The truth about recovery

Carrying out great training is not just a matter of conducting tough, high-quality workouts, but the ability to recover well and fast. just a small percentage of amateur athletes actually reach their pinnacle of fitness. The reason for that is not that athletes are lazy; most work very hard. The real problem is that high-quality work is a double-edged sword: it can lead you to your highest-possible level of performance, or it can destroy your ability to perform as well as you can. Doing too much hard training can devastate your muscles, harass your hormonal system, and implode your immune system. Strenuous training must be balanced optimally with rest and recovery in order to reach the mountain-top.

Unfortunately, identifying the right balance of hard work and recovery is the most difficult part of serious training. It's much more intractable than the creative process of determining which workouts will actually be undertaken. If your training program has too much recovery, you won't be able to carry out enough quality work to reach your peak. If your schedule has too little recovery, muscular trauma will accumulate steadily over time (because muscles won't be able to repair themselves properly after workouts), until performances actually worsen instead of getting better. As noted training theorist Tudor Bompa said in his popular book Theory and Methodology of Training, Recovery should be so well understood and actively enhanced that it becomes a determinant component in training. In other words, recovery must do more than simply rest the muscles; it must actually move fitness upward.

For that to be true, you must completely understand recovery. You must know exactly what recovery is and precisely how long it takes. Just as you actively work to upgrade your speed of movement in competitions, you must also learn techniques for increasing your speed of recovery, so that the amount of quality work you do can be progressively expanded.

What exactly is recovery?

Understanding recovery is the easy part. It's simply the repair of the damage which naturally occurs to structural proteins in muscles and connective tissues during a workout. If you're a runner, those structural proteins are traumatized by the impact forces associated with running; some proteins are literally torn apart by the eccentric forces which occur as muscles are stretched under tension during the gait cycle. If you're a cyclist, swimmer, skier, race-walker, etc., the impact forces are lower or non-existent, but your muscles still are strained by the forces required to carry out your workouts. Recovery is also the restoration of the energy-producing enzymes inside muscle fibres which are naturally broken down during training. In addition, it's the refilling of the carbohydrate fuel stores within muscle cells, fuel depots which are at least partially emptied during workouts. And it's the return to normal of the endocrine, nervous, and immune systems, all of which are perturbed by a bout of physical training.

However, it's important to remember that if training is proceeding correctly, muscles should do more than just restore their status quo during recovery periods. Rather than merely repair existing proteins, they should add additional proteins to their overall structure in order to increase strength. They should also synthesize greater-than-normal quantities of aerobic enzymes in order to expand lactate threshold and VO2max. And they should store unusual quantities of energy so that the durations of quality workouts can be extended and high-quality speeds can be maintained for longer periods of time during races. If these extra processes do not occur, then one would never improve in response to training. Race performance times would be constant (or deteriorate if recovery processes could not even preserve the status quo).

A one-armed study

But how long does it take for the body to fully recover and perhaps adapt after a strenuous workout? Recently, researchers at McMaster University in Hamilton, Ontario, and the Washington University School of Medicine in St. Louis made a stab at determining how long recovery really takes.

Their subjects, six healthy young men who regularly engaged in weight training, carried out four sets each of biceps, concentration, and preacher curls (12 sets in all), with three to four minutes of rest between sets. Resistance was set at 80 percent of maximum (ie, 80 per cent of the heaviest weight which could be lifted successfully once only), and each set consisted of as many reps as a subject could handle (The Time Course for Elevated Muscle Protein Synthesis following Heavy Resistance Exercise, Canadian Journal of Applied Physiology, vol. 20(4), pp. 480-486, 1995).
A unique aspect of the research was that each athlete carried out the curls with only one arm, while the other arm rested. The scientists used an isotope tracer to determine protein uptake in the exercised arm, comparing it with routine protein synthesis in the arm which had not done any lifting.

