PHYSIOLOGY OF THE STRESS RESPONSE

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Introduction

This article provides an insight into what happens at a physiological level when a person becomes stressed. Although this article may seem rather complicated, it is an oversimplification of what happens. It is suggested that readers interested in increasing their understanding about this topic refer to advanced texts that are available.

The Stress Response

When people perceive that they are in threatening situations that they are unable to cope with, then messages are carried along neurons from the cerebral cortex (where the thought processes occur) and the limbic system to the Hypothalamus. This has a number of discrete parts.

The Anterior Hypothalamus produces sympathetic arousal of the Autonomic Nervous System (ANS). The ANS is an automatic system that controls the heart, lungs, stomach, blood vessels and glands. Due to its action we do not need to make any conscious effort to regulate our breathing or heart beat. The ANS consists of two different systems: the sympathetic nervous system and the parasympathetic nervous system. Essentially, the parasympathetic nervous system conserves energy levels. It increases bodily secretions such as tears, gastric acids, mucus and saliva which help to defend the body and help digestion. Chemically, the parasympathetic system sends its messages by a neurotransmitter called acetylcholine which is stored at nerve endings.

Unlike the parasympathetic nervous system which aids relaxation, the sympathetic nervous system prepares the body for action. In a stressful situation, it quickly does the following:

- Increases strength of skeletal muscles
- Decreases blood clotting time
- Increases heart rate
- Increases sugar and fat levels
- Reduces intestinal movement
- Inhibits tears, digestive secretions.
- Relaxes the bladder
- Dilates pupils
- Increases perspiration
- Increases mental activity
- Inhibits erection/vaginal lubrication
- Constricts most blood vessels but dilates those in heart/leg/arm muscles

The main sympathetic neurotransmitter is called noradrenaline which is released a the nerve endings. The stress response also includes the activity of the adrenal, pituitary and thyroid glands.

The two adrenal glands are located one on top of each kidney. The middle part of the adrenal gland is called the adrenal medulla and is connected to the sympathetic nervous system by nerves. Once the latter system is in action it instructs the adrenal medulla to produce adrenaline and noradrenaline (catecholamines) which are released into the blood supply. The adrenaline prepares the body for flight and the noradrenaline prepares the body for fight. They increase both the heart rate, and the pressure at which the blood leaves the heart; they dilate bronchial passages and dilate coronary arteries; skin blood vessels constrict and there is an increase in metabolic rate. Also gastrointestinal system activity reduces which leads to a sensation of butterflies in the stomach.

Lying close to the hypothalamus in the brain is an endocrine gland called the pituitary. In a stressful situation, the anterior hypothalamus activates the pituitary. The pituitary releases adrenocorticotrophic hormone (ACTH) into the blood which then activates the outer part of the adrenal gland, the adrenal cortex. This then synthesizes cortisol which increases arterial blood pressure, mobilizes fats and glucose from the adipose (fat) tissues, reduces allergic reactions, reduces inflammation and can decrease lymphocytes that are involved in dealing with invading particles or bacteria. Consequently, increased cortisol levels over a prolonged period of time lowers the efficiency of the immune system. The adrenal cortex releases aldosterone which increases blood volume and subsequently blood pressure. Unfortunately, prolonged arousal over a period of time due to stress can lead to essential hypertension.

The pituitary also releases thyroid stimulating hormone which stimulates the thyroid gland, which is located in the neck, to secrete thyroxin. Thyroxin increases the metabolic rate, raises blood sugar levels, increases respiration/heart rate/blood pressure/and intestinal motility. Increased intestinal motility can lead to diarrhea. (It is worth noting that an over-active thyroid gland under normal circumstances can be a major contributory factor in anxiety attacks. This would normally require medication.)

The pituitary also releases oxytocin and vasopressin which contract smooth muscles such as the blood vessels. Oxytocin causes contraction of the uterus. Vasopressin increases the permeability of the vessels to water therefore increasing blood pressure. It can lead to contraction of the intestinal musculature.

If the person perceives that the threatening situation has passed then the parasympathetic nervous system helps to restore the person to a state of equilibrium. However, for many people they perceive everyday of their life as stressful. Unfortunately, the prolonged effect of the stress response is that the body's immune system is lowered and blood pressure is raised which may lead to essential hypertension and headaches. The adrenal gland may malfunction which can result in tiredness with the muscles feeling weak; digestive difficulties with a craving for sweet, starchy food; dizziness; and disturbances of sleep. Below are some of the symptoms of stress. Please note that these symptoms can also occur with a range of medical or psychological disorders. When in doubt, do consult your doctor or consultant.

RESPONSES TO STRESS (Palmer and Dryden, 1995)

BEHAVIOUR
Alcohol/drug abuse
Avoidance/phobias
Sleep disturbances/insomnia
Increased nicotine/caffeine intake
Restlessness
Loss of appetite/overeating
Anorexia, bulimia
Aggression/irritability
Poor driving
Accident proneness
Impaired speech/voice tremor
Poor time management
Compulsive behavior
Checking rituals
Tics, spasms
Nervous cough
Low productivity
Withdrawing form relationships
Clenched fists
Teeth grinding
Type A behavior e.g. talking/walking/eating faster; competitive; hostile;
Increased absenteeism
Decreased/increased sexual activity
Eat/walk/talk faster
Sulking behavior
Frequent crying
Unkempt appearance
Poor eye contact

AFFECT (Emotions)
Anxiety
Depression
Anger
Guilt
Hurt
Morbid jealousy
Shame/embarrassment
Suicidal feelings

SENSATIONS
Tension
Headaches
Palpitations
Rapid heart beat
Nausea
Tremors/inner tremors
Aches/pains
Dizziness/feeling faint
Indigestion
Premature ejaculation/erectile dysfunction
Vaginismus/psychogenic dyspareunia
Limited sensual and sexual awareness
Butterflies in stomach
Spasms in stomach
Numbness
Dry mouth
Cold sweat
Clammy hands
Abdominal cramps
Sensory flashbacks
Pain

IMAGERY
Images of:
Helplessness
Isolation/being alone
Losing control
Accidents/injury
Failure
Humiliation/shame/embarrassment
Self and/or others dying/suicide
Physical/sexual abuse
Nightmares/distressing recurring dreams
Visual flashbacks
Poor self-image

COGNITIONS
I must perform well
Life should not be unfair
Self/other-damning statements
Low frustration statements e.g. I can't stand it.
I must be in control
It's awful, terrible, horrible, unbearable etc.
I must have what I want
I must obey 'my' moral code and rules
Others must approve of me
Cognitive distortions e.g. all or nothing thinking

INTERPERSONAL
Passive/aggressive in relationships
Timid/unassertive
Loner
No friends
Competitive
Put other' needs before own
Sycophantic behavior
Withdrawn
Makes friends easily/with difficulty
Suspicious/secretive
Manipulative tendencies
Gossiping

DRUGS/BIOLOGY
Use of: drugs, stimulants, alcohol, tranquillizer, hallucinogens
Diarrhea/constipation/flatulence
Frequent urination
Allergies/skin rash
High blood pressure/coronary heart disease(angina/heart attack)
Epilepsy
Dry skin
Chronic fatigue/exhaustion/burn-out
Cancer
Diabetes
Rheumatoid arthritis
Asthma
Flu/common cold
Lowered immune system
Poor nutrition, exercise and recreation
Organic problems
Biologically based mental disorders

Reference
Palmer, S. and Dryden, W. (1995). Counseling for Stress Problems. London: Sage.