ISSUE 2, VOLUME 9 · JUNE 21 2023

# FRIENDS OF NVT

OFFICIAL NEWSLETTER OF INNEURACTIVE

## INTRODUCTION

Welcome to Issue 2, Volume 9 of the Friends of NeuroVisual Training Newsletter! In line with our mission, we continually strive to deliver the latest findings, insights, and practical applications of NeuroVisual Training. Our goal is to empower you with knowledge and techniques to optimize injury prevention, rehabilitation, and performance enhancement, all at no cost.

This issue dives deep into an exciting discussion about muscle physiology, specifically dissecting the fascinating world of extraocular and skeletal muscles. These muscles, although performing different roles, share intriguing similarities and boast unique differences. These characteristics play an integral part in our visual perception and subsequent motor responses. Understanding them better can offer fresh perspectives on how to augment NeuroVisual Training protocols.

The 'How To' section of this issue offers an interactive journey into the world of pendulum based NVT. We illustrate how pendulums, everyday objects that symbolize principles of motion, gravity, timing, and inertia, can be ingeniously incorporated into NVT. By following our step-by-step guide, you can design effective pendulum drills that not only boost NeuroVisual skills but also inject fun into your training routines.

We hope this issue offers a compelling read and provides actionable strategies to enrich your NVT practice. We appreciate your continued support in our mission to enhance understanding and application of NeuroVisual Training.

### WHAT'S IN OUR LATEST ISSUE:



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# Similarities and Differences Between Skeletal and Extraocular Muscles

Skeletal and extraocular muscles differ considerably in their physiological and biochemical characteristics. For those familiar with skeletal muscle physiology, biochemistry, exercise physiology, and pathophysiology, the transition to understanding extraocular muscles introduces several distinct and fascinating differences. Here are 13 key differences between these two muscle types, each contributing to their unique functions:

1. **Muscle fiber type:** Extraocular muscles are composed primarily of fast-twitch fibers, while skeletal muscles contain both slow- and fast-twitch fibers. The extra ocular muscles move their load quickly and are somewhat fatigue resistant. Their load is also generally isotonic.
2. **Innervation:** Extraocular muscles are innervated by cranial nerves, while skeletal muscles are innervated by spinal nerves.
3. **Contraction speed:** Extraocular muscles contract much faster than skeletal muscles.
4. **Fatigue resistance:** Extraocular muscles have a higher resistance to fatigue than skeletal muscles. This is a function of fiber type along with a larger energy production apparatus.
5. **Mitochondrial density:** Extraocular muscles have a higher density of mitochondria than skeletal muscles. This helps supply energy to the muscles and supports the fatigue resistance of the extraocular muscles.
6. **Capillary density:** Extraocular muscles have a higher capillary density than skeletal muscles. The capillary density ensures blood flow, metabolite delivery and removal of waste. It all supports the fatigue resistance.
7. **Oxygen consumption:** Extraocular muscles have a higher rate of oxygen consumption than skeletal muscles. The mitochondrial density increases the VO2 max of the muscles as reflected with the higher oxygen consumption.
8. **Myoglobin content:** Extraocular muscles have a higher myoglobin content than skeletal muscles. The myoglobin aids in supporting the high energy demands of the extraocular muscles.
9. Glycogen content: Extraocular muscles have a lower glycogen content than skeletal muscles. This is consistent with the greater dependency in the oxidative metabolism.
10. **pH regulation:** Extraocular muscles are better able to regulate their pH than skeletal muscles. They are somewhat resistant to pH induced metabolic changes, although like skeletal muscles extraocular muscles do experience delayed onset muscle soreness.
11. **Calcium regulation:** Extraocular muscles have a higher capacity for calcium regulation than skeletal muscles. This is essential for the contractility and precision of the extraocular muscles. Calcium is tightly regulated making the extraocular muscles resistant to calcium dysregulation.
12. **Protein turnover:** Extraocular muscles have a higher rate of protein turnover than skeletal muscles. Notwithstanding the extraocular muscles are not as prone to hypertrophy as skeletal muscles, likely due to them residing in an enclosed space restricting muscle growth.
13. **Metabolic rate:** Extraocular muscles have a higher metabolic rate than skeletal muscles. This is related to the higher oxidative metabolism and greater dependance upon oxidative metabolism compared to glycolytic metabolism.

