

# Supplement Performance

By Sebastian Balcombe, BSE, NSCA-CPT and Anssi Manninen, MHS

## Pre-Exercise Supplementation

### Part 1: Central Fatigue

**B**y timing nutrient intake through pre-exercise supplementation, you can prime your body for consistently better workout sessions, leading to better results. While daily supplements and post-exercise formulas certainly can be effective, they have their limitations. Conversely, the right pre-exercise nutrients target and support the physiological responses occurring during exercise, providing benefits that other supplements do not.

Some of the physiological responses to exercise include increased neural activity, which enhances muscular contraction and mental function; accelerated blood flow, improving nutrient and hormone delivery to muscles; increased cell receptor sensitivity, allowing key chemical compounds (e.g., glucose and amino acids) to enter the cells more efficiently, maximizing their effects; and a boost in metabolic rate. Each of these physiological responses can be aided by proper pre-exercise supplementation.

Now that we have established some of the many reasons why pre-exercise supplementation is so important, we will be discussing many of these physiological responses that affect exercise performance through two articles. Part 1 focuses on fatigue occurring at the central nervous system (CNS) and how the right pre-exercise supplementation can target and fight it, allowing you to stay energized and intense throughout your workout session.

#### Just Say "No" To Carb Loading

Ideally, during exercise, personal records are broken, strength and endurance gains are made and bigger muscles are born. But all too often, sluggish muscles and low energy form a brick wall—stopping or slowing these results. Fortunately, new scientific research has created powerful new weapons to defeat these enemies. Even if you've only casually followed the latest advancements in

sports nutrition, you know that advancing at the leading edge of difference-making formulas are pre-exercise supplements. But what we are about to talk about isn't another one of yesterday's carb-loaded, pre-exercise powders. Rather, we are talking about pre-exercise supplementation that is specifically designed to target and support the neurological systems during exercise, creating a pre-exercise environment in the body that boosts intensity, strength, focus and fights the different types of fatigue.

#### The Importance Of Pre-Workout Supplementation

While exercise scientists are well aware of the importance of post-exercise nutrient timing, the advancement of pre-exercise supplementation is only now beginning to make its presence felt. And why shouldn't it be on the cutting edge of supplement research?

Without powerful, energy-fueled workouts, results just don't happen. Poor workouts make post-exercise nutrition almost pointless, don't they? The facts are this: Results from your workouts come from intense, focused workout sessions, which simply don't occur if the body is not sufficiently primed for them. So wouldn't it be nice if we could simply ingest certain nutrients

15-20 minutes prior to exercise and be able to work out harder and not feel as fatigued?

That's precisely what the right pre-exercise supplementation can achieve—greater energy, less fatigue and more power and stimulation to your muscles. It can also give you greater mental focus and concentration, more intensity and better recovery. But to understand exactly how this happens, we first need to understand the limiting factors in our exercise performance. Among the more familiar ones are diet, energy production within muscle and hormonal environment, to name a few. But perhaps the most overlooked factors are CNS and peripheral nervous system (PNS)

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fatigue. In this article, we'll focus on CNS fatigue and how the right pre-exercise supplementation can decrease it, allowing for more effective, result-producing workouts.

## CNS Fatigue

Let's start with CNS fatigue. Ever wonder why some days you simply can't train at the intensity you would like? Your diet hasn't changed, yet you can't train as hard and you feel much more fatigue from the same workout that you blasted through only weeks before. So what's causing this plummet in performance? Well, research has shown that your psychological state can actually affect how many motor units are recruited. (A motor unit is a motor neuron and all of the muscle fibers it innervates. The more you activate, the more muscle fibers are stimulated, making you stronger and more powerful.)

