Starting Strength

Training Female Lifters:
Neuromuscular Efficiency

by

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In a previous article I stated, "The reason why women's deadlifts don't always obey this rule hasto do with the same reason women can perform a much higher percentage of their 1RM for reps, but that's a subject for another article." This was in reference to ideal deadlifting mechanics, and specifically refers to the fact that women can pull a deadlift with worse technique than men can at the 1RM-level of effort.

If I need to tell you that women are physiologically different than men, you either have not coached both men and women or you have not been paying any attention while you were. A 1RM effort performed by a female trainee is a different event than a limit rep performed by a male lifter.

Several Observations

1. **Women can perform a much higher percentage of their 1RM for a set of 5 than men can.** Most women can do 5 reps on the bench press within 5-7 pounds of their one rep max. A woman with a 100-pound bench can normally do 95 for 5 reps – 95% or perhaps even as much as 96-97% of their 1RM for 5. In contrast, men generally work with sets of 5 about 85-87% of their 1RM; a 350 bencher can usually triple 315 and do 5 with 300. This is not because women possess the fictional quality known as "strength endurance." And it's not that she's "very efficient with the use of her strength." It is because a 1RM for a female is not the same type of limit lift that it is for a male lifter. So when she does a 5RM close to her 1RM, it's really the 1RM's fault.

Funny story: a long time ago I took a female trainee to a powerlifting meet. Rosellen was just getting started, and I have always been a believer in the power of competitive pressure to improve a person's training. Her opening deadlift was an easy 220 – looked like a set-of-5 weight – and I, having apparently not paid close attention to her training lifts, decided that 237 would be an excellent 2nd attempt.

It was welded to the floor. Didn't move at all. A guy would have at least broken it loose, but she couldn't put even a crack of daylight between the plates and the platform, despite pulling on it for several seconds.

This was entirely my fault. My observation at that time that she could have done a set of 5 with 220 was entirely compatible with the actual and unrealized-by-me fact that her 1RM – that day, anyway

– was probably about 231, maybe. So, good second and third attempts would have been 225.5 and 231. So, 220 wasn't heavy, but 237 was in excess of her limit. There was a spread of about 5% between what could have been pulled for 5 reps and a limit single. This phenomenon, and the observation that there isn't much room between a woman's opener and her 3rd attempt, was the probably one reason that Olympic weightlifting went to the one-kilo rule for increases between attempts after the women's division was added to the Olympics.

2. **Even after concentric failure, women can continue to exert eccentric control over a load.** Second funny story: I decided to experiment with my dawning awareness of this phenomenon on a gal from the gym doing the incline bench press. I haven't used the incline in decades, but at the time it suited my purposes because the construction of this particular bench made it very easy to spot the exercise. Kay was fairly strong, and had been training several months. I warmed her up, then loaded 65 pounds on the bar and started the set. She finished 6 reps by herself, and failed at 7. I helped her up with the 7th rep and told her to lower the bar under control. Kay did 13 more reps under eccentric control, for a total of 20 after concentric failure had occurred at 7. Later that week, she reported minimal soreness, and was ready to train again.

In a similar situation, a guy would get 2 more reps, and then be able to isometrically hold one more, maybe. But 13 controlled negatives after failure doesn't happen to a male trainee. Because a set of 5 or 6 reps to failure produces sufficient fatigue to shut down further muscular effort in a male, but not apparently for Kay. Even after they reach failure during a set, women retain the ability to continue generating force eccentrically long after a male would have fatigued to the point of eccentric failure.

3. As previously mentioned, **women can perform a 1RM personal record absolute-strength-dependent squat, press, deadlift, or bench press with less than perfect technique,** which post-novice male lifters can't usually do. No personal funny story this time – look it up yourself. Youtube is full of videos of female lifters performing record or personal record squats, bench presses, and deadlifts with sloppier form than males can use for limit attempts, although it may take a trained eye and frame-by-frame video to detect the problems.

