Acute Training Variables, Muscle Growth, Strength, and Power – Velocity and Frequency

Researched and Composed by Jacob Wilson, M.S., PhD. Candidate, C.S.C.S, and Gabriel Wilson, M.S., C.S.C.S

Repetition Velocity

Literally every month a new article comes out regarding super slow training. In fact at my old gym there was this one guy who worked out with small weights each week, and performed 1 long, slow repetition per set. Is it just an isolated incident that this guy was not growing in the gym, or is there evidence to support my observation of the ineffectiveness of this training style? As a background, there are generally two ways an individual can perform a slow repetition. The first is non-intentional and usually occurs near the end of the set as the muscles begin to fail and can no longer generate the same force output. For example one study found that during a 5 repetition maximum set of bench presses during the up phase the average speed was 1.2-1.6 seconds, while the last two reps were 2.5 and 3.3 seconds[1]. This is a natural part of lifting.

The second way is to intentionally slow the repetition speed. This is a problem because force is equal to mass X velocity. Thus if you lower velocity, you lower force output, which means you will not need to recruit as many muscle fibers[2]. One study found that super slow lifting (10 s concentric and 5 s eccentric), compared to a faster velocity (2 s concentric, and 4 seconds eccentric) not only lowered force output during the exercise session, but also resulted in lower strength gains following 10 weeks of exercise[2] Overall both moderate (1 to 2 seconds for concentric and eccentric), and fast (1 second each) velocities compared to slow velocities ($\geq$ 5 seconds) have increased total work done in a given workout[3], enhanced strength[4], and **most importantly** resulted in greater muscular remodeling and hypertrophy[5, 6] Overall, data currently suggests that individuals should work within a moderate (1-3 each for concentric and eccentric, depending on the range of motion and weight lifted) to fast repetition (1 for each) range for optimal strength, hypertrophy, and power gains.

To many this may come as a surprise – for decades so called "experts" have preached the importance of performing slow, succinct reps to achieve maximal strength and hypertrophy gains. But once again, this is where we come in, and separate fantasy from reality.

There are several rationales to explain these results. First, as discussed, from a biomechanics point of view you will exert greater force (mass X velocity), and perform more work (force X distance), which may also result in a greater hormonal response. Second, from a neurological perspective high velocity repetitions have been shown to selectively recruit type II fibers, which are largely responsible for muscle size and strength. Additional advantageous neural adaptations to high velocity movements may also be expected, such as synchronous motor unit recruitment (refer to the Neural Adaptation Guide). A third possible mechanism is actually related to muscle damage. Skeletal muscle is composed of a cytoskeleton which holds the tissues together (non-contractile components), as well as contractile tissue (actin and myosin) (refer to Anatomy of a Muscle). What is important to understand is that muscle fibers are most susceptible to damage in the non-contractile elements. Now, the greater time you have to contract, the more cross bridges will be formed between actin and myosin filaments; consequently, distributing the resistance across contractile tissues, thereby alleviating the non-contractile elements. However, with higher velocity contractions damage is higher for the reason that the actin and myosin filaments do not have time to build up maximal force and so the non contractile components of muscle have to bear a greater load resulting in more muscle damage and a greater local growth factor response (e.g. greater local IGF production).

Overall, we suggest that you should perform high velocity repetitions, as long as injury is not at risk. For instance, with maximal lifts, especially on injury prone muscles such as the pectorals, it would not be advisable to slam heavy weights down on your chest, as you may risk injury. Rather, a 2-3 second controlled lift is likely more suitable. However, with lighter loads (e.g. 50% of 1 RM) higher velocity movements (e.g. 1-2 seconds) may be optimal.

Exercise Training Frequency

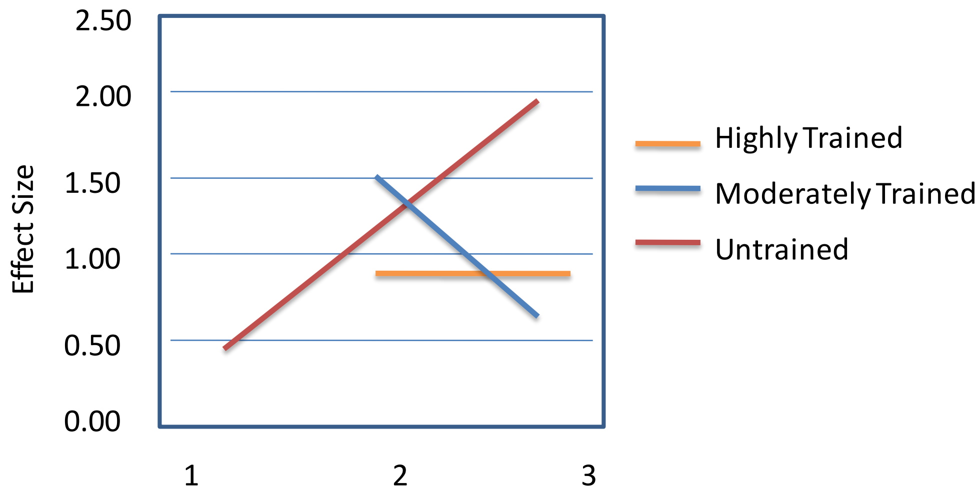

Figure 1.0 Effects of 1, 2, and 3 days a week of training per body part on strength. Re-drawn by combining graphs from two meta-analytical studies[7, 8].

Once again most data analyzing frequency of training has used strength as the main variable. When analyzed across numerous studies strength is maximized at 3 sessions per week in untrained individuals[8], and twice in trained and moderately trained individuals[7, 8]. Differences between moderately trained and untrained in terms of frequency are most likely a factor of moderately trained individuals being able to workout at much higher intensities, thereby requiring greater recovery periods. For time efficiency two days per week are fine for highly trained, but for introducing variety within a body part 3 sessions may be a valuable tool. Once again because strength is largely a factor of muscle growth in moderately trained and trained individuals 2-3 training sessions are generally recommended for hypertrophy as well [9-11]. This was supported by a recent study in which scientists had individuals perform two training sessions in a week, separated by 48 hours[12]. Indicators of the main pathway responsible for protein breakdown were lowered 30% more after session two than session one, while there was a tendency for greater protein synthesis in session two than session one.

Table 1.0 Take home messages

❖ **Super slow (10 s concentric, 5 s eccentric) training hinders force output, motor unit recruitment and ultimately strength and hypertrophy gains**
❖ **It appears that strength and hypertrophy are optimized at moderate (1-3 seconds each for concentric and eccentric) and fast (1 second each) speeds. On heavier loads (e.g. 85% 1 RM) a 2-3 second cadence is advised to avoid injury. While training with lighter loads (e.g. <50% 1RM) 1-2 second cadences may be employed.**
❖ **For power the individual should attempt to explode on each repetition with as much acceleration as possible.**
❖ **For strength, power, and growth untrained individuals should trained at least 2, and optimally 3 times per body part a week**
❖ **For strength, power, and growth moderately trained individuals optimize gains at 2 days per week. This is similar for highly trained individuals, but they receive similar gains training 3 days per week, thus if variety is needed for a more complete muscular development, it may be advantageous to use the extra day on occasion**

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