Review: Patient HM

- https://www.youtube.com/watch?v=KkaXNvzE4pk&list=PLYLFbXOYRbtY9ruwAlFH_tj7tnMiW_jae

Brain Basis of Emotion

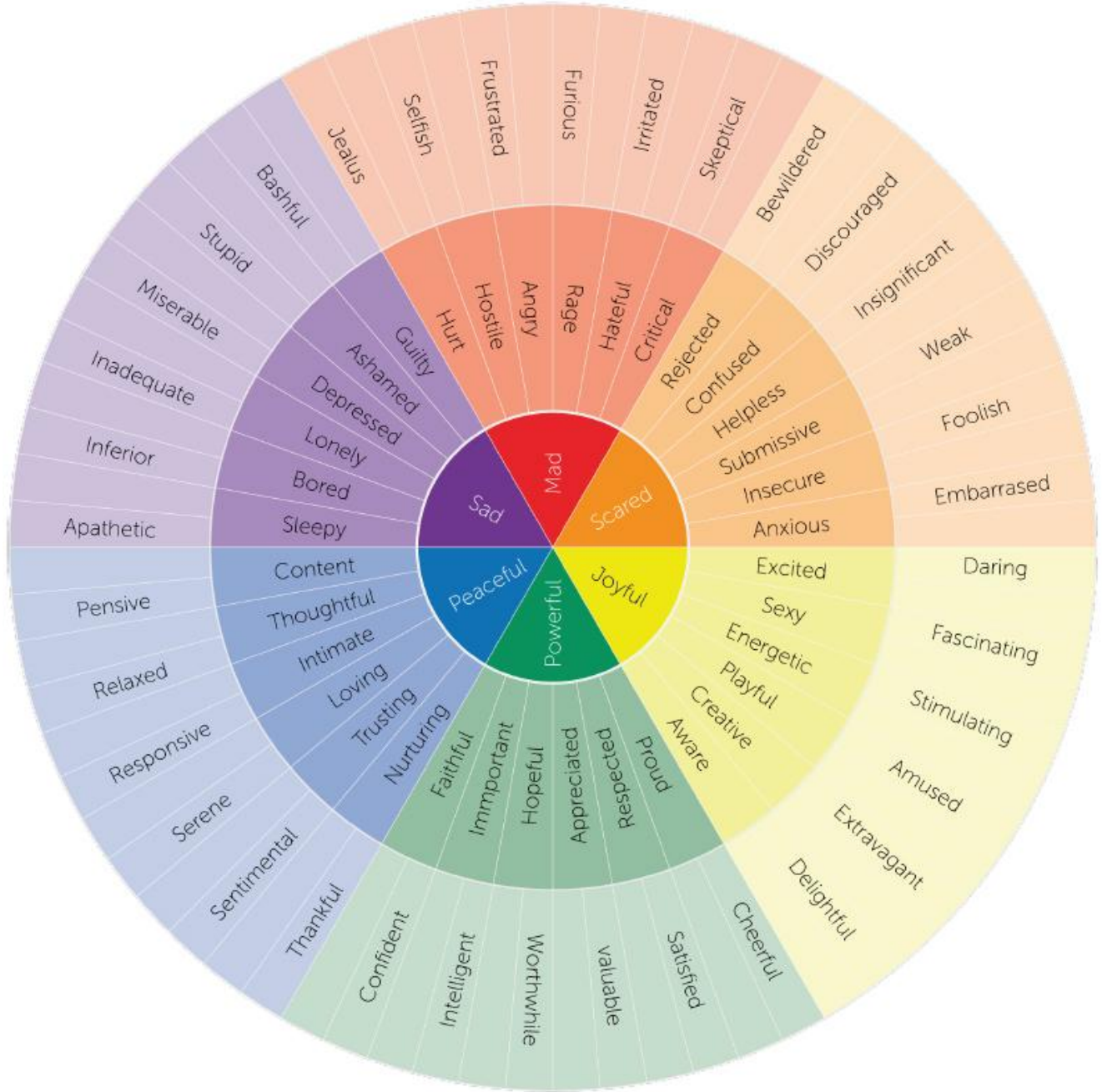


Figure 15.1 An emotion wheel listing several related subtly different feelings.

What are emotions?

- Complex neurophysiological states that contribute to an internal feeling and guide behaviour.
- Difficult to define
  - Fluid nature
  - Overlapping experience of multiple emotions simultaneously
  - Perceived by different people in unique ways

Affective neuroscience

- Study of the neural mechanisms that underly emotions

In small groups

- Imagine you are an affective neuroscientist. What neuroscience method (recall Chap 6) would you use to study the brain basis of emotion? Give the broad strokes of a possible experiment. What are some challenges that might come up?

Review: Patient HM

- https://www.youtube.com/watch?v=GhfNtyL_Cj0
- https://www.youtube.com/watch?v=pdJBiiiwI_Y

History of emotion research

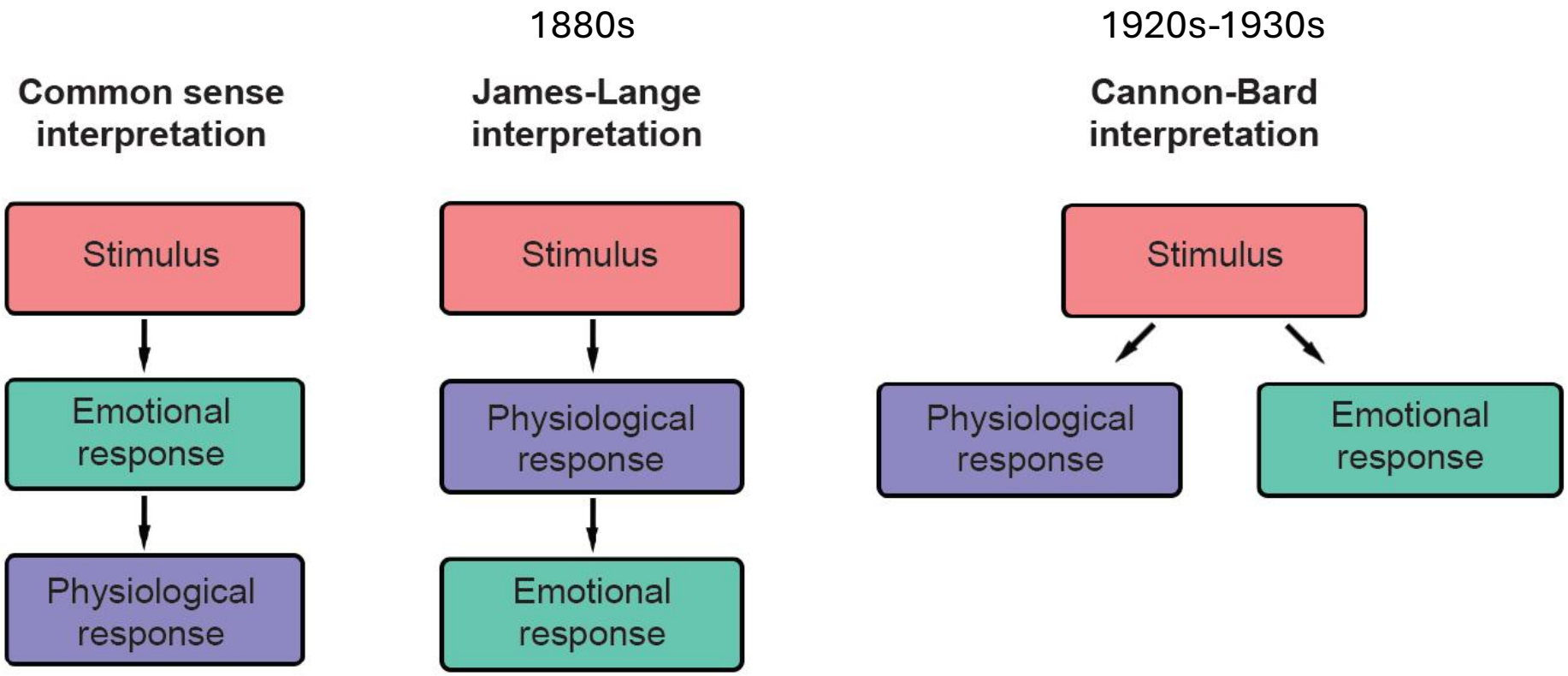


Figure 15.2 Three different theories about how an organism responds to some stimulus.

