Brain and Behaviour – Emotion, Aggression and Stress

PSYC 304

Announcements

- ***FINAL EXAM – AUGUST 15, 7pm SWING 121 (or Zoom)***
- ***Reading CLUB 4A and 4B – AUGUST 5th***
- ***Don't forget your tweets!***

Outline

1. Emotion – theories
2. Emotion – Evolution & Neural mechanisms

-break-

1. Aggression

-break-

1. Stress

Learning Objectives

Theories of emotion

1. Describe and compare three dominant theories of the relationship of emotion to physiological changes.
2. Discuss the integration of autonomic responses with the perception of specific emotions.
3. Evaluate the ways in which people differ in their responses to emotional stimuli.
4. Review the evidence for a core set of emotions.
5. Discuss the evolution of emotions as preprogramming for responding to environmental challenges.
6. Discuss the role of facial expressions of emotion and the ways in which cultural differences influence facial displays.

Theories of emotion

Emotion:

- a subjective mental state usually accompanied by distinctive behaviors and involuntary physiological changes.
- Emotional states often activate the autonomic nervous system:

Sympathetic nervous system

- “fight or flight” system; activates the body for action.

Parasympathetic nervous system

- prepares the body to relax and recuperate.

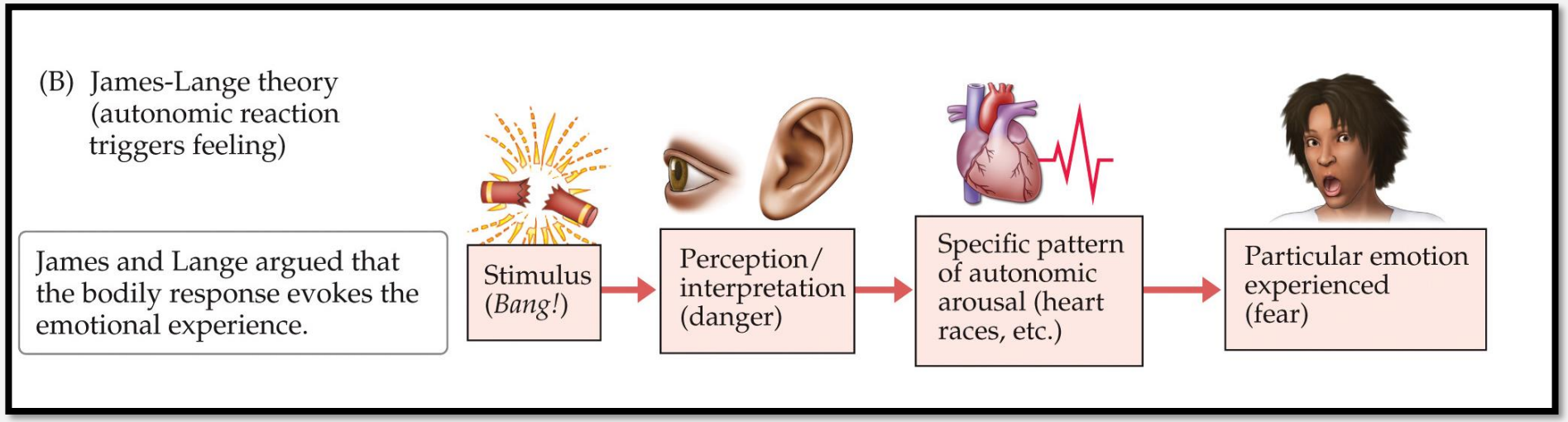
Theories of emotion

Folk wisdom

- autonomic responses (like stomach churning) are caused by emotions.

James-Lange theory:

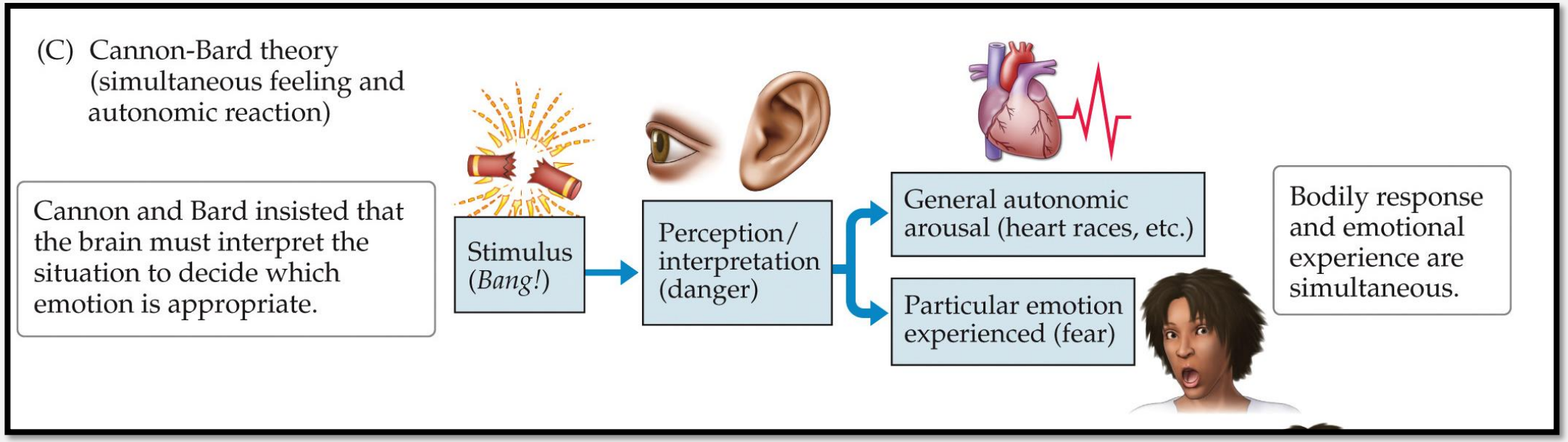
- the emotions we feel are *caused* by bodily changes; emotions differ due to different physiological responses.
- But there is no distinctive autonomic pattern for each emotion.



Theories of emotion

Cannon-Bard theory:

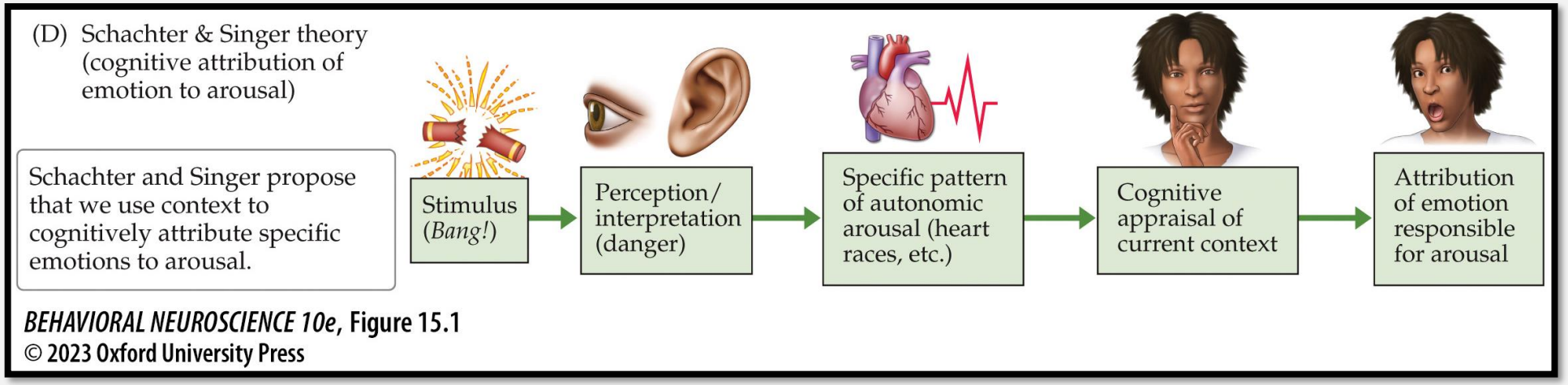
- emotions precede physiological responses and help deal with a changing environment.
- The cerebral cortex decides on the emotional response and also activates the sympathetic response.



Theories of emotion

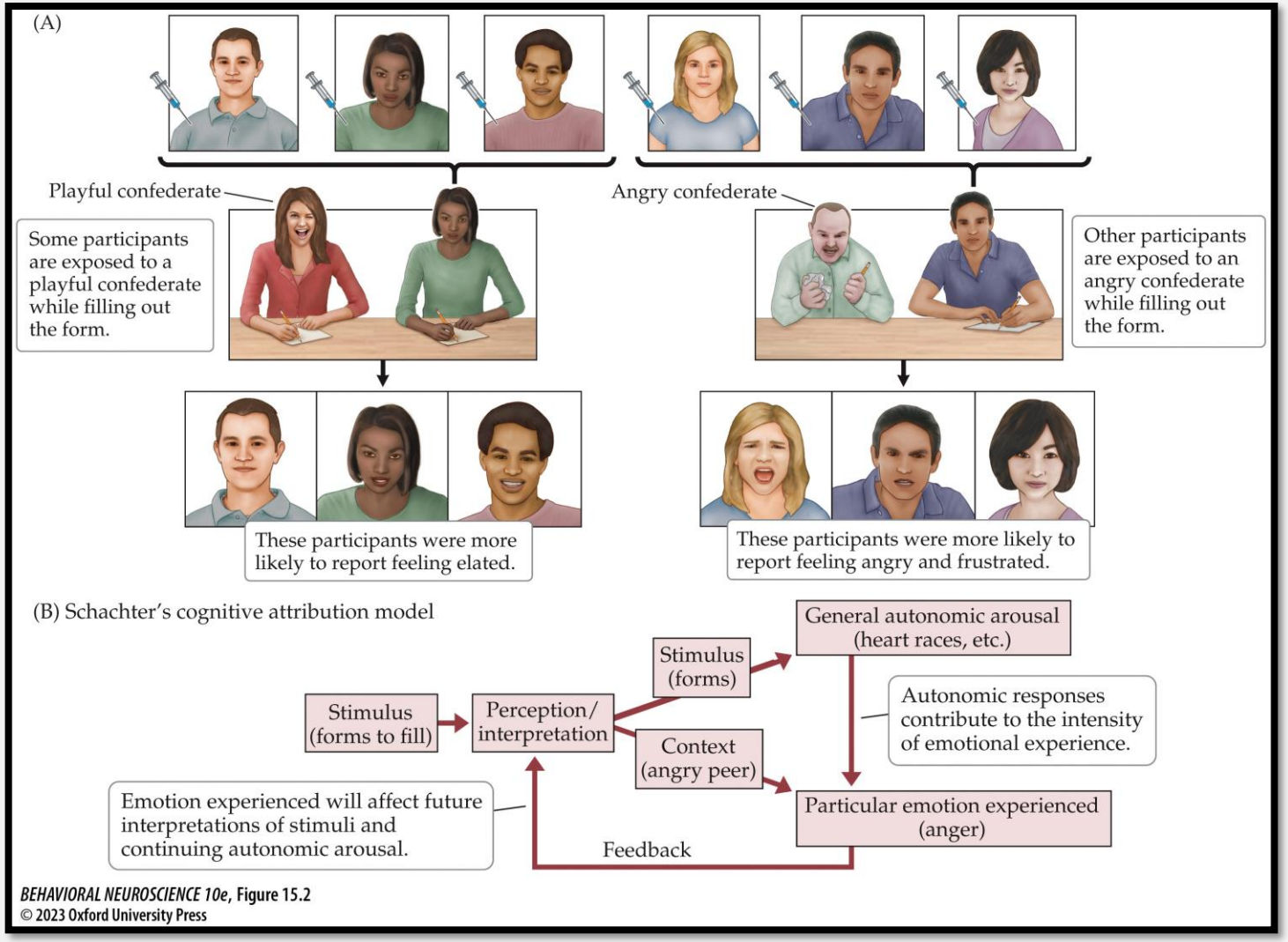
Schachter's cognitive attribution model:

- emotional labels (e.g., anger, fear, joy) are attributed to relatively nonspecific feelings of physiological arousal.
- *Which* emotion we experience depends on *cognitive* systems that assess the context.
- But there is evidence that patterns of autonomic activity differ between some emotions.



