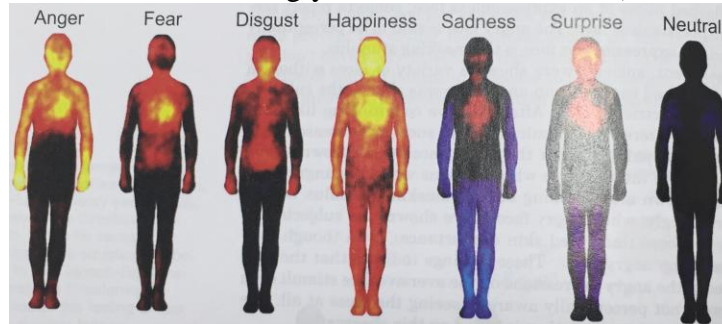


Unit VIII – Problem 11 – Physiology: The Limbic System



- “Pleasure, elation, euphoria, ecstasy, sadness, love, depression, anxiety” all of these are emotions which are provided by the limbic system and are coloring our life and giving it a meaning (making us different from robots!).
- Most of the output from the limbic system is going to hypothalamus which is responsible for expression of emotions through visceral responses. Therefore, emotional stress can result in visceral illness (this is more common in males and a good example is gastric ulcer which is strongly associated with stress!).



- **Insula:** it is part of the limbic system which is receiving sensory information from the gastrointestinal tract and is responsible for enhancement of vomiting as a response to the presence of toxic materials in the gut.
- If you perform a surgery and remove part of the cortex + hypothalamus → the subject will be unable to express emotions but if you remove part of the cortex only (sparing the hypothalamus) → the subject will still be able of emotional expression.
- **Limbic system (الجهاز الحافى/الطرفى):** the name is related to the site/position of this system. It was named by Broca who thought that its main function is concerned with olfaction. Then, Papez suggested that is the site where formation of memories occurs.
- The most important 2 structures concerned with emotions are amygdala and hypothalamus (both of them are not included in Papez’s circuit). Notice that amygdala is the principle center for emotions (emotional memories, facial expressions of the person himself, availability of reading facial expressions of others... etc).
- A stimulus is received by the cerebral cortex and then sent to the limbic system which will evaluate if there is an emotional component in the stimulus (such as: pain, sadness, happiness... etc). Afterthat, the stimulus will be sent back to the pre-frontal cortex (which will give us the feeling of the emotion) and to hypothalamus (which is responsible for expression of that specific emotion).
- **Alexithymia (common in males):** means that the patient is unable to identify/ describe emotions. Therefore, he will be more vulnerable to visceral illness (لأنه يكتب مشاعره).
- Notice that amygdala is more active in females (this explains why they have increased expression of their emotions). Amygdala is also responsible for emotional memories which will be recalled by the amygdala itself when a similar situation is re-experienced.
- So, amygdala is responsible for emotions while pre-frontal cortex is responsible for logic (taking a decision depends on which one of them is more active although most of our decisions are taken by the pre-frontal cortex).
- In addition, amygdala triggers a fight-or-flight response when deciding that the situation is risky
- Hippocampus has only an indirect role in emotion (it is an important structure for the formation of emotional memories).
- Growth of the amygdala reaches its maximum in teenagers → this will result in increased emotionality and risk-taking behavior during this phase. Amygdala is secreting dopamine which is providing us with satisfaction and considered as a reward. Notice that in young adolescents, amygdala is less active in response to negative feedback (e.g. when an adolescent is facing a risky situation, his amygdala will not be active. Therefore, he



will have no fear and this explains his risk-taking behavior → this will start to decline at the age of 16).

