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Brain and Body: The Neuropsychology of Anxiety

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Abstract

The complex and intricate nature of the brain involves a comprehensive approach when researching and treating mental health concerns such as anxiety conditions. Generally, mood and anxiety concerns are viewed from a biopsychosocial perspective, which provides thorough insight to conceptualize individuals' presenting issues in treatment. This perspective considers the biological (hereditary), psychological (emotional), and social (environmental) aspects that contribute to an individual's mental state. To expand the perspective of anxiety for research and treatment purposes, adding a neurological component would elucidate anxiety by increasing the understanding of an essential part in anxiety, the brain. Within the brain is a structure called the amygdala, wherein the emotional processing resides. One such emotion apropos to anxiety is fear. Often overlooked in treatment models for anxiety, the amygdala initially processes external emotionally salient stimuli and subsequently initiates an appropriate physiological (e.g. palpitations) and behavioral (e.g. avoidance) response. In those with an anxiety condition, the brain stem constantly emits signals of detecting threat of harm, signaling fear, thus triggers the fight or flight response and leads the body to react accordingly. Individuals with anxiety remain in the fight or flight mode even in the absence of actual threat but rather due to perceived threat. For those not suffering from anxiety conditions, the brain and body returns to a calm state after the threat has surpassed. Occasional worry about daily activities or general life aspects (i.e. bill payment, presentation, or commute time) is common and the fight or flight response can be safe, as it helps to detect danger to keep safe. However, worry differentiates from anxiety in that anxiety is persistent, intense, long lasting, and when there is not any real danger in the present. The brain and body are interconnected and communicate with one another to send signals and produce responses based upon the communicated signals. Treating anxiety holistically, considering both the brain and the body, could destigmatize mood and anxiety conditions and increase awareness of brain structures and brain processes. Gaining knowledge of how the brain functions and how it functions on anxiety will contribute to the field in that further research is possible and treatment practices can be developed, factoring in the amygdala and other brain structures to design treatment models that address the mental and physiological aspects. A neuropsychological perspective, to compliment the biological and social aspects, would demonstrate the intertwining of the brain and body.

Keywords: *Anxiety; Brain and Anxiety; Serotonin; Sympathetic Nervous System*

Introduction

The intersection of anxiety disorders and the brain is complex, common, and central to understanding both the anatomical functioning and manifestation of anxiety. As the brain and body are deeply interrelated, the brain stem, neurotransmitters through the Central Nervous System (CNS), and the emotional-processing brain structure, known as the limbic system, allows individuals presenting with Anxiety Disorder as defined in the Diagnostic Statistical Manual (DSM) to experience disruptions mentally and physically. The duality of brain and anxiety disorders exhibits the benefit of conceptualizing, researching, and treating both collectively as opposed to independently. A neuropsychological approach provides a comprehensive perspective on the development and functioning of anxiety, which may elucidate the brain activity, heart functioning, and contributing external factors.

More than 40 million people in the United States over 18 years of age suffer from an anxiety-related disorder, including Generalized Anxiety Disorder (GAD), Social Anxiety Disorder (SAD), Panic Disorder (PD), Post-traumatic Stress (PTS), and others. This includes only those who have been diagnosed or whose symptoms match a similar condition [1]. Millions more, however, go undiagnosed. Anxiety Disorder is intense, excessive, and persistent worry or fear about common situations and interfere with daily activities, are long lasting, challenging to control, and disproportionate with the actual danger present [2]. As "feeling anxious", which differs from an anxiety disorder, is a normal response to fear-inducing situations and serves a purpose - to protect oneself through a "fight or flight response"- this bodily response is designed to be engaged when needed and disengaged when not needed. Conversely, when it is constant and inconsistent with the reality of a threatening situation, anxiety keeps the brain (and body) on alert at all times, thus is problematic. Although the goal is not to dismiss anxiety entirely or conceptualize solely as psychopathological, the objective should be to make anxiety healthy, manageable, and understandable. Even if not suffering from an anxiety-related disorder, anxiety of any sort appears at some point in life, thus knowledge of its functioning is necessary to cope in a healthy manner.