Cannon and Bard's work

- Surgically removed the entire sympathetic nervous system from cats
- Cats exhibited fear/aggression responses (e.g., posturing, hissing, clawing) even without a sympathetic nervous system
- Therefore, physiological response is not needed for an emotional response

More evidence: people with spinal cord injuries lack autonomic inputs to the brain but have intact emotional responses

Cannon and Bard's work

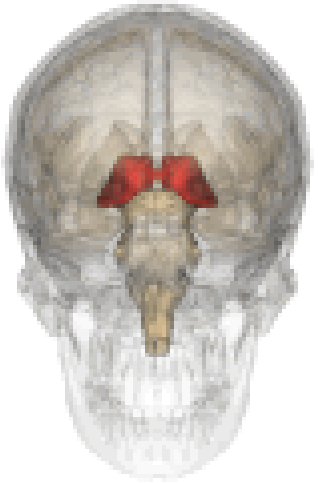
- Noted that sympathetic nervous system activity is not always related to emotion (e.g., exercise, exogenous administration of epinephrine)

Figure 15.3 Contrary to the James-Lange theory of emotion, physical exercise produces a high physiological state without always inducing an emotional response.

Role of different brain regions

- Decorticate cats: hyperaggressive (sham rage)
- Lesion thalamus: Sham rage eliminated
- Conclusion: Rage and other powerful emotions are normally under inhibitory control of the cortex

Figure 15.4 Decorticated cats express sham rage in response to harmless stimuli, suggesting that anger is kept under control by cortical inhibition.



Anatomography via CC-BY-SA-2.1-jp

Papez circuit

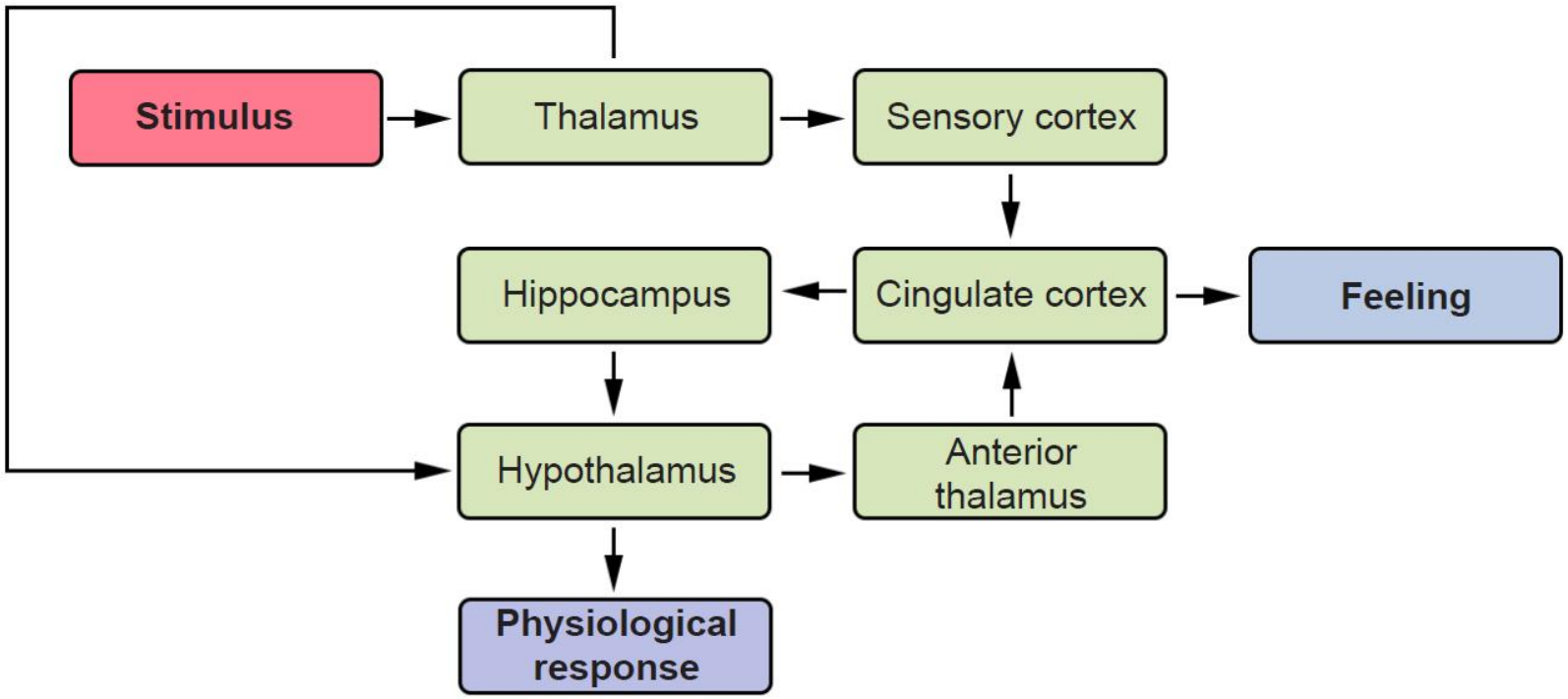


Figure 15.5 The Papez circuit was an early neuroanatomical description of some structures (green) involved in emotional processing and responding (purple).

Papez circuit

- Unusual aggression observed among animals with injury to these structures
- Emotional responding is distributed across brain areas (not localized)
- Amygdala missing from original 1937 version – added in a 1950s revision

Impact of bilateral temporal lobe removal in the monkey

- Fail to display fear or anger, even in life-threatening stimuli such as a large snake
- Visual agnosia (inability to recognize faces or objects visually)
- Psychic blindness ("inability to recognize "the emotional importance of events")
- Hypersexuality
- Hyperorality
- Klüver-Bucy syndrome (named after researchers)
- Seen in humans occasionally after stroke, brain surgery, viral encephalitis, traumatic brain injury, etc.
- Bilateral amygdalectomy is sufficient to produce Klüver-Bucy syndrome

Figure 15.6 In addition to a loss of fear, a macaque monkey with Kluver-Bucy syndrome would display hyperorality.

The same physiological response can be related to different emotions

- E.g., Rise in heart rate associated with fear or elation
- **Two-factor theory of emotion**: Combine physiological response with cognitive label