These physiological and biochemical distinctions underscore the unique properties and functions of extraocular muscles compared to skeletal muscles; each muscle type precisely adapted to their roles in the human body.

**NEUROTRANSMITTERS**

Numerous neurotransmitters contribute significantly to the control and precision of eye muscle movements, particularly acetylcholine, dopamine, norepinephrine, and gamma-aminobutyric acid (GABA):

**Acetylcholine** is instrumental as the primary neurotransmitter governing the contraction of extraocular muscles. Released by innervating motor neurons, it instigates the discharge of calcium ions within the muscle fibers, leading to muscle contraction. This intricate process underlies the swift and accurate movements of the eyes during tasks requiring visual tracking.

**Dopamine** and **norepinephrine** also partake in modulating eye muscle movements. As constituents of the sympathetic nervous system, these neurotransmitters, emanating from neurons nestled in the midbrain, adjust the activity of the extraocular muscles.

This modulation is particularly significant in response to alterations in visual stimuli, such as shifts in the direction or velocity of a moving object.

**GABA**, functioning as an inhibitory neurotransmitter, regulates the activity of motor neurons controlling the eye muscles. It operates by enhancing chloride ion permeability, culminating in neuron hyperpolarization, which diminishes excitability. GABAergic neurons residing in the midbrain help to fine-tune eye movements, thereby forestalling excessive or inappropriate movements.

In summary, while acetylcholine primarily orchestrates the contraction of eye muscles, neurotransmitters such as dopamine, norepinephrine, and GABA modulate the motor neuron activity that governs eye movements. This complex interplay of neurotransmitters ensures optimal control and adaptability of our visual tracking abilities.

**MOTOR UNITS FOR THE EXTRAOCULAR MUSCLES**

The extraocular muscles, a set of six muscles controlling eye movements, are distinct from skeletal muscles in numerous ways, notably in terms of motor unit size and speed.

In skeletal muscles, a motor unit comprises a single motor neuron and the muscle fibers it innervates. The size of the motor unit varies according to the function of the muscle. For example, muscles requiring fine motor control, such as those in the fingers, have smaller motor units than the quadriceps of the thigh. Contrarily, extraocular muscles, which demand precise and rapid eye movements, have even smaller motor units. This design allows for a high degree of precision, as more motor neurons are available to control fewer muscle fibers.

The speed of motor units in extraocular muscles outpaces that of skeletal muscles, responding to the need for rapid eye movements in response to visual stimuli. Extraocular muscles boast a high density of motor endplates, which are junction sites where the motor neuron and muscle fiber communicate. This configuration facilitates rapid and efficient signal transmission from the motor neuron to the muscle fibers.

In summary, extraocular muscles have smaller but faster motor units compared to skeletal muscles, a necessary adaptation for the requirement of quick, precise eye movements.

**References:**

Man, CY., Chinnery, PF., and Griffiths., PG. **Extraocular muscles have fundamentally distinct properties that make them selectively vulnerable to certain diseases.** Neuromuscular Disorders. 15, 17-23, 2005.

Clark, JF. Personal experience.

# "How To" – Using Pendulums for NeuroVisual Training

One of the more commonplace engineering objects, the pendulum, is used in clocks, amusement park rides, and earthquake seismometers. The physics of pendulums helps us understand motion, gravity, centripetal force, timing, and inertia. Extrapolating that knowledge to the world of sports, why haven't we used pendulums to enhance athletic performance? Today is a new day, and we will show you How To use pendulums for NeuroVisual Training.

