The Concurrent Training Paradigm (Evidence Based)

Health and fitness have remained ambiguous terms for decades, often thrown around glibly and used generally. It is well understood that exercise of all types can be beneficial for increasing quality of life, mortality, psychological well-being and overall daily function. Oftentimes individuals may engage in a variety of exercises based on personal preference and accessibility. Although this approach is largely recommended for enjoyment and adherence, if one desires to maximize growth and progression in one mode of exercise, they may need to eventually consider specializing. Here enters the Concurrent Training Paradigm.

Exercise can generally be classified into two categories, those that focus on endurance (aerobic capacity) and those that focus on strength (anaerobic capacity). It is worth noting that many exercise selections will benefit both, however they are often majoring in one and minoring in the other. Endurance focused activities include: running, cycling, skiing, rowing and anything else that would be performed under the heading of "cardio." Strength or anaerobic activities include various forms of resistance training (Olympic lifting, bodybuilding, powerlifting), calisthenics, isometric training, and anything that is done to improve muscular strength. With that introduction out of the way, let's unpack the different objectives between training for endurance vs. strength.

The overall goal of endurance training is to improve your VO2 Max. Although not all terms in this paper will be described this thoroughly, VO2 Max is important to grasp, as it builds the very foundation for endurance training. VO2 Max measures how much oxygen your body can take in and utilize during an incremental all-out exercise bout. Not only does improving your VO2 Max mean your body is able to able to perform at a higher absolute work rate, it also means your metabolism and cardiovascular system are operating more efficiently (*VO2 Max Testing* |

Exercise Physiology Core Laboratory, n.d.). As an aside, oxygen consumption is a direct indication of how many calories are burned by the metabolism. Therefore, achieving a higher oxygen consumption via increased VO2 Max and therefore capacity for work, leads to a higher caloric expenditure. To further understand oxygen consumption, we need to look at the components. VO2 Max is described in a simple equation: VO2 Max = Heart Rate x Stroke Volume x a-vO2 difference. Heart Rate is the speed at which the heart pumps and Stroke Volume is the amount of blood that is ejected from the heart in each beat. The a-vO2 difference is the measure of oxygen that the working tissues extract from the blood before it goes back to the heart. In the short term (<4 months) VO2 max is primarily improved through adaptations to Stroke Volume. In the long term (32 months), a-vO2 difference is largely responsible for the improved cardiorespiratory fitness (Scott K. Powers, 2018). For more on how this works mechanistically, in various climate conditions and exercise intensities follow up and ask me!

Strength Training is fundamentally different from endurance training, observable by the objective goal that drives the training modality. This type of exercise focuses on increasing absolute strength (usually measurable by 1 RM). Adaptations generally affect the Central Nervous System and locally facilitate muscle hypertrophy. A bigger muscle is a stronger muscle, the body accomplishes this by laying down more myofibrils to increase the amount of cross section area for contraction to take place. This results in larger muscle fibers, not an increase in number since humans cannot physically divide their muscle fibers into more (Scott K. Powers, 2018). Although the cardiorespiratory system is improved significantly when compared to an untrained individual, the overall training stimulus and therefore adaptation focuses on the anaerobic rather than aerobic system. The anaerobic system is utilized at max or near max efforts, where metabolic demand for oxygen cannot be met. When this occurs, the body transitions into producing energy via the PCr and anaerobic glycolysis systems.

These systems can supply the body with energy at high intensities but have overdrive consequences that reduce the duration with which they can be sustained. This is the reason why we can only perform maximum intensity exercise for a very short amount of time. It is counterintuitive at face value that high intensity activities like 100-meter sprints, do not significantly increase our VO2 Max system, in fact they barely have any influence. This is because VO2 Max is a measure of aerobic capacity, and activities that do not utilize large quantities of oxygen (anaerobic) do not stress that particular system.

Now that we've considered the fundamental markers of endurance and strength training, we will dive slightly into the weeds to determine how these two training styles signal the body to adapt in different ways. There is not possibly time to explain each of the terms, but you are welcome to follow up with me at a later time to discuss them if you are interested.

