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Stress, Hair Tissue Mineral Patterns and the Hypothalamic-Pituitary-Adrenal Axis (HPA)

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All living organisms are subject to stress to some degree and have a built-in innate ability to respond to many different types of stressors. Plants can specifically modify their hormonal response to different types of stress conditions in their environment such as drought, attack by pathogens or insects. They can even produce chemicals to warn nearby plants of their distress. Even single cell organisms can modify their shape in response to stress. Of course humans and animals have this ability to respond to stress and many times adapt to the stress or develop coping or avoidance mechanisms. We should first recognize that all stress is not bad for the body. Human beings are constantly under stress. It is both inescapable and indispensable to life. Some types of stress can be motivating and positive. Distress however, is destructive to the body and if prolonged can lead to physical deterioration.

When discussing stress we have to give a great deal of credit and gratitude to the early pioneers such as Walter Cannon and Hans Selye, who developed the foundation for the study and understanding of stress, its response and effects on living organisms. Cannon was the first to use the terms 'fight or flight response' and 'homeostasis' in describing the body's attempt to be in equilibrium when challenged by environmental stressors such as maintenance of body temperature, lack of food or water intake, etc. When the body does not reach homeostasis then the long-term result would be tissue and organ damage leading to diseased states.

Later, Selye used the term stress to describe the problem with a lack of homeostasis, and developed the 'general adaptation syndrome' theory (GAS) focusing on the stress as a response. The GAS has three stages, the alarm, resistance and exhaustion stages. Selye felt that regardless of the type of stressor individuals are exposed to, the GAS response is the same.

More recently other researchers particularly Bruce McEwen and colleagues studying the work of Cannon and Selye, coined the term 'allostasis' which refers to the body's ability to adapt to changes due to stress. He refers to 'allostatic' overload as a result of repeated stressors causing permanent physiological changes and tissue damage due to a lack of adaptation.

The nervous system and endocrine system are integrated and work together in regulating physiological processes in the body. This neuro-endocrine integration regulates the stress response as well as the immune response, reproduction, digestion, energy production, utilization of nutrients, behavior and survival, and is regulated by the hypothalamus, pituitary and adrenals, termed the hypothalamic-pituitary-adrenal axis or HPA. The autonomic nervous system consists of two major branches the sympathetic and parasympathetic branches. The HPA also consists of two major groups that correspond to the branches of the nervous system and can be termed sympathetic and parasympathetic endocrines.

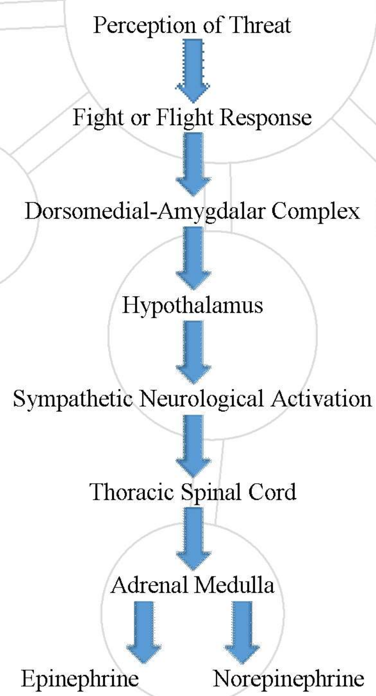
The Fight or Flight Stress Response (FFSR) and the HPA

It is probably safe to say that the FFSR mechanism is the same in both humans and animals. The FFSR can be considered a survival mechanism that occurs rapidly to life-threatening situations. In fact, it can be so rapid that an individual can respond even before processing the threat completely and thereby react without thinking. Examples include running into a burning building to rescue someone, or walking into the path of a wild animal, or nearly being hit by a passing automobile. The reaction can be jumping out of the way, running or standing still to avoid the accident.

