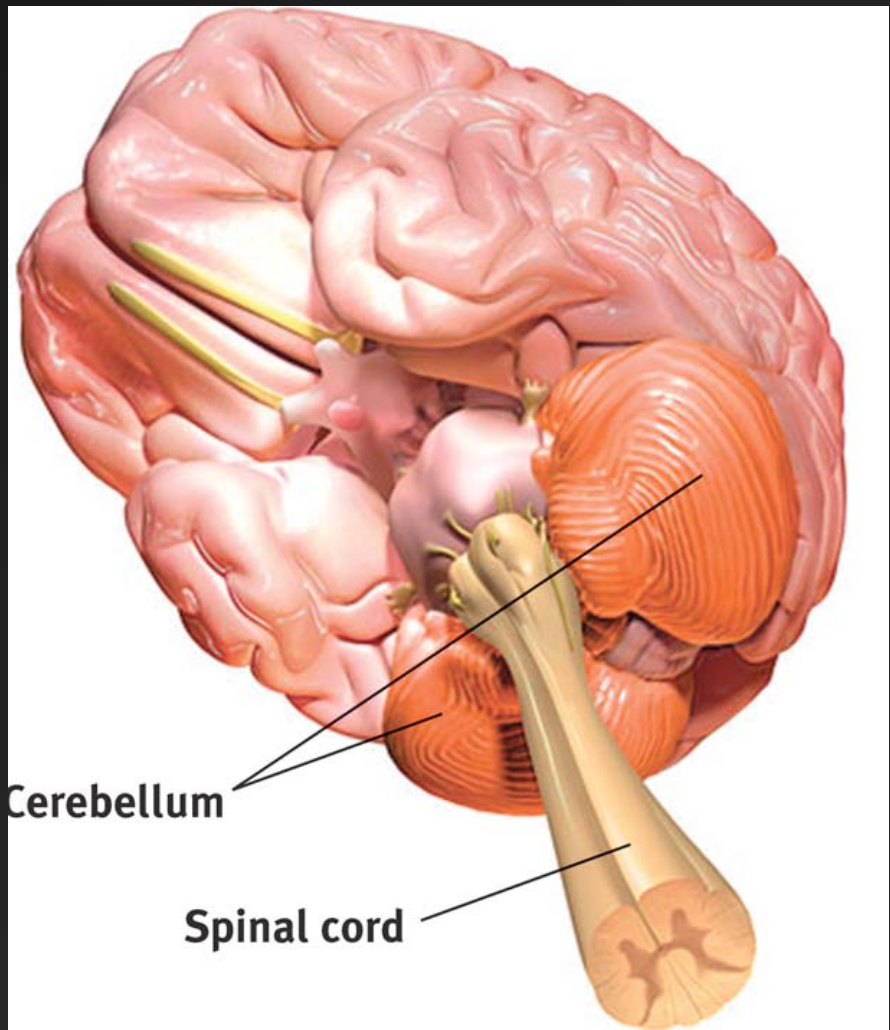
- lateral--side;
  medial--middle
- ipsilateral--same;
  contralateral--opposite
- proximal--toward the soma;
  distal--away from the soma
- anterior--front;
  posterior--back
- ventral--front
  dorsal--back
- rostral--towards the nose;
  caudal--towards the tail
- efferent--output/motor;
  afferent--receiving/sensory





B. Brain Specifics

1. Primitive central core
   a. Cerebellum
      1. "little brain"
      2. smooth coordination of movements
      3. learning of complex motor activities



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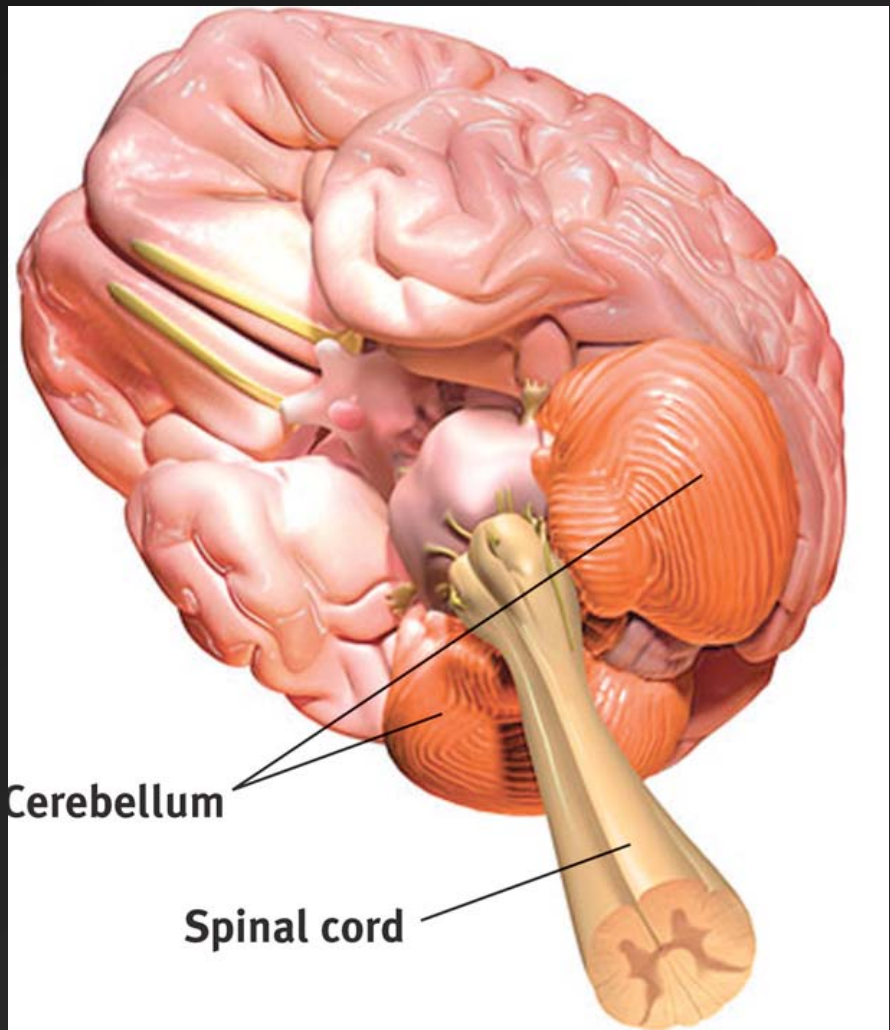


B. Brain Specifics

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

B. Brain Specifics

1. Primitive central core

b. Thalamus & Hypothalamus:

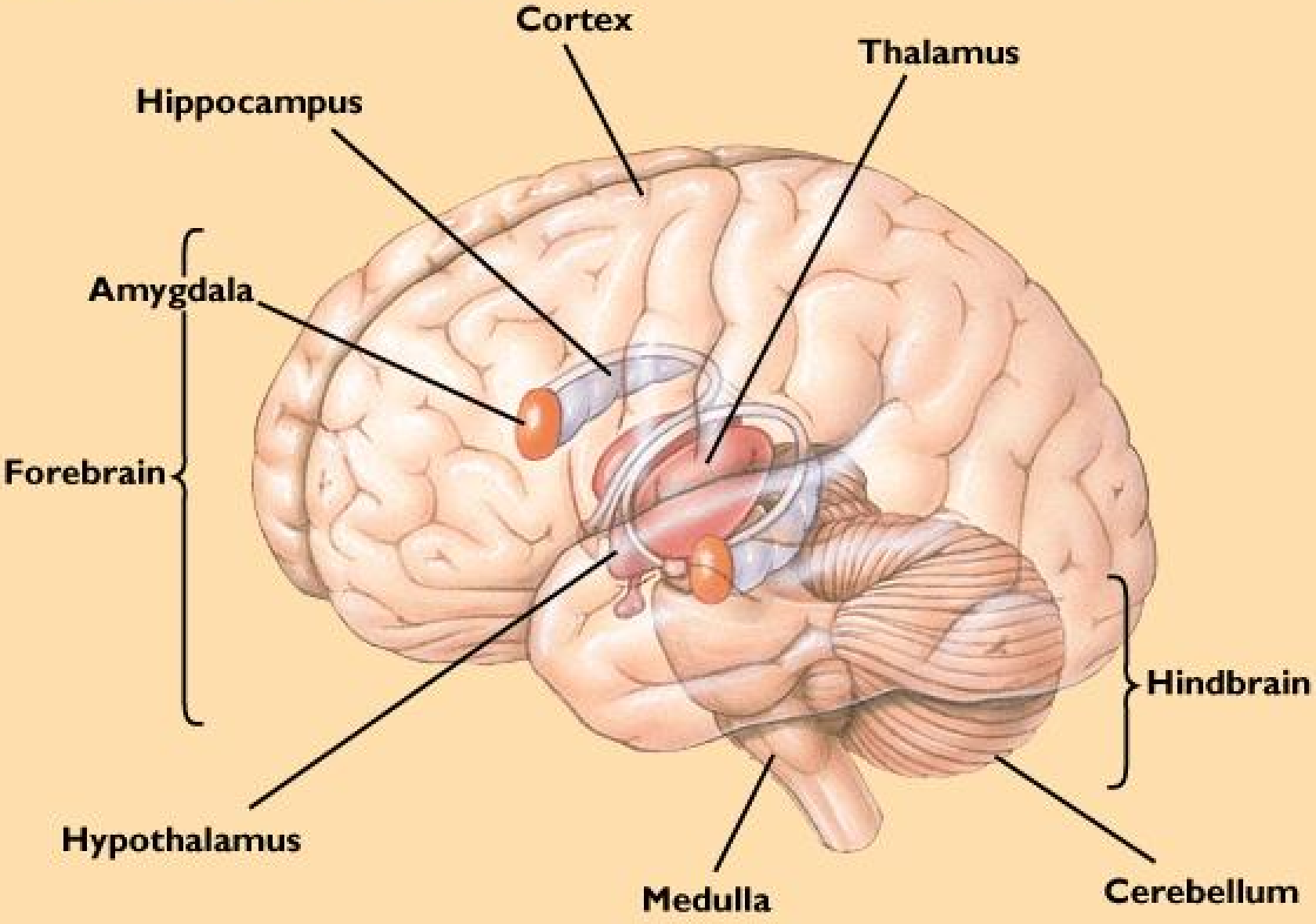
2.Hypothalamus

a. literally = "under thalamus"