Heavy squats and pulls must move in a vertical line over the mid-foot for efficiency of balance and leverage mechanics. Yet their lifts are completed, are in fact PRs and record performances, and are impressive displays of strength, despite the fact that they could be better technically, and the fact that men would miss attempts with a similar level of technical irregularity. Women can lift "heavier" weights with a lower dependence on technical perfection than men, who must increase mechanical efficiency as the weight goes up. Women *should*, but men *have to.*

More Observations

1. The Standing Vertical Jump is a standard test for explosive power. It measures the difference between the height of the maximally upraised hand and the height of the hand at the top of a jump initiated

with a single countermovement drop and no foot movement. The average women's Standing Vertical Jump (SVJ) is 14 inches. It's very hard to find a record – there is a 29.5-inch jump listed at Nebraska track and field in 2002. In contrast, the men's average is 22 inches, with a 46-inch jump at a 2006 NFL combine being the best controlled record I can find. So both the average and the record women's SVJ is 64% of the men's. (This refers to the standard controlled performance of the SVJ, not the internet version.)

Contrast this with the fact that women's individual timed sports performances average about 90% of the performances of men, across all timed sports.

2. Men's and Women's divisions exist in all athletics events in which both sexes ("gender" is a linguistics term – our discussion here refers to a person's physical sex) participate. If golf is segregated by sex, you know that profound differences in physical performance exist between the sexes. Some sports – badminton, tennis, squash, table tennis, curling, "korfball," figure skating, and a few others – feature mixed competition, where teams consist of both men and women. The equestrian sports feature both riders and horses of both sexes (including geldings) in the same event. But no legitimate competitive sport pits human females against human males directly.

3. Men's and women's combat sports are particularly segregated, due to the high injury potential a mismatch presents. Men and women train and spar together in many dojos, but there are no serious competitive venues for mixed matches that count towards the record. Yes, at the professional level, the best woman can beat the worst man in her weight class, but that's not how fights are arranged in actual sports. And that's obviously not the point.

Some Speculations

Speculation 1: Women tend to be more flexible than men. Range of motion around a joint is associated with the ability to relax into a stretch, a skill that must be learned by inflexible people. I assure you that there are significantly more inflexible men than women. Could it be that this phenomenon is associated with the issue of men's vs. women's strength?

Speculation 2: Most people who train women report that their female trainees have significantly less delayed onset muscle soreness (DOMS) than their male trainees. (DOMS is associated with unadapted-to eccentric loading.) Their soreness lasts for a shorter time, and it interferes less with their training than it does with a male. This could be attributed to either a lower volitional training intensity, or to inherent differences in the quality of the eccentric loading women experience. Kay's ability to work eccentrically far beyond concentric failure indicates both a lack of fatigue from the preceding concentric work and a lack of fatigue during the eccentric work itself. It's quite likely that she was *unable* to work hard enough against the bar to approach a more typical-for-a-male response pattern.

So, how to explain these observations? It's rather obvious that testosterone is involved, but what does it do that explains this particular aspect of sexual dimorphism? Testosterone has profound effects on neuromuscular efficiency. And neuromuscular efficiency is the primary physical difference between

men and women. It accounts for the differences in strength evident even at similar lean body masses, and all the factors cited previously.

Finally. The Point.

A 1-Repetition Max "PR" is, theoretically, a maximum motor unit recruitment event, an indication of your motor nervous system's ability to recruit a maximum number of the muscle's contractile components – and therefore the maximum amount of muscle mass – into a muscular effort. A 1RM is essentially a combination of your neurological and muscular ability, a display of your maximum force production capacity through the "recruitment" of very high numbers of "motor units" – the basic component of the muscle's contractile machinery, one motor nerve and all the muscle fibers it controls – into contraction. Most authorities reckon that a true 100%-of-motor-unit-recruitment event is impossible, and I've seen 95-98% batted around as the most likely cap on neuromuscular efficiency.

This efficiency decreases with age, unfortunately. But it also varies with genetic endowment, *and sex*. Neuromuscular efficiency explains the spread between average and elite athletic performances, between the performances of younger and older athletes, and between male and female athletic performances.