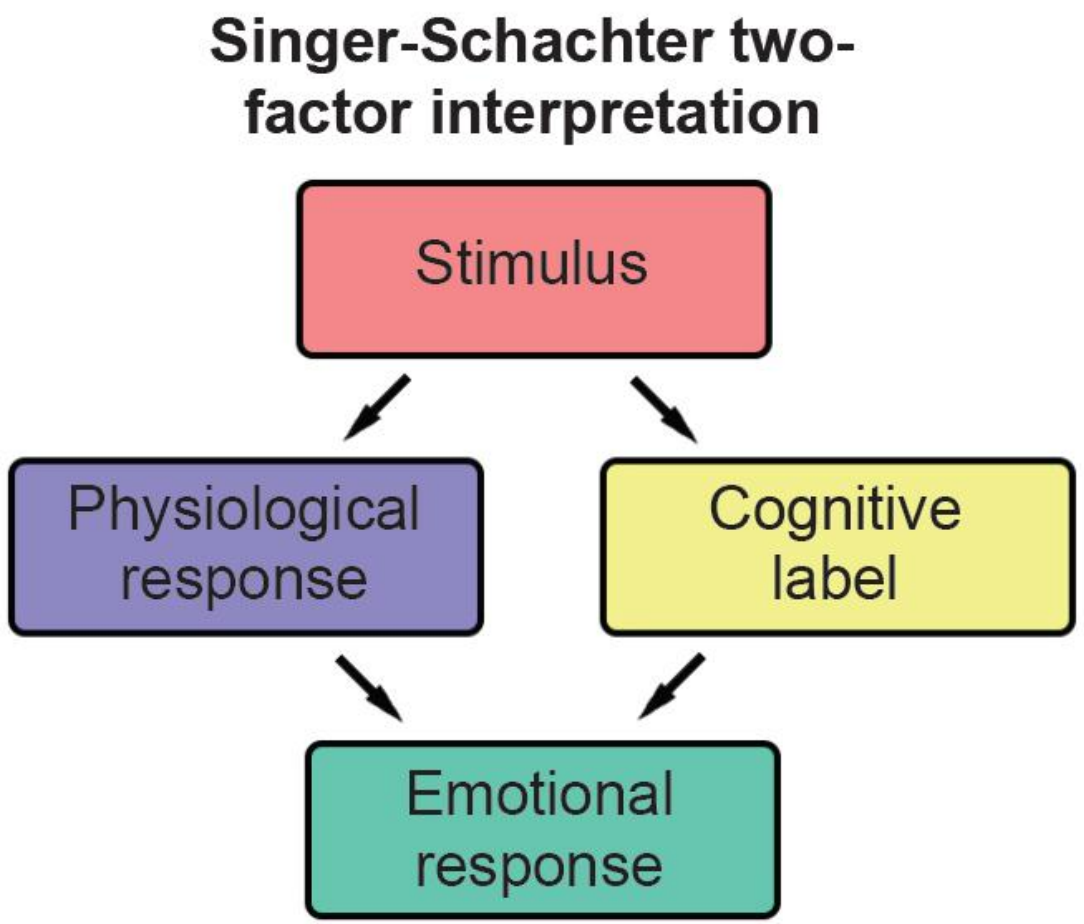


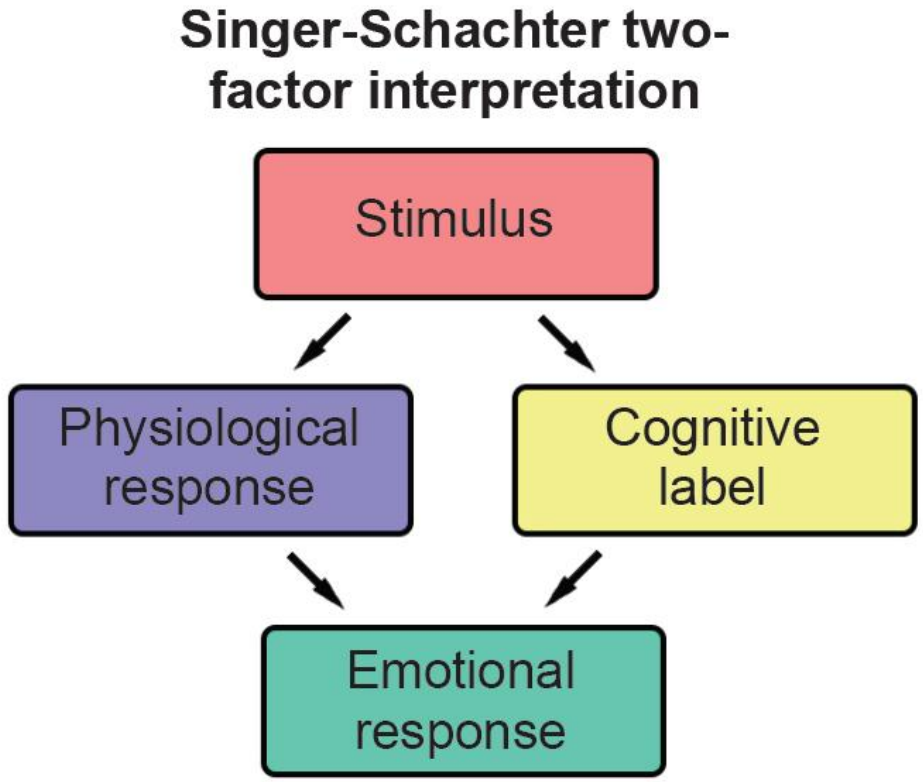
Figure 15.7 The Singer-Schachter two-factor theory of emotion suggests that both the physiological response and a cognitive label contributes to the emotional response.

Testing the two-factor theory

- Administer epinephrine to participant

- 4 groups:
  - Expectancy: epinephrine effects explained or not explained
  - Confederate: euphoric or angry

- The group who did not have epinephrine effects explained were more sensitive to the emotional display of the confederate



Emotional facial expressions: Darwin's contribution

- 1872: *The Expression of Emotions in Man and Animals*
- Similar emotional responding is found across different cultures and to some extent, even in nonhumans
- Main purpose: To communicate survival cues between individuals
  - Within- and between-species

Ekman: 7 basic categories of emotions Match them up

Anger *contempt disgust fear happiness sadness surprise

1 2 3 4 5 6

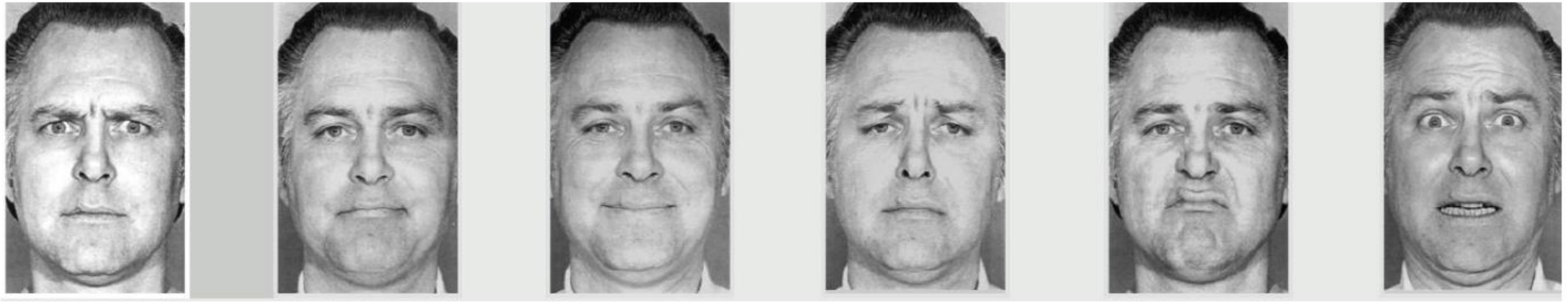


Figure 15.9 Paul Ekman's research in Papua New Guinea suggests that across cultures, humans use similar facial muscle activity patterns to convey a universal set of emotions. Ekman also developed anatomical definitions for describing specific emotions.

Ekman's theory: facial expressions of emotions are universal

- Tested in remote Papua New Guinea village
- 1972: published evidence in support of his theory
- https://www.paulekman.com/resources/universal-facial-expressions/
- https://www.paulekman.com/micro-expressions-training-tools/

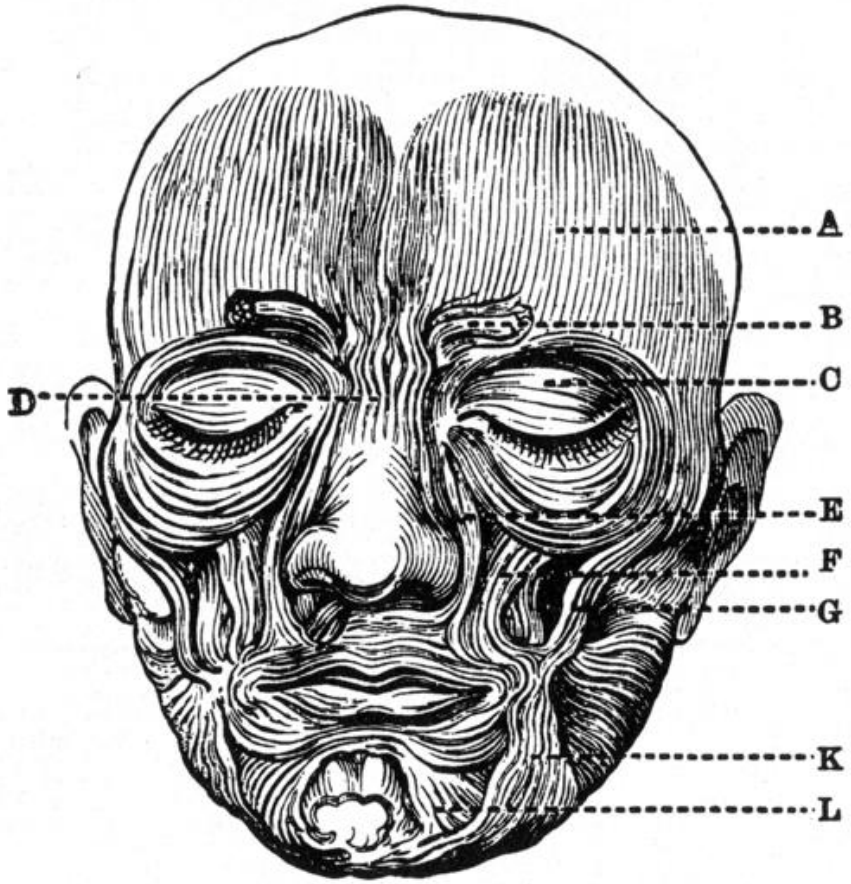


Fig. 1.—Diagram of the muscles of the face, from Sir C. Bell.