Simply put, your state of mind can determine your levels of strength, and you know that your state of mind can be vastly different on a day-to-day basis. In other words, how you feel mentally affects your exercise performance, your levels of fatigue and ultimately, your progress. To perform at your best, from a neurological standpoint, it is vitally important that you have an optimal amount of what is called central nervous system "arousal." This is when your brain is stimulated to the point of reaching the ideal environment—"the zone" as some call it—for maximal production and minimal fatigue. The key is reaching an optimal state; too little arousal and performance plummets, but having too much arousal can lead to lack of focus and actually worsen performance.

The major players in nervous system arousal, the factors that promote this optimal "zone," are a class of neurotransmitters called catecholamines, namely epinephrine (adrenaline), norepinephrine (noradrenaline) and dopamine. All act as central motor stimulants and affect performance both indirectly by stimulating the nervous system and directly by exerting their effects on muscles. This close relationship between certain nerve cells, neurotransmitters and hormones has brought about what's now dubbed the neuroendocrine system (nerves that produce neurotransmitters that have both neural and hormonal functions).

## Pre-Exercise Supplements To Fight CNS Fatigue

Exercise is actually one of the best ways to stimulate the neuroendocrine system and boost these beneficial neurotransmitters, though exercise is a double-edged sword. While exercise stimulates these neurotransmitters it also depletes them, which is a large reason why you feel mental fatigue during exercise. From a dietary standpoint, it is obvi-

ously imperative to supply your body with adequate carbohydrates to promote an optimal psychological state, but there are also supplements that can potentially improve that state. More importantly, these supplements can not only get you in the zone, but can keep you there longer by minimizing the depletion of these vital neurotransmitters and also by stimulating their release.

One of these supplements is tyrosine. In fact, the neurotransmitters epinephrine, norepinephrine and dopamine are all derivatives of the amino acid tyrosine, underscoring the importance of tyrosine for optimal neurological function. Tyrosine at the proper dose has been shown in human studies to improve performance, mood and psychological function under stressful physiological conditions such as exercise. It can also improve cognitive function, enhancing focus and concentration. Many of these positive attributes of tyrosine are believed to come from its ability to manufacture these neurotransmitters and prevent their depletion during exercise. This makes tyrosine an ideal pre-exercise compound, but only in the proper dosage (2-3 grams) and timing (prior to exercise).

So now in tyrosine we have an amino acid that supplies the raw material for your body to make performance-enhancing neurotransmitters, and we know that exercise itself can release them. But the idea of pre-exercise supplementation for workout enhancement becomes even more interesting when further synergistic compounds are added. One of these compounds, and a very powerful one at that, is caffeine.

Caffeine stimulates the nervous system by triggering the release of epinephrine from the adrenal glands and by indirectly blocking a chemical in the body called adenosine, which has calming effects on the CNS. Remember, there is an optimal level of nervous system stimulation, so taking too much of a stimulant such as caffeine can actually worsen performance. Finding the correct dose and ingesting it with proper timing can aid greatly in helping you achieve the optimal state for the most intense and focused training sessions. What's the most effective dose and timing? Research on caffeine shows effective doses in the range of 1.8mg to 4mg per pound of bodyweight, taken about 30 minutes prior to exercise.

The branched-chain amino acids (BCAAs) are crucial for gym rats looking to increase both anabolism (muscle building) and decrease catabolism (muscle breakdown). But their benefits don't stop there, as research suggests they may also be able to boost performance by fighting central fatigue. While BCAAs' potential ability to fight central fatigue is not well understood, one theory referred to as "The Central Fatigue Hypothesis" has emerged as one of

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## Placebo Controlling In Ergogenic Studies

By Anssi Manninen

The placebo effect is a favorable performance outcome derived from the belief that a beneficial treatment (e.g., dietary supplement) has been received. In other words, an athlete's belief regarding what the ingested substance might do could influence his performance. The "gold standard" in scientific research is the prospective, randomized, double-blind, placebo-controlled study. In a double-blind experiment, neither the individuals nor the researchers know who belongs to the placebo group and the experimental group. Only after all the data are recorded do the researchers learn which individuals are which. In many cases, a double-blind study is an effective way to lessen the influence of the prejudices and unintentional physical cues on the results. However, sometimes it's simply not possible.