Athletic performance in most sports is greatly dependent on *power*. The ability to explode is the ability to display strength quickly, to recruit huge numbers of motor units into contraction in a very short time, and is another way to describe neuromuscular efficiency. If men can recruit 98% of their motor units into a 1RM contraction, women are only able to recruit some lower percentage into the same relative effort – maybe 90%, maybe 85%, maybe less. Quite literally, a 1RM for a male and a female are two different neuromuscular events.

Strength and Power

Strength and power are intimately related. The math is: Power = force x distance/time. Force is strength, your ability to apply force to an external resistance, like the floor, an implement, a barbell, or an opponent. The distance a load is moved is typically controlled by the circumstances of the display – a clean or a snatch, or a football lineman's action across the line of scrimmage. Time is the period during which the explosion occurs, the time it takes to produce the contraction we want to measure.

Resist the temptation to express power as Force x Velocity, because it's easy to misunderstand the true situation this way. Yes, distance/time is velocity, but in trying to understand muscular power production we are only secondarily concerned with the velocity of the load being moved. Our primary concern is the time it takes to produce the force that moves the load – the explosion of muscular force itself and not the result of the explosion.

Strength and the ability to display it quickly are also intimately related in that "genetically" gifted explosive athletes are also stronger than more average athletes when they start training. If a kid comes into the gym with a 36-inch SVJ, he always squats quite a bit more – maybe twice as much – as a kid with a 16-inch vertical on the first day of training.

The Limitations

Here's the bad news: Human athletic capacity is pretty much limited by genetic and congenital endowment. The *genetically*-controlled aspects are anthropometry, which influences leverage efficiency

in the mechanical expression of force production. For example, long tibias and shorter femurs are associated with sprinting efficiency, height and skeletal size often determine the sports in which the athlete may excel – basketball, football, and jockeying are obvious examples of sports that select for anthropometry.

Explosion and neuromuscular efficiency are associated with nervous tissue quality (the link between brain and muscle is long and complicated, and can display varying amounts of functional capacity), the quality of the nerve/muscle interface, and the contractile characteristics of the sarcomere proteins themselves. The ratio of Type I to Type II muscle fibers is fixed, and along with neurological tissue limitations (think about how difficult it is to heal a damaged nerve), this represents a significant bottleneck. I'm very sorry, but it's just not possible to make a silk purse out of a genetic sow's ear.

In addition, all of these variable characteristics are subject to hormonal mediation, the result of the congenital sexual expression of the genotype as male or female. Every system that influences human physical development is dependent on the hormonal environment in which it *develops*, and in which it *functions*. Males and females and old and young people have different hormonal environments, both developmentally and functionally. A male, having bathed in testosterone since his pre-natal days, shows its effects in every system of his body, from neuromuscular to behavioral to tonsorial, just as a woman shows its absence in hers. This means that women who take androgens and anabolic steroids can make up some of the differences, but nowhere near all of them. It also means that Caitlyn Jenner shouldn't get to enter the masters division women's heptathlon.

And there is huge variation within the abilities of these systems to respond to their particular hormonal environment, to the extent that much of the cause of this huge amount of variation remains unknown. What is known is that every aspect of physical development is focused through the lens of the hormonal milieu into an individual expression that varies with sex, all other genetically-determined characteristics, and the physical environment in which development takes place. To save time, we'll abbreviate this complex concept as "genetics."

SVJ

The SVJ test is a very good measurement of this "genetic" explosiveness endowment, because it measures your ability to accelerate your own body's mass to impart sufficient momentum to carry you up in the air a measured distance after you stop applying force to the ground. Since the force production that generates this acceleration must occur in the short time it takes to produce a counter-movement jump, the height of the jump is a very precise measurement of your ability to recruit a lot of motor units ***right now*** – this is your ability to explode.

Strength improvement helps, but not much because the weight you're moving is only your bodyweight – pretty light relative to a strong athlete's squat. If you gain muscle mass, force production has increased enough to compensate for the increased bodyweight, but absolute force production isn't the limiter in the SVJ – instantaneous recruitment of the submaximal contraction is.

