Muscle Memory

AusDBF - eLearning Modules

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Muscle Memory

Welcome to AusDBF eLearning module – Muscle Memory.

This presentation contains texts, graphics, videos and an online survey questionnaire.

It is important that you read all the text and instructions before you proceed to the next page or option.

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An Introduction - Muscle Memory

Muscle memory is a form of procedural memory that involves consolidating a specific motor task into memory through repetition, which has been used synonymously with motor learning.

When a movement is repeated over time, a long-term muscle memory is created for that task, eventually allowing it to be performed with little to no conscious effort.

This process decreases the need for attention and creates maximum efficiency within the motor and memory systems.

An Introduction - Muscle Memory

Examples of muscle memory are found in many everyday activities that **become automatic and improve with practice**, such as Dragon Boating, gym activities, riding a bicycle, typing on a keyboard, entering a PIN, playing a musical instrument, martial arts or even dancing.

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Physiology - Motor Behaviour

When first learning a motor task, movement is often slow, stiff and easily disrupted without attention.

With practice, execution of a motor task becomes smoother, there is a decrease in limb stiffness, and muscle activity necessary to the task is performed without conscious effort.

Stages of Learning

In learning a new skill, moving from a complete beginner through to an expert performer, an athlete progresses through three distinct stages of learning.

THE STAGES OF LEARNING MODEL

COGNITIVE (Beginner Stage)

- attention is given to understanding the task
- many errors in performance, and unable to detect and correct errors
- shortest stage, however, improvements in skill tend to occur quickly

ASSOCIATIVE (Practice Stage)

- more consistent in performance
- learner concentrates on skill refinement
- improved ability to detect and correct some errors

AUTONOMOUS (Expert Stage)

- highly skilled with fewer errors
- performance is mostly automatic, able to multitask
- greater awareness of, and able to adapt to the environment

Stages of Learning…..

Mastery of a skill is also about having effective practice, rather than just accumulating hours.

Depending on the athlete's stage of learning, factors surrounding practice sessions, can have a significant impact on skill learning and development.

To ensure the progression in skill development, each stage of learning requires different practice and instructional strategies to maximize the athlete's development.

Some considerations include - skill level, the actual task and environment, the volume of practice undertaken, as well how the practice sessions are structured.

Quality, consistent and effectiveness of practice is important to enable improved performance.

Practice Distribution & Muscle Memory

PRACTICE DISTRIBUTION

- refers to the time actively practicing compared to time spent resting
- can greatly influence the effectiveness of practice
- can influence the development of “muscle memory”

MASSED PRACTICE

- a continuous practicing of skills, with little to no rest between repeat performances of a skill, and is highly repetitive in nature
- useful when developing discrete skills eg. golf drive
- more suited to more experienced athletes due to concentration and the ability to use immediate feedback to make corrections.

DISTRIBUTED PRACTICE

- practice where smaller practice time intervals are interspersed with rest periods.
- allows time for learning to “sink In” and allow memory consolidation
- best for new or the learning a complex skills
- Used when rehearsing skill is physically or mentally fatiguing.
- can assist with maintaining the performer’s motivation levels

Muscle Memory or changes in Neural Pathways….

The brain is constantly sending messages to the muscles, via axons, in order for movement to occur.

Muscles, as such, don't really have memory, but rather the athlete's myelin surrounding the axons, changes through practice and training, to allow faster and more efficient neural pathways.

Practice and repetition appears to change the myelination, forming a sheath, surrounding these axons.

This insulation reduces energy loss from electrical signals, moving from the brain to the muscles, allowing them to more efficiently move along the neural pathways.

The increase in the layers of the myelin sheath creates a "super highway" for signals to travel, hence more efficiently connecting brain and muscles.

The greater the layers, the more insulation the more efficiently the brain can pass signals to the muscles.

Muscle Memory Encoding

The neuroanatomy of memory is widespread throughout the brain; however, the pathways important to motor memory are separate from the medial temporal lobe pathways associated with declarative memory.

As with declarative memory, motor memory is theorized to have two stages: a short-term memory encoding stage, which is fragile and susceptible to damage, and a long-term memory consolidation stage, which is more stable.

The memory encoding stage is often referred to as motor learning, and requires an increase in brain activity in motor areas as well as an increase in attention.

Brain areas active during motor learning include the motor and somatosensory cortices; however, these areas of activation decrease once the motor skill is learned.

The prefrontal and frontal cortices are also active during this stage due to the need for increased attention on the task being learned

Muscle Memory Consolidation

Muscle memory consolidation involves the continuous evolution of neural processes after practicing a task has stopped.

Though the exact location of muscle memory storage is not known, studies have suggested that it is the inter-regional connections that play the most important role in advancing motor memory encoding to consolidation, rather than decreases in overall regional activity.

These studies have shown a weakened connection from the cerebellum to the primary motor area with practice, it is presumed, because of a decreased need for error correction from the cerebellum.

However, the connection between the basal ganglia and the primary motor area is strengthened, suggesting the basal ganglia play an important role in the motor memory consolidation process.

Muscle Strength Training & Adaptations

When participating in any sport, like Dragon Boating, new motor skills and movement combinations are frequently being used and repeated.

Dragon Boating requires some degree of strength, endurance training, and skill development in order to be successful in the required tasks.

Muscle memory related to strength training involves elements of both motor learning and long-lasting changes in the muscle tissue.

Evidence has shown that increases in strength occur well before muscle hypertrophy, and decreases in strength due to detraining or ceasing to repeat the exercise over an extended period of time precede muscle atrophy.

To be specific, strength training enhances motor neuron excitability and induces synaptogenesis, both of which would help in enhancing communication between the nervous system and the muscles themselves.

SYNAPTOGENESIS – is a long developmental process involving synapse formation, synapse maintenance and activity-dependent synapse refinement and elimination, and is important for the establishment of the neuronal network and the precision of brain circuitry (Cohen-Cory, 2002 – from Reproductive & Developmental Toxicology, Second Edition, 2017)

Muscle Memory Impairment

It is difficult to display cases of motor memory impairment because the memory system is so widespread throughout the brain that damage is not often isolated to one specific type of memory.

Likewise, diseases commonly associated with motor deficits, such as Huntington's and Parkinson's disease, have a wide variety of symptoms and associated brain damage that make it impossible to pinpoint whether or not motor memory is in fact impaired.

Case studies have provided some examples of how motor memory has been implemented in patients with brain damage.

Please **turn up your volume** then click on the URL link below to view a short video of Muscle Memory.

When the video is completed please return and go to the next slide in this presentation.

https://youtu.be/f2O6mQkFiiw