BEHAVIORAL NEUROSCIENCE 10e, Figure 15.1

Testing the cognitive attribution model



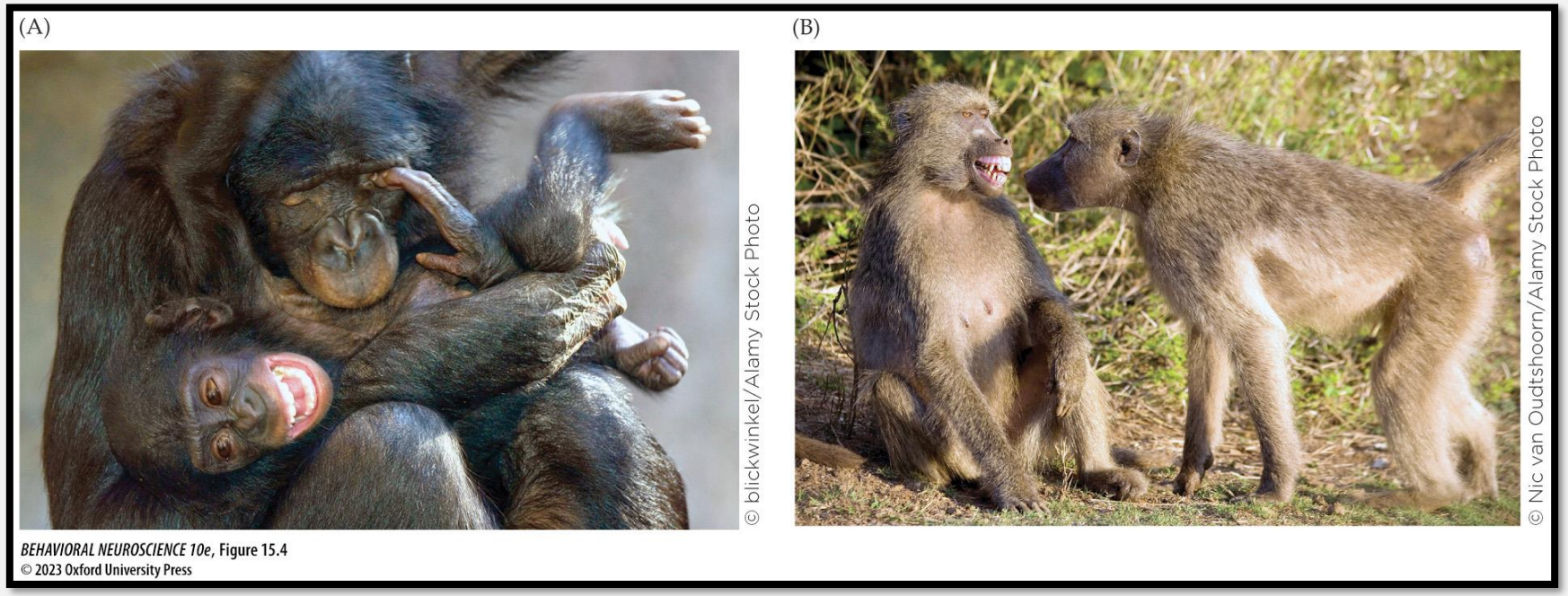
Theories of emotion

Individual response stereotypy:

- people differ in emotional reactivity and physiological responses to emotional situations; evident even in infants.
- Response patterns are remarkably consistent throughout life.
- Infants with exceptionally strong reactions to stimuli (“high reactives”) were more likely to have increased phobias or fear responses later in life.
- Individual differences in temperament bias attention to relevant emotional cues (e.g. socially anxious/highly reactive individuals may process facial cues more deeply and respond more intensely)

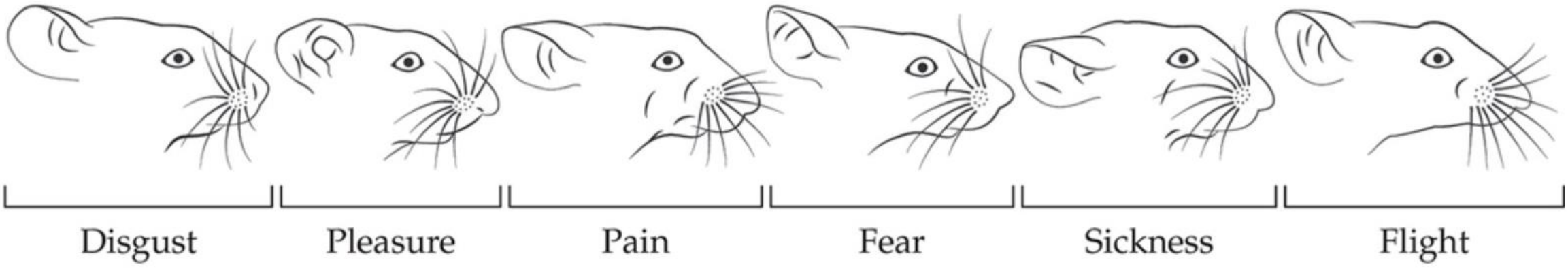
Evolution of emotion

- Darwin presented evidence that certain expressions of emotions are universal among all humans.
- He observed that nonhuman primates have the facial muscles as humans, and argued that aspects of emotional expression may have originated in a common ancestor.



Expression in mice

By processing many hours of video of mice in varying emotional circumstances, a computerized AI system learned to categorize the six subtle-but-distinct mouse facial expressions shown here. The facial expressions were associated with activity in brain mechanisms known to be involved in emotion in humans.



15.5 Facial Expressions of Emotion in the Mouse (After Dolensek et al., 2020, *Science* 368: 89. Courtesy of Julia Kuhl.) View larger image

Evolution of emotion

Evolutionary psychology

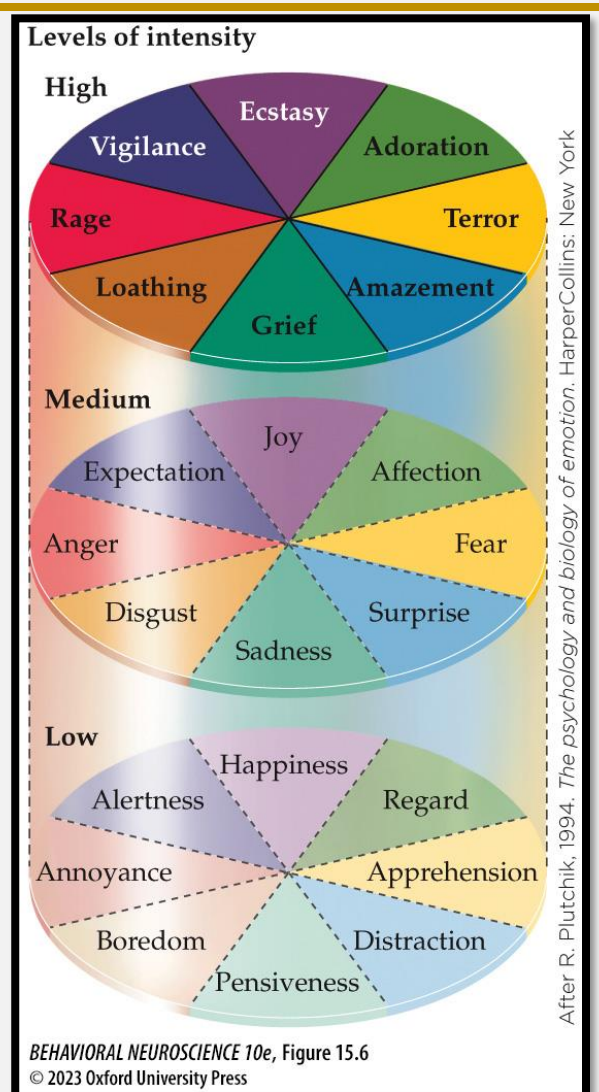
- studies how natural selection has shaped behavior.
- Cooperating with a group, choosing a mate, avoiding predators, finding food, may have required emotional adaptation.
- Emotions can be seen as evolved preprogramming that helped us deal quickly and effectively with a wide variety of situations.

Evolution of emotion

Plutchik suggests eight basic emotions, in four pairs of opposites:

- Joy/sadness
- Affection/disgust
- Anger/fear
- Expectation/surprise

But researchers do not yet agree about the number of basic emotions. One clue may come from the number of facial expressions we have.

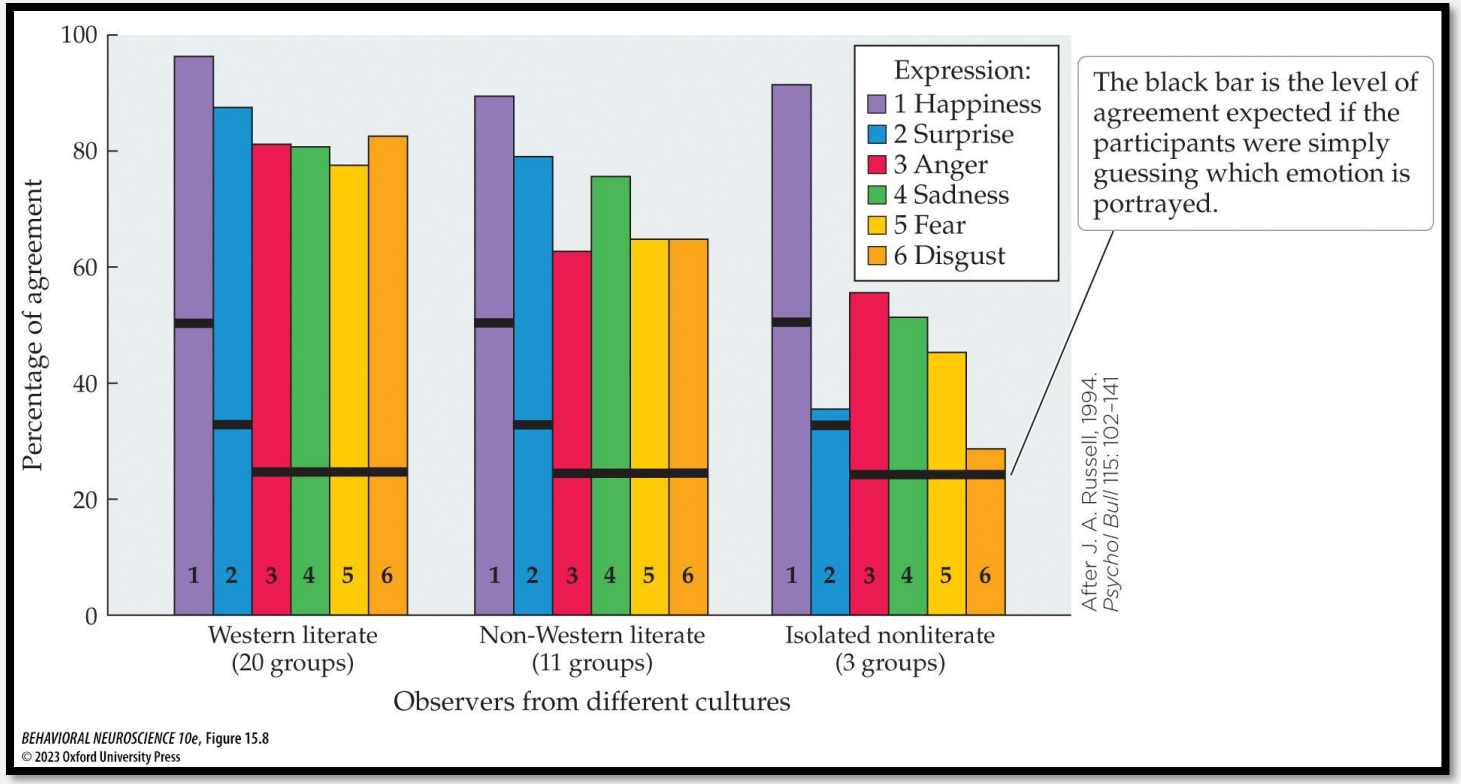


Evolution of emotion

- Ekman says there are 8 distinctive expressions: anger, sadness, happiness, fear, disgust, surprise, contempt, and embarrassment.
- These different emotions can be detected in facial expressions that are similar across cultures.

Evolution of emotion

- Facial expressions are not completely universal; researchers have found isolated groups whose identifications of emotions from facial expressions did not fully agree with those of Westerners.
- The extent of cultural influence is under debate.
- A major role of facial expression is paralinguistic—an accessory to verbal communication.

