ASCA World Clinic Yearbook - Effective Strength and Motor Learning
Extracts from " The Physiology of Dry Land Training" Prof Heusner

A muscle is composed of fibres, which are divided into groups and controlled by many motor units, each having a certain number of fibres to control.
The motor units are in turn activated by nerves, some of which are excitatory and cause the muscle to contract, and others are inhibitory which prevent contraction, or random muscle action

All or Nothing

In skeletal muscles, the" all or nothing" law of muscle physiology applies to the **muscle cell,** not to the whole muscle. It states that a muscle cell will contract to its fullest extent when it is stimulated adequately; it never partially contracts. However, since skeletal muscle consists of thousands of muscle cells, the **whole** muscle will react to a stimuli with **graded responses** given that some muscle cells will contract and others relax simultaneously. In general, graded muscle contractions can be produced in two ways:
** a) By changing the **speed** of muscle stimulation, or b) by changing the **number** of muscle cells being stimulated.*
Exercise designed to increase the size and strength of muscle fibres would result in fewer motor units being needed to perform a given task. These motor units would then enjoy a better work/rest ratio, and in turn enable the muscle to contract at a high rate for a longer time.

Neuromuscular adaptation

But possibly, especially for a lot of swimmers, the most important increment in strength gained through exercise, is the neuromuscular adaptation.
In the preceding description, inhibitory nerves were mentioned. Inhibition is really a protective mechanism: many of our muscles have much more contractile tissue than is normally used at any one time. Some muscles and groups of muscles are potentially capable of exerting so much force that assuming simultaneous activation of the entire muscle or groups of muscles, we would end up with really serious skeletal damage.

However, specifically performed exercise which progressively stress and cause changes in the muscle, bone and connective tissue making them much stronger, has the effect of overriding part of the neural inhibition which prevents the motor unit from contracting and so releases a much greater amount of muscle force.
Furthermore, this disinhibition gets enormous changes in strength and power without increasing the muscle bulk, because the increased force is due to an increased motor unit activity.

Extracts from ' Strength and Conditioning'

"In the gym I often see skinny guys using heavier weights than bigger and more muscular guys, how can this be explained? If the level of quantitative development of the muscles hypertrophy (increase in muscle size) is lower, there should be a qualitative compensation which justifies this phenomenon. I think that, especially in the field of power, the muscular cross-section represents an important, but indirect contribution to performance, while the percentage of fast twitch fibres, *the degree of their innervation* and the degree of *synchronization* of the activity of motor units, is really the heart of the matter."

"Keeping in mind that strength is a very wide field, going from resistant strength to explosive power (and many other manifestations) I think that, while muscular hypertrophy can be more or less important according to the type of strength required

by a particular sporting event; the *neuromuscular* aspect is always of first importance. It will specalize according to the requirements of each sport, and always represents the most direct contribution to high-power feats." (Pedemonte)

"Both high force and high speed weight training exercise will recruit fast twitch fibres, moving one closer towards the force-velocity capacity curve, increasing the power output and subsequent strength-power training effect"(O'Bryant)

Motor Learning

A good understanding of motor learning is important for swimming instruction, stroke technique and training.

Within each motor nerve there are many motor neurons or little alpha fibres. Each one branches out and innervates a whole bunch of muscle fibres. One neurofibre and the muscle fibres that it innervates is called a motor unit. (previously mentioned)

It is the smallest functional unit that we have in the neuromuscular system.

When a new skill is attempted, the body has to recruit a bunch of motor units, and initially that recruitment may be rather haphazard and quite inefficient. With training, you get more units that will do the trick for you efficiently. Some would operate but be inefficient, and some would actually be antagonistic.

This happens on a trial and error basis, but as we continue to work on a new motor skill we gradually refine that recruitment of motor units to a point where we isolate the effective ones. We recruit more effective ones; then we get rid of the ineffective ones and the antagonistic ones, and organize the recruitment on a time related basis.

We now have a nice summed response which gives us the smooth, flowing kind of actions that you are used to seeing in the skilled athlete.

From the forgoing, it is easy to imagine the problems involved in changing wrong movements that have been programmed into the neuromuscular system.

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