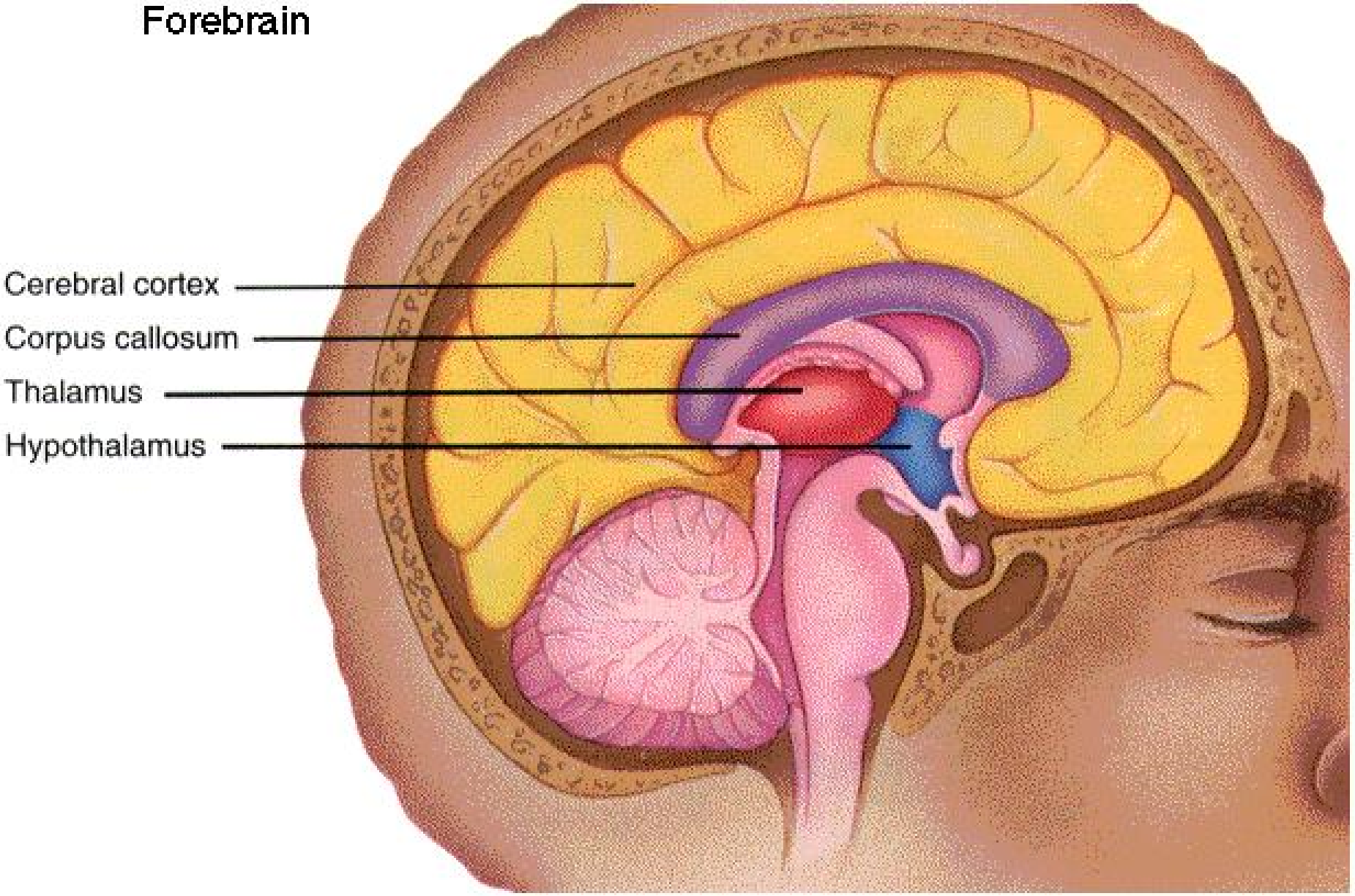
b. 4 F's:

Emotion/Motivation	Feelings/Fleeing/Fighting
Thirst/Hunger	Feeding
Body Temp	Fever
Sexual Drives	Fourth F

Structures of the Brain



Forebrain



B. Brain Specifics

1. Primitive central core
   b. Basal Ganglia:
      1. Necessary for voluntary motor movements
      2. Involved in numerous disorders
         a. Parkinson's
         b. Obsessive-Compulsive