Public domain
https://commons.wikimedia.org/wiki/File:Expression_of_the_Emotions_Figure_1.png

Duchenne versus non-Duchenne (fake) smile

- https://images.app.goo.gl/zPnsnZTHW4KYXmRP7
- Different muscles involved
- Would score differently on the Facial Action Coding System (FACS)

Brain structures involved in emotions

- Amygdala
- Hypothalamus
- Pituitary gland
- Insula

Amygdala

- Structure of the limbic system
- Part of the medial temporal lobe
- Divided into several nuclei
- Involved in emotional memory formation

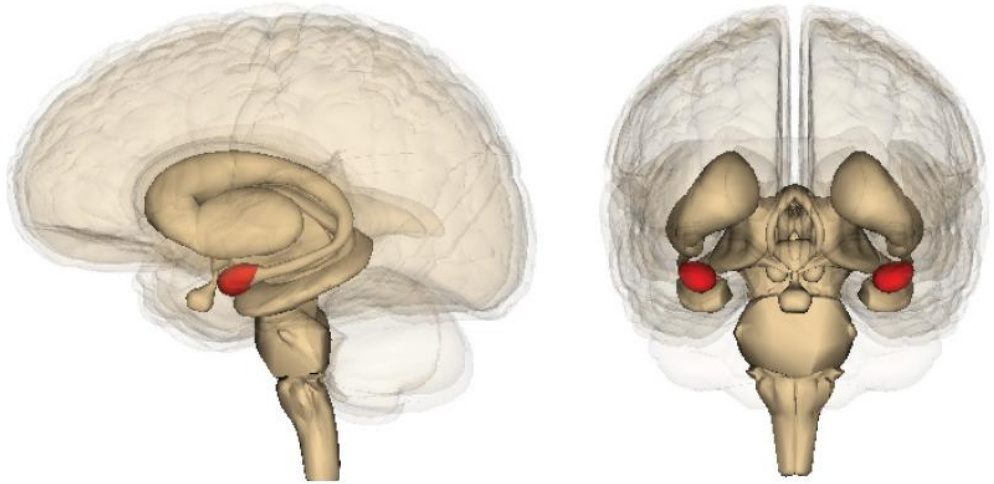


Figure 15.10 The amygdala (red) contribute to emotional processing.

Hypothalamus

- Receives signals from amygdala
- Initiates endocrine (hormone) responses in the rest of the body
- Regulates homeostasis, hunger, circadian rhythms

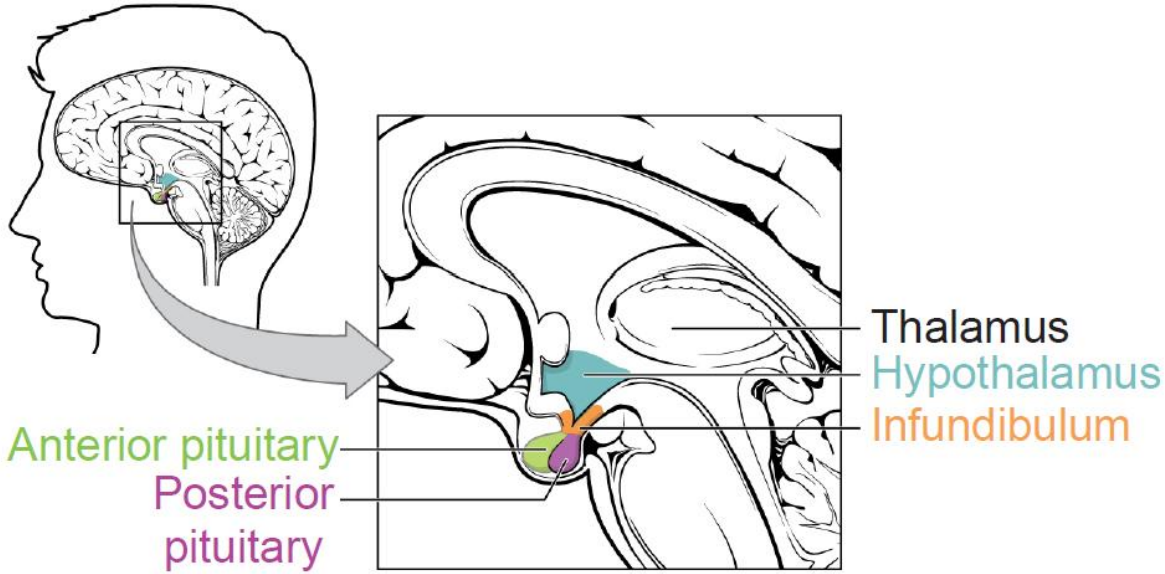


Figure 15.11 The hypothalamus is a brain structure that initiates hormonal changes through influencing the pituitary gland.

Pituitary gland

- Receives signals from hypothalamus
- Produces and releases neurohormones that influence several organs throughout entire body
- Anterior pituitary and posterior pituitary

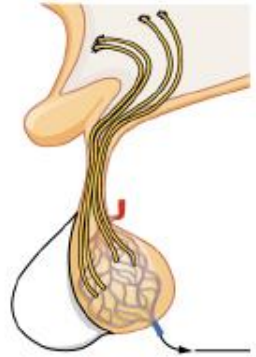
Posterior pituitary

- AKA neurohypophysis
- Does not synthesize any neurohormones
- Hypothalamus secretes neurohormones into posterior pituitary vial the hypophyseal portal system (leaky capillaries)
  - Oxytocin: development and maintenance of prosocial behaviours, lactation
  - Vasopressin: similar to oxytocin but also regulates osmolarity (increases water retention)

Anterior pituitary

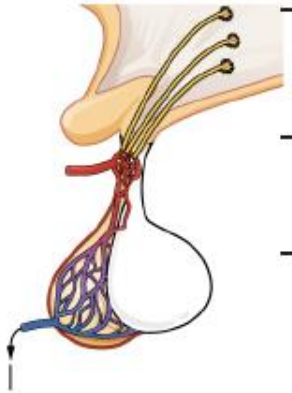
- AKA adenohypophysis
- Receives signals from hypothalamus
- Synthesizes and secretes neurohormones
- Trophic hormones
  - Stress response, growth, sexual development, circadian rhythms

Posterior pituitary hormones



Releasing hormone (from hypothalamus)	Pituitary hormone	Target	Effect
	OT	Breasts Uterus	Milk letdown Contractions
ADH (vasopressin)		Kidneys Circulatory system	Increased water retention Constricts blood vessels

Anterior pituitary hormones



GHRH	GH	Somatic tissue	Promotes anabolism
CRH	ACTH	Adrenal glands	Glucocorticoid production (stress response)
GnRH	LH	Reproductive system	Sex hormone production
	FSH	Reproductive system	Production of sperm and eggs
Thyroid releasing hormone	Thyroid stimulating hormone	Thyroid gland	Promotes metabolism
	Prolactin	Mammary glands	Milk production

Figure 15.12 The hypothalamus sends a variety of hormonal signals, which influence several different physiological features.

Insula

- Interoception
- Activated in many functional imaging studies of emotion
- Strongly impacted in disgust
  - Both experienced and perceived in others

