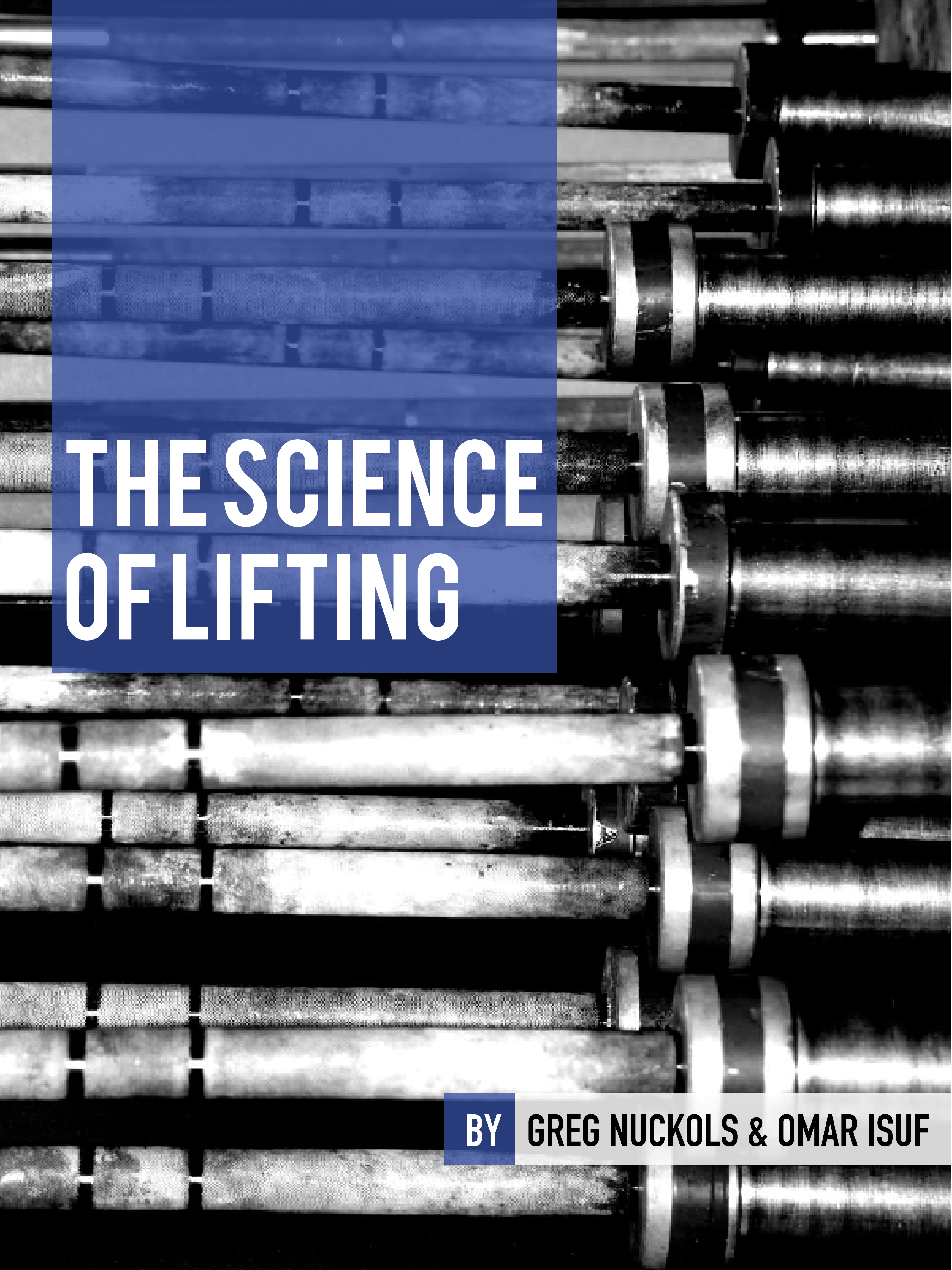
THE SCIENCE OF LIFTING

BY GREG NUCKOLS & OMAR ISUF



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All graphics by Lyndsey Nuckols and Jewelya Williams

CHAPTER 1

What Are Models?

Your body is insanely complex.

Humans, with all of our scientific knowhow and the aid of vast computational power from supercomputers, have just reached the point of being able to model a single cell of the world's simplest organism. We're still a long way from having a comprehensive model for a single human cell, let alone modeling, from the bottom up, how individual cells interact, or how entire organs signal back and forth with each other, or how the human brain works in its entirety, or how it interacts with, influences, and is influenced by the other tissues of the body, and how we interact with other complex organisms (each other) and our environment.

We, as a species, know a lot, and we're quickly learning more every day. But we still have a long way to go to understand all of the workings of a single one of our cells.

Just let that sink in for a moment.

A nihilist, when faced with this realization, would throw his hands in the air and lament: "Compared to how much there is to know, we know effectively nothing. There's no way to understand all of this stuff, so why even try?"

Luckily, I'm not a nihilist, and I think that response is nonsense. Not knowing EVERYTHING doesn't mean we don't know anything. Far from it. We know enough to treat many diseases, put a man on the moon, and split the atom. Heck, hundreds of years ago, Isaac Newton could describe, with stunning accuracy, how the planets move the way they do with nothing but a telescope and some calculus. We, as humans, are really good at doing a lot with astoundingly little (relatively) information.

But, because we don't know everything, we have to construct models.

Models are our way of wrapping our minds around complex systems that we don't know everything about, distilling them down to their most important features, and being able to have a basic idea of how they work and predict how they'll respond to various challenges (stimuli or stressors).

A good model has three main features:

1) It captures enough of the system's complexity to be useful in describing how it works and how it will respond.

2) It accounts for few enough factors to actually be user-friendly.

3) It actually works.

CHAPTER 2

Why Models?

As an athlete, coach, or fitness professional, you have to know a lot about a lot. Programming, biomechanics, recovery modalities, nutrition, supplements, athlete psychology, and the list goes on. There are people who specialize in every one of those specific subjects – who get advanced degrees, do research, and devote their lives to really understanding the ins and outs of one small piece of the pie that you have to concern yourself with.

In a perfect world, you'd know everything about everything. You'd know all the research and be able to talk to elite practitioners in all of those fields to know specific answers to every discrete question you come across. However, in the real world, that's simply not feasible.

That's where models come in. They help you deal with a lot of information without getting overwhelmed, and they help you make useful predictions about specific questions you've never been confronted with before. This is especially necessary when you're in the moment and don't have time to seek out an answer

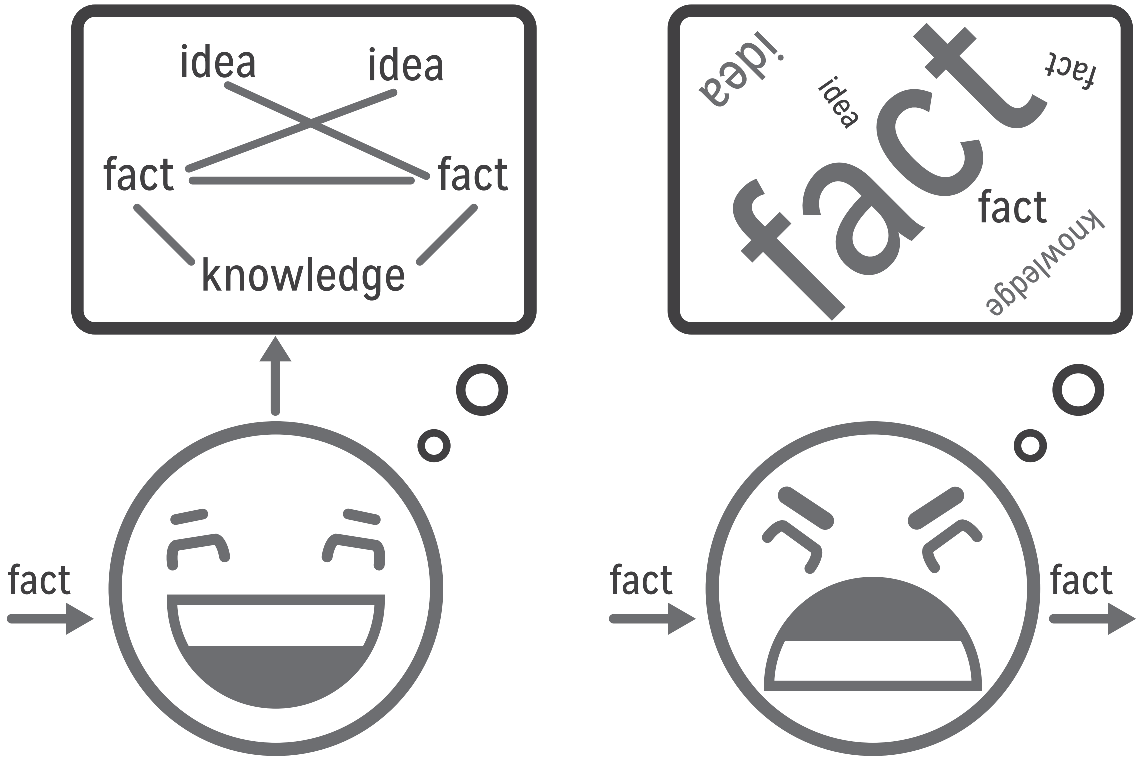


Figure 2.1

to a specific question, or perhaps you're dealing with a question that hasn't been investigated yet in research. If you're equipped with a model that helps answer similar questions, it will help you think through new problems and make good choices.

In effect, models take a LOT of information, and compress it into a manageable amount of information that you can work with. They also make it easier to learn new things, since you already have a mental framework for dealing with similar problems. If I told you a battle took place in a specific city in Sweden during the Great Northern War, you probably wouldn't remember it by tomorrow. However, if you already know Scandinavian history and understand the geography of Sweden, you'd have a much better chance of remembering it. If you're the type that tried to cram the night before exams in college, then freaked out and realized you didn't remember any of it when the comprehensive finals came, that was probably your problem; instead of really understanding the material and having a useful mental framework to hang new bits of information on, you were trying to memorize facts and figures as discrete tidbits.

Basically, *The Science of Lifting* will help turn you into the person who only studied for an hour and aced the comprehensive finals in college; you'll gain a mental framework for retaining information, instead of random discrete facts scattered across their brain. Here's the difference: Instead of getting a 4.0 GPA, you'll get jacked (which is much more important, obviously).

CHAPTER 3

The Power Law Distribution of Non-Stressful Inputs

The basic idea behind a power law distribution is that the majority of your results come from a small number of your inputs, and that further inputs may improve results, but not substantially. You may also recognize this as the Pareto Principle, or the Law of Diminishing Returns. It was the basic idea *The Art of Lifting* was based on.

This is the type of distribution that usually applies to non-stressful inputs to training (usually things that are lumped into the overall category of "recovery.")

For these things, each increase initially yields a large increase in results, but each subsequent input helps a little bit less than the prior one, to the point that eventually the difference is effectively meaningless.

Three examples: Meal frequency, training frequency, and sleep.

Meal Frequency

As a reactionary position to the gospel of "six meals per day to stoke metabolism," people have taken to saying "meal frequency doesn't matter."

Let's think about that for a moment. The most extreme interpretation of this statement would have you believe that eating one meal per week will give you equivalent results to eating three meals per day. I hope we can dismiss that as ludicrous at face value. Total caloric intake is certainly the most important factor for diet success, but it's certainly not everything.

Eating one meal per day is going to clearly be substantially better than eating one meal per week, even if total caloric intake is the same.

Eating three meals per day is going to be noticeably better than eating one meal per day (specifically eating protein spread throughout the day instead of all at once).

From there, though, you're probably reaching a point of diminishing returns. Would six meals be better than three? That's a little hazy. The evidence on untrained populations indicates that it's probably not going to make much of a difference, but for more highly trained people, there may be a noticeable effect (scroll down to "Athletic Populations" here).

How about 10 meals per day versus six meals per day? Probably won't make enough difference to worry about. At that point, you're on the long tail of the power law distribution – the initial increases account for the majority of the results, while subsequent increases matter less and less.

Training Frequency

It's also been popular lately to espouse high training frequency, especially for drug-free lifters. The idea is that each session causes an elevation in protein

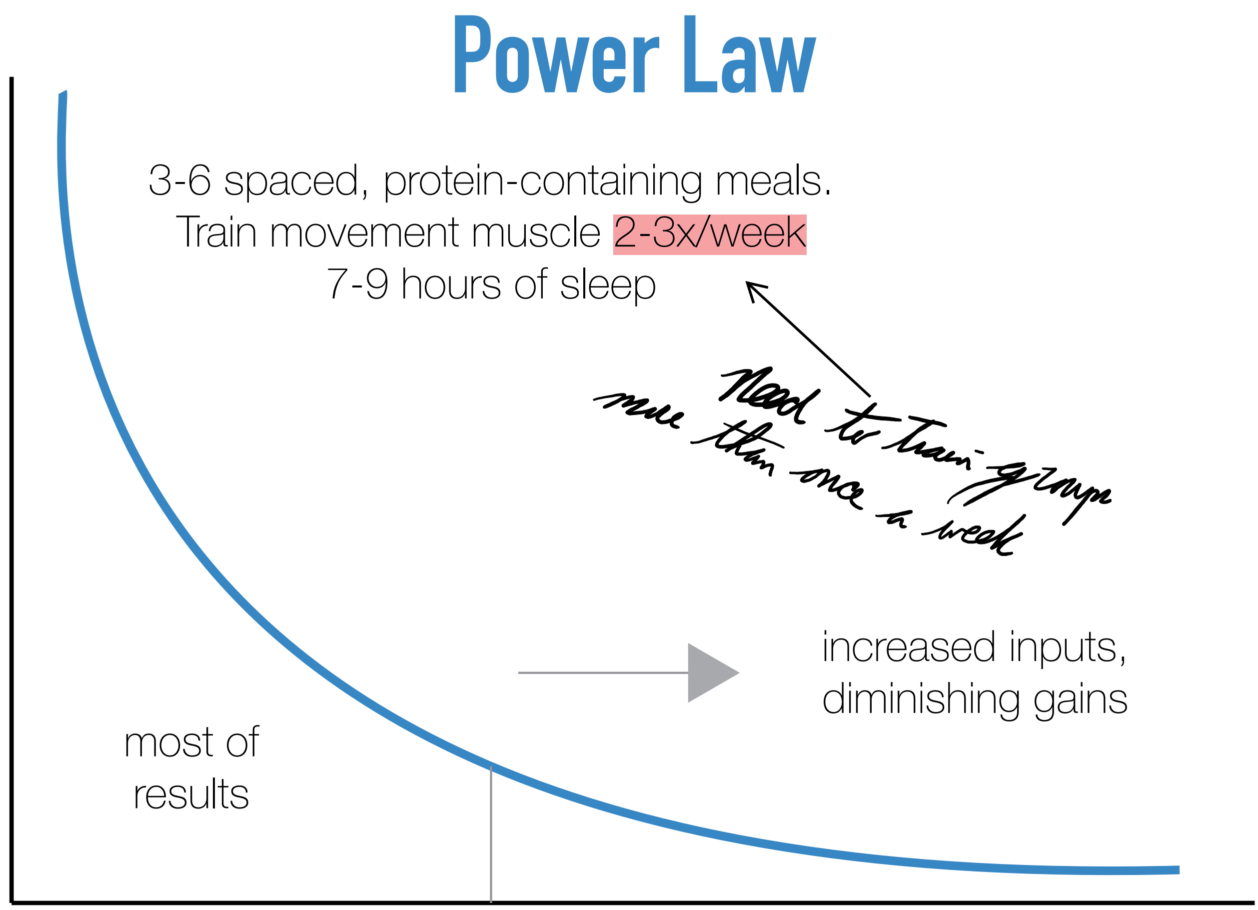


Figure 3.1

synthesis, so you get more "growth cycles" per muscle in the training week. You also get more opportunities to practice a motor pattern, so you master a movement faster.

It's certainly an idea with some merit behind it.

For example, the Norwegian powerlifting team got noticeably better results from doubling the training frequency.

This general trend is seen elsewhere in research. Strength gains tend to be a little better with higher frequency training, and hypertrophy gains seem to favor somewhat higher frequency as well, at least in trained subjects.

However, the same power law distribution still applies. Once per week per muscle or movement will be a lot better than once per month. Twice per week will probably be noticeably better than once per week. However, with each further increase, the magnitude of difference decreases. For most people, the difference between two and three times per week will be small, and the difference between three and four will be minimal.

Sleep

Obviously the most important hours of sleep are your first few hours of sleep. Though it's certainly not pleasant, you can survive on just a couple of hours of sleep per day. Obviously, you can't make gains if you're not alive, so the first few hours of sleep (input) give you the most pronounced "results" – simply staying alive.

Past that point, further benefits accrue by getting a full night of sleep. I've written about this previously, but getting 8 hours of sleep instead of 5.5 hours of sleep can have a substantial impact on your ability to lose fat and gain muscle.

However, there's also evidence that sleeping too much can be harmful to your health. People who sleep 9 hours or more per night are at an increased risk of developing diabetes than their 7-8 hour per night counterparts, though it's probably not a direct cause, but rather an indicator of some other underlying problem (i.e. if you regularly NEED to sleep or CAN sleep more than 9 hours per night, it may be because of some other issue that puts you at an increased risk of diabetes). Apart from that, I'm unaware of any evidence that forcing yourself to sleep more than your body demands is beneficial for health or body composition.

So sleep follows a power law distribution as well, with the largest benefits occurring initially (staying alive), and further benefits accruing as you sleep more, to the point of the 7-8 hours your body requires, after which point it won't make much difference.

• • •

There are obviously other factors that fall under the umbrella of "recovery" as well. These are just a few examples to illustrate the point.

When you're thinking about factors such as these, even if you don't have the time to keep up with all the scientific literature (which is darn near impossible, especially if it's not basically your full-time job), you can just adopt this mental framework for thinking about such factors. The largest benefits occur initially, with further benefits accruing with increased inputs until you get to a point that further increases won't make much of a difference.

CHAPTER 4

Curvilinear Effects of Stressful Inputs

When thinking about stress, it's always useful to start with the General Adaptation Syndrome in mind (we'll discuss this is more depth in the next chapter). Very small amounts of stress won't provoke a very robust adaptive response, but more stress increases adaptation. However, too much stress – to the point that you can't cope with it physically or psychologically – also decreases the rate of adaptation. An important factor to keep in mind is that your body doesn't differentiate between different types of stress to a great degree. Although the specific adaptations to different types of stress (lifting weights, a car crash, tight deadlines at work, etc.) differ, your body's general response when it encounters and copes with any stressor is very similar for any stressor you encounter. This means (to simplify things a bit) that all the stressors in your life pool together, and dip into the same reservoir of "adaptive reserves" that are available for recovering from those stressors, allowing you to adapt so you'll be better equipped to handle them next time. In the case of strength training, that means bigger, stronger muscles, more resilient tendons and connective tissue, and bones that can handle heavier loading.

Your body needs a certain amount of stress simply to function normally. Remove all the stressors from your life, and your body begins to deteriorate. For example, if you won the lottery and spent a year laying on the couch, watching reality TV – facing no stressors that challenge you physically or mentally – you'd be much weaker and in much worse health than you are now with some baseline level of physical and psychological stress in your life.

Past that baseline level, further stress causes beneficial adaptation, with diminishing returns and eventually negative returns. The first input of any sort of stress tends to cause the largest beneficial adaptation, with further stress having an additive effect, though each additional unit of stress doesn't add as much additional benefit as the first one did. However, once the total amount of stress you're coping with (physically and psychologically) exceeds the threshold of what your "adaptive reserves" can handle, additional stress begins having negative effects.

Application to Training

The easiest way to visualize this concept is by looking at the integral of a skew right normal distribution with x-intercepts at 0 (for an untrained lifter – more on that later) and some arbitrary positive number. If those words mean nothing to you, don't worry - the pictures should help you make sense of it.

Figure 4.1 shows one such curve sketched out, with intercepts at 0 units of stress (no stress means no adaptation) and 4 units of stress (the maximal amount

The Training Stress Response Curve

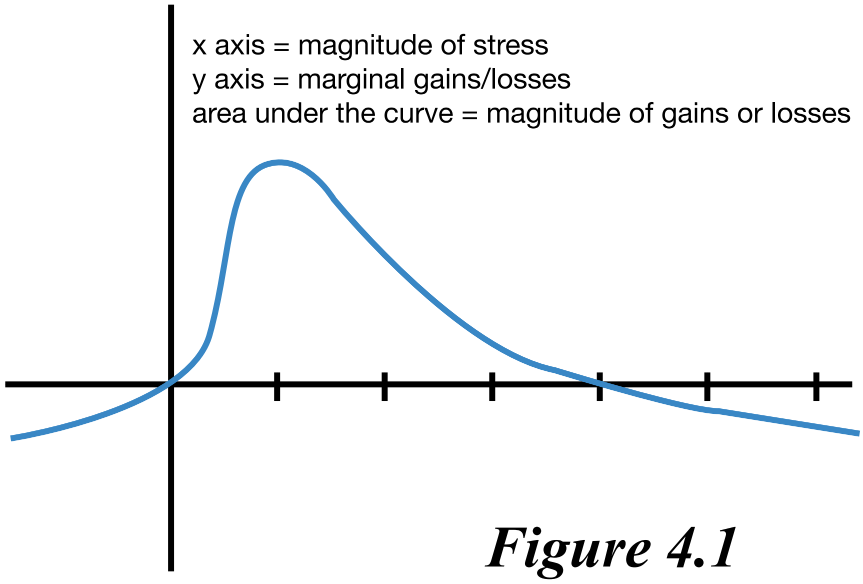


Figure 4.1

The Magnitude Of Adaptation From A Small Stressor

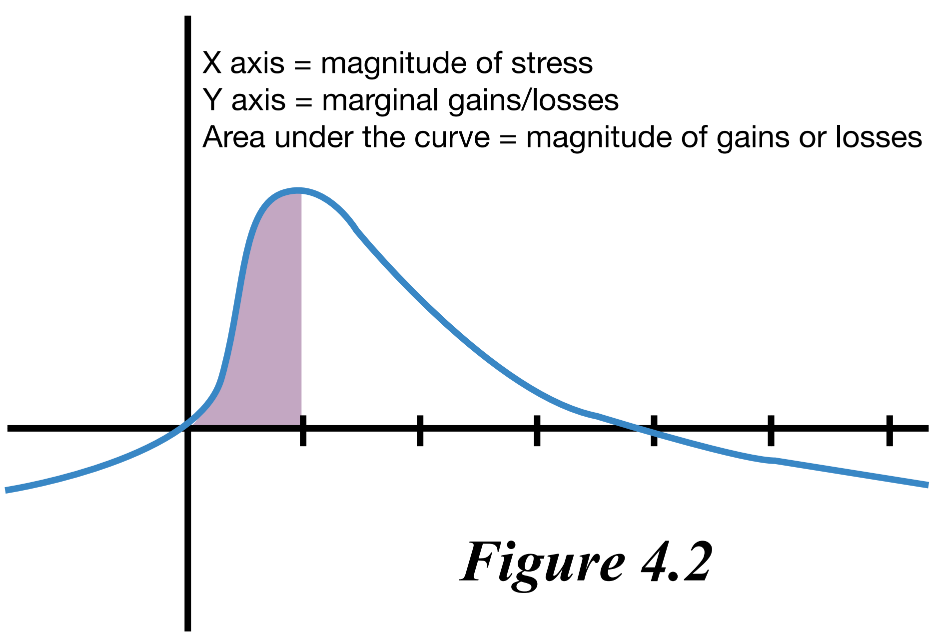


Figure 4.2

you can handle without reaching beyond your ability to cope).