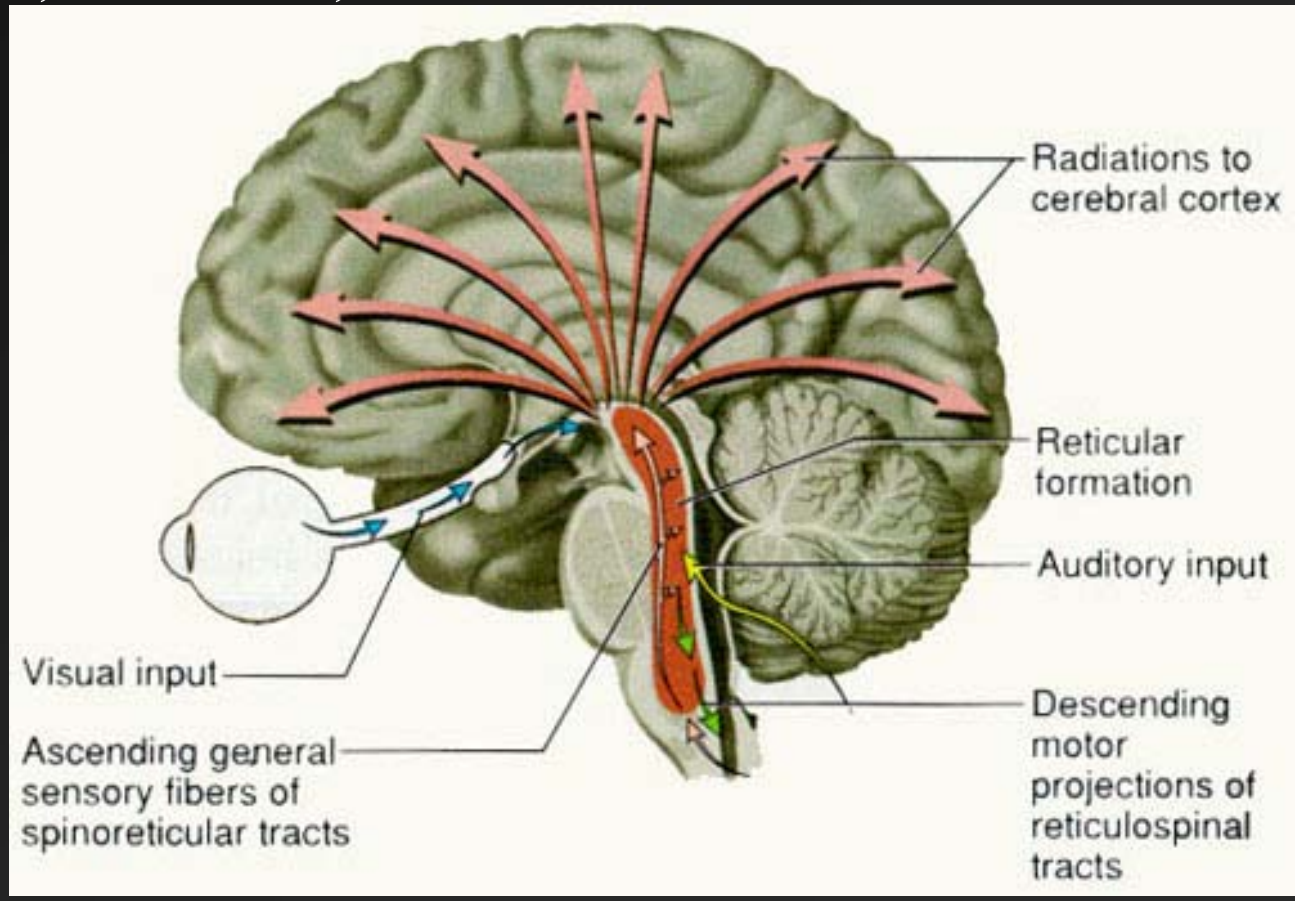
B. Brain Specifics

1. Primitive central core

c. Reticular system

1. diffuse from brainstem to thalamus

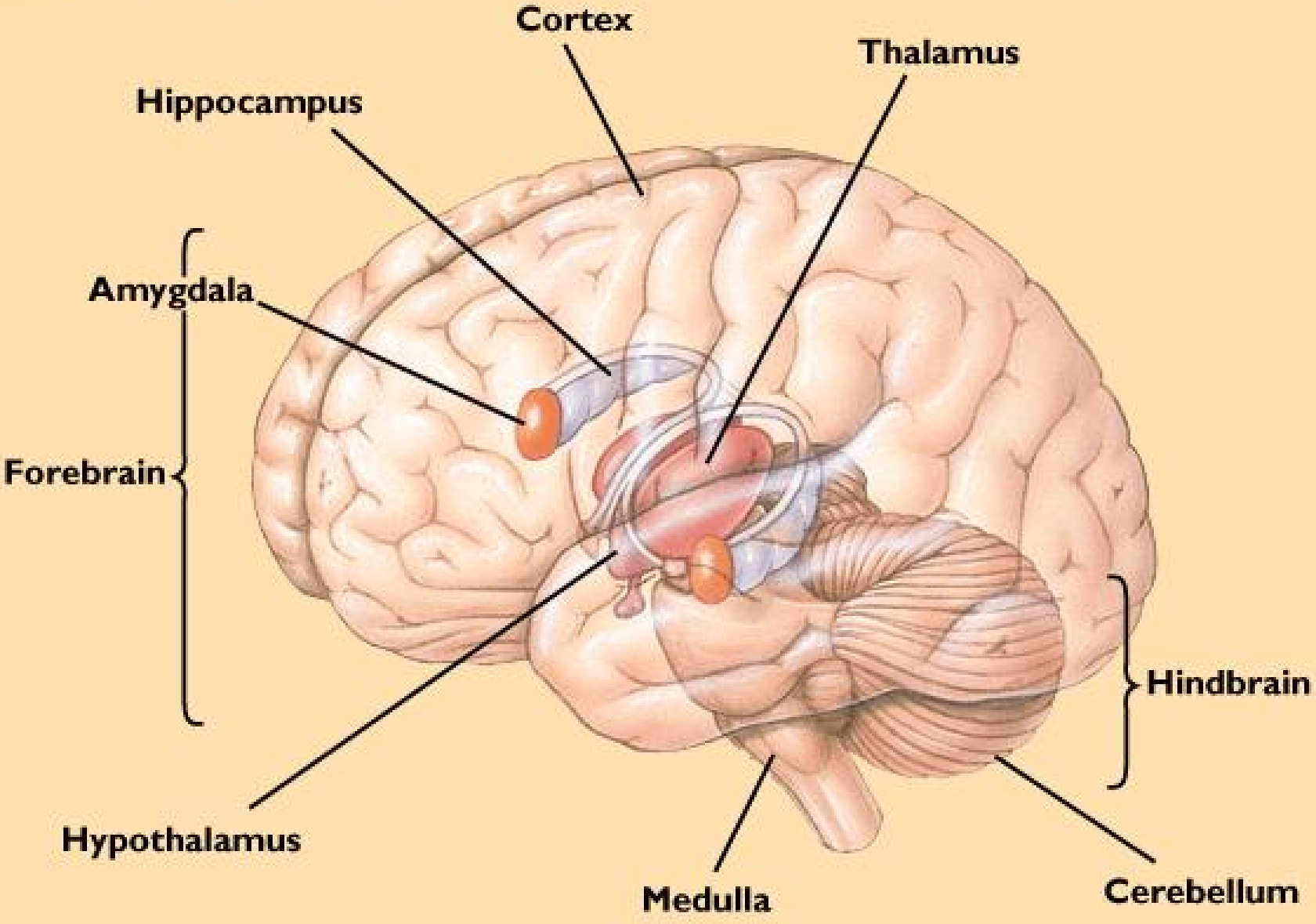
2. 3 A's, arousal, awareness, attention



B. Brain Specifics

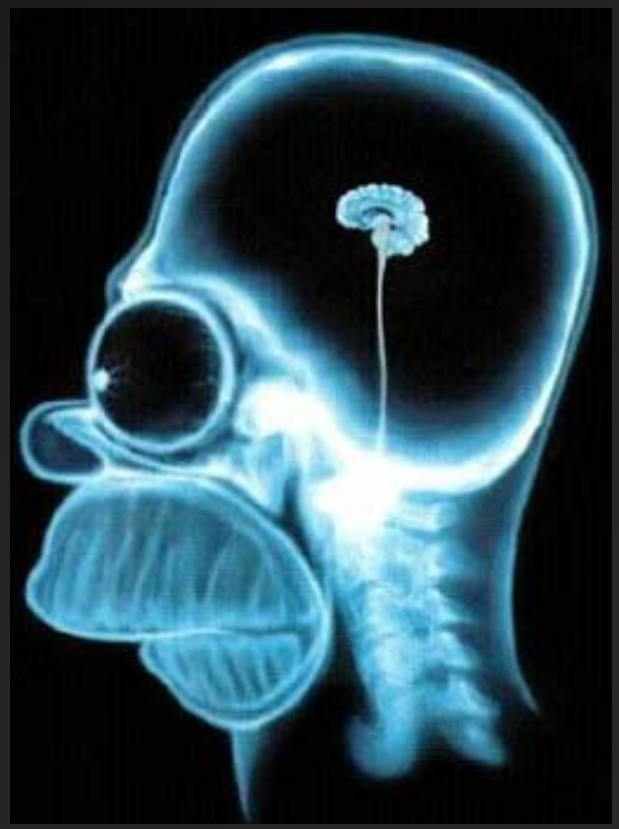
2. Limbic system
   a. a group of structures lying along the innermost edge of the cerebral hemispheres
   b. involved in instinctual behaviors in lower animals (caring for young, mating, fleeing from attackers, fleeing from prey)
   c. involved in memory and emotion in humans
   d. Especially important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

Structures of the Brain

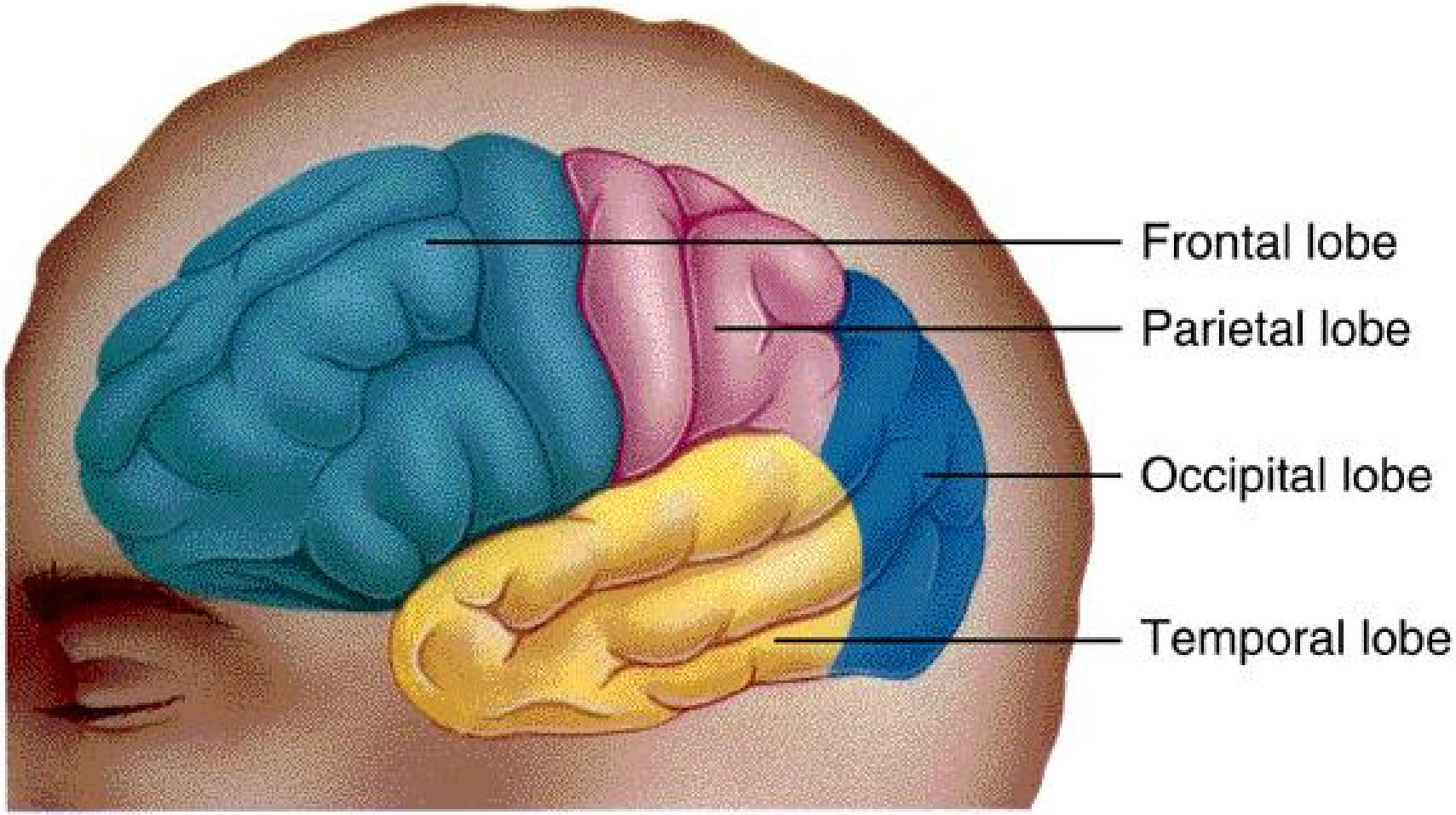


The common household brain

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

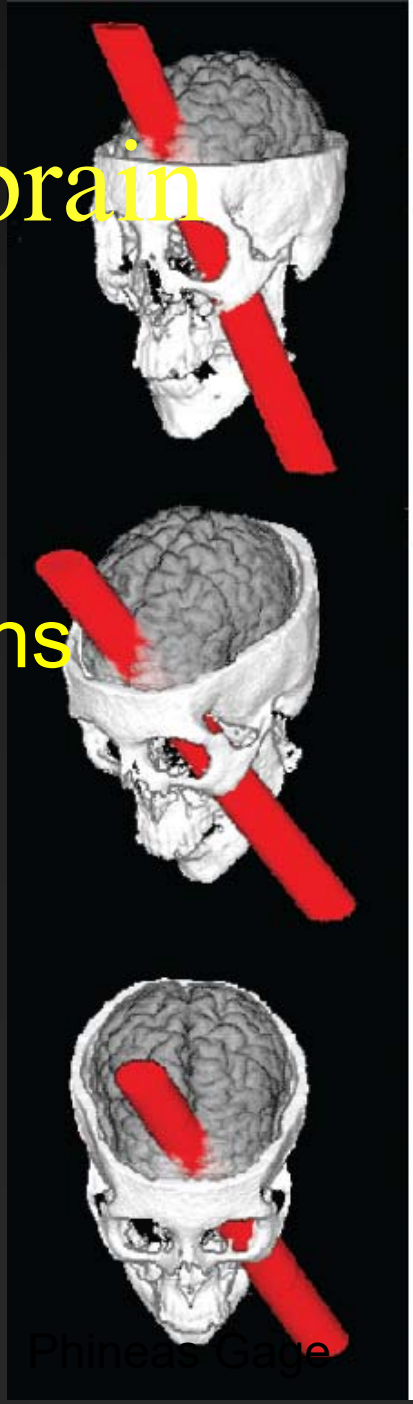


Four Lobes of the Cerebral Cortex



The common household brain

3. The cerebral hemispheres
   b. Four lobes: Sample Functions
      1. frontal — Planning, Abstract thought, Motor
      2. parietal — Sensory Integration
      3. occipital — Visual Perception
      4. temporal — Object Identification