For this reason, the SVJ is a test of genetics, a pretty good way to assess the genotype of the prospective athlete. It responds quite minimally to practice, because it's not very technical and there's no way to "game" the test if the test administrator is paying attention. A kid who first tests his SVJ with a 95-pound squat, and who later tests it after accumulating a 365-pound squat will show a little improvement, maybe 15%, because the quantity being tested is not absolute force, but the ability to recruit. For this same reason, some very strong powerlifters do not have big SVJs.

The relatively limited ability for neuromuscular efficiency improvement is born out by the evidence of SVJ testing over time. Barring a large bodyfat loss, SVJ improvement is limited to perhaps 20% under the most optimum of circumstances for males, and usually 10-15%. Most women show very little improvement, maybe 5%, and maybe none at all, because of their inherently less efficient neuromuscular capacity. Strength coaches with no countervailing agenda all agree – you just can't improve the SVJ very much, and to the small extent it can be improved, a strength increase is the primary factor. Because of "genetics."

And why would you want to anyway? The test is designed to reveal your natural explosive capacity, not your ability to game the test. It demonstrates the difference between the 12s and the 36s, not the ability of a 26 to get to 30.

The Hard Reality

There will be screaming, I know, but *show us your data.* Rate of force development (RFD) training is very *very* popular right now, completely replacing actual strength training in many athlete's programs. Once again, Youtube is jam-packed with videos about how to avoid getting your squat and deadlift strong. Seminars are available that will certify your ability to teach agilities, cone drills, plyometrics, balance tricks, single-leg dumbbell exercises, and explosive movements with weights too light to make you stronger, in lieu of coaching the heavy lifts.

But RFD training is largely a waste of time, a mere display of what the athlete can already do and not a way to make him better at it. Even if you increase the RFD around a single joint – the knee, for example – this improvement does not result in significant improvement in explosion within the whole system. SVJ does not significantly increase with RFD training, *because the only variable in the power equation that is truly trainable is F.* Force. *Strength.*

Athletes at the professional and D1 college level are explosive, quick, agile, balanced, and coordinated, *or they wouldn't be playing at the professional and D1 level.* They are elite athletes, hired for their genetics. Explosion and power is a genetic endowment, and this is why God made college sports recruiters – and the NFL Combine, which tests for both "genetics," that can't be trained, and strength, which most assuredly can and *should* be trained. Since many, if not most, of these gifted athletes have never been effectively trained for strength, because their coaches have been caught up in the latest trendy RFD/strength-avoidance protocol, their potential remains undeveloped.

Sex. Hey, It Sells.

Sex obviously determines most of the hormonal milieu, in that sex is an obvious aspect of "genetics." But variations between individuals in sex hormone receptor efficiency are also a major determinant of hormonal response. Two young men with the same height and bodyweight, perhaps even the same testosterone level, will have different physical capacities. In general, a younger man will display more neuromuscular efficiency than an older man. In general, a male will show more neuromuscular efficiency than a female.

The difference between natural athletes – the explosive guys with 36"+ SVJs that learn visually quite easily – and their less gifted brethren is quite profound. An explosive athlete, who by definition recruits more motor units, and therefore more muscle mass, into a contraction, receives a different training stimulus from that contraction than an athlete who recruits less muscle mass into the contraction. This explains why less-talented athletes cannot benefit from the same training programs that produce world-class performances for athletes with better "genetics."

The Bulgarian Olympic weightlifting team may well be able to snatch, clean and jerk, and front squat, and that's all. For them, that may be enough training because they're working more muscle mass at a higher capacity with every snatch, clean and jerk, and front squat, as a result of being able to recruit more motor units into each contraction – because of who they are and what they are. In contrast, your narrow ass probably needs to squat, deadlift, and press heavy if you want to have a chance to lift in the same meet with them.

There will be examples of gifted older athletes who are better than less-gifted younger athletes, as well as gifted females who are better than average males, especially older males. Male and female differences, however, remain the most profound predictor of absolute physical capacity. For the same reason that the average male *cannot* be trained to a level of neuromuscular efficiency of the gifted male, the average female *cannot* be trained to perform beyond the average male's trained capacity.

