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CONJECTURAL FATIGUE: HIGH-REPETITION WEIGHTLIFTING

The snatch and clean and jerk can safely be used for conditioning—and have been for years.

BY LON KILGORE

Shaun Cleary/CrossFit Journal

High-repetition Olympic lifts can be used for both strength and conditioning.

Michael Brian/ CrossFit Journal

A tremendous amount of criticism has been leveled at high-rep Olympic weightlifting.

Much of it comes from a variety of sport-specific coaches—often vocal weightlifting coaches and personal trainers who state that doing higher repetition snatches, cleans, and jerks is not effective in application and likely dangerous. In their opinion, no one can perform these lifts with proper technique in higher repetitions because of fatigue-generated technique errors.

In fact, some coaches suggest the Olympic lifts should not be used to train anyone other than elite athletes.

The issue arises in discussions and in the media on a seemingly regular cycle. Let's consider it from two angles:

1. What position do some of the best coaches in the world take on high-repetition weightlifting?

2. Is there any evidence to suggest that higher repetitions are ineffectual or dangerous?

Coach Says

Anecdotally, football and strength coaches have used high-repetition cleans for decades to add mass, strength and local muscular endurance to players. More formally, the National Strength and Conditioning Association (NSCA) has published in its many outlets examples and recommendations for use of Olympic lifts to generate metabolic fatigue or the use of high-repetition cleans. In the NSCA trove, we can see highly regarded coach Bob Takano's recommendation for repeated sets of 3-5 cleans with short rest between set for conditioning purposes (NSCA Webinar Series).

While 3-5 is not high repetition per se, the reps are done in a condition of fatigue. But we can also see in the writings of other high-level coaches that high repetition (more reps rather than less rest) of Olympic lifts is considered useful, and these coaches fully support high repetition as a conditioning tool. Jim Schmitz, three-time coach for the U.S. Olympic Weightlifting team, describes 10-rep clean and jerks as a conditioning tool in an article published on IronMind.com.

"When people question the conditioning value of the Olympic lifts, I say talk to me when you can do 10 consecutive reps with no rest in between in the clean and jerk with your body weight!" he wrote.

We can delve even further, back to the era of Bob Hoffman (1920s-'70s), the father of American weightlifting, who recommended up to 16 repetitions in some of his program publications.

With that in mind, it's very hard to argue that variations of higher and fatiguing repetition schemes should not be used in training. These variations have been used successfully and safely for conditioning purposes for more than half a century on the advice of experienced and elite coaches.

From a coaching perspective, the accusation that use of Olympic lifts for conditioning is ineffectual or dangerous is similarly poorly supported. The heart of the chaos can be traced to the inability of some to separate the use of weighted exercises to develop strength from their use to develop endurance. The logic levied by the detractors of higher and fatiguing repetitions is that weights are lifted to increase strength, and any consideration or application of weighted exercise, most specifically the Olympic lifts, to develop endurance is ineffective and irresponsible.

But, when considered objectively, any exercise can be used for conditioning purposes. That's right: any exercise—you just have to define the conditioning purpose and parameters, then program the exercise to fit those parameters.