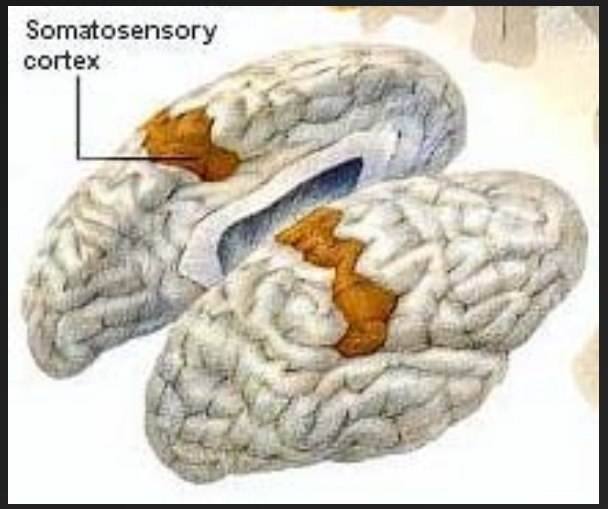


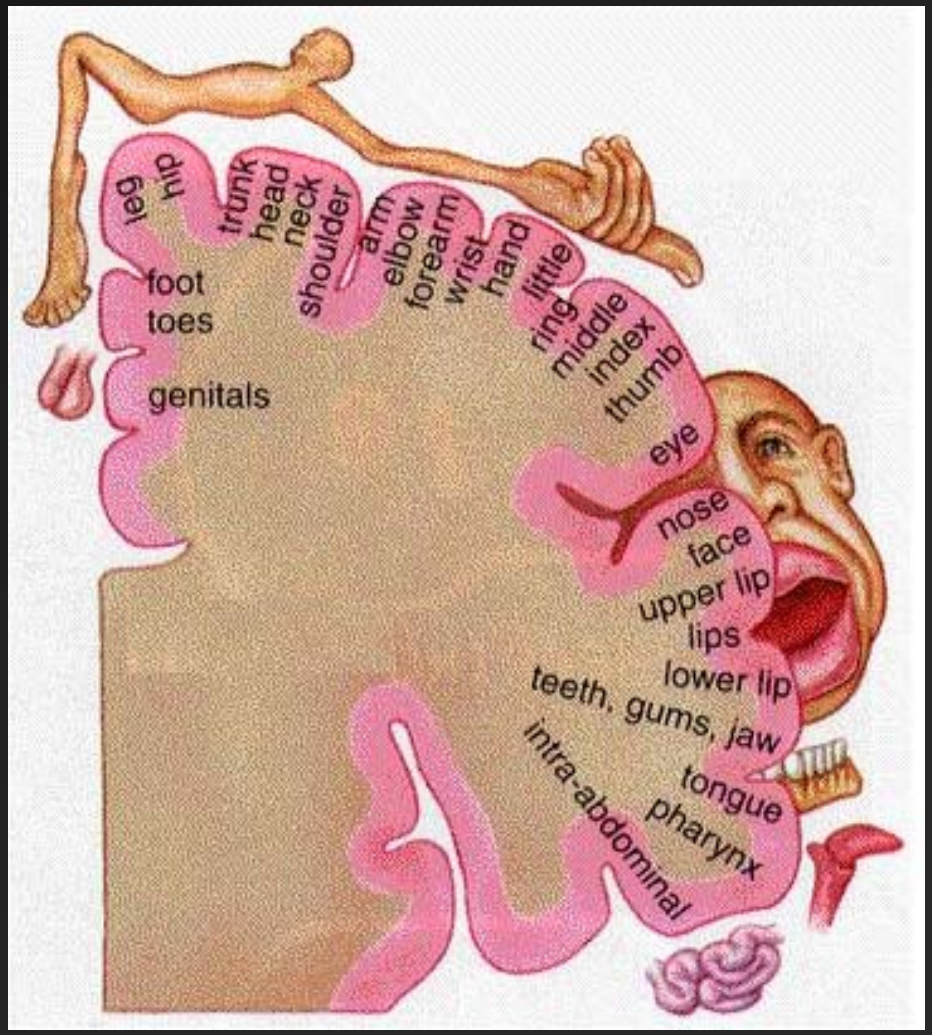
Phineas Gage

From H. Damasio, T. Grabowski, R. Frank, A. M. Galaburda & A. R. Damasio (1994), The Return of Phineas Gage: Clues about the brain from a famous patient, *Science*, 264, 1102–1105. Dornsife Neuroscience Imaging Center and Brain and Creativity Institute, USC.

The common household brain

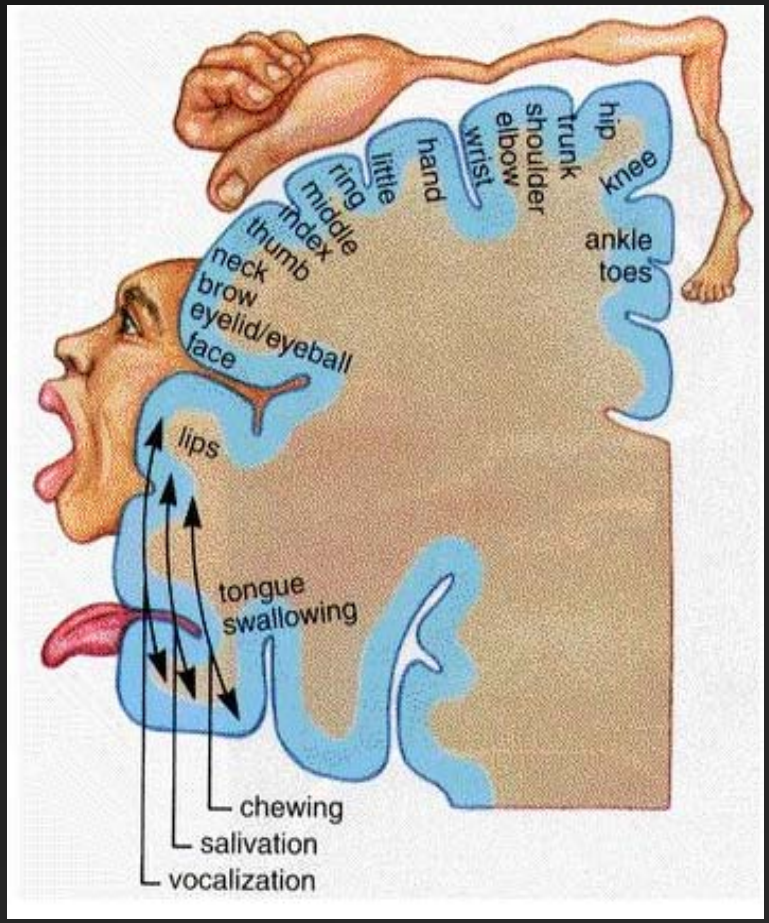
3. The cerebral hemispheres
   c. Somatosensory area
      1. heat, cold, touch, pain, sense of body movement
      2. contralateral
      3. space appropriated in accord to amount of use or need