Based on this study and a previous investigation, the scientists determined that the rate of protein synthesis in muscles stressed by a hard workout increases by about 50 per cent four hours after the rugged workout is over, while the rate of synthesis in muscles not used during training remains unchanged. This is evidence that muscles are repairing damage accrued from the workout and perhaps building new structures to make themselves stronger and more fatigue-resistant in the future (if this were not the case, protein synthesis in the exercised and unexercised arms would be the same).

How long does it take?

This repair and perhaps renew process seems to peak about 24 hours after a workout, when muscle protein synthetic rate was up by a hefty 109 per cent in the McMaster-Washington research. However, the McMaster-Washington scientists found that about 36 hours after a rough workout, the building process is pretty much over, and the muscles are back to routine housekeeping. It's important to point out that this study was carried out with experienced weight trainers; novice lifters might have required a longer recovery process. It's also important to note that the research was conducted with strength rather than endurance athletes, so the recovery process might proceed within a different time frame following an endurance-type workout. Note, too, that a more difficult workout might have required longer recovery.

Finally, there is undoubtedly variation between athletes. For example, although the average recovery time was 36 hours in the McMaster study, some individuals might be finished recovering just 30 hours after a similar workout, while others could take 40 to 48 hours. As you can see, lots of factors can interact to determine recovery time.

The 36-hour scheme

However, if recovery time truly averaged 36 hours or so after high-quality endurance workouts, there would be some intriguing implications. As a case in point, you might carry out a high-quality workout early on Monday morning. 36 hours later you would be recovered, so you could do some intervals at a high intensity on Tuesday evening. 36 hours after that, you would be ready again, so you might complete some hill climbing (or swimming against resistance if you're a swimmer) or some fast reps on Thursday morning. By avoiding working out at the same time every day and by using the 36-hour recovery principle, you would have completed three good sessions in the Monday-through-Thursday time slot, instead of your normal two, and yet achieved excellent recovery. You could then take it very easy (or do nothing) on Friday and compete in a race or carry out a long workout on Saturday. After an easy Sunday, you would be ready to resume your 36-hour, training-recovery scheme.

However, there's an even more appealing aspect to the McMaster research. An elite athlete might carry out a variety of different workouts and using the radioisotope technique perfected by the McMaster scientists check leg-muscle recovery after each type of training session. The same athlete could then carry out his/her high-quality sessions at almost the exact moment at which recovery from prior training was complete.

By doing this, little training time would be wasted (unnecessary recovery would not be undertaken) and more quality work could be wedged into any particular cycle of training.

But here's the rub

Of course, the only nettlesome point in all of this would be the unpredictable effects of accumulated fatigue. For example, an athlete might normally take 36 hours to fully recover from a particular interval workout. However, if two days prior to the interval session the athlete had undertaken an unusually tough training session, he/she might not be fully recovered at the outset of the interval workout. As a result, recovery from the intervals would take longer than expected (because the muscles would have to repair problems not only from the intervals but from the previous hard exertion as well), and the athlete who confidently embarked on yet another quality session 36 hours after the intervals, believing that his/her muscles were in good shape, could in fact be training in a

quality way much too soon, increasing the risk of injury and burn-out.
Since determining optimal recovery time can be tough, it's very important to take specific steps to speed up recovery time. By doing so, you'll decrease the risk that you are piling up too many quality training sessions within one portion of your training cycle, and you'll enhance your chances of really adapting to your training.

Speeding up recovery

But how can you hasten recovery? As we've mentioned many times before in PP, one of the best ways to accelerate recovery is to take in an adequate amount of carbohydrate shortly after a workout is over. You're a wise athlete if you consume 300 to 400 calories of carbohydrate shortly after a workout is over and another 300 to 400 calories of carbs within the following two hours.

Our rationale for recommending this carb-replacement strategy is that it appears to be an excellent way to increase the likelihood that muscular fuel stores will be replenished in time for subsequent workouts. After all, muscle cells are most receptive to the idea of taking on carbohydrate during the two-hour window after a workout is over; after that, the carbo-storage process slows down, even when rich lodes of carbohydrate enter the body.