For example, it is hardly possible to conduct a placebo-controlled study on beta-alanine due to the strong tingling sensation after ingestion. Similarly, studies that have evaluated the effects of various strong stimulants (amphetamine, ephedrine, etc.) were not truly placebo controlled. The same applies to most if not all anabolic steroid studies using intramuscular injections, as they utilized water-soluble placebo. It is the oil-based substance that causes the post-injection soreness, not the injection per se. And a water-soluble substance hardly causes any soreness, unless one sticks it in his eye. This creates strong information bias ("Cool, I'm getting the real stuff, as my behind is sore!"), decreasing the scientific value of such studies.

the more popular theories.

In a nutshell, the theory looks like this: Exercise has shown to increase the tryptophan/BCAA ratio, partly due to BCAAs being used as fuel in the muscles during prolonged exercise, depleting their levels. TRP is a precursor to the neurotransmitter serotonin. By exercise depleting BCAAs, there is a possible increase in the tryptophan/BCAA ratio, allowing more tryptophan into the brain, increasing serotonin production. Increased serotonin levels are thought to cause the perception of fatigue to increase and performance to decline.

The theory states if you increase your BCAA intake, the ratio of tryptophan to BCAAs is decreased and we will experience less fatigue and perform better as a result. Some studies support this theory and show performance gains from BCAAs, while others show no performance gains. Based on the current research, it's difficult to draw firm conclusions if BCAAs do in fact decrease fatigue based on the central fatigue hypothesis. Regardless, you can't go wrong taking BCAAs pre-exercise, as they are beneficial from a muscle-building standpoint.

A final, and very compelling, compound is a supplement known as trimethylglycine (TMG), which contains a methyl component that is used to synthesize a substance called SAME. SAME, like tyrosine, is also used to make catecholamines such as adrenaline and dopamine. Add it in with tyrosine, caffeine and BCAAs and you have a recipe for increasing mental and physical stimulation, delaying fatigue and increasing exercise performance. Furthermore, subjects have

described an improvement in a general sense of well-being.

In Part 2 of the "Pre-Exercise Supplementation," we will discuss fatigue occurring at the peripheral nervous system and the best supplements to target and fight it, allowing you to push past workout barriers and maximize your results. Stay tuned! <sup>n</sup>

*Sebastian Balcombe is the owner of Athletic Edge Nutrition. Anssi Manninen has no financial interest with companies selling pre-exercise supplements.*

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## Pre-Exercise Supplementation

### Part 2: Peripheral Fatigue

**In** a perfect world, you would be motivated to work out at least three to four times a week, you would feel energized at every workout session and you'd feel intense, focused and ready to push yourself a little more than your last workout. Ideally, over a few months, you would really start to see the results you were working so hard for and your goals and dreams would start to become reality. Unfortunately, your exercising life doesn't always work out quite the way you planned it. And although there are many reasons why you're not making progress in your training and reaching your goals, a large reason is due to fatigue.

Fatigue, at both the central (brain) and peripheral (nerves and muscles) level, is a major limiting factor that is stopping or slowing you from blasting through your workouts feeling energized, strong and focused. Defined simply, fatigue is the inability to maintain a power output or force during repeated muscle contractions. We've all felt fatigue, some days more than others. Some days we feel fine, but just aren't making progress in our workouts. That's because fatigue can operate below the conscious surface, and through a series of chemical reactions (or lack of reactions), we could actually be functioning at a level well below baseline. This can lead to fatigue, lack of motivation, workout plateaus and overall, generally impede us from getting the best

results from our workouts.

In part one, we explained central fatigue and the factors that affect it, which in turn affect exercise performance. We also discussed the benefits of important pre-exercise supplementation and how effective it can be at combating central fatigue. In fact, specific nutrients, ingested prior to exercise, assist in creating an optimal mental state that consistently fuels training progress. They put you in the "zone."

