

Homeostasis and Hormonal Health

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At any given time of day, there is a constant cascade of chemical reactions occurring within the human body. These reactions can be caused by numerous stimuli, including foods consumed, thought patterns or physical demands placed on the body. These reactions can be categorised into many different types of reaction, and two of such classifications include homeostatic responses, in which the body maintains balance of all biological parameters, and stress responses, where reactions of the body are in reaction to the introduction of an external stressor.

As with all biological systems, there are a large number of highly intricate mechanisms to detect, correct and balance substance and activity levels throughout the body. These systems are multi-faceted and constantly interact with other systems; in this sense, homeostatic and stress responses do not differ.

However, homeostatic responses deal with maintaining balance around the body, mainly through hormones. These are proteins that act as chemical messengers at their specific target tissue. Homeostasis is controlled primarily by the hypothalamus, a gland within the brain that is constantly sensing hormonal levels of the blood to ensure the levels are correct to maintain the correct rate of heat production, water balance and cellular activity. From this point, messages are sent a short distance to the pituitary gland, which acts as a director by manufacturing and then releasing its own hormones that target other endocrine glands such as the thyroid, liver, pancreas, adrenals or testes/ovaries. Other endocrine glands include the pineal gland, parathyroid gland and thymus gland.

Whilst the pituitary gland makes its own hormones, it is still only carrying out the instructions it receives from the hypothalamus. The 'third layer' and frontline gland in this system would be any one of the glands that act on cues from the pituitary; these are the glands that release hormones that moderate the function of the body and its cells. An example of a daily homeostatic response is balancing sex hormones. Beyond simply controlling libido and sexual function, hormones like oestrogen and testosterone cause powerful interactions in the striatal cortex of the brain, the area that determines mood, energy, personality – essentially, almost everything that makes us the person we are. In a man, the HPTA (hypothalamic pituitary testicular axis) is the key to maintaining balance of such an important system. The hypothalamus senses the serum levels of an array of hormones, and signals accordingly. For example, it is constantly measuring free testosterone and, should it drop to sub-optimal levels, releases GnRH (gonadotrophin releasing hormone) as a signal to the pituitary gland; in response, the pituitary gland then releasing both LH (luteinizing hormone) and FSH (follicle-stimulating hormone) which stimulate the testes into action.

With such an intricate system constantly at play, there can be times where homeostasis is disrupted. Where this happens, the only excess/deficiency felt by the individual would be

the frontline hormones (eg. testosterone) as these are the tissues that directly act on tissue; however, an individual will not feel a deficiency of LH or GnRH. Because both of these can be affected by dietary deficiencies, fatigue and stress (as well as gland dysfunction), a number of factors must be considered before an attempt to re-establish a beneficial state of homeostasis is attempted. Too often, doctors dabble with the frontline hormones without dealing with the core problems upstream, leaving the patient at the mercy of a damaging imbalance of powerful hormones. This one-dimensional folly can be seen in action in the field of testosterone replacement.

The hypothalamic-pituitary axis is involved in all hormonal production and balancing so, naturally, this includes hormonal fluctuations triggered during the stress response. Whilst stress responses are controlled through the same mechanisms, they do not work purely through the same 'layered' loop system for constant feedback. Whilst there is a stress-induced preferential shift in hormone production through the hypothalamic-pituitary axis towards more adrenal output (which affects all other 'downstream' endocrine glands), there is also a significant part played by the central nervous system. When the body reacts to stressors, the hypothalamus sends nervous impulses to the sympathetic centres in the spinal cord (the sympathetic nervous system, sometimes referred to as SNS, is the reactive part of the nervous system. Following a stressful reaction, the parasympathetic nervous system, or PNS, 'calms' the body to counter the changes). These sympathetic centres stimulate the splanchnic nerves and the adrenal medulla, which increases production of epinephrine (eg. adrenaline) and norepinephrine. These chemicals are anti-inflammatory and help the body deal with stress through a number of methods; increase in heart rate and blood pressure, vasodilation of blood vessels around the body, increased sweating, slowing of digestion, dilation of airways, a priming of the immune system and increase in glycogenolysis. This cascade of changes is often labelled the Fight or Flight response, as the combination of changes prepares the body to engage in combat or flee.

This is a perfect example of Allostasis (or an 'allostatic response'), whereby the body maintains internal stability through change. Whereas homeostasis describes the ongoing regulation of internal systems within a defined range, allostasis is the altered regulation of the same systems to suit an altered environment. Homeostasis is the basis of long-term health; allostasis allows the body to deal with hunger, extreme temperatures, sleep deprivation, dehydration and other stresses.

An allostatic response facilitates an altered hormonal balance to deal with a variety of changes but, for us and our clients, will be called upon most often in times of psychological stress. This particular response is often labelled the Stress Response. Beyond the more instant Fight or Flight reaction mentioned above, the hypothalamus stimulates the pituitary gland to release hormones that can help in a stressful situation. This includes hGH (Human Growth Hormone), which stimulates the liver to increase the level of fatty acids and glucose in the blood, and ACTH (adrenocorticotrophic hormone), which increases production of many hormones, especially aldosterone and cortisol, which is itself often labelled the body's 'stress hormone'. TSH (thyroid stimulating hormone) is also released, which increases cellular activity and catabolism to help produce more energy to deal with the immediate requirements.