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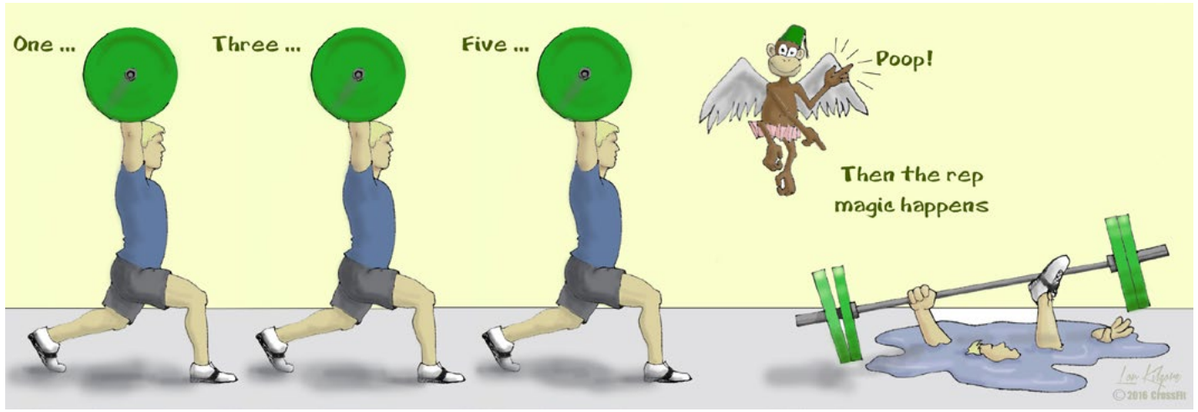
But an extremely common argument is that the Olympic lifts are too technically complex and prohibitively difficult to perform for multiple repetitions. That logic applied to CrossFit—and any other system that uses Olympic lifts or their variants in higher numbers or under conditions of fatigue—is based on a blanket inference. It is a subjective opinion that CrossFit coaches and other trainers cannot effectively teach weightlifting, that trainees cannot effectively learn the lifts to the point they can perform multiple repetitions and that science supports this position.

What is quite interesting is that many of these contrarians—who say that people cannot learn proper technique fast enough to support such training—actually deliver instruction intending to effectively teach the Olympic lifts to beginners in very short weekend workshops, seminars or introductory coaching sessions. And guess what? They can and do teach those complex human movements in a weekend, a day or an afternoon.

But how can their teaching and the trainees' learning of a movement skill only apply to singles, triples and maybe fives but not to 10s? Is there a magic point of no return where neural processing and motor patterns jump ship and leave the body in a quivering, spastic heap of bone and muscle incapable of coordinated movement?

The Olympic lifts help to improve fitness—both at low repetitions and high repetitions.

Shaun Cleary/CrossFit Journal



Some "experts" suggest technique cannot be maintained beyond 5 reps.

Deliberate Practice

Learning a physical skill is frequently presented as a very long process. This idea is often based on the writing of Malcolm Gladwell, who proposes that mastery requires 10,000 hours of deliberate practice. Gladwell's writing is based largely on a paper by K. Anders Ericsson and co-workers, in which the authors evaluate the difference in time of deliberate practice between good violinists and exceptional violinists.

If we are governed by this concept in exercise and train 10 hours per week, it will take 1,000 weeks or 19.2 years to master an exercise skill. If we train 20 hours per week it's 9.6 years. It's important to note that each of the subjects in this study could play the violin competently very early in his or her training career, and it didn't take the violinist years to play a tune.

The problem we face is that few papers dissect this concept down to isolate the physical learning. A violinist is learning independent use of the hands (fingering with one and bowing with the other). He or she is also learning to read, hear and process music intellectually while coordinating played notes to an externally based but internally implemented time reference. It is an intimidating and complex art form.

Pulling a bar from the floor and getting it on the shoulders is a simple bilaterally coordinated movement. It requires virtually no cognitive input and is independent of external time requirements other than those dictated by gravity. Does the simplistic nature of a clean, snatch or jerk require 10,000 hours or even 10,000 repetitions to master? Absolutely not.

A meta-analysis by Macnamara and co-workers found that only 18 percent of the variation in performance between low- and high-level athletes could be explained by the amount of deliberate practice. When the researchers focused on stratifying among the most elite athletes, only 1 percent of the difference between the top and bottom performers—all elite—was explained by the amount of deliberate practice. It's apparent many more factors are involved.