The neuroendocrine response is the same for each event, in that the sympatho-adrenal (sympathetic nervous system and adrenal glands) system (SAS) is initiated. Perception of a threat is processed in the amygdalar complex which sends signals to the hypothalamus activating the sympathetic nervous system located in the thoracic spinal cord causing the adrenal medulla to produce epinephrine (adrenaline) and norepinephrine (noradrenaline). Adrenaline and noradrenalin is produced in a ratio of 80%/20% by the adrenal medulla. Norepinephrine is produced in large amounts by sympathetic postganglionic fibers of the sympathetic nervous system. These hormones affect the entire body causing a number of physiological reactions such as increasing cellular metabolic activity, stimulating organs needed for fight or flight and inhibiting those that are not required, increasing heart rate, respiration and shunting blood to the muscles and vital organs via vasoconstriction and vasodilation. Adrenaline, produced exclusively by the adrenal medulla is considered the most potent sympathomimetic or stimulatory hormone also known as pyrocatechole along with other catecholamines. Interestingly adrenaline is released under stressful conditions that are known while noradrenaline is released under unknown or unexpected stress conditions. The so called “adrenaline rush” for example is produced when a known stress is about to occur. Jumping from an airplane for example or just before being introduced to speak before a large audience, especially if a person is fearful of doing so. Whereas, norepinephrine is produced largely when an unknown stress occurs. An example would be driving down a dark road and an animal runs in front of your headlights and you instantaneously try to avoid it. The physiological reactions differ slightly between these two types of situations. It has also been found that adrenelanine is dominant in offensive situations and noradrenaline is dominating in defensive situations. This would be the case in athletic sports where individuals are playing offense or defense positions. In summary the fight or flight response occurs in everyone and is essentially the same in normal healthy individuals.

In summary, it has become widely accepted in today’s society that individuals are constantly experiencing the FFSR that is contributing to chronic health conditions. It is often said that since we no longer exist in a primitive environment where the FFSR was essential for survival, we are still experiencing it almost daily. I personally agree that stress contributes to major health conditions, but strongly disagree that normal day to day stressors elicit the FFSR. An illustration of a high powered executive suffering from peptic ulcer is often used and attributes the ulcer to the FFSR. The executive is no doubt under significant stress that is contributing to and aggravating his peptic ulcer, but the stress is not a life or death situation threatening his very survival. Moving, changing jobs, getting married etc. are also stressors. It is rare for example that a new bride or groom would develop the FFSR. I do recall a popular movie titled The Runaway Bride, in which apparently the stress of getting married initiated the FFSR and the bride developed the flight response. Perhaps this happens more often than I am aware of. Changing to a new higher paying job is an exciting stress as well as moving into a new home, but again should not illicit a FFSR. If we view the FFSR in context I think we can all recall situations that have elicited the response in each of us. However, I think most would agree that we experience it relatively rarely.

The Fight or Flight Stress Response (SAS)



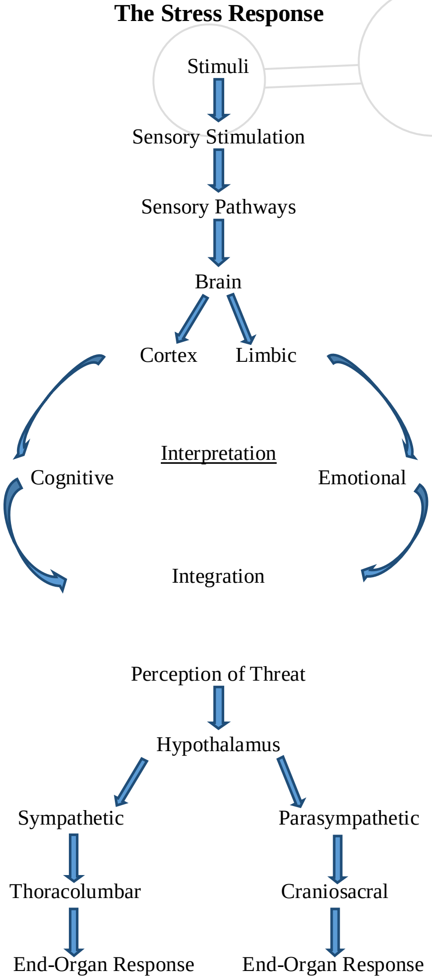
The Stress Response

Humans even though they may be in the same environment and similar circumstance, can respond remarkably different to a common stressor. One person may lose their appetite while another may have an increased appetite. One may gain weight another may lose weight. One person may develop high blood pressure and another has a drop in their blood pressure. Some may experience an increase in their symptoms such as joint pain, while others may experience decreased pain.