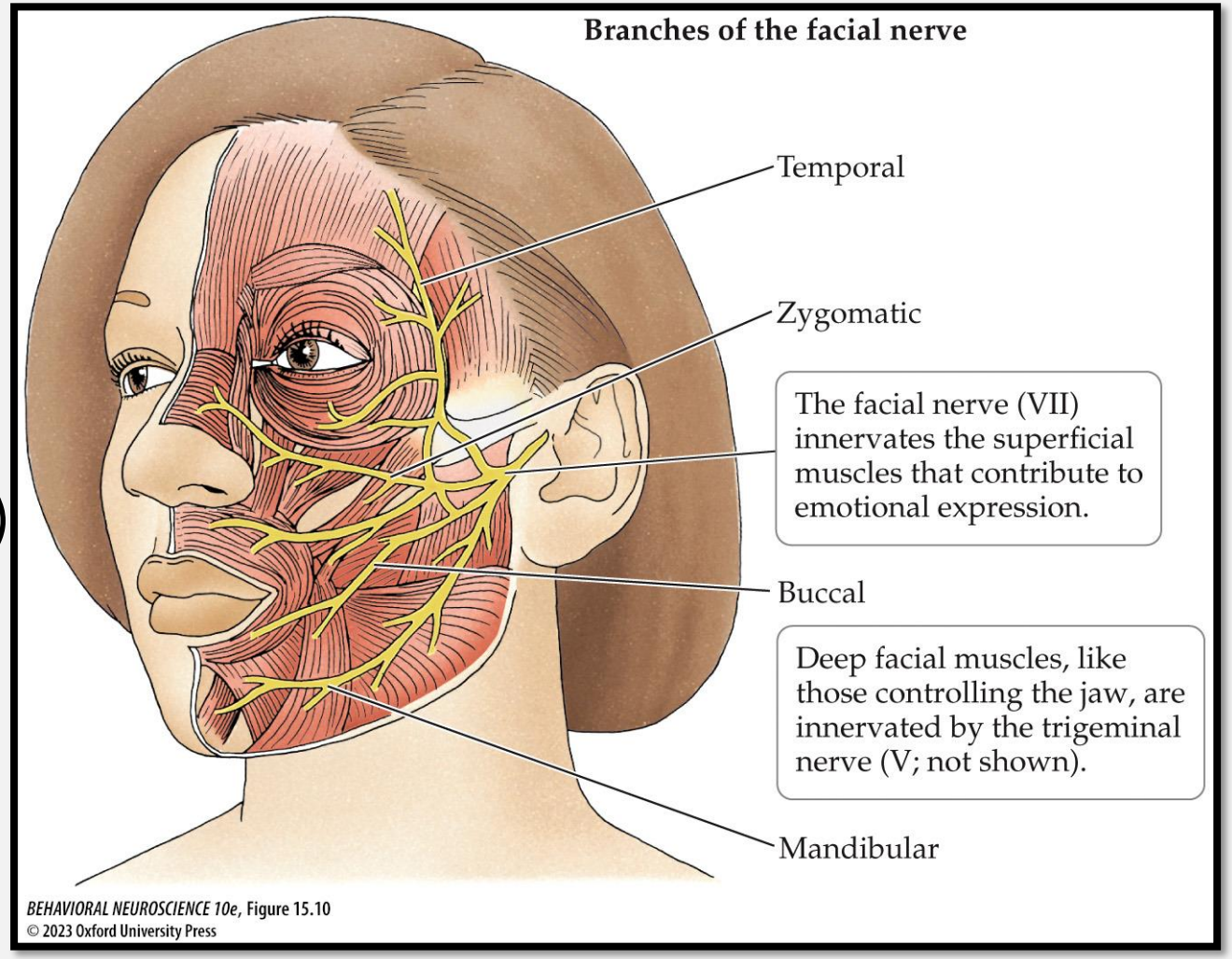


Neural mechanisms of emotion

Neural mechanisms of emotion

Two categories of facial muscles:

- Superficial facial muscles—attach to facial skin
- Deep facial muscles—attach to skeletal structures in the head
- Facial muscles are innervated by cranial nerves: the **facial nerve** (VII) and the motor branch of the **trigeminal nerve** (V).



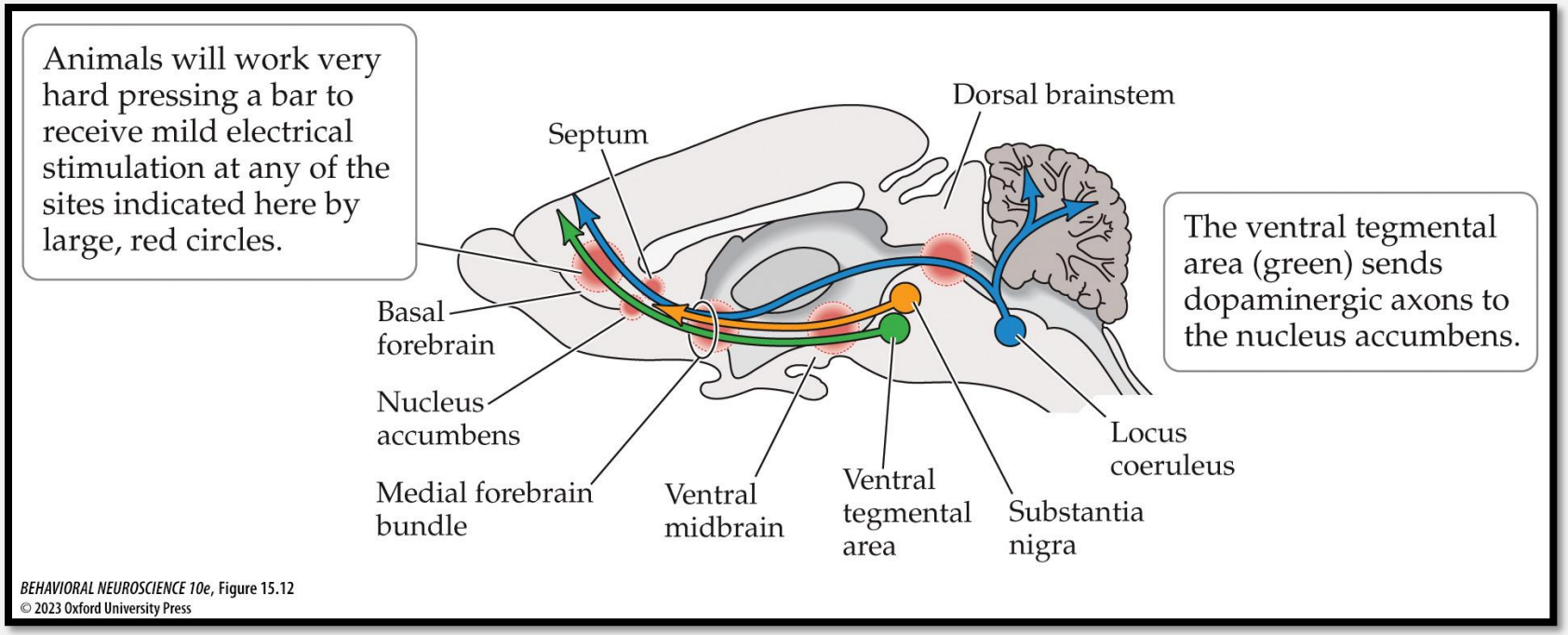
Neural mechanisms of emotion

Electrical stimulation of the brain

- can be used to study the neuroanatomy of emotion.

Brain self-stimulation:

- animals perform a task to receive electrical stimulation to their brain—also works in humans.
- Brain sites that respond to self-stimulation have been mapped.



Neural mechanisms of emotion

Medial forebrain bundle

- tract that rises from the midbrain through the hypothalamus—contains many sites for self-stimulation.

The nucleus accumbens

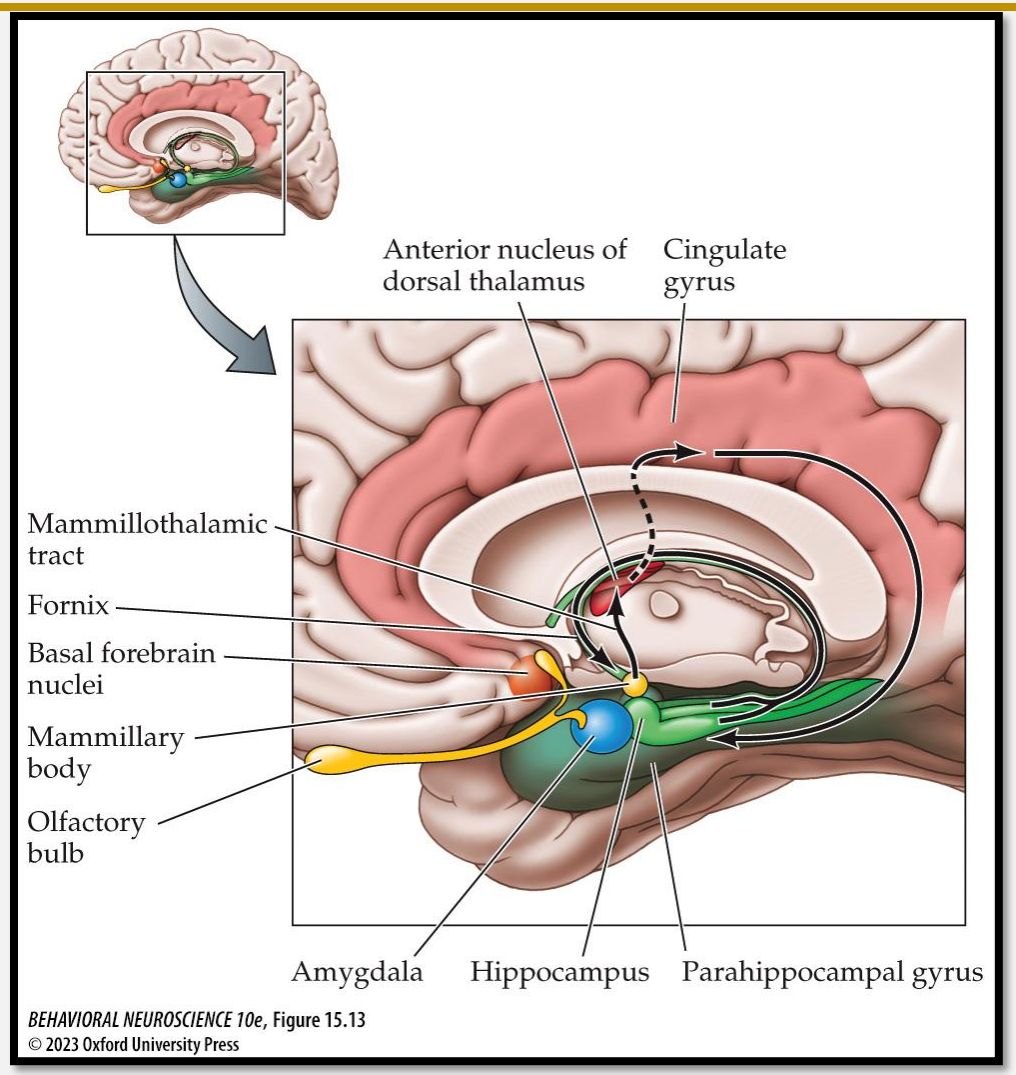
- involved in the dopaminergic circuit, is an important target for the medial forebrain bundle, and stimulating the nucleus accumbens is considered pleasurable.

Neural mechanisms of emotion

Brain lesions affect emotions.

Decorticate rage:

- a sudden intense rage in dogs with their cortex removed, suggesting that the cortex inhibits rage.
- The Papez circuit—interconnected brain regions within the **limbic system**; damaged in some patients with emotional changes.



Neural mechanisms of emotion

Support for the limbic model

Klüver–Bucy syndrome:

- characterized by reduction of fear and anxiety, oral tendencies, hypersexuality; results from bilateral removal of large portions of temporal lobe.
- Further studies identified the **amygdala** as a key structure in the mediation of fear.
- Interconnections within the amygdala are important for fear associations.

Neural mechanisms of emotion

- Fear-associated behaviors are similar in many different species.
- **Fear conditioning**: a previously neutral stimulus is repeatedly paired with an unpleasant experience, causing the subject to act fearful in response to the previously neutral stimulus.
- Fear conditioning studies allowed researchers to develop a map of the neural circuitry of emotional learning.