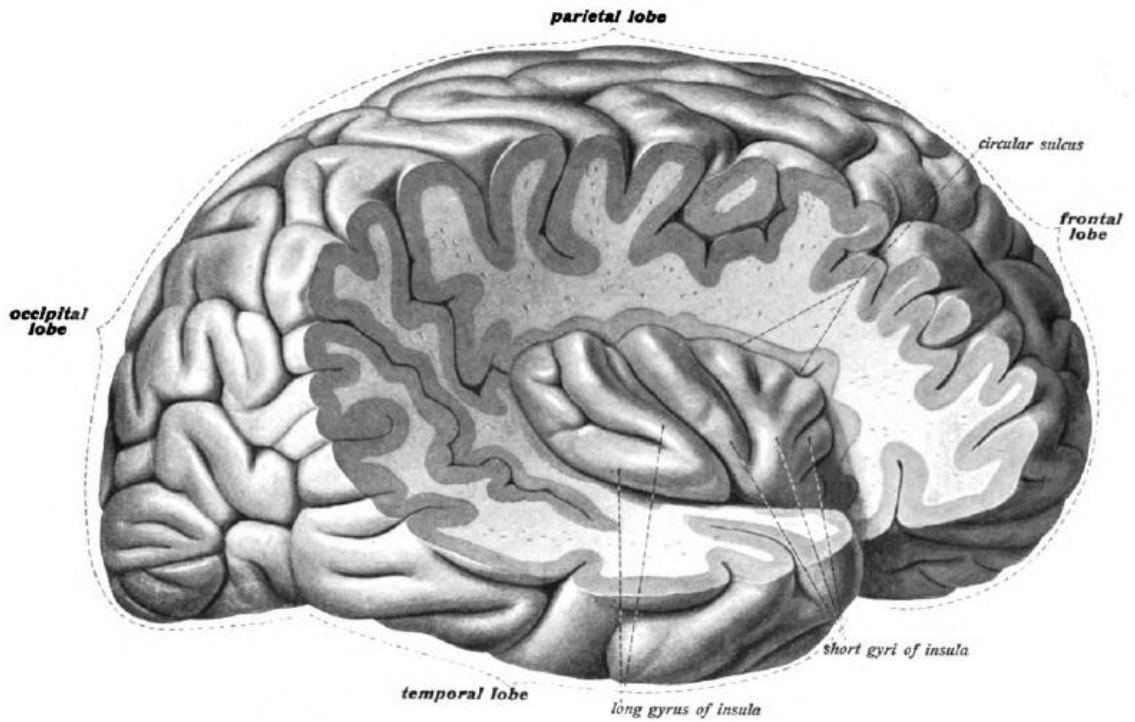


Figure 15.13 The insular cortex is only visible in a cut-away view of the brain.

Fear/Anger

- Patient SM
- Urbach-Wiethe disease (more specific damage to the amygdala than Klüver-Bucy syndrome)
- Rare genetic disorder that causes calcium build up in the amygdala

Plasmatoxmosis

- Caused by *T. gondii* infection
- Impacts amygdala

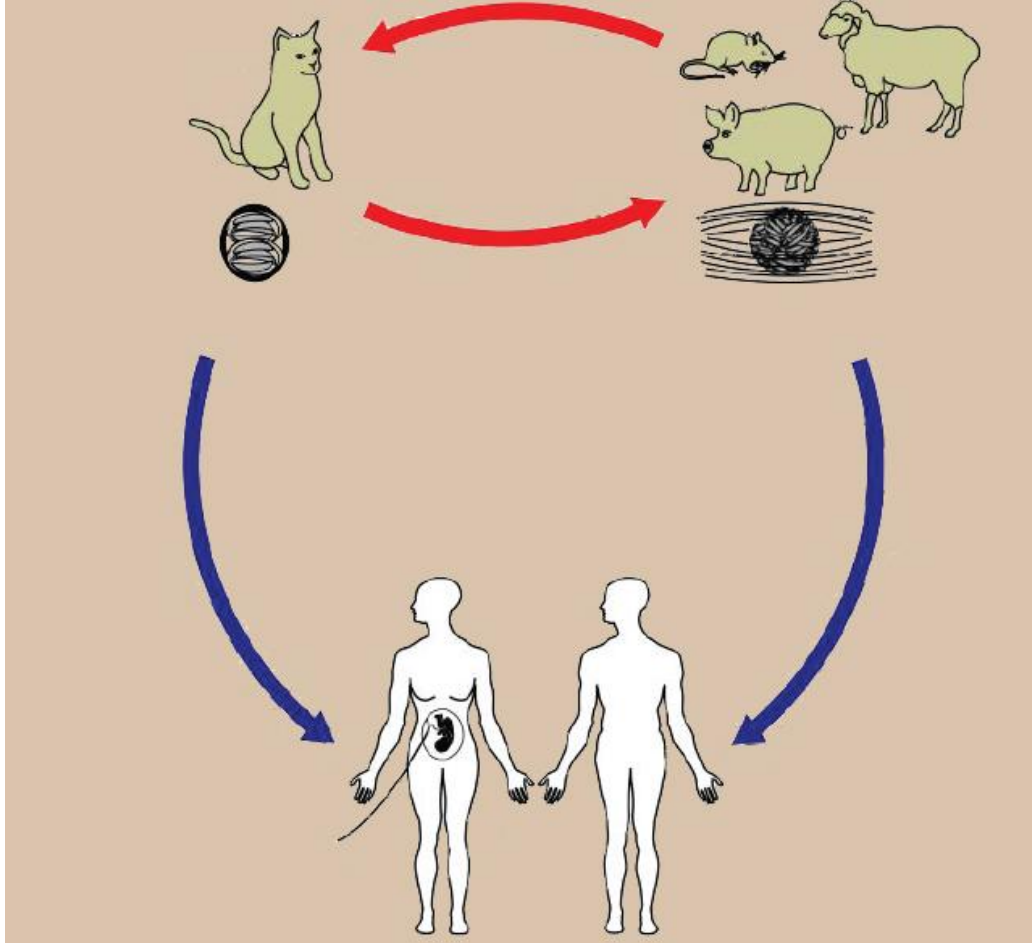


Figure 15.16 A toxoplasma infection changes the rodent fear response, causing them to be less afraid of predators. At either point, plasmatoxmosis can infect humans with potentially severe outcomes during pregnancy.

Borderline personality disorder (BPD)

- Brain and genetic basis: https://pmc.ncbi.nlm.nih.gov/articles/PMC1863557/
- From Wikipedia: The name of the disorder, particularly the suitability of the term *borderline*, is a subject of ongoing debate. Initially, the term reflected historical ideas of *borderline insanity* and later described patients on the border between neurosis and psychosis. These interpretations are now regarded as outdated and clinically imprecise.