But really, how long does it take to learn a physical skill? Kirby and co-workers found that able-bodied subjects could learn to do wheelchair wheelies in less than an hour. In another study, simple elbow flexion assessed for acceleration, deceleration, speed and accuracy was learned in 400 repetitions over 1.5 hours (Flament and co-workers, 1999). Children learned a Wii Fit skiing task effectively with 100 repetitions over five weeks (Smits-Engelsman and co-workers, 2015). Further, it has been noted that motor-output accuracy had improved by the fifth physical practice session, eight additional sessions minimally increased accuracy, and multi-joint movement coordination had improved significantly by the eighth training session (Ya-Ching and co-workers, 2008).

So it is clear that very few discretely purposed training sessions can be effective in providing ample opportunity to learn an Olympic lift. Learning exercise technique does not take as long as some people would like you to think.

What happens if we throw fatigue into the mix? This is one of the central features of most arguments against higher-repetition Olympic lifts. However, as early as 1976 it was noted in a publication from the American College of Sports Medicine that "practicing a gross motor task under conditions of heavy-fatigue would facilitate performance of that task under criterion heavy-fatigue conditions" (Williams and co-worker, 1976). Further, increased body heat, such as when you are training hard, appears to enhance motor-skill acquisition (Littmann and Shields, 2016). We can look at these data in two ways:

1. Technique can improve with fatigue and sweaty body temperatures.

2. If you want to be capable of good technique while fatigued, you must train technique in the presence of fatigue.

Electrical Activity in Muscle

Is it possible that another phenomena might prevent us from learning and performing higher repetitions?

We do know that electromyographic (EMG, a recording of the electrical activity in the muscle) patterns change over repetitions completed, with notable differences seen by 10 repetitions. As repetitions stack up in a set, EMG tracings change.

Although data is limited, it has been proposed that learning a weighted movement is best accomplished using no more than 5 repetitions. The first rationale is that the first few repetitions closely follow the same electrical-stimulation pattern of muscle-fiber recruitment. Later repetitions start to diverge and recruit different muscle fibers. Second, and more importantly, using 5 repetitions gives the trainee an opportunity to learn and make mistakes and be corrected without performing a larger number of repetitions incorrectly. Timely feedback is considered essential to learning physical skills.

But the human mind is adept at learning. The human body is equipped to intuitively solve movement problems and reflexively avoid danger. This includes rapidly calculating the solution to movement problems. The ability of an average human to learn to perform an Olympic lift in a short period of time, often with limited or no external cueing, counters the argument that the lifts are too complex for inclusion in conditioning training. We can learn technique very quickly.

We scale, we individualize, we use the right repetition and set scheme for the goal to be accomplished—a point often ignored by detractors.

But if EMG activity changes over repetitions, doesn't it affect learning or movement?

The change in EMG activity in later repetitions does in fact point to different muscle fibers firing, but they are still muscle fibers (or motor units) in the active muscle, aligned in the same orientation as the other fibers in the muscle, responding to the same electrical impulses sent out by the nervous system. They are firing when they are called upon to do so. This means movement quality is preserved.

Some changes in EMG activity do indicate fatigue, which is defined as a reduced ability to produce force, so it should be evident that we can't do a true 1-repetition maximum (1RM) lift when fatigued. But when we are discussing higher repetitions or repetitions in conditions of fatigue, we are not worried about absolute strength; we are worried about developing endurance and work capacity.

If a trainee can do a 75-kilogram clean as a 1RM, he is not asked to do 10s with 75 kilograms. He is asked to do repetitions with much less, on the order of 30-50 percent less.

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But You're a Bad Coach

Poor coaching is often intimated in the accusations levied against those who use higher repetitions with clients. In addition to the implied inability to teach trainees, irresponsibility is also implied.

Unfortunately for those accusers, those they accuse are as qualified as they are, and they fail to understand that trainees can become appropriately efficient with technique on their own (or even if they were coached poorly).

