Course Administration

Unit 4 Exam:
Wednesday 12/12; this room; this time

Email: Dr. Davis immediately (if not sooner) if there is a need to make other arrangements

Review session:
Day: Time: Room

Optional Cumulative FINAL EXAM
Tuesday, December 18th (this room)
12:30 – 1:45 PM
Classification of Emotion

Emotions are subjective, conscious experiences characterized primarily by psychophysiological (somatic) expressions, biological reactions (autonomic) and mental states.

Studies have shown that people of different cultures make similar facial expressions in similar circumstances. Analysis of these expressions suggests that there are six basic human emotions: anger, happiness, surprise, disgust, sadness and fear.

It is thought that primary emotions blend to form the full spectrum of human emotional experience.
Functions of Emotions

It is believed that expressions of emotion, like other behaviors, are products of evolution.

Functional roles:
- anger – attack
- happiness, sadness – social
- surprise – startle
- disgust – avoid
- fear – escape

Opposite messages are often signaled by opposite movements and postures, an idea called the principal of antithesis.
Theories of Emotion

Psychologists define emotion in terms of three components: perception, feelings and physiological actions.

James-Lange Theory (1884)
Stimulus triggers physiological response which triggers emotion. Physiological reaction is thus necessary to feel an emotion.

Cannon-Bard (1915)
Stimulus triggers both physiological responses and emotion. Physiological responses and emotion are independent.

Modern view
All factors influence one another
Physiological Reactions and Emotion

Basic emotions are associated with unique maps of sensory changes (both somatic and autonomic) across the body [low (blue) to high (yellow) activity].

Are physiological reactions necessary for emotion, and if so, which ones?
• Individuals lacking somatic feedback feel emotions.
• Individuals lacking autonomic inputs report decreased emotional intensity.

Are autonomic physiological reactions sufficient for emotion?
• Rapid breathing or accelerated heart rate for unknown reasons can cause a panic attack.
Limbic System and Emotion

A group of interconnected structures on the medial surface of the cerebrum is thought to play a role in emotion. This collection of cortical areas forms a ring or border around the brainstem, and is thus called the limbic lobe.

fMRI and PET studies suggest that different emotions activate distinct but overlapping areas of cortex primarily within this lobe.

Structures critical for emotion include: the amygdala (autonomic response), anterior cingulate gyrus (feelings; somatic) and the ventromedial (including orbitofrontal) prefrontal cortex (regulation).
Research has demonstrated in many species that the amygdala is important for the appraisal (judgment of the nature and value) of emotion.

- lesions of the amygdala profoundly reduce fear and aggression
- stimulation elicits fear, anxiety and aggression

The amygdala is a complex of nuclei commonly divided into three groups: the corticomedial nuclei receive olfactory inputs; the basolateral nuclei receive non-olfactory sensory inputs; and the central nucleus is the major output. The sensory inputs arise from the thalamus and the ventral stream.
In addition to its sensory input, the amygdala receives input from a number of cortical and subcortical brain systems. Most prominently, the amygdala receives dense input from the hippocampus, anterior cingulate and ventromedial prefrontal cortex. The amygdala also receives input from every neuromodulatory system, including the Raphe nuclei and locus coeruleus.

Output from the amygdala can be directed to both subcortical and cortical brain structures. In particular, the amygdala projects back to the thalamus and sensory cortices, the hippocampus, the anterior cingulate and ventromedial/orbitofrontal cortex.
The Amygdala and Fear

Fear: emotional reaction to threat

Fear Conditioning
• Pair a neutral stimulus (e.g., a tone) with an aversive stimulus (e.g., a shock).
• Present the tone later and the animal will show a conditioned fear response (i.e., a defensive behavior – fight or flight)

Lesions of the medial geniculate body (and auditory cortex) and the amygdala block fear conditioning to simple tones.

The amygdala evaluates the emotional significance of the sound on the basis of previous encounters (memory stored in the hippocampus) and stimulates directly (in a reflex-like manner) the hypothalamus to activate the appropriate autonomic and humoral responses.
The Anterior Cingular Cortex

The cingulate cortex participates in a variety of functions (e.g., part of the secondary motor cortex, part of an episodic memory circuit).

The anterior cingulate cortex (ACC) is connected with the amygdala, the ventro-medial prefrontal cortex (VMPFC), and the dorsolateral prefrontal cortex (DLPFC).

It is thought that the ACC (via its inputs from the amygdala) gives rise to the mental states of emotion (which it reports to the VMPFC), and then motivates appropriate somatic responses (via its outputs to the DLPFC). In addition, it then monitors somatic behavior to ensure that it is consistent with the internal mental state.
The ventromedial prefrontal cortex is connected in a reciprocal manner with both the amygdala and anterior cingulate cortex. It is thus in a position to regulate and inhibit responses to emotional stimuli.

Individuals with damage to the VMPFC (e.g., Phineas Gage) are behaviorally and emotionally disinhibited. Their affect is rarely neutral, constantly oscillating between euphoria and rage, with poor impulse control (“child-like”).

Studies suggest that the VMPFC plays a role in the acquisition of conditioned fear, and is essential for its extinction.
Serotonin and Emotion

Studies indicate that the neurotransmitter serotonin is involved in regulating mood. Serotonin-containing neurons are located in the Raphe nuclei of the brainstem, and their axons ascend in the medial forebrain bundle and project to many structures involved in expressing emotion including the amygdala, anterior cingulate cortex, hypothalamus and medial prefrontal cortex.

Evidence indicates that drugs that block the synthesis or release of serotonin (antagonists) increase aggressive behavior (i.e., lower serotonin levels = higher aggression). Conversely, agonists of serotonin receptors are known to decrease anxiety and aggressiveness in mice. Also, low serotonin levels have been linked to depression, whereas high levels are associated with mania.
A variety of studies have found that emotional functions are lateralized (like language). fMRI and lesion studies have shown asymmetrical activation of brain regions when thinking of emotions, responding to emotional stimuli, and viewing emotional situations. In particular, production and processing of facial expressions appears to be processed predominantly in the right hemisphere.
Episodic memory plays an important role in amygdala function; in turn, emotion affects episodic memory storage in the hippocampus. In particular, abundant evidence indicates that memories for emotional events have a greater persistence and vividness than other memories.

Emotions, in particular those elicited by stress, produce a core pattern of changes in the body, including:

- increased activity of the sympathetic nervous system (fight or flight).
- and activation of the anterior pituitary-adrenal cortex system to release glucocorticoids that enable the body to maintain prolonged alertness, fight infections and heal wounds.
Evidence suggests that increased activity within the amygdala, in response to elevated norepinephrine and glucocorticoids, plays an essential role in mediating the influence of emotional arousal on memory consolidation in the hippocampus.

In particular, it is thought that prolonged activity of the amygdala maintains a calcium influx (via NMDA receptors) in hippocampal neurons, thus putting an “emotional tag” onto synapses already targeted for LTP.

Late-phase LTP is thus enhanced as there is greater dendritic translation of arriving activity-regulated cytoskeleton-associated protein (ARC) mRNA transcripts.

Arousal-mediated affects on memory consolidation exhibit an inverted U-shape: low stress enhances consolidation whereas high stress impairs consolidation.