An anxious state of mind

The Autonomic Nervous System (ANS) is divided in such a way to allow the parasympathetic system to preserve energy for the Central Nervous System (CNS); the CNS avails additional energy and consumes it [3]. The sympathetic nervous system prepares the body for emergency and functions when the conscious as well as the unconscious mind senses a need to defend or to provide energy. When in a state of anxiety, the brain stem transmits signals to the body when it detects a threat, manifesting a physiological response. Such responses include but are not limited to rapid heart palpitations, trembling, fatigue, shortness of breath or hyperventilation, dry mouth, gastrointestinal (GI) issues, and sweat secretion from the sudoriferous glands. During high or intense emotions, the sympathetic nervous system produces what is known as the fight or flight response, wherein the brain detects danger and causes the body either to fight against or flee from it. The objective of the SNS is to protect oneself from danger. This is the point at which fear and anxiety differentiate. The brain instinctually protects by transmitting signals of nearby harm; when there is actual danger, it is fear, and when there is perceived danger and is persistent, interfering with daily activities or about the future, then it is anxiety. The Sympathetic Nervous System leads to the change in breath patterns, palpitations of the heart, and other physiological aspects during high emotionality.

Along with physiological reactions, cognitive symptoms of anxiety consist of racing thoughts, difficulty concentrating, and consistent worry about daily or future situations. In an anxiety state of mind, external stimuli present themselves, which lead to the thought-processing of a potential situation, subsequently attaching emotions to the memory of the situation and to a future occurrence. This triggers those emotions during recall, sending the brain and body into overwhelming conditions, notably in the absence of a threat.

Conclusions of anxiety etiology vary from genetic and environmental factors, and from partly as resulting from an imbalance in the activity of the brain's emotional centers instead of from its higher cognitive areas. The brain is complex and within it, the frontal lobe is responsible for higher cognitive functioning. Furthermore, within the prefrontal frontal cortex (PFC), the brain's executive functioning consists of predicting consequences for potential behaviors, making decisions, planning, and both understanding and moderating social behavior. In anxiety, this involves information processing in a situation that determines the response. The orbitofrontal cortex (OFC) thus is responsible for coding information, regulating mood, and controlling impulses. In those with anxiety, the stress response of fight or flight passes quickly through the OFC, as the brain has decided a threat, or rather perceived threat, is present. In those without an anxiety condition, the natural instinct for protection or survival remain present but will leave and return to baseline when the threat disappears (i.e. coding information in the brain that safety has returned and regulates the corresponding mood in the body). The ventromedial PFC processes rewards and involves visceral responses to emotions, wherein the natural or instinctual reactions to actual threat of harm is enacted. When the threat subsides, the brain and body calms. However, in anxiety, the two remain in constant fight or flight response even in the absence of an actual threat. With anxiety, there is high likelihood for the constant fight or flight mode to go unnoticed and as though this is the regular state of one's own being. However, it is likely the brain and body have been conditioned and reinforced to be in this state; ongoing research continues in this area. These frontal cortical regions in the brain regulate impulses, emotions, and behavior, and for those without an anxiety-related condition, it does so through healthy emotional-processing structures [4].

At the heart of anxiety

Provided the limbic system within the brain is involved with the formation and expression of anxiety, the limbic system is the region that processes emotions and consists of other brain structures within it, such as the amygdala, with similar functionality. Both the insular cortex and cingulate cortex are part of the limbic system. Further, the limbic cortex integrates the sensory, affective, and cognitive components of pain and processes such information concerning internal bodily states. Within the limbic system is the hippocampus, which stimulates the hypothalamic stress-response system with influence in the negative feedback for the hypothalamic pituitary adrenal (HPA) axis [4]. The executive functioning in the frontal lobe might not process a plan fast enough in the presence of harm, and instead the fight or flight response prepares to react to or retreat from the harm or threat of harm.

The feeling of anxiety and all of its physiological and mental facets are part of the body's stress response. When the fight or flight defense mechanism is enacted, the brain fills with norepinephrine and cortisol. Predominantly released from the sympathetic nerve fibro endings and increases both the rate and force of the contraction of the heart, the former is crucial to the fight or flight response. From here, the brain communicates to the heart about potential threat or real danger, thus increasing the rate of the heartbeat.