Neural mechanisms of emotion

- The **amygdala** is a key structure in the mediation of fear; lesions abolish fear.
- It is also crucial for *appetitive learning*: positive reactions to attractive stimuli.
- The amygdala is thought to help form associations between emotional responses and specific memories of stimuli that are stored elsewhere in the brain.

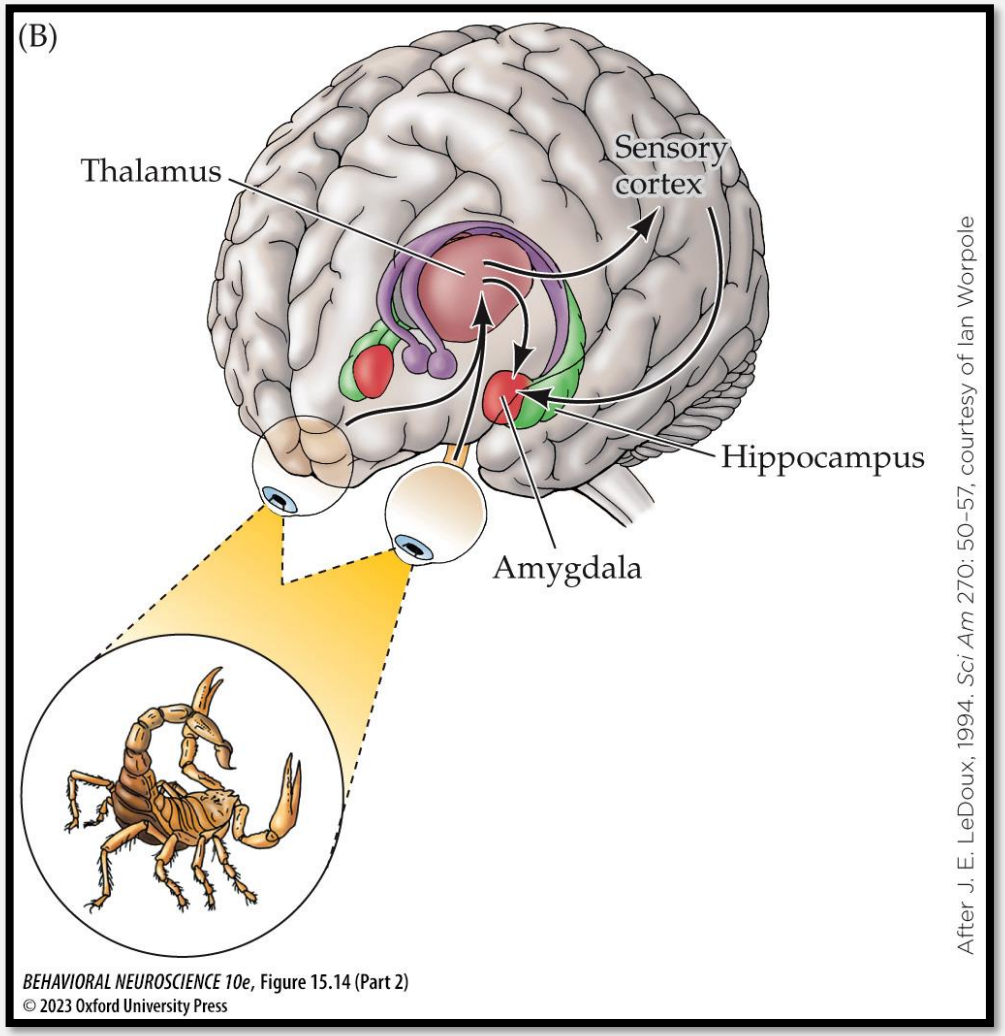
Neural mechanisms of emotion

LOW ROAD

- Sensory information from the thalamus that goes directly to the amygdala bypasses conscious processing and allows for immediate emotional reactions

HIGH ROAD

- information is routed through the cortex, allowing conscious processing.
- *Observational fear learning:* fear of potentially harmful stimuli is learned through social transmission.



Neural mechanisms of emotion

In mice

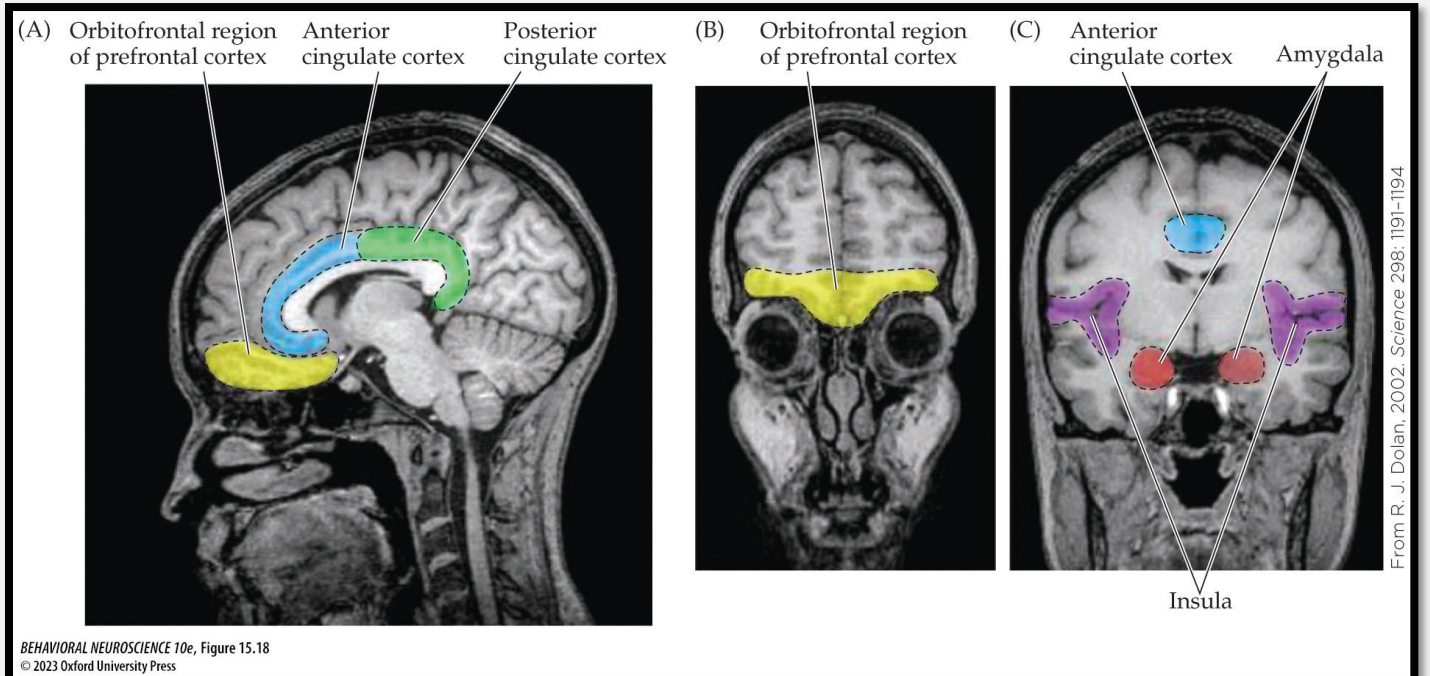
- Learned fears are slow to extinguish.
- During extinction training, activity in the prefrontal cortex, which projects to the amygdala, is necessary.
    - Evidence for the HIGH road ^^

In humans

- Fearful faces activate the amygdala fast than the visual cortex.
- Subject with cortical blindness (following bilateral destruction to the primary visual cortices – could correctly guess an emotional face on a computer display (Pegna et al., 2005) despite no conscious awareness of the face
    - Evidence for the LOW road ^^

Neural mechanisms of emotion

- Different emotions activate different brain regions.
- Brain imaging studies show a unique network of brain areas is responsible for the emotion of love.
- Emotions are associated with bilateral changes in insula, amygdala, caudate, putamen, cingulate cortex and prefrontal cortex activity.



Neural mechanisms of emotion

Damasia et al., 2000

- Participants asked to re-experience either emotional episodes or neutral episodes – when an emotion is felt they signal to the experimenter.
- Brain activation during sadness, happiness, fear, and anger show involvement of several brain regions.
- The same brain region may participate in different emotions.
- Physiological responses preceded the awareness of feeling an emotion.
- These studies confirm there is no simple, one-to-one relation between a specific emotion and activity of a brain region.

BREAK

Learning Objectives

Aggression

1. Define aggression, distinguishing between proactive and reactive forms, and discuss the adaptive significance of aggression.
2. Evaluate the role of testosterone, and other hormones and transmitters, in aggression in humans and nonhuman animals.
3. Summarize brain mechanisms believed to control aggressive behaviors.
4. Describe the behavioral and physiological correlates of psychopathy.

What is the purpose of aggression?

Aggression

Aggression has different meanings;

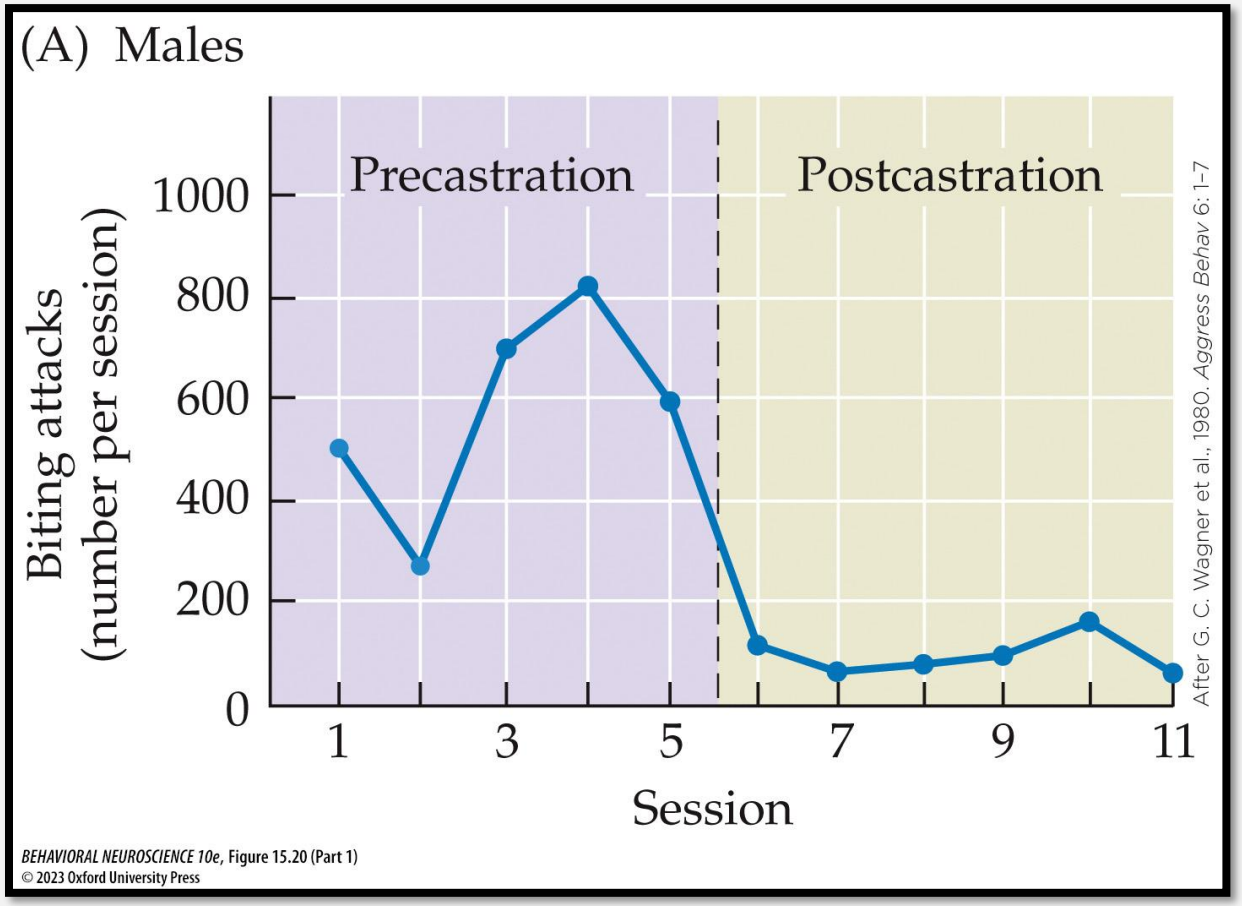
- the primary focus here is physical aggression and violence between individuals.

