The size principle of motor unit recruitment is an important concept and feature of muscle contraction and subsequent energy metabolism. You will learn more of the metabolic significance of motor units after studying the content in the metabolism sections. For now, let us focus on the functional implications of this recruitment profile. When you exercise easy vs. intensely what do you notice about the attention, or focus, needed during the exercise? I am hoping that you have been able to recognize in yourself that more intense exercise for the same action requires added thinking, which translates to increased cortical input and output. This added cortical involvement is somewhat proportional to an increased recruitment of FOG and FG motor units, which require greater neural stimulation to recruit than SO motor units.

Figure 1 provides some electromyography (EMG) data from my research that quantifies the change in electrical activity from muscle contraction as exercise intensity increases. The use of surface electrode EMG is a useful, albeit indirect, method to assess changing motor unit recruitment. This data is from cycle ergometry incremental exercise using a ramp protocol to cause volitional exhaustion (fatigue) in approximately 12 min. Remember that an incremental protocol induces a linear increase in exercise intensity (ATP demand). You will notice that the increases in EMG activity is not linear! The discrete sections of the EMG profile are believed to reflect the increased muscle mass recruited in transitions from SO, to FOG to FG motor units. The muscle mass recruitment is not linear because the muscle fiber numbers per unit for the three motor unit types increases from SO, to FOG to FG. Thus, as motor unit recruitment progress through the size principle, more muscle mass is involved per motor unit recruited for FOG compared to SO, and then again for FG compared to FOG.

Another compelling functional consequence of increasing FOG and FG motor unit recruitment is a decreased control of movement. The SO motor units have the largest nerve to muscle ratio. In having fewer muscle fibers per unit, the recruitment of SO motor units has the smallest increment in force development per motor unit, which in
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Turn means more fine tuned control of muscle contractile force development. This then translates into more precise and controlled movement patterns. Thus, which muscles of the body do you think are inherently genetically expressed as mostly SO motor units? Well, the muscles that control what need to be fine tuned muscle contractions. These are the muscles of the forearm, face, tongue, feet and many of the postural muscles.

For main muscle groups involved in exercise, which are more varied in motor unit expression, this also means that as we increase exercise intensity, and move into FOG and FG motor unit recruitment, the coordinated control of the exercise movement patterns will decrease. This is why our performance capabilities in sports involving high movement skills decreases as we increase intensity. What seems easy to do when exercising at a low intensity becomes more difficult to do at higher intensities.

Here is a simple exercise to test this theory. Get some objects that you can toss across the room without damaging anything. Mark a spot on the floor several paces from you and then throw one object attempting to land the object at this spot. For each subsequent throw, attempt to increase the distance of the throw as minutely as possible. Double the distance of the spot you are trying to hit and repeat this procedure. Your hypothesis is that the harder you have to throw, the less precision you have in increasing the distance of the throw. If you kept doing this by increasing this distance further, you would see a pattern of increasing variability in the distance increment you are trying to do, and also a larger mean distance increment for the throws that were in fact longer. Part of this error is certainly the increased time of the throw that a given error will manifest itself into a larger distance, but a part is also the decreased precision of movement that comes with increasing motor unit recruitment. To test this hypothesis more correctly, you would use objects of increasing mass, when throwing the same distance. Perhaps you should try this outside!

Glossary Words

electromyography (EMG) is a method to acquire electrical signals released from contracting skeletal muscle. Signals can be acquired from surface electrodes or needles inserted into the muscle(s) of interest.

performance refers to the quality of participation in exercise, sports, or athletic competition.