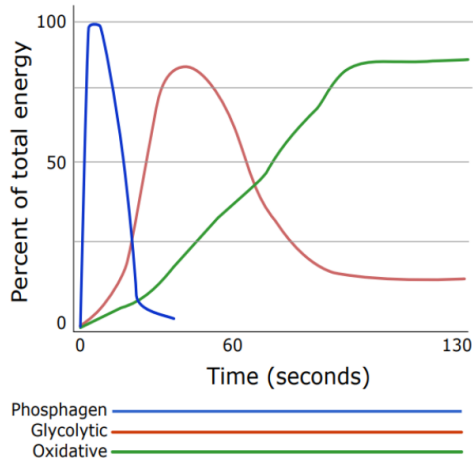


Neuroendocrine Adaptation - Your "End-Run" Around the Menopause Transition

by Carla DiGirolamo, MD



Exercise is a physical stress that challenges homeostasis (physiologic "balance" or "equilibrium"). In response to this physical challenge, the body **responds to re-establish this physiologic balance.** This response is called **neuroendocrine adaptation.**

The **response of the body** to a stressor is **complex** and involves the **cerebral cortex** (brain), **brain stem** ("instinctual"

center), activation of the **sympathetic nervous system** ("fight or flight" response), two integrated endocrine systems involving the hypothalamus in the brain (H), pituitary gland (P) and adrenal (A) glands (**HPA axis**) as well as the reproductive (G) system (**HPG axis**) and the **immune system** (proinflammatory cytokines). Synchronized activation of these pathways occurs in response to **chronic** (ongoing) **stressors or transiently** in response to a specific task, such as **exercise or sport.** The goal of this response is to **return the body to a stable equilibrium, or adaptation.**

Here is a **quick primer on the main hormonal players** in the neuroendocrine response system:

- **HPA Axis:** Brain/brain stem (asses the task): Corticotropin Releasing Hormone (**CRH**) —> Pituitary gland (Adrenocorticotrophic Hormone (**ACTH**) (also growth hormone,

prolactin, and vasopressin) —> Adrenal glands (**Cortisol, Testosterone**).

- **HPG Axis:** Brain/brain stem (**endorphins, (GNRH)**) —> Pituitary gland (Follicle stimulating hormone (**FSH**) and Luteinizing Hormone (**LH**)) —> ovaries (**Estrogen, Testosterone**).
- **Sympathetic Nervous System:** Brain/Brain stem (endorphins, CRH) -> Pituitary Gland (**ACTH**) —> Adrenal Glands (**Norepinephrine, Epinephrine, Cortisol**, other glucocorticoids).
- **Immune System:** Tumor necrosis factor-alpha (**TNF-alpha**), Interleukin-1 (**IL-1**), and Interleukin 6 (**IL-6**):
Initially **augments** the above pathways, then **inhibits** them once the response nears completion to “**reset**” the system. These pro-inflammatory cytokines also aid in **tissue repair**.

Once the neuroendocrine **response system is activated**, this cascade of responses is elicited so that the body can **execute the task/answer the stressor** effectively.

In the case of exercise, the **neuroendocrine adaptation** that results from effective response to training **achieves a new, fitter, stronger, faster equilibrium**. The **ability of the body to adapt** to a training stimulus is a **key component** of gaining **physical fitness!**

During the **menopausal transition**, ovarian production of **estrogen and testosterone declines**. As a result, we see a **reduction in muscle mass, power, and function**. However, when the **neuroendocrine response pathways** are activated by exercise, it elicits a **response to the training stressor** which, when effective, **results in adaptation** which is your fitter, stronger, faster equilibrium.

***Neuroendocrine stimulation and adaptation** become more critical during mid-life when our baseline hormone levels that promote muscle mass, function, and bone density are in decline. The neuroendocrine response pathway provides **a way to compensate for the declining estrogen** stimulus that comes with the menopausal transition.*

To understand the **basis of neuroendocrine adaptation**, let's take a closer look at the **metabolic systems** that provide energy for all types of physical activity.

Three Metabolic Energy Systems

There are 3 metabolic pathways that provide energy for every type of human activity:

- **Phosphocreatine Pathway:** Utilizes **creatine phosphate** to fuel movements lasting **< 10 seconds** (ex - a 1 rep maximum deadlift). Does not require oxygen (**anaerobic**).
- **Glycolytic Pathway:** Utilizes **glucose** stored in the muscles (predominantly **anaerobic**) to fuel moderately powered movements **lasting up to several minutes** (ex- a 1-2 min high intensity running interval).
- **Oxidative Pathway:** Utilizes **carbohydrate, fatty acids, and protein** to fuel low-powered, **longer-duration activities** in excess of several minutes. Requires oxygen (**aerobic**). (ex - long endurance run).