Endurance Training (ET) facilitates several types of bodily adaptations. First, the person becomes more metabolically efficient. The body settles into a steady state much closer to the onset of exercise, leading to a smaller oxygen deficit. The aerobic metabolism starts relying more heavily on fat for fuel, sparing muscle glycogen and improving exercise duration. Endurance training also promotes a muscle fiber type shift. An untrained individual has a mixture of fast twitch (specialized for strength), slow twitch (specialized for endurance) and hybrid muscle fibers (jack of all trades). As one trains, the fiber type distribution shifts in the direction of the training modality. Therefore, endurance training causes a transition of fast fibers to slow fibers, to further meet the specific needs of anaerobic exercise. These fibers are more oxidative in nature, and as endurance training increases, fiber mitochondrial density increases, leading to a bolstered production of energy via aerobic metabolism. All of these adaptations occur through the presence of upregulated calcium, signaling capabilities of PGC1ɑ, CaMK, and AMPK (Koulmann & Bigard, 2006). Additionally, the ratio of AMP/ATP is increased, showing the body that energy has been depleted and adaptation must occur before the next bout.

<u>Summary of ET adaptations:</u>

- Quick adjustment to aerobic demand
- Fuel specialization
- Fast to Slow fiber type
- Increased mitochondrial density
- ↑Calcium release
- ↑PGC1ɑ, CaMK and AMPK

Resistance Training (RT) elicits different alterations to the body. The most notable has already been discussed, an increase in muscle fiber size, or hypertrophy. The underlying concept explaining muscle hypertrophy is Myonuclear Domain. In a nutshell, the muscle fiber receives a signal to grow, and satellite cells located on the outside of the muscle fiber undergo mitosis, then migrate inside the muscle (becoming nuclei) to help manage a certain cytoplasmic area within a muscle. As more nuclei migrate into the cytoplasm, the muscle will grow in size, because the space can be well managed. Myonuclear Domain is inversely proportional to the aerobic capabilities of a fiber, and therefore is found most prominently in fast twitch, strength-oriented fibers (Qaisar & Larsson, 2014). The second, equally notable adaptation is an increase in neuromuscular activity. It is well established that the progress seen in the first several weeks of a RT program has almost nothing to do with muscle hypertrophy, rather the strength improvements reside in neuromuscular adaptations (Powers, 2018). Specifically, the recruitment of motor units is improved, leading to a more effective and efficient force production. Henneman's Size Principle is a marvelous example of the integral role motor units play in physical activity, and should be further explored if you have time. Following these adaptations, there is a converse change of fiber type from what we see in endurance training, with RT stimulus the fibers shift from slow to fast. It is worth noting that this shift is not as dramatic as the fast to slow change that occurs with endurance training, suggesting that perhaps oxidative type 1 fibers are more specialized (Scott K. Powers, 2018). Finally, the most fundamental result of RT is increased protein synthesis. Upregulated calcium, mechanical stress, IGF-1 and later mTOR all lead to powerfully signaling protein synthesis. This results in the aforementioned adaptations to muscle fiber type, size and myonuclear domain.

Summary of RT adaptations

- ↑Hypertrophy
- Larger Myonuclear Domain
- Efficient recruitment of motor units
- Slow to Fast fiber type
- ↑Protein synthesis
- ↑Calcium release
- ↑IGF-1, mTOR

As we can see, the adaptations from these two training types are quite extraneous from each other. The commonality over calcium is based in the truth that calcium is required for any version of muscle contraction and therefore represents general movement over a specific training style. ET augments a muscles oxidative capacity by increasing mitochondria and makes it more adept at using fat for long term fuel. RT facilitates protein synthesis and thereby increases the size of a muscle while simultaneously dialing in force production through the practice of motor unit recruitment. Since these training styles seem to move the body towards specialization in different directions, why do people so frequently mix exercise styles? Doesn’t this impede their progress in both? Well thankfully it’s not quite that simple.