In **Figure 4.2**, I've sketched out the integral (area under the curve) when the body is presented with 1 unit of stress. This would be a fairly small stressor. The magnitude of adaptation is represented by the shaded area.

Figure 4.3 shows the integral for 4 units of stress. As you can see, the shaded area is larger than it was for just 1 unit of stress. This means a larger adaptive response. This would be the maximal amount of stress the body can respond to productively, and the maximal amount of benefit you could possibly get from

The Maximal Amount of Training Stress You Can Handle and Make Gains From

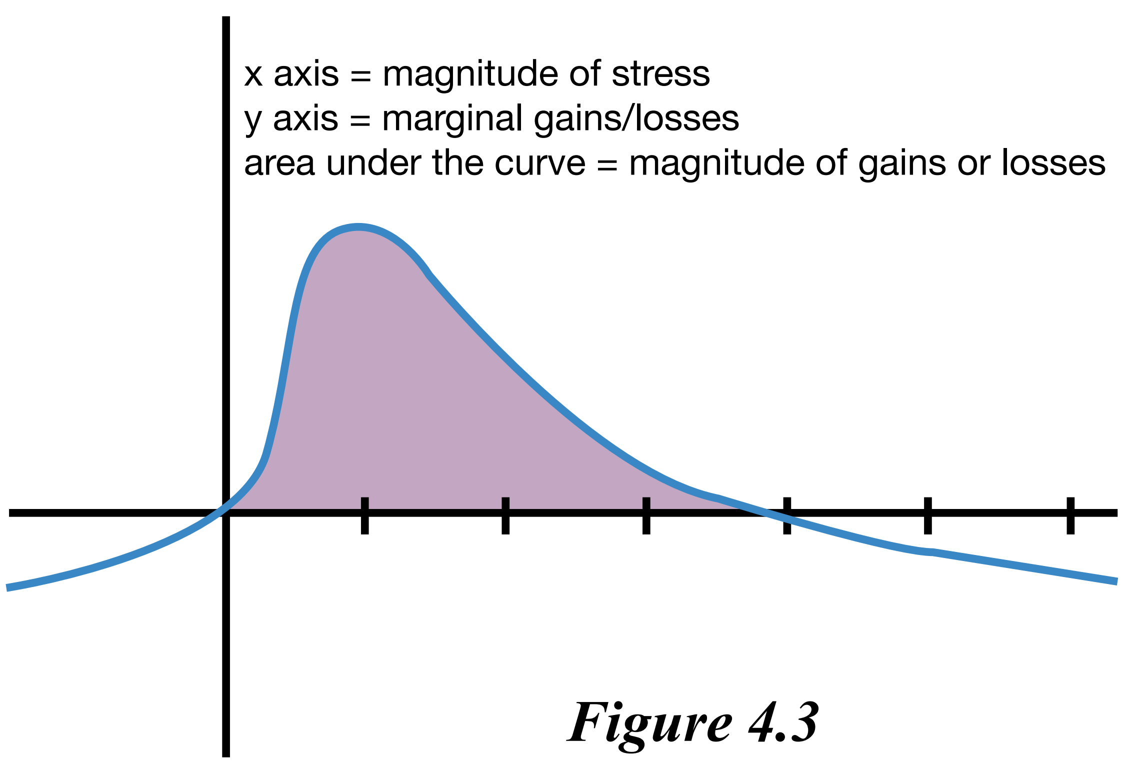


Figure 4.3

training.

Figure 4.4 demonstrates what happens when we have a bit over 6 units of stress. This represents a stressor larger than that which the body would respond maximally too. The area in quadrant 4 (below the x-axis) represents a reduction in the magnitude of the adaptive response. In this case, the area under the curve past 4 represents the magnitude of benefit that's been nullified from doing too much, so that you'd get more benefit from 3 units of stress than you would from

Overtraining, Stealing Our Gains

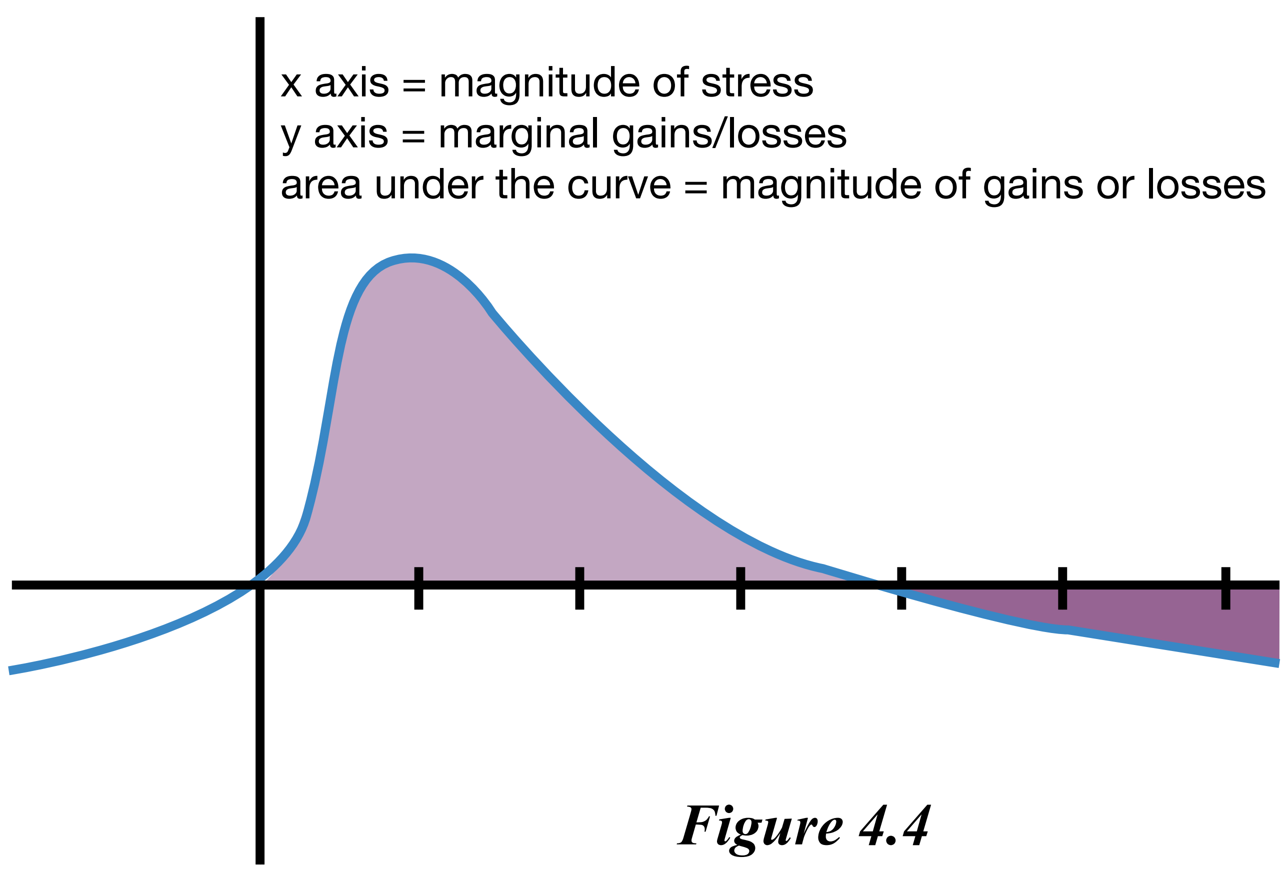


Figure 4.4

doing over twice as much work.

This is roughly what occurs when dealing with training factors that add stress.

So just to sum all of this up, in case you're still a little confused about what exactly you're looking at:

1) The x-intercept on the left (0 for the graphs above) represents the minimum amount of stress necessary to start having a positive effect.

2) The x-intercept on the right (4 for the graphs above) represents the maximum amount of stress the body can respond productively to.

3) The positive area under the curve, minus the negative area under the curve, is the total amount of positive adaptation you get from your training.

4) The curve itself represents marginal gains or losses as the stimulus increases.

Training Volume, Training Intensity, and Cardio

Let's look at three examples: Training volume, training intensity, and cardio training.

Training volume: James Kreiger's wonderful meta-analysis about the effects of doing more sets in training illustrates the first part of this concept beautifully. 2-3 work sets will give you significantly better gains than 1 work set, and 4-6 sets will probably give you better gains than 2-3 sets (it didn't reach statistical significance, but there is a larger effect size). However, there was a much larger difference between 1 and 2-3 than there was between 2-3 and 4-6. The former would represent going from maybe 1 unit of stress in the graphs above to 2 units of stress. The latter would represent going from 2 to 3 or 4 units of stress – increased gains, but not nearly to the same extent.

However, that relationship of increased work leading to increased gains only holds true to a point. Once you accumulate too much volume, you start regressing; you enter the realm of overtraining.

This is a direct message to anyone who says overtraining doesn't exist: Run a marathon every day, lift weights HARD for 4-5 hours every day, eat as much as you want, sleep as much as you want (and shoot, take whatever steroids you want), and tell me at the end of 6 months if you still think overtraining is imaginary (if you survive until the end).

That represents the curve dipping below the x-axis, and the detriments of the stress in excess of the maximal amount you're capable of adapting to overwhelming the benefits you'd have seen from lower levels of stress.

With training volume, more is better until you reach your limit, at which point further increases don't just fail to produce better results, but instead lead to worse results.

Training Intensity: Training intensity is similar to training volume. Research has shown that using loads of at least 60% of your max are necessary to cause robust gains in hypertrophy under normal conditions. From that point, there's a range from about 60-85% that gives you the most bang for your buck in terms of strength and hypertrophy gains.

When you start training above 85% regularly, especially if you're taking a lot of your sets close to failure, the benefits start decreasing. This is because training volume is priority No. 1, and you simply can't handle very much training volume with 90-100% of your max. Training that heavy has its place when peaking for a meet, or if you have the rest of your program adjusted accordingly to allow for appropriate training volume, but it doesn't allow you to simply do enough work to make your best strength and size gains year-round under most circumstances, if that's the only intensity range you use.

To see this in practice, you can simply look around at almost every successful strength training program in existence. You'll see that the vast majority of successful powerlifters and bodybuilders throughout the years have made the intensity range of 60-85% the bread and butter of their training. It allows for adequate training volume without unduly increasing psychological stress; constantly training too light doesn't give your body enough reason to grow, and training too heavy has more of the downside (mentally stressful, and doesn't allow for adequate training volume) with very similar upsides (muscle, bone, and neural adaptations that come with strength training) to training in the 60-85% range.

Cardio Training: Doing some aerobic training will have a positive impact on your lifting, because picking up heavy stuff is an energy-intensive endeavor. If your conditioning isn't good enough to knock out set after set, you're not going to be able to handle enough training volume, and your recovery likely won't be as good.

However, for a strength athlete or bodybuilder, all you're really shooting for is an adequate base of aerobic fitness. Benefits accrue to the point that you attain that sufficient base level of aerobic fitness. However, once you start training like a competitive runner, strength and mass gains suffer.

Proper structuring of training is key here, too. It takes more dedicated cardiovascular training to build aerobic fitness, but relatively little to maintain it. Since it's a stressor you have to account for, a training block dedicated to building more aerobic fitness necessitates reductions in lifting volume. However, once you have an adequate base (a resting heart rate in the low 60s is a good indicator), you can dial back your aerobic training to allow you to ramp your strength training back up.

Need to build up better cardio
Starting at that heart rate as a goal would be a good start

How Genetics, Drugs, Training Experience, Recovery Modalities and Calorie Balance Affect Our Gains

An important thing to keep in mind with this concept is that your training status shifts the curve. As you become more highly trained, the y-intercept would become farther and farther below 0, representing the fact that it requires a certain amount of stress simply to maintain your current adaptations. If you're untrained, no stress means no gains and no losses. With more training, no stress whatsoever means larger and larger losses – it takes more work just to maintain performance (though maintenance is considerably easier than progress).

How Training Experience Affects the Curve

Furthermore, as you become more highly trained, the apex of the curve shifts down and the curve as a whole stretches out. Check out a visualization of this concept in **Figure 4.5.**

In non-nerd speak, this means that the total possible gains you can make decrease, the amount of work you have to do to maintain your strength increases, but the total amount of productive work you can do increases.

Effect of Training Experience on the Stress You Can Handle and the Gains You Can Make

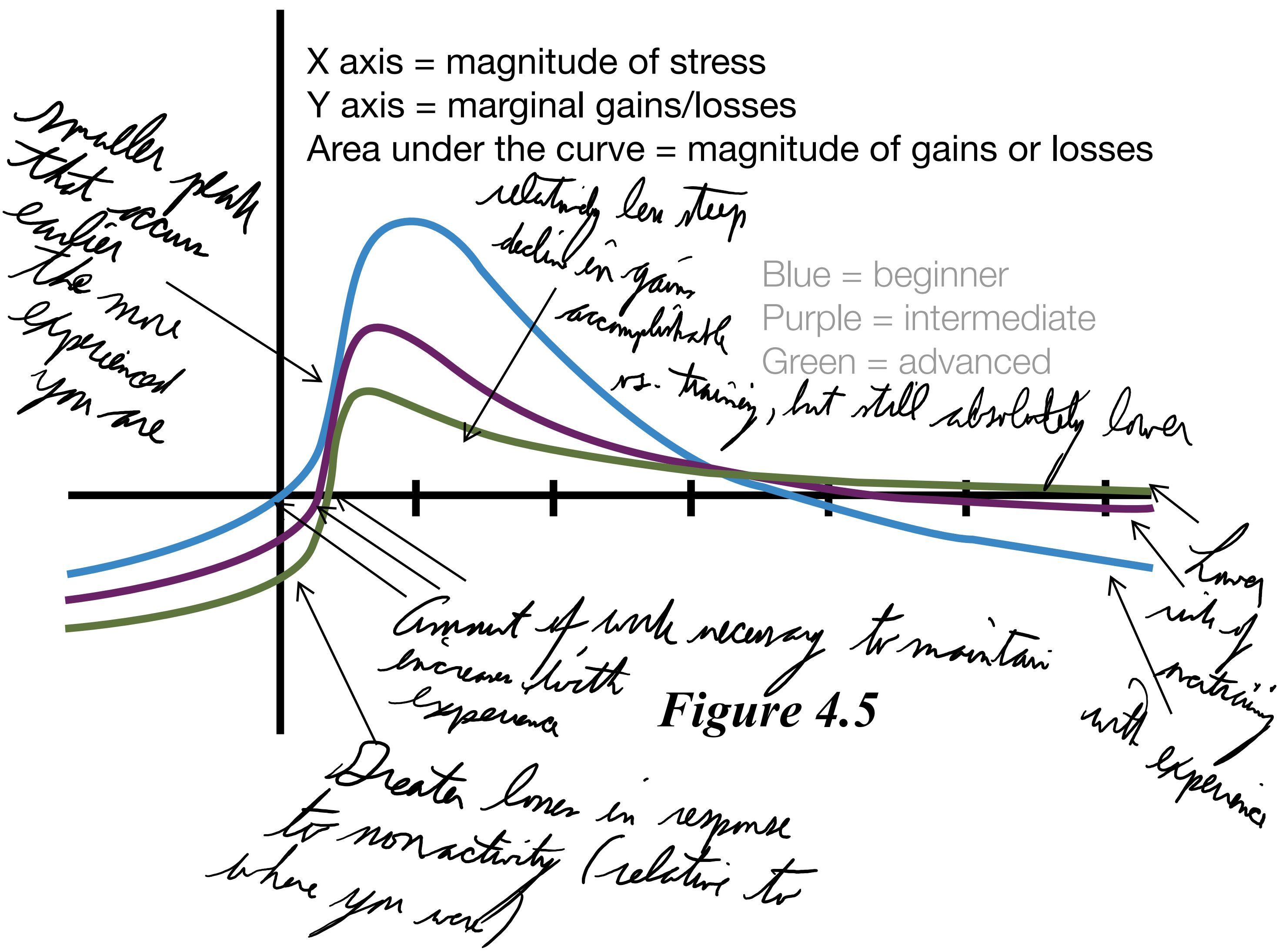


Figure 4.5

How Life Stressors Negatively Impact Our Gains

Life stressors can shift the curve down, as seen in **Figure 4.6**. The minimal amount of training stress necessary to make gains increases, the overall magnitude of adaptations possible decrease, and the maximal amount of training stress you can handle before overreaching/overtraining decreases.

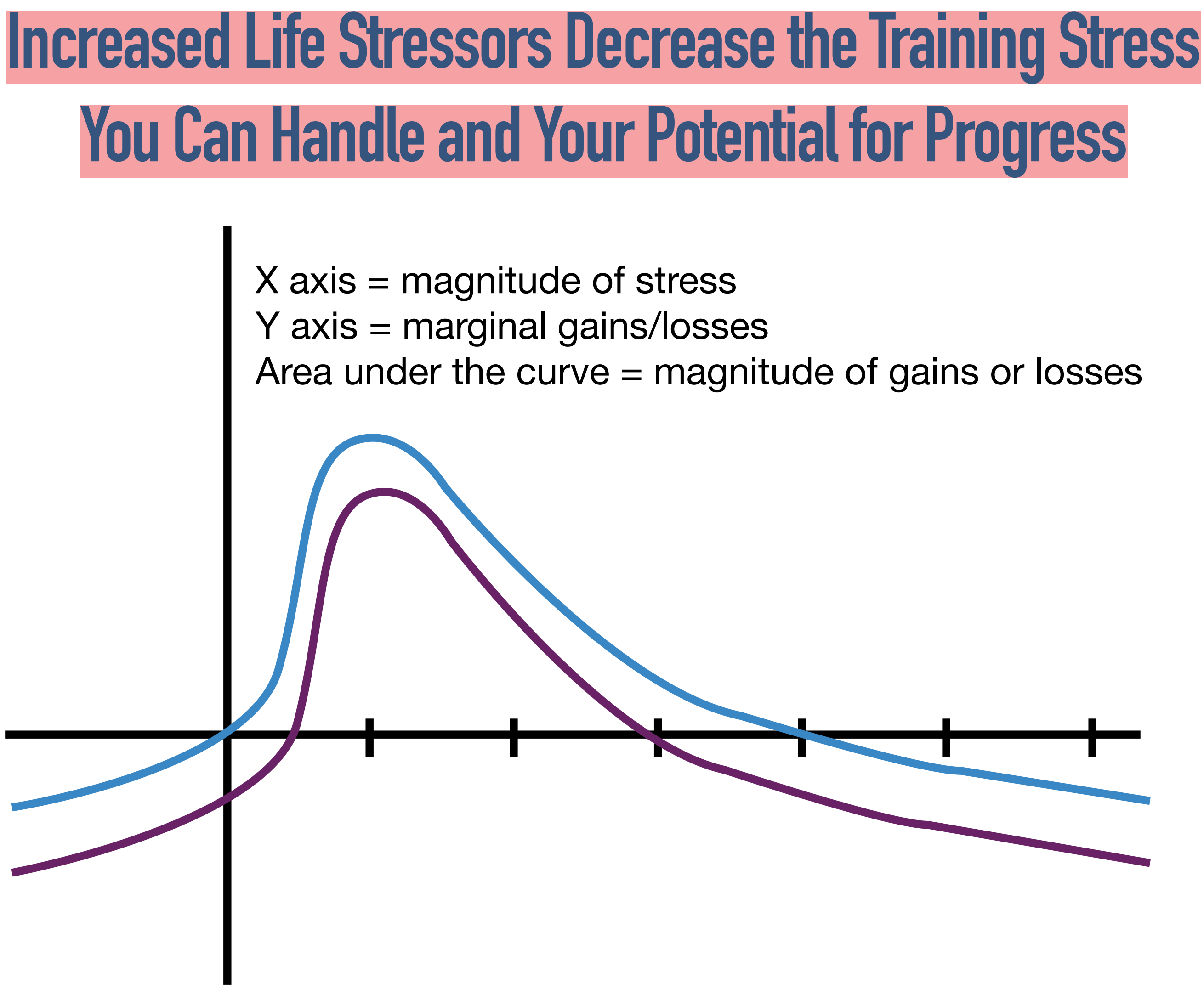


Figure 4.6

How Better Recovery Modalities Positively Affect Our Gains From Training

More attention to stress management and "recovery" modalities (sleep and meditation are two I would recommend for example) can shift the curve up (as seen in **Figure 4.7**), meaning beneficial adaptations to a lower threshold of training stressors, greater total possibilities for adaptation, and a higher ceiling for the amount of training stress you can handle before overreaching/overtraining.