The latter, cortisol, is a stress-inducing hormone and can appear in situations from meeting someone to presenting to a crowd to encountering a natural disaster. Norepinephrine and cortisol increase perception, reflex, and speed during dangerous circumstances. Both escalate the heart rate and contraction, transferring more blood to the muscles, more air to the lungs, and preparing one to navigate the threat. During such times, the body receives signals from the brain and proceeds into full survival mode. With rapid heart rate, the body can exhaust and the brain attempts to find ways to process the frequent thoughts and/or devise a plan. Ideally, the brain and body return to a calm baseline after the threat disappears. In those with anxiety, the state of fight or flight persists, however.

Mind matter

Given the activity of various brain regions, it is important to consider the neurotransmitters that provide communication between the brain regions as well. Mood and anxiety disorders comprise a variety of neurotransmitter, neuroanatomical, and neuroendocrine interferences in the brain [5]. There are several parts of the brain responsible for producing fear and anxiety. Using neurochemical techniques along with brain imaging technology, researchers found that the amygdala and the hippocampus contribute significantly in many of the anxiety disorders [4]. The central nucleus of the amygdala (CeA) connects to the cortical regions, including the limbic cortex and receives input from the hippocampus, thalamus, and hypothalamus.

Deep within the brain is the amygdala, an almond-shaped structure that serves as a communication center between the incoming sensory signal-processing area and the part of the brain that interprets the signals. The amygdala warns the rest of the brain of a present threat, and then triggers a response of fear or anxiety. As indicated, the limbic system houses the amygdala, which initially processes external emotionally salient stimuli and then initiates an appropriate behavioral and physiological response. It is the brain structure responsible for the expression of fear and aggression. Treatment models for anxiety tend to omit the role of the amygdala and may lead to concluding that the treatment was unsuccessful. Once factored into treatment for anxiety the understanding that the amygdala forms emotional memories and attaches a feeling from the memory to the present, then the state of mind in anxiety clarifies how the brain pairs the stimuli that produces a perceived threat with the emotional arousal, thus generating the subsequent physiological response and behavior.

In those suffering from anxiety, an increase in activity within the emotion-processing area of the brain could result from decreased inhibitory signaling by γ-amino-butyric-acid (GABA), which are increased excitatory neurotransmissions [4]. Essentially, before the body feels the effects of anxiety, the brain is already working through the anxiety responses. The neurological processes in action, as the National Institute of Mental Health described, contains CNS and limbic system functions. Within the Central Nervous System are neuropeptides; peptides are small protein-like molecules that neurons use for communicating with one other. These molecules influence the functioning of the brain and the body in specific ways; for example, reward, social behaviors, analgesia, reproduction, metabolism, food intake, learning, and memory [6]. In anxiety, neuropeptides release along with classic neurotransmitters, many of which are within the limbic regions where they are able to influence stress and emotion circulation.

When medication for mood- and anxiety-management factors in, anxiolytic and antidepressant properties of drugs that primarily act on monoaminergic systems implicate the levels of serotonin (scientifically known as 5-hydroxytryptamine or 5-HT), dopamine (DA), and norepinephrine (NE) in the pathogenesis of mood and anxiety disorders [7]. Sometimes referred to as the happy chemical for its contribution to wellbeing, serotonin is a chemical mainly found within the brain, bowels, blood platelets, as well as the CNS. Although it has several capacities, one function of serotonin is regulating mood, thus low levels possibly link to depression; however, it is unknown whether mood imbalances cause or are caused by low serotonin levels. Although serotonin occurs throughout the body, it cannot cross the blood-brain barrier; therefore, any serotonin used within the brain must also be produced in the brain [8]. In stressful situations, such as with anxiety, this bodily chemical may be impacted in the brain and body.