Intermale aggression:

- aggression between males of the same species.
- Human males are more likely than females to commit murder; aggressive behavior between boys, but not girls, in early childhood; suggests testosterone plays a role.

Aggression & androgens

- Androgens seem to increase aggression in other species;.
- Many species – intermale aggression increases at sexual maturity
- Will fluctuate in animals with seasonal breeding patterns
- Spotted hyena's – female more aggressive – dependent on androgen exposure before birth
- **Mice** – castration all but abolishes aggressive biting behaviour in males

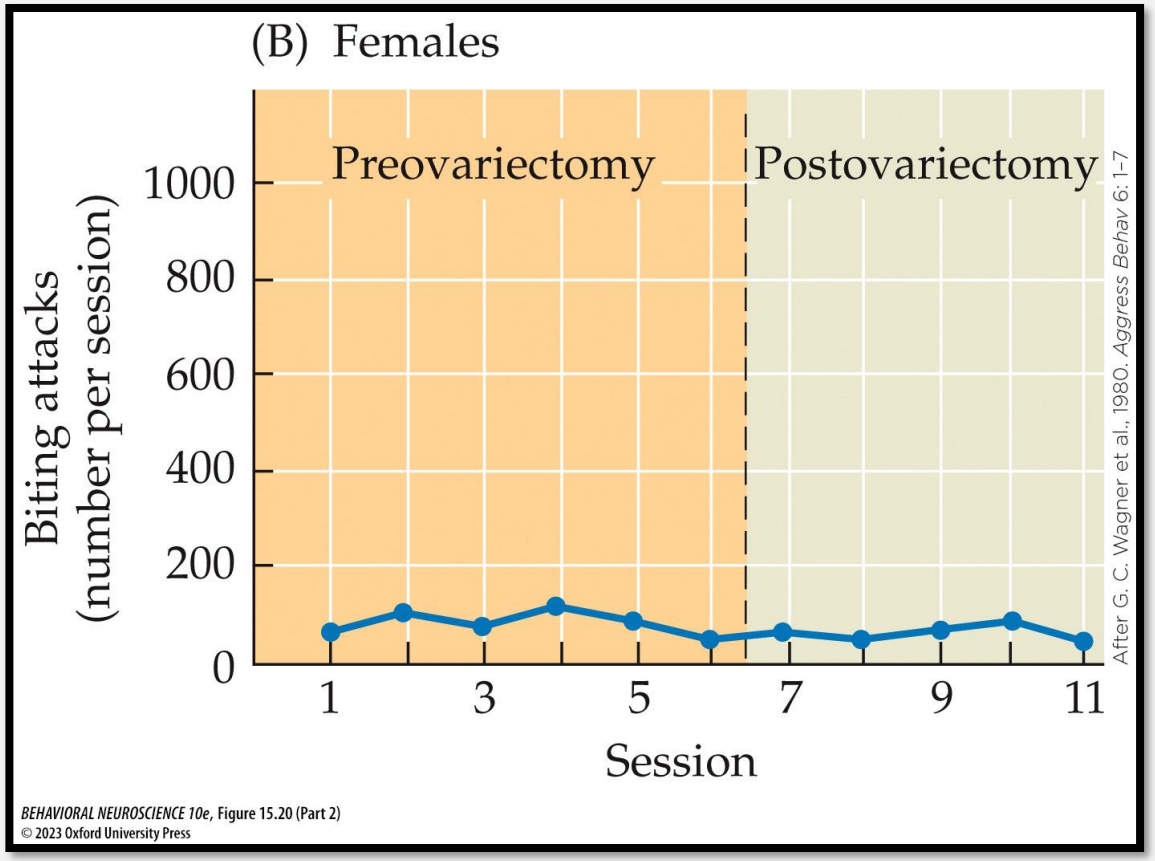


Aggression & androgens

- Female mice – less aggressive to begin with

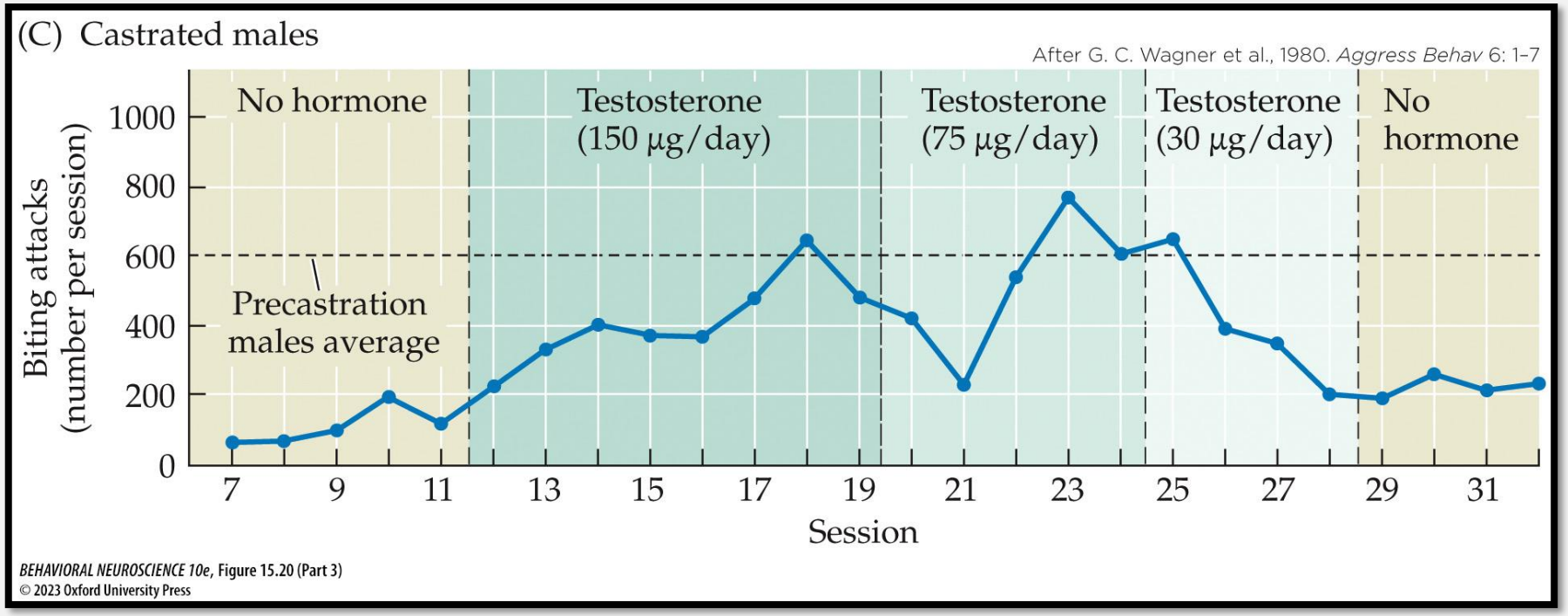
Maternal aggression

- Intruders introduced to the cage of a nursing mother
- Ventromedial hypothalamus implicated in this behaviour



Aggression & androgens

- Androgens seem to increase aggression in other species; decreasing circulating androgens by castration usually reduces intermale aggressive behavior.
- But the correlation in humans is less clear.
- Two confounding variables affect testosterone levels: experience and dominance.



Aggression & androgens

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Experience

- Mice and monkeys – losers of aggressive encounter – reduction in circulating androgen levels (Bernstein and Gordon 1974)
- Winners of competitions (humans) – elevation of post competition testosterone (lasting for days; Casto & Edwards, 2016)
- Also shown when watching “their” team compete, or their children (of some fathers (Alvarado et al. 2018))
- Females - a general increase in testosterone in response to competition, independent of the outcome (Casto et al., 2017

Aggression & androgens

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- Two confounding variables affect testosterone levels: experience and dominance.

Dominance

- Females – treated with testosterone – spend more time staring in the eyes of threatening faces (Terburg et al. 2012)
- Testosterone levels should be associated with behaviour that confers or protects one's social status (and thus, reproductive fitness)

Aggression and Serotonin

There is a negative correlation between serotonin and aggression:

- The most aggressive monkeys in a free ranging colony had the lowest levels of serotonin (Higley et al. 1992).
- Mice lacking a serotonin receptor are hyperaggressive.

Optogenetic studies

- Activation of serotoninergic neurons in fruit flies – increase propensity for fighting (inverted effects from vertebrates) (Hu et al. 2020)
- Activation of locust serotonergic neurons – overcome normal aversion to another to form swarms (Anstey et al. 2009)

Aggression and GABA

- Balance between GABA (inhibitory) and glutamate (excitatory) appears to be important in aggressive responses.
- A drug that enhances GABA transmission reduces aggressive behavior in humans (Gowin et al. 2012).
- Vasopressin, oxytocin, and endogenous opioids control aggression.

Medial Amygdala and VMH

- The **ventromedial hypothalamus** in mice appears to act as a trigger for aggression.
- **Optogenetic studies**
- Stimulate VMH neurons in male mice – switch from mating behaviour to attacking behaviour
- Inhibit VMH activity – reduce intermale aggression

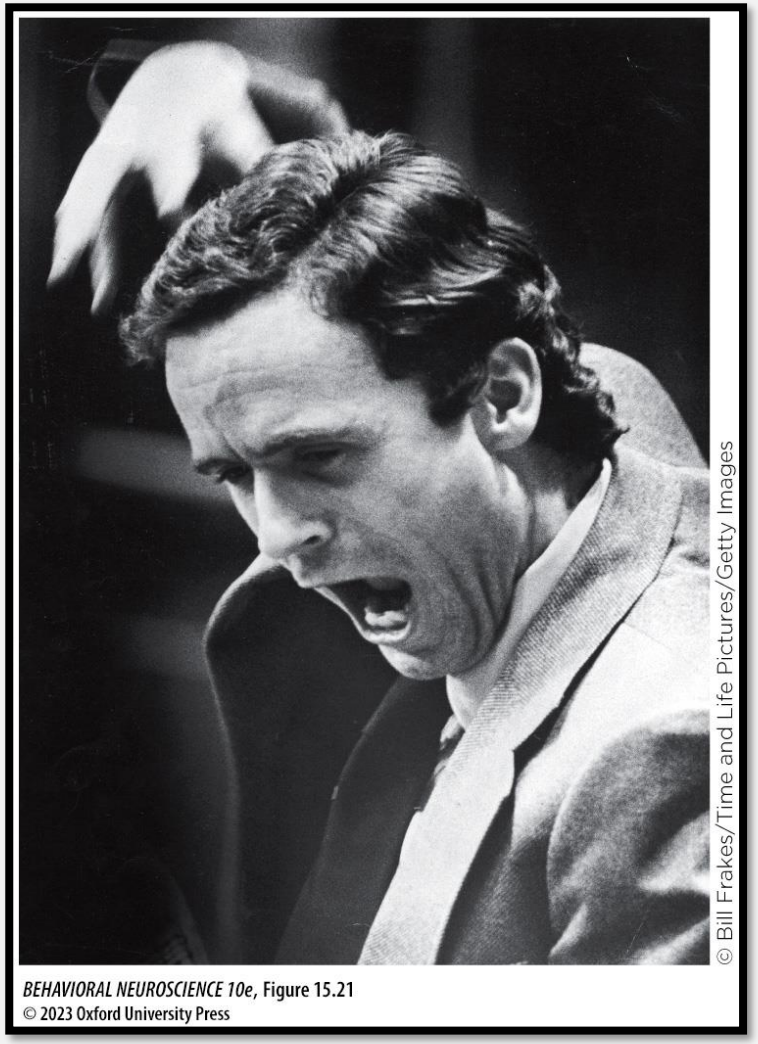
Aggression and Psychopathy

Emotional dyscontrol syndrome:

- behavior disorder that may be the result of temporal lobe disorders.