Improved Recovery Modalities, Good Genetics, and Steroids Increase Stress You Can Handle and Gains You Can Make

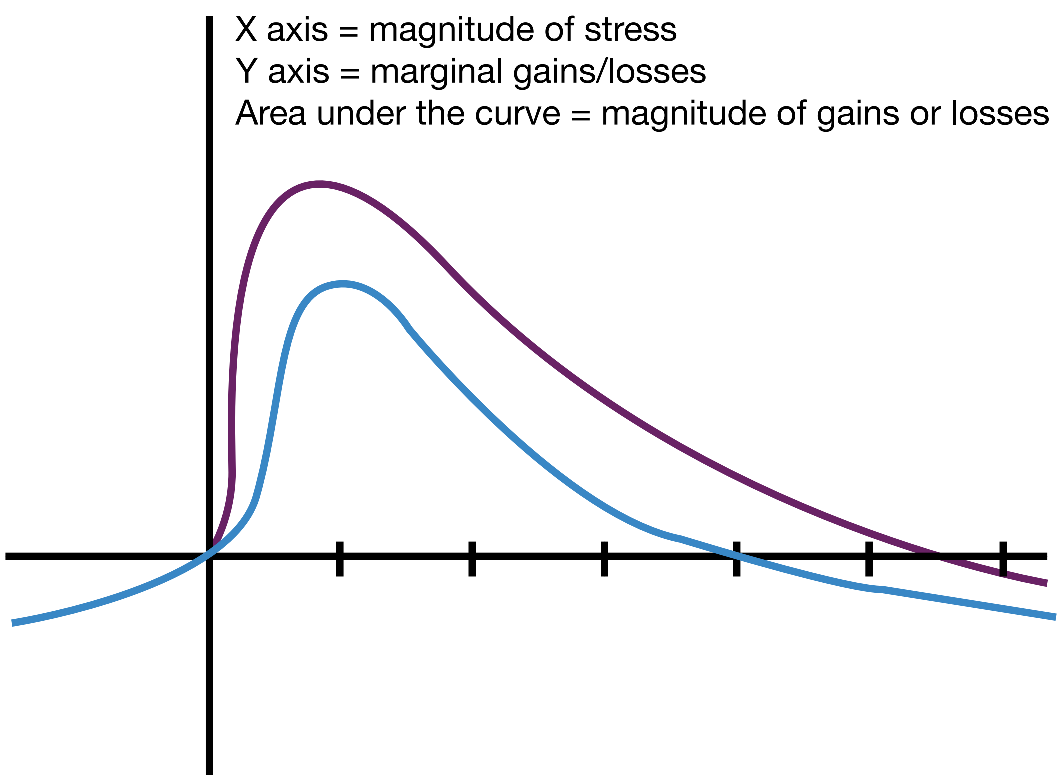


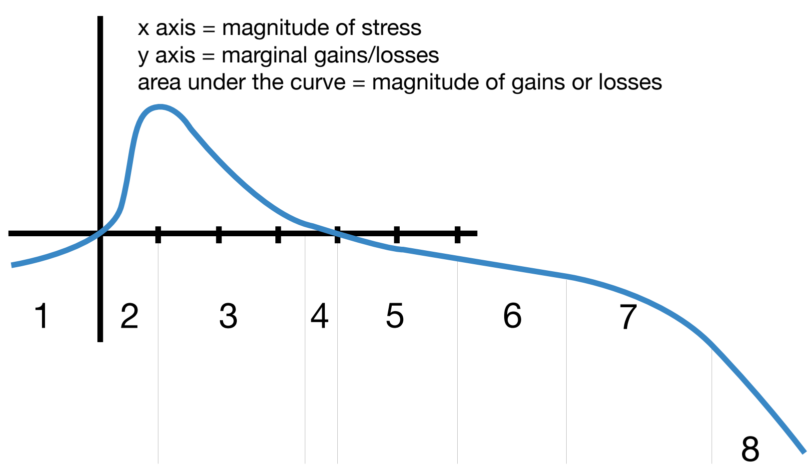
Figure 4.7

Genetic factors and steroids work in a similar manner, with better genetics/more drugs shifting the curve up, and worse genetics/fewer drugs shifting the curve down.

One final note: To make the normal training range easier to see on the graphs above, none of the curves went very far past the right intercept (when excess stress starts eating into your gains). As the stress increases further, there's an increasingly negative effect. A bit over optimal isn't much of an issue, more than that drives you toward overreaching/overtraining, and then past that point really bad stuff starts happening (see **Figure 4.8**).

Figure 4.8

What Happens When You Throw Caution to the Wind And Try to Replicate a CT Fletcher Workout (Exceptionally High Volume)



1. Nothing.
2. Low volume.
3. Sweet spot.
4. Aggressive.
5. A bit too much, but not much of an issue.
6. Overreaching/overtraining.
7. Rhabdo.
8. Death.

How Calorie Deficits Negatively Affect Our Training Response, How Surpluses Positively Impact It

This concept is also crucially important for planning your training in a calorie deficit versus a surplus. A calorie deficit is a stressor that competes for those adaptive reserves by itself, meaning less are left over to respond to the stress of strength training. Add to that the simple mechanistic fact that building new muscle requires energy, and when you're in a calorie deficit, you have less energy left over to build muscle after the energetic needs for survival are taken care of. These things shift the curve down.

Let's look at how energy balance affects the training stress response curve of the novice trainee in **Figure 4.9**.

In **Figure 4.9**, the purple curve may represent maintenance calories. The blue curves below it represent deficits of different magnitudes, and the blue curve above it would represent a surplus.

We can see that even for the novice trainee, as the calorie deficit increases, the y-axis intercept drops further and further below zero. Training is required in order to maintain muscle mass.

The takeaway: In a deficit, you can't gain muscle at the same rate as you can in a surplus, and you can't handle and benefit from the same level of training volume – it takes less total work to dip below the x-axis and migrate from productive work to counter-productive (not just unproductive) excessive work.

In a surplus, those factors are exactly reversed. Eating a surplus of calories is an inherently stress-reducing activity (a major reason so many people stress eat – eating extra when you're stressed helps you cope physically and psycho-

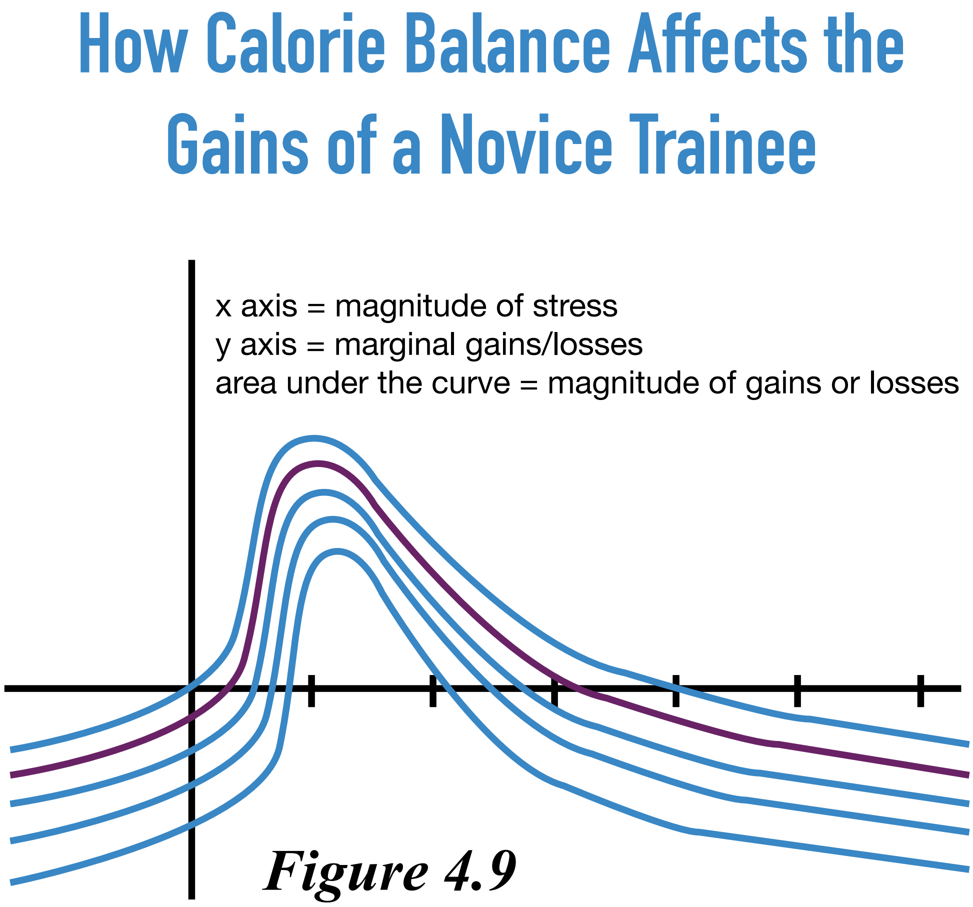


Figure 4.9

logically with the stress) leaves more energy to be used to build muscle after essential life-maintaining functions are taken care of. For this reason, you can and should increase your training volume when in a surplus – you can handle a significantly higher workload to build strength and muscle at a faster rate.

Now let's consider how a deficit affects more advanced lifters:

Recall from figure 4.5 that an increase in training experience shifts the curve down. With a calorie deficit, the response curve shifts down further.

What this means is that the training amount required in order to not regress increases, the overall potential for adaptations is greatly reduced, as is the amount of training that can be handled before over-training occurs (and thus marginal losses have potential to accrue). In many instances, for an advanced lifter, simply maintaining strength and muscle mass during a deficit may be the most you can hope for – the area below the x-axis on the left equaling the maximal positive area under the curve.

How Calorie Balance Affects the Gains of a Highly Experienced Trainee

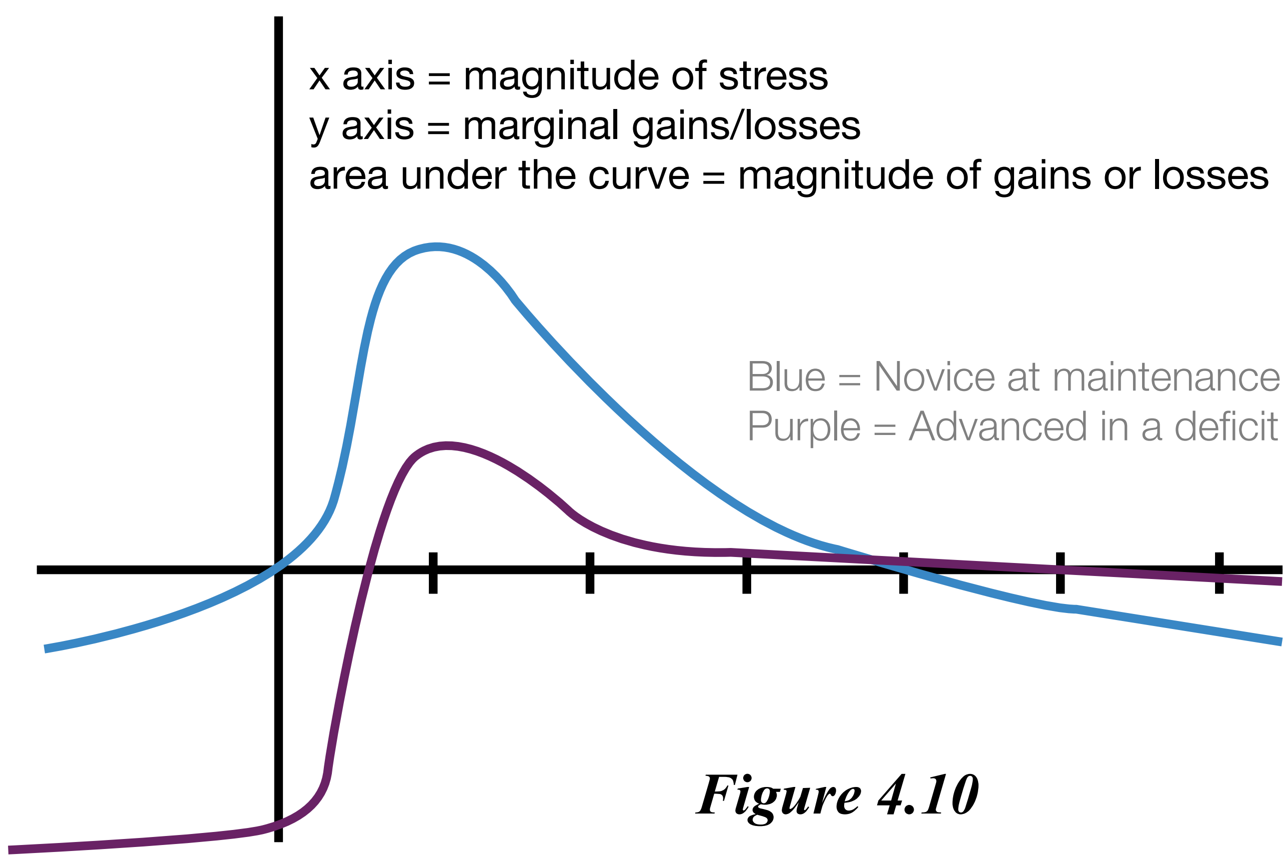


Figure 4.10

If we shift the curve down once more to consider a highly advanced trainee, we would see that the margin for getting positive adaptations to training while in a calorie deficit are minimal, and the margin for error with setting the training stimulus is small – too much or too little and regression will occur.

CHAPTER 5

General Adaptation Syndrome

One of the biggest problems we have when we talk about training is that we tend to only talk about physical stressors.

We like complicated periodization models, manipulating training volume, intensity, and frequency. In short, we like having a sense of control. We like thinking, “If I plan out and control these training factors, I’ll get this outcome.” Sure, nutrition and sleep play a role too, but as long as those factors (often given the blanket term “recovery”) are accounted for, you’re in the clear.

However, those factors don’t paint the whole picture. Biology is messy. Your body is not a simple machine that you can feed inputs and expect predictable outputs.

Now, you can have a general idea of what’ll happen. But 1+1 doesn’t always equal 2. Maybe it’ll be 2 most of the time, but sometimes it’ll be 5, and sometimes it’ll be -3. The reason is that your body isn’t in a static state, only being challenged by the workouts you put it through. There are billions of reactions taking place in your body every moment, affecting what'll happen at the systemic level, while dozens of inputs are simultaneously entering the system via your thoughts and your senses (which then affect and modify other thoughts and sensations). 1+1 won't always equal 2, because your body isn't dealing with 1+1. It's dealing with 1+1 plus a million other inputs and moderating factors. The result may be between 1.5 and 2.5 most of the time, but there's plenty of built-in ambiguity that's difficult to predict, harder to account for, and impossible to quantify.

Biology is nonlinear. You cannot control it. You can, at best, influence it.

Via trial and error, you can get a pretty good idea of how your body will respond to a certain set of training parameters. However, that response is still context-specific and is largely mediated by how well your body can respond to stress. When you're in a comfortable schedule with a 9-to-5, a predictable social life, no large sleep or diet perturbations, etc., you can develop a good idea of how your body will respond to training stress. The more constant the other inputs, the more predictable the result of imposing a particular stressor (training, in this case) will be.

However, increase the overall stress your body is coping with, and your ability to then cope with a given level of training stress is decreased. Although simplistic, Selye's "General Adaptation Syndrome," (see **Figure 5.1**) is still very useful, even 80 years after its introduction.

Even if your training inputs haven't changed, the rest of the inputs feeding into the system have changed, so the system will respond differently and perhaps unpredictably.

General Adaptation Syndrome essentially says that your body feeds all of its stress into a generalized pool of “adaptive reserves” that your body can use to elicit the specific adaptations necessary to respond to the stressors and strengthen the body against them in case the same stressors presents themselves in the future. In the case of lifting, the strain on the structural and metabolic capabilities of the muscle are the stress, and your body responds by building larger muscles with more ability to resist strain and more of the enzymes necessary to handle exercise metabolically.

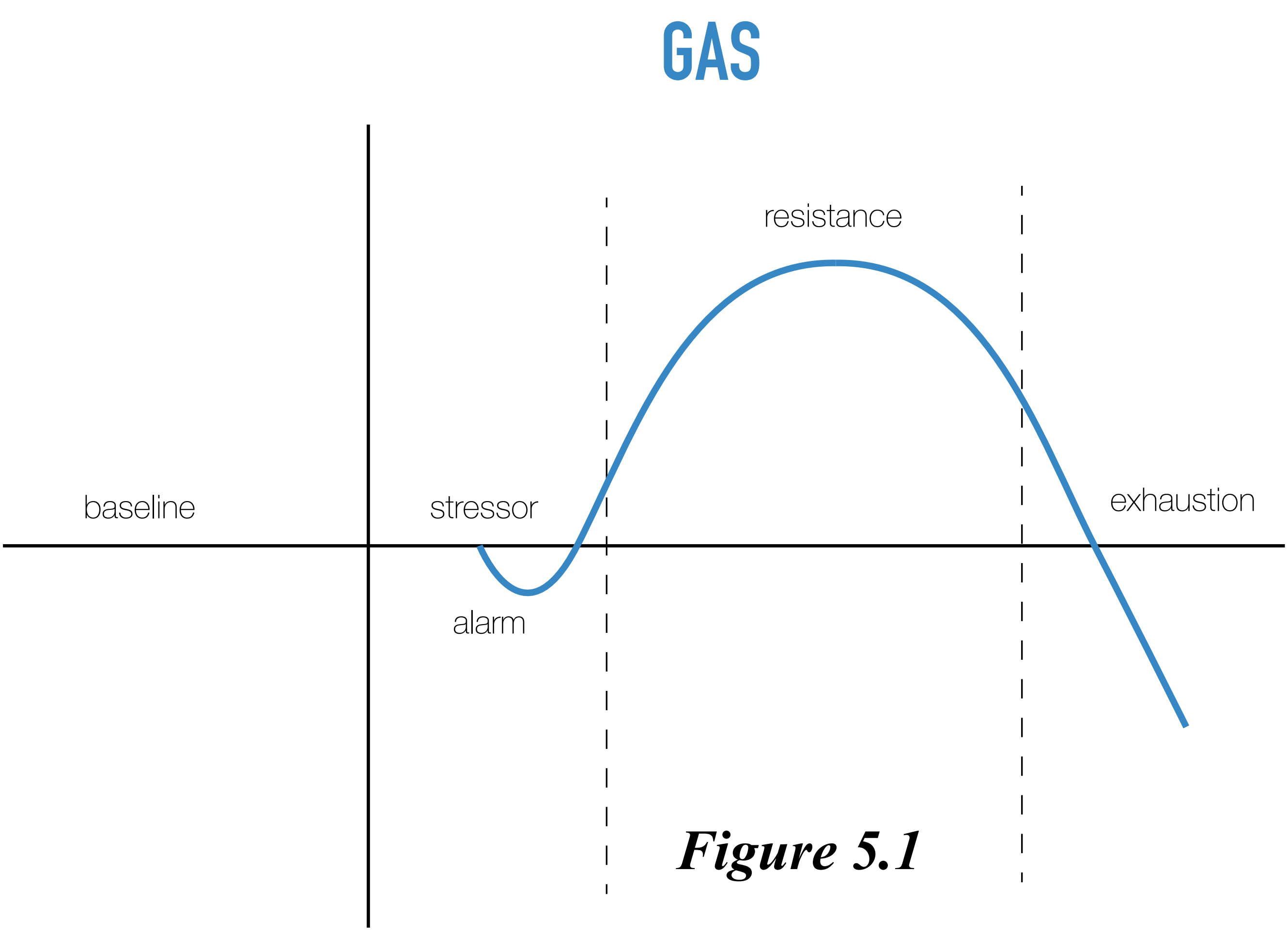


Figure 5.1

However, if other stressors (work stress, poor sleep, heavy drinking, marital issues, moving to a new city, etc.) are present, they're dipping into those adaptive reserves, so your body can't respond to training as robustly to exercise.

In the absence of a stressor, your body maintains homeostasis – a dynamic state of maintaining things as they currently are.

When presented with a stressor, initially performance drops. This is called the compensation phase. The initial shock of the stressor "breaks the body down" so it can no longer perform at peak levels. However, in response to the stress, your body's adaptive mechanisms kick into high gear to deal with the threat.

The next phase is the resistance phase. This is the phase in which your adaptive mechanisms have dealt with the threat, and "overshoot" in their response so that you'll be better equipped to meet the threat the next time you meet it. This happens in between training sessions, provided you're fully recovered and not intentionally overreaching, and it also happens over the course of a longer term training program if the stress you're exposing your body to is sufficient to keep your adaptive mechanisms running at high gear.

The final phase (and the one you want to avoid) is the exhaustion phase, or decompensation phase. This occurs when the cumulative stress (from training and the rest of your life) is too much for your body to deal productively with, so rather than getting stronger, it gets weaker. For our purposes, this is overtraining. This is NOT what happens with productive overreaching (as we'll discuss soon) – when performance dips because of hard training, only to rebound when you take a rest. This is what happens when you accumulate so much stress that your performance goes into free fall, and doesn't return to baseline even after you take some time off. Each phase is represented in **Figure 5.1**.

GAS is useful, primarily because it helps us think about training holistically. The recent study referenced in *The Art of Lifting* helps illustrate this point – psychological stress roughly doubled how long it took people to recover from training. However, beyond giving us a conceptual schema for thinking about how all stressors “compete” with each other for adaptive reserves, GAS doesn’t tell us too much about how to plan training. That’s where our next model comes in.

CHAPTER 6

Impulse Response Model (Fatigue Masks Fitness)

An updated version of GAS was proposed by Banister in 1982: the Impulse-Response model. Instead of dealing with a single independent variable (stress) and a single dependent variable (the response to that stress), the I-R model proposes two outcomes to any training stress. While GAS deals with any stressor the body is exposed to (whether it be a tough training session, work stress, or the flu) and the accumulated effect of all stressors, the I-R model deals primarily with fitness-related pursuits.

Instead of looking at a single factor (stress, and its magnitude and duration), the I-R model looks at two different factors: both fitness and fatigue.

Any training session will have both a fitness-building and a fatigue-inducing effect. Your performance is the difference between the two. The training session increases your potential for improved performance, but the fatigue caused also masks those improvements in fitness.

Both the fitness and fatigue elements are the result of a LOT of different factors.

I-R Model for a Single Training Session

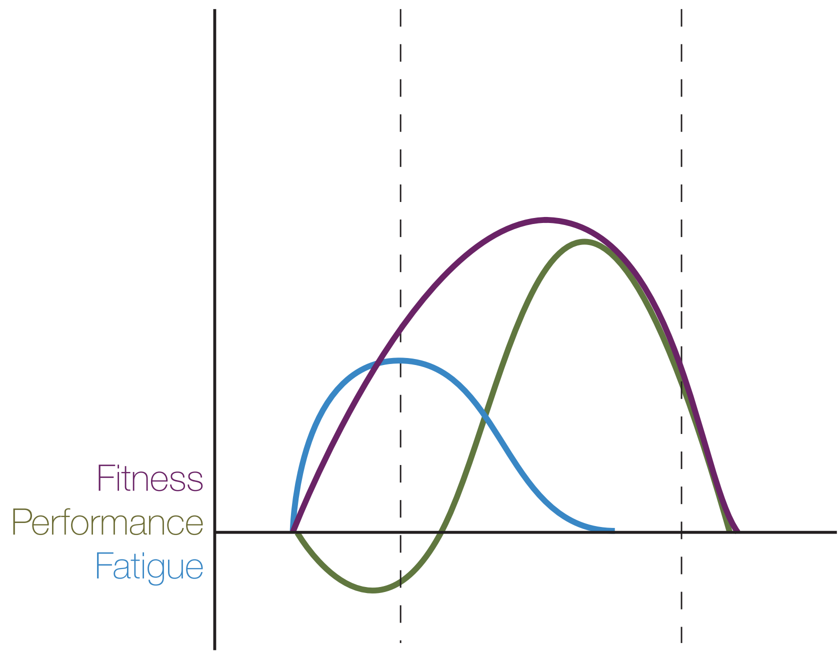


Figure 6.1

Muscle protein synthesis vs. breakdown, metabolic improvements vs. metabolite accumulation, improved neural coordination vs. decreased responsiveness of motor neurons, and many more. Luckily, unless you want to really go into the weeds in research, or unless you're dealing with SUPER elite athletes, you don't really have to concern yourself with most of the nitty gritty.