First, you need to identify the pivot points for the pendulums and ensure they are evenly spaced out and distanced appropriately to avoid them becoming entangled. Get creative with where you hang these. Make sure you only have one pivot point on each pendulum and as little resistance as possible. We typically suspend our pendulums (hanging Marsden Balls) from a garage door rail system and vary the string length per pendulum. These varied lengths will create different durations of loops for each pendulum, distinct resonant frequencies, which can elevate the complexity of the drill.

As a coach, you must be active in this drill by keeping the pendulums moving. The athlete starts at the end of the track, according to Figure 1. Start the exercise by swinging the pendulums randomly and instruct the athlete to study the movement. Once the athlete feels confident, they can progress through the track without breaking stride, they are to walk through the pendulums. If the athlete has read the multiple frequencies correctly, they'll walk through unscathed. However, if they miss timed any, they'll get a soft reminder via the tap of a ball on the torso. We do not hang the balls at head height for safety reasons. We like to see how many runs down and back an athlete can get without being hit by a ball before progressing.

To advance this drill, have the athlete start perpendicular to the pendulum row so that instead of being straight on, the only way to progress is by shuffling. This orientation will force the athlete to adjust calculations and, more importantly, trust their decision-making. This skill is essential when playing any field sport where players run around and behind you.

Have the athlete do a side shuffle down and back for multiple untouched loops before progressing. When an athlete gets comfortable with this drill, we can add pitch and catch plus lateral movement by incorporating Vector Balls. While the athlete is moving through the pendulum track, you can bounce a Vector Ball for the athlete to catch. Remember, Vector Balls flash red, blue, and green, allowing the coach to add more rules for the athlete to follow (i.e., red flash = right-handed catch).

You can also alter the swing of the pendulum by making it go in an ellipse. Now the person has a more complicated movement to consider. All these activities come together for athletes involved in multi-player field sports where an athlete may be required to time their entry into a gap between players. This drill and the progression herein can help train that skill.

Pendulum drills are ideal for NVT when focusing on athletic performance enhancement, but more importantly, they're downright fun to use for both coaches and athletes. The limit is your creativity; we've made athletes go through the pendulums by jumping in Zoids with strobe glasses, reading flash cards at various heights during pitch & catch, and more.

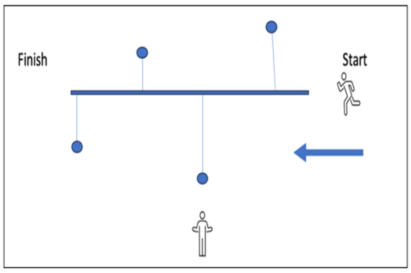


**Figure 1: Schematic of using pendulums for NVT.**

## Announcements

We're thrilled to announce a vibrant new addition to our Inneuractive webstore - the engaging Vector Balls from EOBALL.com. These multi-color flashing tools offer an engaging and dynamic dimension to your NeuroVisual Training routines. Discover more about them on our store: https://inneuractive.com/product/vector-ball/. If Vector Balls are a new concept for you, we suggest you explore our past Friends of NeuroVisual Training Newsletter, Issue I4V8, where we took an in-depth look at their unique features and advantages.

In our upcoming feature, we bring you an exclusive interview with the founder and CEO of EOBALL.com, offering you an insider's perspective on the ingenuity that fuels the creation of these impactful training tools.

Turning our attention to upcoming events, we're delighted to highlight the 40th Annual Symposium of the National Neurotrauma Society. The symposium will take place in the dynamic city of Austin, Texas, from June 25-28, 2023. This esteemed event is a vital platform for discussing and sharing the latest breakthroughs in neurotrauma research. For more information, please visit: https://www.neurotrauma-symposium.org/.

Lastly, we would like to spotlight an important publication from the British Journal of Sports Medicine. Titled "Consensus Statement on Concussion in Sport: the 6th International Conference on Concussion in Sport–Amsterdam, October 2022," this publication is a pivotal step forward in our understanding of sports-related concussions. With the latest insights and recommendations from the leading authorities in the field, it's a must-read for anyone in sports medicine and NeuroVisual Training. Access the article here: https://bjsm.bmj.com/content/57/11/695