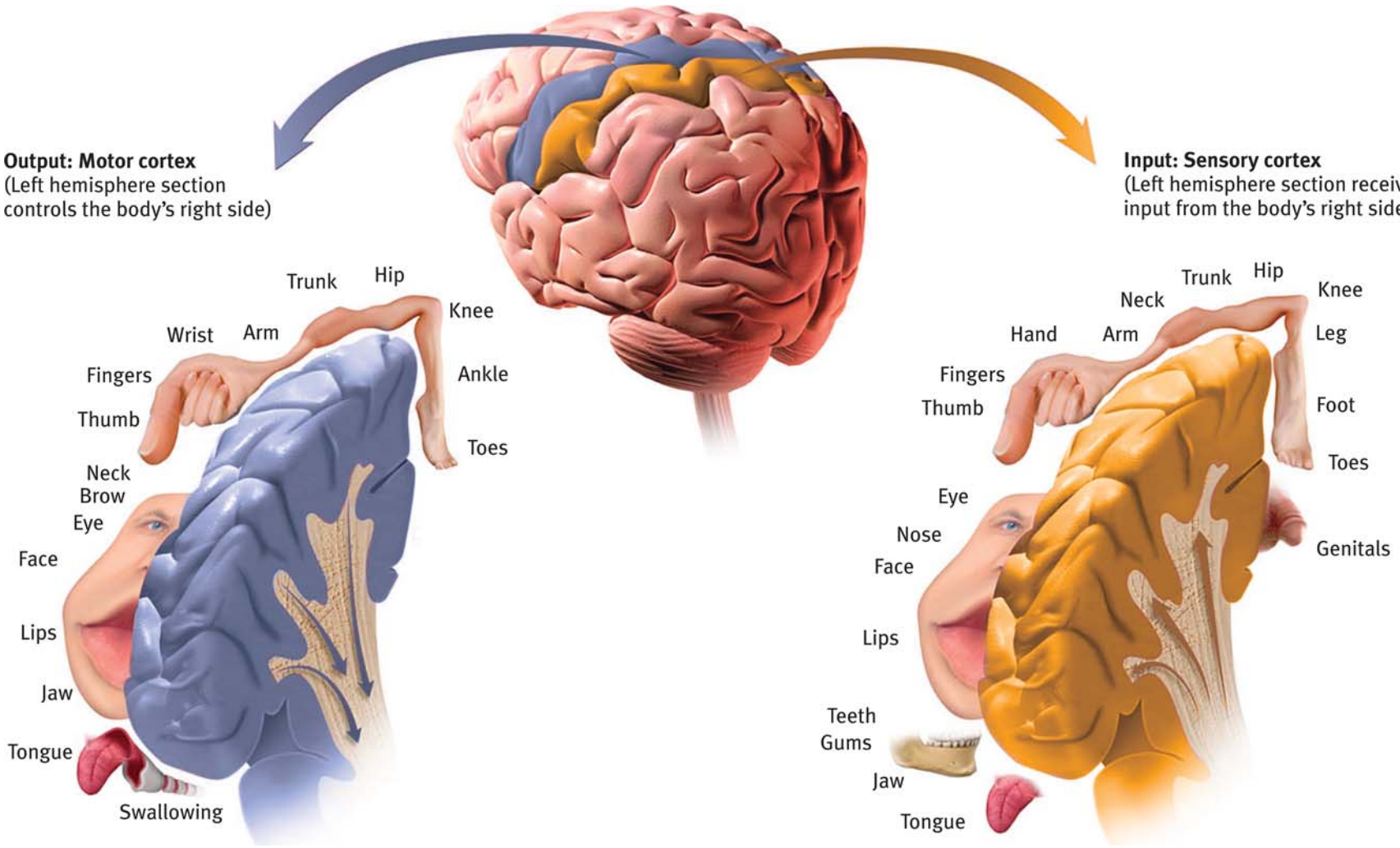




The common household brain

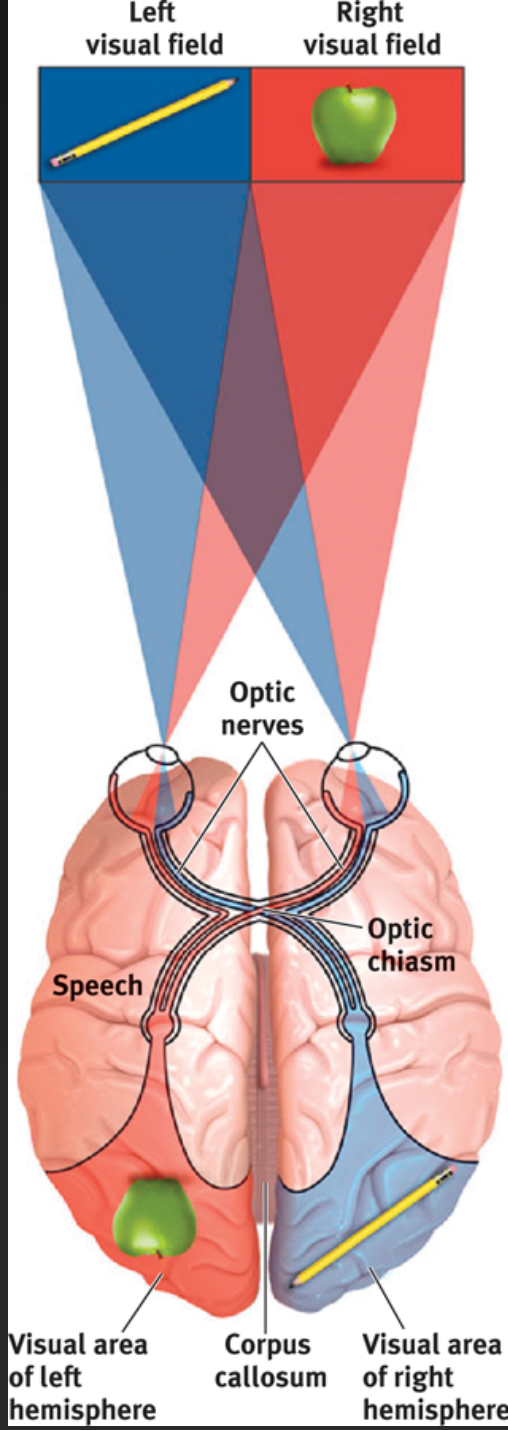
3. The cerebral hemispheres
    d. Motor area
        1. topographic organization-- Homunculus
        2. contralateral control of body

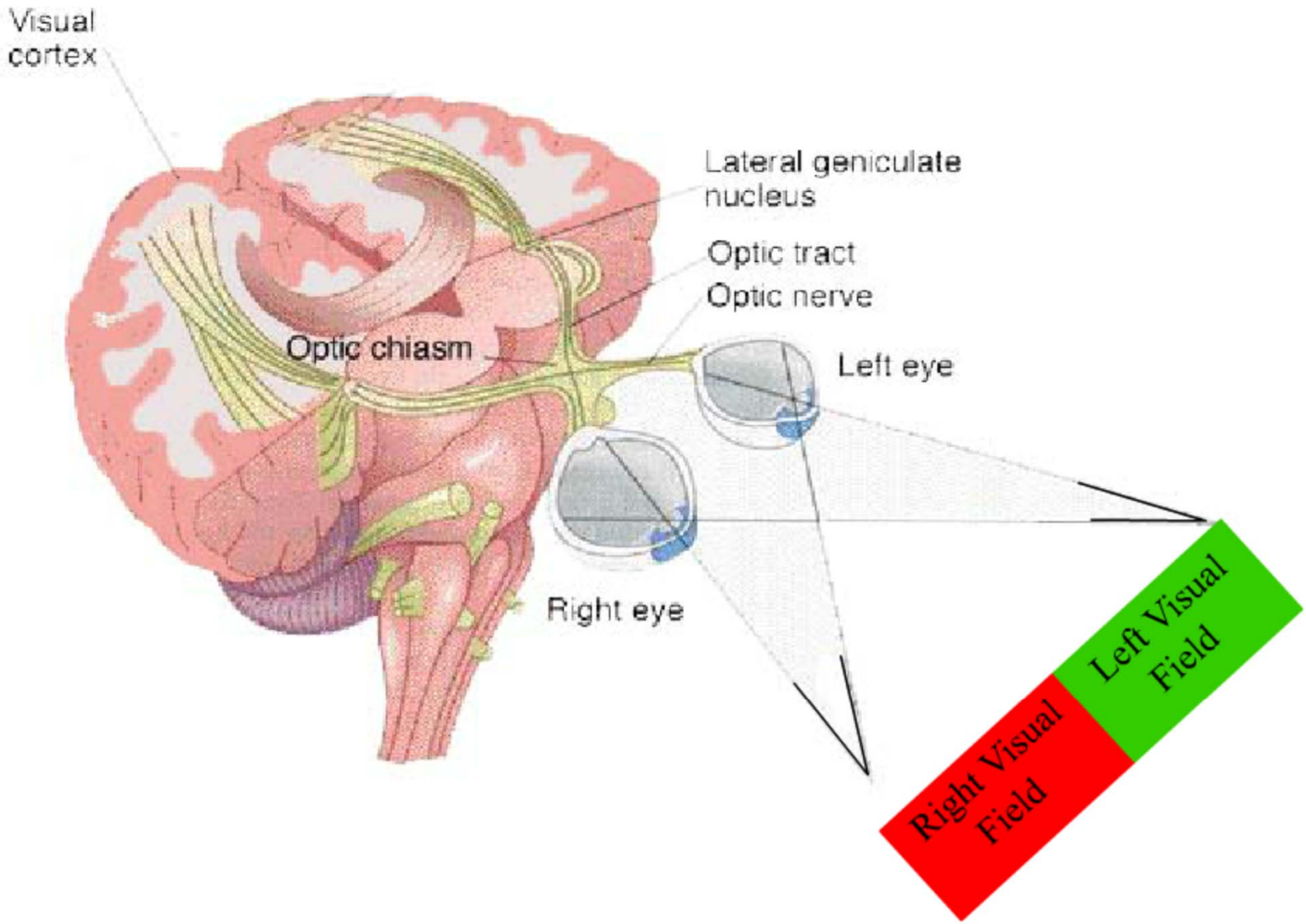



Output: Motor cortex
(Left hemisphere section controls the body's right side)
Trunk
Hip
Knee
Wrist
Arm
Fingers
Ankle
Thumb
Toes
Neck
Brow
Eye
Face
Lips
Jaw
Tongue
Swallowing
Input: Sensory cortex
(Left hemisphere section receives input from the body's right side)
Trunk
Hip
Knee
Neck
Hand
Arm
Leg
Fingers
Thumb
Foot
Toes
Eye
Nose
Face
Genitals
Lips
Teeth
Gums
Jaw
Tongue

The common household brain

3. The cerebral hemispheres
    e. Visual area
        1. Contralateral visual field
        2. Primary vs Secondary

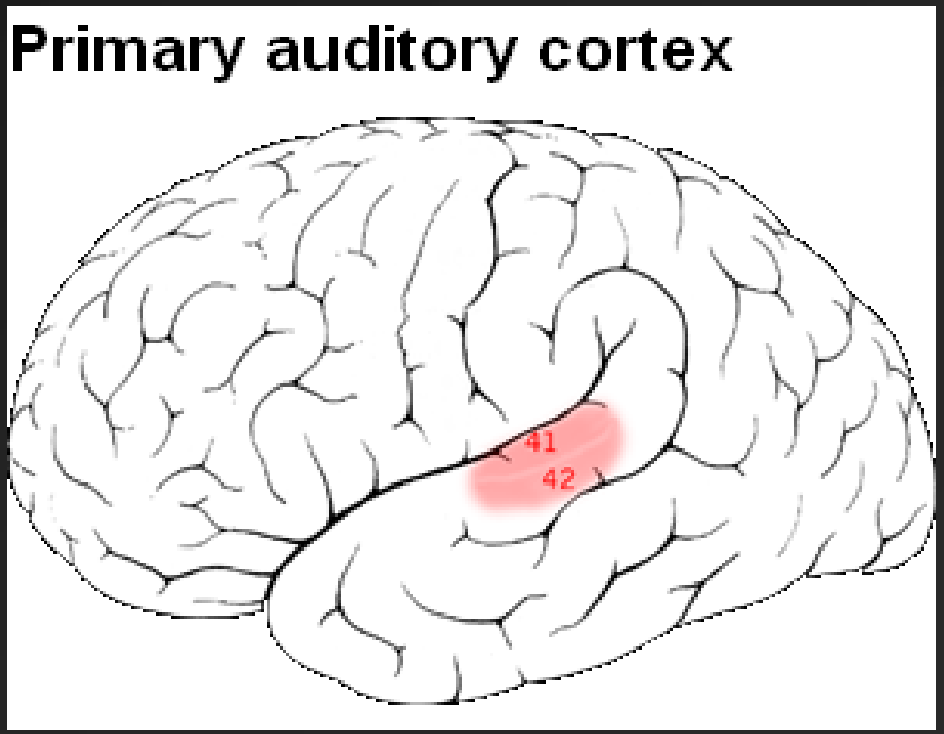



Visual cortex
Lateral geniculate nucleus
Optic tract
Optic nerve
Optic chiasm
Left eye
Right eye
Left Visual Field
Right Visual Field