In the short term, the adaptation curve for the I-R model actually looks a lot like GAS.

As you can see in **Figure 6.1**, fatigue increases faster than fitness, yielding the initial drop in performance (the Alarm Phase in the GAS model), followed by a rise above baseline as fatigue decreases at a greater rate than fitness (similar to the Resistance Phase).

Figure 6.2 would represent someone fairly new to lifting, performing multiple training sessions that all cause fatigue and improve fitness.

As you train for a longer period of time, something called the repeated bouts effect kicks in. The repeated bouts effect means that when you're exposed to a particular stressor repeatedly, each subsequent response to it gets smaller and smaller. That's why you can't keep getting bigger and stronger indefinitely lifting the same weights for the same sets and reps. This decreases both the

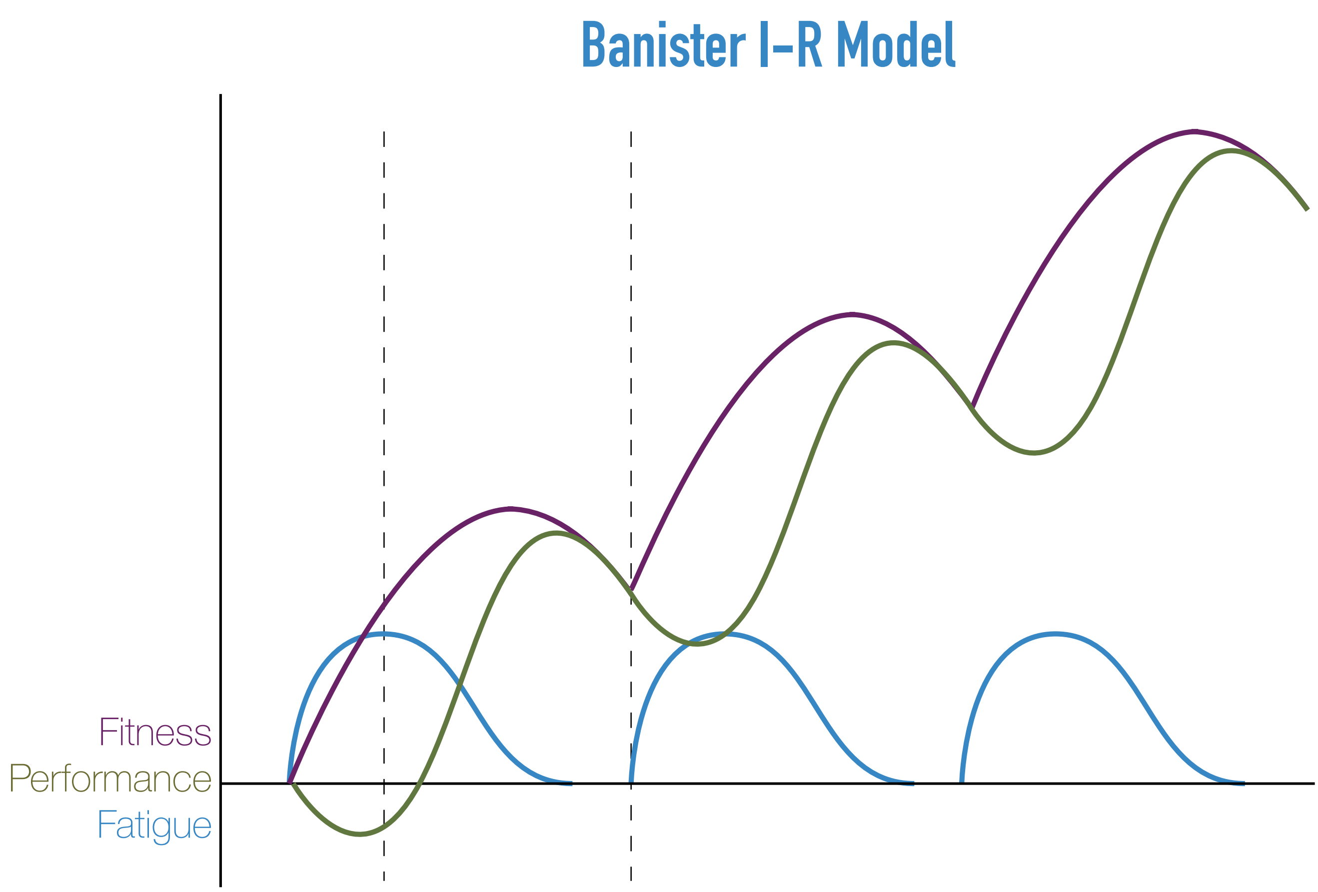


Figure 6.2

magnitude of the fitness and fatigue response to training. Because of this, it becomes necessary to train when you still have some residual fatigue from prior training sessions – otherwise you wouldn't be able to continue making progress at any reasonable rate.

Because of this, the most important thing the I-R model adds to the conversation, especially for more advanced lifters, is its applicability to longer-term training effects. There are two important applications.

The first is maximizing the fitness-building components of training, while minimizing the fatigue-inducing components. If you can maintain high levels of fitness improvements, with less fatigue to mask those improvements in fitness, you can maintain higher levels of performance and train at a higher level, more similar to competition conditions.

The second is peaking for meets. This is an area where a lot of people go astray. They could be making one of two major mistakes, seen in the figures in the next two pages.

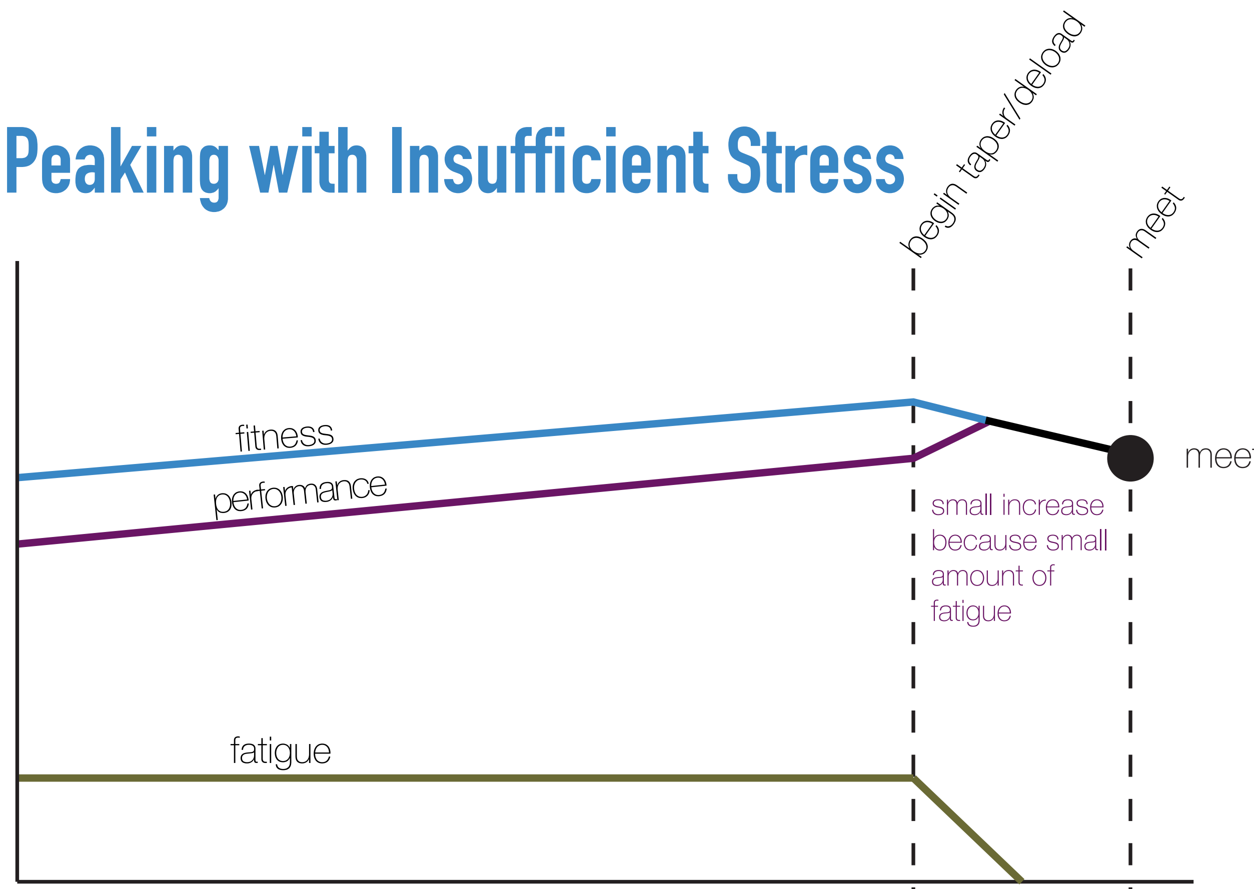


Figure 6.3

1) They aren't training hard enough leading up to a meet, so they don't have a significant amount of fatigue that's masking their fitness. When they reduce training volume further, their performance doesn't improve much (at best) or their performance even decreases because fitness decreases slightly as training volume decreases – a decrease in fitness without a decrease in fatigue means a drop in performance.

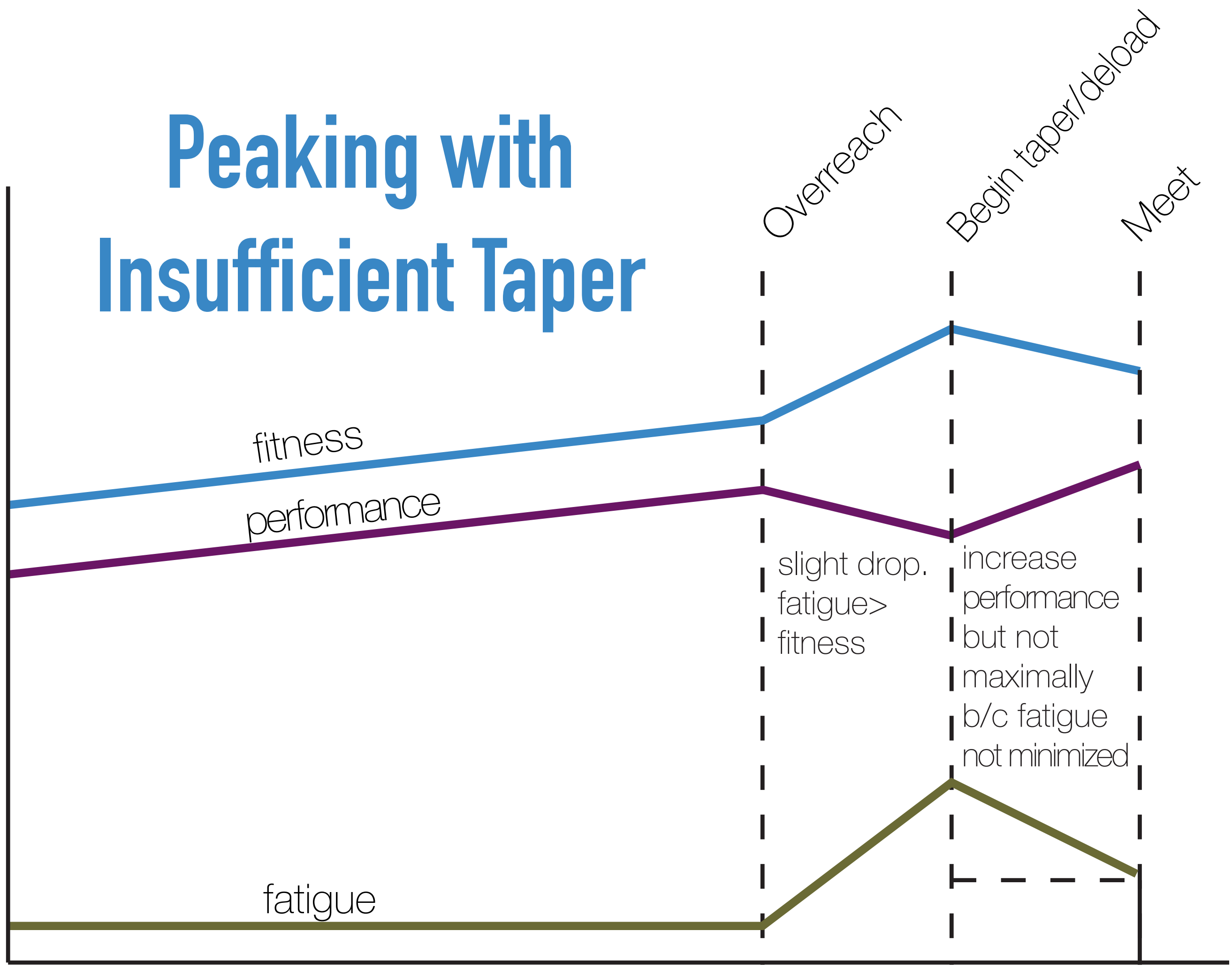


Figure 6.4

2) They train too hard in the weeks just before a meet or don't taper sufficiently, so that at the meet, they haven't sufficiently diminished fatigue. Fatigue is still masking fitness and hindering performance.

I-R Rate of Fitness/Fatigue Accumulation

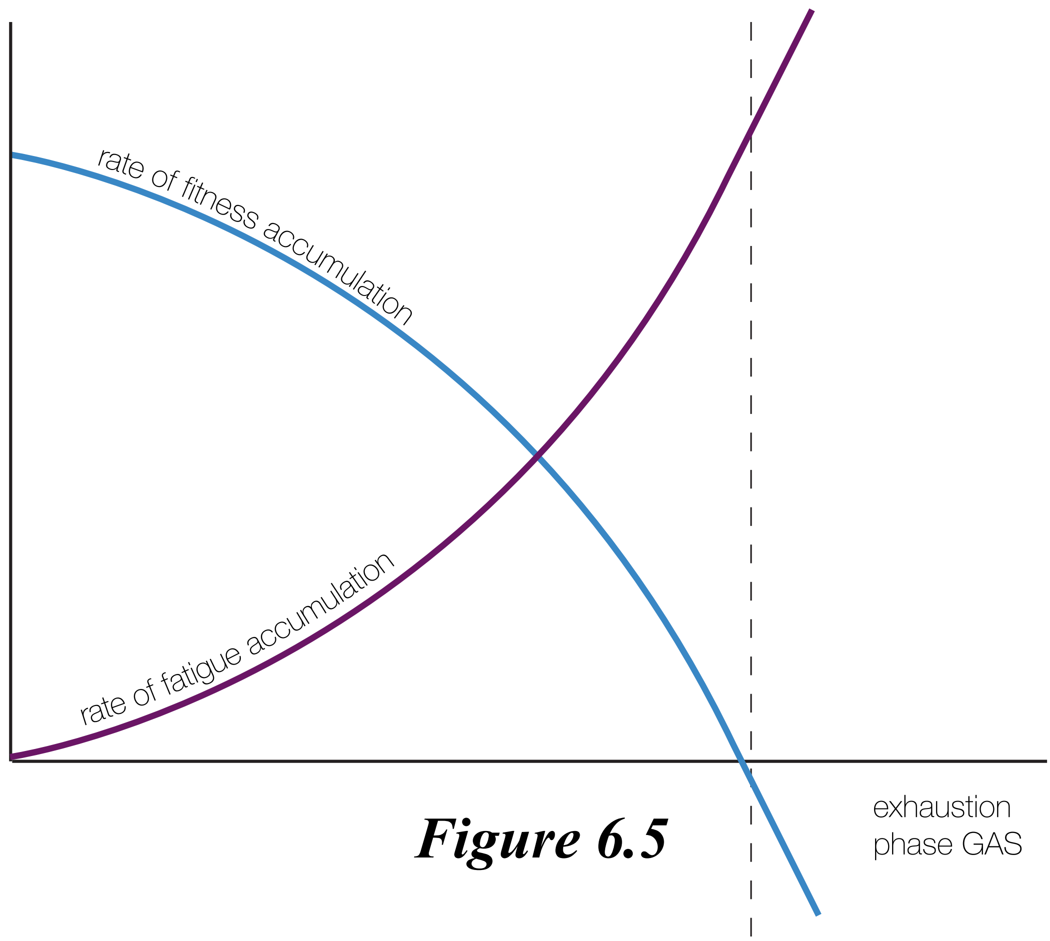


Figure 6.5

Another important feature of this model: Fatigue accumulation past a point doesn't just mask fitness improvements. It actually decreases the rate of beneficial adaptations. The primary reason for this is that as you accumulate fatigue, you're unable to train with the same volume and intensity, meaning you're unable to attain the same rate of positive adaptations for each training session or each training week, as seen in **Figure 6.5**. Excessive fatigue also decreases the rate you can build muscle on a molecular level, so that even if you *could* maintain

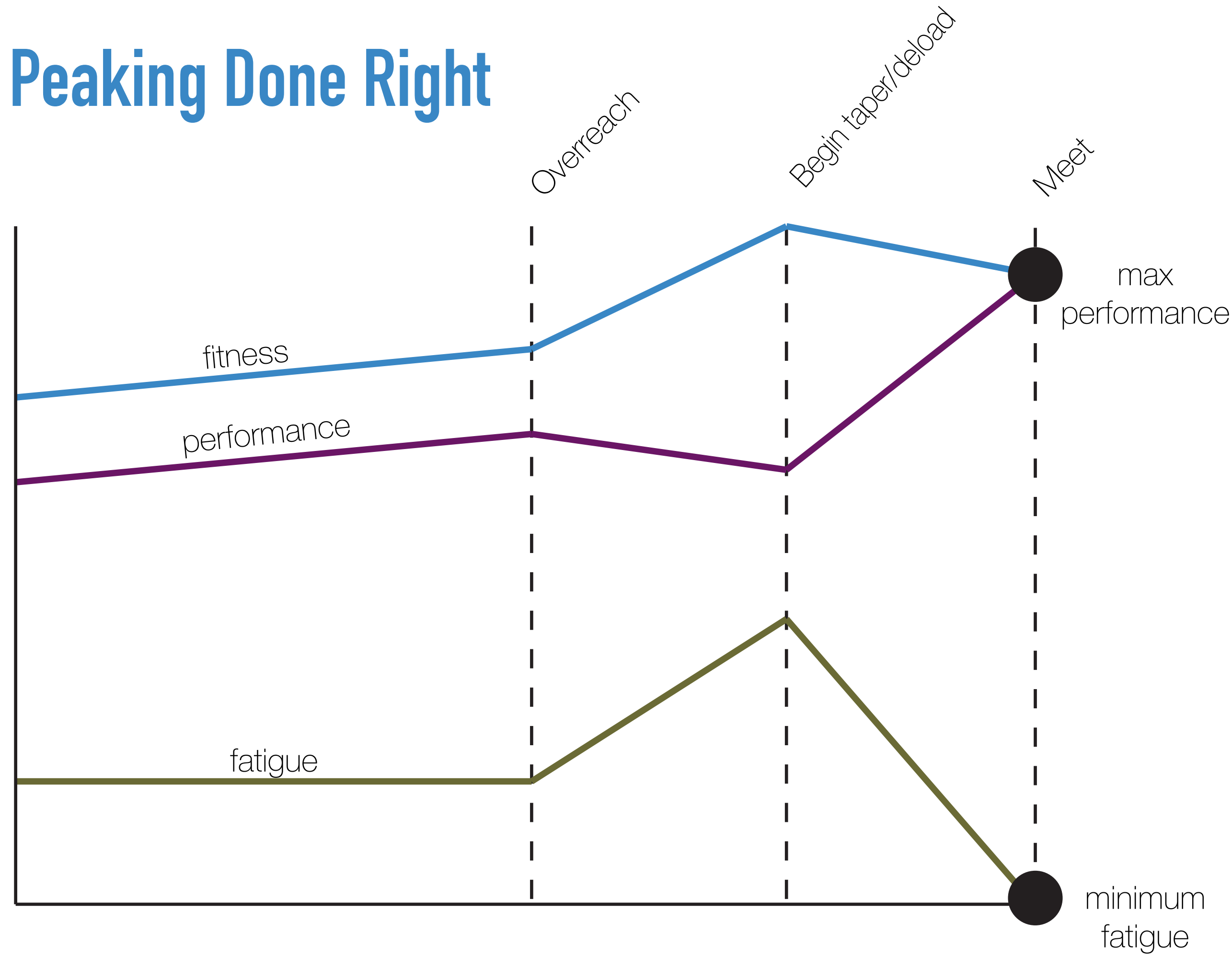


Figure 6.6

your training volume, you still wouldn't make as good of gains. In addition to another factor to be discussed later, this is a major reason why deloads are important. Remember, fatigue diminishes at a greater rate than fitness, so a deload week can usually bring your fatigue to or near baseline, while positive training adaptations are largely preserved.

CHAPTER 7

Fatigue and Intensity/RPE

Building off the last point, equivalent levels of training volume won't necessarily have equivalent effects on fatigue.

Training at a higher relative intensity, given the same total training volume, will tend to be more fatiguing. Imagine you're a 500-pound squatter, doing 10,000 pounds of total volume with 70% (350 pounds) of your max versus 90% (450 pounds). That would be ~29 reps with 350 or ~22 reps with 450. If you do 3 sets of 9-10 or 4 sets of 7-8 with 350, you won't incur nearly as much fatigue as if you did 22 sets of 1 or 11 sets of 2 with 450, even though training volume would be the same.

Although arguably the fitness-building effect of training at 90% would be greater (even though volume is the most important factor, it's certainly not the only factor), the fatigue-inducing effect would be MUCH greater. It's not a workout most people would be able to manage more than once every week or two, whereas you could knock out 3-4 sets of 7-10 reps at 70% 2-3 times per week, no problem.

So even if the fitness-building effect of one workout at 90% would be greater, long term, the effects would probably favor the 70% route, because you could reap those positive adaptations more frequently.