Psychopaths

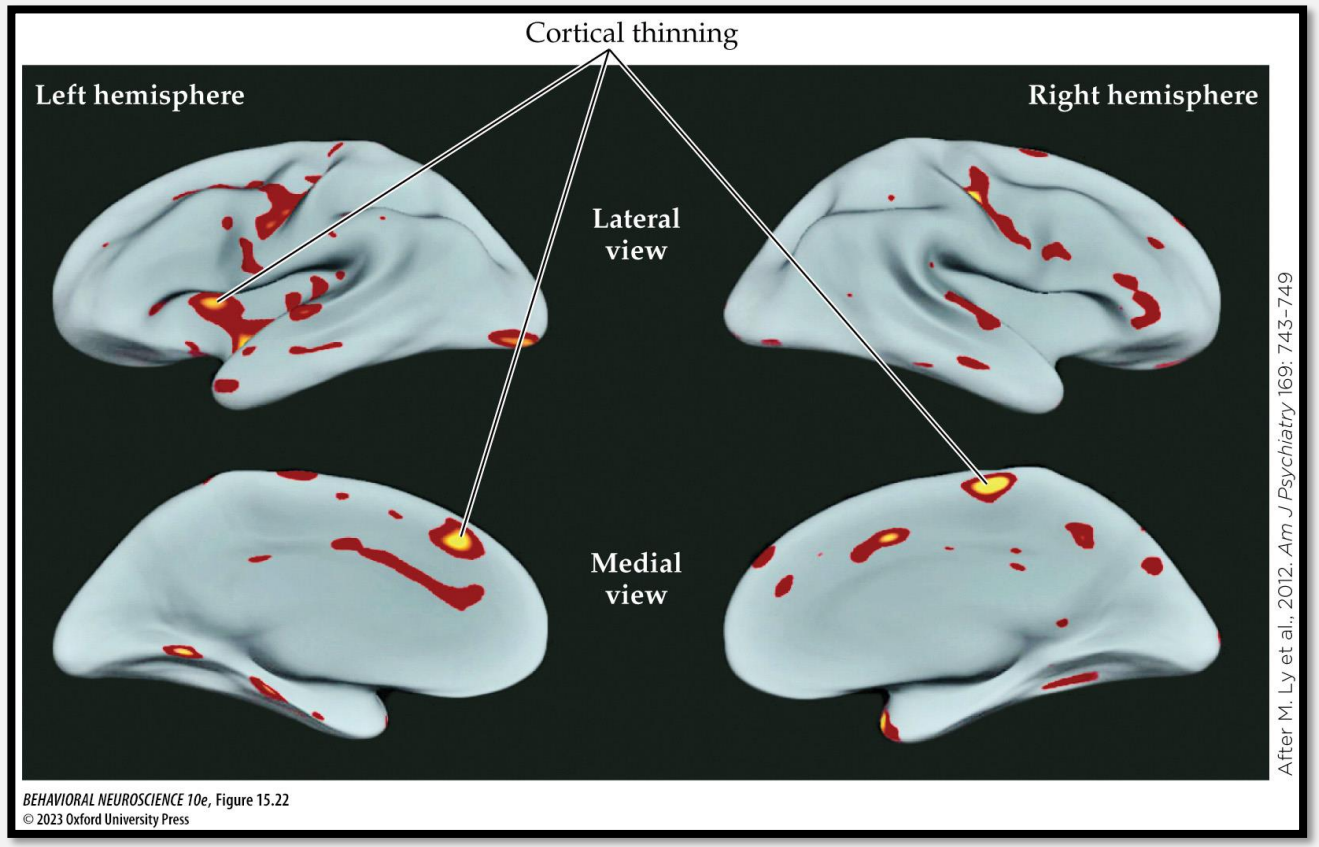
- are intelligent people with superficial charm who have poor self control, a grandiose sense of self-worth, and little or no feeling of remorse.
- Most lead normal lives but some commit very violent acts.



BEHAVIORAL NEUROSCIENCE 10e, Figure 15.21

Aggression and Psychopathy

- Psychopaths don't react as negatively to words about violence as controls do and show blunted responses to aversive cues associated with fear conditioning.
- Imaging studies suggest that psychopaths have reduced size and activity of the prefrontal cortex, which may impair their ability to control impulsive behavior.



Aggression and social psychology

- Number one predictor of aggression and violence – poverty and lack of education.
- Weigh biological control of social dysfunctions over fixing social issues
- QOL of violent person's improved with biological treatments?

Break

Stress

Learning objectives

1. Describe the physiological correlates of stress and contrast acute and chronic stress responses.
2. Discuss individual differences in stress vulnerability and responses to stressful situations.
3. Evaluate the role of early life experiences in lifelong stress responses.
4. Describe the form and function of communication between the nervous system and the immune system.
5. Summarize the impact of chronic stress on health, and offer some ways to mitigate its effects

Stress defined

Stress

- is any circumstance that upsets homeostatic balance.
- **Allostasis –** adjust physiological parameters to accommodate current or anticipated stressors

Alarm reaction:

- initial response to stress.

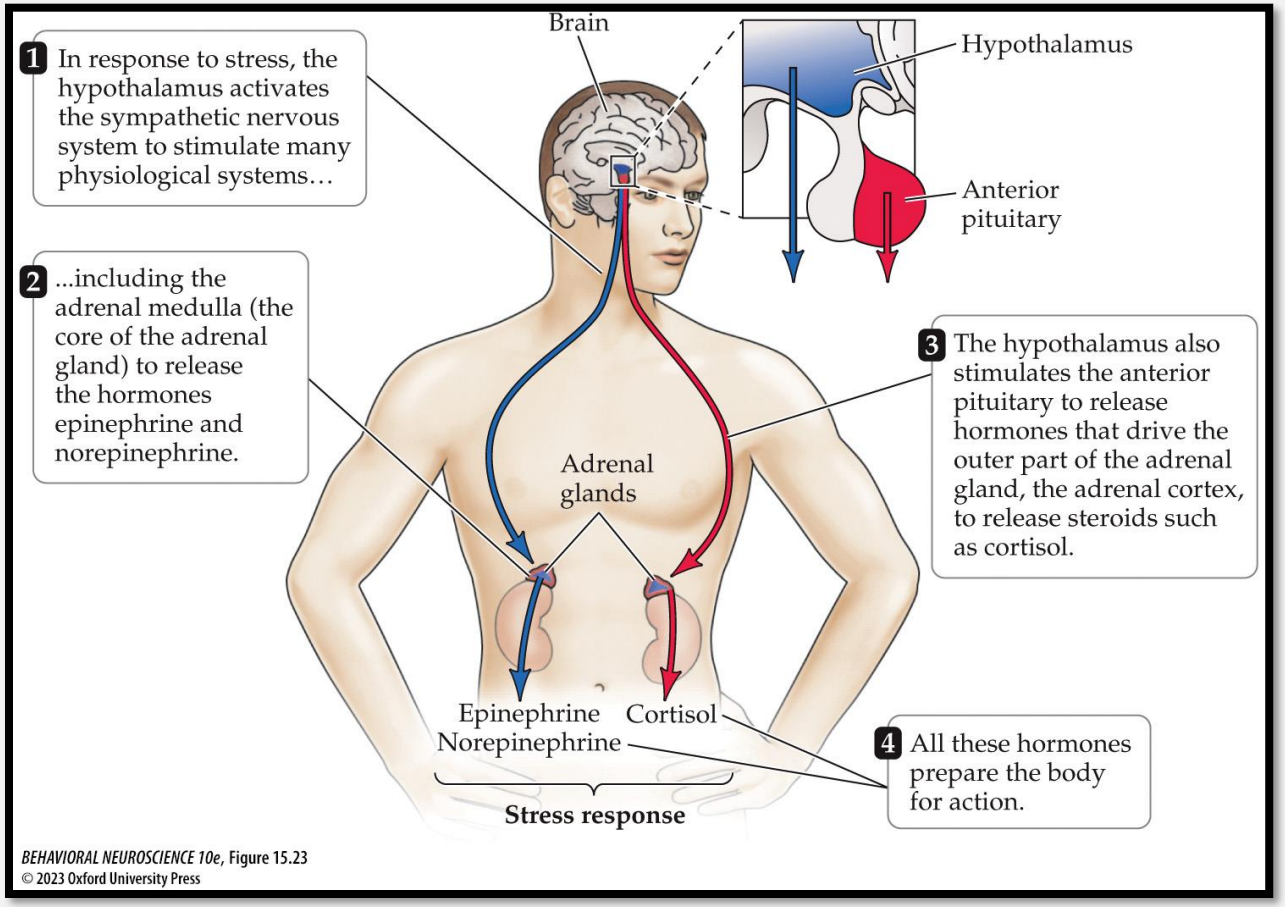
“Fight or flight” system:

- hypothalamus activates the sympathetic nervous system which stimulates the **adrenal medulla** to release **epinephrine** and **norepinephrine.**
- These hormones increase heart rate and breathing; prepare body for action.

Stress - Bodily Responses

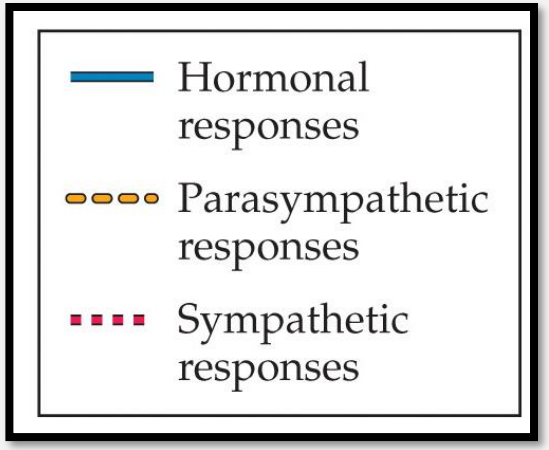
The hypothalamus

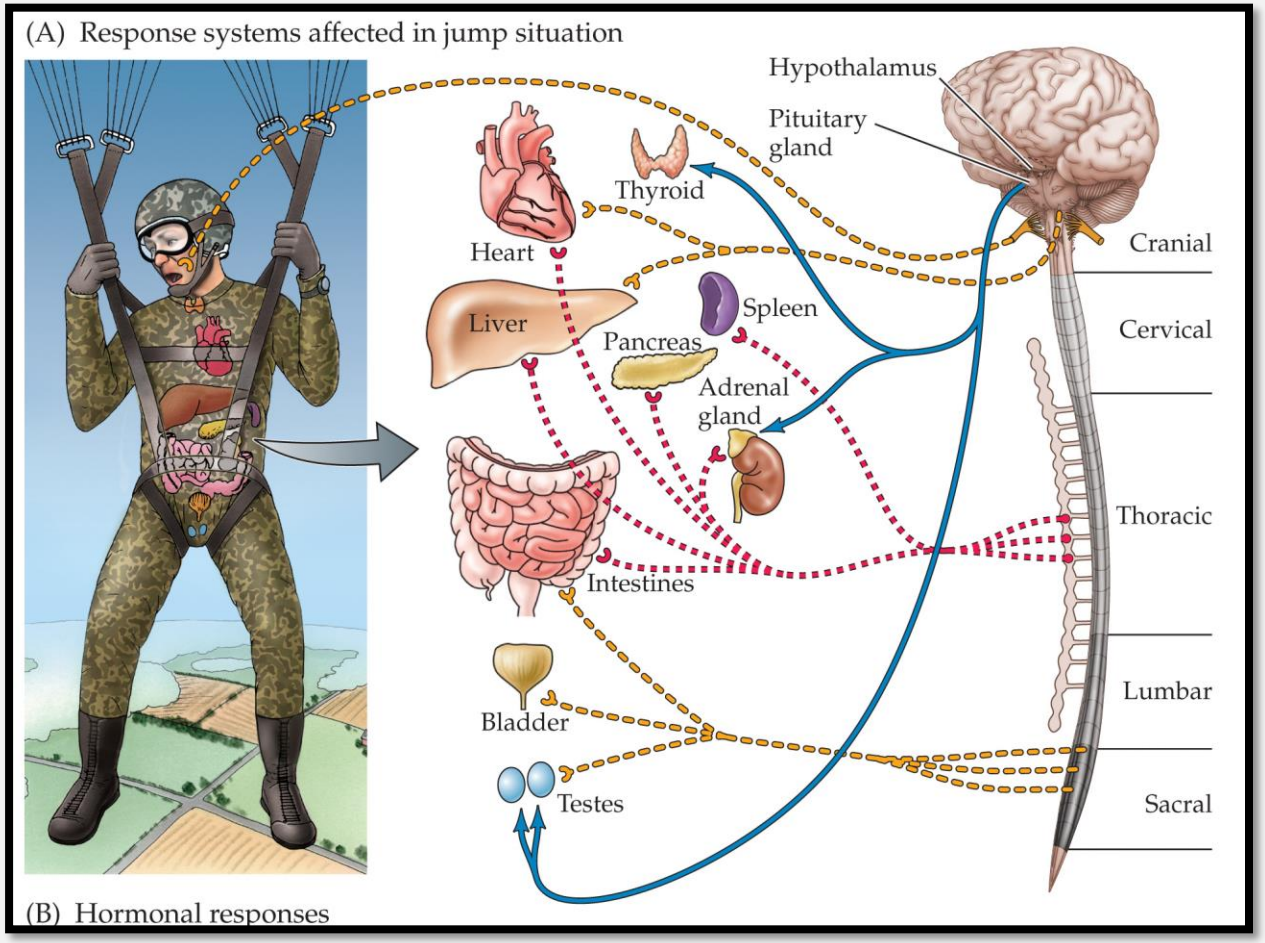
- also stimulates the anterior pituitary to release a hormone that causes the **adrenal cortex** to release **adrenal steroids** such as **cortisol**.
- These hormones act more slowly but also prepare the body for action by releasing stores of energy.