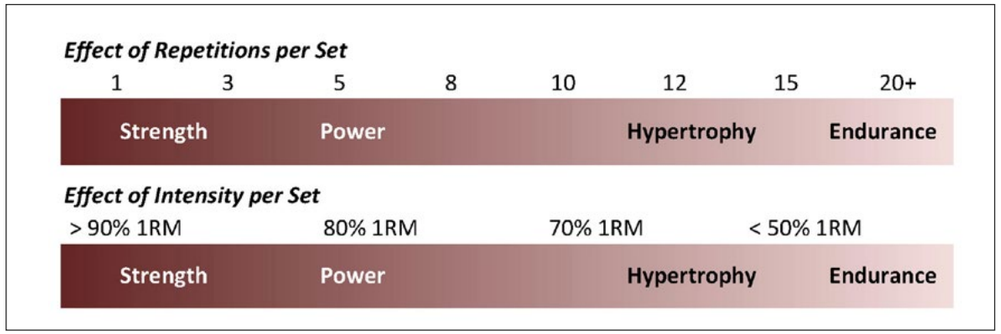
It is not unheard of to have individuals learn to do complex motor skills simply by imitation and without coaching input. A large percentage of weightlifters from the early and mid-20th century (and before) learned how to lift independently. If a coach was available in the small lifting community, it was a luxury.

Somewhere in the annals of the Iron Grapevine column in York Barbell's Strength & Health magazine is an early-'70s reference to this author's being a top prospect out of the Midwest, an observation based primarily on technique, which was largely learned through independent trial and error outside year round on a concrete patio in Mexico, Missouri, initially with Sears Orbitron weights.

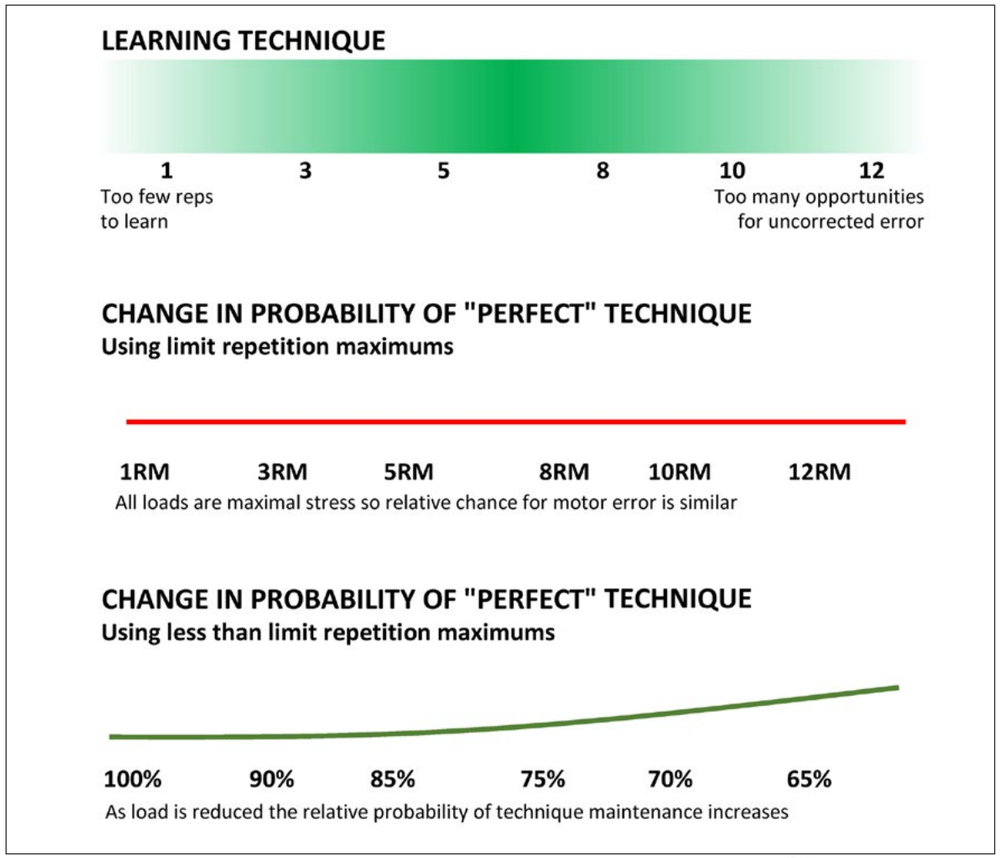
Even today, a very recent world champion and Olympic javelin thrower lists his coach as YouTube.