What follows the adrenaline-fuelled first phase of a Stress response, which typically lasts

for several minutes, is the more prolonged second phase of the stress response, dominated by cortisol. This stage can be seen as a stage of compensation, and typically it reverses the unsustainable changes that occurred during Fight or Flight – that is to say, there is suppression of our immune systems, lipolytic hormones are deactivated and replaced with lipogenic equivalents, and circulation is decreased. These are all typical examples of disturbed homeostasis that affect our clients on a daily basis, and can make our dietary and exercise suggestions less effective. We have evolved with an ability to alter function when required through over-stimulating organs, and compensate for this afterwards. This is allostasis in action. When employed with the regularity that nature intended, this adaptive hormonal response works in tune with the homeostasis response to promote long-term health.

However, if the short-term emergency responses are deployed repetitively, there may be an inadvertent shift in the activities of the body. This is where homeostasis is disturbed through the stress response; an allostatic shift has occurred. A homeostatic response is now required in order to return to 'normality' (although a stressed individual may not be able to remove themselves from the stressor, ensuring this remains impossible).

Homeostatic responses work by detecting the optimal level of a substance then establishing this balance, maintaining it long-term. There will always be levels at which there is too much or too little of a substance, and the job of the hypothalamus is to ensure that the level remains between that and so only needs to act when the readings are outside of these parameters. This ensures long-term health.

Allostatic/stress responses, however, work in the opposite way. Generally, they will affect a chemical that has been previously stabilised by the hypothalamus, increasing/decreasing it to levels otherwise considered unbeneficial. These extreme changes are to allow the body to deal with extreme changes and stress response is generally a short-term mechanism and is designed as such; repeated exposure to stress causes major imbalance. Put another way, stress response ensures short-term survival but are not conducive to good health in the medium- or long-term.

An example of unsustainable allostasis is that of adrenal fatigue, whereby these small triangular-shaped glands increase their output to deal with increased external stressors but, following a prolonged and excessive workload, begin to fail. The result is decreased adrenal output, an insufficient response to external stimuli and stressors (impaired allostasis) and multiple effects across many different organs in the body. These effects on other organs show how 'frontline' endocrine glands are not simply slaves to the hypothalamic-pituitary axis, but that they also share some complex interaction.

For example: the testes/ovaries require not only the hormonal stimuli from the pituitary hormones LH/FSH to do their job, they also require a steady supply of DHEA (dihydroepiandrosterone) from the adrenal glands. For the testosterone/estrogen to have the desired effect, there must be a balanced production of SHBG (sex hormone binding globulin) at the liver. This is just one aspect of a multi-faceted hormonal network.

Prolonged allostatic responses are measurable in clients who display insulin resistance, where the body responds to excessive carbohydrate intake by continually over-secreting insulin; and increased liver enzyme counts, where the liver is forced to over-use specific

resources when toxic load overwhelms its natural capacity. As the liver is involved in everything from blood sugar regulation and hormone deactivation to immune function and digestion, a departure from homeostasis in this manner could show symptoms at quite some distance from the source.

What all these biological reactions have in common is that the body is capable of adapting to the imposed load (be it high external stress, massive doses of sugar or the toxins contained in a typical takeaway), but this does not mean that long-term health can be sustained if these loads are continually imposed. Protracted allostasis will have deleterious health effects, many of which (eg. cholesterol levels and blood pressure) are measurable. In the case of high blood pressure, this is not to say the sympathetic nervous system/kidneys/etc are 'broken', just employing an evolutionary response to cope. Considering issues from this angle shows why using drugs to 'fix' inappropriate biomarkers into what we think are normal levels is ineffective.

We, as trainers, can ensure that we advise our clients to avoid pushing their body into protracted allostasis. Regular consumption of stimulants such as caffeine and sugar, or metabolic intruders such as alcohol and drugs, will do this. Clients should do their best to avoid perhaps the biggest disruptor of all, stress hormones (so this means a good night's sleep and stable blood sugar levels). We should also provide positive stimuli – enough of the right exercise, but not too much – and sufficient raw materials that are essential for all organs at all layers of homeostasis.

By understanding the various fluctuations and what they mean, we can give more appropriate advice when we are faced with clients who are homestatically disturbed/hormonally imbalanced. For example, a male client with a low free testosterone count may feel better if his doctor gives him androgenic hormone replacement, but will this restore him to optimal health if – to refer to the examples given above - the root cause was low levels of DHEA at the adrenal glands, or excessive cortisol suppressing the hormonal output at the pituitary? Or if it resulted from excessive SHBG production at an over-taxed liver? If a client is stuck in allostasis, replacing one hormone will not redress the source of imbalance.

In almost every case, if a client presents with saliva tests that show high levels of cortisol, this does not mean they have a genetic disposition to pump out three times more stress hormones than others. The same rules apply to clients with high blood pressure. Or high LDL cholesterol. These long-term issues generally progress from allostatic shifts, short-term adaptations to help them deal with an unnatural environment (by which I mean their physical environment, as well as their daily schedule and food intake). Problems occur when the body continues to perceive this environment as unnatural. So don't try to change the client, change their environment!

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