But there is an additional reason to reach for the carbs shortly after a training session is over. As it turns out, the post-workout carbohydrate also has a positive impact on protein restoration in muscles, because it both inhibits protein breakdown and stimulates protein synthesis.

And now, a one-legged study

We know this thanks to some excellent work carried out by the same research team which completed the radioisotope-recovery studies mentioned above. In their new investigation, eight men who had been carrying out regular resistance training for at least one year challenged the quadriceps muscles in just one of their legs by performing an exhausting series of knee extensions (eight sets of 10 reps at 85 percent of their one-repetition max). Immediately after these cruel exertions and again one hour later, they ingested either a Nutrasweet-dulcified placebo or a carbohydrate supplement containing one gram of glucose per kilogram of body weight. Since the men weighed about 75 kilograms each, this meant that they were taking in 300 calories of glucose right after the workout and also one hour later. Using their familiar radioisotope technique, the researchers looked at protein synthesis in both the exercised and unexercised legs (Effect of Glucose Supplement Timing on Protein Metabolism after Resistance Training, Journal of Applied Physiology, vol. 82(6), pp. 1882-1888, 1997).

As it turned out, protein synthesis was 36-per cent greater in the exercised leg, compared to the non-exercised leg, when the men took in glucose after the workout. In other words, the glucose was spiking protein synthesis in the exercise-traumatized leg but doing little for the leg which had not engaged in training. Meanwhile, the protein-synthesis rates in the exercised and unexercised legs of the placebo (no-carbohydrate) subjects were exactly the same! Since protein synthesis was not increased in the exercised leg when no glucose was taken on board, the processes associated with recovery were simply not initiated.

In addition, protein breakdown in the exercised legs was significantly lower when glucose was taken after the workout, compared to when placebo was swallowed. Thus, the ingestion of carbohydrate after the training sessions led to a much more positive protein balance in the athletes' bodies (protein balance is simply net protein synthesis minus protein destruction) and therefore was associated with a much more effective recovery.

You might be shocked to hear that protein breakdown would occur inside muscles after workouts. After all, why would muscle fibers want to tear themselves down following a bout of physical exertion? As it happens, this teardown is actually part of the remodeling process that muscle cells undergo after stress; damaged structures and enzymes are destroyed to make way for the new proteins which are about to be created. In addition, if fuel is not quickly supplied to the muscle, some proteins may be broken down and used for energy to keep the muscle cells viable until the empty energy depots are re-filled.

Carbs helping proteins

Why did carbs have such a positive impact on protein creation and why did they thwart protein destruction? They may have helped protein synthesis in a couple of key ways. First, the inflow of carbs may have simply given the muscle cells the necessary fuel to embark on the project of rebuilding. Using this carbohydrate energy, the muscles could grab amino acids from the bloodstream and kick-start the process of creating new proteins.

The carbs also boosted the production and release of insulin from the athletes' pancreases; plasma insulin values were three to eight times higher after the workout in the glucose group, compared to the placebo exercisers. Insulin is a noted anabolic (tissue-building) hormone which has a profound positive impact on protein synthesis in muscles. Insulin also tends to suppress protein breakdown.

The lessons from this research are important and obvious. By taking in ample amounts of carbohydrate immediately after training and again an hour later, athletes can get a head start on re-fueling their muscles after workouts, but they will also shape muscle-protein dynamics to favor protein creation and disfavor protein catabolism.

That is THE essential aspect of the recovery process. Athletes who fail to take carbohydrate following their workouts because of sheer negligence or a desire to shed weight are losing out in the long run, because their recovery processes are sub-optimal.

What about endurance athletes?