Stress

The hypothalamus-pituitary-adrenal (HPA) axis

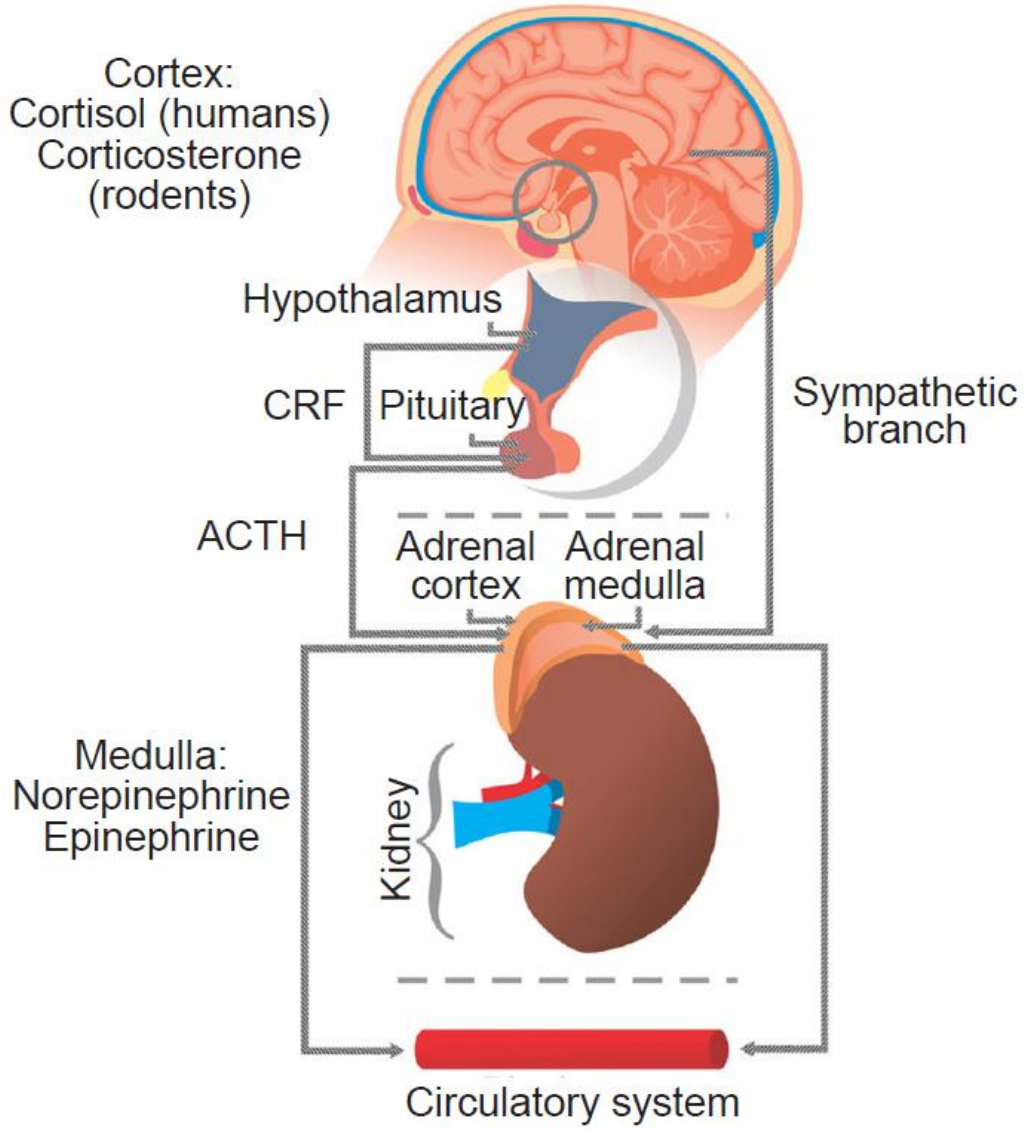
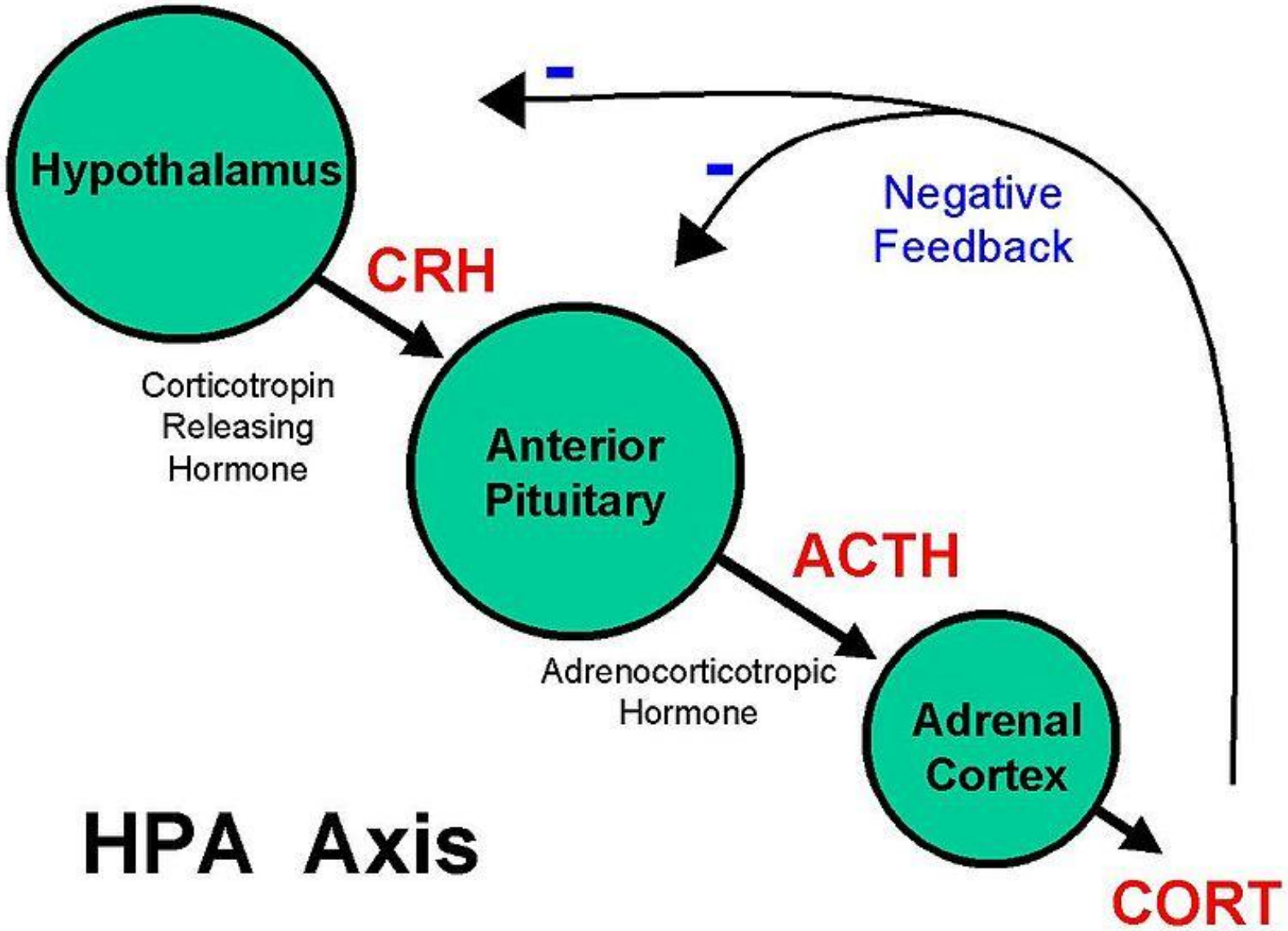


Figure 15.17 The HPA axis regulates both sympathetic nervous system activity and the stress response.



Public domain. https://commons.wikimedia.org/wiki/File:Basic_HPA_Axis.jpeg

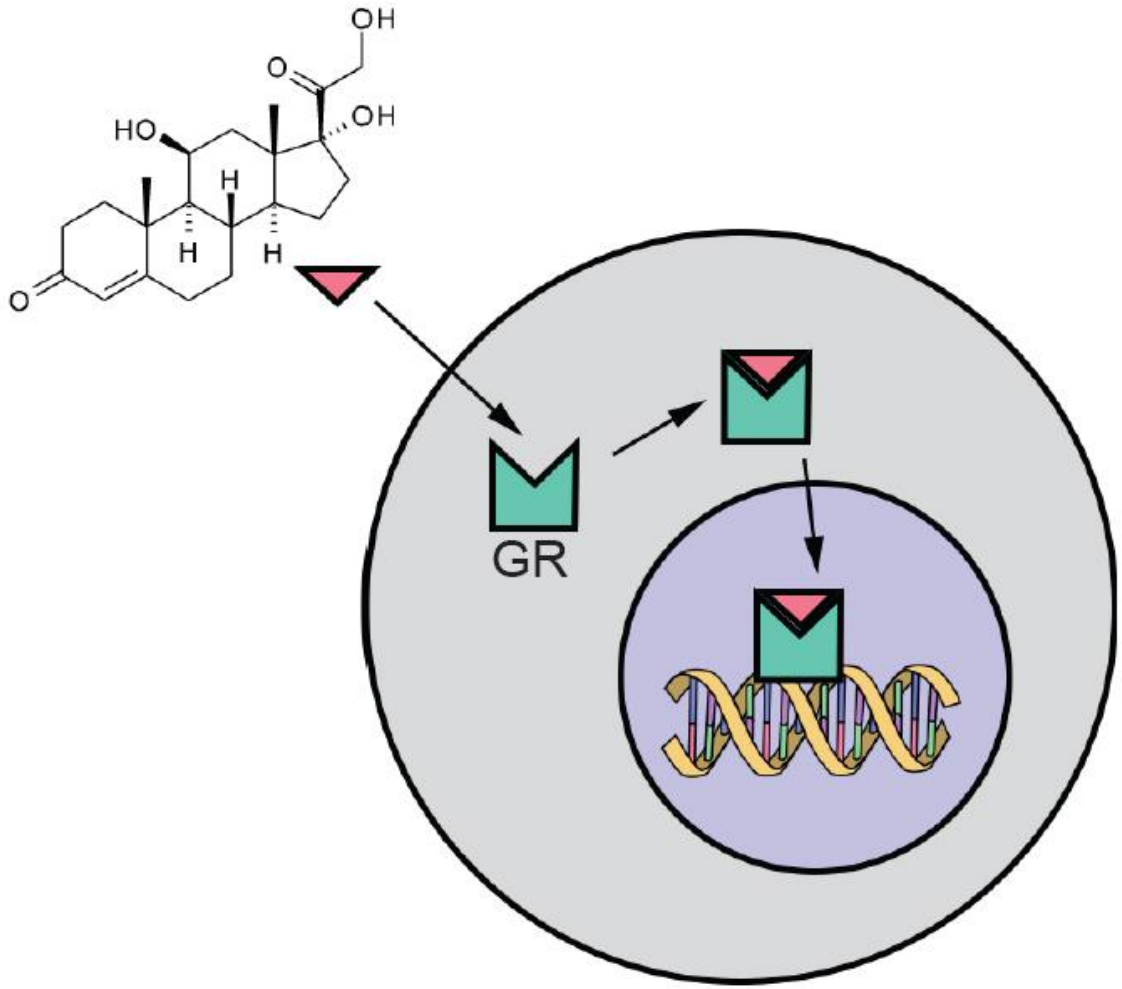


Figure 15.18 A molecule of cortisol (red triangle) diffuses through the cell membrane and binds to intracellular glucocorticoid receptors (GR, green).