Since there is so much variation in humans to common stressors this paper proposes that the differing stress response of individuals may be based upon their particular metabolic characteristics rather than the stressors themselves. Further, I propose that the flight or fight response should be viewed separately from the stress response. The FFSR is largely mediated by the sympatho-adrenal system (SAS) involving mainly hormones produce by the adrenal medulla and sympathetic nervous system. However, common day-to-day stress is governed largely by hormones produced by the adrenal cortex.

In review of the stress response, sensory stimulation is processed in the same manner as the FFSR and SAS. However, the stimulus may be perceived in the cortex or limbic system. The sensory stimuli, depending upon interpretation and integration may activate either the sympathetic or parasympathetic branch of the CNS via the hypothalamus.

The Stress Response



Categorization of the Neuroendocrine System

The hypothalamus and pituitary have both a sympathetic and parasympathetic expression. The ventromedial hypothalamus containing neurons that regulate the pituitary. The anterior pituitary secretes adrenocorticotrophic hormone (ACTH) and thyroid stimulating hormone (TSH). Although other hormones are secreted by the anterior pituitary, ACTH and TSH are the two most stimulatory or sympathetic acting as they target the adrenal and thyroid glands or pituitary-adrenal-thyroid axis (PAT).

The lateral portion of the hypothalamus is considered parasympathetic and is associated with parasympathetic nervous system activity. Oxytocin and vasopressin or antidiuretic hormone is produced in hypothalamus and stored in the posterior pituitary. The parasympathetic nervous system opposes the sympathetic branch and slows metabolic activity in general. Parasympathetic neuroendocrine response is related to low thyroid and adrenal expression, increased thymic activity, hyperinsulinism, and parathyroid dominance.

Hair Tissue Mineral Patterns (HTMA) and the Stress

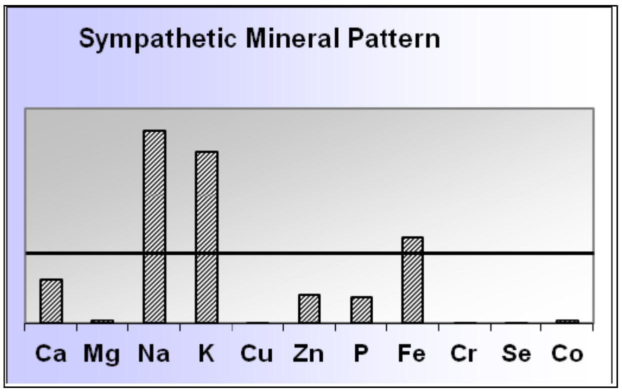
Dr. Melvin Page concluded that the mineral calcium was largely controlled by the parasympathetic neuroendocrine system and phosphorus was controlled by the sympathetic neuroendocrine system. This information was gleaned from analyzing blood calcium and phosphorus levels after consumption of different foods as well as administering small amount of hormones and other factors. We can approximate neuroendocrine dominance by using these two elements from HTMA studies. The calcium to phosphorus ratio can be used to assess the HPA. Elevated tissue phosphorus relative to a low tissue calcium or low calcium to phosphorus ratio (Ca/P) would be indicative of anterior pituitary dominance or sympathetic dominance. Typically the anterior pituitary stimulates both the adrenal cortex and thyroid. Therefore, it is common to see thyroid dominance along with adrenal dominance as they both impact similar metabolic processes. Increased calcium and magnesium excretion can be caused by over activity of both the thyroid and adrenal cortical glands. Adrenal glucocorticoids reduce intestinal calcium absorption due to their antivitamin D effects. Excessive aldosterone secretion also increases urinary calcium excretion.