- **“We can teach the amygdala about a situation without really living it”** → e.g. when someone tells a group of people that there is a monster in a room → normally, they will experience fear although they did not live the real situation and they will not try to enter the room (this is especially seen with females who have more active amygdala). On the other hand, males (who have less activity of amygdala) will try to enter the room and check if there is a monster or not (less fear- more curiosity).
- **Summary:** a sensory stimulus will be received by the cortex → and then sent to the limbic system which will decide if it is an emotional stimulus → afterthat, the stimulus will go to:
 - **Pre-frontal cortex:** which will provide us with the feeling of the emotion.
 - **Hypothalamus:** which aids in physical expression of emotions.
- **The limbic system can prepare us emotionally for certain situations** (e.g. controlling our facial expressions and preventing us from smiling when going to a funeral for example! This is done by stimulating the amygdala for sad expressions).
- **Amygdala is also involved in reading facial expressions of other people and identifying their faces. This is done through:**
 - **Conscious identification of who that person is?** (this occurs in inferior temporal cortex: fusiform face area)
 - **Familiarity with that person** (which has an autonomic component and occurs by the amygdala). Familiarity includes: name of the person, who is he, should I be happy or sad when I see him, is he a friend or an enemy... etc).
- **Amygdala mediates both inborn and acquired emotional responses (How?):**
 - A mouse is placed in a box → where a loud sound will be played → this will generate the feeling of fear in it (increase in blood pressure and freezing).
 - Then, the loud sound will be played again combined with electrical shock → this will cause a greater feeling of fear (more increase in blood pressure and freezing).
 - After sometime, when the loud sound is played without combining it with electrical shock → the mouse will express a response similar to that as if electrical shock is present (this is explained by development of emotional memory).
- **Emotions and decisions:**
 - **If the decision which is taken will result in emotional consequences → the following areas of the brain will be involved in taking that decision:**
 - ✓ Cingulate gyrus.
 - ✓ Angular gyrus.
 - ✓ Medial frontal gyrus.
- **Kluver-Bucy syndrome: involves the following:**
 - Memory loss.
 - Hyperactivity.
 - Learning difficulties.
 - Loss of dominance.
 - Loss of fear.
 - Extreme curiosity.
 - Oral tendency.
 - Strong sexual drive.
- **Notice that facial expressions are inherited and they reveal emotional states. Facial expressions are done by the facial nerve which is controlling voluntary muscles.** Therefore, we can fake our emotions (e.g. we can smile and pretend to love someone when we actually hate him ☺).
- **In the brain, there are:**
 - **Reward centers:** motivate us to repeat doing things that make us feel good. These centers are in: hypothalamus, lateral and ventromedial nuclei.



- **Punishment centers:** these are found in mesencephalon, central gray area, hypothalamus, thalamus and periventricular zones.
- **Dopamine is the particle which is responsible for reward and good feeling.** (e.g. it is secreted when we eat and this explains why we enjoy eating food).
 - **Dopamine is synthesized in ventral tegmental area (VTA) and released in nucleus accumbens.**
 - **Dopamine has the same effect of addiction** (actually it is the one which is responsible for addiction associated with use of drugs).
 - Dopamine is released in synapses and is quickly reuptaken/ **metabolized by monoamine oxidase (MAO).**
 - **There are drugs which cause increase amount of dopamine release in synapses:**
 - ✓ Cocaine: by blocking the normal absorption of dopamine.
 - ✓ Amphetamine: by stimulating excess release of dopamine.
 - ✓ Nicotine: through 2 actions:
 - ❖ Stimulating release of dopamine.
 - ❖ Blocking the action of (MAO).
 - **Withdrawal:** it is a physiological response for stopping drug intake. A severe feeling of depression will be experienced because normal levels of dopamine will not provide reward sensation (due to decrease in dopamine receptors as a response for previous addiction of drugs).
- **There are 3 important neurotransmitters which are involved in regulating mood. These are:**
 - **Dopamine.**
 - **Serotonin.**
 - **Norepinephrine.**
- **Diathesis-stress hypothesis theory:** this theory is explaining any psychiatric disease. It states that any person predisposed to:
 - Genetic inheritance of depression.
 - Brain abnormality.
 - Learning experience.Will suffer from psychiatric problems when these factors are combined with environmental stressors.