Eustress versus distress

General adaptation syndrome

- Chronically ill humans often display a common set of symptoms, no matter the cause of their illness
  - Gastric ulcers
  - High blood pressure
  - Heart attacks
- Theory: There is a substance causing these symptoms

Test the theory

- Inject extracts from various organs of chronically ill humans into rats
- Rats appeared to develop general adaptation syndrome
- But so did the control rats…

Nonhuman models of stress

- Chronic-restraint stress
- Food restriction stress
- Forced-swim test
- Exposure to socially dominant bully rats
- Exposure to predator cues
- Social isolation

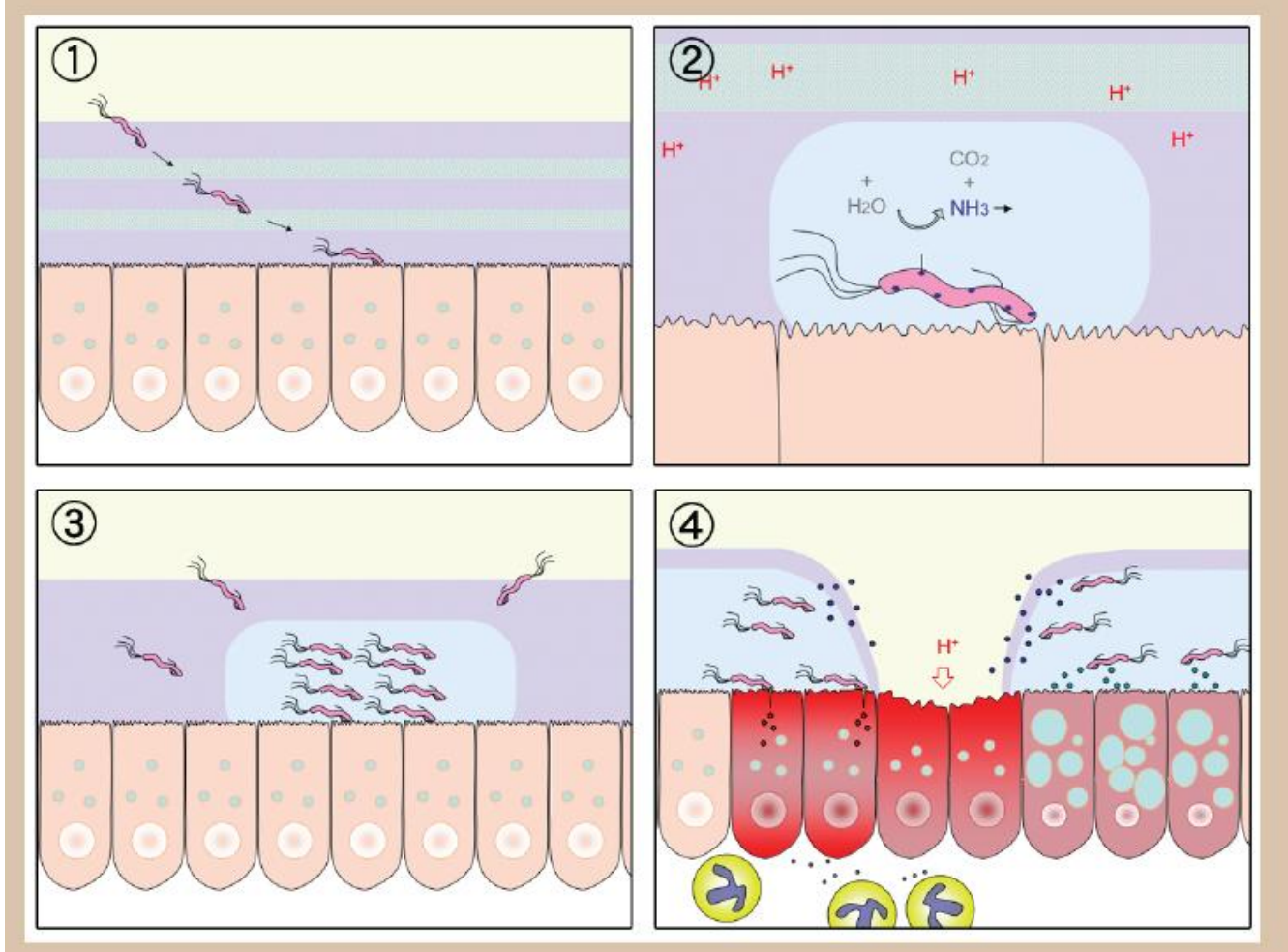


Figure 15.19 H. pylori interacts with stress and may result in stomach ulcers.

Barry Marshall

- https://www.youtube.com/watch?v=EDN0-0OKLFc

Love

- Intensely strong attachment to a person, thing, or concept
- Strict biological definitions difficult
- Several unique forms of interpersonal love

Romantic love

- Social monogamy
- 3 closely interconnected components

Figure 15.20 Unlike mammals, most bird species form socially monogamous bonds after mating.

1. Lust

- AKA libido
- Strong desire for sexual gratification
- Driven by sex hormones testosterone, estradiol, and progesterone
- Both testosterone and estradiol contribute to sex-seeking behaviours in men and women

Brain regions involved in lust

- Sex hormones strongly influence the medial preoptic area of the anterior hypothalamus
  - Contains a sexually dimorphic area
    - Humans: twice as large in males
    - Rats: 8x as large in males
    - Lesioning the sexually dimorphic area results in decreased motivation to engage in sex
- Amygdala
  - Klüver-Bucy syndrome (hypersexuality)
  - Damage can also result in a decrease in responding to socially-derived sex cues

2. Attraction

- High energy investment and preoccupation towards a small number of people
- May have developed to select between multiple possible reproductive partners
- Dopamine
  - Reward circuitry
- Norepinephrine
  - Exhilarated feeling

3. Attachment

- Feelings of comfort and emotional stability
- Contributes to offspring survival

Parental love

- Familial love/kinship: protection and preferential support of genetic relations
- Breastfeeding, oxytocin, prolactin, and the brain