**Specific nutrients, ingested prior to exercise, assist in creating an optimal mental state that consistently fuels training progress.**

Specifically, it's a group of neurotransmitters, members of the neuroendocrine system that, when stimulated, promote optimal exercise performance and fight fatigue. With a solid understanding of the nutrients that fight off central fatigue, you can help your body achieve a peak mental state for every workout, consistently maximizing your progress and forcing results.

#### **Peripheral Fatigue**

Central fatigue isn't the only enemy, however. Peripheral fatigue, or

fatigue outside the central nervous system, can also make you feel weak and tired, but for different reasons. Fortunately, peripheral fatigue can also be attacked, with the right nutritional approach. Unlike central fatigue, which is primarily controlled by chemicals in the brain, peripheral fatigue is primarily affected by neural, mechanical and energetic factors within or around the muscle. We'll focus on neural factors and, specifically, two sites of neural fatigue: the neuromuscular junction and the sarcolemma. These are two hot spots that determine the strength of a muscle contraction, and fortunately they, too, can be influenced by the right pre-exercise nutrients, potentially making you stronger and more powerful at every workout.

Before we discuss how pre-exercise nutrients can boost your strength, let's review the properties of a motor unit. Each skeletal muscle cell is connected to branches of nerve cells called motor neurons coming from the spinal cord. By definition, a motor neuron and all the muscle fibers it innervates is called a motor unit. Just as the name motor neuron suggests, these are nerve cells that stimulate or drive muscular contraction. However, at the site where the motor neuron and muscle cell meet, there is no actual contact. Instead, we arrive at what's known as the neuromuscular junction. This is where a traveling nerve impulse, when it reaches the end of

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the motor nerve, causes a release of the neurotransmitter acetylcholine, which then crosses the neuromuscular junction and enters the muscle cell. It's acetylcholine that triggers the chain of events that leads to powerful muscular contractions.

## Ultimate Combination For Acetylcholine Synthesis

So, acetylcholine is a critical neurotransmitter in the peripheral nervous system. If it doesn't travel across the gap between the motor neuron and the muscle cell, there is no muscular contraction. Recent research shows diminished acetylcholine levels with exercise could be a contributing cause of muscular fatigue and poor workout performance. So, ensuring adequate acetylcholine levels could be crucial for optimal muscular performance. But acetylcholine is not a one-trick pony! It not only impacts the muscles, as we just discussed, but it's vital to brain function, too. (As discussed previously, brain function and the mental aspects of training is every bit important as muscular performance.) Thus, acetylcholine serves double duty, affecting muscular contraction and neurological processes, both of which are essential components of exercise performance.

You might be wondering if there are ways to provide the body with substances that can act as precursors to acetylcholine and the answer is YES! Two such nutrients that act as acetylcholine precursors are L-alpha-glycerylphosphorylcholine (alpha-GPC) and acetyl-L-carnitine. Alpha-GPC is a highly advanced delivery form of choline. By providing the choline component, it acts as a precursor to the formation of the all-important acetylcholine. (Remember, once it reaches the muscle cell, the cascade

of events that lead to muscular contractions start.) With acetyl-L-carnitine, a substance with a large range of neurological and potentially hormonal effects, the results are similarly prolific. This unique form of carnitine is able to cross the blood-brain barrier and act as an acetylcholine precursor by donating its acetyl group. Combine a deliverable form of choline from alpha-GPC with an acetyl donor from acetyl-L-carnitine, and you create the ultimate combination in precursors for acetylcholine synthesis.

## Fight Free Radicals With Antioxidants

So far, everything up to this point has described the process happening between the nerve and the muscle cell. But the potential for fatigue doesn't end there. Fortunately, neither does our ability to fight it. Another site of peripheral fatigue is the calcium storage sites known as the sarcoplasmic reticulum (SR), another step in muscle contraction.