Building **competency** with movements in **all three pathways** sets the stage for developing the **adaptive ability** to **move among these pathways** in short periods of time.

How to Stimulate Neuroendocrine Adaptation

- **Train with functional movements:** These are **complex movements** that require the **recruitment of multiple muscle groups** by the nervous system and coordination using the brain, sense of balance, and body control. An example would be a **barbell squat** as compared to a leg press machine. Other functional movements include **push-ups, pull-ups, jumping, rope skipping, box/bench triceps dips, and running**, to name a few.
- **Mix it up!:** Moving between **different metabolic energy systems** in a short period of time requires a **high level of**

neuroendocrine stimulation and adaptation. An example would be a workout that prescribes 5 heavy deadlifts (Glycolytic pathway) and an 800m row or run (Phosphorylative pathway) performed in sequence 5 times.

- **Interval Training: High-intensity** training with **intervals of work** alternating with **intervals of rest**. An example would be **sprint interval training (SIT)** with 30 seconds of maximum effort alternating with 30 seconds of rest or a classic **Tabata** with 20 seconds of maximum effort and 10 seconds of rest.
- **Low repetition, heavy barbell lifts:** Performing **heavy barbell lifts** for 5 sets of a **1-3 repetition maximum** (with solid technique!) with 3 minutes of rest between sets stimulates the **phosphocreatine** pathway.
- **Try something new!:** If you are a CrossFitter you have undoubtedly experienced looking at the Whiteboard outlining the daily workout and **getting a little bit nervous because there are movements you may not have done** before. This is a good thing! That nervous feeling is your sympathetic nervous system ramping up before you even start the workout!
- **Constant Variation in Movement:** The Human body has an amazing **ability to adapt to repetitive movement**. Once the body has adapted to a certain movement pattern, performing those same movements does not elicit the same level of neuroendocrine stimulation as compared to the first time they were performed. When **movements vary**, it **“keeps the neuroendocrine system guessing”** and **adapting** to each new stimulus.

A Word About Chronic Stress and Over-Training

The **neuroendocrine response** described thus far is **transient** for the time required to complete the physical task. Once the task is completed, the hormones and cytokines **return to baseline in about 30 minutes**.

Following this period, a new fitter, faster, stronger equilibrium is achieved as the **tissues recover, repair, and rebuild**.

In some cases, such as **over-training, chronic energy deficits, sleep deprivation, and life stress**, the neuroendocrine responders do not return to baseline. Instead, there is **chronic activation** of the neuroendocrine pathways and pro-inflammatory cytokines that results in **insufficient tissue repair and rebuilding** that cannot “catch up” with the ongoing stress. When the next stimulus is encountered, the **ability to adapt** is impaired and the **fitter, faster, stronger equilibrium is not achieved**. As a result, **muscle health suffers, injuries develop, and performance declines**.

Mid-Life women are **particularly sensitive** to the effects of chronic **cortisol** stimulation underscoring the importance of **managing chronic stressors** so that the system can return to baseline and **allow sufficient tissue recovery and repair** so that you become fitter, faster, and stronger with every training session. Here are some **tips for dialing down the stress response**:

- **Sleep** - The foundation of recovery.
- **Proper fueling** - Stay out of that energy deficit!
- **Avoid over-training** - Work with a coach. Design a program with shorter duration/higher intensity and more productive training sessions that incorporate a variety of movements that build fitness in all 3 metabolic energy pathways.
- **Massage, bodywork, mobility movements, tissue care** - make friends with the foam roller and the cold shower.
- **Yoga, meditation, mindfulness** - Where your mind goes, your body will follow.
- **Consider Adaptogens**: Adaptogens are derived from plants and help manage the stress response. For a great description of various adaptogens and their effects, check out [Next Level](#) by Dr. Stacy Sims and Selene Yeager.

By incorporating **variability in movement and intensity** and effectively **managing the stress response** following training, you will keep your neuroendocrine response system sharp and ready to adapt so you can achieve **your fittest, fastest, strongest self!**

References

1. **Exercise and the Stress System, Mastorakos, G et al. *Hormones* 2005 4(2) 73-89**
2. **Forging Elite Fitness. Glassman G; *CrossFit Journal* June 2003.**