Anxiety doppelgangers

Several anxiety disorders exist, including PTS, SAD, GAD as well as phobias and situation anxiety. On the surface, stress, worry, or fear can resemble anxiety, but the reality of anxiety is more comprehensive and complex. For example, anxiety can arise from stress, but stress may manifest in other ways. Stressors can generate emotions of sadness, anger, worry, or anxious feeling, whereas anxiety is specifically a feeling of fear, dread, and apprehension with triggers from the emotional memories attached. It is a feeling of intensity, out of control, and catastrophe-like even when not encountering a threat to self. Where external influences often cause stress, anxiety contrarily is an internal response, differentiating between stress and anxiety and making anxiety difficult to manage.

Worry and anxiety typically are used interchangeably but are different psychological states. Although both demonstrate a sense of concern or need to be prepared for self-protection or self-preservation on some level and are created by the imagination, worry is the thought process about a particular instance, still within control, that subsides after resolution. Contrarily, anxiety is persistent, uncontrollable, and excessive, including when not presented with actual threat [9].

Discussion

The etiology of anxiety varies, as mentioned. Some researchers suggest that anxiety is biological with genetic predisposition, although additional research is needed. Others indicate anxiety is environmental, as conditions in which an individual lives evolves into this mental health state. Continuing studies support the suggestion of a dual genetic predisposition and environmental influence, albeit a complex range of gene - environment interaction amongst mood and anxiety disorders in individuals.

With etiology of a mental health condition, psychological theories place anxiety into several perspectives. The behavioral theoretical standpoint of anxiety is that anxiety forms as a learned condition based upon exposure to stressful or frightful occurrences. It suggests that individuals are not born with anxiety but rather learn it through conditioning and reinforcement. Theorizing anxiety psychoanalytically, DeGroat described anxiety as a "battle between the id, ego, and superego" [4]. With a conflict between these three parts of the psyche that Freud introduced, he explained that anxiety acts as the danger signal to the ego and/or superego that the body is highly likely to act on an unacceptable impulse of the id. From this psychanalytical perspective, for those with anxiety, the ego and/or superego attempts to manage the impulses of the id through escalated measures to prevent undesirable outcomes. Anxiety contains brain movement that communicates with the body's physiological response. When anxiety is triggered, an individual can feel the physiological experience of it, as anxiety has warned of a potential threat present and that the individual is close to doing something to which he/she might be opposed. With cognitive symptoms of anxiety, there is also a cognitive theoretical perspective. It suggests that anxiety forms when cognitive distortions make an individual view each situation as a physical threat, both real or imagined whether encountering a neighbor, interviewing, or confronted by a police officer.

The brain and body are closely related in every function of an individual, thus also connected in every vulnerability in an individual. As anxiety functions within the brain and body, understanding the inner functioning clarifies the condition. Within the limbic system of the brain, the emotion-processing amygdala is influential in the formation and retrieval of emotion- and fear-related memories. When triggering anxiety, the brain signals to the body to react to or remove oneself from the situation. The fight or flight response is a response in stressful occasions and help with safety; however, it remains activated in those with anxiety-related conditions rather than subsiding. A neuropsychological perspective factors in the brain matter and body's physiological responses in anxiety [10].

Conclusion

The intertwining of the brain and body contains neurological and psychological substance that communicate with one another to develop, form, and express the function and outcome of anxiety. Biological and environmental factors contribute to anxiety as well, yet

this neuropsychological approach considered brain structures (e.g. amygdala) not typically present in treatment practices, and bodily responses that explain the inner anatomical functioning. Anxiety is a sense of fear and apprehension that puts the brain on persistent alert and produces physiological arousal (i.e. heart palpitation, sweating, muscle tension), cognitive effects (i.e. racing thoughts and difficulty concentrating), and behavior (i.e. avoidance of situations or people that trigger the fear or apprehension). Anxiety heightens the sense of awareness to prepare for potential threat and becomes problematic when a threat does not exist. The brain does not power off the fight or flight response, thus leading to a constant state of heightened senses and emotionality, and living daily with the physical and emotional effects without a reason or cause to do so. Many theories attempt to explicate the etiology of anxiety with biological and environmental components, which are essential. Neurological contributions also must be considered to compliment the psychological nuances of anxiety. The understanding of how anxiety works within the brain and body may inform additional research as well as treatment approaches, as neuropsychology explains important and overlooked brain structures in anxiety and their effects on the body's experience of anxiety.

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