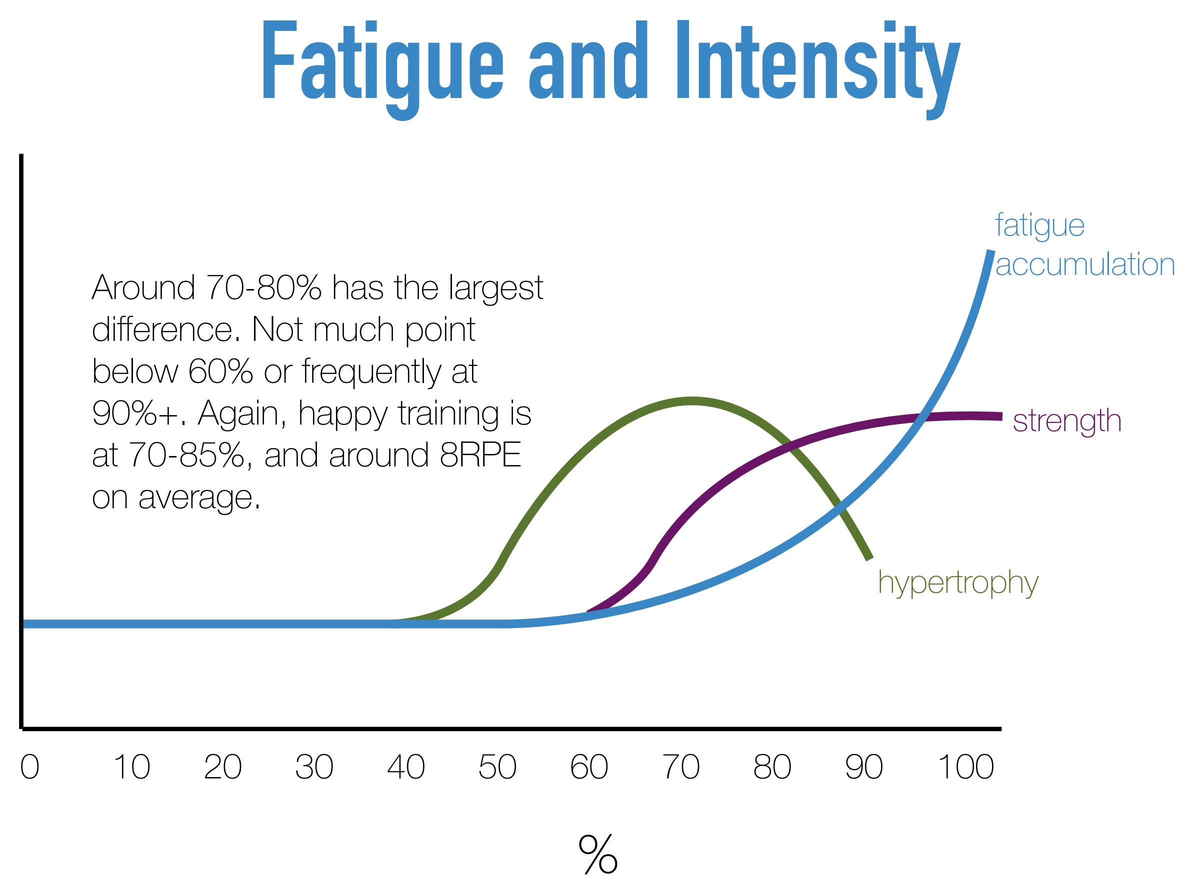
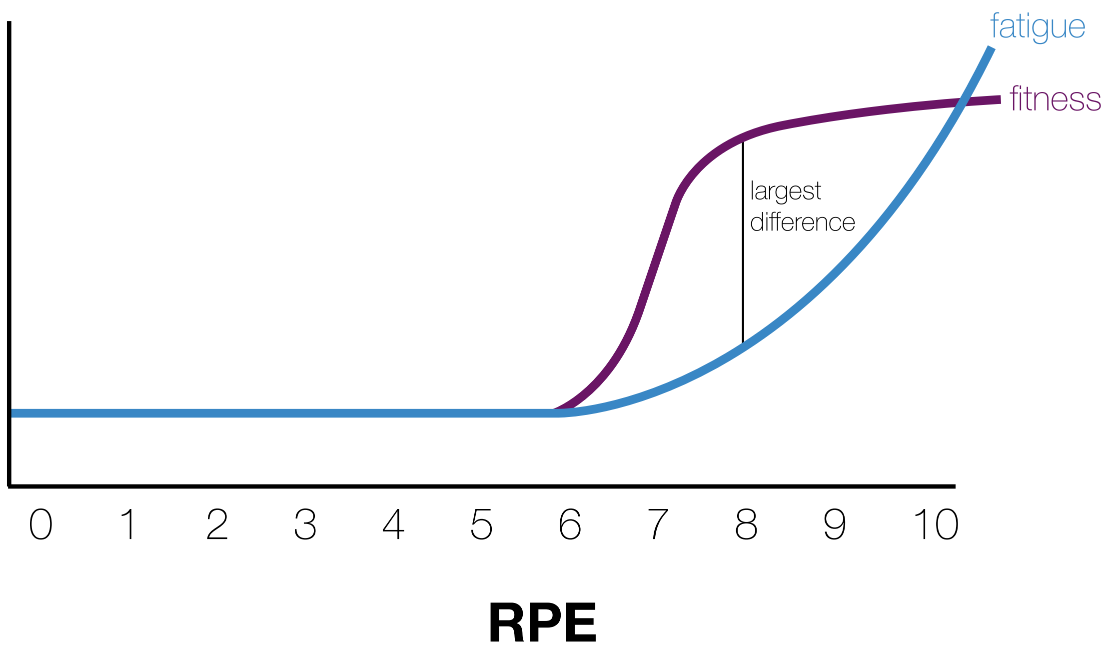


Figure 7.1

Figure 7.2



Another factor that can affect the fatigue response to a given workload is rate of perceived exertion (RPE), as seen in **Figure 7.2**. RPE is your estimation of how hard a set was. An RPE of 6 or less means it was basically a warmup set. An RPE of 7 meant that the set was moderately difficult, but you had at least 4-5 more reps in the tank. An RPE of 8 means that a set was pretty hard, and you only had 2-3 more reps left in you. An RPE of 9 means you only had about 1 rep left in the tank before failure. And RPE of 10 means there was no way you could have gotten another rep.

Training at really high RPEs (9 or above) can increase how fatiguing a training session is. Imagine an all-out set of 10 reps. Then imagine how much less fatigued you would be if you had instead done 2 sets of 5 with the same weight.

As far as I'm aware, there's not a ton evidence that training to failure has positive effects on strength and hypertrophy above and beyond that of the equivalent level of volume, with sets stopped shy of failure (the exception may be very high rep work focusing on hypertrophy via metabolic stress in the muscles, but not the sets of 3-12 where most strength athletes and bodybuilders live for their compound exercises).

Now, there are benefits to training at higher RPEs from time to time (as we'll talk about next), but for the bulk of your training, they cause an increase in fatigue without concomitant increases in fitness. You'd probably be better served not training on the brink of failure, week-in and week-out.

It should also be noted that this type of analysis tends to apply to both relative and absolute intensity. For example, when comparing a 400- and 800-pound squatter, an 80% load would be 320 pounds for the former, and 640 pounds for the latter. Most 400-pound squatters would be able to bang out 5x5 with 320 a couple of times per week while recovering just fine. However, the 800-pound squatters who could do the same with 640 are few and far between.

This is because, looping back around to GAS, we use volume and intensity to approximate stress to the tissues, both mechanical and metabolic. However, it's the stress itself – both the type and magnitude – that is the important factor to determine your response to it, both in terms of fitness and fatigue.

Now, it is true that, all other things being equal (same person lifting the same weights with the same force), more volume means more stress. However, when comparing two different people, or even the same person lifting with different rep cadences (i.e. full speed concentrics vs. intentionally slower concentrics), a given level of volume can result in very different amounts of stress to the tissues.

A stronger lifter will typically find that they can't handle the same level of training volume (reps and sets) with a given relative intensity (i.e. a certain percentage of their max) on their major lifts. This is because lifting a heavier absolute load induces more stress to the tissues, both mechanical (more muscle tension) and metabolic (because more energy is burned to lift a heavier weight the same number of times as a lighter weight).

However, although training volume with a given relative intensity may decrease, that doesn't necessarily mean training stress isn't increasing; as you get stronger, you'll be able to cause more stress with any given relative load.

CHAPTER 8

Technique and RPE/Weight (Teaching to Grind vs. Ingraining Bad Technique)

Strength is a skill. A lot more goes into picking up a heavy barbell than meets the eye. For this point, the most important factors are neural ones. Obviously, the size of your muscles is important, but if you take two people who are exactly the same in every way, and one has a more mechanically efficient motion they can activate more efficiently, they'll lift more weight.

To lift a heavy weight efficiently, you have to have the motor pattern stored in your brain, it has to be processed and coordinated with outside inputs by your cerebellum, and the right motor neurons need to fire, in the right order, very powerfully to both move the load and stabilize your joints. Ideally, this should all be done without any conscious thought; when you have to consciously think your way through a movement, your performance suffers and the likelihood of error increases.

To achieve that automaticity under heavy, near-maximal loads, you need to train heavy and/or close to failure, at least occasionally. This training should

Technique and RPE/Weight

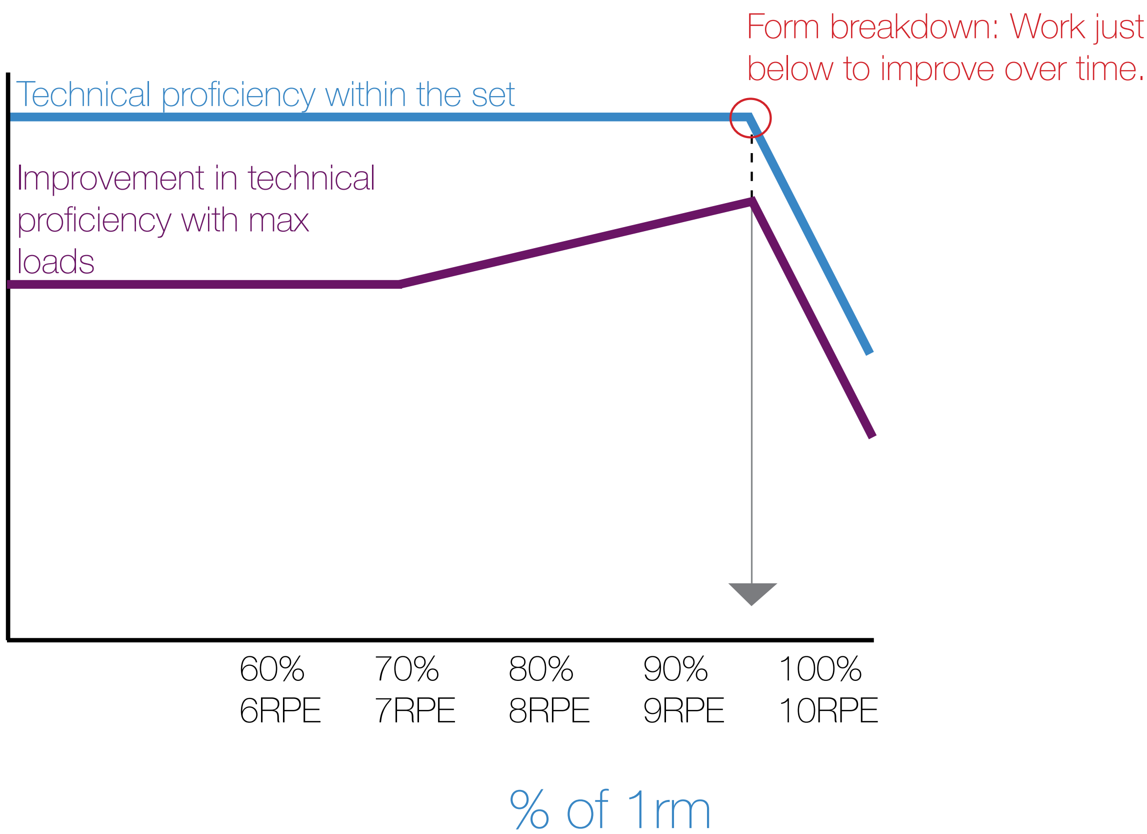


Figure 8.1

teach you how to grind and complete lifts that force you to strain, while still ingraining good technique.

Training with lighter loads (85% or less) and lower RPEs (8 or less), though giving you the best mix of maximizing fitness while minimizing fatigue, doesn't teach you the skill of grinding out a heavy lift – a skill that should be automatic when you step on the platform.

However, training close to failure and training to (or even past) failure are two entirely different things.

Remember, the primary goal of this type of training is to teach the skill of grinding out heavy lifts, with great technique, automatically. For this to happen, you have to maintain great technique.

For most people, the best place to do this is at an RPE of 9, preferably with fairly low reps (i.e. 85%x4, 90%x2, or 95%x1). By leaving a rep in the tank, you still have enough strength reserve that you have less chance of technical breakdown, but the effort is still difficult enough to learn the skill of grinding a heavy load, as seen in **Figure 8.1**.

CHAPTER 9

Work Capacity

Work capacity isn't discussed nearly enough in strength training circles. It is the factor that limits how strong you can become, long term.

A good working definition of work capacity is this: the total amount of training stress (product of volume and intensity) that you can handle and respond positively to.

When you stop making progress on your current strength training program, the most reliable way to continue making gains is to do more. However, you obviously can't continue on that track forever – you reach a point that you can no longer respond positively to an increased level of stress (near the point of exhaustion in the GAS model, or produce so much fatigue it mirrors or overshadows gains in fitness when you're not intentionally overreaching in the fitness-fatigue model).

At that point, the factor bottlenecking your progress is work capacity. You need to do more work, but you're unable to handle more work.

Work capacity is the product of several different factors:

1) Structural factors in the muscles and tendons – how much stress they can handle and recover from (this one is obvious).

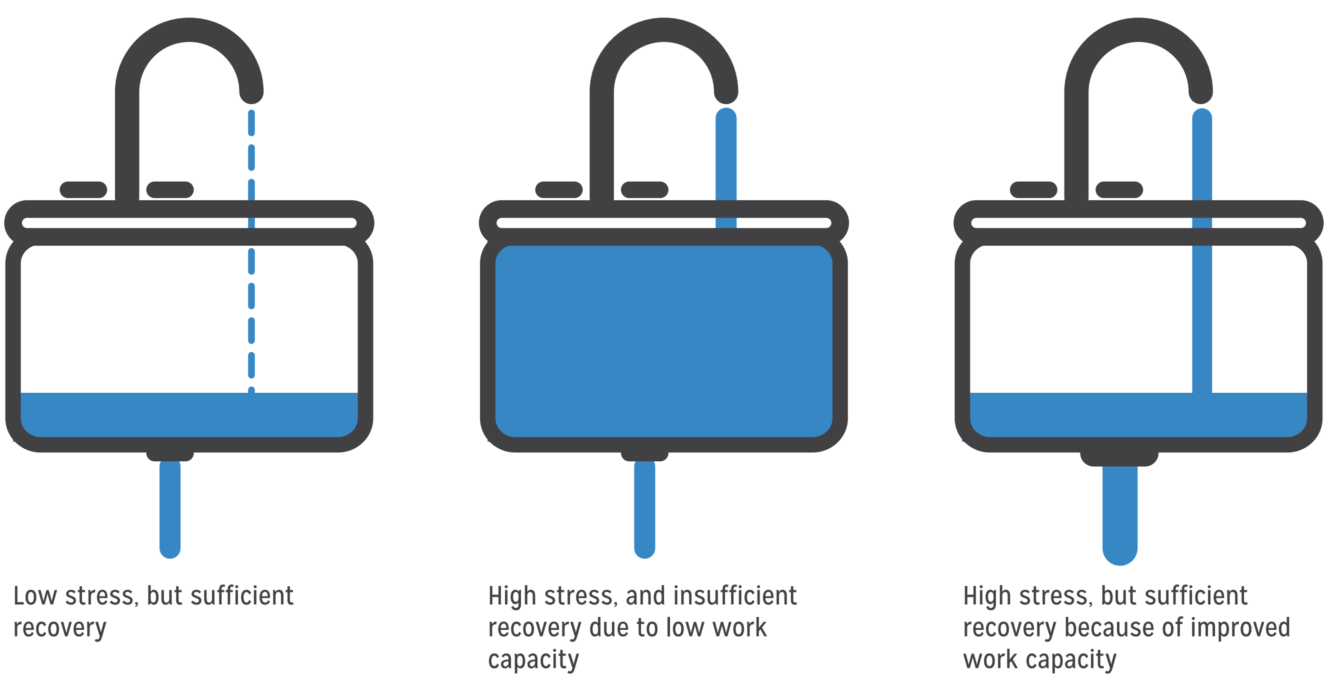
2) Metabolic factors – how quickly your body can produce energy to fuel training and recover in between sets.

3) Nervous system factors – sympathetic/parasympathetic balance, with parasympathetic dominance putting your body in a "recovery" state, and sympathetic indicative of a more "stressed" state.

To train work capacity, you need to improve those three factors.

To accomplish the first, the prescription is simple – decrease average intensity and increase training volume. Expose the tissues to a larger magnitude of stress. There are two types of stress on your tissues: acute and chronic. Acute

Figure 9.1



stress is the amount of strain placed on the tissue by virtue of how powerfully the muscle contracts. You can attain a near-maximal contraction by moving submaximal weights (75-85%) as fast as possible, which you should be doing with all of your sets anyways. You can keep your muscle conditioned to handle a high level of acute stress without very much really heavy training – a few sets of 2-3 with 80-85% of your max on a fairly regular basis should do it.

For training your muscles and tendons to handle more chronic stress, the name of the game is increasing training volume. Remember our previous points, though. A given level of volume with a higher intensity is more stressful and more difficult to recover from. So to train your tissues to handle more chronic stress, you need to increase your training volume by decreasing your average intensity. Instead of, perhaps, doing half your work with intensities from 65-75% and half with intensities from 75-90%, you could do ¾ of your work with the lower intensities and just ¼ at higher intensities. That will allow you to increase training volume, decrease the magnitude of the stressor systemically (i.e. how much stress you demand your adaptive reserves in GAS to deal with), while increasing the local stress on the muscles, improving their ability to handle an increased workload.

For the last two factors – metabolic and nervous system factors – your primary weapon is cardiovascular conditioning. Increased cardiovascular conditioning increases how quickly your body is capable of producing energy to meet the needs of your body during training, and also shifts autonomic nervous system functioning in the direction of parasympathetic dominance, keeping your body in a stronger state facilitative of recovery.

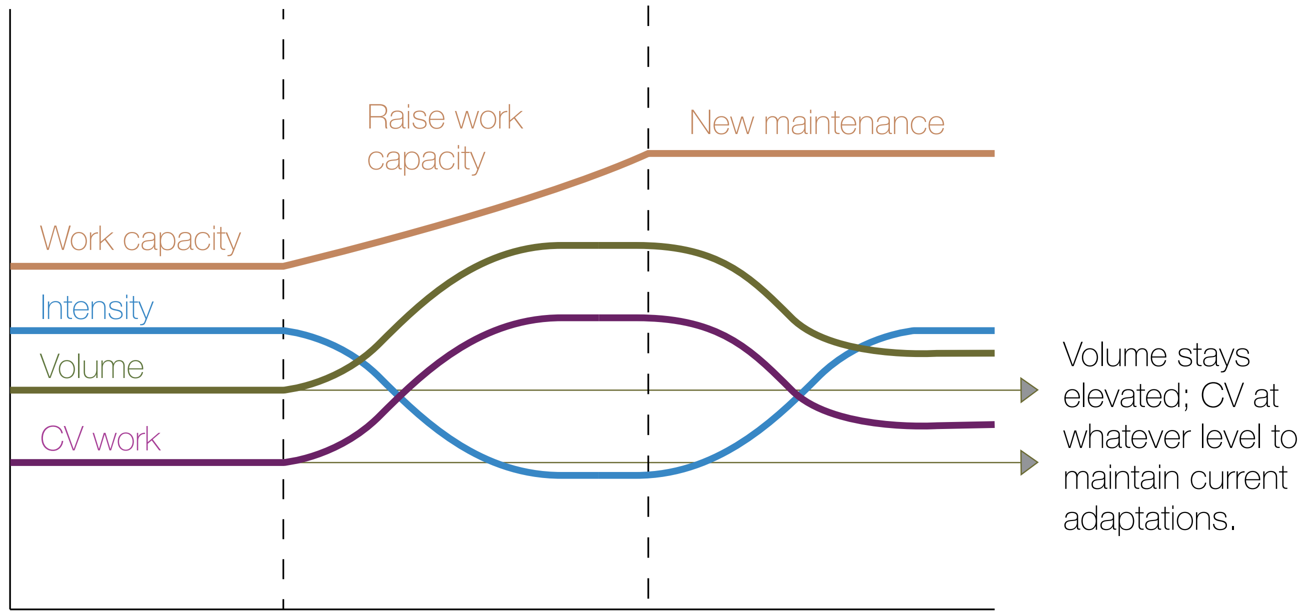


Figure 9.2

As a general rule of thumb, in a phase of training dedicated toward building work capacity, you should shoot for a 25-100% increase in training volume (at a lower average intensity) over a period of 2-6 months. Aerobic training (cardio work for 30-45 minutes, 2-4 times per week with a 65-70% max heart rate) should be aimed at dropping your resting heart rate 5-15 beats per minute over the span of 2-6 months if your resting heart rate is above the low 60s. If you already have a sufficient aerobic base (low resting heart rate, and rarely gassed after hard sets), then there's not much need to do much extra cardiovascular training. Simply find the level that allows you to maintain your current level of aerobic fitness. These concepts are illustrated in **Figure 9.2**.

CHAPTER 10

Deloads and Responsiveness to Stress

A rather unsavory implication of our last model is this: Since you have to increase training volume and your ability to handle more training volume long term to continually make progress for years and decades at a time, eventually you'd make it to the point that lifting weights would essentially need to be your full-time job to continue getting bigger and stronger. Hours and hours in the gym every day.

That's true to a point (the bulk of elite and professional athletes in almost any sport handle absurd training loads), but obviously it's not feasible for most of us.

Here's where deloads and planned decreases in volume come in. They're the workaround for needing to eventually push yourself toward astronomical levels of training volume.

To this point, we've been talking primarily about stress, and treating your reaction to it in a basic curvilinear way – to get more results, you have to do more. You have to do more this month than last month, this year than last year, etc.

However, to maintain progress while stemming the ever-increasing workload, you have a powerful and under-utilized tool at your disposal – deloads or planned decreases in volume.

These serve two basic purposes:

1) Decrease injury risk from the accumulated wear and tear of tough training.

2) Increase responsiveness to a given level of training stress.

The second piece is the one most relevant to our purposes here.

Just to illustrate numerically, let's say currently a certain amount of training stress (let's say 2 sets of 5 at 80% of your max) causes a certain amount of adaptation (let's say a 3 pound increase on your max each week). Just as a baseline, these numbers represent both a stress and response with a magnitude of 10.