The common household brain

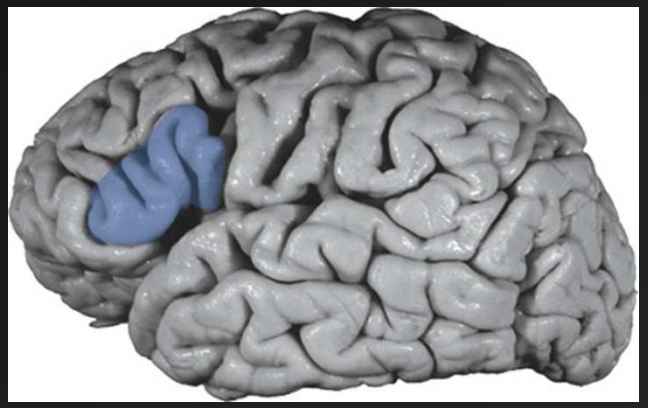
f. Auditory area

1. bilateral representation
2. contralateral stronger

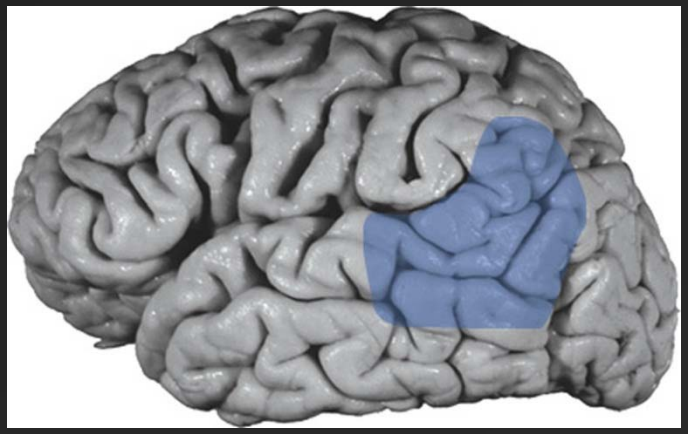


The common household brain

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)



Broca's



Wernicke's

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)

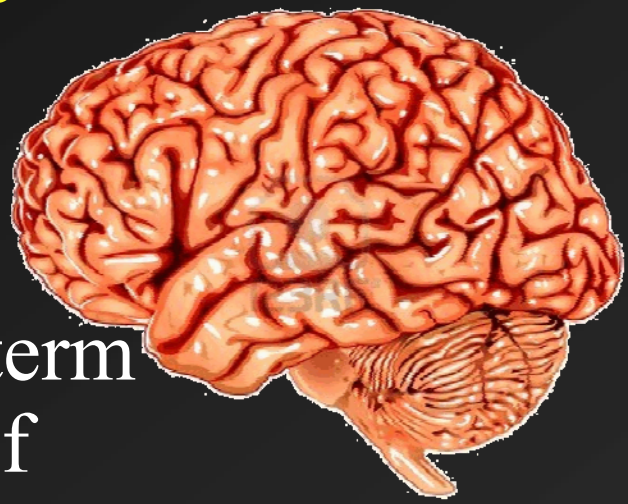
Luria's Functional Systems

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 and to some extent temporal): **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 widely studied by psychophysiologists

Functions of Sweat Glands

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

After Edelberg, 1972

Anatomy of a Gland and the Skin

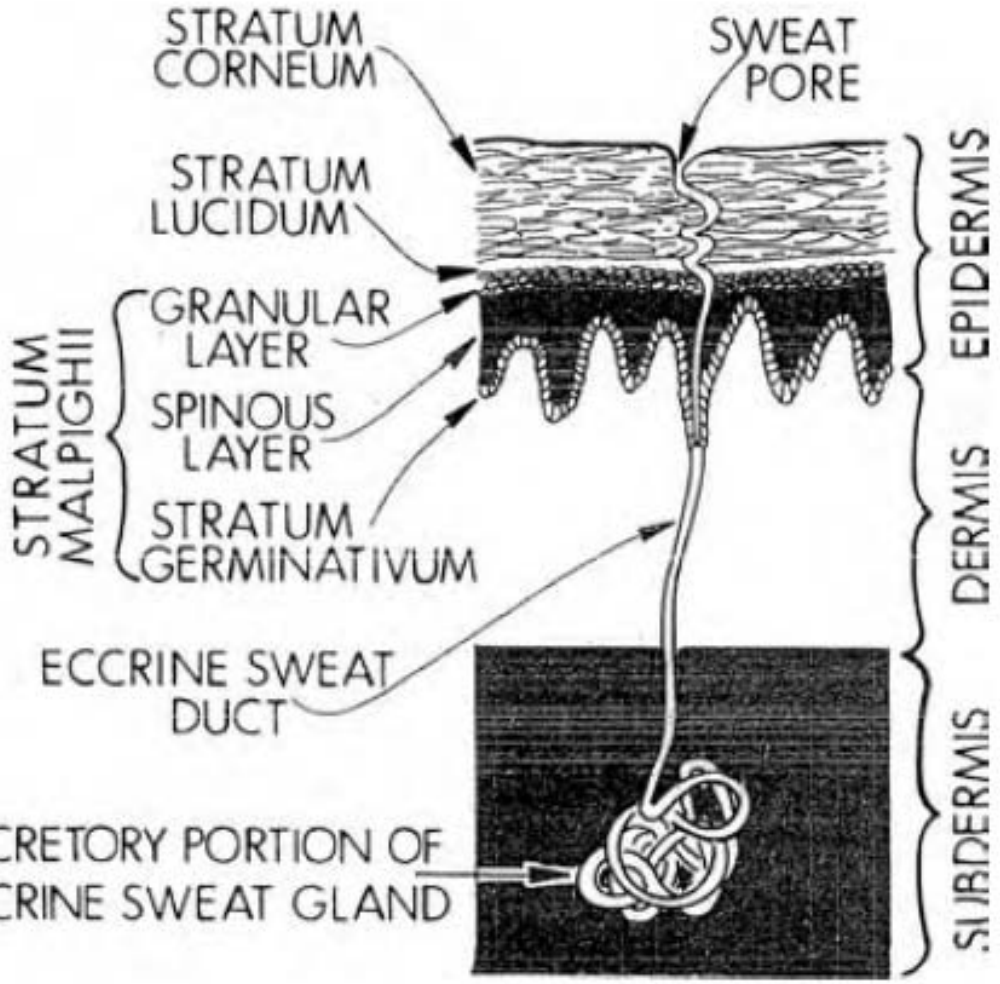


Figure 7.1. Anatomy of the eccrine sweat gland in various layers of skin. (Adapted from Hassett, 1978).

- 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

From
Dawson et al 2007

Central Control

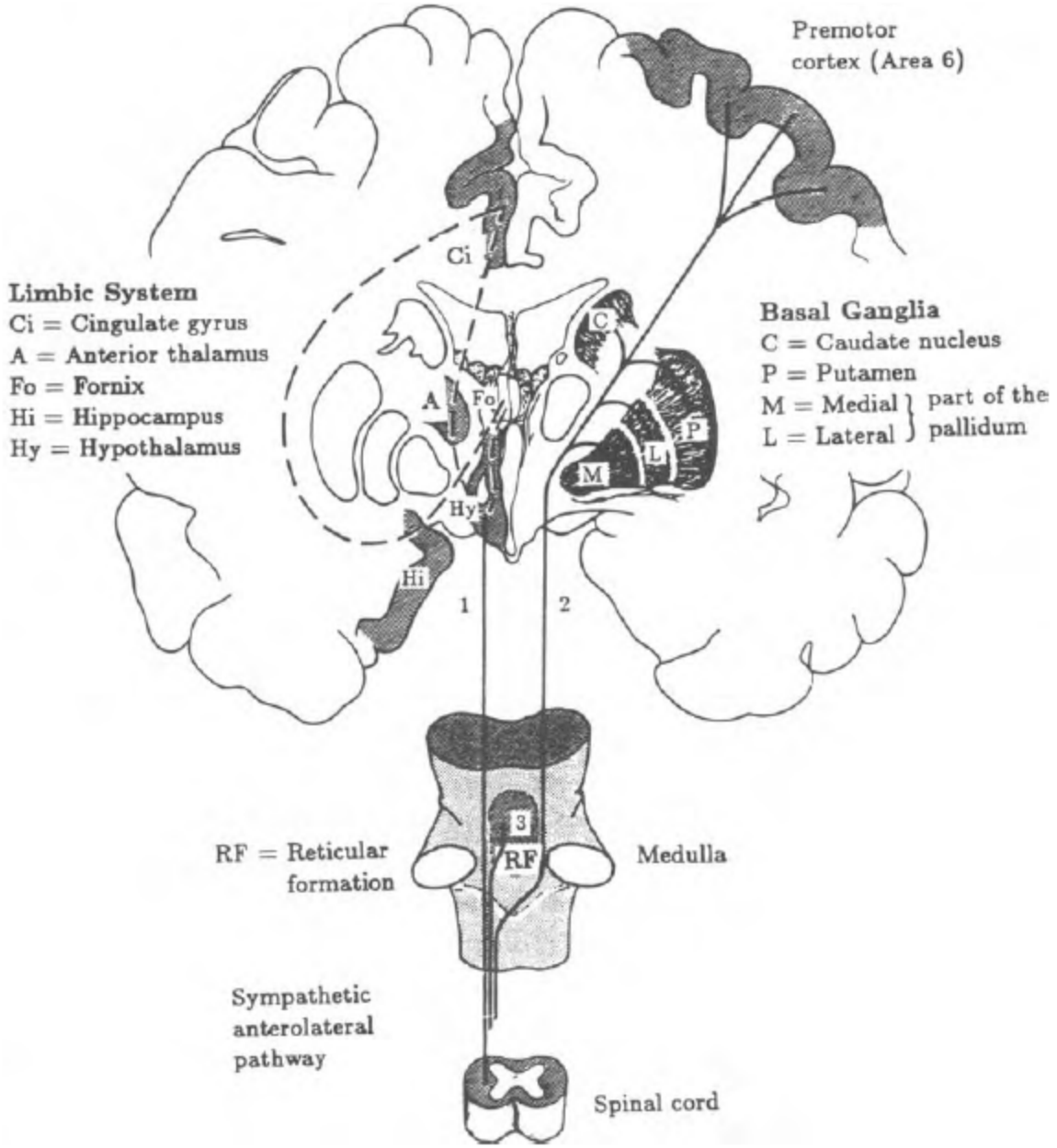


Figure 7.2. Central nervous system determiners of EDA in humans (From Boucsein, 1992).