Stress - Bodily Responses

- Hormonal responses to stress were studied in military recruits learning to parachute.





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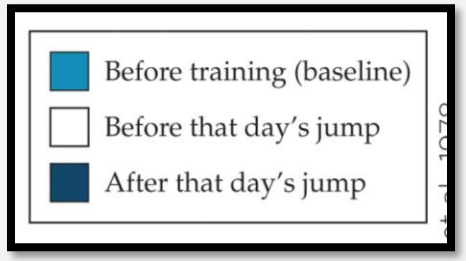
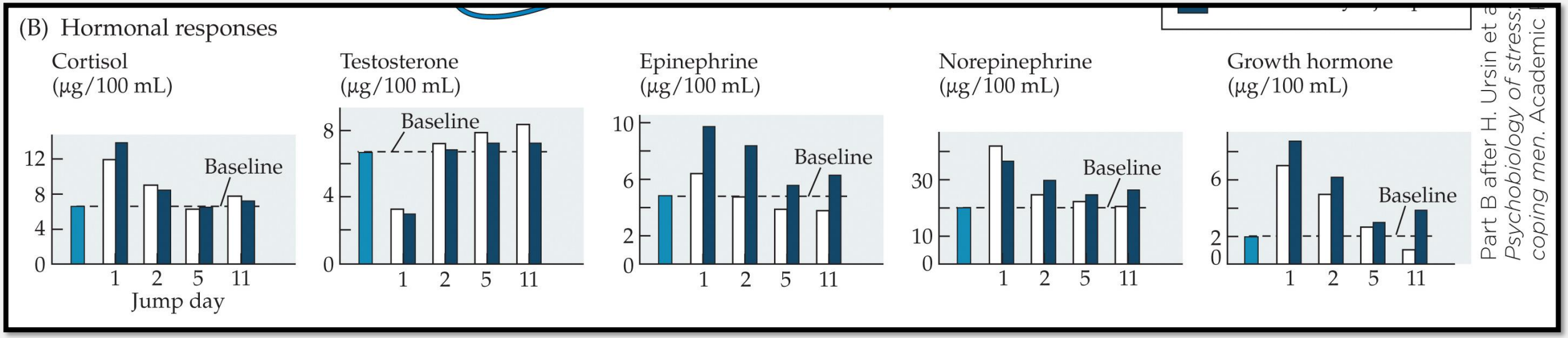
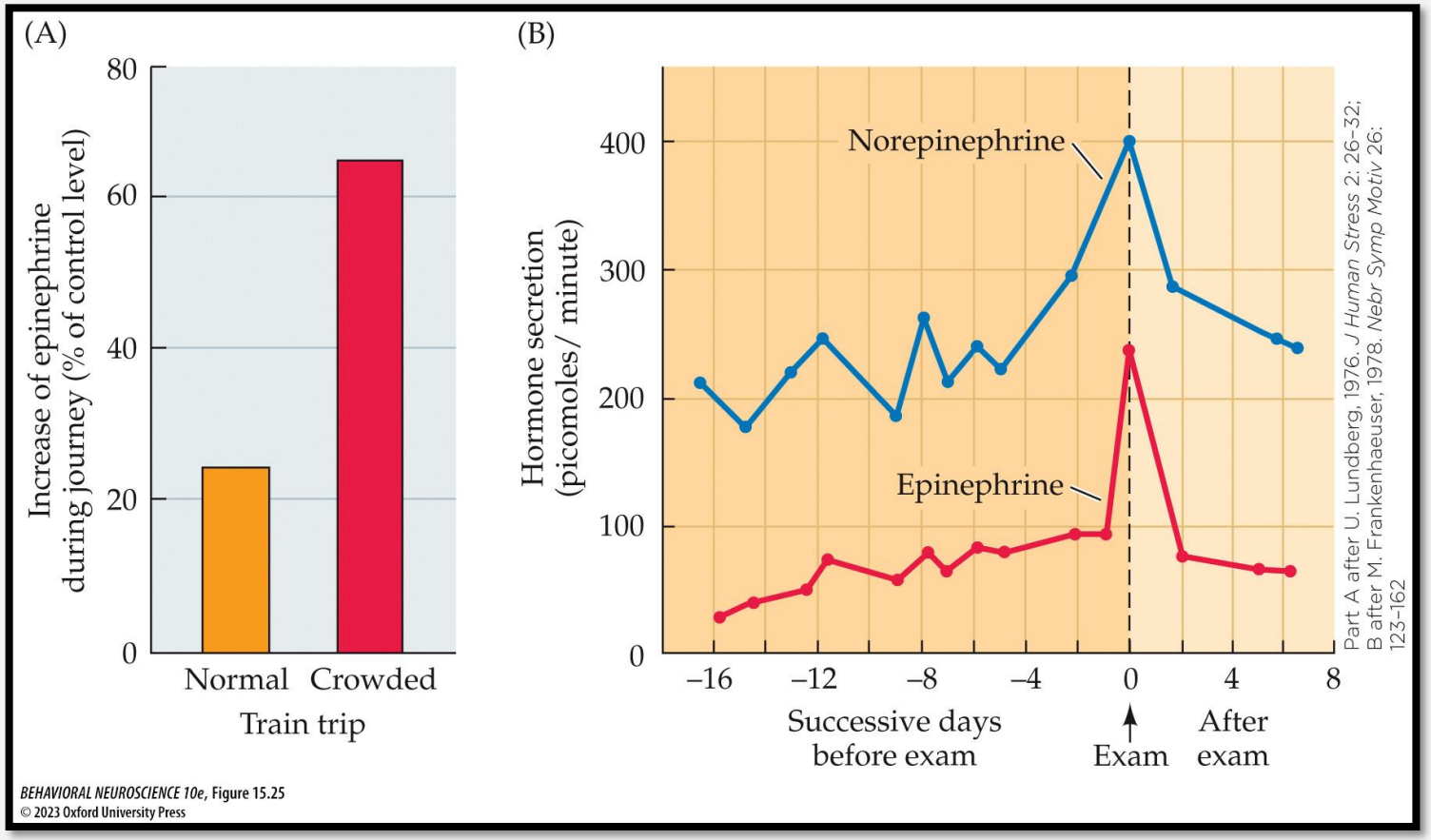




Stress - Bodily Responses

- Hormonal responses to stress have also been shown in work, school and social situations such as riding commuter trains and taking exams.
- Sustained stress can have lasting effects.



Stress - investigated

Why do individuals differ in their response to stress?

- Levine et al. 1967
- One hypothesis: **stress immunization**: Mild stress early in life makes one more capable of handling stress later in life.
- In experiments with rats, pups handled briefly had less response to adult stresses than pups that were left alone.

Stress - investigated

- But the pups benefited because their mothers ***comforted*** them *after* the stress.
- Rat pups separated for long periods and received little maternal attention exhibited increased stress response as adults, had trouble learning mazes, and had reduced neurogenesis in the hippocampus.
- Immunizing effects of maternal grooming behaviour on stress response seen in undisturbed litters too!

Stress - investigated

Epigenetic regulation:

- maternal deprivation exerts this negative effect on adult stress responses by causing long-lasting changes in the expression of genes for adrenal steroid receptors in the brain.
- This has also been found in humans, e.g., suicide victims that were abused or neglected as children.

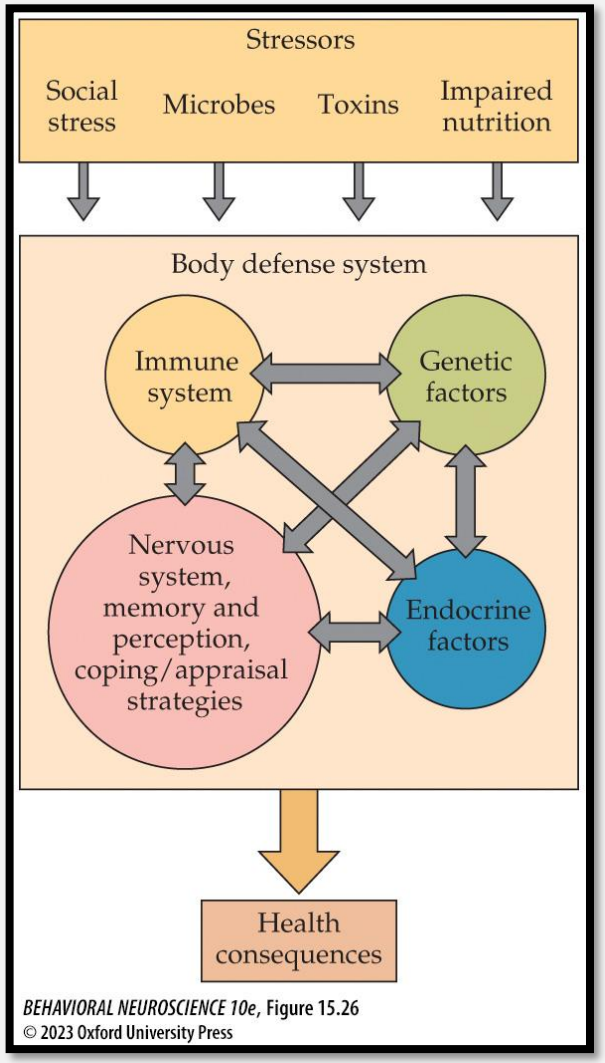
Stress - investigated

Psychosomatic medicine

- explores the role of psychological, behavioral, and social factors in disease.

Health psychology

- (or behavioral medicine) studies psychological influences on health and illness.
- Several factors interact to affect human health and disease.