You might have noticed that both of the studies described above involved strength training. Would the same kind of results be obtained with endurance athletes? That is, do endurance-type workouts produce the protein-breakdown and protein-synthesis rates which are associated with strength sessions?
Research in this area is somewhat sparse, but a couple of years ago investigators at the University of Texas Medical Branch at Galveston studied seven female collegiate swimmers who carried out an interval workout consisting of 4600 total metres of swimming and on separate days a whole-body resistance-training session and also a super-session which combined the interval and strength workouts into one big bout of training (Muscle Protein Metabolism in Female Swimmers after a Combination of Resistance and Endurance Exercise, Journal of Applied Physiology, vol. 81(5), pp. 2034-2038, 1996).

The resistance workout was a tough one, consisting of three sets of six reps of bench presses at 80 per cent of the one-repetition max (1 RM), three sets of 10 reps at 65 per cent of 1 RM for military presses, side laterals, latissimus pull downs, biceps curls, triceps pushdowns, leg presses, leg extensions, leg curls, hip abductions, and hip adductions, and two sets of 30 abdominal crunches. Rest between sets lasted for only 60 to 90 seconds.

Meanwhile, the endurance-training workout, which was typical of the kind of session conducted routinely by the collegiate swimmers, included a warm-up consisting of 500 meters of freestyle swimming, 200 meters of kicking, 200 meters of pulling, and 200 meters of technique drills. The main portion of the session was composed of 10 200-meters intervals at an intensity of 85 to 90 per cent of max heart rate, four 100-metre kick intervals, two sets of four 25-metre pull intervals, plus a 200-metre cool-down. Recovery swims between intervals accounted for the other 700 meters of swimming. As mentioned, the strength-plus-endurance workout simply combined the weight workout described above with this interval session.

What were the recoveries like?

As expected, protein synthesis was greatest after the combined resistance-interval workout, but interestingly enough protein creation tended to be about 35-per workout.

Thus, there's clear evidence that endurance-type work initiates a recovery process which may be even more dramatic than the restoration which occurs after a pile of tough resistance work. In addition, the rate of protein breakdown was about equal after the resistance and endurance-type interval training.

Given that swimming has none of the impact forces associated with running, those findings are very important for runners. One would expect that an intense running workout would produce even more protein breakdown than a swimming session and therefore necessitate even greater protein-synthesis rates following training. Thus, it appears that runners need to be especially scrupulous with their post-workout nutrition.

Overall, the lesson is that combining an endurance workout with a strength session seems to create a need for even more dramatic protein building, compared to performing a single session. Therefore, you need to be extremely vigilant with your recoveries on days when you complete both strength and a quality endurance workout. That particular combination requires extra carbs after each session (or extra-extra carbohydrate if the two types of training are combined in one long workout), extra sleep during the night after the workouts, and a light day of work the next day.

Here are the key things to remember about recovery:

1. If you feel tired or sluggish on a particular day, don't train or train very, very easily: Your body is telling you that what you need is recovery, not hard work. If a quality workout was scheduled for the day, postpone it and carry it out the following day if you feel better, as long as you don't have another quality session scheduled for the day after that. Two quality sessions in a row are usually too much, especially if you have been experiencing above-normal fatigue.

2. To increase the number of quality workouts you carry out (i.e., to avoid spending too much time recovering), try to use the 36-hour principle. For example, you could perform a quality workout Tuesday morning, another Wednesday evening, and a third intense session Friday morning, thus fitting three tough sessions into a time frame which usually accommodates just two. You could then take Saturday off and complete a long workout on Sunday.

3. To jump-start recovery and be kind to your muscle proteins, make sure you replenish yourself with ample amounts of carbohydrate shortly after your training sessions.

4. Ultimately, you are the best judge of how well you are recovering between workouts.

If you look forward to each week of training and approach your quality workouts with high energy and determination, you are recovering well perhaps too well, but it is better to recover too well than to recover poorly (recovering too well means you could probably carry out your difficult workouts sooner than you usually do). If you are feeling tired during many of your weekly workouts and your performance times are a bit off, it's quite likely that you can improve your performances not by working harder but by increasing the quality and quantity of your recovery.

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