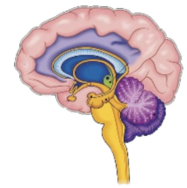
Understanding the Brain's Threat & Stress Response

Chronic activation of this survival mechanism impairs health



A stressful situation — whether something environmental, such as a looming work deadline, or psychological, such as persistent worry about losing a job — can trigger a cascade of stress hormones that produce well-orchestrated physiological changes. A stressful incident can make the heart pound and breathing quicken. Muscles tense and beads of sweat appear.

This combination of reactions to stress is also known as the "fight-or-flight" response because it evolved as a survival mechanism, enabling people and other mammals to react quickly to life-threatening situations. The carefully orchestrated yet near-instantaneous sequence of hormonal changes and physiological responses helps someone to fight the threat off or flee to safety. Unfortunately, the body can also overreact to stressors that are not life-threatening, such as traffic jams, work pressure, and family difficulties.

Over the years, researchers have learned not only how and why these reactions occur, but have also gained insight into the long-term effects chronic stress has on physical and psychological health. Over time, repeated activation of the stress response takes a toll on the body. Research suggests that chronic stress contributes to high blood pressure, promotes the formation of artery-clogging deposits, and causes brain changes that may contribute to anxiety, depression, and addiction. More preliminary research suggests that chronic stress may also contribute to obesity, both through direct mechanisms (causing people to eat more) or indirectly (decreasing sleep and exercise).

Sounding the alarm

The stress response begins in the brain. When someone confronts an oncoming car or other danger, the eyes or ears (or both) send the information to the amygdala, an area of the brain that contributes to emotional processing. The amygdala interprets the images and sounds. When it perceives danger, it instantly sends a distress signal to the hypothalamus.

The hypothalamus is a bit like a command center. This area of the brain communicates with the rest of the body through the autonomic nervous system, which controls such involuntary body functions as breathing, blood pressure, heartbeat, and the dilation or constriction of key blood vessels and small airways in the lungs called bronchioles. The autonomic nervous system has two components, the sympathetic nervous system and the parasympathetic nervous system. The sympathetic nervous system functions like a gas pedal in a car. It triggers the fight-or-flight response, providing the body with a burst of energy so that it can respond to perceived dangers. The parasympathetic nervous system acts like a brake. It promotes the "rest and digest" response that calms the body down after the danger has passed.

After the amygdala sends a distress signal, the hypothalamus activates the sympathetic nervous system by sending signals through the autonomic nerves to the adrenal glands. These glands respond by pumping the hormone epinephrine (also known as adrenaline) into the bloodstream. As epinephrine circulates through the body, it brings on a number of physiological changes. The heart beats faster than normal, pushing blood to the muscles, heart, and other vital organs. Pulse rate and blood pressure go up. The person undergoing these changes also starts to breathe more rapidly. Small airways in the lungs open wide. This way, the lungs can take in as much oxygen as possible with each breath. Extra oxygen is sent to the brain, increasing alertness. Sight, hearing, and other senses become sharper. Meanwhile, epinephrine triggers the release of blood sugar (glucose) and fats from temporary storage sites in the body. These nutrients flood into the bloodstream, supplying energy to all parts of the body.

All of these changes happen so quickly that people aren't aware of them. In fact, the wiring is so efficient that the amygdala and hypothalamus start this cascade even before the brain's visual centers have had a chance to fully process what is happening. That's why people are able to jump out of the path of an oncoming car even before they think about what they are doing.

As the initial surge of epinephrine subsides, the hypothalamus activates the second component of the stress response system — known as the HPA axis. This network consists of the hypothalamus, the pituitary gland, and the adrenal glands.

The HPA axis relies on a series of hormonal signals to keep the sympathetic nervous system — the "gas pedal" — pressed down. If the brain continues to perceive something as dangerous, the hypothalamus releases corticotropin-releasing hormone (CRH), which travels to the pituitary gland, triggering the release of adrenocorticotropic hormone (ACTH). This hormone travels to the adrenal glands, prompting them to release cortisol. The body thus stays revved up and on high alert. When the threat passes, cortisol levels fall. The parasympathetic nervous system — the "brake" — then dampens the stress response.

Oxytocin exerts stress-buffering effects to inhibit the stress-induced HPA activity and decrease cortisol levels. When cortisol stress responses and the protective stress-buffering effects of oxytocin reach a balance, homeostasis is preserved.

Most often oxytocin inhibits sympathetic nervous activity whereas it stimulates parasympathetic nervous activity. Oxytocin can function as a stress-coping molecule, an anti-inflammatory, and an antioxidant, with protective effects especially in the face of adversity or trauma. Oxytocin influences the autonomic nervous system and the immune system. These properties of oxytocin may help explain the benefits of positive social experiences and have drawn attention to this molecule as a possible therapeutic in a host of disorders.

Adrenaline vs Cortisol: Similarities & Differences

These two hormones both play important roles in your body. The fundamental differences between cortisol and adrenaline are the stimuli that promote the release of these hormones, the effect on the body, and the role they play in your overall health and well-being.

Adrenaline, commonly known as the fight or flight hormone, it is produced by the adrenal glands after receiving a message from the brain that a stressful situation has presented itself. Imagine you're trying to change lanes in your car. Suddenly, from your blind spot, comes a car racing at 100 miles per hour. You return to your original lane and your heart is pounding. Your muscles are tense, you're breathing faster, you may start sweating. That's adrenaline. Along with the increase in heart rate, adrenaline also gives you a surge of energy -- which you might need to run away from a dangerous situation -- and also focuses your attention. Think of adrenaline as your emergency hormone. It helps you to get out of sticky situations but isn't necessary for daily health and functions.

When working properly, cortisol starts the day off higher, and then levels come down as the sun goes down, to prepare for sleep. It is also released during stressful and anxiety inducing events and periods in your life to help you deal with what is happening in the moment. It takes a little more time -- minutes, rather than seconds -- for you to feel the effects of cortisol in the face of stress. In survival mode, the optimal amounts of cortisol can be life saving. It helps to maintain fluid balance and blood pressure, says Sood, while regulating some body functions that aren't crucial in the moment, like reproductive drive, immunity, digestion and growth.

But when you stew on a problem – or if your entire life is high-stress and always in high gear – the body continuously releases cortisol, and chronic elevated levels can lead to serious issues. Too much cortisol can suppress the immune system, increase blood pressure and sugar, decrease libido, produce acne, contribute to obesity and more.

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