It appears that concurrent RT and ET has little negative effect on oxidative capacity. This is great news for ET athletes that desire to incorporate muscle building into their exercise regimen, in fact many that do so find rewarding improvements to their ET sport/activity of choice. For example, a cyclist that focuses on building his quads can achieve a larger CSA with relatively low effort. A larger quad means more force production which translates to a stronger pedal stroke and subsequent decrements in race time. However, the reverse scenario is where we run into concern. RT athletes can expect to experience diminishing returns to their gains if they engage in a high volume of ET exercises. To be clear, one run isn't going to take away your hard-earned efforts to accrue muscle. According to a meta analysis of 21 studies on the subject of concurrent training**, ET above a volume of 3 days per week at 30+ minutes per workout** is the threshold at which training interference may occur (Wilson et al., 2012). Furthermore, the timing of ET seems to be important. When examining the response between ET immediately preceding an RT workout vs separating the training types into two different days, it was found that strength, measured through leg press 1-RM was greatly diminished in the same day group (13% increase in strength vs 25%) (Sale et al., 1990). Therefore, it is highly recommended to **perform concurrent ET on a separate day from RT workouts.** Surprisingly the difference in hypertrophy was not statistically significant, however, it is worth considering that the exercise used (cycling) has provided somewhat confounding results to the concurrent training paradigm. For example, high volumes of running mixed with RT have shown low returns in muscle strength and hypertrophy, whereas preliminary evidence suggests that the negative effect is muted when cycling is the chosen modality (Wilson et al., 2012). Lastly, it is interesting to note that this decrement in strength is localized in nature. Concurrent running curtailed lower body strength gains but had no effect on upper body strength. Although not proven, this suggests that mixing ET exercises which target different areas of the musculature (skiing, running, rowing) may mitigate the negative effects on muscular adaptations.

We have unpacked that high ET volume is deleterious to RT induced muscular growth, but why? There are three key reasons why this paradigm exists: interference of muscle fiber recruitment, depleted muscle glycogen, and mixed signals. The first, is explained in the basic adaptation difference between ET and RT. ET activities are inherently performed at a high speed, low force output when compared to RT. Because of this, the recruitment of motor units (maximized at highest force production) is not well practiced. In fact, it may actually be inhibited, following the principle of specificity (the thing that you practice is the thing that you get good at and your body adapts towards that when progressing and improving). Depleted muscle glycogen is another big factor. As mentioned previously, muscle glycogen levels are indicative of muscle endurance and subsequent metabolic ability to operate effectively. Muscle glycogen is a favored fuel source, but the stores are finite, requiring time to restore. Moderate-high intensity ET is particularly guilty of sapping muscle glycogen, as the longer duration (compared to RT) and high workload demand lots of quick energy. If too much training is demanded (such as what happens with ET and RT concurrency), muscle glycogen can be depleted, resulting in performance decrements. If muscle glycogen is scarce, RT workouts will be performed sub optimally, with some combination of less volume, intensity or duration, and gains will be stinted. Finally, mixed signals lead to confusion as to what the body is supposed to do. One example is the antagonist relationship between signalers AMPK and mTOR. When ET workouts are performed, they lead to an upregulation of AMPK, which by nature inhibits mTOR, the leading marker for protein synthesis. This sets the body up in an unfavorable position hormonally to foster muscle gains.

For the sake of length, I will conclude here with a few important takeaways from this paper:

1. ET and RT affect the body in diverse ways, they are different sides of the fitness coin. Both are healthy and have unique benefits to your body and psyche.
2. An average person can find great value when incorporating ET and RT together. However, if you are a RT specific athlete that requires maximum gains and specificity in your sport, limit ET to less than 3x/week at 30 minutes per workout. Focus on cycling if you necessitate a higher volume then recommended, as there may be some muscle sparing benefit.
3. If you make the decision to go hard into concurrent training, load carbohydrates on big training days to optimize your muscle glycogen stores. Try to stick to higher intensity versions of cardio to limit mixed messages for adaptation, and preserve the practice of motor unit recruitment. Separate ET and RT days when possible.

I hope this was informative for you to take in! If you have any questions arise after reading my exposition of The Concurrent Training Paradigm, feel free to reach out and ask me!
Most of all, I hope you took away knowledge that you can later use as wisdom for everyone's well-being.

Always Striving,
Josh
The Fit Famished Fellow
ISSA and NCCPT Certified Personal Trainer
Armourbearer

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