However, as you expose your body to the same stressor repeatedly, it responds less robustly each time. This is known as the "repeated bouts effect." So after a given period of training, 10 units of stress only yields 5 units of adaptations (1.5 pounds per week), so you'd need to roughly double the amount of stress (20, or 4x5 at 80%, although in reality it would be quite a bit more, since you hit diminishing returns on each additional set, but we'll keep the numbers pretty for right now) to cause the initial amount of adaptation (10, or 3 pounds per week).

Then, as time goes on, you'd have to keep increasing training stress more and more to keep getting increasingly diminished gains. Eventually you'd reach a point that you were training as much as you feasibly could, and making minimal progress.

However, here's where deloads come in. It takes a LOT less stress to maintain your current strength and size than it does to make new progress.

In this scenario, you can do one of two things.

1) Take a week or two off of hard training (**Figure 10.1**).

2) Decrease your training volume for a few weeks or months (**Figure 10.2**).

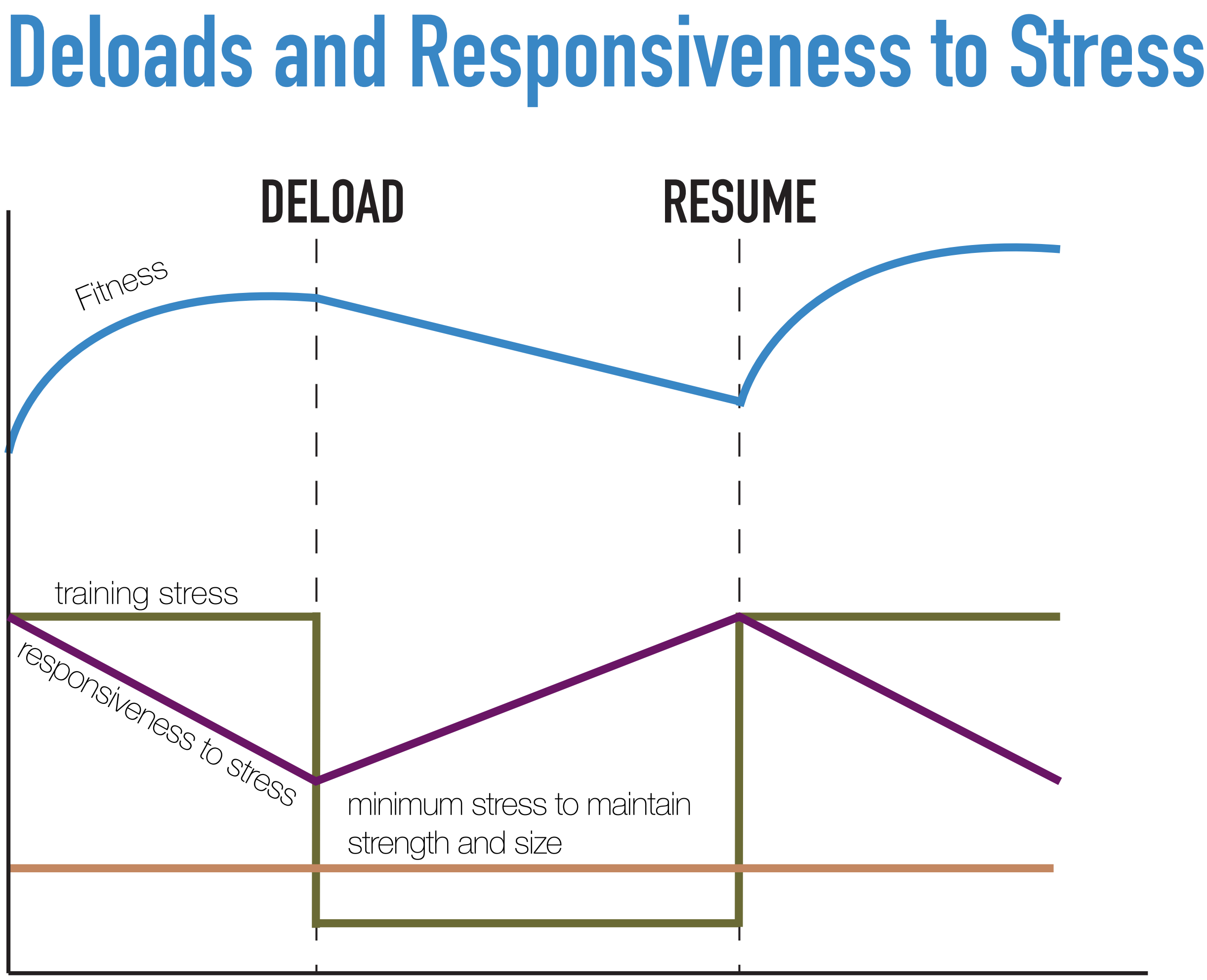


Figure 10.1

The first option, demonstrated in **Figure 10.1,** is pretty straightforward. Personally, this is the route I'd recommend, especially for someone big and strong enough to really cause significant wear and tear with their training. This used to be common fare, especially among strength athletes – they'd compete 2-3 times per year, and take a full week or two entirely off of training after they competed. Here, soreness is a good indicator – did you take enough time off that your first "normal" session back makes you pretty sore? Although soreness isn't a particularly good indicator that something was a good workout for long-term training purposes, it is a reliable indicator that a workout caused microtrauma to the muscles and activated a strong inflammatory response – letting your know the workout was sufficient to provoke a robust reaction from your body.

The second option, demonstrated in **Figure 10.2** on the next page, is good for people who can't stand to be out of the gym for more than a day or two. For this, all you'd do is significantly decrease training volume for 4-6 weeks. Do enough that you don't get significantly smaller and weaker (which doesn't take very much as all – 2-3 heavy sets per movement per week), and be content to simply maintain your current mass and strength. This is a perfect time to work on improving your cardiovascular fitness as well, if that's a need you have. This is the option I personally use in my training when work gets crazy. I'll squat and bench press twice per week, and deadlift once per week. For each movement, I'll work up to a heavy set of 3-5 reps at an 8-9RPE, do one or two sets of 2-3 with a weight 5-10% lighter, and wrap it up – in and out of the gym in 45 minutes or less. This has proven very effective for maintaining strength up to 3-4 months at a time, after which point I can easily gain strength with a

Performance and Responsiveness to Stress with a Period of Reduced Training Volume

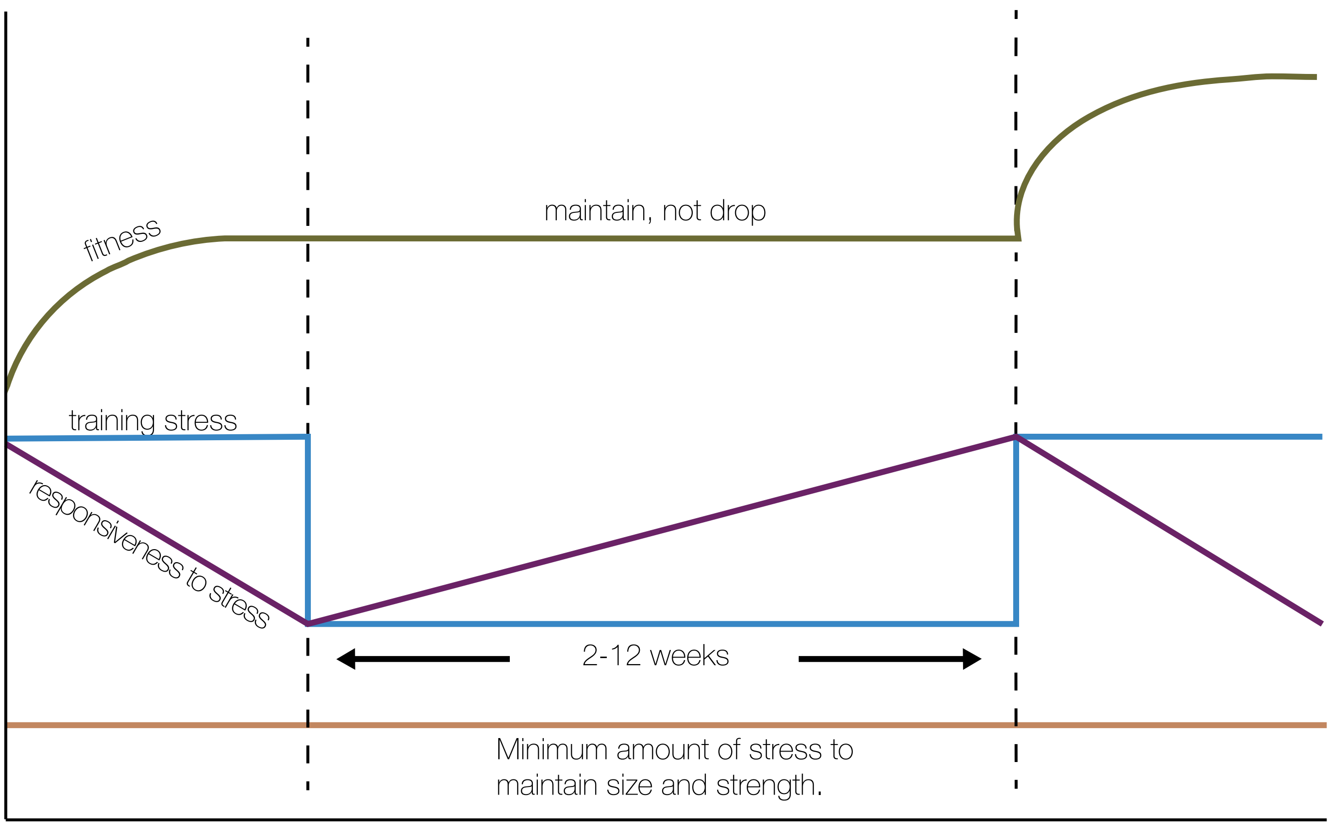


Figure 10.2

very minor uptick in training volume.

Both of these options accomplish the same purpose: to make your body more responsive to a given level of stress. Instead of needing 20 or 30 units of stress to elicit 10 units of adaptation, it may only take 10 units of stress again.

Even if you lose a little strength and size along the way, that's not particularly problematic. The strength lost would primarily be from neural factors (since you'd be practicing the lifts less), and the size lost would come back quickly – within a couple of weeks. This has to do primarily with myonuclear domain theory. Your muscle fibers have a lot of nuclei (as opposed to most cells, which just have one). Each nucleus can "oversee" a certain amount of volume within the muscle fiber. When you lose muscle mass, assuming it's not from some sort of really extreme intervention (like severing a nerve), you may lose muscle protein, but the vast majority of the nuclei stick around. When you start training harder again, rather than having to fuse more nuclei to continue growing (which takes quite a bit longer), your muscles can simply ramp back up protein synthesis so each nucleus is "overseeing" the same volume of muscle fiber contents it was before. That's the basis behind "muscle memory" – why it's much easier to regain muscle mass you had previously than build new muscle if you've been consistently training hard.

This may sound like theoretical mumbo jumbo, but there's research to support it, and you can see how it works in the real world. At least in rodents (no human data on this yet as far as I know, but muscle physiology between humans and rodents is pretty dang similar), it only takes 12 days without training to restore the magnitude of anabolic signaling that was previously seen when the little critters were totally untrained. And in humans, one study showed that training six weeks on, three weeks off caused the same rate of muscle and strength gains over time as training consistently without any layoffs because the participants were more responsive to the training after a layoff.

More often than not, people end up inadvertently applying this principle to their training anyways. They train too hard, too long, get hurt, have to take a few weeks off, and then when they can start training hard again, they end up setting new PRs after a couple of months, provided they don't re-aggravate their injury. With deloads or periods of decreased volume, you can get the same benefits without having to deal with the injuries.

Anyone who has coached team sports athletes has seen this as well. A good in-season program for most sports simply aims to maintain the strength of the athletes in-season with significantly lower volume in the weight room (one study with highly trained lifters showed that just two workouts per week, with 12-18 total sets per workout, including accessory work, could maintain strength for over 3 months), allowing for more time and energy to be spent practicing skills and recovering from competitions. When those athletes get into the weight room after their competitive season is over, it's not at all uncommon for them to make as large of gains in strength and muscle mass in a 12-16 week offseason as most powerlifters or bodybuilders would be happy with in an entire year of training. Since they're coming off a long period of decreased training volume, they're much more responsive to the weight training they do in the offseason.

CHAPTER 11

Strength vs. Mass Gains

Two common problems strength athletes run into:

1) In the first few months in the gym, people tend to get significantly stronger pretty quickly. However, while their physique improves, the mass gains don't seem to come at nearly the same rate as the strength gains.

2) After someone's been competing for a few years, they find a weight class they're competitive in. However, over the span of several years, their lifts plateau. They can't seem to improve their lifts very much more while staying in the same weight class.

Both of these issues are caused by the relationship between strength gains and mass gains.

When you first start lifting, your muscles have the capability to move a lot more than you can actually load on the bar and lift. The motor patterns are foreign to you, so as you're able to add weight to the bar, the primary factor allowing you to do so is simply that your nervous system is learning what the heck you're doing, and learning to tell your muscles how to fire appropriately. Your nervous system can learn much faster than your muscles can grow. So as you double the amount of weight you can squat with only an inch or two added to your thigh circumference, the primary reason for this discrepancy is simply that your muscles had plenty of potential to squat that much from the moment you first touched a barbell – you just didn't know how to do the movement, so you couldn't use your muscle mass to its full potential. Sure, you'll add some muscle mass, but not nearly at the same rate as your lifts improve, as seen in **Figure 11.1**.

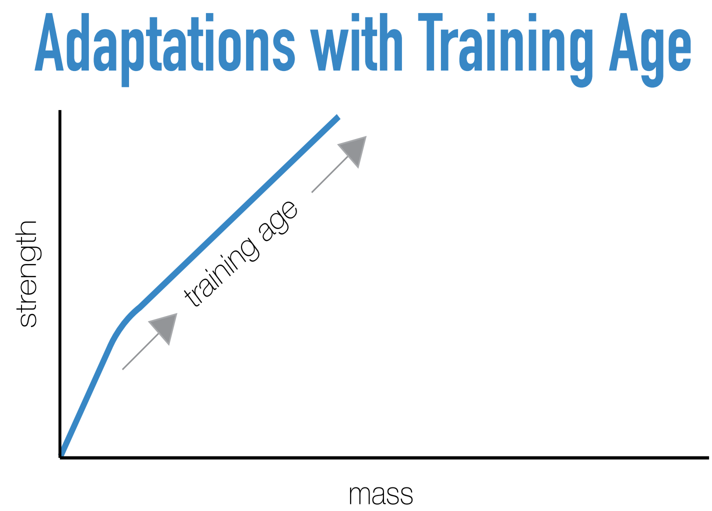


Figure 11.1

Once you're proficient at the movement, however, the factors change. Sure, you can probably add a little more weight to the bar by improving technique and becoming a little more neurally efficient. But there's not the same amount of low hanging fruit from a motor learning perspective. Rather, your nervous system has a pretty good idea what it needs to do to move the weight, so what it's acting on – your muscles – become the limiting factor.

In all the noise of the powerlifting community, one very simple fact can become obscured: Your muscles are what move weight.

Why some people lift more and others lift less

There are, by my count, six factors that largely determine how much weight you can lift right now:

1) Muscle size
2) Muscle fiber types
3) Segment lengths (height, limb lengths, torso length, etc.)
4) Motor learning factors
5) Motivation/arousal/fatigue
6) Muscle origins and insertions

Muscle Size

A bigger muscle, all other things being equal (and those "other things" are the rest of this section), is a stronger muscle. There's no way around it – past a point, you simply have to grow. I won't harp on this one too much more, as I'll be talking about it in more detail later.

Muscle Fiber Types

I wanted to get this one out of the way early, because it's often misunderstood. Most people are under the assumption that you'll lift more if you have a greater proportion of type II (fast twitch) muscle fibers.

However, that belief is based on a misunderstanding of terms.

Type I muscle fibers and Type II muscle fibers differ in several major ways. Type I muscle fibers are less fatiguable (making them great for endurance exercise) and take longer to reach maximal force when stimulated. Type II fibers, on the other hand, are more fatiguable but can reach maximal force much faster when stimulated (making them great for power-dependent exercise).

However, the maximal force production for a given area of Type I fibers is almost exactly the same as the maximal force production for a given area of Type II fibers. Type II fibers simply reach maximal force output sooner, making them better for power-dependent activities like sprinting or jumping. Powerlifting, though (contrary to what the name may lead you to believe), is NOT a power-dependent sport. Power output actually peaks around 30-60%1rm and is quite low with maximal loads.

All of which means, fiber type distribution doesn't influence how much you can lift very much at all.

Two caveats:

1) Type II fibers are more responsive to strength training and grow more than Type I fibers do, so fiber type distribution may limit long-term strength potential somewhat. However, that's purely theoretical, because research has shown that elite powerlifters (average squat/deadlift of about 285kg/630lbs, and bench 170kg/375lbs) actually have about the same Type I/Type II fiber ratio as untrained people, which leads you to believe the sport itself didn't select for people with a fiber ratio skewed toward Type II. So it may be a concern for someone with an unusually high proportion of Type I fibers, but it won't be for the vast majority of people.

2) Since Type II fibers reach peak force output faster than Type I fibers, there's a small chance that they'll allow for more speed to be developed off the chest on bench, out of the hole on squat, or off the floor on deadlift, and that speed may

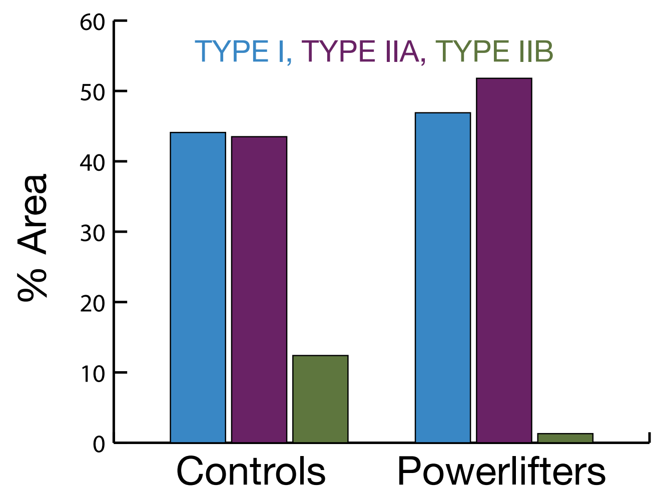
help you get max weights through the sticking point of the lift more effectively.

However, that's a bit of a stretch for both squat and bench because the muscles are already contracting quite hard to control the weight while lowering it; for max loads, all your slow twitch fibers are probably recruited already (since they're the ones recruited first – Henneman's Size Principle) before you reverse the weight, so regardless of fiber type breakdown, the additional fibers activated as you reverse the lifts are primarily fast twitch anyways.

And for deadlift, most people are weakest off the floor. So taking longer to reach maximal force output would mainly just affect how long it took for the bar to break the floor, not the speed of the lift itself.

Keep in mind, I'm only saying fiber type distribution is largely unimportant for powerlifting. For other sports, it certainly matters. More Type I fibers are beneficial for endurance events, and more Type II fibers are beneficial for power-dependent sports.

Figure 11.2



Similar proportions of Type I and Type II (IIa and IIb combined) fibers in pretty strong powerlifters and untrained controls. From Fry et. Al, 2003.

Segment Lengths

So far, we've been talking about how much force a muscle can contract with. Now we're talking about the torque required to produce movement at a joint.

Torque takes into account both the force applied and the length of the lever (or moment arm) it's applied against. Basic application: If you're sitting on a seesaw and someone much larger is sitting across from you, if you're both sitting at the end of your respective sides, the other person will be sitting on the ground, and you'll be way up in the air. If they move closer to the middle (the fulcrum), it can balance out the seesaw, even though they're larger.

So, let's say two people are squatting, and everything is the same about them (same basic technique, same level of training, same amount of muscle mass, etc.) except that one of them has longer femurs. That means that either the moment arm the quads are working against to extend the knees (the distance between the knee and the center of mass – roughly mid-foot), the moment arm the glutes/adductors/hamstrings are working against to extend the hip, or both will be longer for the person with longer femurs. That means that his muscles will have to contract harder (produce more force) to produce the required torque to squat a given weight.

Femur and torso length affect both squats and deadlifts in this manner. Additionally, total height factors in as well – since the length of basically all segments will be longer, it requires more muscular force to produce the requisite torque to lift any given load. Finally, arm length is important for both deadlift (shortens the ROM making the lift easier) and bench press (increases the total ROM).

However, taken as a whole, segment lengths really don't matter too much for OVERALL powerlifting performance. For starters, you're probably not as special of a snowflake as you think you are. Although there is some variability in relative segment lengths, it's usually less than 10% except for extreme outliers (so that guy who squats twice as much as you doesn't do so because you have long femurs. If yours were the same length, he may squat 1.8x as much as you instead of 2x as much). As far as height goes, required torque increases with height, but so does overall muscle mass (meaning muscle mass per unit of height is similar). Shorter people still have a bit of an advantage, but it's taken into account with the Wilks formula, which levels the playing field for shorter/lighter lifters and taller/heavier lifters. Finally, the advantage that different segment lengths provide in one lift is abolished by a disadvantage in another. Long femurs may be bad for squatting, but they're usually good for deadlifting (since long arms and legs tend to go hand in hand). Long arms may be good for deadlifting, but they're usually bad for benching.

On the whole, segment lengths do affect performance in each lift a bit, but not as much as people who use them as a crutch would like to believe (usually a difference of less than 10%). Furthermore, a disadvantage in one lift usually becomes an advantage in another.

Motor Learning/Neuromuscular Efficiency

This is another trendy topic, especially as it relates to training frequency.

Will training a lift more frequently lead to better/faster motor pattern acquisition and greater strength? For new lifters, it doesn't seem like that's the case. For more advanced lifters, it may be (further reading); however, the bulk of the studies that have been done to this point didn't use the types of protocols that proponents (Pavel, Dan John, Bulgarian system advocates, etc.) posit will elicit the beneficial effects. So at this point, it's mostly theoretical without much scientific evidence for or against it.

However, before falling down a theoretical rabbit hole, let's stop and take a look at what really freaking strong people are actually doing: pretty much everything.

A lot of the early strength greats trained lifts 4+ times per week. Top powerlifters from the '70s through the late '90s usually squatted and deadlifted once per week, and benched twice per week. Bulgarian-system weightlifters squat heavy every day and are seemingly all insanely strong (here's Ivan Ivanov with a 4x bodyweight front squat, and Ivan Chakarov with a beltless 3x bodyweight squat for a triple, although his coach says he's squatted 350kgx3 – almost 4x bodyweight). Most great Eastern-bloc lifters squat 3 times per week, bench 4-5 times per week, and deadlift twice per week. The fast-rising Norwegian team trains with similar volume and intensity as the Eastern-bloc powerlifters, but with about twice the frequency. The Chinese weighlifting team squats heavy twice per week (and has produced plenty of insane squatters). The Lillebridges squat and deadlift heavy once every two weeks (with lighter squats and deadlifts on the other week).