Before we get into why this is a trouble spot, and what you can do to target it, bear with us while we give a brief description of what this is and what it does. For those of you who aren't interested in all of the science and just want the bottom line, don't worry...it's coming soon! The SR is located within a portion of the cell membrane called the sarcolemma, which surrounds a muscle cell. Once the muscle cell is initially stimulated by acetylcholine, this stimulation or excitation, travels deep into the muscle cell and reaches the SR. When the SR is stimulated, it releases calcium, allowing the two protein filaments—myosin and actin—to interact and shorten, causing a muscle contraction. This whole sequence of events, though highly summarized, beginning from the nerve impulse to the actual shortening of the muscle cell is called

“excitation-contraction coupling.”

Scientific research has soundly established that tissue damaging, reactive oxygen species (ROS) called “free radicals” are increased during exercise. While free radicals are a necessary process of physiology, recent studies have shown that elevated levels during exercise may actually contribute to muscular fatigue. One theory suggests that free radicals contribute to fatigue by damaging the SR, causing less calcium to be released. Quite logically, this could greatly interfere with and diminish optimal muscular contraction.

One way to fight elevated free radical production during exercise is by increasing your intake of antioxidants such as vitamin C or plant extracts such as green tea or grape seed extract. Green tea is one of the most effective sources, boasting a huge range of powerful antioxidants called catechins. Catechins have been shown to generate a wide array of antioxidant activity and are able to fight many different types of free radicals. Few plants can compare to green tea extract.

## Beta-Alanine Delays The Onset Of Neuromuscular Fatigue

Another highly effective ingredient that has repeatedly been shown in research to delay the onset of neuromuscular fatigue is beta-alanine. As we exercise, our energy systems and lactic acid release hydrogen ions (H+). Hydrogen ions cause our muscles' pH to drop (become more acidic). A decrease in muscular pH interferes with the muscular contraction process in multiple ways. Beta-alanine delays neuromuscular fatigue by boosting a powerful H+ buffer in our muscles called carnosine. Boosting carnosine levels helps stabilize muscular pH and

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delays the onset of neuromuscular fatigue. While beta-alanine isn't necessary a preworkout supplement, as it needs to be taken continuously to build up carnosine levels, it is relevant to mention it, as it does impact performance at the neuromuscular level.

## Summing Up

We know that fatigue is our enemy, getting in the way of optimum workouts and rapid gains. We've identified two types of fatigue— central and peripheral. Central fatigue, originating in our brain and central nervous system, affects our mental state, or how we feel and has real and profound effects on our physical performance. Stimulants (such as caffeine) and adrenaline precursors (like tyrosine and TMG) may combat central fatigue, making us feel better and ultimately

perform at our peak. Peripheral fatigue, on the other hand, is occurring between nerves and our muscles. The latest research suggests that diminished acetylcholine and impaired SR functioning caused by exercise-induced free radical production can be contributing factors to peripheral fatigue. Nutrients such as alpha-GPC, acetyl-L-carnitine, antioxidants such as green tea and beta-alanine help fight peripheral fatigue, helping us stay energized and focused, maximizing our workout sessions.

Combining the information from these two articles, hopefully you were able to get a clear picture of the importance of pre-exercise supplementation and how critical it can be in helping you achieve your fitness goals. We believe pre-exercise supplementation, along with a post-

workout supplement, should be a staple to anybody who is serious about working out and making progress. With the right pre-exercise nutrients, you can have a profound effect on central and peripheral fatigue though neuroendocrine support, neurological support, neuromuscular support and antioxidant support.

In summary, the nutrients that affect central and peripheral fatigue, reviewed this month, and last month, are:

- Tyrosine
- Caffeine
- TMG
- Alpha-GPC
- Acetyl-L-carnitine
- Antioxidants
- Beta-Alanine <sup>n</sup>

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