Learning exercise technique takes attention, dedication and effort, but is not the tremendously difficult task it is often made out to be. It can be accomplished independently by isolated trainees if they are attentive, studious, creative and persistent.

Not everyone wants to learn how to exercise alone. Some individuals have learning styles that respond better to external input. Coaches and trainers are important in both instances as they make learning easier, faster and more effective. They are extremely valuable assets if they don't let ill-informed preconceptions interfere with their training of clients.



With maximum efforts, form variations are equally likely no matter how many reps are performed. As loads are reduced, it is increasingly likely that form will be maintained.



Each end of the repetition contiuum targets different aspects of fitness. This is independent of the movement selected.

A Continuing Problem

So why does the debate about high-rep Olympic lifting keep coming to the forefront?

Availability of information is a blessing and a problem for new trainers and trainees. The internet allows every opinion to be published whether it is supported by fact or not. If the right person writes something that strikes a chord and garners lots of views, it can erroneously assume the mantle of authoritative fact. It is often difficult to discriminate between fact and fallacy.

And this is where it is important for trainers to understand science. Being able to apply simple anatomical, physiological and physical principles to fitness can prevent the adoption of errant conjectures as supported fact. This helps you use the right tool for the right purpose at the right time. Trainers, even though they are busy, need to take time to read critically and grow professionally.

We cannot completely blame the open nature of the internet for the recurrence of such controversies. Exercise science needs to be better. Without actual high-quality data, we will never be able to move our level of understanding from conjecture to theory. Without reliable data, we cannot say whether 3 sets of 10 are better than 10 sets of 3 to produce strength. The data does not exist. Without reliable data we cannot determine how fast strength and endurance decay over the lifespan if we train. We can only conjecture using limited data. Change is needed in how exercise science is funded and conducted, as brilliant professors cannot get support to do quality research addressing essential questions.

Finally, we need better and unbiased "authoritative references" from professional organizations that espouse their eminence within the fitness field. The argument between high-repetition proponents and detractors cannot be settled using any of these organizations' books. Those groups, which had noble intentions at creation, have devolved into confused tangles of revenue streams that no longer serve the needs of working fitness professionals and the exercising public.

Ultimately, the best advice to trainers and trainees is to strive to use the best technique individually attainable on every repetition and to not adopt a dogmatic position about high-repetition Olympic lifts because both ends of the repetition continuum produce different fitness gains effectively and safely. ■

About the Author: Lon Kilgore earned a Ph.D. from the Department of Anatomy and Physiology at Kansas State University's College of Veterinary Medicine. He has competed in weightlifting to the national level since 1972 and coached his first athletes from a garage gym to national-championship event medals in 1974. He has also competed in powerlifting, the first CrossFit Total event, wrestling and rowing. He has worked in the trenches, as a qualified national level coach or scientific consultant, with athletes from rank novices to the Olympic elite, as a small business owner, and as a consultant to fitness businesses. He was co-developer of the Basic Barbell Training and Exercise Science specialty seminars for CrossFit (mid-2000s) and was an all-level certifying instructor for USA Weightlifting for more than a decade. He is a decorated military veteran (sergeant, U.S. Army). His illustration, authorship and co-authorship efforts include several best-selling books and works in numerous research journals. After a 20-year professorial career in higher academia, he currently delivers vocational-education courses through the Kilgore Academy, provides online commentary and analysis of exercise-science papers, and works as a writer and illustrator. He has done Grace, Isabel, Randy and Diane with the same technique he uses with heavy singles, doubles and triples—and he's not that talented; most people can do the same thing.