So, what can we take away from all of this?

1) It's undeniable that improved neural/motor learning factors will let you lift more via improved muscle activation, more efficient technique, better neuromuscular coordination (increased activation of synergist muscles and decreased activation of antagonist muscles) but…

2) You can master a motor pattern over time with just about any training frequency, as has been demonstrated by elite strength athletes throughout time. Maybe increased training frequency will allow you to master a movement quick-

er, but if you're planning on lifting for years and years, you'll reach mastery regardless of training frequency (keep in mind, I'm talking about the relatively non-technical power lifts, not the more technical Olympic lifts).

Motivation/Arousal/Fatigue

These all relate to how much you can lift today. If you're more motivated to lift, you're less fatigued (basic application of Banister's Impulse-Response model, otherwise known as the fitness-fatigue paradigm), and if you are at optimal arousal (with both too little and too much being detrimental – Yerkes-Dodson Law), you'll be able to lift more.

Muscle Origins and Insertions

This is a huge factor not many people talk about. Our bodies aren't actually built very well for lifting heavy things. When you compare humans to comparably sized animals, we tend to be far weaker.

The primary reason for that is difference in muscle attachments. A muscle that attaches further from a joint is capable of producing more torque at that joint. Our muscles, for the most part, attach very close to the joints they move. This is good for allowing large ranges of motion (because a given amount of movement at a joint requires less tissue extensibility), but means that the force (linear) our muscles produce isn't translated very efficiently into torque (angular) at our joints.

Figure 11.3 is a simple illustration. If you grip this wrench at point A, you'll have to pull a lot harder to turn the bolt than if you were gripping it at point B.

For the most part, humans' muscles attach in a manner more similar to point A, and other animals' attach in a manner more similar to point B.

For example, let's compare the hamstrings of a human and a cat. The hamstring muscles of a cat insert far down the tibia and fibula. In contrast, human hamstrings insert very close to the knee. That means that if a human and a cat contract their hamstrings with the same amount of force, the cat will produce WAY more knee flexion torque.

Humans have some variability in muscle attachment points, and this variability matters far more than variability in segment lengths, because a small change can make a big difference.

Just to illustrate: Let's say you're comparing hip extension torque for two people doing good mornings with their torsos parallel to the ground. One person's torso is 10% longer than the other person's. That means the moment arm (basically the front-to-back distance from the barbell to their hip joint) is 10% longer for the person with a longer torso, so they need to produce 10% more hip extension torque to lift a given load.

Now let's say you're comparing two people with the same torso length, but one person's ischial tuberosity (the origin point for the hamstrings) protrudes an extra inch, or their hamstrings originate a bit further down on the ischial tuberosity – which is entirely within the realm of possibility. Pelvises come in all shapes and sizes.

Let's say the distance between the hip joint and the origin of the hamstrings is about 3 inches on average. That extra inch means they produce ~33% more hip extension torque if their hamstrings contract with the same force.

Because muscles attach so close to joints (usually not more than 2-4 inches away), small variations can make a big difference.

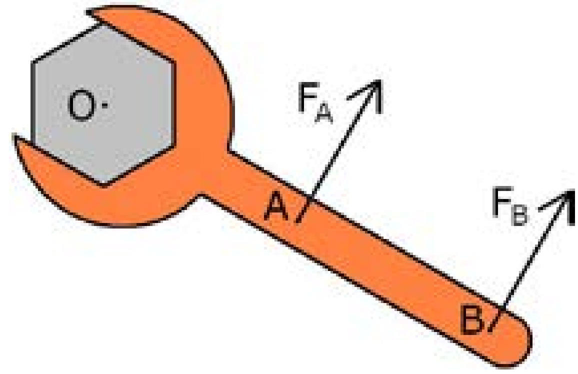


Figure 11.3

As an aside, something I've noticed is that a lot of huge deadlifters tend to be more "hip-dominant" squatters (Steve Goggins and Mike Tuchscherer are great examples) and are more apt to be able to grind a lift out if the bar pitches them forward a bit, whereas people who squat about the same or more than they deadlift (Chad Wesley Smith and Eric Lillebridge come to mind) tend to squat a bit more upright, and tend to fail lifts if they get pitched forward a bit. It wouldn't surprise me if anomalous hip extensor attachment points largely explain this trend.

So far I've mainly been talking about the hip extensors, but the same goes for prime movers at every joint. If your pecs insert farther down your humerus, you're more apt to be a big bencher. If your lats insert farther down your humerus, you're more apt to be able to do some really heavy weighted pullups. If your patellar tendon inserts a bit farther down your tibia, you'll probably be able to squat more. You know that guy who can curl a ton without impressive biceps? I'd bet he has biceps that insert farther down his radius.

So what do we do with all this?

Now let's take a look back at each of these factors to see where we should direct our efforts in training.

Origins and insertions: This may impact what technique will allow you to lift the most weight (another reason why the notion of universal "perfect form" is laughable), but you can't really change them, barring surgery.

Motivation/arousal/fatigue: These are all acute factors. Learning how to mitigate fatigue and manage arousal are good skills to acquire, but they have more to do with how much you can lift today rather than long-term strength potential.

Motor learning/neuromuscular efficiency: It's possible that training more frequently could lead to quicker mastery, but if you're going to be training the power lifts (relatively simple movements) for years and years, mastery is going to come with practice as long as you're lifting heavy things at least somewhat frequently (at least once per week for most people).

Segment lengths: Similar to muscle origins and insertions, these may affect technique to a certain degree, but you've got to play the hand you're dealt.

Muscle fiber types: Ditto. Plus, they don't really matter too much for powerlifting anyways.

Muscle size: Ding ding ding. We have our winner.

Of the factors we've discussed, muscle size is the only one you're able to change in a major way in the long run, except for motor learning/neuromuscular efficiency. However, the latter pretty much takes care of itself via practice lifting heavy weights. Muscle size increases with pretty much any type of strength training as well, but it's clear that there are techniques that are more or less effective for building size. Hint: It's not max sets of 1-5.

Before going any further, I'd just like to point out that training with a focus on gaining mass to dominate at powerlifting is directly supported in the literature.

One study found that in elite level powerlifters, performance in all three lifts was strongly correlated (r=0.8-0.9 for some) to muscle thickness in the prime movers (although bizarrely, it was most strongly correlated to subscapularis thickness in all three lifts, just as an aside). Another, hot off the presses, found again that one of the strongest predictors of performance in national-level lifters was muscle mass per unit height. Big is strong.

Think of muscle mass as potential strength. If you gain mass, you may not necessarily be stronger right away (i.e. if you trained with lower weights and lost a bit of technical efficiency with max weights), but you have the potential to be stronger. If you stay the same size, you have a cap on how strong you can possibly get. When comparing two individuals, the one with more muscle may not necessarily be the stronger one (for all the factors listed above – muscle attachments, segment lengths, technique, etc.), though he probably will be. However, when comparing small you to jacked you, all other things being equal, jacked you will be stronger.

All of those other factors (apart from muscle size), particularly segment lengths and muscle attachment points, largely explain why some relatively light people who aren't overly jacked-looking can still lift huge weights. It's not that their smaller muscles contract any harder than yours do - it's that either they have body segment lengths that are advantageous for a certain lift, requiring less torque to lift a given weight, or they have muscle attachment points that allow them to produce more torque at a joint with the same force of muscle contraction. There wasn't any special training that allowed them to lift heavy weights with relatively little mass; most of it simply has to do with how they're built.

So, obviously the question becomes, how do you get more jacked?

For muscle growth, volume is priority No. 1. There are two basic ways to go about accruing this volume:

Train "like a powerlifter" (heavy sets of 1-5, but more of them).

Train "like a bodybuilder" (mainly sets of 8-12)

If you go the first route, you'll need to set up your training similar to Eastern bloc (i.e. Sheiko-style) or Norwegian lifters: Drop your average intensity. To tolerate the necessary training volume, you'll need to do your sets of 1-5 with lighter loads, usually in the 70-80% range, with very few lifts at 85% or above. Furthermore, the sets will need to be fairly easy, leaving at least 2-3 reps in the tank each set. If you try to handle the volume necessary to maximize hypertrophy while still focusing on lifting 85-90%+, or within a rep of failure, you increase your risk of injury and burnout.

I'd recommend the second route for most people. Why? It's simply a much more efficient way of reaching the same end point.

A recent study by Brad Schoenfeld illustrated this point beautifully. Two groups of lifters either did 3x10 or 7x3 with the heaviest loads they could lift. At the end of 8 weeks, the group doing sets of 3 gained more strength, but both groups gained the same amount of muscle. Ironically, a lot of strength athletes jumped all over this study, saying, "See, I can get swole doing my heavy triples!" without noticing two major caveats: The 3x10 workout only took 17 minutes, whereas the 7x3 workout took 70, and the subjects in the 3x10 group all wanted to train more, whereas the subjects in the 7x3 group were wrecked by the end of the study.

The superior gains in strength in the 7x3 group don't particularly phase me either. Of course they'd test better at the end of the study: They were lifting loads closer to max, so they'd be more prepared for hitting a max single. I would almost guarantee if both groups were put on the same 4-6 week peaking protocol after the 8 weeks of different training, those strength differences would largely vanish as the 3x10 group had a chance to improve confidence and efficiency with heavier loads.

So if you can gain the same amount of muscle with ¼ the time in the gym, that probably means that, in the real world, the 3x10 group would have ended up gaining even more mass than the 7x3 group, because they had the desire and the ability to handle more volume than the study protocol allowed for.

General Recommendations

For starters, don't get married to your current weight class if you compete in powerlifting. The weight class where you'll be most competitive will be the one in which you're carrying as much muscle (remember, muscle mass per unit height is the key factor) and as little fat as possible. If you've only been training for a year or two, the weight class you're in now is probably NOT the weight class you should wind up in. You may be more competitive in a lighter class now, but if you stay there when you still have the potential to grow, you're limiting yourself in the long run.

As far as general training setups go, I recommend one of two options:

1) Block periodization set-up with the bulk of your year spent effectively doing "bodybuilding" training – hitting each muscle or movement 2-3 times per week,

focusing on sets of 5-10 for your main lifts, sets of 8-15 for accessory lifts, and doing 6-10 (depending on how long you've been training) sets per muscle each time you train it. Don't be attached to the barbell for your bodybuilding-style training. Obviously you should keep practicing the competition-variety lifts, but there's nothing wrong with using dumbbells or machines for hypertrophy work (and they may even be better, allowing for a longer range of motion and more constant tension on the muscles). Take 6-8 weeks before a meet handling heavier loads to develop confidence with the weight and the skill of lifting near-max and max loads.

2) Train your main lifts like a powerlifter, and your accessories like a bodybuilder. Farther out from a meet, just do 1-3 sets of 2-5 reps of your main lifts per workout, so you have more time and energy to devote to accessory lifts that you train bodybuilding-style (6-10 sets of 8-15 reps per muscle/movement). Then, over 6-8 weeks when you're 9-12 weeks out from a meet, gradually shift the emphasis toward your main lifts, eventually doing 4-8 sets of 2-5 reps (still leaving at least a rep or two in the tank on each set), while cutting your accessory work in half. Then take 2-4 weeks to peak (heavier loading but less volume on your main lifts, with little to no accessory work to minimize fatigue) leading up to the meet.

Once you train like this for a few years (at least 3-5) to build a solid muscular base, then it may be wise to transition into more of a Sheiko/Norwegian setup to increase specificity and ensure that the bulk of your training volume is devoted to adding mass in the most specific manner possible (not most efficient – though that wouldn't be as much of a concern since you should be nearing your muscular potential by that point).

If you focus on growth, the strength will take care of itself, provided you train with heavy loads occasionally, especially leading up to meets. If you focus purely on heavy strength work while neglecting the volume necessary to maximize hypertrophy, you're limiting yourself in the long run. The bulk of your time in the gym should be focused on growth, at least until you're nearing your muscular potential. The line between bodybuilder and powerlifter should be drawn at the point of competition, with the distinction being much hazier as far as training methods go, except for the very elite.

CHAPTER 12

Specificity of Adaptations With Training Experience

When you first start lifting, you have a lot of room for improvement in virtually all areas. Your technique can improve a lot, your neural efficiency can improve a lot, and your muscles can grow a lot.

So when you talk about applying an overload in training, what will get you both bigger and stronger? Well, just about anything. In fact, in untrained participants, training at intensities as low as 30% 1rm can cause strength gains, and virtually any training, regardless of intensity, can cause size gains (even just a single set of an exercise). Why? Because when your baseline for training intensity is 0, 30% IS an overload in intensity. When your baseline is 0, a single set IS an overload in volume.

Obviously, you don't see the same types of things happening in highly trained folks. I doubt you'll find a single 500-pound squatter who can increase his max training with 150 pounds exclusively. Why? Because training responses become more divergent, as demonstrated in **Figure 12.1**.

SPECIFICITY OF ADAPTATION WITH TRAINING EXPERIENCE

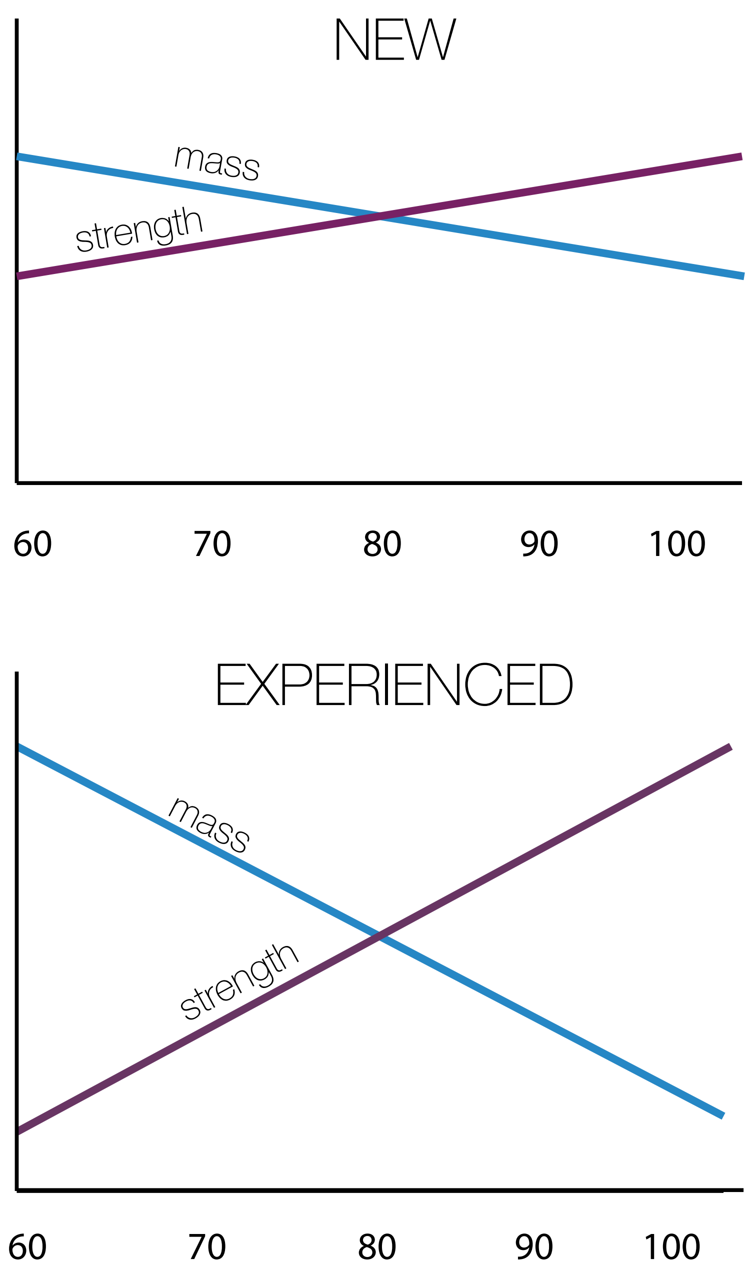


Figure 12.1

If you train light (65% 1rm or less) without any heavier training, you may get bigger but you won't get much stronger (at least immediately, though increased muscle size will set the stage for increased strength long-term), and if you train super heavy all the time (90%+ 1rm) you may be able to gain some strength, but you won't add much size because training volume will be too low.

Because of this, you need to start paying attention to the range of tools you have at your disposal, and ask yourself what you're trying to accomplish with each one.

For example, if you're a powerlifter, your goal is to move more weight than you were previously capable of in the squat, bench press, and deadlift. It requires a high degree of technical proficiency with near-max loads to excel. Because of this, the majority of the training you do using the squat, bench, and deadlift should be with loads and rep schemes that allow you to exert maximal force against the bar with perfect form: Usually 80% of your max or more, and stopping each set before bar speed drops substantially (force output decreases), technique breaks down (to make sure you're engraining good form), and fatigue accumulates out of proportion to positive fitness-building adaptations.

You want to use the tool (the squat, bench, or deadlift) for the purpose it serves best – building maximal strength in those specific movement patterns.

Of course, that all flies in the face of the No. 1 tool in your arsenal – volume. If you do a ton of sets with heavy weights moved at maximal force, you're headed for trouble. If you use the squat, bench, and deadlift to accomplish every training purpose simultaneously (building strength, increasing muscle size, and improving conditioning), you can certainly get the job done, but you're not doing so as effectively as possible. You're training your body to move the weight in a way other than what your sport demands, somewhat negating the effects of your heavy training.

So to accomplish your other training purposes, you use different tools – accessory lifts. Let's say your hamstrings are limiting your deadlift. Could you do competition-variety deadlifts with a ton of volume to add some size to your hamstrings? Sure, you COULD, but it's not the best option. (See **Figure 12.2** for visualization.) Instead, continue to deadlift heavy with relatively low volume to train the deadlift itself, and do RDLs or good mornings to specifically train your hamstrings. Ditto for if your pecs are limiting your bench press. You could just do more reps on the bench press, but you'd be better served to use the bench to train the bench, and use DB presses or flyes to strengthen and grow your pecs.

Your average training intensity will still wind up between 70-80% like I proposed in *The Art of Lifting*, but that doesn't mean it has to be 70-80% for every lift, all the time. It may be 87% for your main lifts (from sets of 1-3 at 85-90% of your max) and 70% for your accessories (sets of 10-12), averaging out to somewhere in the high 70%s.

This approach for more advanced lifters will accomplish three purposes:

1) Allowing you to build more strength in your main lifts by training them in a manner most specific to the demands of competition.

2) Allowing you to build just as much mass, because total training volume isn't compromised. Furthermore, you can target your hypertrophy work for your weak areas.

3) Minimizing fatigue from training, because a given level of volume for, say,

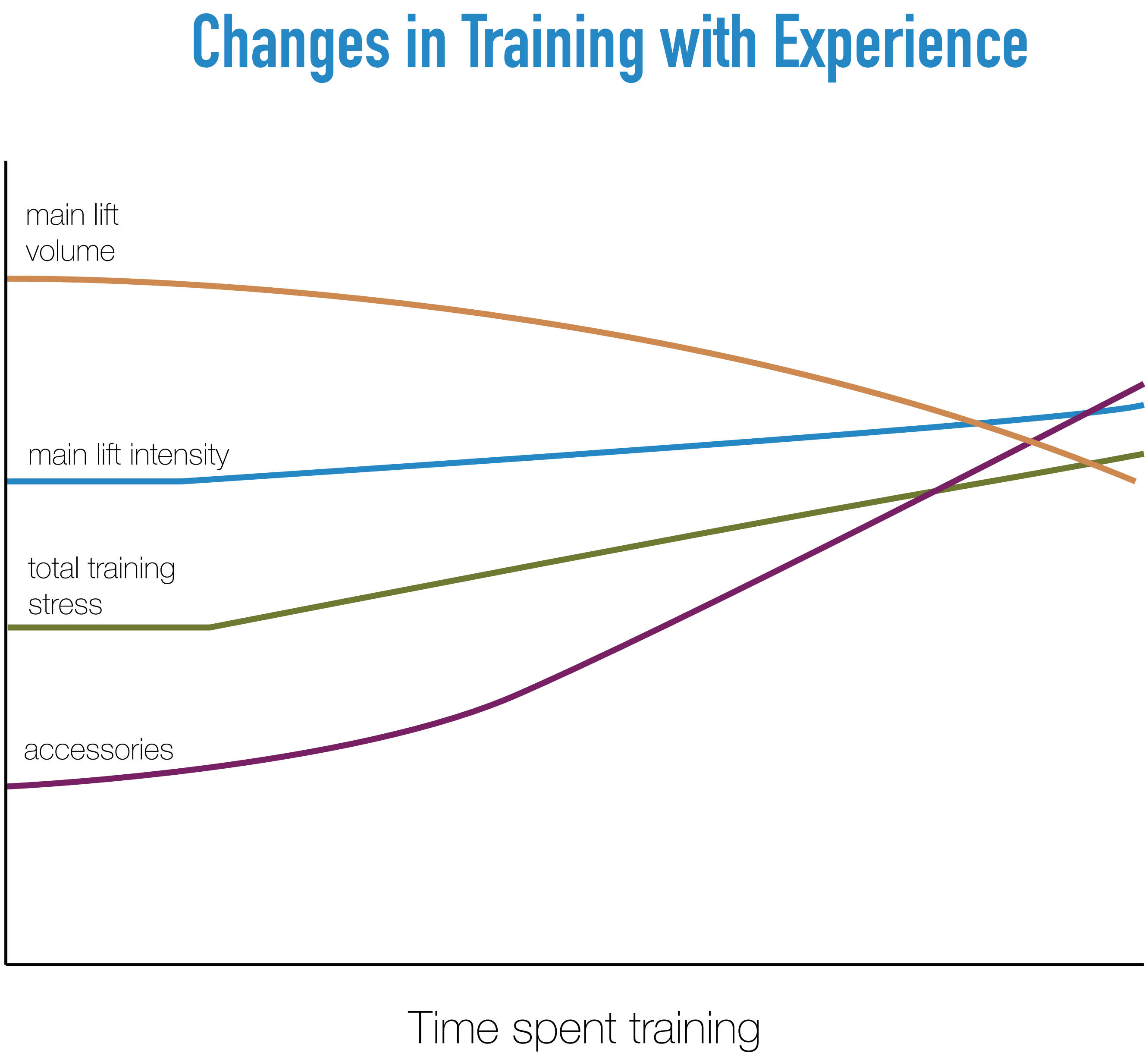


Figure 12.2

RDLs, will be much less stressful than an equivalent level of volume (sets and reps at a given percentage of your max, not necessarily total reps x load) for competition-variety deadlifts.