Stress - investigated

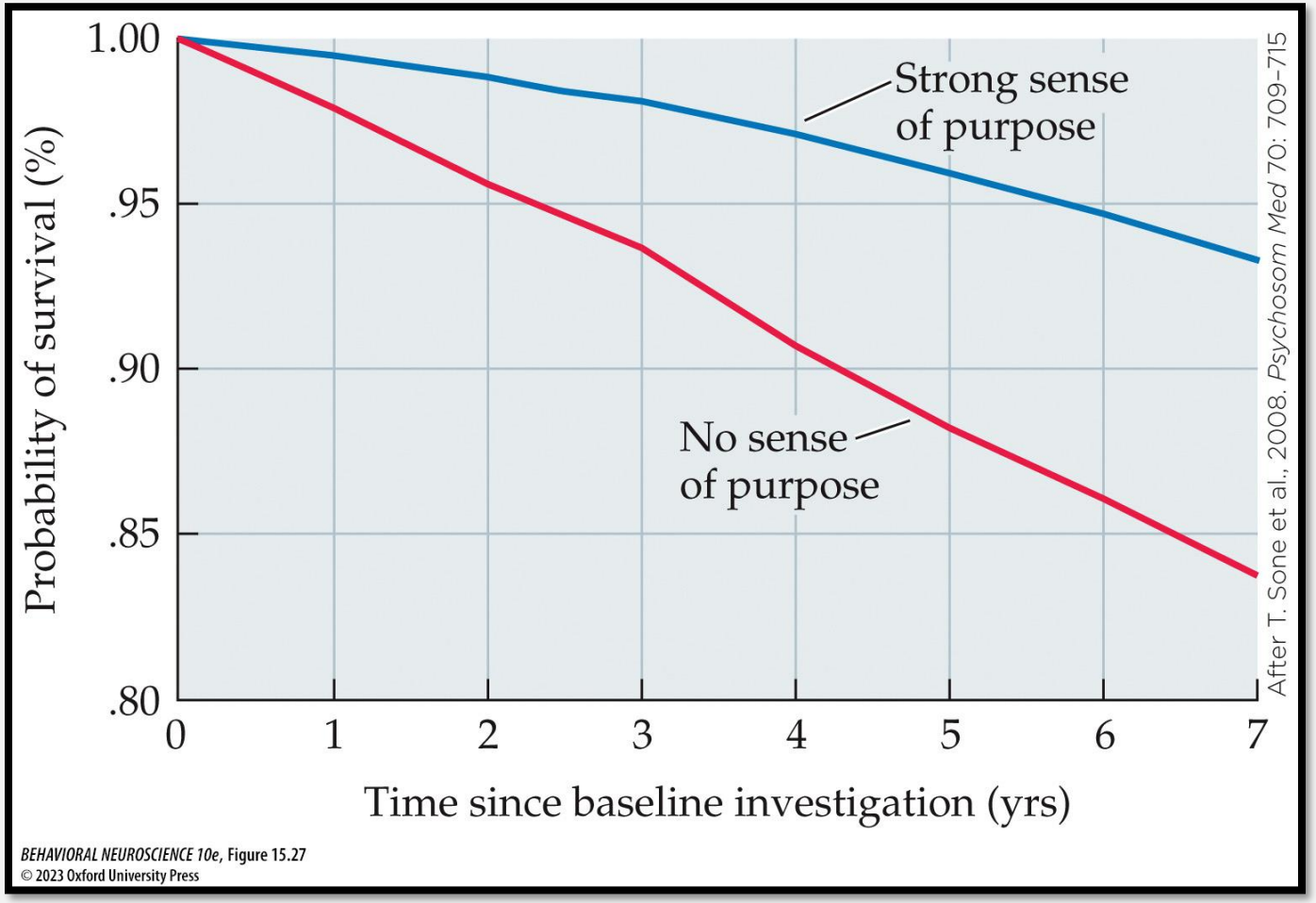
- Links between strong emotions and heart attacks:
- **Type A vs Type B personality** – What do you think?

- Other risk factors for dying of heart disease include poor sleep, depression, stressful jobs and/or relationships, social isolation, and lack of life purpose.

Stress - investigated

Other risk factors

- include poor sleep, depression, stressful jobs and/or relationships, social isolation, and lack of life purpose.



Stress and illness

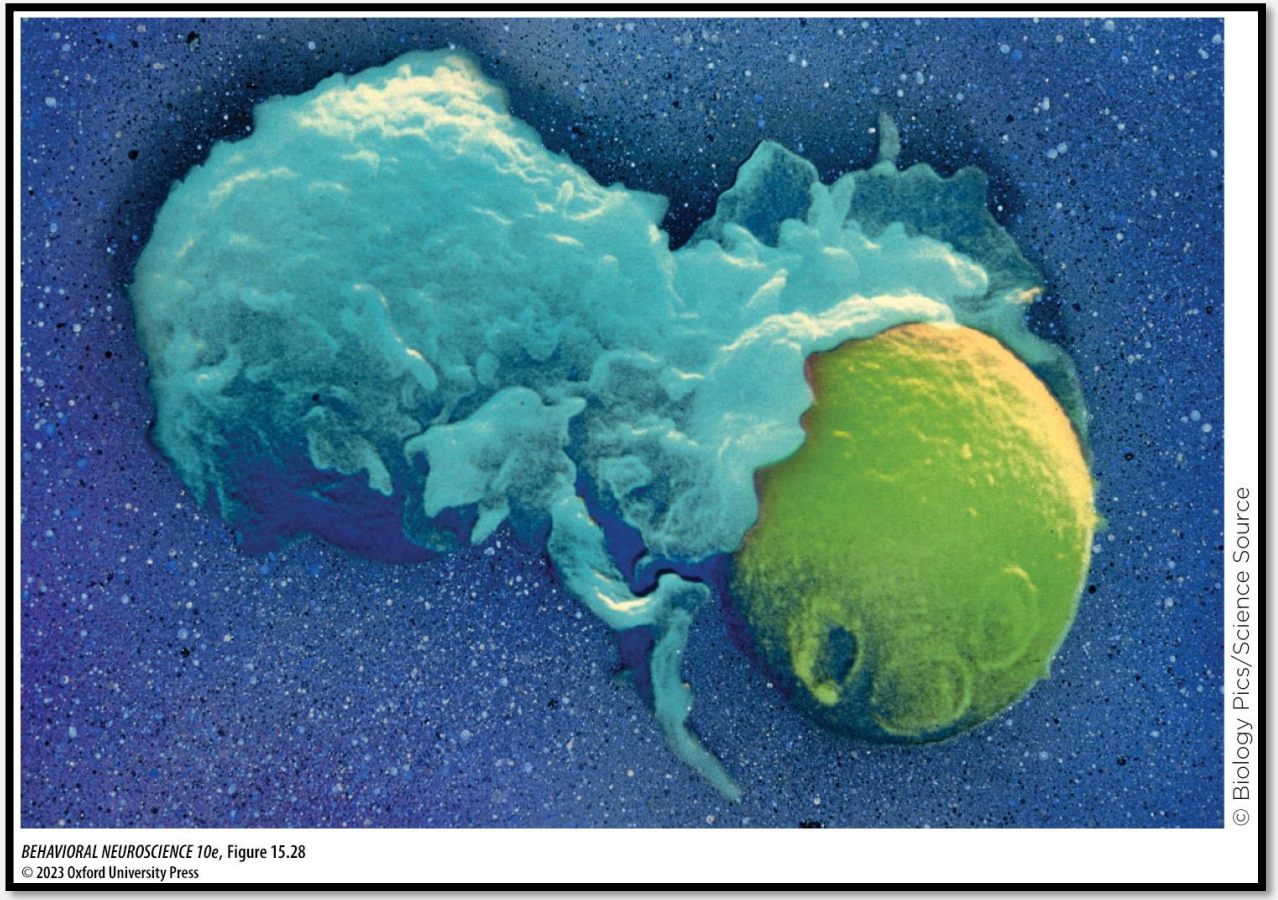
Psychoneuroimmunology

- studies interactions of the immune, endocrine, and nervous systems.
- People who have happy social lives and social support—such as hugs—are less likely to develop a cold, even when exposed to a virus.
- **Cohen et al., 2015**
- *Methods* –
    1. Complete a questionnaire on social relationships including frequency of conflict
    2. Get injected with a rhinovirus (common cold)
    3. Monitor immune response
- *Findings* –
    1. More conflict = more symptoms
    2. More social support (and more hugs) = less severe symptoms

Stress and illness

White blood cells:

- **Phagocytes** engulf and destroy microbes.
- **B lymphocytes** (B cells) produce **antibodies** against foreign molecules.
- **T lymphocytes** (T cells), some act as killer cells, attacking microbes.
- Helper T cells secrete **cytokines**, proteins that induce cell proliferation in the immune system.

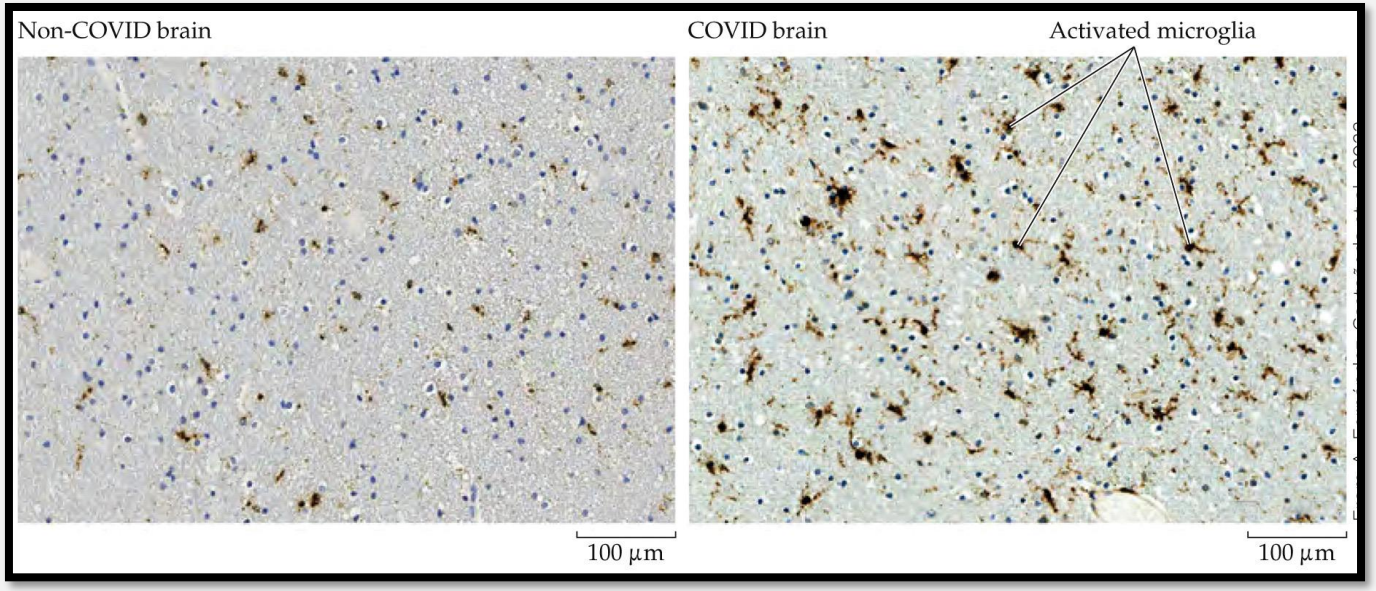


BEHAVIORAL NEUROSCIENCE 10e, Figure 15.28

Stress and illness

Resident immune cells of the nervous system

- **Microglia** – kind of macrophage (type of phagocyte)
- Neuroprotective – clear debris and maintain tissue integrity
- Also – mediate inflammatory responses – can be harmful when prolonged
- Brain fog and fatigue from COVID-19 thought to be a product of overactive microglia



Stress and illness

The brain impacts immune function

- Seeing photograms of sick people can trigger the release of cytokines (regulation of B-cells; Schaller et al. 2010)

The brain monitors immune function

- Vagus nerve – detects high levels of cytokines, leads to release of acetylcholine which inhibits cytokine release from immune organs
- The immune system acts as a sensory receptor system, informing the brain.

Stress and illness

- The immune system is compromised during depression.
- Stress can produce a decline in the number of immune cells and in levels of cytokines.

The dental experience

- *Experiment* – two small wounds placed in the mouths of dental students
    1. *First wound – during summer vacation*
    2. *Second wound – during first major examination*
- *Result* - healing took 40% longer during exam period. No student healed faster during exams
- *Take away* - The perception of stress can decrease the number of antibodies produced to fight illness, e.g., if a student perceives an academic program to be stressful.

Stress and illness

Immediate stress response

- Adrenal steroid hormones released during stress directly suppress the immune system.
- Why would the you suppress immune function when you might be more likely to sustain an injury or get an infection?

Sustained stress

- Any animal that is stressed for a prolonged period dies
- Humans – unique ability to be stressed for prolonged periods (analytical minds and highly social lives)

Prolonged stress

TABLE 15.1 The Stress Response and Consequences of Prolonged Stress

Principal components of the stress response	Common pathological consequences of prolonged stress
Mobilization of energy at the cost of energy storage	Fatigue, muscle wasting, steroid diabetes
Increased cardiovascular and cardiopulmonary tone	Hypertension (high blood pressure)
Suppression of digestion	Ulcers
Suppression of growth	Psychogenic dwarfism, bone decalcification
Suppression of reproduction	Suppression of ovulation, impotence, loss of libido
Suppression of immunity and of inflammatory response	Impaired disease resistance
Analgesia	Apathy
Neural responses, including altered cognition and sensory thresholds	Neural degeneration in hippocampus and prefrontal cortex

Stress and illness

Mindfulness-based stress reduction (MBSR)

- A therapy inspired by meditation that has been shown to
- Reduce activity in the amygdala
- Prevent relapses of anxiety disorder or depression

End