Fast Metabolic Type 1 and the Stress Response

In reviewing the sympathetic mineral pattern, the low calcium-to-phosphorus ratio would indicate sympathetic dominance via the ventromedial hypothalamus and anterior pituitary. Sodium and potassium elevation would be indicative of increased adrenal cortical activity as well as thyroid dominance. We can see from the illustration of the stress response that a stress or stressors can predominantly activate the sympathetic branch of the nervous system via the thoracolumbar spinal cord. Individuals with a sympathetic mineral pattern under recurring stress may have excessive sympathetic activity to the end-organs innervated by the sympathetic nervous system.

Characteristics of sympathetic dominance include:

Type A Personality Traits	Stress Seeker
Elevated Metabolic Rate	Anxiety
Increased Body Temperature	Elevated Blood Pressure



Health conditions we have categorized into the sympathetic category include:

Anxiety	Arthritis (Rheumatoid)
Allergies (Histamine)	A. L. S.
Multiple Sclerosis (Type I)	Hyperactivity
Malignancies (Metastatic)	Hypertension
Diabetes (insulin antagonism)	Hyperthyroidism
Hyperglycemia	Hyperadrenia
Hypoparathyroidism	Infections (Bacterial)
Osteoporosis (Type I)	Parkinson's Disease
Ulcers (Duodenal)	Post Menstrual Syndrome
Seizures	Cystic Fibrosis

Auto-immunity (Cellular Immuno-Suppression)

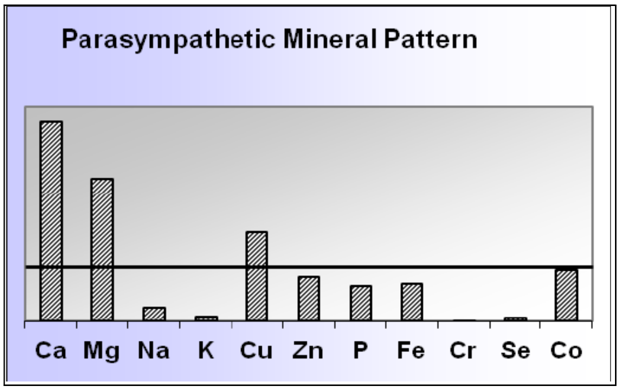
Both an elevated adrenal and thyroid activity would contribute to the loss of both calcium and magnesium, as well as vitamin co-factors such as vitamin D and vitamin B12. Theoretically, the sympathetic health conditions could be aggravated by the stress response in sympathetic dominant individuals.

Slow Metabolic Type 1 and the Stress Response

The parasympathetic mineral pattern is shown with an elevated calcium-to-phosphorus ratio indicating parasympathetic dominance via the medial hypothalamus and posterior pituitary. Low sodium and potassium levels would be indicative of decreased adrenal cortical activity. We can see the potential for chronic activation of the parasympathetic branch of the craniosacral nerves. In individuals with a parasympathetic dominance, the stress response can predominantly activate the parasympathetic branch of the nervous system via the craniosacral spinal cord contributing to excessive parasympathetic activity to the end-organs innervated by the parasympathetic nervous system.

Characteristics of parasympathetic dominance include:

Type B Personality Traits	Stress Avoidance
Reduced Metabolic Rate	Decreased Body Temperature
Reduced Blood Pressure	Depression



Health conditions we have categorized into the parasympathetic category include:

Depression	Arthritis (Osteo)
Allergies (Ecological)	A. I. D. S.
Malignancies (Tumors)	Anorexia
Diabetes (Hyperinsulinemia)	Hypotension
Hypothyroidism	Hypoglycemia
Hypoadrenia	Hyperparathyroidism
Infections (Viral)	Multiple Sclerosis (Type II)
Osteoporosis (Type II)	Sjogrens Syndrome
Ulcers (Gastric)	Premenstrual Syndrome
C. F. S.	Lupus - Scleroderma

Auto-Immunity (Humoral Immuno-Suppression)

The stress response in parasympathetic dominant individuals could contribute to and exacerbate the above health conditions.

Understanding Stress From a Metabolic Perspective

As noted previously, individuals experiencing a common stressor in a common environment can have markedly different responses or reactions to stress. We should also be aware that stress can be either physical, emotional or a combination of both. Stress can contribute to psycho-somatic conditions as well as somato-psychic conditions.