CHAPTER 13

Pyramid of Nutrition Priorities

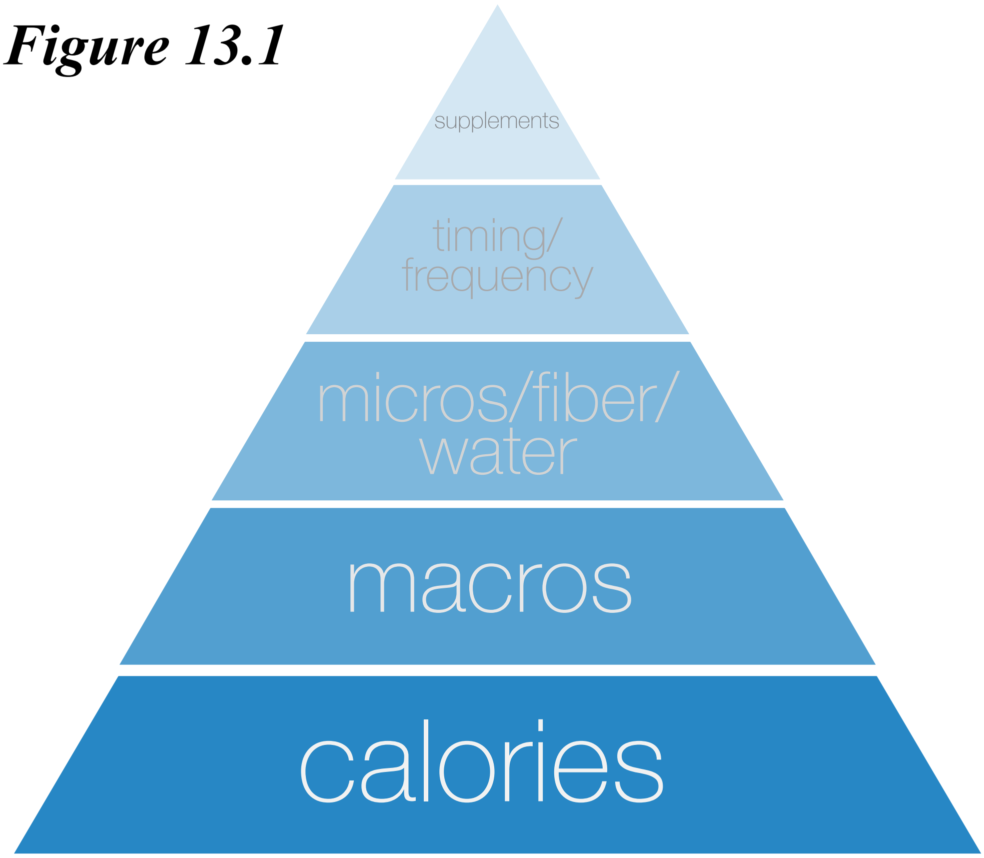
I credit my friend Andy Morgan (who in turn, insisted on crediting Eric Helms) with the model in **Figure 13.1** on the next page. It's incredibly easy to grasp, and I'm sure you're aware of this basic idea anyways, so I'm not going to spend a tremendous number of words harping on it.

A lot of different factors go into planning a diet for strength or physique domination. However, not all of those factors are created equal. This is denoted by the pyramid – the top of a pyramid doesn't matter much without the base being stable and sturdy.

The most important factor, hands down, is caloric intake. If you're trying to gain mass and you aren't eating enough calories, nothing else matters. If you're trying to lose fat and you're eating too much, you're setting yourself up for failure. The way to determine appropriate caloric intake for your goals is discussed in *The Art of Lifting* already, so I won't reiterate all those points here.

The next most important factor is the macronutrient content of your diet. Again,

Figure 13.1



Pyramid of Nutrition Priorities

this has already been discussed in more depth in the companion volume, so I won't go over those steps again. However, once calorie intake is set, if you aren't eating enough protein to build and repair muscle, and enough carbohydrate to fuel the level of exercise you're doing, those are the next factors you should address, provided your caloric intake is in line.

The next most important factor is fluid intake, micronutrient intake (vitamins and minerals), and fiber intake. In the companion volume, the latter two factors are alluded to in the discussion of "food quality." As long as the bulk of your diet comes from whole food sources (meat, fruit, vegetables, fruits, eggs, dairy, whole grains, etc.), then your micronutrient intake is probably covered. As for fiber, general recommendations are 38g/day for men and 25g/day for women – as long as you're eating your fruits and veggies with most meals, you're probably in the clear there too. As for water, the best recommendations I've heard are from Lyle McDonald and Dan John: You should take at least five clear pees per day, and you should be peeing clear by noon. These factors are obviously still very important, especially for overall health. However, as far as physique and strength pursuits go, they're secondary to calories and macros (assuming you aren't so dehydrated you can't function, or have such a severe nutrient deficiency that it causes illness).

Moving further up the pyramid, we come to meal timing and frequency. These are factors that aren't overly important for the average gym warrior, but become increasingly important as you have grander goals and aim to become a competitive athlete. For meal timing, having some food in your stomach within the 2-3 hours prior to training, and getting some protein and (especially) carbs in your system post-workout can have some benefit, both in how hard you are capable of training and how well you recover from it. Meal frequency plays a role as well. Eating 3-6 protein-rich (at least 20-40g per meal) meals spaced throughout the day tends to be superior to eating less frequently, or consuming the majority of your protein within a small window of time. However, while these factors certainly contribute to attaining your strength or physique goals, (you should be picking up a trend by now), they are significantly less important than calories and macros, and matter much less for general health than food quality and sufficient water intake.

At the top of the pyramid are supplements. Yes, supplements can play a role, especially those well-supported in the literature like creatine. However, as far as nutritional priorities go, this is easily the least important factor for attaining your strength and physique goals, unless you're talking about the type of supplements you can't get at GNC (vitamin S). For more information about supplements, I'd highly suggest you get a copy of the Examine.com supplement goals reference guide or their stack guides. Examine.com is a website dedicated solely to collating and explaining all of the research on supplements in a totally unbiased manner. The site itself and the resources they sell are absolutely incredible (previously linked in *The Art of Lifting*, Chapter 27: Supplements) – they'll save you a ton of money on needless supplements, and save you a ton of time reading the research for yourself.

Keep the pyramid model in mind – make sure you have the factors at the bottom layers in check before worrying about the bells and whistles at the top.

CHAPTER 14

Different Calorie Levels' Effects on Muscle and Fat

Diving further into the effects of diet, let's touch on the effects of different levels of calorie intake on changes in fat and muscle mass.

These trends are pretty straightforward, though pinning down exact numbers is, of course, largely based on genetic potential, how far from your muscular potential you are, training, initial body-fat percentage, other dietary factors (i.e. protein intake, and the other factors on the pyramid to smaller extents), and drugs.

In general, though, with good training and an otherwise solid diet, a eucaloric diet (the amount of calories needed to maintain weight), a very small deficit, or a very small surplus (losing less than a pound per week, or gaining less than 1 pound per month) generally allows for a slow body recomposition – simultaneous muscle gain and fat loss.

A larger caloric surplus increases the rate of muscle gain, but also increases the rate of fat gain. However, both don't increase linearly with increased caloric intake past a point. Eventually, you top out the rate at which you can gain muscle, so the added rate of weight gain is made up for by increased fat gain.

The opposite isn't necessarily true in calorie deficits. Increased rates of weight loss tend to come primarily from fat, although muscle loss DOES increase as well. However, it's not the same type of relationship as was seen with a huge caloric surplus. Fat loss in a large deficit doesn't flatline the same way muscle loss does in a huge surplus, and muscle loss doesn't increase in a linear fashion in a large deficit the way fat gain does in a large surplus. Muscle is both harder to gain and harder to lose. See **Figure 14.1** below.

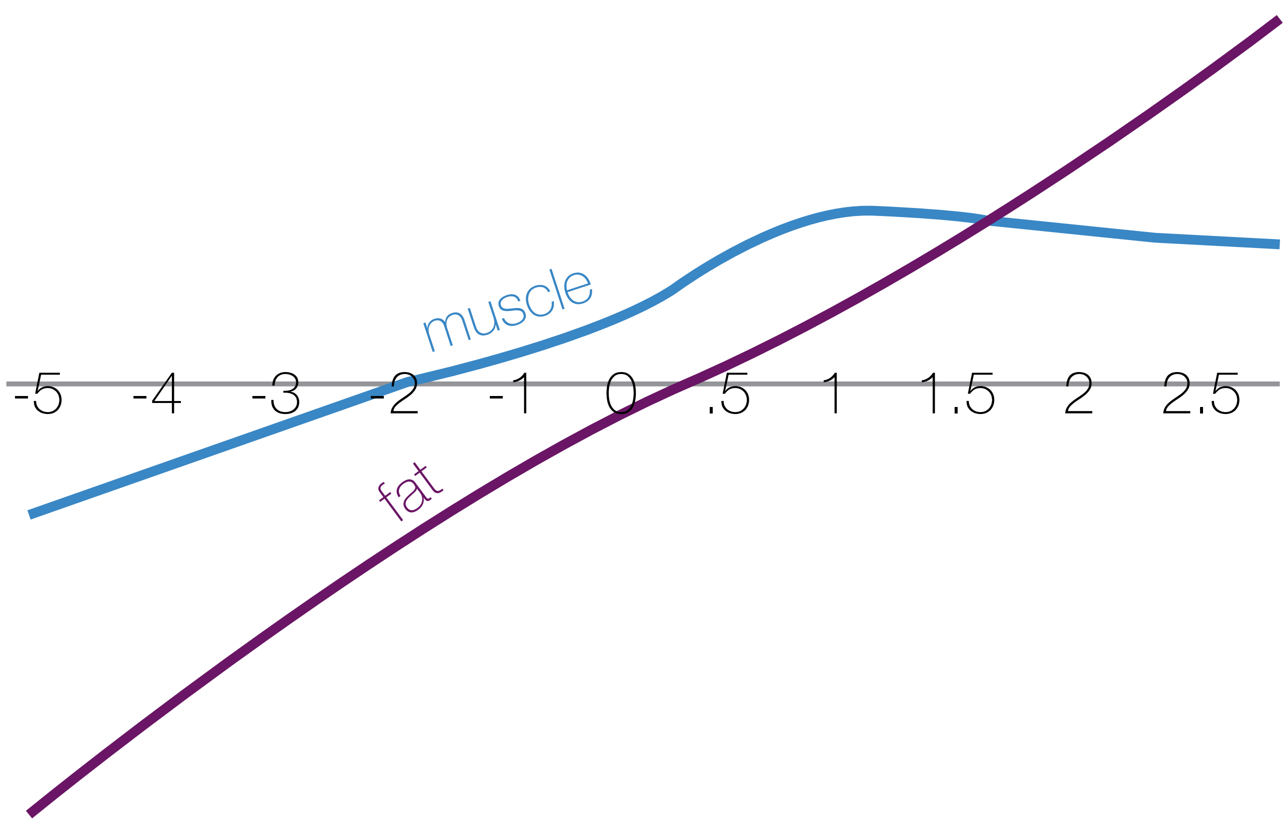


Figure 14.1

To be clear, the independent variable we're dealing with here is rate of weight gain or loss, not calorie level directly. Your body has mechanisms to cope with small deficits and surpluses. In a small surplus, your metabolic rate tends to increase slightly via changes in hormones like leptin, and you tend to inadvertently burn more calories through non-exercise activities like sitting or standing with better posture, fidgeting, getting up to do a chore when you may otherwise stay in a chair, etc. In a small deficit, the opposite occurs, with activity-related factors probably playing a larger role than decreases in resting metabolic rate. After you have been in a deficit or surplus for a period of time, further calorie manipulation tends to have fairly predictable results on weight, but at calorie intakes near maintenance, there's a zone where not many changes in weight occur. So, for example, if you're losing 1 pound per week, you're in roughly a 3,500kcal/week deficit, but to get there, it may mean eating 700kcal/day below maintenance instead of 500kcal/day. Everyone responds to increases or decreases in caloric intake slightly differently, which is why I'm using change in weight as the basis for this model, rather than necessarily how many calories over or under maintenance you're consuming.

As alluded to at the start of this section, there are several factors that influence these curves. In a perfect world, you'd want to shift the muscle gain curve up as much as possible, and the fat loss curve down as much as possible.

Some factors that shift the muscle gain curve up, and the fat loss curve down (and, by extension, the opposite of these factors would have the opposite effects on both curves), roughly ranked by order of magnitude:

1) Genetics.

2) Good training/drugs

3) Adequate protein intake

4) Sufficient sleep and minimizing stress

5) High G-Flux – both consuming and burning more calories. For example, when losing weight, expending an extra 200 calories per day and eating 300 fewer will tend to have a more favorable effect on body composition than just eating 500 fewer.

6) Other dietary factors, like meal timing, food quality, supplements, etc.

The oddball is body-fat percentage. When you're lean, it's much harder to lose fat and preserve muscle when losing weight, but it's much easier to gain muscle with relatively little fat gain when you're gaining weight. Conversely, when you're quite puffy, it's easier to lose fat without sacrificing muscle (or for many, it's still possible to build muscle), but it's harder to gain muscle and much easier to gain fat in a surplus.

Figure 14.2 depicts rates of muscle gain and fat loss on a relatively short time scale. However, we're obviously aiming to maximize results in the long run. Here's where selecting a caloric intake specific to your goals comes in.

If you're trying to maintain maximal leanness year-round, you won't be able to maximize muscle gain unless you're a genetic freak, for the simple reason that muscle is best grown in a caloric surplus. The rate at which you gain muscle when you're gaining half a pound or a pound per week will be significantly higher than if you're maintaining your bodyweight or gaining weight very slowly, at maybe a pound per two months. Conversely, the rate at which you lose fat will be significantly greater when you're in a caloric deficit, losing 1-2 pounds per week, instead of taking a super slow approach to dieting.

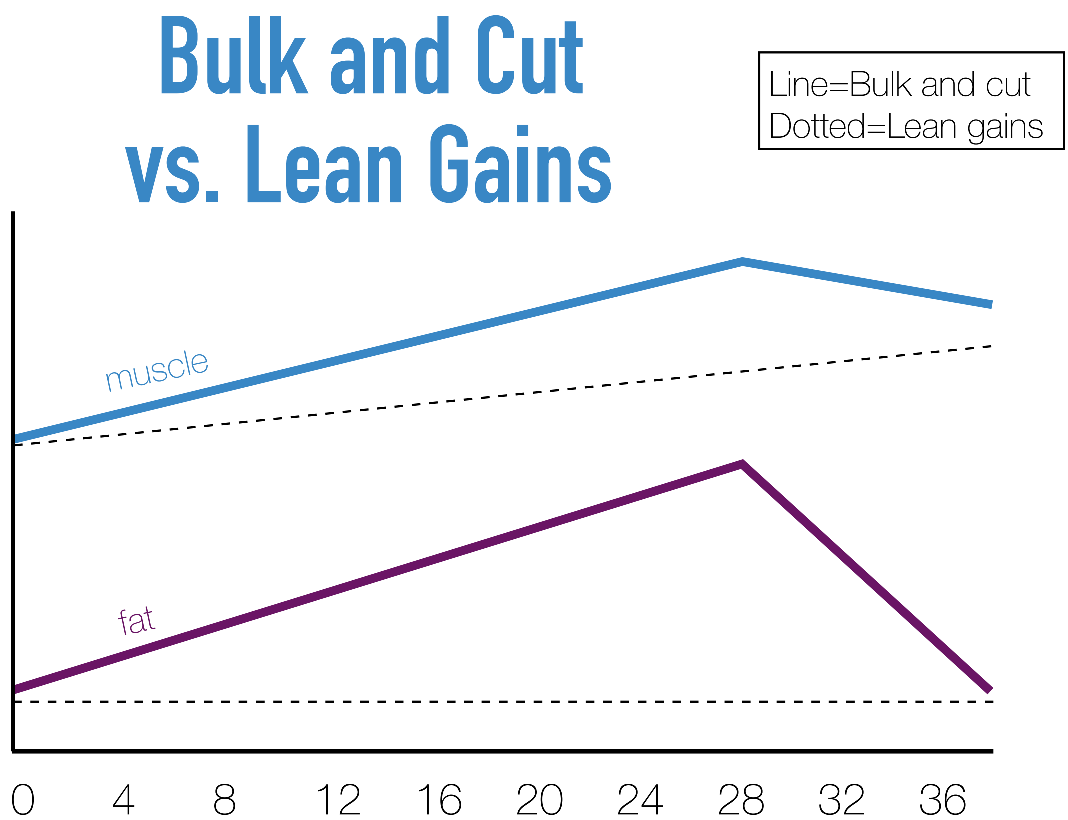


Figure 14.2

CHAPTER 15

Minimum Effective Dose vs. Maximum Tolerable Dose

This is the distinction between making progress, and reaching your full potential – the difference between the hobbyist and the pro.

Minimum effective dose is the minimum input necessary to attain a desired result.

Maximum tolerable dose is the maximum input a system can handle before negative consequences start to occur.

If you lift for general health, to attract the opposite sex, or to blow off stress while maintaining balance in your life, the minimum effective dose is a concept to live by.

If you lift to get huge enough to scare small children, lift small houses, and leave a trail of desolation in your wake, the maximal tolerable dose is what you build your life on.

Now, this is not to be confused with the maximum tolerable dose in a medical context – the drug dosage people can take before really serious side effects start showing up. The main difference is that maximum benefit for a drug usually occurs well before MTD, so increasing the dose up to MTD increases risks without increasing benefits. In the context of training, however, benefits still accrue up to the point of MTD (the right x-intercept of the curve describing stressful inputs, to refer back to an earlier model), as seen in **Figure 15.1**.

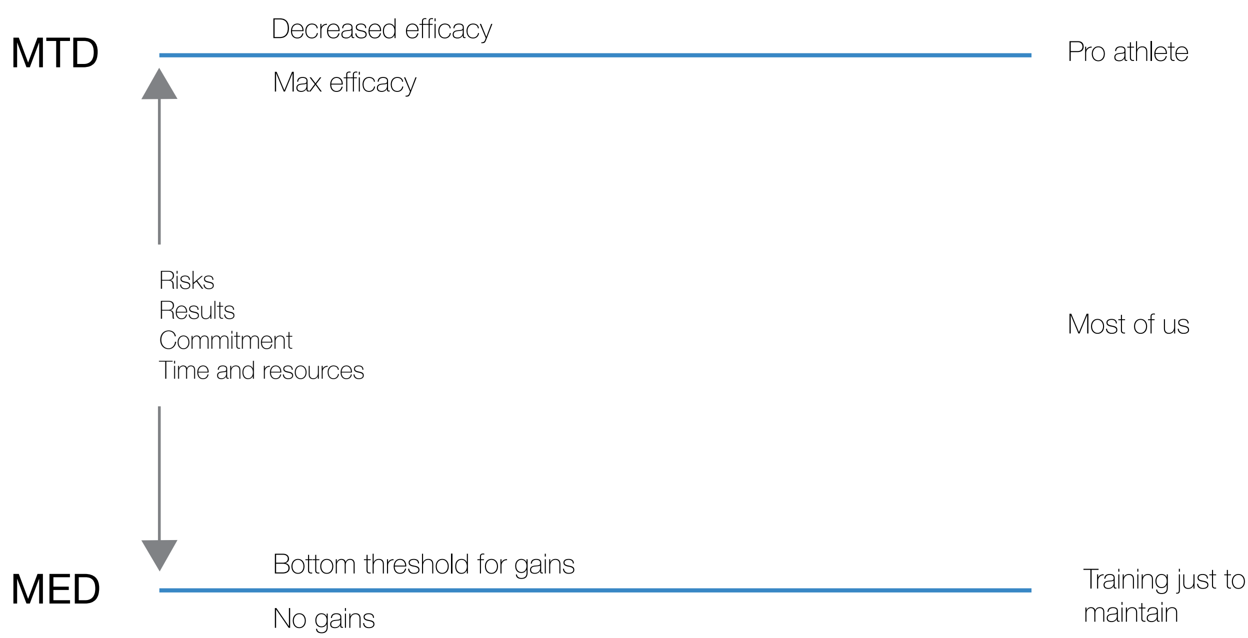


Figure 15.1

Minimum effective dose

With the MED, you ask yourself what direction you want to move in, find the least amount of work necessary to make progress toward that goal, and only increase it when necessary. Here is where these models come full circle. Referring back to our model for stressful inputs, you find a level of stress where the curve just peeks above the x-axis – enough to make progress, but a long way from overreaching (barely into the resistance phase in GAS, or enough stress to improve fitness without significantly impacting fatigue in the fitness-fatigue model). Probably only two hours in the gym per week, focusing on high ROI movements like squats, presses, deadlifts, and upper body pulling exercises (big compound lifts). For nonstressful inputs, you can probably get away with little attention to them – sleep 6-7 hours per night, and hit your diet goals at least 80% of the time (with no need to worry about the top two tiers of the pyramid – eating a healthy diet with sufficient calories and protein is all you need to care about).

Maximal tolerable dose

With the MTD, everything matters. Your training should leave you teetering on the edge of overreaching without tipping over the edge toward overtraining and injury, you should focus on never having to wake up to an alarm, focus on additional recovery practices like regular massages, hot/cold therapy, monitoring stress using something like HRV or Omegawave, and dial in every piece of your diet – all the way up to a regimented supplement protocol. If something is within your power to improve, and you fail to do so, you're not meeting the MTD. This level of diligence and detail isn't necessary for most of us, but if you want to reach your genetic limit or be the best in your sport, the entire premise of the companion volume is ludicrous – nothing is unimportant. Your sport is your life, and your life is your sport. This is the realm many professional athletes and Olympians live in.

Most people

Most of us are somewhere in between. We want to make progress faster than a snail's pace, but we don't want to devote our entire life to the process of making gains. Most of us aim for a compromise between achieving our goals and maintaining balance in our lives.

For all of these models, the applicability of any of these principles and where you fall on any of these continuums is relative to your goals. The loftier your goals and expectations, the more effort is required – there are no shortcuts. The more training is an adjuvant to the rest of your life, not a major focus of it, the less effort is required.

However, in closing, make no mistake about it – the most important factor that's in your control is how hard you work.

Do not take these models as mental masturbation and obsess about precisely quantifying everything you do inside and outside the gym if you aren't busting your ass to a degree commensurate with your goals.

These models help you understand your hard work, your recovery from it, how your body reacts to it, and how you can get the most out of it. But a beautiful, well-designed training program is worthless without the key element for its application – hustle.

Making progress is easy to a point – punch the clock, follow a basic routine, and reap the rewards: MED.

Reaching your full potential and destroying the competition is not – your life and soul are devoted to your goals: MTD.

Where you fall along that continuum is entirely up to you and the effort you're willing to exert.