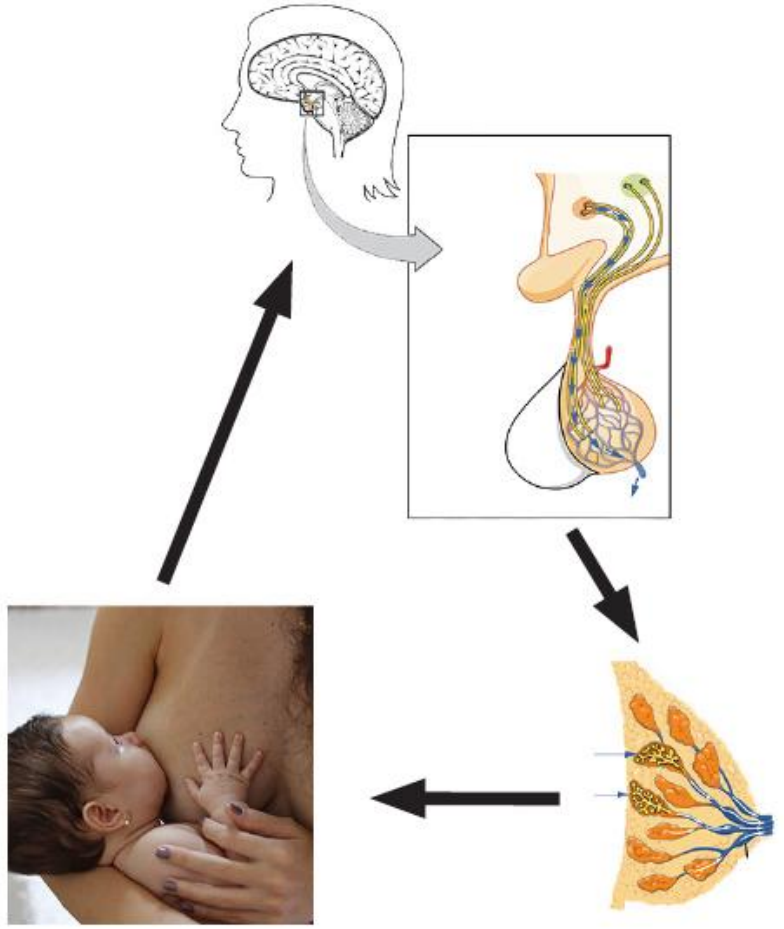
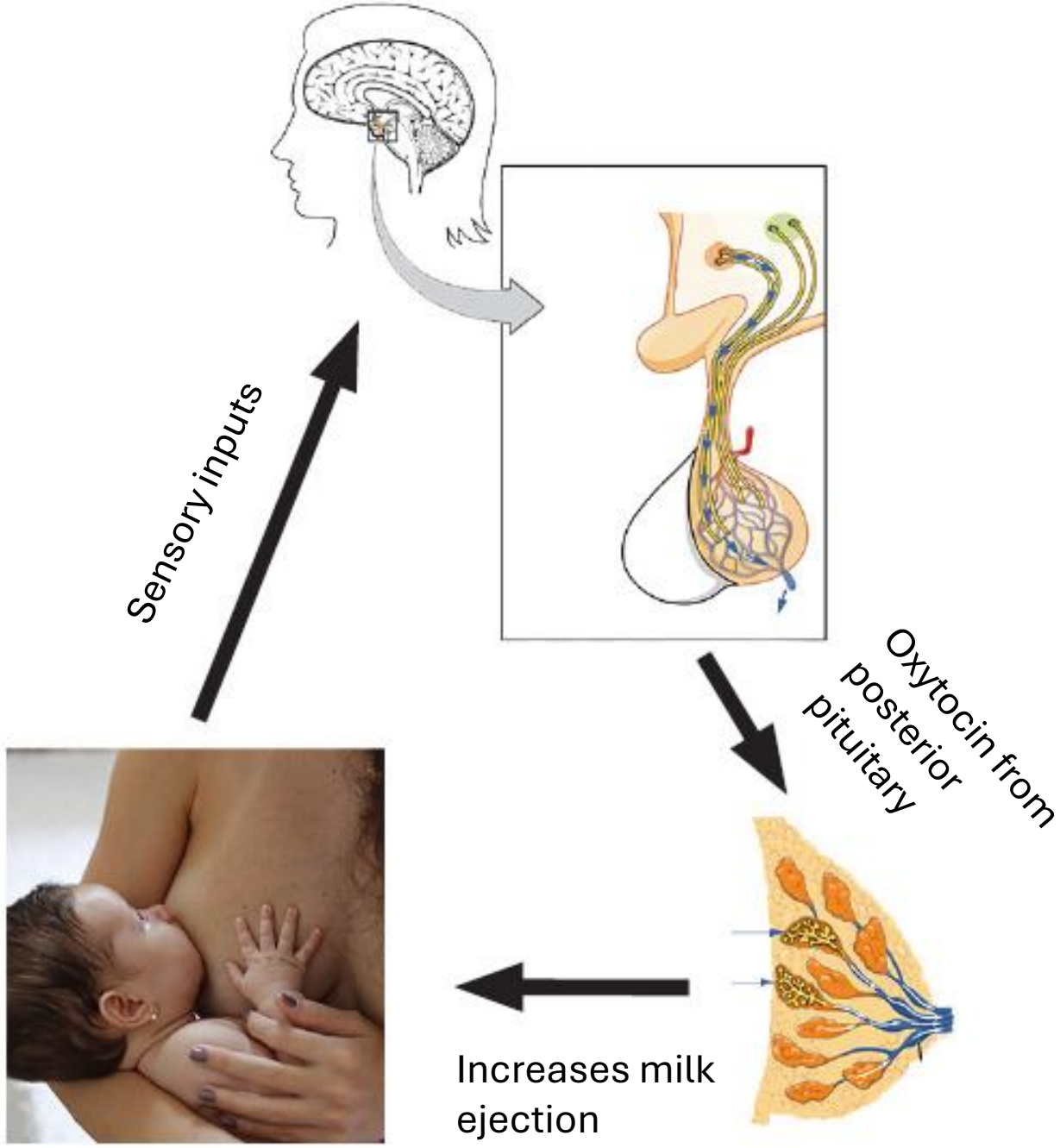


Figure 15.23 Suckling (bottom left) triggers somatosensory inputs, which send afferents into hypothalamus (top), increasing blood levels of oxytocin. Oxytocin increases accumulation of milk in the mammary glands (bottom right), which encourages increased suckling.

- https://images.app.goo.gl/B5FUSr6chPH8hgc68
- https://images.app.goo.gl/UySKQRJsZauFD4WK8
- https://www.researchgate.net/figure/Lactation-Reflex-Arc-and-role-of-Prolactin-and-Oxyticin-8_fig1_371968784

Positive feedback loops

- In parallel:
  - Increase in prolactin release from anterior pituitary
  - Increases milk production



Disgust

- Cultural differences
- Antisocial behaviours
- Behaviours that lead to low reproductive success
- Insula activation on fMRI

Obsessive-compulsive disorder

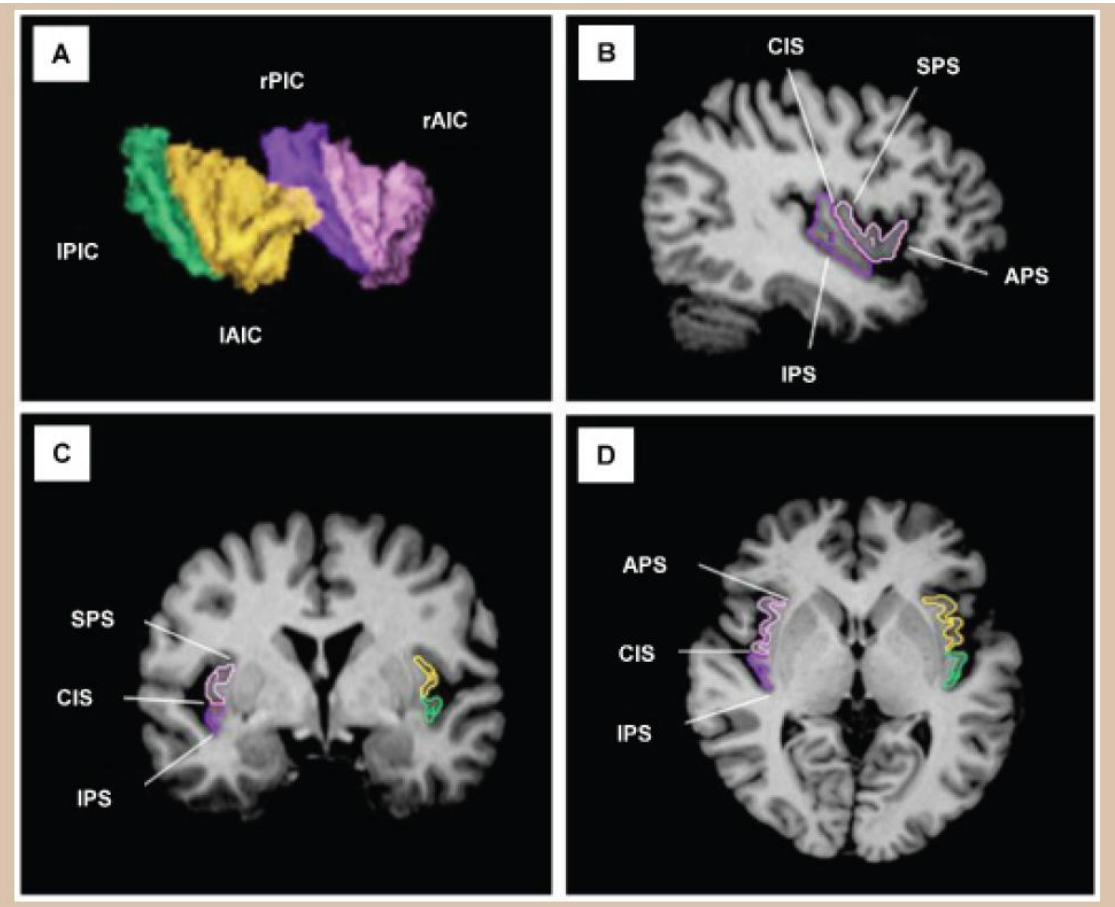


Figure 15.25 Morphological differences are observed in the volume of the insular cortex between people with OCD and neurotypical patients.