In general the sympathetic nervous system is the branch that speeds up the metabolic processes while the parasympathetic keeps the sympathetic group in check and slows the metabolism back to normal in healthy individuals. However, when one branch becomes more dominant than the other, individual characteristics emerge. As listed previously we can see the contrast between the characteristics of sympathetic and parasympathetic dominance. We can also include body type, such as the apple-shape and pear-shape. The neuroendocrine dominance contributes to these body types as well as emotional characteristics, such as type A and B personality.

Organs typically are innervated by both the sympathetic and parasympathetic nerves and can be effected by dominance of either branch depending on metabolic dominance. For example, the pancreas is innervated by the vagus (parasympathetic) and splanchnic (sympathetic) nerves. Electrical stimulation to these nerves readily affects insulin and glucagon output. Parasympathetic stimulation produces an increase in insulin release and sympathetic stimulation inhibits insulin release. Sympathetic stimulation to the liver results in activation of glycogenolytic enzymes, phosphorylase and glucose-6-phosphotase, while parasympathetic stimulation increases hepatic glycogenesis. Of course the heart rate is increased by sympathetic and reduced by parasympathetic activity. We can readily see the impact of stress on individuals depending upon metabolic dominance. Stress in the sympathetic type could result in high blood pressure, increased heart rate, elevated glucose and reduced insulin levels. Stress in a person being parasympathetic dominance may experience hyperinsulinemia, hypoglycemia, low blood pressure etc. Stress can even trigger hunger centers causing an increase in appetite or a loss of appetite.

Emotions can also be attributed to metabolic dominance. For example, sympathetic dominance is often associated with anxiety over the future, hyper-reactivity, while parasympathetic dominance is associated with fatigue, depression and worry about the past. We can also view emotional stress in two major categories that correspond to metabolic types. Emotional suppression is a conscious act of trying to deal with unwanted or troubling thoughts and emotions and is associated with sympathetic dominance. For example a person contemplating changing jobs, moving, or holding deep resentment or anger, can be extremely stressed by these decisions and the stress typically increases with time if they are not dealt with. Often the person may attempt to control or develop techniques to control anger, but until the underlying issue is resolved it lingers not only in the mind but eventually the physiology, contributing to headaches, hypertension, arthritis, and cardiovascular disease. Repression is a parasympathetic characteristic, whereby distressing thoughts or emotions are pushed deep into the subconscious mind. However, these thoughts still exist even though the person may not be aware of them and the stress of keeping them hidden contributes to stress that can manifest physically in fatigue, depression, eating disorder, arthritis, digestive conditions, or may aggravate any of the conditions listed under the health disease categories of parasympathetic dominance.

Conclusion

Stress and the stress response whether physical, emotional, environmental or a combination of these is a normal part of life and should be accepted as inescapable. There can be good stress that is positive and motivating, but distress over time affects our health and well-being and is destructive to the body and can lead to physical deterioration. In a previous paper I expanded on Selye's GAS theory to include not only the alarm, resistance and recovery stages, but also added the adaptation and exhaustion stage. Acute stress is typically initiated with the alarm response. This is reflected in HTMA patterns as an elevation of sodium-to-potassium (Na/K ratio > 5.0) that may also be associated with inflammation. The resistance phase results in other adrenal cortical hormones (anti-inflammatory) being produced to reduce inflammation and, or the alarm phase. This hormonal response results in potassium becoming elevated above that of sodium, (Na/K ratio < 1.4). In a recovery phase the hormonal cascade lessens and the sodium-to-potassium ratio returns to normal (Na/K ideal = 2.4) However, in some individuals the alarm phase can become chronic due to the inability to produce a resistance and recovery response. If this is the case, chronic inflammation can ensue. The resistance phase can also become chronic without progressing to recovery and the body begins to adapt to these long-term changes caused by chronic resistance, resulting in disease of adaptation. Eventually the exhaustion stage can develop due to the inability to recover. Each stage of the stress response requires a neuro-endocrine response that not only impacts nutritional requirements but will also contribute to nutritional imbalances. We can see from HTMA mineral patterns the effect of stress on nutritional status, which we can then provide specific and individualized therapy to counteract the effect of chronic stress or distress.