From Dawson et al 2007

Acronym Glossary

- Generic terms
  - EDA = electrodermal activity
  - GSR = galvanic skin response
- Skin Resistance
  - SRL = skin resistance level (tonic); 10,000-500,000Ω
  - SRR = skin resistance response (phasic); 100-10,000 Ω
- Skin Conductance
  - SCL = skin conductance level (tonic); 2-50 μsiemens
  - SCR = skin conductance response (phasic); .05-5 μsiemens
  - 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

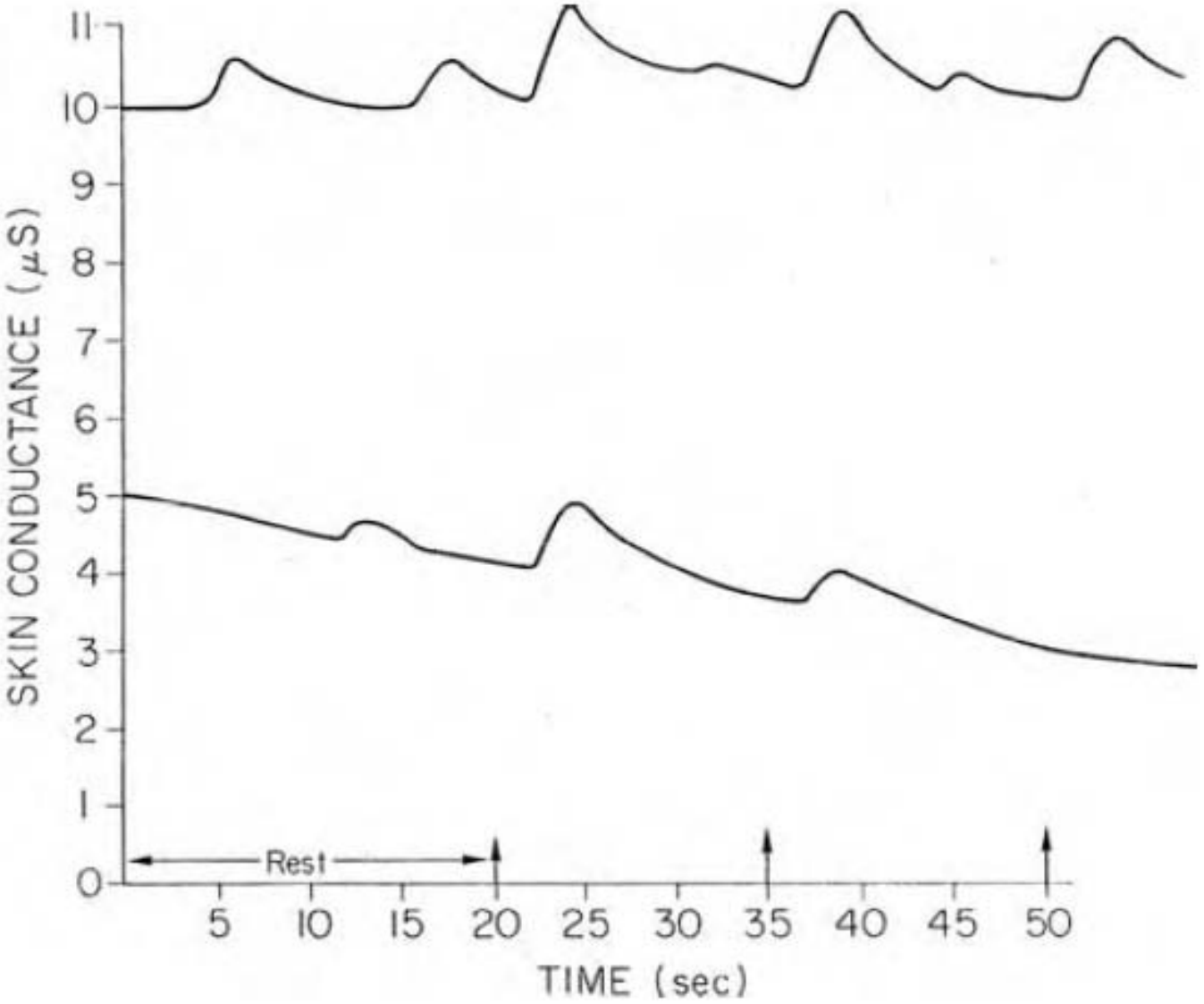


Figure 7.4. Two hypothetical skin conductance recordings during 20 s of rest followed by three repetitions of a simple discrete stimulus. Arrows represent the presentation of a stimulus (From Dawson & Nuechterlein, 1984).

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 habitation (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.

DEMO!

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

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

- 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 (Ω)	SCL(μS)	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

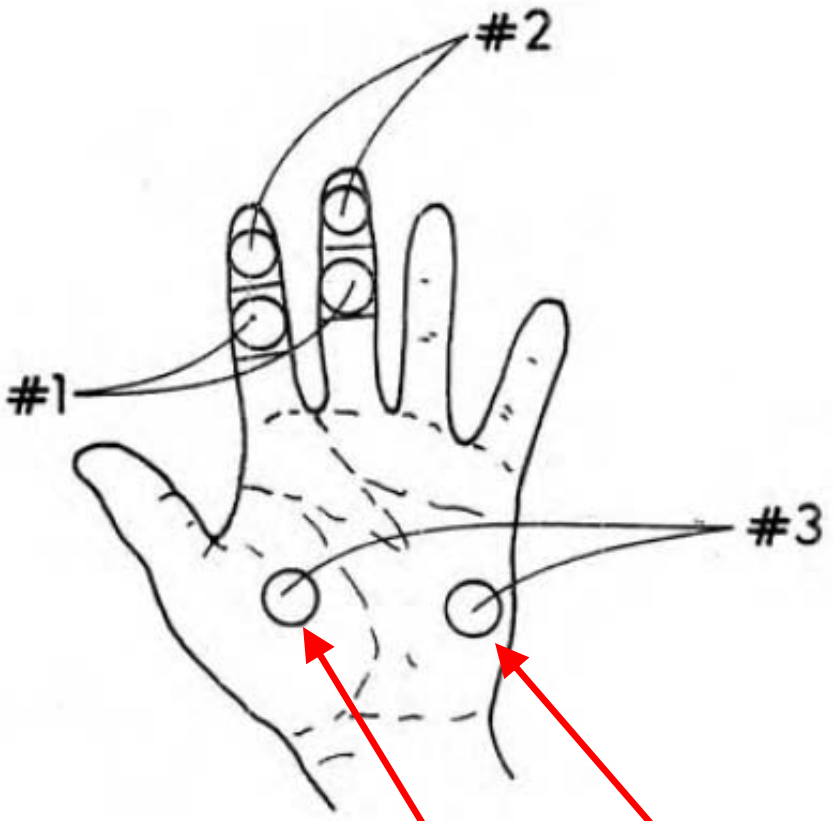


Figure 7.3. Three electrode placements for recording electrodermal activity. Placement #1 involves volar surfaces on medial phalanges, placement #2 involves volar surfaces of distal phalanges, and placement #3 involves thenar and hypothenar eminences of palms.

From Dawson et al 2007

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Methodology

A Major Effect of Recording Site on Measurement of Electrodermal Activity

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ABSTRACT

Although the medial phalanx has been recommended as the preferred site for recording skin conductance activity, a review of articles published in *Psychophysiology* indicates that a large minority (34%) of studies employ the distal phalanx. Informal observations also suggest that the distal site may be more reactive than the medial site. This study formally tests this observation by recording skin conductance from both medial and distal phalanges. Twenty-four right-handed subjects (12 male, 12 female) were exposed to a series of 10 orienting and defensive stimuli. Electrodes were placed on the fore and middle fingers of each hand, with distal sites used on one hand and medial sites on the other for each subject. Skin conductance amplitudes were 3.5 times larger at distal than medial sites ($p<.002$), while skin conductance levels were 2.08 times larger at distal sites ($p<.0005$). A significant Site × Stimulus interaction ($p<.025$) indicated that the distal site was more sensitive to habituation over trials and to increases in skin conductance amplitudes with increasing stimulus intensity than the medial site. On the basis of these findings it is recommended that distal sites be used in preference to medial sites in the recording of skin conductance activity.

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

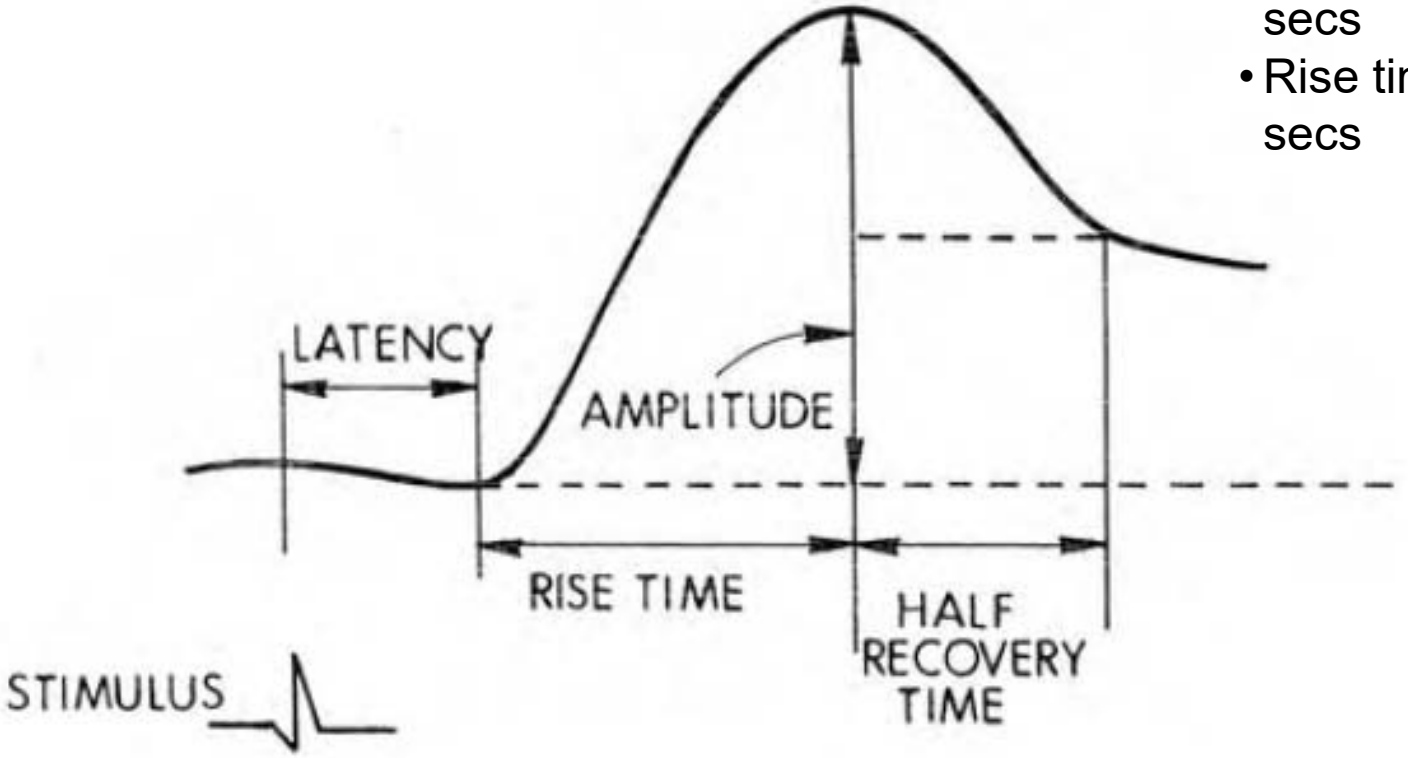


Figure 7.5. Graphical representation of principal EDA components.