Another obvious implication is just lying there, waiting to piss people off. The role of women in infantry combat positions in the military is controversial, and it shouldn't be. If there is a way to quantitatively evaluate the role of strength and power in the physical demands of combat, and the preparation of soldiers for combat readiness, the differences between male and female physical potential cannot be ignored. As unpopular as this may be politically, the fact remains that the reality of human sexual dimorphism must be dealt with.

The Application of All This Previous Material

How? By taking into account what we know about the differences in male and female neuromuscular efficiency, understanding the implications for training, and planning appropriately. A 1RM for a female is a different neuromuscular event than it is for a male, perhaps only an 85-90% recruitment effort, perhaps less, perhaps more, depending on individual differences. If this is the case, and decades of training experience and much empirical evidence indicate that it is, then a 5RM is also a different neuromuscular event, a different stress, and therefore a different training stimulus. It is lighter relative to a male's 5RM, to the extent that 3 sets of 5 reps do not constitute the same training stress for males and females.

After the first couple of months of training, "heavy" sets of 5 for a female may not be heavy enough to drive the stress/recovery/adaptation cycle the same way it does for male trainees. Therefore, the productive training stress a male can apply with sets of 5 may have to be produced with relatively heavier weights, heavy 3s for example. Volume can be maintained with more sets, and 5 sets of 3 reps have been successfully used to drive a strength adaptation for females longer than 5s have.

And by this reasoning, sets of 10 reps are as pointless for females as 20s are for males who are trying to get stronger. Any weight a male trainee can do for 20 reps is not heavy, even though it may feel like shit at the end of the set. If force production is strength, a weight that requires such sub-maximal force production that it can be done for 20 reps is not heavy enough to drive a strength adaptation for any significant length of time. For women, 10s are the equivalent waste of time if strength is the training objective, and after the initial weeks of training, 5s aren't that much better, because they just

aren't heavy enough for her. Sets of 3, or perhaps even 2s, are required to get close enough to a weight that is actually heavy enough to drive a strength adaptation.

And in fact, experience has shown that 5 sets of 3 for women works as well, and for as long, as 3 sets of 5 does for men. Where men will plateau on 3s after a few weeks, women can train productively with this relatively-heavier-but-really-about-the-same-heavy-for-them program, for months.

Women can train heavier more frequently than men, because they get less sore, they recover faster, and they can deal with more frequent exposures to a training stress, since the stress is lower relative to a male's capacity to beat himself up. Heavy 3s for 4-5 sets 3 days per week, with no light days may be necessary to drive a strength increase in more advanced females. Such a schedule would kill most men, and is necessary for most women.

Women can also train the deadlift more frequently than men, and need to do so to drive it upward. Most men cannot recover from frequent heavy deadlifting, and most men cannot tolerate multiple sets across in a workout. Women need the heavy volume as well as the high intensity of multiple heavy triples, and this is some of the highest quality strength stress they can apply.

Women need less rest between sets than men. Heavy squats for 5 sets across for an intermediate male might take 15 minutes between sets, adding up to a very long workout when the other lifts are added in. Women can recover faster between sets of work that for them is not as taxing as it is for men. This is necessary to keep in mind, especially considering the need for more heavy workouts in the week's schedule and the ability to do the work in a more manageable time frame.

And women's lifting technique, while it can withstand more slop than men's technique will tolerate at limit weights, still obviously needs to be as close to perfection as possible. Just because a lift can be completed with an inefficient bar path doesn't mean you, the coach, are off the hook. If you can't produce close to perfect technique in your lifters, you aren't a competent barbell coach, even though you may be able to hide behind your naturally talented female lifters like many D1 S&C coaches hide behind their recruiters.

But really, what we do know for sure is that women respond to the stress of strength training in a different way, because they produce a different quality of stress from which to recover and thus adapt. The adaptation curve is different, but it still trends upward, like that for all humans exposed to an adaptive stress. We're still learning. Keep these things in mind, and we'll all learn together.

Tom DiStasio SSC, Assistant Strength and Conditioning Coach at Sacramento State University, contributed quite a few ideas to this article. I'm grateful for his experience, his judgement, and his time.

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