From Dawson et al 2007

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 (Őhman)
- Individual Differenc
- Deficient anticipato (Hare)
- Deception Detectio

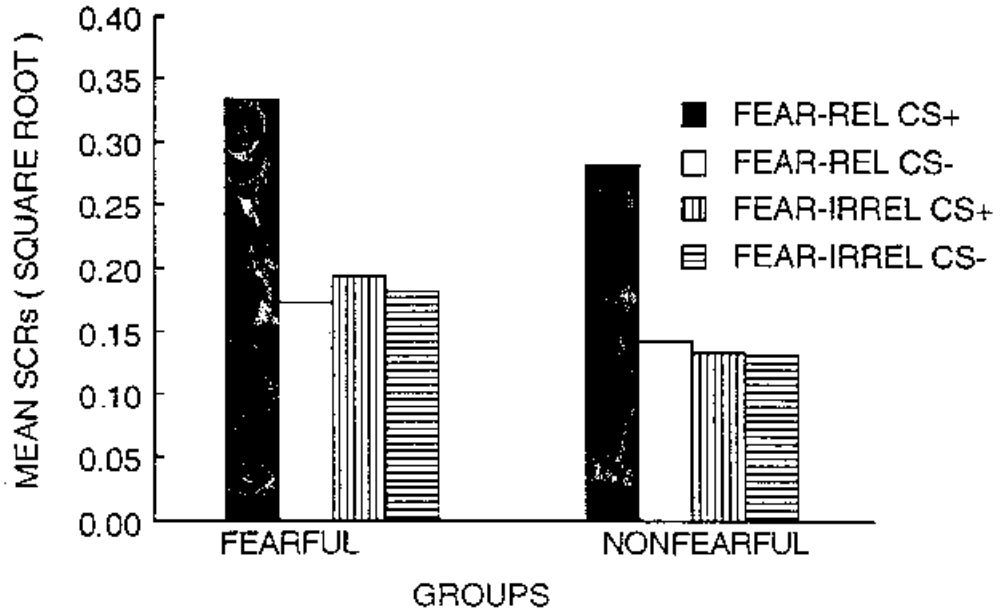


Figure 1. Mean skin conductance responses (SCRs) (square-root transformed) to fear-relevant (snakes, spiders, and rats) or fear-irrelevant (flowers and mushrooms) stimuli previously followed (CS+) or not followed (CS−) by an electric shock unconditioned stimulus among the fearful and nonfearful groups of subjects during extinction.

Applications

- Orienting (Bauer, 1984; Tranel and Damasio, 1985)
- Fear conditioning (Őhman)
- 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*

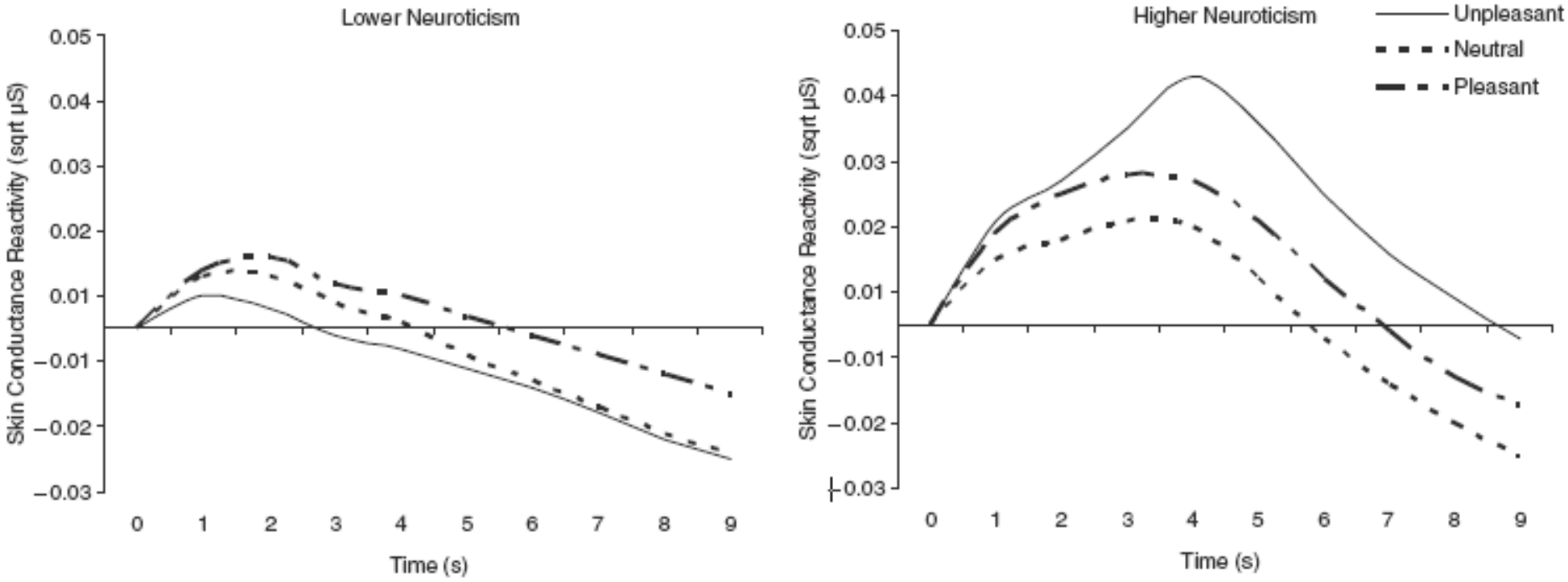
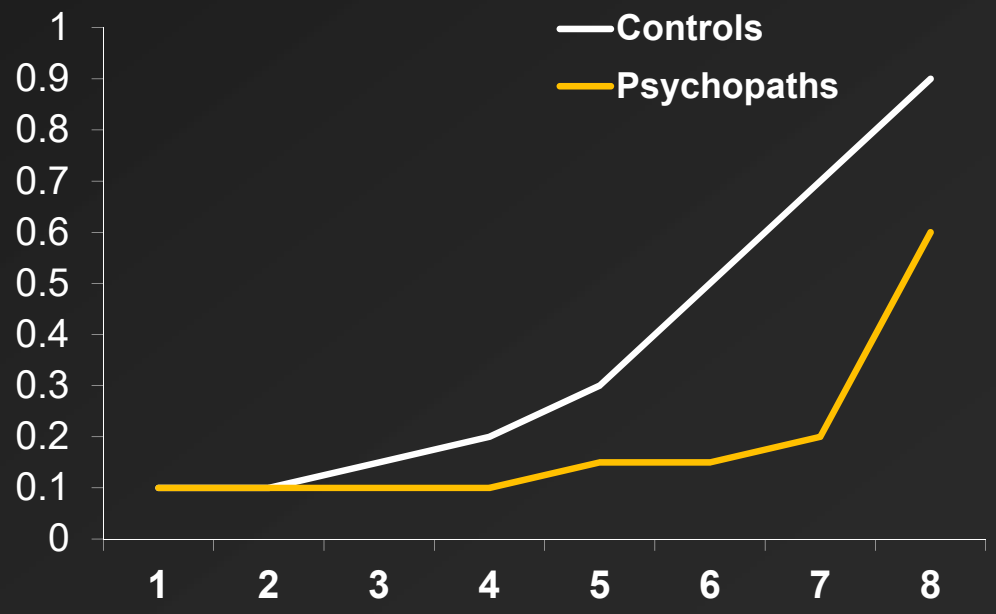


Figure 1. Skin conductance reactivity as a function of picture valence, time, and neuroticism. Pictures were presented from 1–6 s. Estimated means for participants lower (1 *SD* below the mean) and higher (1 *SD* above the mean) in neuroticism are plotted separately.

Anticipatory Arousal in Psychopathy

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



Fearless Dominance (dual-process model of Psychopathy)

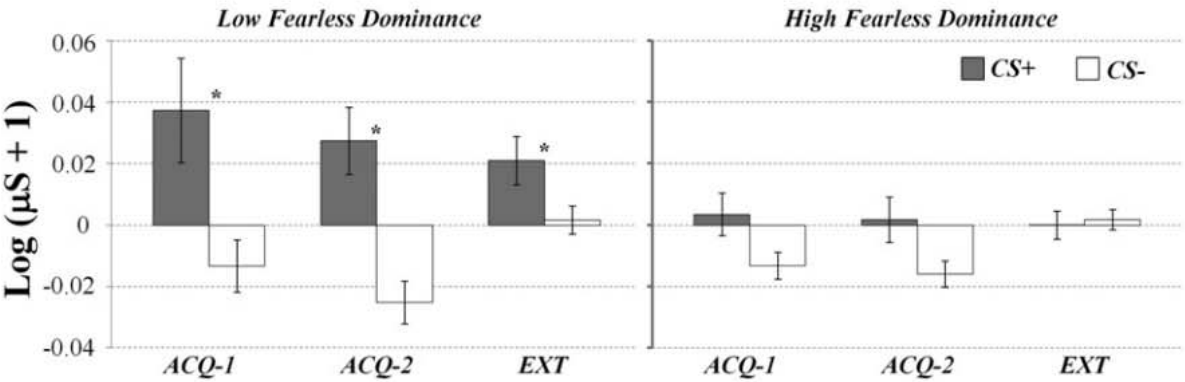


Figure 1. Mean skin conductance change (log [μS + 1]) for high and low fearless dominance groups when viewing CS+ and CS– during acquisition (ACQ-1 and ACQ-2) and extinction (EXT) phases of the fear conditioning procedure.

López,R., Poy, R., Patrick, C.J., & Moltó, J. (2013) *Psychophysiology*

Deception Detection